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LIST OF ACRONYMS AND ABBREVIATIONS

2SLS	-	Two Stage Least Squares
ADF	-	Augmented Dickey-Fuller
AGOA	-	African Growth and Opportunity Act
AIH	-	Absolute Income Hypothesis
ARCH	-	Autoregressive Conditional Heteroscedasticity
ARMA	-	Autoregressive Moving Average
BOP	-	Balance of Payments
BOS	-	Bureau of Statistics
CBL	-	Central Bank of Lesotho
CBLMM	-	Central Bank of Lesotho Macroeconomic Model
CGE	-	Computable General Equilibrium
CMA	-	Common Monetary Area
CPI	-	Consumer Price Index
DF	-	Dickey-Fuller
ECM	-	Error Correction Model
EFO	-	Edgren, Faxen and Odhner
EU	-	European Union
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
GOL	-	Government of Lesotho
IFS	-	International Financial Statistics
ILS	-	Indirect Least Squares
IMF	-	International Monetary Fund
IO	-	Input-Output
IFS	-	International Financial Statistics
JB	-	Jaque-Bera
KIPPRA	-	Kenya Institute for Public Policy Research and Analysis
KK	-	Keynes-Klein
KTMM	-	KIPPRA-Treasury Macro Model

LCH	-	Life Cycle Hypothesis
LHWP	-	Lesotho Highlands Water Project
LM	-	Lagrange Multiplier
LR	-	Likelihood Ratio
LRA	-	Lesotho Revenue Authority
MAE	-	Mean Absolute Error
MAPE	-	Mean Absolute Percentage Error
MLAR	-	Minimum Local Asset Requirement
NEPRU	-	Namibian Economic Policy Research Unit
OECD	-	Organisation of Economic Co-operation and Development
OLS	-	Ordinary Least Squares
PIH	-	Permanent Income Hypothesis
PP	-	Phillips-Perron
PRGF	-	Poverty Reduction and Growth Facility
RESET	-	Regression Specification Error Test
RIH	-	Relative Income Hypothesis
RMA	-	Rand Monetary Area
RMSE	-	Root Mean Square Error
SA	-	South Africa
SACU	-	Southern African Customs Union
SARB	-	South African Reserve Bank
SMP	-	Staff Monitoring Programme
U	-	The Theil Inequality Coefficient
USA	-	United States of America
VAR	-	Vector Autoregression
VAT	-	Value Added Tax
VECM	-	Vector Error Correction Model
WB	-	World Bank

CHAPTER 1

BACKGROUND AND INTRODUCTION

1.1 INTRODUCTION

Macroeconometric modelling is a fairly mature field in the discipline of economics. It has over the years continued to fascinate modellers and policy makers alike because of its dynamic nature and usefulness. Its importance in policy-making decisions need not be emphasized any further. Macroeconometric models have over the years and continue to provide effective analytical frameworks for policy-making decisions.

The development of a sound and comprehensive macroeconometric model is of utmost importance if robust policy decisions are to be taken and followed. The entire exercise of profound macroeconomic management rests on the ability of the model to capture adequately and reasonably the key characteristic features of the economy under observation.

As with other developing economies, sound economic analysis of the economy of Lesotho is to a large extent hindered by problems of inadequate and poor quality data. Furthermore, structural instability caused by persistent policy regime changes pose a major challenge in economic modelling. The fact that a robust database is a prerequisite for a model to produce reasonable forecasting and policy analysis qualities does not however preclude attempts to develop econometric models in such situations. It is however necessary that the limitations imposed by these constraints should be borne in mind.

Against this background, the general objective of this study is to develop a fairly comprehensive and operational macroeconometric model for the economy of Lesotho, suitable for the simulation of the effects of fiscal, monetary and external policies. The model developed here takes advantage of the available data, improved analytical

techniques and relevant economic theory. Its merit lies not in its capacity to capture all the complexities of the economy but in its ability to produce reasonable and robust results within a consistent framework.

1.2 PROBLEM STATEMENT

The last two decades provide evidence of several policy regime shifts and not so much improvement in the performance of the economy of Lesotho. Much of this instability has been blamed on structural rigidities, Lesotho's peculiar geographical position, the narrow resource base and lack of credibility in economic policy. Among these, many have hailed appropriate and sound economic policy as a remedy to the ailments of the economy. The need for policy transformation and adjustment is often emphasised. This was also the premise on which the International Monetary Fund (IMF) and World Bank (WB) based their adjustment programmes in many developing countries, Lesotho included in the late 1980s.

The fact remains however, that in order to address issues of policy relevance to the problems that the economy is facing, there is a need for an appropriate framework that serves as a reference point and a reasonable representation of the economy under observation. It is also of utmost importance to have a firm grasp of the underlying interrelationships between policy instruments and targets in order to understand the relevant policy variables to address different objectives. It is also important to evaluate the extent to which policy variables are able to influence given targets. The understanding of transmission mechanisms through with the ultimate target variable are affected is also crucial for identifying and dealing with potential spillovers.

The exercise of modelling is much more important in developing countries like Lesotho for the reason that many of them are nothing like the text-book prototypes on which mainstream economic theory is based. For many of these economies, many relationships that are predicted by theory are either non-existent or do not work as predicted. In these

economies, individual empirical analyses serve as the best predictor of the behaviour of economic variables.

Econometric models provide a representation of the economy in a way that provides answers to policy makers and other interested parties. Although macroeconometric models have undergone criticism in the past, they have proved to still be appropriate tools for this purpose and have been used extensively for policy analysis and various other purposes. Since the introduction of the first macroeconometric model by Tinbergen (1936), macroeconometric modelling has undergone tremendous improvements in terms of theoretical developments and estimation and computing methods.

The six macroeconomic models of the Lesotho economy that are known have either not been revamped adequately to keep up with the economy's structural and other changes or are specific to the needs of a specific sector. These and other deficiencies in the existing models have provided a motivation for the construction, in this study, of a macroeconometric framework that is all-inclusive. Given the developments within the economy, and in the global economy, it is seen as important to develop a framework that will assist in providing a policy guideline by:

- Analysing the potential impact of alternative policy measures;
- Forecasting short-term behaviour of key macroeconomic variables; and
- Providing an informed basis for embarking on long-term planning.

It is perceived that a quantitative model provides both a theoretical and practical structure that can be used to achieve these goals as it features both theoretical structures while taking into account the key attributes of the economy.

1.3 OBJECTIVES OF THE STUDY

The general objective of this study is to develop and estimate a macroeconometric model for the economy of Lesotho that will provide not only short-term but also medium to long-term forecasts. The framework developed in this study is premised on economic

theory and attempts to incorporate the underlying structure of the economy and developments in estimation techniques. The model is then subjected to different policy shocks with the view of evaluating the impacts of alternative policy scenarios and making policy-relevant recommendations. Using the model to forecast one period ahead assesses the forecasting performance of the model.

The specific objectives of this study include:

- To construct a comprehensive and robust macroeconometric model for the economy of Lesotho that captures the basic elements of the economy, theoretical developments and data structure;
- To estimate a macroeconometric model for Lesotho;
- To run different policy simulation experiments with the view of analysing different policy options;
- To evaluate the robustness of the model; and
- To derive policy implications from the analysis.

1.4 METHODOLOGY AND ESTIMATION PROCEDURES

1.4.1 Methodology

The study develops a model that captures both the supply and the demand side of the economy. The model is designed within the framework of the small-open economy IS-LM-aggregate supply framework. It consists of four sectors, namely the real sector, the external sector, the monetary sector and the public sector. The real sector consists of the production sector and the employment sector which make up the supply side, and the aggregate demand and prices. As might be expected, many interrelationships exist between endogenous variables of the model. However, given the softness of the data and to minimize problems that may arise from this limitation, the model is designed to be as parsimonious as possible. The model is made to mimic an economy that is small and open, supply constrained, has a surplus of labour, and in which markets do not clear. There are 65 endogenous variables of which 22 are determined by stochastic behavioural equations and 43 are determined by identities. The model also has 36 predetermined and

exogenous variables. There are 39 dummy variables that are intended to capture structural and policy regime changes and other events that might have had significant impacts on the economy. Thus the model has 140 variables in total.

The equations in the model are estimated using annual time series data spanning the period 1980 to 2000. The primary source of data is the Central Bank of Lesotho database and Annual Reports. Other sources include the Bureau of Statistics (BOS), the IMF's International Financial Statistics (IFS) and South African Reserve Bank (SARB) Quarterly Bulletins.

1.4.2 Estimation techniques

The estimation technique used in this study is the Engle-Granger (1987) two-step procedure. The procedure involves testing for the order of integration of the individual data series to avoid the common problem of spurious regressions that incorrectly give the impression that relationships exist between two or more variables.[1] Both the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were used for this purpose. This is followed by testing for the presence of a long-run relationship between various sets of variables. This involves estimating the cointegration or long-run relationships by ordinary least squares (OLS) and subjecting the residuals derived from these relationships to unit root testing. The ADF test was used in this case, although the critical values in this case are the McKinnon (1991) response surface values. The second stage involves constructing the error correction model (ECM), on condition that an equilibrium or long-run relationship between a set of non-stationary variables exists. This implies that the stochastic trends of these variables are linked and that the variables cannot move independently of each other. The ECM is then intended to estimate the short-run or dynamic adjustment process to long-run equilibrium. This approach has several merits; i) in the event that the concerned variables are cointegrated, the ECM captures both the short-run and long-run effects. The short-run component of the model becomes non-zero during periods of disequilibrium and imparts information about the distance of the system

[1] See for example Granger and Newbold (1974).

from equilibrium; ii) assuming cointegration exists and that estimates of the concerned parameters exist, all terms within the ECM are stationary. This implies that standard OLS estimation techniques can be applied; iii) since the ECM is linked directly to the concept of cointegration, Granger's representation theorem for dynamic modelling effectively implies that the presence of cointegration renders the ECM immune from the problem of spurious regressions; and iv) because it is possible to specify the ECM in a multivariate form, it is also practically possible to allow for a set of cointegrating vectors. By far, a major advantage of this approach rests in its better forecasting abilities over other methods and its ability to limit specification errors to those that arise because of inclusion of irrelevant variables rather than the omission of relevant variables.

1.5 OUTLINE OF THE STUDY

This study is organised into nine chapters. Chapter one provides an introduction and background of the study. Chapter two provides an overview of the economy of Lesotho. The overview seeks to establish an understanding of the structure of the economy and grounds to adopting various modelling strategies in line with the objective of capturing the key salient features of the economy. Literature related to macroeconometric modelling is divided and presented in two distinct parts. Chapter three provides a review of the related theoretical literature. This takes the form of an inspection of the theoretical models for each of the sectors of the economy. This is done with the view of establishing the possible linkages that exist between the sectors and that make the economy a single interdependent system. The second part of literature reviewed is presented in chapter four and deals with the empirics and practicalities of macroeconometric modelling. This exercise is carried out by an inspection of some of the relevant empirical work. The literature review in its entirety makes preparation for the specification of the model in line with developments in theory and in estimation techniques. The model is specified and presented in chapter five and follows directly and draws heavily from the literature discussed in chapters three and four as well as consideration of the structure of the economy as discussed in chapter two. Chapter five also discusses in detail the estimation techniques adopted in this study. The actual estimation of the model is done in chapter

four. The estimation results are presented in three parts. First, the estimation results of the individual behavioural equations are presented and discussed in chapter six. The discussion in this chapter involves assessing the consistency of the individual equations with regard to economic and statistical theoretical criteria as well as evaluating their individual performance. Chapter seven presents the results of the consolidated model. This chapter presents the tracking performance of the model for the static and dynamic solution values of the endogenous variables for both *ex ante* and *ex post* scenarios. The chapter also makes an evaluation of the forecast accuracy of the model. Simulation experiments that are aimed at impact analysis of the model are made and presented in chapter seven. Here the sensitivity of the endogenous variables of the model, to changes in some exogenous and policy variables is assessed with the aim of evaluating the potency of various policy instruments and regimes. Chapter eight presents an evaluation of the model and policy simulation experiments and makes an assessment of the policy implications drawn from the analysis. Chapter nine presents a summary of the study and draws conclusions based on the analysis.

CHAPTER 2

AN OVERVIEW OF THE ECONOMY

2.1 INTRODUCTION

The basic aim of this chapter is to provide a background to the economy of Lesotho over the sample period with a view to highlight the major elements and state of the economy and the policy developments over that period. The background is presented in two parts. The first part presents and discusses the developments in the economy during the study period. The second part of the review highlights the monetary and fiscal policy environment during the period under review and slightly beyond. The analysis made here is based primarily on Annual Reports of the Central Bank of Lesotho (CBL), Reports of Government of Lesotho (GOL) and Ministries of Finance and Economic Planning and Statistical Bulletins of the Bureau of Statistics (BOS).

2.2 AN OVERVIEW OF THE ECONOMY OF LESOTHO

For the economy of Lesotho, the 1980s were in general characterised by low levels of economic growth and internal and external economic imbalances. The end of the 1980s marked a major structural and macroeconomic policy transition in the economy. The launching of the Lesotho Highlands Water Project (LHWP) in 1987/88 and the implementation of the structural adjustment programmes in 1988/89 brought significant changes in the structure of the economy. Specific targets of the adjustment policies included increasing domestic output, reducing the government budget and balance of payments deficits as well as achieving price and monetary stability.

While the structural rigidities and its peculiar geographical position are still considered a major impediment to economic growth and development, significant improvements, though erratic, were observed in the performance of the economy during the 1990s. From a depression in the 1980s, the economy began recovering almost immediately following the commencement of adjustment programs in 1988/89. Table 2.1 gives a summary of

selected macroeconomic indicators. The 1990s began with a modest growth rate of 6.4 per cent in 1990, reaching a peak of 10 per cent in 1996. Notable improvements were observed with the inflation rate falling from 16.5 per cent in 1981 to 6.1 per cent in 2000. Fiscal discipline and hence a budget surplus, is one of the major highlights of the 1990s. Because of the progressive improvements in the fiscal position, the debt burden remained at relatively low levels with a debt service ratio of less than 5 per cent in the mid-1990s.

Table 2.1 Selected Macroeconomic Indicators (Percentages)

	1981	1985	1988	1990	1992	1994	1996	1998	2000
GDP growth	0.7	4.9	10.6	6.4	4.6	3.4	10.0	-4.6	4.1
GNP growth	2.9	-2.5	7.8	4.8	6.8	1.1	4.4	-9.0	-3.2
CPI inflation	16.5	15.1	11.4	11.5	17.0	7.2	9.1	7.8	6.1
Gross savings ratio	15.8	22.8	20.9	23.5	29.0	24.9	17.4	11.2	16.9
Budget def/sup to GDP	-3.0	-2.6	-6.7	-1.8	1.8	4.6	4.5	-2.4	-5.6
Current acc to GDP	-2.4	-1.5	-8.4	-11.6	-22.9	-22.2	-36.3	-36.8	-26.5
Total debt to GNP	-	-	48.8	45.3	38.7	48.5	47.2	53.1	66.1
Debt service ratio	-	-	-	-	3.5	3.5	4.1	7.2	8.4

Source: Central Bank of Lesotho Annual Reports and Database

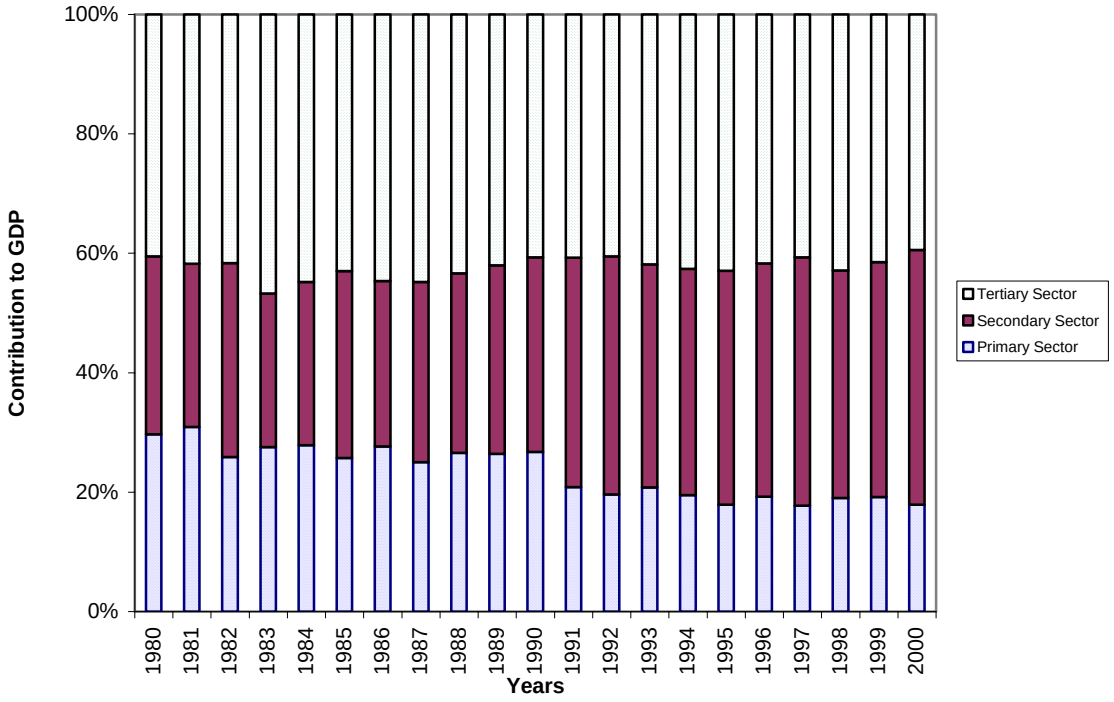
2.2.1 Supply sectors

Three major productive sectors, namely the primary (predominantly agriculture), the secondary (including manufacturing and construction) and tertiary sectors, make up the real sector of the economy. Higher growth rates of output during the 1990s were attributed to a large extent to the satisfactory performance of the construction sector led by the LHWP related activities, especially a surge in capital expenditures at that time, and the rapidly growing export-oriented manufacturing sector following intensified campaigns to attract investors. The contribution of the construction sub-sector towards the secondary sector was however offset by the near-stagnant growth in the manufacturing sector in 1994 owing to industrial actions that disrupted productivity within that sector.

Like many developing countries, the agricultural sector has traditionally played a pivotal role in the economy of Lesotho. The end of the 1980s was characterised by a marked fall in the growth of real GDP largely attributed to a decline in agricultural value added and a

slack growth rate of value added in the manufacturing sector. In the early 1990s favourable weather conditions resulted in higher crop and livestock production and hence an increase in value added of the agricultural sector. On the other hand, modest developments in the tertiary sector, which consists largely of services, have largely been linked with improved government service as well as the expansion of wholesale and retail trade and other services. Figure 2.1 portrays value added by different aggregate sectors during the review period.

Figure 2.1 Value added by major production sectors
(Million Maluti, 1995=100)

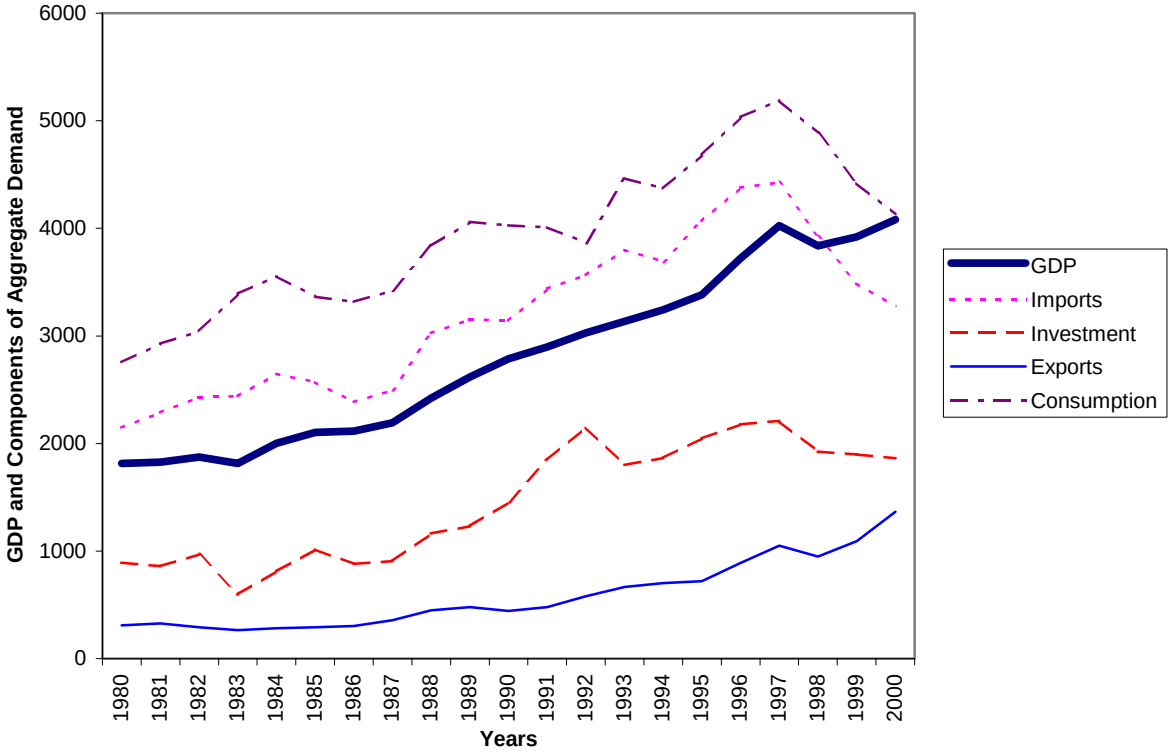


Since 1990 the primary sector has on average contributed about 20 per cent to GDP owing to the decline in agricultural output in the 1980s, while the secondary sector and the tertiary sector seem to have each accounted for approximately 40 per cent of total output.

2.2.2 Aggregate demand components

Viewed from a broader perspective, the national accounts reveal an interesting feature of the economy. A comparison of economic activities from the supply side and the demand side shows quite clearly that the economy is supply constrained and demand driven. Throughout the 1990s, consumption expenditure exceeds GDP (see figure 2.2) by an average of 75 per cent. This indicates dissaving and the fact that most of the domestic demand is satisfied from abroad. Imports of goods and services actually exceed GDP for most of the time and constitute about 60 per cent of total supply.

Figure 2.2 GDP and aggregate demand components
(Million Maluti, 1995=100)



Consumption expenditure dominates other components of aggregate demand. In 1990 it constituted 68.9 per cent of total demand and 138.4 per cent of domestic supply. It has increased steadily above GDP for the entire period. This means that more than a third of total resources have invariably been allocated to consumption annually. The second

largest component of aggregate demand is imports of goods and service making up for 54.7 per cent of total supply in 1990. The increase in the size of imports has been linked to the activities of the LHWP. According to the CBL (1996:10), imports related to the LHWP project increased on average by 32.4 per cent in the five-year period ending 1996. The financing of imports has been covered to a large extent by inflows of remittances and transfers.[2] This suggests that the stability of the economy is highly susceptible to external shocks. Since 1998 imports have fallen below GDP. This has been associated with the winding up of the activities of LHWP phase 1A.

Investment is the third largest component of demand. It accounted for 23.5 per cent and 24.9 percent of total demand in 1990 and 1999 respectively. An impressive growth in investment of 45.8 per cent was recorded in 1991. Again this has been attributed largely to increases in LHWP related capital expenditures. With the contraction of the LHWP construction activities in the mid-1990s, the growth of investment waned to 24.2 per cent in 1995. Lower growth rates of 16.8 per cent in 1999 and -8.4 per cent in investment in 2000 can, to a large extent, be related to the after-effects of the political unrest during the third quarter of 1998.

Exports, a large portion of which comes from textile manufacturing, make up the smallest portion of overall demand.[3] The large gap between exports and imports shows the extent of the deficit on the current account. From 7.5 per cent in 1990, the share of exports and non-factor services receipts in total resources rose to 12.6 per cent in 1999. This represents a surge in export earnings of manufactured goods which have increased overall during the 1990s owing to promotional efforts in the form of tax and financing incentives, low wages in the sector and preferential access to international export markets in European Union (EU), United States of America (USA) and Japan.[4] In contrast, the

[2] Net factor income from abroad has contributed up to 50 per cent to GNP in the past. In 2000, its share in GNP had dropped to 19.6 per cent because of the continuing retrenchments in the South African mining industry.

[3] Because of different adjustments made by the BOS and the CBL, export statistics are notorious for discrepancies.

[4] Lesotho has enjoyed preferential treatment for its exports in major international markets through the Lome convention, Southern African Customs Union (SACU) and other arrangements, and lately, African Growth Opportunity Act (AGOA).

export earnings of the agricultural sector, mainly from exports of wool and mohair declined substantially during this period. This has been a result of the decline in productivity in the agricultural sector due to unfavourable weather conditions. Because of the decline in the quantity and quality of agricultural products, they have failed to attract decent earnings in international markets. In contrast, the former benefited furthermore from the depreciation of the Rand against major currencies in recent years. The following table displays the distribution of domestic output and expenditures.

Table 2.2 Shares of expenditures in GDP and GNP (Percentages)

	1980	1985	1988	1990	1992	1994	1996	1998	2000
Final consumption to GNP	88.68	89.83	91.82	91.02	85.08	92.3	100.6	101.47	91.05
Final consumption to GDP	151.93	160.08	158.38	144.59	127.57	134.8	135.28	127.41	101.21
Shares to final cons.									
Private sector	87.17	88.02	88.99	89.37	88.05	87.8	88.1	84.69	82.41
Government	12.86	11.98	12.0	10.63	11.95	12.19	11.89	15.31	17.59
Gross investment to GNP	49.28	48.25	48.02	52.19	71.01	57.50	58.52	50.13	45.60
Gross investment to GDP	28.77	27.07	27.84	32.86	47.36	39.37	43.51	39.93	41.02
Shares to gross investment									
Private investment	13.61	18.92	24.59	40.57	49.62	51.87	53.32	57.13	57.11
Government investment	82.71	81.57	74.03	59.57	48.78	50.95	46.43	46.61	49.32
Total exports to GNP	9.99	7.81	10.72	10.03	12.78	14.81	17.76	19.69	30.11
Total exports to GDP	17.13	13.93	18.49	15.93	19.16	12.62	23.88	24.73	33.47
Total imports to GNP	69.08	68.6	72.4	70.96	78.53	78.0	87.5	81.45	72.22
Total imports to GDP	118.34	112.25	124.89	112.71	117.74	113.92	117.67	102.26	80.28
Factor income from abroad to GNP	37.88	44.32	42.18	39.76	34.15	31.26	25.96	21.96	19.62

Source: CBL Annual Reports and Database

2.2.3 Employment and wages

Though labour market statistics are quite scanty, a few pointers can be made on the basis of surveys conducted by the statistical office from time to time. Given an estimated population growth of 2.6 per cent per annum, labour force growth of 2.8 per cent and an annual average growth of per capita GDP of 1.6 per cent in the 1990s, it is not surprising that poverty alleviation has been one of the main focuses of government since the

beginning of the 1990s. Employment statistics show that the unskilled and low-skilled labour force grows at a higher rate than the capacity of the economy to create employment despite the recent growth in the export-manufacturing sector. Since 1990, employment growth rates have lagged behind the rate of growth of GDP causing the employment-GDP elasticity to fall below unity. Within the formal sector, government is the largest employer, taking up 60 per cent of the 7.8 per cent of the labour force that was employed in the formal sector in 1994. The manufacturing sector and the LHWP accounted for 31 per cent and 8.4 per cent, respectively. However, because of the restraints, the growth of government employment has fallen from 27.7 per cent in 1990 to 0.02 per cent and 0.2 per cent in 1993 and 2001 respectively. The following table shows employment by sector and employer in 1991 and 1999.

Table 2.3 Employment by sector and employer (Percentages)

By sector	1991	1999
Primary	53.1	58.4
Secondary	14.7	13.2
Of which:		
Manufacturing	29.9	44.5
Construction	65.9	50.8
Other	4.2	4.7
Tertiary	32.2	28.4
By employer		
Government and parastatals	-	13.1
Private	-	35.6
Subsistence farming	-	51.3

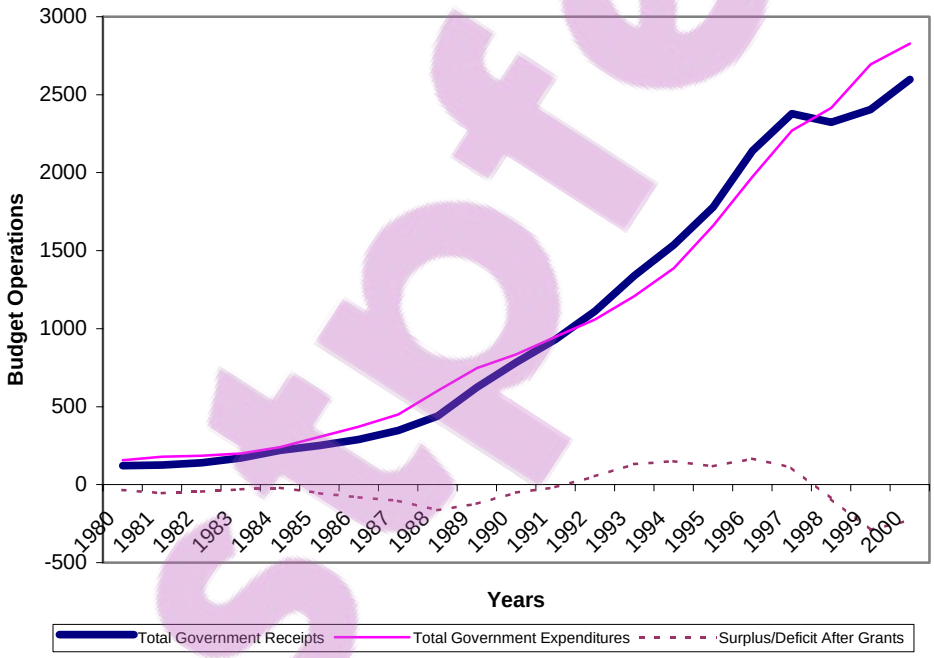
Source: BOS Labour Force Surveys and CBL Annual Reports

On the basis of these statistics, the primary sector is the largest employer in the economy followed by the tertiary sector and the secondary sector. Within the secondary sector, the construction sub-sector takes the lead. Although with scanty information, it can be inferred from the statistics that while the secondary and tertiary sectors are leaders in terms of output (see table 2.2), they lag behind the primary sector in terms of employment.

2.2.4 Fiscal developments

Evidently there has been a remarkable improvement in the government budget since the implementation of the stringent measures that accompany the structural adjustment policies. This reflected efforts of government to curb expenditure and improve administration and coverage of the tax system. Fiscal control has always been a major policy option for Lesotho notwithstanding the slight loss of sovereignty through the common tariff of the SACU arrangement. Since 1992, total receipts have been in excess of total expenditures although the margin narrowed from 1994. This improvement is reflected in the growth rate of expenditure relative to receipts as well as their relative shares in GDP. Figure 2.3 shows a summary of the position of government finances from 1980 to 2000.

Figure 2.3 Summary of government budgetary operations (Current Million Maluti)



Government receipts are composed mainly of customs revenue and different taxes. Of these, customs revenue is the largest source of revenue. Prior to 1990 it constituted more

than half of total government receipts. In the early 1990s, the increase in customs revenues was made possible mainly by the growth of imports related to the LHWP. Official statistics show that the share of customs revenue in total receipts was 43.5 per cent in 1990 while that of tax revenue was 24.1 per cent. Towards the mid-1990s customs revenue declined because of the slowdown of the growth of imports related to the LHWP. From a growth rate of 13 per cent in 1994, a lower rate of growth of customs revenue of 8 per cent was realised in 1995. Although the rate of growth of tax revenue fell between 1990 and 1993, there was a remarkable recovery in 1994, offsetting the fall in customs revenue. This followed a range of tax reform measures undertaken during the 1990s. It is notable that water royalties, though not much, emerged in 1996 towards the completion of the first phase of LHWP.

Recurrent expenditure feature predominantly in government expenditure. Their share has ranged from 55 per cent to 83 per cent during the 1990s. The early 1990s were characterised by a slowdown in the growth of recurrent expenditure due to the reduced wage bill following restructuring. However, government efforts to contain expenditure since the late 1980s seem to have been successful only up to 1996 after which resurgence was experienced. This is reflected by the experience of a budget deficit starting from 1998 and can be explained by increased expenditure during and after the political unrest experienced in 1998. It is noteworthy that the ratification of the European Union-South Africa (EU-SA) free trade agreement in recent years has been perceived as a threat to the customs revenue given that it renders imports from the EU tariff free. However, there are prospects for recovery beyond 2001 given the lower rate of growth of expenditures relative to receipts. It is noteworthy that while the government managed to contain the growth of expenditure to some extent, there has not been much change in its composition. Recurrent expenditure still account for the largest share of total expenditure.

2.2.5 The monetary sector

Because of developments in the fiscal sector, the government has assumed the position of net creditor throughout the 1990s and has since maintained a policy of financing its

overall budget from external borrowing on concessional terms. Significant government deposits with the domestic banking system eased government borrowing from the banking sector and have helped to shift domestic financial resources in favour of the private sector which was previously marginalised by a government policy of subsidising holdings of government debt by commercial banks. Treasury bills have since become the main instruments for monetary policy and government short-term financing.

Table 2.4 A summary of monetary aggregates and their statistical counterparts, 1980 - 2000 (Million Maluti)

	1980	1985	1990	1992	1994	1996	1998	2000
Net Foreign assets	93.2	216.6	360.9	768.6	1609.0	2230.8	3646.7	3585.3
Net Domestic credit	48.5	178.8	426.6	235.3	-256.5	-503.3	-944.3	228.6
Of which:								
Government	22.8	87.9	206.6	-140.8	-840.9	-1320.6	-2011.1	-733.6
Statutory bodies	9.2	11.3	26.2	28.9	30.9	141.3	225.5	79.2
Private sector	16.8	79.6	193.8	347.2	553.5	676.0	841.2	883.0
Of which:								
Mortgages (%)			-	-	14.0	1.6	9.4	11.5
Business enterprises (%)			75.5	78.3	67.4	63.9	44.4	38.4
Households (%)			24.5	21.7	18.6	34.5	46.2	50.2
Money supply (M2)	117.1	306.0	619.2	821.0	1132.2	1334.0	1768.8	1700.9
Other items	7.5	77.2	184.4	182.1	220.3	393.5	933.6	2112.9
Money supply (M2) growth	22.1	15.1	11.1	17.5	16.3	17.2	15.5	1.4

Source: CBL Annual Reports and Database

Although the growth of total domestic credit has been declining, the share of credit to the private sector has been increasing. It is also clear that the composition of total credit has changed significantly over the years. This is clearly indicated by the higher growth of credit to private sector relative to the growth of credit to the public sector. It is important to note that private investment has grown at a faster rate than public investment during the same period[5].

On the other hand, the growth of Maluti denominated money supply (M2) had been moderate in the 1980s until 1991. In 1992 the growth of broad money increased to 17.5

[5] See table 2.2.

per cent, after which it stabilised somewhat. This was a reflection of notable increases in net foreign assets, inclusive of funding related to LHWP. It is noteworthy that net foreign assets contribute the largest share to money supply. The stability of money supply growth can partly be attributed to the budgetary surpluses that the government has maintained over a large part of the 1990s (see figure 2.3). Because of this and the fall in domestic credit, there has been a slight dampening effect on the growth of money supply.

2.2.6 Price developments

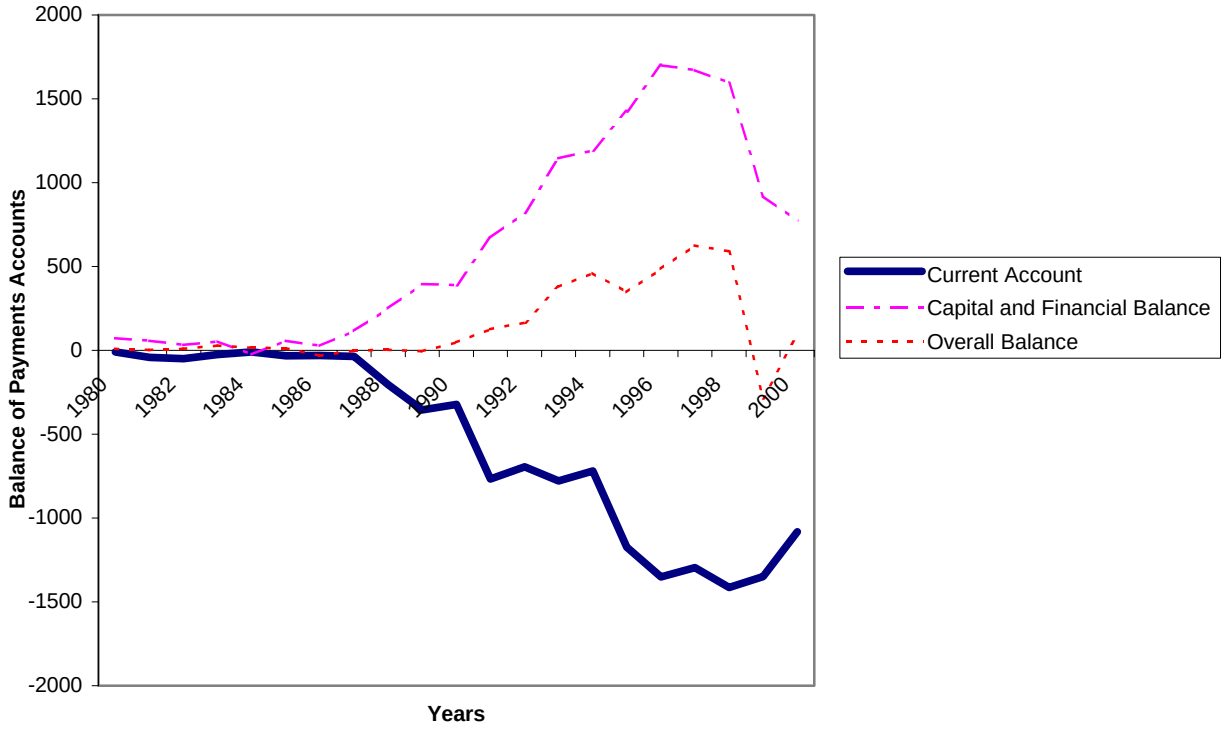
The 1980s were almost invariably characterised by a double-digit inflation rate. The inflation rate declined from 16.5 per cent in 1981 to 9.1 and 6.1 per cent in 1996 and 2000, respectively.[6] This improvement was explained by the decline of the annual growth rates of individual indices from which the CPI is compiled. According to the CBL (1996), approximately 75 per cent of a combination of goods and services from which the CPI is computed comprise imports from South Africa (SA). This implies that imported inflation and exchange rate movements in SA that pass through to domestic prices explain most of the changes in prices. This, however, does not rule out the influence of pressure from aggregate demand despite efforts to curb inflation through wage restraints and tight monetary policy. Though the authorities have not had much leverage with respect to monetary policy, it is notable that the general price developments also match the stable growth of money supply during the 1990s.

2.2.7 The balance of payments

The external position of the economy is summarised by the balance of payments. While the economy has enjoyed a positive capital balance, the current account has remained in deficit over the entire period since 1990. The margin between exports and imports shows the extent of current account deficit (see figure 2.2). The deficit in the current account has however been offset by the observed surplus in the capital account resulting in an overall surplus in the balance of payments for most of the period. The position of the balance of payments is summarised in figure 2.4.

[6] See table 2.1.

Figure 2.4 Summary of major accounts in the balance of payments (Current Million Maluti)



In all years, merchandise imports have the highest value as compared to other components of the current account. In 1991 this item exceeded the current account deficit by 293 per cent.[7] Of these, LHWP related merchandise imports alone accounted for only 35 per cent of the current account deficit (CBL 1994). This trend continued to the mid-1990s. Exports also grew substantially during the same period. Manufactured exports account for about 80 per cent of total exports. In 1992 exports grew by an impressive 67 per cent as compared to the growth of 12 per cent in 1991 (see table 2.5). The steady expansion of the export oriented manufacturing sector played a major role in this development. This was also accounted for by the sharp depreciation of the Rand and hence the Loti during that time. Imports remain significantly higher than exports in absolute terms notwithstanding their growth of only 14.3 per cent during the same period.

[7] This represents the share of merchandise imports in the current account balance.

Remittances and unrequited transfers play a major role in financing imports. In 1994 workers' remittances financed about 40 per cent of imports. Their role fell to 32 per cent in 1996 and 30 per cent in 2000 owing mainly to the continuing retrenchments in the South African mining industry. However, overall the shortfall in net exports continues to grow more rapidly than income. This fact is depicted in table 2.5. Because of this, the external position of the economy remains vulnerable, particularly in the light of the anticipated decline in the remittances and SACU revenues.

Table 2.5 Summary of balance of payments 1980-2000 (Current Million Maluti)

	1980	1985	1990	1992	1994	1996	1998	2000
Current account	-8.7	-32.3	-321.8	-695.0	-719.4	-1350.6	-1413.7	-1083.8
Goods, servs & income	-	-225.3	-635.9	-1162.6	-1368.6	-2154.8	-2255.9	-2019.9
Goods	-285.3	-672.1	-1574.5	-2253.6	-2491.2	-3490.9	-3589.6	-3582.2
Of which:								
Exports	46.6	50.0	166.9	310.9	509.3	812.1	1109.6	1468.4
Imports	-331.9	-722.1	-1741.4	-2564.5	-3000.5	-4303.0	-4699.	-5050.5
Net services balance	-	-39.9	-39.9	-54.2	-31.9	-86.9	-58.1	-1.2
Income	205	486.7	978.5	1145.2	1154.5	1422.9	1391.8	1563.6
Of which:								
Labour income	205	471.4	1000.5	1226.1	1206.1	1390.2	1409.6	1553.8
Transfers	63	163.8	314.1	467.6	649.2	804.2	842.2	936.1
Of which:								
SACU receipts	35.2	96.2	195.1	328.5	532.7	682.6	709.8	803.2
Capital & fin. acc.	71.9	57.7	389.9	820.9	1192.3	1699.9	1595.8	773.6
Of which:								
Capital account	20.4	15.7	110.6	173.2	142.9	194.2	122.6	150.7
Financial account	51.5	42.0	279.3	647.7	1049.4	1505.7	1473.2	622.9
Overall balance	10.2	13.8	47.3	165.9	461.6	487.4	589.1	92.0

Source: CBL Annual Reports and Database

Private foreign investment dominates the long-term capital transactions and has grown rather steadily over time. This follows a range of incentives such as income tax holidays for a given period, export financing schemes and establishment of more efficient investor advisory services to attract foreign investment. On the other hand, LHWP related financing dominates the financial account of the balance of payments. A combination of these major accounts has produced and maintained a surplus in the capital account over

the 1990s. However, overall the balance of payments remains in deficit because of a huge shortfall on the current account.

2.3 SUMMARY OF MACROECONOMIC DEVELOPMENTS

The end of the 1980s and the beginning of the 1990s were characterised by major changes in both the structure of the economy and macroeconomic policy. Firstly, the inception of the LHWP in 1987/88 represented significant changes in the structure of the economy directly through elevated investment and capital inflows as well as imports. These have had great implications for the real sector of the economy as well as the balance of payments. Secondly, the adjustment programs in 1988/89 marked major policy changes for the economy. The ultimate outcomes of these have been observed and felt to a large extent in the public sector. Thirdly the decline in labour income, which has historically played a pivotal role in national income, was a major milestone during the review period.

Having gone through a recession in the 1980s, an analysis of the performance of the economy in the 1990s reveals mixed outcomes. On the fiscal front, a combination of fiscal restraints, tax reforms and increased imports and hence SACU receipts, seem to have jointly benefited the fiscal stance directly. Through stringent revenue raising and expenditure cutting policies, government has managed to secure a surplus position in its budget for a series of years. Increased LHWP capital expenditures and the improved fiscal discipline have tended to propel investment expenditures, while the fall in labour income has led to a decline in aggregate consumption expenditures. From the supply side, the former changes have jointly increased domestic output through the increased value added of the manufacturing and construction sub-sectors in particular. A view from the demand side reveals a rise in investment expenditures and a fall in consumption expenditures, though consumption remains significantly higher than investment in absolute terms.

Developments in the balance of payments seem to have been driven predominantly by LHWP related activities rather than the policy changes and changes in labour income combined. The current account deficit has been worsened by increased total imports of which the LHWP imports take a large part, as well as the decline in labour income, which has traditionally played a major role in financing imports. It is notable, however, that the decline in labour income has been partly offset by the rise in LHWP related SACU receipts and transfers. On the other hand, the capital and financial accounts have benefited from increased foreign investment, due to government policy especially with respect to the manufacturing sector and LHWP activities. Overall, the balance of payments remains in deficit. The monetary sector is linked to the system by the growth of net foreign assets in the balance of payments of which transfers and grants are a part. A large part of grants are related to the funding of LHWP. Though the growth of money supply has remained stable, it feeds directly into prices.

Uncertainties in both the external and domestic economic environment threaten both the implementation and effectiveness of policies. Because of the degree of openness of the economy, any major changes in South Africa tend to have repercussions for Lesotho. There is evidence of instability in the external position of the economy resulting mainly from faster growth of merchandise imports and those that are related to the LHWP, as compared to exports. Although the growth of imports and hence the worsening of the external position as well as the growth of private investment may be related to LHWP activities, which may be considered a temporary shock to the system, it is also evident that the economy is susceptible to external shocks. It is anticipated that this trend will continue, given the large volume of imports of the continuing LHWP and the fall in the mineworkers' remittances, which finance a large percentage of the current account deficit. At present the erosion of remittances and SACU receipts pose a major challenge to the maintenance of a stable macroeconomic environment.

2.4 THE CONDUCT OF MACROECONOMIC POLICY

Lesotho has ample, but not complete flexibility in the conduct of fiscal policy as compared with monetary and other policies. The inflexibility and lower potency of

economic policy can be attributed, to a large degree, to existing institutional arrangements. In particular, its membership of the Common Monetary Area (CMA) and SACU effectively imply that it cannot have independent monetary and fiscal policies, the principal tools of economic management.

2.4.1 Monetary policy

The primary objective of pursuing monetary policy in Lesotho is to achieve and maintain price stability (CBL 2000). Lesotho is a member of the CMA, which replaced the Rand Monetary Area (RMA) of 1974 in 1986. It is noteworthy that the potency of monetary policy is to a large extent restricted by this arrangement. Since the Loti is pegged to the Rand, which also circulates in the economy, Lesotho has limited control over money supply, and none over the exchange rate.[8] To the extent that the Loti is fully backed by the Rand, the CBL can issue Maluti only if it has sufficient backing Rand deposits.

2.4.1.1 Monetary policy developments in the 1980s

Monetary and general economic policy developments in Lesotho are closely linked to those in SA. According to CBL (2001:5), the objective of price stability is achieved if the inflation rate does not deviate significantly from that of SA. The CMA provides for free mobility of financial resources among member countries.

The tradition has been to keep interest rates in Lesotho very close to those prevailing in the CMA region and in particular in South Africa where investment opportunities are usually more attractive than elsewhere in the region. The rationale for this has been to avoid large differentials in interest rates between members that would trigger undesirable and destabilising capital flows. The CBL has relied more on the use of direct controls as

[8] One of the problems that the agreement poses is the estimation of the total money supply with precision. In recent years, the problem has been aggravated by the fact that both individual residents and business enterprises perform the bulk of their banking activities in SA (GOL 1996). Furthermore the banking structure, which can be classified as ologopolisitic in nature, the inherent problem of excess liquidity in the economy, and the common problem of a relatively underdeveloped money market, restrict the extent of administration and or potency of monetary policy.

instruments of monetary policy. These included rather flexible bank to bank credit ceilings, minimum deposit rates, the setting of a ceiling for the prime lending rate, restrictions on foreign asset holdings by banks, reserve requirements and a liquidity asset ratio differentiated by maturity of liability which banks have to observe.

A policy of administrative determination of some principal interest rates has been pursued in the economy.[9] Although interest rates in general move together with SA rates, there is some time lag in setting the rates. In general, the borrowing and lending rates in Lesotho are slightly lower than in South Africa because of the deliberate policy of the central bank to keep lending rates lower to stimulate demand for bank credit.[10] The monetary authorities have however continued to manoeuvre within this framework as fully as possible in order to adjust monetary trends to the specific needs of the economy. In the face of low economic activity in the mid-80s the central bank kept interest rates for bank lending down and encouraged the banking system to lend a higher proportion of its funds locally. The main policy instruments used were moral suasion and the variation of interest rates that the Central bank pays on the commercial banks' deposits with itself (CBL 1983:8).[11]

In an attempt to encourage lending to local investors, the government instituted capital controls in the form of the minimum local asset requirement (MLAR) in 1981. By this requirement, commercial banks are required to hold domestic assets equal to at least 85 per cent of their liabilities to the public plus their required paid-up capital and reserves.[12]

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[9] These include the prime lending rate, the minimum deposit rate, the Treasury bill rate and the rates on bank's deposits with the CBL.

[10] For example, the rate paid by the Central bank on commercial banks' surplus funds follows the call rate on large deposits in South Africa to avoid penalizing the commercial banks for complying with the legal minimum asset requirement (CBL 1985:9).

[11] Negative real rates of interest were a result of this policy and implied severe erosion in the real value of savings. A trend of declining rates continued into the early 1990s. This was followed by a rise in the mid to late 1990s induced by a similar trend in the discount rate of the South African Reserve Bank (SARB). Corresponding to the rise in interest rates, the rate of inflation also declined to less than 8 per cent during the same period resulting in low real deposit rates. In 2000, inflation in Lesotho and neighbouring countries remained under control despite pressure from rising international rates and the depreciation of the Rand mainly owing to the policy efforts of the larger neighbour in curbing inflation. For this reason, interest rates remained relatively stable.

[12] This policy has not attained much success since it was put in place. It is argued that its effectiveness was hindered by the problems of both supply and demand. Regarding the supply side, the argument is that the

The CBL also maintained a high variance between the lending rates and the deposit rates in the economy during the 1980s. This policy is also blamed for the high cost of banking in the economy. According to the estimates of the GOL (1996), the spread of the lending rate from the deposit rate in the period 1990 to 1995 averaged 7 to 8 per cent as compared to 4 per cent in SA.

2.4.1.2 The policy environment during the reform period - 1990s

A realization that direct controls tend to be ineffective and distortionary and encourage inefficient use of financial resources, among others, led to the adoption of reforms in the financial sector. Since the implementation of the structural adjustment program in 1988/89, a number of reforms have been undertaken in the financial system. At the inception of the program, the broad objective of government towards the financial sector was to enhance financial intermediation by way of broadening the range of money market instruments available for policy consideration.

Mobilization of savings into equity holding was envisaged as a starting point towards establishing a capital market. Although at a very young stage, Lesotho Investment Holdings was established to encourage savings to be channelled into holdings of equity. Moreover, the sale of treasury bills and government bonds was initiated as a way of developing a securities market. In an attempt to encourage competition and participation of the non-bank private sector and individual savers in the market, the CBL issued securities in smaller denominations since 1992. The frequency of auctions has also been increased from quarterly to monthly since 1993. Later, the CBL began to issue its own securities owing to the lack of supply of treasury bills, as government debt repayments became rapid. This would pave way for market determination of interest rates and add to

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rate on the CBL deposits are too high and therefore provide a disincentive to lending to the private sector. On the other hand, the demand is constrained by the ill-defined property rights on real estate and land, which constitute major holdings of wealth by residents and could provide collateral. Identification of convincing and feasible projects by the private sector poses a further problem due to lack of relevant expertise.

the range of monetary instruments. This policy has indeed increased participation in the market substantially, although it is believed to have crowded out private savings to some extent.

To promote further financial integration and competition and to facilitate this development, it seemed conducive for the Central Bank to maintain conditions for entry of new participants in the market while adhering to prudential regulations and minimum capital requirements. This called for the review of the legal and regulatory frameworks that govern the operations of financial institutions as contained in the Financial Institutions Act of 1973. It is anticipated that provision shall be made in the revision of the regulations for the future administration of reserve and liquidity ratios. The gradual reduction of the MLAR would facilitate and enhance flexibility of the market. In view of this, in 1998 the MLAR was reduced from 85 per cent to 60 per cent. This implies that commercial banks were now allowed to keep up to 40 per cent of their assets abroad. The envisaged changes were to assist in encouraging lending to the private sector by commercial banks.

2.4.1.3 New and proposed monetary strategies - beyond 2001

Although some major steps have been taken to move away from direct policy instruments, the CBL perceives that the existence of a variety of indirect instruments is essential to exercise greater flexibility in monetary policy. It is with the view of a more efficient allocation of financial resources that this strategy is envisaged. In view of this, new instruments to control inflation and maintain a favorable balance of payments position are being considered for implementation. At the core of these are the open market-type operations (CBL 2001:2). These are already operative through the competitive auctions of treasury bills. The repurchase order system (repo system) in which all transactions will be fixed for a maximum period of six weeks and the cash reserve requirements without interest is earmarked to complement the former. It is perceived that the latter calls for an active interbank and money markets to facilitate the exploitation of the indirect instruments. Therefore, complementary policies proposed for

the promotion of effective financial intermediation and removal of distortions include, non-payments of interest on commercial banks' surplus funds, abolition of the MLAR and introduction of an overnight lending facility for commercial banks in the form of a Lombard facility[13].

2.4.2 Fiscal policy

The medium to long term aim of fiscal policy, as an economic management tool is to maintain fiscal stability and to stimulate sustainable economic growth (GOL 1997). Though the government's flexibility with fiscal policy is somewhat limited, it remains the most important option for the economy of Lesotho as it has a relatively high degree of flexibility in its use. With membership to SACU, Lesotho cannot exercise independent policy decisions with regard to trade-related fiscal policy.

2.4.2.1 Fiscal policy developments in the 1980s

In the late 1970s to early 1980s the government undertook fiscal reforms that entailed curtailing capital expenditure and strengthening its financial position in the light of rising deficits and the much less predictable foreign aid. The deterioration of the government's budgetary position had stemmed from rapid increases in capital expenditures in the 1977/78 fiscal year and increased recurrent expenditures as a result of the rise in the wage bill in the 1978/79 fiscal year (WB 1983).[14] This situation continued into the 1980s. By 1980/81 the government's revenues could not cover even the recurrent expenditures.[15] In 1981/82, the granting of a tax relief by government with the belief that the tax burden was too high by international standards worsened the situation. The introduction of a five

[13] The Lombard facility is the overnight lending facility by commercial banks from the central bank. At the inception of this facility, the Lombard rate was set at a 2.5 per cent margin above the Treasury bill rate. The facility is intended for commercial banks to meet their clearing requirements and the rate is viewed as a penality to encourage banks to seek funds elsewhere before approaching the Central Bank (CBL 2001).

[14] This increase was caused by political developments that culminated in the necessity for government to invest in infrastructure.

[15] During this time, the gap in the government budget was financed, to a large extent, by grants and external loans. During 1980/81 government revenues remained virtually stagnant. Customs revenue did not increase and even though income tax revenues rose, they were offset by a fall in non-tax revenues. On the other hand, a 50 per cent rise in wages and salaries in the public sector caused a sharp surge in recurrent expenditures.

per cent retail sales tax in December 1982 helped to alleviate the situation. This tax became the major source of revenue at that time. The establishment of an internal audit mechanism that monitored the day-to-day operations of the ministries was also effective. At the same time, the government reduced capital expenditures by about 18 per cent and froze public sector employment to keep the wage bill in check. The budget deficits continued to be a major problem for government despite a 43 per cent increase in customs revenue brought about by the revision of the revenue sharing formula in 1983/84 (WB 1983).

Since 1985 the government undertook substantial non-concessional borrowing to accommodate the decline in remittance revenue that resulted from increasing retrenchments in the SA mining industry. At this time, the government monetised part of the deficits indirectly through borrowing from the domestic banking system and other financial institutions as well as the Central Bank.

It is against this background of fiscal imbalances and the unstable fiscal stance that dominated the major part of the 1980s that government adopted the IMF and World Bank's structural adjustment programmes in 1988/89. The basic aim of the programmes was to improve the macroeconomic situation and to establish a framework that would encourage and receive the development of a sound private sector. Specific targets for the adjustment policies included increasing domestic output, reducing the government budget and balance of payments deficits as well as achieving price and monetary stability. Expenditure restrictions and revenue raising measures dominated the operations of government at this time. Improved administration and a wider coverage of income and sales tax ensured increased customs and other revenues. This was of great assistance in easing the pressure on borrowing from the banking sector and non-bank financial institutions.

2.4.2.2 The policy environment in the 1990s

The implementation of the structural adjustment programmes in the late 1980s introduced a shift in the government policy regime that was carried through into the 1990s. Following their adoption a budget surplus was realised in the early 1990s. Moreover, the government assumed the position of a net creditor the financial system while domestic debt declined steadily. In 1994 the privatisation and parastatal reform programme was officially launched with the aim of further easing the financial burden on the budget, improving efficiency in production, encouraging and improving domestic investment by local residents and attracting foreign investment into the economy.

Against a background of fiscal and balance of payments deficits in the late 1990s, the government implemented the IMF Staff Monitored Programme (SMP) in 1999 and the Poverty Reduction and Growth Facility (PRGF) with the IMF at the end of 2000. The focus of these was to ensure prudent management of government finances (CBL 2001). Specific objectives of the programme were to lay the basis for strong economic growth, curb the decline the foreign assets and restrict the budget deficit to two per cent of GDP (CBL 2000). Within the confines of the PRGF, the government's budgetary position was to be safeguarded by setting a ceiling on the net domestic financing requirement of the government. Two strategies have dominated the improvements in tax administration and compliance under the PRGF so far. These are the establishment of the Lesotho Revenue Authority (LRA) and the introduction of value-added tax (VAT). Under the LRA, notable improvements have been made in the sales and income tax departments. Moreover, significant improvements have been made in border surveillance with the aim of strengthening the valuation of imports for tax purposes. Expenditure control and rationalization focused on the elimination of off-budget spending to allow for a prudent and efficient budget making process.

2.5 CONCLUSION

This chapter has outlined the developments in the economy of Lesotho for each of the major sectors for the sample period, 1980 to 2000. One of the major conclusions from this review is that while economic growth has been impressive for most of the review period, this position is hardly sustainable as it is attributable, in most cases, to transitory structural changes such as the LHWP-related activities. This position is also made fragile by the low prospects of growth in the agricultural sector, on which most of the population depends, but which faces major challenges. It is evident that while the government, through policy, has contained problems of budget deficits and inflation, problems of unemployment and external imbalances are still at large.

This review has highlighted the intricate features of the economy ranging from its structural framework to the historical and current policy stance. This is useful in the modelling process as it gives an indication of the relationship between certain groups of variables and policy variables and targets in the economy. It is in turn used as a guide in the formulation of the different interrelationships in the specification of the model.

CHAPTER 3

THEORETICAL BASE FOR MACROECONOMETRIC MODELLING

3.1 INTRODUCTION

This chapter reviews the literature related to macroeconometric modelling in preparation for the presentation of the empirical model for the economy of Lesotho. The review seeks to explore the origins, developments and salient features of macroeconometric modelling from a theoretical point of view. The approach adopted in this exercise is that of dwelling on the role of the individual sectors in a macroeconomic setting and their interlinkages with other sectors.

3.2 BACKGROUND TO MACROECONOMETRIC MODELLING

The primary concern of macroeconomic modelling has been to provide a framework that is a representation of the real economy. Its development has undergone phases that have made it more practical and usable for policy analysis. Early works on macroeconometric modelling laid robust foundations for the development of modelling although they were heavily criticised for presenting a static representation of the economy and for being abstract.[16] Later works represented a major breakthrough in terms of theoretical foundations and improved estimation techniques.[17]

Major developments in the construction of macroeconometric models can be traced from the work of Tinbergen (1936) and that of the Cowles Commission under Klein (1950).[18] In the following periods, macroeconomic modelling became the leading basis for the formulation of macroeconomic policy and forecasting. However, with time and as models failed to deliver desired explanations to policy makers, their popularity waned. This was

[16] See for example, Walras, Pareto, Frisch (1933) and Kalecki (1935).
[17] For instance, the Klein-Goldberger (1969) model and the Tinbergen (1936) model.
[18] See Wallis (1994) and Allen and Hall (1997).

followed by scepticism on the part of policy makers and heavy criticism by authorities and academics alike.

The most influential criticisms were those that were based on identification restrictions. Because of its requirement of a complex system of simultaneous equations, the identification process would depend to a large extent on the presence of dynamics in the model. Moreover, the interaction of policy regimes and the importance of the role of expectations rendered the process of identification a difficult one.

These criticisms and subsequent debates not only fuelled interest in the development of other modelling techniques, notably, VAR and CGE modelling techniques, but also led to intensive research in developing techniques that overcame the weaknesses inherent in macroeconometric modelling. With the initial works of Davidson and Hall (1991) and others, came more powerful modelling strategies. In particular, the techniques provided ways to estimate and test the structural relationships and over-identifying restrictions. Because of these and other developments, macroeconometric modelling has since regained its status in the policymaking sphere and is still used today to tackle policy-making in challenging situations.

3.3 PRINCIPLES OF STRUCTURAL MODELLING

A considerable amount of work has gone into developing macroeconometric models. The IS-LM framework can be recalled as one of the major reference frameworks and has served as a benchmark for constructing macroeconomic models for a long time. It gained much popularity prior to the 1970s partly because of its simplistic principle of determining only two variables. However, persistent inflation in the 1970s introduced scepticism with regard to its applicability because of its inability to determine an equilibrium price level. Following this, the AS-AD framework became dominant as an analytical framework. In this framework, income and price level are determined endogenously. These frameworks are summarised as the Keynes-Klein (KK) type of

models. These models used to occupy a dominant position in macroeconometric modelling as they were used extensively to model developed and under-developed market economies alike (Challen and Hagger 1983).

One of the frameworks that enjoyed considerable success is the Mundell-Flemming framework, developed in the 1960s and used extensively afterwards. This framework however had a fatal flaw of not taking into account the aggregate supply or exchange rate influence on domestic prices. Two-sector open economy models based on the tradable and non-tradable sectors were then custom designed to bridge this gap. In these models the purchasing power parity was restricted to tradable markets while prices of non-tradables were influenced to a large extent by domestic factors. In line with the assumption of a small open economy, the price taker assumption was applied to both goods and asset markets.

In the complex economic environments of recent times, a common problem in modelling is the choice of a suitable theoretical framework, the extent of institutional and structural detail and the use of the model. In principle, it is the varying perceptions of the economic system that are formulated into theories of economic behaviour that constitute the different analytical frameworks for economic analysis. These theoretical frameworks in turn determine the specifications of the equations in the system and implicitly the ultimate use of the model. Lee (1997) outlines three aspects that are usually considered in developing a model. These are: (i) the relevance of the model to the key attributes of the economy on which policy should be directed; (ii) the coherence of the model to the analytical framework of how the economy operates; and (iii) the model's ability to represent historical data sufficiently.

Although macroeconometric modelling can be outlined in steps as done by, among others, Hall and O'Sullivan (1997), Greenslade and Hall (1996) and Jacobs and Sterken (1995), there is still a lack of consensus on analytical macroeconomic models for developing countries, particularly at the empirical level.[19] One of the contentious subjects

[19] See Haque *et al*. (1990).

in macroeconometric modelling is the level of disaggregation in the model. The process of disaggregation of variables is said to refine the model and linkages between the variables with the aim of avoiding the 'black box' phenomenon. However, it is also argued that even though a model that is highly disaggregated can be interesting in terms of its capabilities, there is a possibility that it might contain details that obscure the main features of the model and therefore reduce its relevance to the problem that it is supposed to address.

Varying assumptions about the degree of substitutability between foreign and domestic assets and goods is yet another issue of contention in developing models. These assumptions include issues such as the degree of capital mobility and purchasing power parity. For instance, the issue of the substitutability of assets in the fixed and flexible exchange rate regimes and the way in which foreign bonds are viewed by domestic residents are at the centre of the contention.

The use of two- or more-sector models has also been discussed and researched at length in the sphere of macroeconometric modelling. A major argument for these kinds of models is that there are large relative price movements between tradables and non-tradables as well as a way of explaining purchasing power parity (Prachowny 1984:3). However, in some cases this segregation has been seen as impractical for several reasons. Single sector models are preferred in such cases.

3.4 MACROECONOMETRIC MODELLING IN THE CONTEXT OF DEVELOPING ECONOMIES

Within a broad category of developing countries, African countries collectively have particularly unique economic structural features. A general observation is that the effects of policy and structural changes are rarely reflected in most models used by policy makers in African countries (Soludo 1995:2).

Among their common characteristics when considering macroeconometric modelling, is the problem related to the inadequacy of time series data in terms of both quantity and

quality. Other problems related with data include discontinuities, changes in definitions and missing observations (Jacobs and Sterken 1995:112). It is important to incorporate these aspects explicitly in constructing models for such economies. According to Hall and Pauly (2001:2), econometric modelling can still be useful despite structural change if it takes into account the form of change that has taken place.

On the practical front, the development of economy-wide macroeconometric models for purposes of dynamic policy analysis is still at a very rudimentary phase for many developing countries. Even though a number of models have been developed for a large number of African developing countries, they are usually constructed for academic purposes and are hardly maintained for purposes of policy analysis. Emphasis is often put on the economic and structural history of the economic system, rather than on the analytical transparency of model design and results. Because of this, many models apply to short-run policy issues and ignore the long-run sustainability of economic behaviour. These designs are usually justified on the basis of structural rigidities and institutional features such as the dual economic systems, the underdeveloped financial systems and excessive government intervention. This often leads to lack of consistency in policy formulation and introduces some scepticism in the relevance of conventional analytical frameworks in explaining economic behaviour (Soludo 1995:2).

Another important issue in modelling developing countries, in general, concerns the correct stance of theory and structural properties of the economy in policy analysis. In some cases more emphasis is placed on economic theory while in others the structural features of the economy dominate the design of the model. Some analysts argue that economic theory is economy specific and that structural and institutional features should be taken as exogenous. Such models tend to be robust, given that the policy environment and structures are stable. A plausible alternative is to assume that economic theory is given. Under these circumstances, it is easy to attribute failure of theory to work to distortions in the institutional and structural framework. A halfway approach that seems practical, while it accommodates as much information as possible, is to entertain both aspects in order to preserve analytical intuition.

The treatment of expectations still poses a major hurdle in modelling developing economies. It seems difficult to justify the use of any type of expectations. The argument is that both adaptive and forward-looking expectations are extreme characterisations (Soludo 1995:15). In recent attempts, learning models of expectations take precedence, though with some criticism.

Hall and Pauly (2001) provide a framework for modelling individual African economies. Two key factors are highlighted. Firstly, that the framework should assume that in the long run the economy would conform to the predictions of economic theory. This effectively gives way to calibrating long-run parameters in line with economic theory as a point of departure. Secondly, it is important to bear in mind that structural changes may render some coefficients unstable and lead to measurement problems. In many cases the Kalman filter is used to deal with these two problems while it also introduces the learning type of expectations in the system.

The use of some variant of the ECM is appropriate to represent the basic structure of the model. Because of the limited span of data and measurement problems, it recommended that the model should be kept small and simple while it incorporates as much prior information and economic theory as possible. In order to preserve the degrees of freedom it is also important to limit the amount of lags that are used in the model. Since structural change affect the parameters in the model, the use of time-varying parameter estimation techniques is appropriate to capture these changes.

3.5 MACROECONOMIC MODELLING IN THE PRESENCE OF STRUCTURAL CHANGES

Conventional econometric models rest to a large extent on the assumption that the structure of the economy is stable in the short and long run (Hendry and Clements 2000). It is noteworthy, however, that structural breaks are the most common features in macroeconomic data sets of developing and transitional economies alike. The presence of structural breaks in the data generating mechanism implies that it is impossible to

establish the primacy for forecasting of causal information over non-causal variables since the economy is basically moving between two different regimes with different structural characteristics. This then raises scepticism towards the usefulness of causal information for forecasting, the role of parsimony and the impact of collinearity (Hendry and Clements 2000). The two sets of coefficients will essentially follow a non-stationary process during the change because the underlying model parameters will have changed. Because structural changes introduce volatility in the long-run parameters of the model and affects the forecasting performance of the model, it is crucial that it is incorporated in the model explicitly (Greenslade and Hall 1996). In accommodating structural change, one of the options that modellers have in such cases is to specify the equations to fit only the latest data set using *a priori* assumptions on how they believe the economy has changed. Greenslade and Hall (1996) however warn that although this approach may work for models whose purpose is forecasting, it is not suitable for models that are to be used for policy analysis and understanding past trends.

Hendry and Clements (2000:4) outline a number of approaches that can be used to avoid systematic forecasting errors due to deterministic shifts caused by structural breaks. These include intercept corrections, differencing, co-breaking and regime-switching models. A more plausible remedy often used for this condition is time-varying parameters and the Kalman filter (Hall and O'Sullivan 1997:267).[20] Intercept corrections are described by Hendry and Clements (2000:15) as non-zero values for a model's error terms added over the forecast period to adjust a model-generated forecast to prior beliefs thus allowing for expected future events that are not explicitly catered for in the model. It is also crucial to incorporate as much information as possible concerning the form and timing of the structural change. This may include issues such as the type of the change, the time at which the change began and when it ended, the speed of adjustment and the rate of change of parameters.

Alternatively, the use of switching models can be instrumental in portraying structural change. This approach was traditionally used to model disequilibrium markets that switch

[20] See also Basdevant (2000).

between demand and supply constraint conditions. The basic assumption of this approach is that the model switches in a discrete pattern between two sets of parameters representing different states of nature with only a random error. The role of the Kalman filter in this and other techniques is then to introduce a learning type of expectations that evolve with the model. Since it is built into the model, it automatically changes the values of the perceived parameters in line with observed expectation errors. If the Kalman filter can be used for these purposes it can obviously be used to allow parameters of the model to change in the face of structural change. The implication of this approach is that through the Kalman filter, the simulation properties of the model may be preserved while the dynamics of the model will change in response to structural change to produce forecasts that are consistent with the new regime (Hall and O'Sullivan 1997:268-270).

3.6 THEORETICAL GUIDELINES TO SECTORAL MODELLING IN THE CONTEXT OF MACROECONOMIC MODELS

3.6.1 Theoretical models of aggregate supply

Increasingly detailed modelling of the supply has come under the spotlight in macroeconomic modelling than was formerly the case (Challen and Hagger 1983). In contrast to the Keynesian view that expanding aggregate demand will raise income and reduce unemployment, proponents of the supply side focus on the view that increased saving is necessary for increasing capital formation that can raise productivity and hence economic growth. Instead of demand management, a key feature of the supply side view is therefore to create capacity through capital formation. According to Meiselman (1982:42), and Roberts (1982:49), supply side economics acknowledges that fiscal policy, in particular the tax component of fiscal policy, affects incentives to invest, economic efficiency and economic growth by way of changing relative prices. This suggests that in order to evaluate policies designed to redress the improvement of capital formation, it is important to analyse factor supply decisions in the economy. Following the neo-classical flexible accelerator theory pioneered by Jogernson (1969), the decision to invest is influenced by, among others, the cost of capital which, in turn depends on tax

policy and other investment incentives such as low rates of interest and inflation, a stable foreign exchange market and general macroeconomic stability. A reduction in the erosion of investment incentives can encourage both private and public capital accumulation substantially. However, the increase in demand for either type on investment needs to be accompanied by an increase in the supply of financial capital available to finance investment. According to Boskin (1982:22), if supply is not increased simultaneously, the increased demand will merely hike interest rates.

Conventional models of the supply side consist of two approaches namely, the production function approach and the cost structure approach. While many recent works tend to use the cost structure to model the supply side, the production functions approach is also widely used and suited for cases in which there are data limitations. The former approach places emphasis on wages and prices. The latter approach involves the presentation and estimation of the functional relationship between inputs and output in the production process. Much emphasis is placed on the treatment of technology and the demand and supply of factors. In principle, the two approaches can be seen as identical in many ways. It is the technical issues that often lead to divergences in treatment (Whitley 1994:111). While the choice of variables in each case depends on individual analyses, a number of basic functional forms have been developed over time.

3.6.1.1 The production function approach

Assuming a general production function of the following form

$$Y = f(L, K, T) \tag{3.1}$$

Where Y is output, L is employment, K is capital stock and T is technology, factor demands can be derived from the marginal productivity conditions obtained by profit maximization. Under conditions of perfect competition, the marginal productivity conditions imply that firms equate the real wage to the marginal product of labour such that

$$\frac{w}{p} = f(L, K, T) \tag{3.2}$$

The demand for labour can then be derived from the above relation as

$$L^d = f(\frac{w}{p}, Y, T) \tag{3.3}$$

The Cobb-Douglas production function is one of the widely exploited functional forms that allow substitution between the factors of production. The function takes the following form

$$Y = L^{\alpha} K^{\beta} \qquad \alpha, \beta > 0 \tag{3.4}$$

Among the desirable properties of this function is the relative ease with which it can be manipulated. More importantly, the distributive factor shares of are given by the exponents of the factors and are constant. In addition, the Hicks and Allen elasticities of substitution are identical for all factors and equal to unity. These properties originate from the additivity and homotheticity assumptions imposed on the Cobb-Douglas production function and represent some of its major limitations.

A major theoretical improvement with regard to the flexibility of the unitary elasticity of the Cobb-Douglas function by independent efforts of Arrow and Solow in 1961 led to the introduction of the constant elasticity of substitution (CES) production function given by:

$$Y = \gamma[\delta L^{-\rho} + (1-\delta)K^{-\rho}]^{-\nu/\rho} \tag{3.5}$$

In this function γ is the efficiency parameter, δ is the distribution parameter and ρ is the substitution parameter. The returns to scale are given by ν while the Hicks and Allen

elasticities of substitution are identical and given by $\frac{1}{(1+\rho)}$. A major breakthrough of the CES is that it allows for an arbitrary degree of substitution between factors. However, because it is homogeneous and quasi additive, its factor shares are independent of total output and its elasticity of substitution is the same for all input pairs. According to Chung (1994:111), although the constant value of the elasticity of substitution can assume a wide range of values, it is not as flexible as a variable. Thus, the range of variation of the elasticity is to a large extent still limited. In addition, as a corollary to the homotheticity and quasi-additivity characteristics, the factor shares of output are also quite rigid.

The transcedental logarighmic (translog) function originated from Kmenta's 1967 log-linearization of the CES function and has been widely used in recent empirical analysis. It arose as an attempt to develop a more flexible technology and therefore removes the assumptions of homotheticity and separability. Although these two restrictions can be imposed as testable hypotheses, they are not prerequisites. The translog function is written as follows for an n-input case

$$\ln Y = \ln a + \sum_{i=1} \alpha_i \ln x_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} \ln x_i \ln x_j \qquad (i \neq j, \quad i, j = 1,...,n) \tag{3.6}$$

This function provides a greater variety of substitutions of transformation patterns than those restricted by the constant elasticity of substitution. The form of the functions determining output shares of inputs and the Allen-Uzawa partial elasticities of substitution for the production and cost frontiers are identical. Because of its flexibility, the translog function has proven highly useful in bridging the gap between theoretical and empirical research and is considered more desirable.

Whitley (1994:112) points out several practical problems of using the production function approach. One of them is that real wage elasticities with respect to employment are often below unity. This tends to conflict with the built-in restrictions of the Cobb-

Douglas function. Moreover, output should be treated as an endogenous variable in the estimation. It also becomes difficult to ascertain consistency between factor demands and price setting decisions under the production function approach.[21]

3.6.1.2 The cost function approach

The use of the cost structure addresses the problem of consistency between factor demands and price setting decisions in particular. In principle, the approach involves minimisation of the cost function of the following form with respect to the production function

$$C = wL + rK \tag{3.7}$$

Where w and r are the wage rate and the cost of capital respectively. As with the production function approach, this approach yields factor demand as functions of relative factor prices, an exogenous output level and technology. Thus the labour demand function takes the following general form

$$L^d = f(\frac{w}{r}, Y, T) \tag{3.8}$$

An important feature of this approach is that is possible for the price equation to be derived within a consistent framework together with factor demands. While the approach seems to have desirable properties in technical terms, it is also noteworthy that the explicit estimation of the production function facilitates the derivation of a more direct measure of capacity utilisation, a feature that the cost function approach lacks, yet a primary objective of many macroeconometric models.

[21] See Allen (1997:169) and Whitley (1994:112).

3.6.2 Theoretical models of aggregate demand

The modelling of the demand side involves the determination of the behaviour of aggregate demand in the economy by modelling the individual expenditure behaviour of all economic agents based on theoretical and practical experiences. Viewed from the demand side, actual economic activity is assumed to be influenced by demand factors and is therefore represented by the national income identity.

$$Y^{ACT} = C_P + C_G + I_P + I_G + (X - M) + INV \qquad (3.9)$$

Where C_P is private consumption expenditure, C_G is government consumption expenditure, I_P is private investment expenditure, I_G is government investment expenditure, X is exports of goods and services, M is imports of goods and services and INV represents the change in inventories.

3.6.2.1 Consumption behaviour

Four basic theories of consumption behaviour, dating back to the 1930s, form the core of the theoretical literature on consumption and its extensions. Collectively, these theories attempt to provide understanding of the determinants of optimal levels of consumption. With their foundations in the microeconomic analysis of consumer behaviour, they explain the consumption behaviour of larger units in the economy.

The pioneering absolute income hypothesis (AIH) developed by Keynes in 1936, predicts a positive relationship between the individual's consumption at any time, and the current level of disposable income. On the other hand, the relative income hypothesis (RIH) developed independently by Duesenberry (1949) and Modigliani (1949) relates consumption to the income of the individual relative to that of the rest of society. Drawing from optimization behaviour, it contends that an individual maximizes utility subject to a weighted average of the population's consumption. Solution to this problem suggests that consumption is dependent on the individual's percentile position in the

income stream as well as past levels of this variable. This model has been generalised in the habit persistence model of Brown (1952).

The permanent income hypothesis (PIH) developed by Friedman (1957) and the life–cycle hypothesis (LCH) developed by Modigliani and Brumberg (1954) and Ando and Modigliani (1963) have gained greater popularity in empirical analyses. The LCH relates consumption to lifetime income as opposed to contemporaneous income. The underlying problem in this model is the maximization of intertemporal utility subject to a lifetime budget constraint. The theory presupposes that an individual maintains a constant or steadily increasing consumption pattern throughout a lifetime given low or negative levels of income at the beginning and end of life and higher income levels at mid-life. The basic idea is that the individual maximises utility in such a way that it does not exceed the present value of lifetime income. The outcome is a consumption function that is dependent on the unobservable present value of lifetime income. To overcome this measurement problem, the theory defines total income as consisting of human and non-human income. This ultimately yields consumption as an increasing function of labour income and non-labour income or household net worth.

Starting from similar foundations, the permanent income hypothesis (PIH) developed by Friedman (1957) contends that consumption is a positive function of permanent income which is defined in simple terms as the average of present and future income. Thus the slope of the consumption function is determined by the relative variation in permanent and transitory incomes. An important implication of this hypothesis is that the rise in current income is associated with an increase in consumption only to the extent that it reflects an increase in permanent income. In turn, permanent income is defined as the product of real rate of return on total wealth and the present value of lifetime income. It is the measurement of permanent income, which introduced the role of expectations in the analysis of consumption behaviour. Early works on PIH-based consumption functions, including that of Friedman (1957), made extensive use of adaptive expectations and a distributed lag formulation with a Koyck transformation in the measurement of permanent income. With time and theoretical developments, the use of rational and

learning models of expectations has taken the centre stage.[22] This was also a result of the instability of the consumption function stressed by Lucas (1976) in the critique on econometric policy assessment. This has made forward-looking models of consumption more popular.

Different approaches have been used to build on the basic theoretical frameworks in the preceding discussions. These include analysis of consumption paths under conditions of uncertainty, extending analysis to account for multiple assets and risk, liquidity constraints and buffer stock models. A host of other variables that are hypothesised to influence consumption patterns and which have surfaced implicitly in the original frameworks have been given more attention. These include the interest rate, different types of wealth, taxation, financial intermediation and demographic factors.

Consideration of uncertainty follows the analysis analogous to that of PIH and yields the proposition of the unpredictable consumption patterns and Hall's (1978) hypothesis that consumption follows a random walk. Counter to predictions of the basic frameworks, Hall's extension posits that unexpected fall in income led to decline in consumption only by the amount of the fall in permanent income. Thus, changes in consumption are unpredictable in the face of uncertainty.[23]

The rate of interest is introduced into the model by relaxing the assumption of zero interest rates and thus allowing for a non-zero discount rate. The analysis under these conditions suggests that consumption need not be a random walk. Consumption rises over time if the rate of interest exceeds the discount rate and falls otherwise. Variations in the real rate of interest then suggest variation in the predictable component of consumption growth.[24]

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[22] Among others, Hall (1978) reformulated the LCH and the PIH by adding the assumption of rational expectations to the first order conditions of the intertemporal optimizing model of consumer behaviour.

[23] It is noteworthy however that most empirical works fail to confirm that lagged values of income and consumption fail to predict changes in consumption. See for example, Hall (1978), Campbell and Mankiw (1989a) and Shea (1995).

[24] Early empirical works however suggest that growth of consumption is not very responsive to changes in the rate of interest, thus implying a low intertemporal elasticity of substitution. See for example, Mankiw (1981), Hansen and Singleton (1983), Hall (1998b) and Campbell and Mankiw (1989a).

The relation between consumption and taxation is implicit in the relation of the former to disposable income and provides a nexus between the real sector and the government sector. This link stresses the role of taxes paid by the households to government. The obvious effect of taxations is traced to the budget constraint of the household. According to Sachs and Larrain (1993:98), higher taxes reduce consumption for a given path of output by reducing the present value of disposable income. In turn, whether changes in taxes are transitory or permanent may potentially have important policy implications.

Accounting for multiple assets provides a link between the household behaviour and asset markets. Within an intertemporal setting, and given expected returns to assets, the model shows that the aspect of riskiness, that matters to the decision of whether to increase holdings of a particular asset, turns out to govern the relation between the assets' payoff and consumption. As the individual increases investments in assets, consumption tends to depend on the assets' payoff. This suggests that hedging risks is important to optimal portfolio choices. The model further shows that if the expected returns on assets are determined by their demands, using the consumption capital-assets pricing model brings us to the conclusion that the premiums that assets offer are proportional to the covariance between an asset's return and consumption (see Romer 1996:330).

The PIH has also been extended to incorporate the effects of liquidity constraints. This effectively relaxes the assumption that consumers borrow and save at the same rate of interest in intertemporal models of consumption. If individuals face higher interest rates for borrowing, there is a likelihood of lower borrowing for purposes of smoothing out consumption given lower current income. Thus liquidity constraints tend to put more weight on current income as a determinant of consumption than predicted by the PIH.[25]

The rate of inflation or prices in the consumption function is used to capture the inflation loss on liquid assets (Whitley and Bai 1997:69). According to Thomas (1993), a rise in

[25] See Hayashi (1982), Hayashi (1985) and Flavin (1985) for empirical evidence on the effect of liquidity constraints on consumption.

the price level, with real income and real wealth held constant, should produce an equiproportionate rise in nominal income and wealth and hence should not affect consumption expenditure. A positive coefficient of the price level would suggest money illusion. Besides the inflation loss on liquid assets, the inflation variable in the consumption has been rationalised by Deaton (1978) as a proxy for uncertainty particularly in cases of accelerating inflation.[26]

3.6.2.2 Investment demand

Empirical analysis of investment behaviour follows form a number of theoretical models proposed within different schools of thought. While the Keynesian present value and marginal efficiency of investment criteria trace investment behaviour from the basic profit maximisation behaviour of a firm and have been widely used in empirical analysis, later models such as the Jorgenson's (1971) accelerator principle linked the theory of investment to growth models.

A major argument of these later developments lies in the introduction of dynamics to the static present value model. Restrictive assumptions behind the accelerator theory prompted further developments in the theory of investment by, among other, Jorgenson and Hall (1971). In this approach, the level of output and the user cost of capital influence optimal/desired capital stock. In turn, the user cost of capital depends on the price of capital, the real rate of interest and the rate of depreciation. Although it uses a different approach of introducing adjustment costs, the Tobin Q principle by Tobin and Brainard (1968) and Tobin (1969) complements the accelerator theory (Sundararajan and Thakur 1980:825; Hayashi 1982:214).

Of these frameworks, the neoclassical flexible accelerator theory and the Tobin Q theory are considered more suitable for modelling investment behaviour in cases where the economy is supply-constrained. Their appropriateness stem from the ease of identifying

[26] While empirical works by Deaton (1978) and Juster and Watchel (1972) using US data suggested that consumption levels fall as the price level rises, Branson and Klevorick (1969) found contrasting results for the same data.

policy instruments that government has at its disposal to influence or enhance aggregate supply from the resulting investment function. Although Q models of investment have quite appealing features that provide firm theoretical and empirical foundations for the analysis of investment, in that they start from the micro foundations of optimisation behaviour and rationalise the importance of expectations in investment decisions (Blundell *et al*. 1992:234), the flexible accelerator theory is usually chosen over the Tobin Q theory for modelling investment for several reasons. Firstly, the measurement problems associated with the unobservable marginal Q (usually measured by the average Q which is the ratio of the market value of the existing capital stock to its replacement cost) in the case of the Tobin Q principle pose threat to the performance of a model if used in such a context. Hayashi (1982:218) shows that the marginal and average Q can only be the same in the special case where the firm is a price taker and the production function and the installation function are the same. Measurement problems are at the core of the poor performance of the Q models and have cast scepticism on the adequacy of the forward-looking neoclassical investment theory itself (Allen 1997:42).[27] The problem is further compounded by the realisation that it is highly likely that in many instances financial markets measure the financial firm inaccurately (Blundell *et al*. 1992).[28] The application of the Tobin Q model within the context of developing economies is limited by rudimentary stage of capital markets (Geda *et al*. 2001).

On the other hand, the accelerator principle also has some shortcomings. The first shortcoming concerns the impact of changes in exogenous variables and the second deals with the role of expectations in investment decisions (see Romer 1996:347). Firstly, by implication, the model suggests that discreet changes in exogenous variables require infinite rates of investment. However, it is common knowledge that investment in the economy is constrained by the level of output and therefore cannot be infinite. Secondly, it is assumed that firms equate the current revenue product of capital to its current user cost. However, in practice, expectations about demand and costs are central to investment

[27] A vast amount of empirical analysis provides comprehensive of this deficiency. These include von Furstenberg (1977), Summers (1981) and Blundell *et al*. (1992). See Jorgenson (1971) for a detailed survey of empirical works on investment behaviour,
[28] See also Blanchard *et al*. (1993) and LeRoy (1989).

decisions. Firms expand their capital stocks when they expect their sales to be growing and the user cost of capital to be low. The introduction of adjustment costs in this case caters for the difference introduced by expectations. These consist of internal and external adjustment costs. Internal adjustment costs are associated with changing or installation of new capital stock while external costs are associated with changes in the price of capital relative to other goods so that firms have to make decisions of whether to invest or disinvest. To account for these arguments, liquidity and credit allocations in the economy may be included to capture adjustment costs and to reflect the fact that in many developing countries financial constraints and limited availability of foreign exchange affect investment decisions.

A variant of the accelerator principle permits the exploration of the contention that public investment may be a stimulus to or hinder private investment. A number of potential channels through which government investment is related to private investment are outlined in the literature. Firstly, government may compete with the private sector for scarce physical and financial resources, hence exerting a negative influence on private investment at least in the short run. Secondly, since public investment essentially complements private investment by contributing to increasing the productivity of private capital stock, private investment requirements per unit of output may be eroded. Thirdly, an increase in public investment may raise the demand for the output of the private sector thereby affecting output expectations and investment requirements of the private sector. Finally, by raising output and savings, thereby supplementing economic resources, public investment may work to offset part of the crowding out effects.

3.6.3 The government sector in a macroeconomic context

Though it is not usually accorded the attention that it deserves in macroeconomic models, the modelling of the governments sector should occupy a central position and made as comprehensive as possible. This argument stems from the fact that the behaviour of government almost invariably is the major driver of many key macroeconomic variables. This is especially true for developing economies in which the private sector is at an infant

phase and government plays a major part in economic decisions. According to Schmidt-Hebbel (1994:15), overindebtedness and the resulting debt crisis, high inflation and poor investment and growth performance in developing countries can all be traced back to imbalances in the public sector. This implies a strong linkage between the public sector and other sectors of the economy. From the monetarist point of view, large deficits are translated into inflationary pressures. The linking factor in this analysis is the way in which government chooses to finance its deficit (Easterly and Schmidt-Hebbel 1994:15; Biggs 1998:238). Domestic borrowing is highly linked with credit squeeze and rising interest rates, while foreign borrowing and money creation are linked with external imbalances and inflationary pressures respectively. According to Easterly and Schmidt-Hebbel (1994:17), external borrowing may lead to a current account deficit though either higher interest rates or credit allocation practices and real exchange rate appreciation and sometimes a balance of payments crisis or debt crisis depending on the level of reserves. Another likely outcome in all these cases is the fall in investment and economic growth induced by the erosion in the profitability of investments. The real sector may also be affected through the response of consumption and investment expenditures to budget imbalances. With regard to consumption expenditures, the Ricardian equivalence hypothesis by Barro (1974) is an attempt to establish the relationship between private consumption and changes in taxation. The degree of substitutability or complementarity of public investment has important policy implications.[29]

The debate of the possible mechanisms though which the behaviour of government influences economic activity dates as far back as the times of Mercantilism and the early classical economists such as Hume, Smith, Ricardo and Mills.[30] A vast amount of literature attests to the fact that the main ways in which the behaviour of government affects macroeconomic activity are taxation and its expenditure patterns. Budget imbalances in turn affect the performance of the economy in two main ways, namely, their effects on resource allocation and through their effects on the rate of capital accumulation (Biggs 1998:235). Within the neoclassical school, even though an increase

[29] See Buiter (1997) for a taxonomy on crowding out theories.
[30] See Mundell (1993).

in deficits may seem to increase output in the short run, the effect is very temporary, for an increase in deficits has detrimental effects on economic growth in the long run. The capital accumulation channel works regardless of the budget financing choice of government. The rate of interest is the main conduit in this analysis and works in the general case to stifle private investment. In principle, a deficit is a reflection of increased consumption levels and by implication, lower levels of saving. Given that demand for loanable funds is in excess of supply at a given rate of interest, this creates an upward pressure on interest rates and hence discourages investment. In the context of developing economies, deficits have been known to crowd out exports as well. The rise in interest rates further induces capital inflows and an appreciation of the real rate of interest. In turn, the competitiveness of local commodities in international markets is hampered.

The Keynesian mechanism operates by way of changes in resource utilisation and produces results that are directly opposite to that of the neoclassical view. In the Keynesian view, private and public investments are complementary to each other and work to produce a higher overall level of capital accumulation. A deficit is perceived as a reflection of an increase in aggregate demand and ensures that previously unemployed resources are utilised to increase output. In addition, investors view the increased aggregate demand as an inducement to expect increased profitability from investments. Although the resource allocation mechanism seems to be a theoretically sound argument, its practical use for policy purposes may however be limited. It is argued that spare capacity that is needed for output to rise may not be available in all sectors of the economy. In such situations, prices may be pushed up or a surge in imports may be realised depending on the openness of the economy. Ultimately, this leads to a worsening of the current account translating into a reduction in reserves or balance of payments crisis, which can easily lead the economy into a debt trap. On the other hand, this reduces investor confidence while it also increases the risk of investments and consequently a fall in investment.

3.6.4 Theoretical models of the external sector

International trade in goods and services is the primary channel that links the domestic economy with other economies. While some proponents argue that the relationship may have been overstated over the years[31], the relationship between the openness of the economy through trade and economic development is the basis for the importance of the external sector in any economy. Economic theory postulates that through specialisation, increased efficiency and skills and technology transfer, international trade increases output and welfare across nations. This follows from the pioneering works of Adam Smith (1776) through the theory of absolute advantage, Robert Torrens (1808) and David Ricardo (1821) through the theory of comparative advantage and Gottfried Haberler (1936) through the theory of opportunity costs, among others. Although refinements and modifications have been developed over time to accommodate practical trade relations, the basic notion that underlies the relation between the external sector and the rest of the economy is still that unrestricted trade provides more benefits overall.

While ideas regarding the linkage between trade policy and economic development seem to be changing rapidly in the wake of liberalisation and globalisation in recent years, the notion that trade policy is central to the overall design of policies to enhance economic development remains at the fore. While the idea of inner oriented policies such as import substitution and high levels of protection enjoyed much favour in their times, an outer oriented trade regime coupled with the removal of restrictions has become dominant in recent years (Krueger 1997:1). With the emphasis of protectionist strategies and the invariable need for foreign exchange, the former led invariably to insurmountable BOP crises across developing countries. The subsequent intervention by the World Bank and the IMF by way of the stabilisation programs whose main recommendation entailed measures that restrained domestic demand (Crockett 1981:61; Khan and Knight 1982:713). On the other hand the stabilisation programs have tended to loose their popularity in many developing countries owing to the deterioration of country economic performances. The present idea of outward oriented trade policies supports supply-side

[31] See Rodriguez and Rodrik (1999).

policies intended to increase economic efficiency. These measures have the potential to increase the overall level of capacity output given the existing stock of resources without lowering current levels of consumption. They basically involve the overall removal of restrictions and other distortions with the objective of improving efficiency and resource allocation.[32] While these strategies have their own drawbacks, the move is clearly towards the revival of the neoclassical growth and trade theory encouraging free trade and more integration of international markets.

Because of the growth of international trade and developments in international market relations and policy, as well as the sceptical view that empirical evidence in support of the globalisation is very weak,[33] the development of international trade policy remains at stake for developing countries at large. While the current wave of globalisation seems to have overwhelmed policy makers, there is still need for an in-depth analysis of domestic characteristics that will help to design trade policies that best suit the domestic economy, while at the same time fits well with changes in the global economy.

Earlier works on the balance of payments include the elasticities approach due to Robinson (1937) and Machlup (1955), and the absorption approach to the balance of payments developed by Alexander (1952). Inclusive among the theories of the balance of payments are the highly exploited Mundell-Fleming approach developed by Fleming (1962) and Mundell (1962, 1963). An addition to these is the monetary approach to the balance of payments following Dornbusch (1973), Whitman (1975) and Frenkel and Johnson (1976). The portfolio balance approach is a later and expanded development stemming from the monetary approach.

The main focus of the elasticities approach to the balance of payments is on the demand conditions and on the current account of the balance of payments with heavy reliance on the Marshall-Lerner condition. This approach puts more emphasis on the price effects of a devaluation. Its core message centres on the effect of a devaluation on the current

[32] See for example, Khan and Knight (1982).
[33] See for example, Rowthorn and Kozul-Wright (1998).

account balance and hence the overall balance of payments. Depending of the price and volume effects, a devaluation will improve the position of the current account only if the sum of the foreign elasticity of demand for exports and home country elasticity of demand for imports exceeds unity, that is, $\eta_x + \eta_m > 1$. If the sum of the elasticities is less that unity then devaluation will lead to a deterioration of the current account.

The absorption approach complements the elasticities approach by extending the analysis to encompass the income effects that result from a devaluation and hence also relies on the Marshall-Lerner condition. In this method a current account imbalance is perceived as the difference between domestic output and absorption, in which case a surplus in the current account imply an excess of domestic output over absorption and a deficit will reflect a shortfall of absorption over output. It predicts that if a devaluation raises domestic income relative to domestic absorption, the current account improves, provided that the marginal propensity to absorb is less that unity. On the other hand, if a devaluation raises domestic absorption relative to domestic income, the current account will deteriorate. The overall effect of a devaluation depends on the employment and terms of trade effects of a devaluation on income. In turn, direct absorption is affected by a devaluation through various channels including the real balance effect, the income distribution, the money illusion effect, the expectational effect and the Laursen-Metzler effect. Despite their simplistic assumptions, ambiguous conclusions, and deficiencies, the two approaches have remained influential as they contain useful messages for policy makers and have been widely used in empirical analyses.[34]

The Mundell-Flemming model is one of the frequently used Keynesian approaches to modelling the balance of payments. Its main contribution is that it integrates the capital account of the balance of payments in the analysis. By an application of the portfolio theory pioneered by Tobin (1958) and Markowitz (1959) to international markets, the theory relates interest rate differentials to capital flows. The model rests on the law of one price and is less dependent on the Marshall-Lerner condition than other models

[34] For a review of empirical works see for example Gylfason (1987), Knight (1984), Goldstein and Kahn (1985) and Krugman (1991).

(Stevenson *et al.* 1988:213). Although the model enjoyed considerable success, its fatal flaw is that it allowed neither aggregate supply considerations nor the exchange rate to influence domestic prices (Prachowny 1984:3). Besides the capital account, the model also links the balance of payments to the monetary sector with implications that a balance of payments surplus will increase domestic money supply depending on the sterilisation policy being followed in the economy.

The monetary approach to the balance of payments developed by Dornbusch (1973) makes use of the law of one price in both goods and assets markets and full or natural level of employment, a common feature of the monerarist models. The fundamental idea of this approach is that the balance of payments is the outcome of a flow divergence between the growth of the demand for money and the growth of credit with the money stock consequences of the balance of payments bringing the money market into equilibrium. In the words of Frenkel and Johnson (1976:21), the model "stresses the budget constraint imposed on the country's international spending, and views the various accounts of the balance of payments as the windows to the outside world, through which the excesses of domestic flow demands over domestic flow supplies, and of excess domestic flow supplies over domestic flow demands are cleared". This elucidates the monetarist view that the balance of payments is entirely a monetary phenomenon. One of the notorious policy implications dictated by the monetary approach is the impotence of monetary policy in its effects on domestic variables, while it becomes fully potent in its effects on the balance of payments. The Mundell-Flemming model under conditions of no sterilisation also dictates this result.[35] In addition, the monetary approach predicts an automatic adjustment mechanism for the balance of payments with no permanent effects, provided that a shock to the balance of payments is not underwritten by a change in domestic credit (Stevenson *et al*. 1988:243).

Early versions of the portfolio models of the balance of payments can be found in Oates (1966), McKinnon (1969) and Branson (1974). The main contribution of these models is the integration of the stock theory of the capital account and the role of wealth effects.

[35] For a synthesis of the two approaches, see Frenkel *et al.*, (1980).

The model is an extension of the monetary approach designed to embrace more liquid assets and hence draws heavily on the diversified portfolio theory pioneered by Tobin (1958), Markowitz (1959) and Sharpe (1964), which in turn is superimposed on the real sector. The basic element of the model is to trace the process of portfolio adjustment to the balance of payments following a monetary disturbance. According to the portfolio theory, changes in the money stock are translated into changes in wealth, and hence wealth effects, that change the demand for varying types of assets in the economy depending on a number of factors, including the sizes of different portfolio multipliers and the degree of substitutability between assets (Stevenson *et al*. 1998:162). Within the context of the balance of payments any disturbance in the current account gives rise to wealth and substitution effects that counteract each other so that the long-run equilibrium income level is given by the current account, unless they are sterilised. In essence the portfolio balance approach suggests changes in domestic and foreign interest rates, changes in wealth resulting from changes in savings and expectations as important determinants of the balance of payments. Although this approach seems to take on a generic form, it is often criticised on the grounds that it does not appropriately cover the real sector. In addition, because it assumes that markets clear, it is hardly suitable for application in developing countries where financial markets are characteristically narrow and inefficient.

In practice, issues such as the level of disaggregation and the distinction between the tradable and non-tradable sectors of the economy seem to play a major role in modelling the external sector. Most importantly, considerations of the size of the economy, the degree of capital mobility and the exchange rate regime take precedence in individual country models.

3.6.5 The labour market, prices and wage determination

The control of inflation and unemployment are some of the major objectives of stabilization macroeconomic policy. While the labour market is directly linked to the supply side of the economy, the price sector links the supply side of the real sector to

other sectors of the economy, in particular the final goods sector, the external sector and the monetary sector. This is an integral part of the model as it deals with factors that are responsible for the generation of price instability in the economy. As with the monetary sector, it is difficult to disentangle price developments from the labour market. Theoretical foundations of inflation almost invariably have their roots in the monetary impulses, and more so, in the labour markets. In the view of Whitley (1994:121), price equations tend to be a mark-up on costs of production in partial wages and imports costs with the mark-up being sensitive to demand influences. However, in supply-constrained economies, this represents a narrow view of the price mechanism since prices may be quite responsive to changes in supply conditions as well. In addition, because of the reliance of these economies on imports, import prices have to be taken into account. It may prove crucial to distinguish between imports costs related to cost of raw materials and other inputs from the competing prices of final goods.

Two types of analytical frameworks, namely, the monetary models of inflation and the wage price mechanisms have dominated advancements in macroeconomic price theory. Monetary models stress the role of monetary variables in the generation of price instability. In these models, increases in money supply are transmitted into the real sector via changes in the price level. On the other hand, the wage-price mechanism moves along with the Keynesian view by emphasising the role of excess demand in changing prices. Lately, structural models of the inflation have also taken their stand, relating inflationary pressures to limitations of the market mechanism.

In another view, price changes can be traced back to both supply and demand shocks that originate at home and from abroad. This brought forth the distinction between demand-pull and cost-push theories. Either a monetary or fiscal stimulus or a change in private spending behaviour that causes aggregate demand to increase can initiate demand-pull inflation. The monetarist version of demand-pull theories emphasised the causative role of monetary changes while the Keynesian view stressed non-monetary impulses. In contrast, cost-push inflation is initiated by supply factors. Supply shocks take a number of forms. A reduction in harvest and therefore output can lead to a rise in prices for

agricultural based economies in particular. Similar increases in wages can be interpreted as a supply shock as it in effect reflects a rise in the costs of production. Wage-push from unions as well as profit-push generated by administered pricing constitute cost-push factors. On the other hand, an increase in the price of oil is a famous example of an external supply shock that influence price changes especially in oil importing economies. Within the monetarist doctrines, the distinction between cost-push and demand-pull is spurious because an increase in wages or profits can only raise the level of prices and not their rate of change unless accompanied by a faster monetary growth. Thus, any sustained inflation, whether Keynesian fiscal induced money-accommodated inflation or whether quantity theory money initiated inflation, amounts to the same thing in monetarist principles.

Traditional Keynesian analysis puts more emphasis on quantity changes and the multiplier mechanisms within the context of closed economies and does not dwell much on price and wage formation in open economies. One result of this has been an underdevelopment of the mechanisms that explain international price linkages. Later improvements of the Keynesian model such as the Mundell-Fleming model, the Dornbusch sticky price model, the Solow-Swan model and others incorporated international relations but emphasized monetary transmission mechanisms and stabilization policy in the context of exogenous wages and domestic prices. These models still did not explicitly and adequately address the question of price and wage determination.

The development of the Phillips curve relation in 1958 introduced a formalised way of examining the relationship between inflation and unemployment having been explored as early as 1926 by Irvin Fischer (Santomero and Seater 1978:500). According to the Phillips curve relation, as in other markets, excess demand in the labour market indicated by the (un)employment rate is the source of wage inflation. However, the implied trade-off between unemployment and inflation faced serious criticisms founded in both its theoretical and methodological procedures. The most detrimental flaw of the Phillips curve arose from its lack of stability, which made it difficult for it to produce any

conclusive results (Frisch 1983:30). Later insights into the relation were introduced by Friedman (1968) and Phelps (1968) with the notion of the natural rate of unemployment. Attempts to explain changes in the closed-economy scenario centred on what came to be known as the expectations augmented Phillips curve. This body of theory explains variations in inflation and unemployment as caused by inflationary expectations. The central message of the augmented Phillips curve analysis is that wages and prices are rigid and tend to adjust slowly to shocks because of the existence of long-term contracts and costs of wage and price changes.

The case for international price linkages in open economies is usually tackled with the classical assumptions of perfect price and wage flexibility and full employment in contrast to the Keynesian sticky price models. Like in the case of closed economy models, the wage and price formation mechanisms are embodied in the sphere of monetary factors. These models have tended to sacrifice the analysis of inflation-unemployment trade-offs at the expense of models that elaborate the monetary mechanism. A typical example of these is the Hume's price specie flow mechanism. In these models long-run equilibria are the primary focus while the short- to medium-run analysis of wage-price-output interactions, which are essential for policy designs come secondary.

3.6.5.1 Models of inflation based on the Phillips curve

Macro models of inflation

According to the early works on the wage price mechanism, prices are mark-ups over unit costs at standard rates of output and capacity utilization and did not respond to demand movements (Blanchard 1990:785) it was believed that prices only played a passive role and that their adjustment to changes in nominal money only reflected wage increases. The relation between prices and nominal money was considered quite stable such that the direct effect of demand on prices was negligible. A major shortcoming of this approach has been cited as its lack of theoretical foundations and in the view of

Nordhaus (1972), although mark-up pricing was designed to address non-competitive markets, it became optimal only under conditions of perfect competition and constant returns to scale. According to Gordon (1976), prices should not be set simply as a mark-up over labour costs but as a weighted average of all costs of production.

Though attempts were made to provide theoretical bases for the Phillips curve relation by, among others, Lipsey (1960) and Samuelson and Solow (1960), their analysis was later perceived to be inadequate in explaining changes in inflation.[36] Constructive theoretical developments, especially with regard to measurement issues subsequently emerged.[37] Santamero and Seater (1978:513) suggest a number of measures of inflationary pressures. A number of variables are suggested as measures of unemployment.[38] Of these, the one that received most recognition is that of the concept of the natural rate of unemployment by Friedman (1968) and Phelps (1967). With regard to the rate of change of the price level, others such as France (1962:67) vaguely hinted the expectations hypothesis. (see also Archibald 1965:5 and Archibald *et al*. 1974:7). Arguments for and against productivity as an explanatory variable have been advanced in Kuh (1967:118) and Vanderkamp (1972:220), among others. Profit is also considered in many works on the grounds that unions may be more hostile and firms more relaxed when profits are high. Early woks that consider profit as an explanatory variable include Ecksterin and Wilson (1962), Bhatia (1962), Schultze and Tryon (1965) and Hamermesh (1970). The hypothesis that union power may cause an increase in the wage rate has been tested using varying measures by, among others, Hines (1964, 1968 and 1971), Throop (1968), Thomas (1974), Ashenfelter and Johnson (1972), Schmidt and Strauss (1976), Tobin (1972), Ashenfelter and Johnson (1969), Godfrey (1971) and Ashenfelter *et al*. (1972).[39] The influence of socio-political factors on wage inflation has also been explored

[36] A salient outcome of Lipsey (1960) is that wage inflation originates from unemployment represented by excess demand in the labour market, which in turn is derived from excess demand in the goods market. The Samuelson and Solow (1960) analogy implies that the rate of inflation is determined by demand pressure in the labour market, the expected rate of inflation and the proportion of growth in labour productivity that is not transferred to the workers in the form of money wages (see for example, Klein, 1978).
[37] See Santamero and Seater (1978) for a critique of the inflation-unemployment trade-off.
[38] For these see Lipsey (1960:127), Dow and Dicks-Mireaux (1958:50), Hansen (1970:97), Simler and Tella (1968:197), Taylor (1970:202), Mackay and Hart (1974:137), Gordon (1977:83).
[39] See also Johnston (1972), Pencavel (1970) and Zis (1974).

by many studies such as Beveridge (1945), Turvey (1951), Pitchford (1957, 1961 and 1968) and Tobin (1972).

The expectations augmented Phillips curve

The contributions of Friedman (1968) and Phelps (1967) can be summarised by the following relation

$$\frac{D_w}{w} = f(U) + \left(\frac{D_p}{p}\right)^* \tag{3.10}$$

Where $\frac{D_w}{w}$ is the rate of wage inflation, U is the natural rate of unemployment and $\left(\frac{D_p}{p}\right)^*$ is the expected rate of inflation.

By this relation, a rise in inflation triggers revisions of inflationary expectations causing the Phillips curve to shift and unemployment to return to its natural rate and introducing the concepts of the short-run and long-run Phillips curves. Thus, if expectations are allowed to vary, the long-run Phillips curve turns out to be vertical at the natural rate of unemployment, which is consistent with any rate of inflation that is anticipated. In this framework, expectations are assumed to adjust through adaptive behaviour. In practical applications, this version of the Phillips curve implies that lagged inflation rate, the level and the change in the level of excess demand in the labour market explain actual inflation.

The expectations augmented Phillips curve was challenged by among others, Lucas (1972, 1973) and Sargent and Wallace (1975), on the basis of the use of adaptive expectations. Arguing that expectations are formed by intelligent agents who take into account all available information, they introduced the notion of rational expectations in the inflationary process. In this variant, the natural rate hypothesis is fitted with rational

expectations and an excess demand relation that is derived from the Keynesian IS-LM system and Okun's law. The degree of excess demand in the labour market is a function of the rate of growth of real money supply so that if the rate of monetary expansion exceeds the rate of inflation, the positive real balance effects generates excess demand and reduces unemployment. Thus the rate of inflation is explained by the expected rate of inflation, the rate of growth of money supply and some random component. An important implication of this formulation is that the actual rate of unemployment tends to oscillate randomly around the natural rate. Thus, the Phillips curve is unstable even in the short run and deviations of unemployment from its natural level are attributed entirely to random factors. This has been termed 'the persistence dilemma' by Gordon (1981).

Micro models of the Phillips curve

In search of alternative explanations, attention has since been focused on the microeconomic foundations of inflation. Most notable of these theoretical advancements are the search and matching models of unemployment pioneered by Stigler (1962). The crux of these theories is the existence of imperfections such as incomplete information in the labour and commodity markets, so that allowance is made for some normal level of search unemployment. In these models workers and jobs are heterogeneous, so that they engage in a costly process of matching up idiosyncratic preferences, skills and needs, misperceptions and misinformation. On the other hand, the contribution of Phelps (1969) to this body of models stresses the firms' relative wage setting behaviour. Firms are viewed as prices setters and the desired differential between the firms' wage offer and the average market wage depends negatively on aggregate unemployment and positively on the aggregate vacancy rate relative to the firm's vacancies (Santamero and Seater 1978:518). In principle, three categories of search models of unemployment are identified. The first group of models has the basic feature that individuals speculate on the distribution of nominal wages over current vacancies. In the second group individuals misperceive their real wage while in the third category individuals speculate over time on the normal level of nominal wages. The first group consists of models of among others Alchain (1970), McCall (1970), Mortensen (1970), Lucas and Prescott (1974) and Siven

(1974).[40] Starting from the basic problem of maximising the present value of lifetime income, the basic ideology of these models is that an individual will change the market in which he offers his labour services if he perceives a change in his wage relative to the wages associated with current vacancies. This translates into choosing the optimal reservation or acceptance wage that is given by the wage that equates the marginal cost of searching to its marginal gains. The Phillips relation arises from these models by imposing the assumption that people's inflationary expectations are slow to adjust to changes in the actual aggregate rate of inflation. An important implication of these models is that unanticipated increases in inflation will reduce unemployment only temporarily. Another body of search theories stresses the notion that labour supply depends positively on the expected real wage. While the individual has full information regarding changes in the nominal wage, he misperceives the changes in the price level. This is the path followed by, among others, Friedman (1968), Almonacid (1971), Lucas (1973, 1975) and Sargent (1973). In these models individuals maximise income, and supply labour, but do not engage in search activities. As in the first category of models, people's perceptions of inflation are slow to adjust to changes in the actual rate. In addition their perception of the increase in prices is slower than in wages. In this way, they continuously have a mistaken belief that real wages have increased. The basic outcome is that while the short-run Phillips curve is negatively sloped, there is no trade-off in the long run.

In the third category of models due to Lucas and Rapping (1970), Lucas (1972) and Weiss (1972), the individual maximises lifetime utility and has to decide on the amount of time spent on work and leisure. The intertemporal labour supply depends on the time path of nominal wages. The current labour supply depends on the current and expected future real wages, the rate of interest and the current real assets. The Phillips curve is derived from these models by assuming that the substitution effect of a change in the perceived real interest rate outweighs the income effect, the perceived real interest rate is inversely related to the perceived inflation rate and that the perceived rate of inflation is inversely related to the current price level (Santamero and Seater 1978:520). The general

[40] See also Gronau (1971), Parsons (1973) and Salop (1973).

outcome in this case is a negatively sloped short-run Phillips curve and a positively sloped long-run Phillips curve. Criticisms of the search theories have brought into consideration resignation and layoff decisions and have led to major debates and yet another body of literature.[41]

Non-competitive models of inflation and unemployment

A shift from search models introduced the view that unemployment is a direct result of market failure. Among others, Hansen (1970) and Grossman (1974) share this view. In line with these developments, Friedman (1977) introduces a positively sloped variant of the Phillips curve characteristic of a transitional period in which government intervention, the existence of contracts, and uncertainty and rigidities in the labour market are dominant. In this case, markets do not clear instantaneously because of structural imbalances and frictional forces. It is assumed that an increase in aggregate demand will reduce unemployment in all markets, producing a standard Phillips curve. An expected change in the wage rate produces a wedge between actual and market clearing wages so that it makes sense to include both wage expectations and excess demand in the determination of nominal wage adjustment. Thus a cycle in aggregate demand can produce either clockwise or anti-clockwise loops. In this framework the tendency for clockwise looping is greater, the larger the adjustment parameter for price expectations and employment. Ultimately there is no trade-off between inflation and unemployment even in the long run. Other models that yield similar results are that of Ross and Wachter (1973) and Brunner and Meltzer (1976).

[41] See for example Tobin (1972:210), Gordon (1976: 205), Santamero and Seater (1978:523), Grossman (1973:85), Lucas (1975), Barro and Grossman (1971, 1976), Okun (1975), Barro (1977:23), Azariadis (1975), Baily (1974) and Gordon (1974, 1976).

3.6.5.2 Monetary models of inflation

Closed economy monetary models

The explanation of inflation has also played a pivotal role in monetary models. The basis of these models is that inflation is entirely a monetary phenomenon. The rate of growth of money supply solely explains the rate of inflation. These models are almost invariably founded on four basic propositions. Firstly, it is assumed that the economic system and markets are inherently stable so that labour markets in particular tend to equilibrate. Secondly, these models invoke the long-run quantity theory and perfect foresight so that the rate of growth of money supply is translated to the rate of growth of prices. Thirdly, the short-run dynamics are such that the growth of money induces only a temporary change in real output that lasts only during the adjustment process. Lastly, demand management policy, whether monetary or fiscal, is considered to be a source of instability in the economy. As in the wage-price mechanisms, subdivisions according to ideologies have developed in the monetarist theories. There is a group that believes in the distinction between the short-run and the long-run Phillips curve, commonly known and monetarist mark I, and the rational expectations school, known as monetarist mark II.

The former advocates for changes in real variables at least during the adjustment period. In this model, the rate of growth of money supply determines the rate of inflation with the Phillips curve as a nexus between the monetary and real sectors and facilitation of the adjustment process. A presentation of this model takes the following form.

$m = x + \pi$	-	The quantity theory	(3.11)
$\pi = \pi^* - b(u - u^*)$	-	The Phillips curve	(3.12)
$u - u_{-1} = -a(x - x^*)$	-	Okun's law	(3.13)

where m represents the rate of growth of money supply, x is the rate of growth of output and π is the inflation rate, π^* is the inflationary expectations, u is the unemployment rate, u^* is natural rate of unemployment. In this model there are no inflationary expectations in

the short run and hence real variables are affected. In addition, the Phillips curve remains stable and short-run equilibrium prevails. Thus, a monetary impulse leads to a real as well as an inflationary effect. However, in the long run expectations shift according to adaptive behaviour so that the Phillips curve and Okun's law are adjusted so that the real effects vanish. It is noteworthy that the long-run adjustment process in this model is subject to under- or overshooting because of system oscillations.

In contrast, the rational expectations school assumes a continuous sequence of long-run equilibria. A distinction is made between systematic and unanticipated changes in money supply. The former triggers a change in expected and actual inflation and remains neutral even in the short-run. It is only the latter which cannot be influenced by systematic economic policy that can produce sustained changes in real output and employment. The model takes the following form.

$$m = \pi + x^* + g + e^1 \quad - \quad \text{The quantity theory} \quad (3.14)$$

$$\pi = \pi^* - b(u - u^*) + e^2 \quad - \quad \text{The Phillips curve} \quad (3.15)$$

$$u = u^* - ag + e^3 \quad - \quad \text{Okun's law} \quad (3.16)$$

The major contention of this model is that an acceleration of real growth pushes the rate of unemployment below its natural rate. In addition, the generation of monetary impulses follows a particular rule given as follows:

$$m = \mu_0 + \mu_1 g_{-1} + \mu_2 \pi_{-1} + e \quad (3.17)$$

By this rule, the rate of monetary growth depends on an autonomous component and the deviation of its growth from its natural rate and the rate of inflation both lagged by one period. In addition, it is assumed that agents know this systematic component of money supply growth and take it into account in forming expectations. This then implies that the actual rate of inflation will be explained by the rationally expected component and some random component given by the deviation of the actual rate of growth from its expected

rate. This implies that the rates of unemployment and growth of real output will depend on the expectational error. Thus, the real sector is totally independent of anticipated monetary shocks.[42]

In an attempt to divide monetary shocks into inflation and output effects, Friedman (1970) identified both over-utilisation of capacity and an unanticipated acceleration of the rate of real growth as determinants of inflation. The incorporation of Okun's law and the Phillips curve then suggest that inflationary expectations, a surprise acceleration of real growth and the level of excess demand explain inflation. This can be contrasted to the traditional quantity theory in which the money market plays a significant role in the determination of price and the Keynesian system in which the price level is determined exogenously. Friedman (1971) later developed an intermediary between these two with the rate of interest assumed to be constant. In this framework, the price level increases proportionately with money supply. As in the Keynesian system, fiscal policy plays an important role while monetary policy is completely impotent. A dynamic implication of this framework is that unanticipated changes in the rate of growth of money supply produce a deviation in the rate of growth of nominal income from its trend growth. The rate of inflation rises only in the long run. When a higher rate of inflation is anticipated, the system reaches a new steady state characterised by a higher money supply with an unchanged real growth. This has been interpreted to represent a long-run theory of inflation.

The inflation tax model is one of the important mechanisms of the inflation process in developing countries (Blejer and Cheasty 1988:869). The existence of fiscal deficits, regardless of the method by which they are financed, are viewed as a major driver of growth of money supply. This mechanism is restricted to cases in which deficits are financed by money creation. Because of the link between fiscal deficits and the rate of domestic credit expansion, a distinction between monetary and fiscal policies becomes

[42] This result has triggered criticism based on the implicit assumption that markets clear. (see for example, Tobin 1980; Buiter 1980; Friedman 1981 and Gordon 1981). Models that eliminated this assumption show the potency of discretionary policy. These make use of assumptions such as multiperiod contracts (Fischer 1977), staggered wage setting (Taylor 1979), predetermination of prices (Phelps and Taylor 1977) and slow wage and price adjustments (Buiter 1980).

vague, especially if the exchange rate is fixed. Thus, changes in money supply are by definition equivalent to changes in credit to government and private sector and international reserves (Khan and Knight 1982:715). The basic assumption of the model is that the maintenance of deficits requires the generation of inflation tax, which in turn requires continuous increases in money supply leading to inflation (Aghevli and Khan 1978:384). Thus, a reduction in fiscal deficits is expected to be deflationary.[43]

Open economy monetary models of inflation

The question of how inflationary impulses are transmitted from one economy to another is an important one for open economies. Apart from the traditional routes in which increased foreign demand and increased input costs reach the domestic price level through the effect of higher exports on aggregate demand and directly through the Keynesian multiplier, as well as through the inclusion of import prices in the aggregate mark-up price equation, open economy inflation has been analysed by means of two predominant frameworks, namely, the monetary approach to the balance of payments, and the Aukrust- Edgren, Faxen and Odhner (EFO) approach. The crux of the former model is that changes in the supply of domestic money do not only influence the domestic rate of inflation but the overall balance of payments as well. Thus the money and capital markets play a major role in the transmission of inflation across national borders and a disequilibrium in the balance of payments is a reflection of a imbalance in the money market. This model rests, to a large extent, on the assumption that there exists a stable and well-defined demand for money function. The monetary approach introduced two additional assumptions. The first is the assumption of purchasing power parity, that all goods are tradable with prices quoted in international markets. Secondly, the domestic holdings of foreign reserves are allowed to increase as a direct result of the export surplus and also because the higher price level raises the demand for money relative to the original supply. In practice, the rate of interest plays a crucial role here. High rates of interest in developed countries lower the rate of inflation there, while they also attract

[43] It is noteworthy however, that feedback relationships may complicate the determination of optimal fiscal policy in situations of stable prices and high inflation. In particular, the size of the deficit itself may be a function of the inflation rate (See Crockett 1981 and Khan and Knight 1981).

foreign capital, thereby increasing the exchange rate. This, in turn, implies that imports from developed countries to developing countries are more expensive and therefore directly influence the increase in prices in the latter. Thus, the transmission runs from high interest rates, increased demand for foreign currencies, high exchange rates, and increased cost of production and ultimately increased domestic prices. In another dimension, high interest rates in developed countries trigger interest rate hikes in international money and capital markets. This raises the cost of credit, resulting in a fall in output and an increase in prices worldwide. In addition, the increase in financial liquidity internationally contributes directly to demand-pull inflation.

Another variant of the model starts from a consolidated balance sheet of the banking system and contends that a change in foreign exchange reserves is given by the difference between that change in the existing money supply and the change in the volume of domestic credit (Johnson 1972 and 1976). In turn, this difference gives the overall balance of payments. The model assumes a small open economy, producing one internationally traded commodity, a fixed exchange rate and hence equality between domestic and world inflation. Instantaneous adjustment is assumed in the money markets because of open international markets of commodities and securities. Thus, the central monetary authorities do not have control over money supply. For example, excess money supply is translated instantaneously into a fall in reserves and a deterioration of the balance of payments. It is only the composition of money supply that changes. Given that money demand depends on the price level, the level of output, and for simplicity, a constant rate of interest, the monetary approach comes to a conclusion that an increase in foreign reserves or an improvement in the balance of payments depends positively on the rate of growth of domestic real income and world inflation. Thus, for a given rate of world inflation, real growth in the domestic economy leads to accumulation of foreign exchange reserves or balance of payments surplus if a restrictive monetary policy is pursued. The monetary authorities can only control inflation by controlling the balance of payments or foreign reserves.

This is in contrast to the Keynesian model in which a growth of real income in a small open economy would lead to an increase in imports and a balance of payments deficit, so that high levels of employment come at the expense of external stability. This is also in contrast with a closed economy version in which the monetary authorities can control money supply and the rate of inflation. The adjustment process is taken to be instantaneous and incorporates the Alexander (1952) absorption mechanism.[44] If real cash balances increase because of an expansion in domestic credit at a given price level, domestic absorption increases relative to output. This induces a deficit in the balance of payments and a reduction in foreign exchange reserves, money supply and subsequently real absorption. This process depends to a large extent on a positive relationship between absorption and real cash balances and a positive relationship between the balance of payments and a change in the nominal money supply.

Another conduit of international inflation is provided by the system of floating exchange rates. Changes in the exchange rate tend to determine the pattern of real economic activity domestically and abroad. In principle, the stronger the currency of a country, the lower the inflation rate. The importance of the exchange rate in the determination of inflation depends to a large extent on the share of foreign trade in the country's economy. The greater the share of foreign trade in economic activity, the higher the stake that exchange rates take in the determination of inflation. A depreciation results in higher costs of inputs. This causes the costs of final goods to increase and leads to a mechanism of cost-push inflation. While domestic prices rise, so do prices of exported goods. This in turn leads to a devaluation undertaken as an attempt to increase competitiveness of exports in foreign markets. The costs of inputs then rise again and so does the domestic price level. In the context of developing countries, given that export and import demand elasticities are usually low, a devaluation hardly improves the balance of payments. The only sure outcome is accelerating inflation, chronic balance of payments problems and large amounts of foreign debt.

[44] See also Swoboda (1976 and 1977).

The view of Kydland and Prescott (1977) that lack of prior commitment in monetary policy can lead to inefficiently high inflation has given rise to a body a literature that also provides a linkage between domestic inflation and openness of the economy. In their view, the existence of imperfect competition and distortions produces sub-optimal levels of output which gives policy makers an incentive to create inflation in an attempt to affect real output through monetary policy. In essence, an inverse relationship between openness and inflation is predicted in the absence of precommitment. Subsequent works of among others, Barro and Gordon (1983), Taylor (1983), Rogoff (1985) and Fischer (1990) have suggested mechanisms by which policy makers can avoid the tendency towards inefficiently high inflation rates. In particular, Rogoff (1985) points out that an unanticipated monetary expansion results in a depreciation of the real exchange rate, which in turn reduces the incentives for expansion of output. Policy co-ordination in this case yields better results. If countries co-ordinate their monetary policies, they form a coalition of a single larger and less open economy that reduces the impact of depreciation and raises the equilibrium rate of inflation.

The basic analytical framework used in these models is that of a closed economy model of the dynamic inconsistency of optimal monetary policy (Romer 1993:872). It is assumed that unexpected monetary shocks affect both prices and real output. This implies that the difference between actual output from its equilibrium value is positively related to the difference of actual inflation from expected inflation as a result of either imperfect information about prices or incomplete adjustment of prices. The models also assume that policy makers prefer higher output levels to inflation. The sub-optimality of the levels of output arises from imperfectly competitive forces or distortionary taxes in the economy. The policy maker's problem involves choosing the optimal rate of money growth or equivalently the rate of inflation. This problem yields a sub-optimal outcome of positive inflation and output that is at a natural rate. Thus it would be desirable for the policy maker to precommit to a zero inflation policy.

However, the basic implications of this framework are that an increase in imports affects inflation in two ways. Firstly, the increase in the degree of openness reduces the benefits

of increased output. Domestic expansion increases domestic output relative to foreign output. This means that the relative price of domestic goods falls unless domestic and foreign goods are perfect substitutes. Secondly, while it increases output, the increase in the degree of openness also increases the rate of inflation. The reason for this is the real depreciation associated with an increase in domestic output. The depreciation affects inflation in two ways. Firstly, the impact of inflation is higher for imported commodities than for local commodities, and secondly, the costs of domestic firms are increased through the input costs. Thus, increased openness means that a monetary expansion will lead to a larger increase in domestic prices for a given increase in output. Because openness affects the main determinants of inflation, the incentives of policy makers to expand are eroded in more open economies so that equilibrium inflation is lower.

3.6.5.3 Structural models of inflation

The long-run tendency of inflation is often attributed to failure of the market mechanism resulting from a number of factors. These include differences in productivity and price and income elaticities in the industrial and services sector while growth of money wages in these sectors is usually uniform and there are rigidities of prices and wages particularly in a downward direction (Frisch 1983:153). In many structural models, the economy is sub-divided into the industrial or progressive sector and the service or conservative sector. Changes on relative prices in different sectors are linked to changes in the general price level (Canavese 1982:523). The Baumol (1976) model of unbalanced growth is usually considered as a prototype of structural models. In this and other models, the industrial sector is assumed to exhibit an increase in labour productivity while the service sector is characterised by constant labour productivity. Given that money wages grow at the same rate in both sectors, and that firms in the services sector use the mark-up pricing rule, the supply price in this sector rises relative to that of the industrial sector. This proposition assumes a small price elasticity and a large income elasticity of demand for the output of the services sector. The practical implication for inflation is that while prices in the industrial sector remain unchanged, prices in the services sector increase at the same rate as money wages because money wages rise at the same rate as labour

productivity. With time, the general price level rises at a rate proportional to the rate of increase in the price of the services sector.

A variant of this theory is the Hicks-Tobin theory of labour supply due to Tobin (1972) and Hicks (1974) whose core argument is the existence of contracts in the labour market. With similar basic assumptions this model assumes downward rigidity of money wages because of the contractual agreements between employers and workers. The basic implication is that the contracts eliminate or undermine the power of the market forces to enforce adjustments. Even if markets would respond, the principle of continuity, which depends to a large extent on the principle of fairness, leads to a lagged response of money wages to market forces. It is however possible that in the long run market forces and changes in productivity will determine wages. The question then is what factors determine real wages or relative money wages in the short run? In the view of Tobin (1972:3), it is only rational that workers judge the fairness of their compensations on the basis of wage differentials or relative wages. Thus, if real wages fall, the Tobin-Hicks hypothesis suggests that workers will attempt to defend their relative wage as opposed to their absolute wage (Frisch, 1983:162). This is in harmony with the Keynesian theory of labour supply (Keynes 1936:14), in which if money wages of one group are raised, other groups will strive for the same change in order to stabilise its real wage. This maintenance of wage differentials results in cost-push inflation.

The monetarist version of world inflation due to Johnson (1976), Swoboda (1977) and Classen (1976 and 1978) applies the classical version of the quantity theory. In its simplest form the model assumes there is only one world money. The world price level is then determined by the relationship between world real money supply and world real money demand. An increase in foreign money supply is met by an increase in foreign money demand and is translated into an increase in world price. Thus world inflation is endogenous. This model has raised concern over the monetary effects on output and employment, at least in the short run.

Dornbusch (1973) extended this model to allow for both traded and non-traded goods. The movement of goods, in particular raw materials such as oil, also plays a major role in the international transmission of inflation. This movement affects inflation through the changes in the terms of trade. If prices of exports grow more relative to import prices, a country essentially becomes a net exporter of inflation. In effect, the prices of domestic non-traded goods are flexible and the labour market clears instantaneously stimulating foreign demand. In the Dornbusch model, this in turn will require an increase in the nominal wage rate and a fall in the relative price of non-traded goods. The inflow of reserves increases the domestic money supply by a sufficient amount to finance a rise in the relative price of non-traded goods to the initial level. In the final analysis all nominal variables will have increased by the same proportion as the increase in the world price.

The Scandanavian model of inflation formulated by Edgren, Fax'en and Odhner (EFO) in 1973 and Aukrust (1977) supports the structural foundations of inflation and uses the same analogy as the Dornbusch model. In contrast to the above, the model is formulated in a manner that emphasises a small open economy hence the subdivision of the economy into the tradable and non-tradable sectors. Nevertheless, the basis principle still lies in the differences in productivity between the two sectors. With the exchange rate, labour productivity and money wages fixed, the basic prediction of the model is that while the domestic rate of inflation is given by weighted inflation rates of the two sectors, its deviation from world inflation is founded in structural factors. Thus, the rate of inflation is independent of excess demand. Instead, it depends on the difference between the rates of growth in labour productivity in the two sectors. In addition, the share of non-tradables in total expenditures determines the magnitude of the difference between domestic and world inflation. In other words, domestic inflation is determined solely by cost factors and results from imported inflation and productivity differences. As in the Dornbusch model, wage determination does not feature in this model so that differences in demand and supply of labour do not play any role in the adjustment process. This is in direct contrast to the Phillips-Lipsey model in which inflation is determined solely by demand factors and results from excess demand. Attempts to reconcile these contrasting views have been provided by, among others, Branson and Myhrman (1975). In this

interpretation, the Scandanavian model is considered as a long-run supply model with implicit demand conditions. By assuming that the rate of unemployment is exogenous, demand management policy is made to be strong in achieving a given level of unemployment, thereby implicitly choosing a given level of inflation with the help of the Phillips curve. In another reconciliation attempt by Aukrust (1977) and Calmfors (1977), the long-run Phillips relation becomes handy in determining the degree of excess demand compatible with the Aukrust-EFO model.

3.6.6 Theoretical models of the monetary sector

There exists a massive body of literature on the transmission of monetary impulses to the macro economy.[45]As in other fields, the debates on this issue are plagued with controversies and hence the varying schools of thoughts. While classical economic theory holds that in a framework of flexible prices, money should be neutral so that changes in nominal money is reflected only in nominal prices and not in output, strong linkages have since been identified in the literature between the monetary sector and other sectors of the economy. For example, some of the imperfect information models suggest that changes in the price level are triggered by changes in output, originating from changes in the monetary sector (Blanchard 1990:798).[46]

A common view that changes in money supply are translated into changes in aggregate demand dominated the perceptions of researchers until the 1970s. It was believed that changes in nominal money led to sustained changes in real money and in output. This in principle reflected the stickiness of wages and prices to changes in employment and output. Models of the transmission mechanism of money to aggregated demand and those of the wage-price mechanism provided the basis for analysis.[47] In general terms, the models suggested that changes in money lead to a slow change in prices and wages and therefore a sustained effect on output and real wages. However, the introduction of rational expectations later brought scepticism into the existence of a long-run Phillips

[45] See for example, Laidler (1999), Christiano *et al.* (1999), Fares and Srour (2001), Dib (2003) and Klaeffling (2003).
[46] See also Fry (1995).
[47] See, for example, Tobin (1972) for a generalization of the wage price mechanism.

curve on which the wage-price mechanism was based. Major theoretical shifts in the theory or money and economic growth include the elimination of the long-run trade-off and the introduction of exchange rates. These in turn introduced the price behaviour of economic sectors that are related to foreign competition and the distinction between producer and consumer prices (Blanchard 1990:787). Early evidence on these theoretical developments is found in among others, Friedman and Schwarts (1963), Sims (1972), Barro (1977), Mishkin (1983) and King and Plosser (1984).

Models of imperfect competition in which even changes in nominal money balances could affect output followed this body of theoretical advancements. Lucas (1972) developed macroeconomic models in line with this development. The core message of these models was that anticipated money changes had no effect on output and how unanticipated money could influence output under conditions of market clearing and imperfect information. However, as a policy implication, the models revealed that if the monetary authority had no more information than the public, the effect was unlikely to improve welfare.[48]

A third body of literature accommodates the aspect of imperfect information by incorporating rational expectations within the wage price mechanism. Fischer (1977) and Taylor (1980) developed models of this nature. Within Fischer's framework, demand for money shocks affect output only to the extent that they are unanticipated. In line with Keynesian analysis, given flexible prices and fixed nominal wages, demand shocks cause an increase in prices, a fall in wages and an increase in employment and output. In the context of Taylor's framework, wages are fixed at some nominal level for two periods. An increase in unanticipated money therefore has no effect on wages or prices in the current period implying a full-scale effect on output. However, with time wages and prices adjust so that output returns to the equilibrium level.

[48] See for example, Lucas (1973), Sargent (1973) and Sargent and Wallace (1975).

3.6.6.1 Models of perfect competition

Mishkin (1995:4) concurs with Tobin (1968) that while monetary policy is a powerful tool, it has the potential to produce unexpected and sometimes dreadful results. In another dimension, while others (for example Laidler 1999:9) believe that a transitory monetary shock cannot have lasting effects on the economy while a permanent shock will, depending on among others the nature of the monetary system, others believe that whether transitory or permanent, a monetary shock will affect the real economy. On the other hand, early evidence such as Friedman and Schwartz (1963) suggest that changes in money supply create movements in real variables.

While the Keynesian belief is that money is non-neutral in the economy, mainly because of the existence of wage and price rigidities, the classical belief is that money is neutral with changes in nominal money being reflected only in nominal prices and not in output and employment. Beginning from the development of the quantity theory of money by Fischer (1920) and the cash balance equation by the Cambridge school, the classical doctrine has maintained the neutrality of money. Within this framework, changes in money balances are reflected in changes in the price level and are regarded as a source of instability in the economy. This mechanism implicitly assumes perfect foresight.

Since the 1930s to the mid-1970s, economists shared a common view that changes in nominal money balances brought about changes in aggregate demand, thereby influencing real variables. The adjustment was believed to take place by way of the rate of interest. Given the Keynesian fixed price system, nominal wages and prices were slow to adjust to changes in employment and output so that changes in nominal money balances could be translated into changes in real money and ultimately output. The transmission from money to aggregate demand and the wage price mechanism dominated research at that time. The fixed price model of Barro and Grossman (1971, 1976) provides the basis for exploring the effectiveness of policy regimes in a non-Walrasian

setting.[49] Blanchard (1990:782) presents the Keynesian framework that supports the transmission from money to aggregate demand as follows.

$$y = a(m - p) \qquad a > 0 \tag{3.18}$$

$$y = b(w - p) \qquad b < 0 \tag{3.19}$$

$$w = w^{*} \tag{3.20}$$

where y is real output, m, w and p are real money, real wages and prices respectively. The first equation represents aggregate demand. Equation (3.19) represents aggregate supply while equation (3.20) represents fixed real wages. This framework is based on the assumption of a Walrasian *tatonnement* process that real wages provide an adjustment mechanism in the labour market. However, workers suffered from money illusion so that they observed nominal wages, which are rather sticky compared to prices (Gordon, 1976:188). For this reason, and because the process of adjustment would take some time, an increase in nominal balances would lead to a rise in prices, a reduction in real wages and ultimately an increase in employment and output.

3.6.6.2 Wage-price mechanisms

As already mentioned, according to the wage price mechanism, prices were regarded as mark-ups over unit costs and were not believed to be following movements in aggregate demand (Blanchard 1990:784; Gordon 1976:212).[50] Thus prices played a passive role in the adjustment process so that real wages changed instantaneously and fully. In this mechanism, the augmented Phillips curve played a major role in the determination of wages. Tobin (1972) and Blanchard (1990) present the wage price mechanism by the following system.

$$y = a(m - p) \tag{3.21}$$

$$p = w \tag{3.22}$$

[49] See also Benassy (1990).
[50] See also Tobin (1972) and Santomero and Seater (1978).

$$w - w_{-1} = b(p_{-1} - p_{-2}) + cy \qquad 0 < b < 1; c > 0 \qquad (3.23)$$

As in the previous system, the first equation represents aggregate demand. Equations (3.22) and (3.23) show the instantaneous pass through of prices into real wages and the wages equation that gives wages as a function of lagged prices and output as a proxy for unemployment respectively. This model shares a common view with the Keynesian system that aggregate demand determines the level of output, at least in the short-run. A rise in nominal money leads to an increase in output and aggregate demand initially, leading to a rise in prices. However, in this system there is no money illusion so that real wages are changed instantaneously. In the final analysis, output returns to its original level.

3.6.6.3 Models of imperfect competition

Imperfect information and expectations

Towards the mid-1970s the wage price mechanism faced a serious crisis based on weaknesses in its theoretical foundations. Phelps (1967) and Friedman (1968) advanced one of the major criticisms by introducing the natural rate hypothesis and the rational expectations. This implied that unexpected demand movements only and not systematic components, could explain unemployment. By this, the trade off between inflation and unemployment was very much doubted. This swerved further developments into two directions. One involves a move back to the classical based models of perfect competition and price flexibility but featuring imperfect information. The other takes the imperfect information route. The essence of this line of thinking is that with agents having limited information, there is potential that nominal monetary shocks could influence output. One of these models is that of Lucas (1972), which suggested that with imperfect information, money could influence real output. The development of wage price mechanisms with imperfect information has to a large extent followed the theoretical foundations of the search models of unemployment. Within a framework of imperfect competition, the

Lucas model maintains the assumption of perfect competition and is represented by the following system.

$$y = a(m - p) \tag{3.24}$$

$$p_i = p + e_i \qquad i = 1,...,n \tag{3.25}$$

$$y_i = b(p_i - E_i p) \tag{3.26}$$

Equation (3.24) is the aggregate demand while equation (3.25) gives the price that is faced by each firm p_i, which is different from the price level p, by the random component e_i. Equation (3.26) is the supply of each firm, which depends on price expectations $E_i p$. In this model the fact that there is imperfect competition implies that there is a component of money supply increase that is not anticipated. It is this component that leads to a change in output. Thus, firms misperceive monetary shocks for relative price shocks. A major shortcoming of this model is failure to explain the mechanism through which monetary shocks are translated into permanent changes in output. Further investigation by Lucas and Rapping (1969) suggested that while it is unlikely for perceived permanent changes in real wages to trigger changes in supply because of their conflicting income and substitution effect, temporary changes could have the potential to trigger larger responses because they depend only on substitution effects. Thus if firms realised a temporary increase in the price of output, they would increase output.[51]

Two channels through which misperceptions of monetary shocks could lead to permanent changes in output were in turn identified. Lucas (1975) pointed out that if misperceptions led agents to change variables that affected their decisions in the future, for example, capital, then the initial shock would have lasting effects.[52] The second channel identified by Lucas (1975) and Taylor (1975) reveals that if there still is a lack of information, *ex post*, large permanent shocks could be misperceived for changes in the relative price for a long time during which they will change output. The model developed by Weiss (1980) to assess the role of monetary policy under conditions of perfect and imperfect

[51] See also Hahn (1978), Hart (1982), Snower (1983) and Weitzman (1985).
[52] See also Howitt (1986), Blinder and Fischer (1981) and Sargent (1979).

information reaches similar conclusions. The model of Benassy (1987) also provides theoretical understanding of monetary policy under conditions of imperfect competition and unemployment and can be used to explain conditions of monetary neutrality and non-neutrality.

The general policy implication of these models is that while anticipated money cannot influence output, unanticipated monetary shocks could only affect output. This, in turn, implies that the role of monetary policy is reduced significantly as compared to its role under standard wage price mechanisms. Notwithstanding, a word of caution is provided that if monetary authorities had no more information than the public, the outcome would reduce the allocation of efficiency of the price system, as it would provide incorrect signals (Blanchard 1990:797).[53]

Research along the lines of imperfect information later took the route of real business cycle models. In many of these models, it is not the role of monetary shocks per se that takes the centre stage, but fiscal shocks and changes in technology. A salient feature however is the reverse causality between money and output. An exception in which money precedes output is when money is regarded as a factor or production.

Nominal rigidities and rational expectations

One of the models that introduced nominal rigidities and rational expectations within the context of the wage price mechanisms is that developed by Fischer (1977). The framework is represented by the following system.

$$y = (m - p) + u \tag{3.27}$$

$$y = -(w - p) \tag{3.28}$$

$$w = E(P|-1) \tag{3.29}$$

[53] Also see Lucas (1975), Sargent and Wallace (1975) and Sargent (1973).

Equation (3.27) is aggregate demand. Equation (3.28) is output supply and equation (3.29) indicates that nominal wages are preset at the beginning of the period on the basis of available information. Solving for real wages in this system gives the outcome that both demand and monetary shocks influence output only when they are unanticipated. The transmission channel is similar to that of the Keynesian models. Given that prices are flexible and money wages are rigid, an increase in demand leads to a rise in prices, a fall in real wages and a rise in output. In this model, policy makers need to have more information than the wage setters to be able to maintain stable output levels. In the staggered wage setting model in which wages are set for periods longer that the time between policy decisions, the models suggest that activist monetary policy can be used effectively to offset the effects of multi-period predetermination of wages.

In Taylor's (1980) model, wages are not only predetermined but are fixed to two consecutive periods. The model as presented in Taylor (1979) is as follows.

$$y = (m - p) \tag{3.30}$$

$$p = \frac{1}{2}(w - w_{-1}) \tag{3.31}$$

$$w = \frac{1}{2}[p + E(p(+1)|-1)] + \frac{1}{2}a[E(y|-1) + E(Y(+1)|-1)] \tag{3.32}$$

Equation (3.30) is aggregate demand, equation (3.31) gives the price level as a weighted average of the wages and equation (3.32) is the wage chosen in the current period for the current and next period. The solution of this model under rational expectations reveals that money has no effect on wages or prices in the current period so that it has a full effect on output. However, with time, nominal wages and prices adjust and output returns to its original path. In this model, the effects of money last for a longer period than in the previous model of Fischer. While the two models predict non-neutrality of money, it is important to note that this outcome requires the existence of real rigidities.

3.6.6.4 Standard monetary policy channels

A digression from the wage price mechanisms is the standard monetary policy channels. The mechanism of monetary impulses through the rate of interest represents one of the important elements of the Keynesian system. According to this mechanism, contractionary monetary policy leads to a rise in the rate of interest, which in turn raise the cost of capital so that investment spending falls. Falling investment is then transmitted into a fall in aggregate demand and output. Within this framework the interest rate effect has not only come to be associated with investment spending but also with durable consumer spending as well (Taylor 1995).[54] However, Laidler (1999:7) points out that the account of this mechanism is incomplete, given the complex interactions of open economies.[55] He emphasises the credit channel arguing that the willingness to buy or borrow following a fall in the rate of interest does not depend so much on the interest elasticity of demand for money as it depends on the interest elasticity of supply of indebtedness in the banking system.

The exchange rate represents one of the important conduits of monetary impulses in the advent of flexible exchange rates and intensified integration of economies (Taylor 1995; Obstfeld and Rogoff 1995). This channel is however dependent on the effect of the interest rate on the exchange rate. By this mechanism expansionary monetary policy leads to a fall in the rate of interest, which in turn leads to outflows of portfolio investment and a depreciation of the domestic currency. This makes domestic commodities less expensive than foreign commodities, hence a rise in net exports and output.

The effect of money supply on prices of other assets takes a rather universal approach to the assessment of the effects of relative prices of assets and real wealth. Two main channels are usually associated the effect of relative prices. These are the Tobin Q

[54] This proposition is however not supported by empirical evidence in many cases. In addition, evidence of the interest elasticity of investment is hard to come by, particularly in developing countries. See for example, Fry (1980), Molho (1986), Oshikoya (1992) and Hadjimichael and Ghura (1995).
[55] Also, this mechanism has been heavily criticized on the use of only one relative asset price, the rate of interest (see Tobin 1968:29).

investment channel and the wealth effects channel that operates through consumption spending. The former works itself though the valuation of assets. The argument is that a monetary expansion increases expenditures on investment through a higher demand for stocks. In turn, this increases the prices of equities. This increases the Q value of stocks, increasing investment and output. This channel closely resembles the Keynesian interest rate channel though it uses a narrower definition of assets. The consumption channel works via the relative asset prices through the life cycle hypothesis. By this mechanism, when stock prices rise, the value of financial wealth rises, increasing the lifetime resources of consumers. Thus, lifetime consumption rises. According to Meltzer (1995), this analysis can be extended to its effect on land and property values.

Bernanke and Gertler (1995) discuss two basic channels of monetary transmission namely, the bank lending channel and the balance sheet channel. The bank-lending channel works through the role of the banking institutions in the financial sector. According to this route, monetary expansion that increases bank reserves and deposits is expected to cause a rise in bank loans, investment expenditures and income.[56] On the other hand, the balance sheet channel operates through the net worth of firms. Several ways is which this channel works have been identified. One way is through the change in equity prices, which in turn leads to two different changes namely, changes in the behaviour of the firm and changes in its portfolio composition. Another view is through the interest rate channel. Starting with the former, an increase in stock prices originating from monetary expansion may lower adverse selection and moral hazard behaviour so that the net worth of the firm rises. This in turn raises investment and aggregate demand. Similarly, a rise in stock prices increases the value of financial assets, reducing the likelihood of financial distress. This in turn leads to a rise in expenditures on consumer durables and therefore income. The interest rate channel works such that a fall in the rate of interest following a monetary expansion improves the balance sheet of the firm, so cash flow rises. This in turn reduces adverse selection and moral hazard behaviour. In that way lending increases, and so does investment and output.

[56] This effect is however believed to have eroded considerably with developments in the financial sectors over the years (Edwards and Mishkin 1995; Meltzer 1995 and Bernanke and Gertler 1995).

3.7 CONCLUSION

The literature reviewed in this chapter has laid the foundations for the interrelationships that exist among the different sectors of the economy. The mechanisms by which the variables tend to affect each other provide a basis for modelling the individual sectors with the view of integrating them in a macroeconomic system. This review brings out clearly the importance of the government sector in the context of a macroeconomic model and how imbalances in that sector affects key macroeconomic variables. One of the important features that are highlighted by the review is the interdependence of the monetary sector, the prices sector and the labour market at a theoretical level. This review is used as a basis for the specification of the model in chapter five.

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.

CHAPTER 5

MODEL SPECIFICATION

5.1 INTRODUCTION

This chapter aims to specify and present the macroeconometric model for Lesotho that is constructed and estimated in this study. The chapter draws heavily on the literature reviewed in chapters three and four, especially on issues of specification and estimation techniques. It also draws on the review of the economy discussed in chapter two for guidance on capturing the specific features and uniqueness of the economy of Lesotho. The following four sectors of the economy are modelled:

The real sector

The real sector consists of the supply side, the demand side and the price block. The supply side determines real aggregate domestic output by estimating a Cobb-Douglas type production function, demands for private investment and labour as well as real wages. The demand side of the real sector determines private consumption expenditure. The price block estimates four relations, *viz*, the producer prices, the consumer prices, export prices and import prices.

The external sector

The external sector consists of identities describing the major accounts in the balance of payments, namely, the capital and financial balance, the current account balance and the overall balance of payments balance. It estimates real exports of goods and services and real imports of goods and services.

The government sector

The government sector consists of identities describing the major components of government expenditure and its relation to other sectors. It determines five kinds of taxes stochastically. These are the individual income tax, company tax, other income tax, goods and services tax and other taxes. Other sources of revenue, namely,

customs revenue and non-tax revenues are assumed exogenous. It defines the government budget deficit as the difference between government revenue and expenditures. The sector also estimates the levels of government external and domestic debt and relates them to the balance of payments and the government budget deficit.

The monetary sector

The monetary sector estimates the demands for three monetary aggregates namely currency in circulation, demand deposits, and time and saving deposits. It also estimates the nominal Treasury bill rate.

5.2 LIST OF VARIABLES

The list of variables in the model is presented below in the order of endogenous, exogenous and dummy variables. Unless otherwise stated, the variables are measured in millions of Maluti.

ENDOGENOUS VARIABLES

VARIABLE ACRONYM	NATURAL LOG FORM	VARIABLE NAME AND DESCRIPTION	SOURCE
BOP		Overall balance of the balance of payments	CBL
COMPTAX	LCOMPTAX	Company tax revenue	CBL
CPI95	LCPI95	Consumer price index (1995=100)	CBL
CU2	LCU2	Capacity utilization	(RGDPFC/RGDPFC_POT)*100
CUR		Nominal currency in circulation	CBL
DD		Nominal demand deposits	CBL
DEBT		Total government debt	CBL
DOMDEBT		Total government domestic debt	CBL
ED	LED	Excess Demand	(RGDE/RGDP)*100
EXTDEBT		Total government external debt	CBL
GDPDEF	LGDPDEF	GDP deflator (1995=100)	(NGDP/RGDP)*100
GOVBAL		Government budget balance	CBL
GSTAX	LGSTAX	Goods and services tax revenue	CBL
IITAX	LIITAX	Individual income tax revenue	CBL
INFL1	LINFL1	CPI Inflation rate	((CPI95/CPI95(-1))-1)*100
INV		Change in inventories	CBL

K	LK	Capital stock	CBL
L[77]	LL	Labour	CBL
LABPROD1	LLABPROD1	Labour productivity	(RGDP/L)*1000000
M		Money multiplier	(MS/RM)
MGSRELP1	LMGSRELP1	Relative price of imports of goods and services	(PMGS1/CPI95)*100
NCAB3		Nominal current account balance	CBL
NGCONS		Nominal government consumption expenditure	CBL
NGDP		Nominal GDP at market prices	CBL
NGDPFC		Nominal GDP at factor cost	CBL
NGNP		Nominal GNP	CBL
NKFB		Nominal capital and financial balance of BOP	CBL
NM1		Nominal M1 money supply	CBL
NM2		Nominal M2 money supply	CBL
NM3		Nominal M3 money supply	CBL
NMGS		Nominal imports of goods and services	CBL
NWAGES	LNWAGES	Nominal wages	CBL
NXGS		Nominal exports of goods and services	CBL
NYD		Nominal disposable income	CBL
OINCTAX	LOINCTAX	Other incomes tax revenue	CBL
OTAX	LOTAX	Other tax revenue	CBL
PMGS1	LPMGS1	Import prices (1995=100)	(NMGS/RMGS)*100
PXGS	LPXGS	Export prices (1995=100)	CBL
RCUR	LRCUR	Real currency in circulation	(CUR/GDPDEF)*100
RDD		Real demand deposits	(DD/GDPDEF)*100
RGCONS		Real government consumption expenditure	CBL
RGDE		Real GDE	(RTOTINV+RGCONS+RPCONS)
RGDP	LRGDP	Real GDP	CBL
RGDPFC		Real GDP at factor cost	CBL
RGINV		Real government investment	(RTOTINV-RPINV-INV)
RGNP	LRGNP	Real GNP	CBL
RM31	LRM31	Real M3 money supply	(NM3/GDPDEF)*100
RMGS	LRMGS	Real imports of goods and services	CBL
RNTOTINV		Real net total investment	((RTOTINV-(DEPR*RTOTINV))
RPCONS	LRPCONS	Real private consumption expenditure	CBL
RPINV	LRPINV	Real private investment expenditure	CBL
RTBRATE1		Real treasury bill rate	(TBRATE-INFL1)
RTSD	LRTSD	Real time and savings deposits	(TSD/GDPDEF)*100
RUCC	LRUCC	Real user cost of capital	(GDPDEF/100)*((RTBRATE/100)+DEPR)/((1-

[77] Measured in thousands.

			(((COMPTAX/GDPDEF)*100))/RGDPFC))
RWAGES2	LRWAGES2	Real wages	(NWAGES/GDPDEF)*100
RWAGESUCC2	LRWAGESUCC2	Ratio of real wages to real user cost of capital	(RWAGES2/RUCC)
RXGS	LRXGS	Real exports of goods and services	CBL
RYD	LRYD	Real disposable income	(NYD/GDPDEF)*100
STDDEBT		Short term government debt	CBL
TBRATE	LTBRATE	Treasury bill rate	CBL
TOTGOVEXP		Total government expenditure	CBL
TOTREC		Total government receipts	CBL
TOTREV		Total government revenue	CBL
TSD		Nominal time and saving deposits	CBL
XGSRELP1	LXGSRELP1	Relative price of exports of goods and services	(PW1/PXGS)*100

EXOGENOUS VARIABLES

CAPEXP		Government capital expenditures	CBL
CONSDEF		Deflator for government consumption	(NGCONS/RGCONS)*100
CURTRS		Current transfers in BOP	CBL
CUSTREV		Customs (SACU) revenue	CBL
DEPR		Rate of depreciation	Assumed to be 20%
ERR		Errors and omissions in BOP	CBL
EXRATE	LEXRATE	Rand-Dollar exchange rate	CBL
FB		Financial balance in BOP	CBL
GDPFCDEF		Deflator for GDP at factor cost	(NGDPFC/RGDPFC)*100
GNPDEF		GNP deflator	(NGNP/RGNP)*100
GOVDEP		Government deposits	CBL
GOVEXPRES		Total government expenditures residual	TOTGOVEXP-(RECUEXP+CAPEXP)
GOVRESID		Residual for nominal government expenditures	NGCONS-(RECUEXP-OGS-SUBTRS)
GRANTS		Grants	CBL
INCBAL		Incomes balance in BOP	CBL
KB		Capital balance in BOP	CBL
KRES		Capital stock residual	
LTDDEBT		Long term government domestic debt	CBL
MGSRES		Residual for imports of goods and services	$NMGS^{NATIONAL\ ACCTS}$-$NMGS^{BOP}$
NNFIB		Nominal net factor income from abroad	CBL
NONTAXREV		Non-tax government revenue	CBL
NTRS		Net transfers	CBL
OGS		Purchases of other goods and services by government	CBL

PNETAX		Net taxes on production and imports	CBL
PW1	LPW1	World price	IFS
RECUEXP		Government recurrent expenditure	CBL
RF		SA short-term interest rate (Bankers acceptance rate)	SARB
RGDPFC_POT		Potential real GDP at factor cost	Derived by applying Hodrick-Prescott filter on RGDPFC
RM		Reserve money	CBL
RTOTINV		Real total investment	(RPINV+RGINV+INV)
SERVBAL		Balance of services in current account of BOP	CBL
SUBTRS		Government expenditure on subsidies and transfers	CBL
TIME		Time trend (proxy for technological advancements)	1,2,3,…,N
VALADJ		Valuation adjustment in BOP	CBL
WDEMND	LWDEMND	World demand	IFS
XGSRES		Residual for exports of goods and services	$XGS^{NATIONAL\ ACCTS}$-XGS^{BOP}

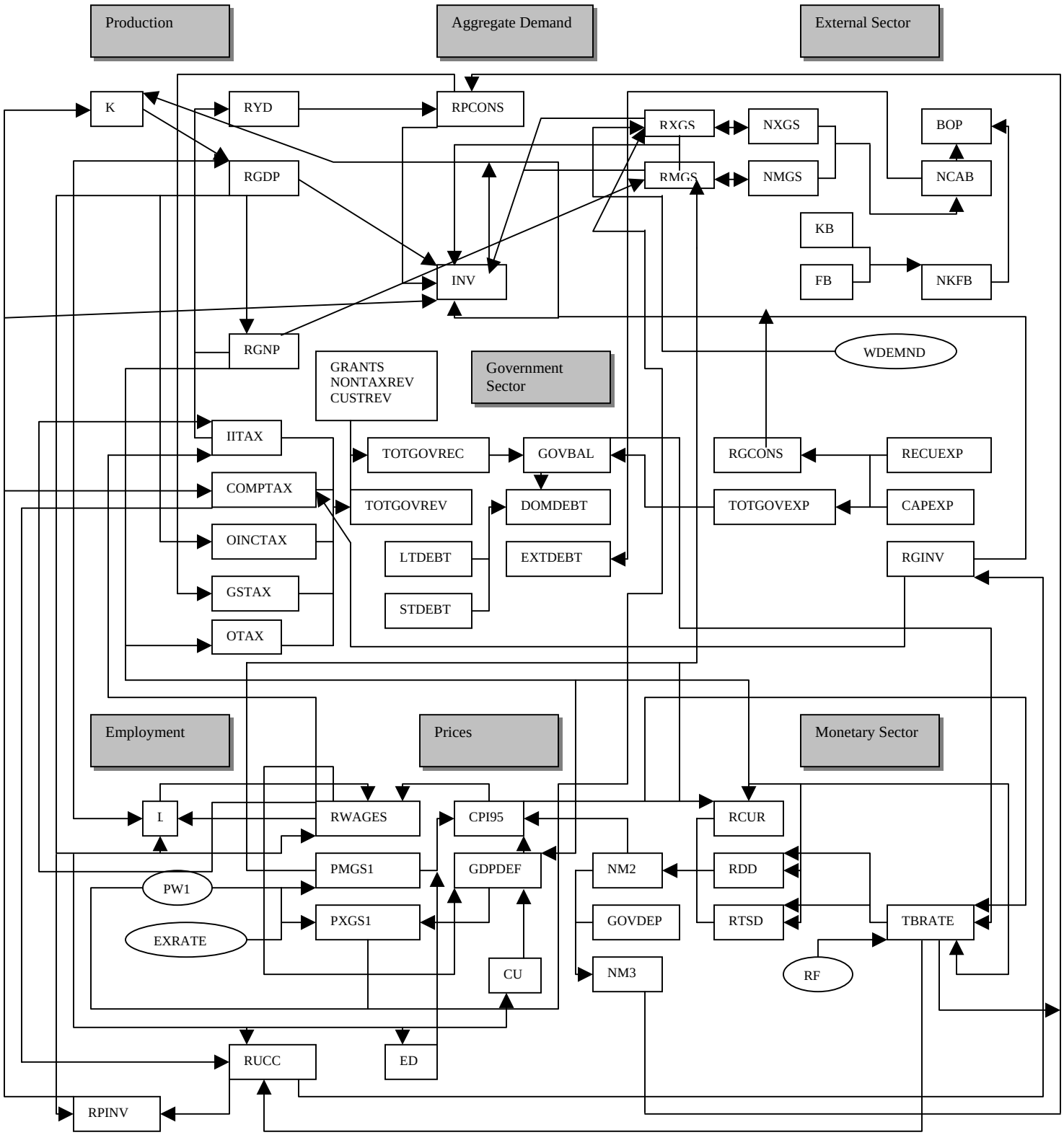
DUMMY VARIABLES

LABEL	DESCRIPTION	CONSTRUCTION
DUM8084	Tax reforms	1980-1984 = 1; 0 otherwise
DUM8086	1986 Coup	1980-1986 = 1; 0 otherwise
DUM8088	Tax reforms	1980-1986 = 1; 0 otherwise
DUM8090	Tax reforms	1980-1990 = 1; 0 otherwise
DUM8092	Tax reforms	1980-1992 = 1; 0 otherwise
DUM82	Tax reforms	1981-1983 = 1; 0 otherwise
DUM83	Tax reforms	1983 = 1; 0 otherwise
DUM8384	Tax reforms	1983-1984 = 1; 0 otherwise
DUM84	Tax reforms	1984 = 1; 0 otherwise
Dum85	Tax reforms	1985 = 1; 0 otherwise
DUM86	1986 Coup	1986 = 2; 0 otherwise
DUM8687	1986 Coup	1986-1987 = 1; 0 otherwise
DUM8691	1986 Coup	1986-1991 = 1; 0 otherwise
DUM8695	1986 Coup	1986-1996 = 1; 0 otherwise
DUM87	Inception of LHWP	1987 = 1; 0 otherwise
DUM88	Inception of SAPs	1988 = 1; 0 otherwise
DUM8892	Phase 1A of LHWP	1988=1.1; 1989=1.2; 1990=1.5; 1991=1.8; 1992=1.5; 0 otherwise
DUM89	Inception of the SAP	1989 = 1; 0 otherwise
DUM8992		1989-1992 =1; 0 otherwise
DUM90	Inception of reforms	1990 = 1; 0 otherwise
DUM9020	Economic reforms	1990-2000 = 1; 0 otherwise
DUM9092	Inception of reforms	1990-1992 =1; 0 otherwise

DUM91	LHWP expenditure increases	1991 = 1; 0 otherwise
DUM9192	LHWP expenditure increases	1991-1992 = 1; 0 otherwise
DUM9194	LHWP expenditure increases	1991-1994 = 1; 0 otherwise
DUM92	LHWP expenditure increases	1992 = 1; 0 otherwise
DUM93	LHWP expenditure increases	1993=1; 0 otherwise
DUM9298	Duration of major LHWP expenditures	1992-1998=1; 0 otherwise
DUM94	Industrial actions in the manufacturing sector	1994 = 1; 0 otherwise
DUM95	Industrial actions in the manufacturing sector	1994-1996 = 1; 0 otherwise
DUM9598	Industrial actions in the manufacturing sector	1995-1998 = 1; 0 otherwise
DUM96	LHWP expenditure increases	1996 = 1; 0 otherwise
DUM9697	Interest rate hikes	1996-1997 = 1; 0 otherwise
DUM97	Interest rate hikes	1997=1; 1998=1.2; 1999=1.3; 2000=1.4; 0 otherwise
DUM9798	1998 Political riots	1997-1998 = 1; 0 otherwise
DUM98	1998 Political riots/Winding up of LHWP construction activities	1998 = 1; 0 otherwise
DUM982	1998 Political riots	1998=1.5; 1999=1.3; 2000=1.2; 0 otherwise
DUM99	Implementation of SMP	1999-2000 = 1; 0 otherwise
DUM20	SMP Period	2000 = 1; 0 otherwise

5.3 A SCHEMATIC VIEW OF THE MODEL

Figure 5.1 A Flow Chart of the Model



The model is presented in the form of a flow chart in Figure 5.1. The chart highlights the major interactions and basic relationships in the model and keeps the secondary details to the minimum. Aggregate real GDP is produced under the production sector according to the Cobb-Douglas technology and leads to the demand for factors of production, labour and capital. The demand for labour is determined by real output and real wages while investment demand is determined by real output and the real user cost of capital. Real wages depend on the endogenous labour productivity and consumer prices. Real GDP is linked to the real GNP by net factor income from abroad and to real disposable income by indirect taxes net of subsidies and net transfers. The aggregate demand sector determines the private consumption, which depends on real disposable income, real broad (M3) money balances and the real interest rate. The price sector determines consumer and producer prices and export and imports prices. These are affected directly by variables in the monetary and the employment sectors in particular and in turn affect variables in the monetary sector, the employment sector, the government sector, aggregate demand and aggregate supply. Producer prices depend on capacity utilization, real wages and the user cost of capital, while consumer prices depend on producer prices, import prices and the excess demand in the economy. Export prices depend on the world price, the exchange rate and the producer prices while import prices are determined by the exogenous world prices and the exchange rate.

The external sector determines the major balances in the balance of payments, real exports of goods and service and real imports of goods and services. The flow of exports to the rest of the world depends on the exogenous world demand and the relative price of exports. Real GNP and the relative price of imports determine the demand for imports of goods and services. The flows in the balance of payments are directly related to net exports in the aggregate demand sector. The government sector determines the revenues and expenditures as well as the external and internal indebtedness of government. The government receives taxes, non-tax revenues and grants and customs revenue. The latter three are exogenous while the five different types of taxes estimated depend on variables determined in the aggregate demand sector, the supply sector and the employment sector. In turn, government expenditures consist of broader classifications of capital and

recurrent expenditures. The interaction of the receipts and expenditures of government determines the government budget deficit. In general, the government sector is linked directly to the monetary sector, the external sector, the aggregated demand and supply sectors and indirectly to the price and employment sectors. The monetary sector determines the real demand for money and nominal Treasury bill rate of interest and is fed by impulses from the government sector and the production sector. In turn, the monetary sector feeds directly into the price sector and the aggregate demand sector.

5.4 MODEL SPECIFICATION

This section presents the equations of the model. These include the behavioural equations, identities and bridge equations of the sectors. While the specifications are made to be anchored on strong theoretical grounds, it is acknowledged here that, because of the softness and inconsistency of the data, a general-to-specific specification search is employed to obtain short run adjustments equations. In addition, the model makes liberal use of dummy variables in the estimation stage, to capture major events and structural changes in the economy.

5.4.1 The real sector

5.4.1.1 Aggregate supply

Production

The long run specification of the production function follows a Cobb-Douglas structure and relates aggregate output to capital, labour and a measure of technical progress in the form of a time trend.

$$LRGDP = \alpha + \beta_1 LL + \beta_2 LK + \beta_3 TIME + \varepsilon \qquad (5.1)$$

The variable, *TIME*, a proxy of technological advancements, is treated as exogenous in the model.

While labour demand is determined stochastically, the following relation describes the evolution of the capital stock,

$$K = RNTOTINV + (1 + DEPR)K_{-1} - KRES \quad (5.2)$$

[78]

where *RNTOTINV* stands for real net total investment and is derived by means of the following relation.

$$RNTOINV = RTOTINV - (DEPR * RTOTINV) \quad (5.3)$$

RTOTINV is real gross total investment and is the sum of the real private and government investment and the change in inventories. This definition is captured in the following derivation of government investment expenditure (*RGINV*), which is derived as a residual of the following form:

$$RGINV = RTOTINV - RPINV - INV \quad (5.4)$$

Real private investment demand

Within this framework, real private investment is determined stochastically and is specified in the long run as a function of real output, the real user cost of capital and four dummy variables. This specification combines the accelerator principle with the Jorgenson neoclassical approach.

$$LRPINV = \alpha + \beta_1 LRGDP + \beta_2 LRUCC + \varepsilon \quad (5.5)$$

The user cost of capital is determined endogenously as follows

[78] *KRES* is a balancing item, created as a difference between the capital stock and the conventional way of deriving capital stock. This difference is a result of the discrepancies in the data set and presumably the assumption of a 20 per cent depreciation of capital stock.

$$RUCC = \frac{\left(\frac{GDPDEF}{100}\right) * \left(\frac{RTBRATE1}{100} + DEPR\right)}{\left(1 - \left(\frac{\left(\frac{COMPTAX}{GDPDEF}\right) * 100}{RGDPFC}\right)\right)} \tag{5.6}$$

where real GDP at factor cost, *RGDPFC* is defined as

$$RGDPFC = \left(\frac{NGDPFC}{GDPFCDEF}\right) * 100 \tag{5.7}$$

where *GDPFCDEF* is the exogenous deflator for GDP at factor cost and

$$NGDPFC = NGDP - PNETAX \tag{5.8}$$

where *PNETAX* is net taxes on production and imports and is determined exogenously.

Labour demand

To portray the surplus labour feature of the economy, only labour demand is modelled. This makes allowance for labour demand to determine employment conditions in the model. Given that labour demand is a derived demand, the long-run relationship is specified as a function of real output and real wages. This specification derives from the micro foundations of profit maximizing behaviour by firms by which the level of employment is determined by the condition that the marginal revenue product of labour is equal to the wage rate. Because of the waning dependency of employment, the idea of the inclusion of foreign GDP, particularly that of South Africa, was considered not relevant (see for example, Elliot *et al*. 1986).

$$LL = \alpha + \beta_1 LRGDP + \beta_2 LRWAGES2 + \varepsilon \tag{5.9}$$

The following relationship serves to explain the derivation of real wages and its relation to nominal wages.

$$NWAGES = \left(\frac{RWAGES2 * GDPDEF}{100} \right) \tag{5.10}$$

In turn, real wages and the GDP deflator are determined stochastically in the following section.

Real wages

The long-run specification of the wages equation presents real wages as a function of labour productivity and the consumer price index. A suitable measure of unemployment could not be obtained because of data limitations, hence, consumer prices are used in this equation as a proxy for the disequilibrium in the economy.

$$LRWAGES2 = \beta_1 LLABPROD1 + \beta_2 LCPI95 + \varepsilon \tag{5.11}$$

While consumer prices are determined endogenously in the price block, labour productivity, *LABPROD1*, is defined as the ratio of labour to real GDP as follows

$$LABPROD1 = \left(\frac{L}{RGDP} \right) * 1000000 \tag{5.12}$$

5.4.1.2 Aggregate demand

Ideally, the expenditure sector determines the aggregate demand for goods and services. Of all the components of aggregated demand, only real private consumption is determined in the expenditure sector in this model.

Real private consumption expenditure

The specification of the real private consumption follows the permanent income and life-cycle hypothesis. In the long run, it is specified as a function of real disposable income, real broad money supply (*M3*) to proxy real wealth and the real Treasury bill rate. This

specification is based on the notion that liquidity-constrained consumers make consumption choices based only on disposable income and that their rate of time preference and rate of return are identical. On the other hand, unconstrained consumers base their decisions on total lifetime resources with the marginal propensity to consume fluctuating over time to account for consumption smoothing (Pauly 2000:6).

$$LRPCONS = \alpha + \beta_1 LRYD + \beta_2 RTBRATE1 + \beta_3 LRM31 + \varepsilon \qquad (5.13)$$

In turn, the following relation describes real disposable income.

$$RYD = \left(\frac{NYD}{GDPDEF} \right) * 100 \qquad (5.14)$$

Nominal disposable income is defined as the sum of nominal gross national output and net transfers.

$$NYD = NGNP + NTRS \qquad (5.15)$$

While net transfers are determined exogenously in this model, national output in nominal terms is defined as the sum of nominal domestic output and nominal net factor income from abroad as follows.

$$NGNP = NGDP + NNFIB \qquad (5.16)$$

Nominal net factor income from abroad is determined exogenously, while nominal domestic output is defined as and related to real domestic output by the following relation.

$$NGDP = \frac{(RGDP * GDPDEF)}{100} \qquad (5.17)$$

Real broad money (*M3*) is derived in the following relation.

$$RM31 = \left(\frac{NM3}{GDPDEF} \right) * 100 \qquad (5.18)$$

where nominal *M3* is given as the sum of nominal *M2* and government deposits as follows.

$$NM3 = NM2 + GOVDEP \qquad (5.19)$$

While the determination of nominal *M2* and the real Treasury bill rate of interest are described in the monetary sector, government deposits, *GOVDEP*, is treated as exogenous.

5.4.1.3 Prices

This section presents the modelling of prices, consisting of producer prices, consumer prices, export price, and imports prices.

Consumer prices

The CPI is used to represent consumer prices in the model. In the long run, consumer prices are modelled as a function of the producer prices as represented by the GDP deflator, a measure of excess demand, *LED* and import prices.

$$LCPI95 = \alpha + \beta_1 LGDPDEF + \beta_2 LED + \beta_3 LPMGS1 + \varepsilon \qquad (5.20)$$

Excess demand (*ED*) is defined and specified as the ratio of expenditures (*RGDE*) to real output (*RGDP*) and hence, captures the demand and supply sides.

$$ED = \left(\frac{RGDE}{RGDP} \right) * 100 \tag{5.21}$$

where RGDE is defined as the sum of total investment (*RTOTINV*) and private and public consumption

$$RGDE = RTOTINV + RGCONS + RPCONS \tag{5.22}$$

Producer prices

Because of limitations in the data, the GDP deflator is used as a proxy for producer prices in the model. In the long run producer prices are specified as a function of capacity utilisation and the ratio of real wages to the user cost of capital.

$$LGDPDEF = \alpha + \beta_1 LCU2 + \beta_2 LRWAGESUCC2 + \varepsilon \tag{5.23}$$

In turn, capacity utilisation is defined as the ratio of actual real GDP at factor cost (*RGDPFC*) to potential real GDP at factor cost (*RGDPFC_POT*).

$$CU2 = \left(\frac{RGDPFC}{RGDP\_POT} \right) * 100 \tag{5.24}$$

Potential real GDP at factor cost is derived by fitting a trend on *RGDPFC* using the Hodrick-Prescott filter.

The following relation gives the ratio of real wages to the real user cost of capital:

$$RWAGESUCC2 = \frac{RWAGES2}{RUCC} \tag{5.25}$$

Export prices

Export prices are specified in the long run as a function of world prices, the nominal exchange rate and producer prices.

$$LPXGS = \alpha + \beta_1 LPW1 + \beta_2 LEXRATE + \beta_3 LGDPDEF + \varepsilon \quad (5.26)$$

The exchange rate is considered exogenous in this model.

Import prices

In the long run, import prices are specified to be a function of the world price, the nominal exchange rate and *DUM8088*.

$$LPMGS1 = \alpha + \beta_1 LPW1 + \beta_2 LEXRATE + \varepsilon \quad (5.27)$$

5.4.1.4 Closure of the real sector

Specifying the national income identity closes the real sector. The change in inventories is derived by an identity and as a residual such that it is defined as the difference between real domestic output and final expenditure. Thus,

$$INV = RGDP - RPCONS - RGCONS - RPINV - RGINV - RXGS + RMGS \quad (5.28)$$

5.4.2 The external sector

The scope for modelling the external sector in Lesotho is fairly limited by the fixed exchange rate regime and existing institutional arrangements. The sector is described in this model by a set of identities that describe the current account and the capital and financial accounts of the overall balance of the balance of payments. The sector stochastically estimates the demand for exports and imports in real terms.

5.4.2.1 The current account

The current account balance is explained in one identity describing the nominal current account balance. It is defined as the trade balance, derived as the difference between exports and imports. [79] To this, the services balance, the incomes balance and current transfers are added. While the exports and imports of goods and services are derived stochastically in real terms, the services balance, the incomes balance and the current transfers are determined exogenously.

$$NCAB3 = NXGS - XGSRES - NMGS + MGSRES + SERVBAL + INCBAL + CURTRS \quad (5.29)$$

Real exports of goods and services

In the long run specification, demand for real exports of goods and services is a function of the level of world demand and the relative price of exports. This specification includes an own price, prices of related goods and an income variable as dictated by standard economic theory. Given that the destination of exports from Lesotho is spread over a large number of countries, in particular, the USA, the EU and the Far East, a broader definition of income is chosen over the narrower definition of income of the major trading partners.

$$LRXGS = \alpha + \beta_1 LWDEMND + \beta_2 LXGSRELP1 + \varepsilon \quad (5.30)$$

[79] The terms *XGSRES* and *MGSRES* were created as balancing items for nominal exports of goods and services and nominal imports of goods and service respectively because of the discrepancies in the data. *XGSRES* is derived as the difference between the nominal exports of goods and services as reported in the balance of payments and the nominal exports of goods and services as reported in the national accounts. Similarly *MGSRES* is the difference between the nominal imports of goods and services as reported in the balance of payments and the nominal imports of goods and services as reported in the national accounts. It is noteworthy that the trade statistics in Lesotho are notorious of discrepancies and imbalances. The disparities in data between the national accounts and the balance of payments are explained to arise from differences in the timing of recording transactions and errors in data. The two accounts are hence connected in the model by statistical means.

While world demand is treated as exogenous, the relative price of exports of goods and services is determined as follows.

$$XGSRELP1 = \left(\frac{PW1}{PXGS} \right) * 100 \tag{5.31}$$

where the world price (*PW1*) is exogenous and the price of exports of goods and services (*PXGS*) is determined by a stochastic behavioural equation in the price sector of the model.

The following relation links real exports of goods and services to the nominal exports of goods and services in the balance of payments.

$$NXGS = \frac{(RXGS * PXGS)}{100} \tag{5.32}$$

Real import of goods and services

Demand for real imports of goods and services is a function of real gross national output and the relative price of imports.

$$LRMGS = \alpha + \beta_1 LRGNP + \beta_2 LMGSRELP1 + \varepsilon \tag{5.33}$$

The relative price of imports of goods and services is determined as the ratio of import prices and the consumer prices as represented by the *CPI*.

$$MGSRELP1 = \left(\frac{PMGS1}{CPI95} \right) * 100 \tag{5.34}$$

Both the import prices and the consumer prices are determined by behavioural equations in the price sector of the model.

The following relation links the real imports of goods and services to the nominal imports of goods and services in the goods and services balance of the balance of payments.

$$NMGS = \frac{(RMGS * PMGS1)}{100} \tag{5.35}$$

Real national output is linked to nominal national output by the following identity.

$$RGNP = \left(\frac{NGNP}{GNPDEF} \right) * 100 \tag{5.36}$$

The deflator for *GNP*, *GNPDEF*, is exogenously determined.

5.5.2.2 The capital and financial balance

The capital and financial balance is defined as the sum of the capital account and the financial account balances and is given as,

$$NKFB = KB + FB \tag{5.37}$$

where the both the capital balance (*KB*) and financial balance (*FB*) are treated as exogenous.

5.4.2.3 The overall balance of payments

The overall balance of payments is given as the sum of the nominal current account balance, the nominal capital and financial balance, errors and omissions and valuation adjustments such that,

$$BOP = NKFB + NCAB3 + ERR + VALADJ \tag{5.38}$$

where errors and omissions and valuation adjustments are treated as exogenous to the model.

5.4.3 The government sector

Modelling the government sector in this study is intended to establish how government influences economic activity through a comprehensible yet simple representation of the main features of the public sector. The multiplier analysis is the cornerstone of the model and is used to highlight the impact of a policy shock on the economy through its interaction with other sectors. The study models the government sector with a description of government expenditures, revenues, the budget financing requirements and debt accumulation. It is assumed that the main instruments by which government can influence economic activity are taxation and government expenditures. Hence, the specific aim is to determine the impact of changes in government expenditures and taxation on the different sectors as well as on the aggregate economy. This will elicit information on the extent to which government can influence economic activity and the implications of fiscal policy on the economy. The fiscal sub-model consists of 14 equations of which six are stochastic behavioural equations and eight are identities.

5.4.3.1 Government revenues

Five types of tax revenues are modelled and determined endogenously. The reason for disaggregation here is to obtain a better fit, as well as to assess the individual importance of each of the taxes.[80] Other revenues, including customs revenues and non-tax revenues, as well as other receipts of government, such as grants, are also treated as exogenous. The tax revenues determined by behavioural stochastic equations are individual income tax, goods and services tax, company tax, other income tax and other taxes. The individual taxes are made to depend on suitable bases.

[80] See Brooks and Gibbs (1994) and Randakuwa *et al*. (1995).

Individual income tax

The long-run equation for individual income tax is modelled as a function of the level of nominal wages.

$$LIITAX = \alpha + \beta_1 LNWAGES + \varepsilon \quad (5.39)$$

Other income taxes

Other income taxes are modelled in the long-run as depending on the overall economic activity. They are hence expressed as a function of gross domestic output.

$$LOINCTAX = \alpha + \beta_1 LRGDP + \varepsilon \quad (5.40)$$

Company tax

The long-run equation for company tax is such that the level of company tax is a function of private investment.

$$LCOMPTAX = \alpha + \beta_1 LRPINV + \varepsilon \quad (5.41)$$

Goods and service tax

Goods and services taxes are modelled in the long run as a function of the level of private consumption and the level of exports of goods and service.

$$LGSTAX = \alpha + \beta_1 LRPCONS + \beta_2 LRXGS + \varepsilon \quad (5.42)$$

Other taxes

Other taxes are made a function of gross national output.

$$LOTAX = \alpha + \beta_1 LRGNP + \varepsilon \tag{5.43}$$

Total receipts of government are determined as the sum of total government revenue and grants;

$$TOTREC = TOTREV + GRANTS \tag{5.44}$$

In turn, total government revenue comprises individual income tax, company tax, other income taxes, goods and services tax, other taxes, customs revenue and non-tax revenue.

$$TOTREV = IITAX + COMPTAX + OINCTAX + GSTAX + OTAX + CUSTREV + NONTAXREV \tag{5.45}$$

Of these components, customs revenue and non-tax revenue are exogenous.

5.4.3.2 Government expenditures

The sector is modelled in a way that treats government expenditures and transfers as exogenous. Total government expenditure is the sum of recurrent expenditures and capital expenditures. A term, *GOVEXPRES* is added to this identity as a balancing item because of the existing discrepancy in the data.[81] Thus

$$TOTGOVEXP = RECUEXP + CAPEXP + GOVEXPRES \tag{5.46}$$

The expenditures of government are linked to the expenditure sector by the nominal government expenditures. Nominal government expenditures are defined as the recurrent expenditures of government less government expenditures on other goods and services,

[81] Because of the discrepancy inherent in the data, a variable, *GOVEXPRES*, equivalent to the difference between total government expenditure and the sum of recurrent expenditure and capital expenditure, was created to balance the identity.

and expenditures on subsidies and transfers. Again, because of discrepancies inherent in the data, a balancing item, *GOVRESID*, was created and added to the identity.[82]

$$NGCONS = RECUEXP - OGS - SUBTRS + GOVRESID \quad (5.47)$$

The linkage of total government expenditure to the national income identity is then made operational by transforming the nominal government expenditures to real values by the following identity:

$$RGCONS = \left(\frac{NGCONS}{CONSDEF} \right) * 100 \quad (5.48)$$

where *CONSDEF* is the deflator for government consumption expenditures.

The government budget balance is defined by an identity as total receipts of government less total government expenditures.

$$GOVBAL = TOTREC - TOTGOVEXP \quad (5.49)$$

5.4.3.3 Government debt

The model makes a distinction between five concepts of debt. These are total government debt, government external debt, government domestic debt, short-term domestic debt and long-term domestic debt. The former four are determined endogenously while long-term domestic debt is exogenous. Government domestic debt and government external debt are determined by stochastic behavioural equations while total government debt and short-term domestic debt are determined by identities.

[82] *GOVRESID* is the difference between nominal government consumption expenditure and recurrent expenditure less government expenditure on other goods and services and subsidies and transfers.

Government's domestic debt

In the long run, the level of government domestic debt is modelled to be a function of the government budget balance and the nominal Treasury bill interest rate following Easterly and Schmidt-Hebbel (1994) and Randakuwa *et al*. (1995). The relationship between domestic debt and the government budget balance is expected to be negative, reflecting a fall in domestic debt as the government budget moves towards a surplus position.

$$DOMDEBT = \alpha + \beta_1 GOVBAL + \beta_2 LTBRATE + \varepsilon \qquad (5.50)$$

Government's external debt

In line with Randakuwa *et al*. (1995), government external debt is specified as a function of the nominal current account balance in the long run. The justification for this specification is that higher export earnings reduce the need for external borrowing while higher import payments raise the need for external borrowing. Thus external debt is expected in this relation to be a negative function of the surplus of the nominal current account balance.

$$EXTDEBT = \alpha + \beta_1 NCAB3 + \varepsilon \qquad (5.51)$$

Total government debt is defined as the sum of domestic debt and external debt as follows:

$$DEBT = DOMDEBT + EXTDEBT \qquad (5.52)$$

Short-term domestic debt is defined as domestic debt less long-term domestic debt as follows:

$$STDDEBT = DOMDEBT - LTDDEBT \qquad (5.53)$$

5.4.4 The monetary sector

The modelling of the monetary sector in this study is intended to elicit information regarding the extent to and the manner in which the monetary variables feed in to the other sectors of the economy. The monetary sector consists of 17 equations of which four are stochastic behavioural equations and ten are identities. The sector is modelled to explain the behaviour of the monetary aggregates and the nominal Treasury bill interest rates. Because of the perfect substitutability of the Rand and Loti in the economy, and because of the absence of an instrument to estimate the amount of Rand circulating in the economy, it is assumed that total money supply in the economy is given by the Maluti denominated money supply. This assumption seems reasonable, given that the amount of Rand in the economy is immediately wiped up by the Central Bank to be converted into foreign reserves. The model assumes that money supply is determined exogenously and adjusts to meet money demand. The key variables determined in this model are the money demand and the nominal Treasury bill rate. For purposes of modelling money demand, broad money (*M2*) is disaggregated into currency in the hands of the public, demand deposits and time and saving deposits. Thus,

$$NM2 = NM1 + TSD \tag{5.54}$$

where

$$NM1 = CUR + DD \tag{5.55}$$

5.4.4.1 Money demand

Currency

Real currency in the hands of the public is specified simply as a function of real gross national output in the long run. This specification follows the transactions balance approach to money demand by which public holdings of currency represent the money held for purposes of effecting transactions.

$$LRCUR = \alpha + \beta_1 LRGNP + \varepsilon \tag{5.56}$$

In turn, nominal currency is defined as a product of real currency to the GDP deflator according to the following relation.

$$CUR = \frac{(RCUR * GDPDEF)}{100} \tag{5.57}$$

In turn, the rate of inflation is determined endogenously as the rate of change in the consumer price index

$$INFL1 = \left(\frac{CPI95}{CPI95(-1)} - 1 \right) * 100 \tag{5.58}$$

Demand deposits

Real demand deposits are specified in the long run as a function of real national output and the real Treasury bill rate.

$$LRDD = \alpha + \beta_1 LRGNP + \beta_2 RTBRATE1 + \varepsilon \tag{5.59}$$

The following relation translates real demand deposits to nominal demand deposits.

$$DD = \frac{(RDD * GDPDEF)}{100} \tag{5.60}$$

While the real Treasury bill rate (*TRBRATE1*) is derived as the nominal Treasury bill rate less the annual *CPI* rate of inflation.

$$RTBRATE1 = TBRATE - INFL1 \tag{5.61}$$

Time and saving deposits

In the long run specification, real time and saving deposits are a function of real national output and the real Treasury bill rate.

$$LRTSD = \alpha + \beta_1 LRGNP + \beta_2 RBRATE1 + \beta_3 DUM8084 + \beta_4 DUM9020 + \beta_5 DUM97 + \beta_6 DUM20 + \varepsilon \tag{5.62a}$$

The following relation translates real time and saving deposits to nominal terms.

$$TSD = \frac{(RTSD * GDPDEF)}{100} \tag{5.63}$$

5.4.4.2 Interest rates

The nominal Treasury bill rate is modelled and determined stochastically in this study. In principle, interest rates are treated as exogenous if the monetary authority directly controls interest rates in the economy (Pauly 2000:10). This situation is prevalent in many developing countries in which interest rates play a very limited role. In such cases money demand determines the volume of money supply in the economy. The modelling of interest rates in this study is made to follow recent changes in the determination of interest rates, in particular the Treasury bill rate in the economy of Lesotho. From an administrative determination regime, the Treasury bill rate is currently determined by the system of quarterly auctions of Treasury bills.

The nominal Treasury bill rate

In the long run specification, the nominal Treasury bill rate is modelled as a function of real national output, the government budget balance and the CPI inflation rate.

$$LTBRATE = \alpha + \beta_1 LRGNP + \beta_2 GOVBAL + \beta_3 LINFL + \varepsilon \quad (5.64)$$

In the short run, the nominal Treasury bill rate is specified as a function of the change in real national output, the nominal short-term SA bankers' acceptance rate, the change in CPI inflation rate and a one-period lagged nominal Treasury bill rate.

In closure of the monetary sector, the money multiplier is determined and defined as the ratio of the nominal broad money (*M2*) to reserve money. Thus,

$$M = \frac{NM2}{RM} \quad (5.65)$$

5.5 ESTIMATION TECHNIQUES

5.5.1 Background to the methodology

Time series data is used to estimate the model. Developments in econometric techniques have progressed to extensive use of cointegration methodologies. These developments derive from the realisation that firstly, most economic time series are non-stationary and tend to have a long memory of past errors, and secondly, that while traditional specifications elicit information about the long-run behaviour of variables, they provide little insight into the short-run dynamics of the variables. The first concern implies that the statistical properties of regression analysis in such cases become dubious. Because of the statistical properties of the series, the OLS estimators are rendered inefficient. OLS estimation that disregards these characteristics of the data produces promising results and diagnostic test statistics while there is no sense in the regression analysis. The second concern implies that the classical methods of estimation tend to ignore short-run dynamics that explain the evolution of the long-run relationships.

Recent time series techniques aim to highlight and capture the characteristics of time series and data generating processes, as well as taking into consideration the short- and

long-run dynamics to achieve a better representation of reality in econometric models. The application of cointegration and error-correction techniques in models represent these revisions in modelling macroeconomic relationships. The basic departure point of these techniques is that econometric time series contain one or more unit roots and are therefore subject to fluctuations that render them non-stationary over time.[83] With these characteristics, random shocks tend to have permanent effects on economic variables (Perron 1989:1362). This implies that the error terms produced by non-stationary series do not exhibit the usual desirable characteristics of being white noise. The idea is then to test for the presence of unit roots in time series and to apply transformations by which the series can be declared stationary. This would then make it possible for the data to be used in estimations that can be rendered efficient using standard OLS procedures.

5.5.2 Tests for the order of integration of variables

To investigate the possibility of the existence of unit roots in the error terms, a series of tests such as the Dickey-Fuller (DF) test due to Dickey and Fuller (1979), Augmented Dickey Fuller (ADF) test and the Phillips-Perron (PP) test have been developed.

Given the following data generating mechanism:

$$y_t = \alpha y_{t-1} + \mu_t; \qquad y_0 \equiv 0 \tag{5.91}$$

The series is considered stationary if $|\alpha| < 1$, with statistical properties of a finite, time independent mean, a finite variance and that the series tends to return to its mean value. Conversely, the series is considered non-stationary if $|\alpha| \geq 1$. This implies that the series has at least one root. In this case the mean and variance are asymptotically infinite. The use of OLS methods of estimation on such series tends to produce spurious regressions whose interpretations are misleading.

[83] See for example, Nelson and Plosser (1982) and Perron (1988).

5.5.3 Cointegration analysis

Cointegration analysis is based on the long-run or equilibrium relationship between variables. Tests for cointegration are a means of investigating the existence of such relationships. The basic notion is that if economic theory is correct, we then expect a specific set of variables to be related to each other. Thus, there should be no tendency for economic variables to drift further away from each other with time. This type of analysis requires the satisfaction of two basic conditions. The first is that all variables should exhibit similar statistical properties. The variables must in particular be integrated of the same order. A series is considered to be integrated of order d if it has a stationary invertible ARMA (p,q) representation after differencing the series d times, but which is not stationary after differencing $d-1$ times. Thus, the series has d unit roots. It is then denoted $x_t \sim I(d)$, where d is the order of integration (Adam 1998:11). The second condition for cointegration is that there should exist a vector such as z_t (a linear combination of the series for x and y) that must be stationary or integrated of a lower order that the original variables. The vector z_t is given by the residuals from a static OLS regression of the variables.

5.5.4 The Engle-Granger method

Following the Engle-Granger (1987) methodology, cointegration analysis involves a two step procedure corresponding to the two conditions of the process as mentioned above. The first step involves determining the order of integration of the data series. The second step involves the examination of the residuals from the static cointegration regression or the long-run relationship for the existence of a cointegrating vector. If the null hypothesis of non-stationary residuals is rejected, it can be concluded that there is cointegration among the variables in the long run relationship. Otherwise the hypothesis of no cointegration is upheld. In the former case in which there is cointegration, the Granger represantation theorem states clearly that an error correction model becomes a valid representation of relationship between variables.

5.5.4.1 Error correction models

The problem of spurious regressions associated with regressions of non-stationary series and/or series of varying statistical properties is avoided by the use of error correction models (ECM). In its simplest form, a two variable ECM can be written as:

$$\Delta y_t = \delta \Delta x_t - \lambda (y_{t-1} - \beta x_{t-1}) + \varepsilon_t \qquad (5.92)$$

where δ measures the short-run effect of changes in x on y, β is the long-run or equilibrium solution of the dynamic model, λ is the error correction of the current level of y towards its equilibrium level.

By design, this formulation is meant to avoid problems of non-stationary data by using differences rather than levels while it also avoids the problem of losing information conveyed by the levels about any long-run relationships by incorporating these relationships into the differences specification describing short-run relationships between variables. Thus, the approach has several distinct advantages:

- In the event that the concerned variables are cointegrated, the ECM captures both the short-run and long-run effects. The short-run component of the model becomes non-zero during periods of disequilibrium and imparts information about the distance of the system from equilibrium;
- Assuming cointegration and that estimates of the concerned parameters exist, all terms within the ECM model are stationary. This implies that standard (OLS) estimation techniques can be applied;
- Since the ECM is directly linked to the concept of cointegration, Granger's representation theorem for dynamic modelling effectively implies that the presence of cointegration renders the ECM immune to the problem of spurious regressions; and
- Because it is possible to specify the ECM in a multivariate form, it is also practically possible therefore to allow for a set of cointegrating vectors.

The Engle-Granger procedure is usually praised for its computational ease. For example, Harris (1995:57) mentions two merits of using this procedure. Firstly, the static, short-run model can easily be estimated by OLS after which unit root tests can be performed on the residuals. Secondly, the second stage involves only estimating the short-run ECM and using the estimates of the extent of the disequilibrium to obtain information on the speed of adjustment to equilibrium. Although this procedure has been widely used in empirical applications it has faced heavy criticism from its implicit assumption of a unique cointegrating vector. It is argued that in the case of a multivariate regression, the cointegrating vector may not necessarily be unique and there may be other linear combinations of the variables in the vector which determine the evolution of the variables in the vector x. Secondly, the procedure yields results that are not invariant with respect to the direction of normalization or the choice of a dependent variable. The predetermination of a set of endogenous and exogenous variables and the assumption of zero restrictions in the system tends to bind the model onto strict economic foundations and hence pre-empt the outcomes of the model.[84]

5.5.5 The Johansen Procedure

The shortcomings and criticisms of the Engle-Granger procedure when it comes to the multivariate case, call for consideration of other methods of estimation. An attractive option is the maximum likelihood approach suggested by Johansen (1988). The desirable characteristics of the Johansen framework is the consideration of the possibility of multiple cointegrating vectors and the allowance for determining causality and the testing of hypotheses in a more satisfactory way. Unlike the Engle-Granger procedure, this method makes use of the general Vector Autoregressive (VAR) model of the form

$$x_t = \prod_1 x_{t-1} ..... \prod_k x_{t-k} + \varepsilon_t \qquad (5.93)$$

to derive a vector error correction model (VECM) of the following form

[84] See Sims (1980).

$$\Delta x_t = \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \prod x_{t-k} + \varepsilon_t, \qquad t = 1,...,T \tag{5.94}$$

where $\Gamma_i = -(I-\Pi_1-\ldots-\Pi_i)$ and $\Pi=(I-\Pi_1-\ldots-\Pi_k)$. The Γ_i are the dynamic vector parameters of the model and the Π matrix contain the long-run static parameters of the model which may or may not be cointegrated.

The procedure involves determining the rank of the Π matrix with the aim of identifying the number of cointegrating vectors within the eigenvector matrix. The significant vectors are then determined by the value of the maximum eigenvector statistic and are examined with the aim of isolating a set of uniquely identified cointegrating vectors binding the levels of the variables. In cases where only one significant cointegrating vector is identified, the assumption of weak exogeneity as well as single equation estimation is validated. In cases of multiple cointegrating vectors, which individually enter more than one equation, the assumption of weak exogeneity does not hold and hence simultaneous equation estimation is required.

The Johansen procedure has numerous advantages over the Engle-Granger procedure, particularly for multivariate analysis. Firstly, it produces results that are invariant with respect to the direction of normalization since it makes all variables explicitly endogenous. Secondly, it captures the underlying time series properties of the data and lastly it allows for direct hypothesis testing on the coefficient of the cointegrating vectors. This means that the Johansen procedure produces statistical properties that are generally better than that of the Engle-Granger procedure in the sense that the power of the cointegration test is higher.

Testing and analysing cointegration within a VAR framework is often considered a superior and desirable feature of the Johansen procedure over the Engle-Granger procedure. It is however notable that the VAR framework that is needed in the Johansen procedure requires large sample sizes especially with multivariate analysis that involves a

system of equations. Since data limitations in terms of the sample size, in particular, represent a major constraint in this study, the use of the Johansen procedure could make the entire modelling process impossible. This leaves us with the option of the Engle-Granger method notwithstanding its shortcomings. The EViews software package is used to carry out the estimation of the model as well as model simulations.

5.5.6 Unit root and cointegration tests

The study employs the ADF and PP statistics to test for the order of integration of the individual time series used in the behavioural equations. Unless otherwise stated, natural logarithms of variables are used in the estimations. The Engle-Granger test for cointegration that makes use of the ADF or PP statistics and the McKinnon (1991) critical values are used to test for cointegration among the variables.[85]

5.5.7 Diagnostic tests

The analysis of the individual equations of the model involves assessment of whether the variables conform to the theoretical predictions, their statistical significance and the overall explanatory power of the equation. This involves examination of the signs and magnitudes of the individual coefficients in each equation, the corresponding *t* statistics and the adjusted R^2 and F statistics. In addition, all short-run equations are subjected to a battery of tests to assess the appropriateness of the specification, the stability of the equation and the statistical properties of the residuals of the equations. Normality of the distribution of the residuals is tested using the Jarque-Bera (JB) statistic. The Ljung-Box Q and the Breusch-Godfrey statistics test the existence of serial correlation in the residuals while the presence of heteroscedasticity is tested by means of the autoregressive conditional heteroscedasticity (ARCH) Lagrange multiplier (LM) test and the White test. The Ramsey RESET test is used to assess the existence of misspecification errors while the recursive estimates are used to examine the stability of the parameter estimates.

[85] The actual tests are performed in chapter six.

5.5.8 Forecast accuracy of endogenous variables

It is desirable to have some measure of how closely individual variable estimates track their actual data series. The predictive performance of the model is evaluated by means of four statistics, namely the root mean square error (RMSE), the mean absolute error (MAE), the mean absolute percentage error (MAPE) and the Theil inequality coefficient (U).[86]

5.5.9 Issues relating to data availability and quality

One of the requisites for consistency in a macroeconomic model is a good data set. The forecasting ability of a macroeconomic model does not depend only on the accurate presentation of the structural features of the economy being studied, but also on how well the model approximates theoretical standards. A consistent data set is at the centre of these two qualities. As in many developing countries, the Lesotho data series hardly portray good consistency and quality.

The national accounts statistics are available in a continuous series from 1975 onwards with minor changes in definitions and classifications and shifts in the base years. The quality of the series on national accounts is hardly up to standard as a result of institutional weakness within the BOS and adjustments made by both the CBL and IMF. The monetary series are however available only from 1980, corresponding with the establishment of the CBL. Thus, a full data set can be obtained from 1980. The year 2000 was chosen as the end of sample period in this study because of the imbalances that result from year to year revisions that the CBL carry out.

The government accounts series also suffer from quality problems. This is again partly because of the institutional problems and partly because of lack of adequate response from government ministries (CBL 1999). Data on capital expenditures in particular are not adequately reported.

[86] See Pindyck and Rubinfeld (1991) and Greene (2003) for detailed discussions of these statistics.

Major problems exist in the balance of payments statistics. The series for exports and imports hardly tally with the series in the national accounts. In addition, data on imports of goods and services and capital flows is subject to serious under-reporting (CBL 1999). Other weaknesses relate principally to the wage-employment data and capital stock. The BOS keeps records of employment in the manufacturing and government sectors but not in other sectors. Labour market surveys that are carried out from time to time permit approximations of employment by assuming that employment grows at the same rate as output. The data on wages is also made possible by approximations derived from the GOL wage bill. Like in many developing countries, data on capital stock has been non-existent for a long time. It is only recently that estimates of the capital stock from the investment series have been made by the CBL.

5.6 CONCLUSION

This chapter has presented the empirical macroeconomic model for the economy of Lesotho. The construction of the model follows from, and is driven by the deductions made about the structure of the economy, as discussed in chapter two, and the theoretical and empirical guidelines, as discussed in chapters three and four respectively. The discussions in these chapters have formed a basis for the formulation hypotheses about interrelationships between different variables and the linkages between sectors. It is the framework that is developed in this chapter that is estimated in the next chapter, and used to analyse policy scenarios in the following chapters.

CHAPTER 6

ESTIMATION RESULTS OF INDIVIDUAL BEHAVIOURAL EQUATIONS

6.1 INTRODUCTION

This chapter presents the behavioural equations of the model. First, the chapter presents the specifications of the econometrically estimable equations. This is followed by an examination of the statistical properties of the time series data used for estimation. This is followed by the presentation of the estimation results and a brief review of the estimation results. All equations, except for two in which the two-step procedure was deemed unnecessary, are estimated in two stages. The first stage involves level-based long-run estimation of the equations by OLS. Given that these estimations may produce spurious results depending on the order of integration of the variables included in the estimation, the residuals from the long-run estimations are used to test for cointegration between the given set of variables. Obtaining at least one cointegrating vector in the long-run equations allowed the estimation process to proceed to the second step of estimation. This involved the estimation of the error correction models for the equations. The errors obtained from the error correction model were then subjected to a series of statistical tests for normality, serial correlation, heteroscedasticity, misspecification and stability of parameters over the sample range.

6.2 LISTING OF BEHAVIOURAL EQUATIONS OF THE MODEL

A list of the behavioural equations that are estimated and reported in this chapter is presented in this section for a convenient reference. The equations are presented here in both their long-run versions.

6.2.1 The real sector

Aggregate supply

Real domestic output

$$LRGDP = \alpha + \beta_1 LL + \beta_2 LK + \beta_3 TIME + \varepsilon \quad (6.1)$$

Real private investment expenditure

$$LRPINV = \alpha + \beta_1 LRGDP + \beta_2 LRUCC + \varepsilon \quad (6.2)$$

Labour demand

$$LL = \alpha + \beta_1 LRGDP + \beta_2 LRWAGES2 + \varepsilon \quad (6.3)$$

Real wages

$$LRWAGES2 = \beta_1 LLABPROD1 + \beta_2 LCPI95 + \varepsilon \quad (6.4)$$

Aggregate demand

Real private consumption expenditure

$$LRPCONS = \alpha + \beta_1 LRYD + \beta_2 RTBRATE1 + \beta_3 LRM31 + \varepsilon \quad (6.5)$$

Prices

Consumer prices

$$LCPI95 = \alpha + \beta_1 LGDPDEF + \beta_2 LED + \beta_3 LPMGS1 + \varepsilon \quad (6.6)$$

Producer prices

$$LGDPDEF = \alpha + \beta_1 LCU2 + \beta_2 LRWAGESUCC2 + \varepsilon \quad (6.7)$$

Export prices

$$LPXGS = \alpha + \beta_1 LPW1 + \beta_2 LEXRATE + \beta_3 LGDPDEF + \varepsilon \quad (6.8)$$

Import prices

$$LPMGS1 = \alpha + \beta_1 LPW1 + \beta_2 LEXRATE + \varepsilon \quad (6.9)$$

6.2.2 The external sector

Real exports of goods and services

$$LRXGS = \alpha + \beta_1 LWDEMND + \beta_2 LXGSRELP1 + \varepsilon \quad (6.10)$$

Real imports of goods and services

$$LRMGS = \alpha + \beta_1 LRGNP + \beta_2 LMGSRELP1 + \varepsilon \quad (6.11)$$

6.2.3 The government sector

Individual income tax

$$LIITAX = \alpha + \beta_1 LNWAGES + \varepsilon \quad (6.12)$$

Other income taxes

$$LOINCTAX = \alpha + \beta_1 LRGDP + \varepsilon \quad (6.13)$$

Company tax

$$LCOMPTAX = \alpha + \beta_1 LRPINV + \varepsilon \quad (6.14)$$

Goods and services tax

$$LGSTAX = \alpha + \beta_1 LRPCONS + \beta_2 LRXGS + \varepsilon \quad (6.15)$$

Other taxes

$$LOTAX = \beta_1 LRGNP + \varepsilon \quad (6.16)$$

Government domestic debt

$$DOMDEBT = \alpha + \beta_1 GOVBAL + \beta_2 LTBRATE + \varepsilon \quad (6.17)$$

Government external debt

$$EXTDEBT = \alpha + \beta_1 NCAB3 + \varepsilon \quad (6.18)$$

6.2.4 The monetary sector

Real currency demand

$$LRCUR = \alpha + \beta_1 LRGNP + \varepsilon \quad (6.19)$$

Demand for real demand deposits

$$LRDD = \alpha + \beta_1 LRGNP + \beta_2 RTBRATE1 + \varepsilon \quad (6.20)$$

Demand for real time and saving deposits

$$LRTSD = \alpha + \beta_1 LRGNP + \beta_2 RBRATE1 + \varepsilon \quad (6.21)$$

Nominal Treasury bill interest rate

$$LTBRATE = \alpha + \beta_1 LRGNP + \beta_2 GOVBAL + \beta_3 LINFL1 + \varepsilon \quad (6.22)$$

6.3 STATISTICAL PROPERTIES OF INDIVIDUAL TIME SERIES

While formal tests, namely the ADF and PP tests, are used to assess the order of integration of the individual time series in this study, the trends of the individual series are also plotted to visually assess their probable statistical properties as a backup mechanism because of the well-know problem of low power of these tests. The plots of the individual series are presented in appendix A. The ADF results for tests of the order of integration are reported in tables 6.1 and 6.2 for each of the variables used in the estimation of the behavioural equations. Table 6.1 reports the tests for the variables in levels. The variables that are found to be non-stationary are differenced and re-tested. The tests of the first differences of these variables are presented in table 6.2. As is often

the case with many time series variables, most of the variables that are used in the estimation of the behavioural equations are found to be integrated of the first order. Only a few variables are found to be stationary.

Table 6.1 Statistical properties of variables in the model – ADF tests for the order of integration of variables in levels, 1980 – 2000

Series	Model	Lags	τ_τ, τ_μ, τ^a	Φ_3, $\Phi_1{}^b$
BOP	Intercept and trend	0	-2.632682	3.515199
	Intercept	0	-2.329532	5.426720**
	None	0	-1.904637	
LCOMPTAX	Intercept and trend	3	-2.334783	2.703430
	Intercept	3	-1.545698	1.888101
	None	3	0.001487	
LCPI95	Intercept and trend	0	-0.555810	2.334436
	Intercept	0	-2.191396	4.802217
	None	1	1.496711	
LCU2	Intercept and trend	0	-3.339085*	6.134950**
	Intercept	0	-3.405926**	11.60033***
	None	0	-0.523624	
GOVBAL	Intercept and trend	3	-2.999692	4.801298
	Intercept	3	-2.753932*	5.358795**
	None	1	-3.024169***	
DOMDEBT	Intercept and trend	1	-3.191264	3.739192
	Intercept	0	-0.690707	0.477077
	None	0	0.345336	
EXTDEBT	Intercept and trend	1	1.883554	19.51842***
	Intercept	1	7.080783	31.22901***
	None	1	9.303658	
LEXRATE	Intercept and trend	0	-2.251470	2.763131
	Intercept	0	-1.105634	1.222427
	None	0	2.471614	
LGDPDEF	Intercept and trend	0	-0.486437	1.085889
	Intercept	0	-1.457330	2.123810
	None	0	11.61382	
LGSTAX	Intercept and trend	2	-6.319810***	50.72404***
	Intercept	3	-2.850050*	62.25590***
	None	3	1.066389	
LIITAX	Intercept and trend	0	-2.389501	3.007283
	Intercept	0	-0.173729	0.030182
	None	0	1.902944	
LINFL1	Intercept and trend	0	-2.430407	2.986701
	Intercept	0	-2.249809	5.061641
	None	0	-0.372629	
LK	Intercept and trend	0	-2.459789	20.21536***
	Intercept	3	-2.043720	19.57919***
	None	1	1.433561	
LL	Intercept and trend	0	-2.870028	4.189632
	Intercept	0	-0.0200010	0.000400
	None	0	4.695357	
LLABPROD1	Intercept and trend	0	-3.378440*	5.727237
	Intercept	0	-1.559659	2.432535
	None	0	-0.678525	

LMGSRELP1	Intercept and trend	0	-0.657443	1.754548
	Intercept	0	0.779866	0.608191
	None	0	1.859082	
LNWAGES	Intercept and trend	0	-2.419610	3.069313
	Intercept	2	0.943109	1.647535
	None	3	4.104553	
LOINCTAX	Intercept and trend	0	-2.588890	3.661697
	Intercept	0	0.016457	0.000271
	None	0	1.634293	
LOTAX	Intercept and trend	0	-1.985451	3.411704
	Intercept	1	-1.371714	2.739488
	None	0	-0.775040	
LPMGS1	Intercept and trend	0	-0.789872	1.730262
	Intercept	0	-1.775226	3.151428
	None	1	1.568131	
LPW1	Intercept and trend	0	-1.942746	2.155251
	Intercept	2	-1.565412	2.592121
	None	0	3.822762	
LPXGS	Intercept and trend	0	-1.484626	1.178230
	Intercept	0	-0.554016	0.0306934
	None	0	5.091378	
LRCUR	Intercept and trend	0	-2.853160	4.803047
	Intercept	0	-3.127629*	9.782062***
	None	0	0.770352	
LRDD	Intercept and trend	0	-2.928213	4.680361
	Intercept	0	-1.328487	1.764877
	None	0	1.788332	
LRGDP	Intercept and trend	0	-2.583138	3.366381
	Intercept	0	-0.115328	0.013301
	None	0	4.577838	
LRGINV	Intercept and trend	0	-3.690753**	6.815297
	Intercept	0	-2.381101	5.669640**
	None	2	0.532671	
LRGNP	Intercept and trend	0	-1.798041	3.035599
	Intercept	0	-2.132204	4.546293
	None	0	1.850368	
LRUCC	Intercept and trend	0	-2.485756	3.216769
	Intercept	0	-1.115064	1.243367
	None	0	-1.988348	
LRM31	Intercept and trend	0	-0.448620	1.130188
	Intercept	0	-1.543545	2.382532
	None	0	1.686870	
LRMGS	Intercept and trend	0	-0.238695	1.468644
	Intercept	0	-1.709893	2.923733
	None	0	1.170750	
LRPCONS	Intercept and trend	0	-0.836128	2.227080
	Intercept	0	-2.171667	4.716140
	None	0	0.963420	
LRPINV	Intercept and trend	0	-1.32381	0.772223
	Intercept	0	-0.874250	0.764313
	None	0	1.798144	
LRTSD	Intercept and trend	0	-0.517089	8.591061**
	Intercept	0	-2.638687	6.962670**
	None	1	-0.419878	
LRWAGES2	Intercept and trend	0	-1.940856	2.353117
	Intercept	0	-1.751754	3.068641

	None	0	-0.013848	
LRWAGESUCC2	Intercept and trend	0	-2.355819	3.031746
	Intercept	0	-1.465653	2.148139
	None	0	1.452586	
LRXGS	Intercept and trend	2	-3.709943**	9.490754**
	Intercept	2	1.418119	3.173491
	None	2	3.705750	
LRYD	Intercept and trend	0	-1.328458	2.243631
	Intercept	3	-3.141379**	3.196291
	None	0	2.360940	
LTBRATE	Intercept and trend	1	-4.400218**	7.657137**
	Intercept	1	-4.000410***	9.153859***
	None	3	-0.495142	
LUCC	Intercept and trend	0	-3.274210*	5.589335
	Intercept	0	-2.945576*	8.676420***
	None	3	0.196657	
LWDEMND	Intercept and trend	0	-2.987110	5.086071
	Intercept	0	-1.499209	2.247626
	None	0	4.132118	
LXGSRELP1	Intercept and trend	0	-2.246244	2.627842
	Intercept	0	-2.244737	5.038846
	None	0	0.431892	
RTBRATE1	Intercept and trend	1	-3.754133**	4.962878
	Intercept	1	-3.972275***	7.936427***
	None	0	-2.726388***	
RF	Intercept and trend	3	-5.985278***	9.981270**
	Intercept	3	-4.901219***	8.703180***
	None	0	-0.512589	
STDDEBT	Intercept and trend	0	-2.657333	3.690135
	Intercept	0	-1.027343	1.055434
	None	0	0.143761	
NCAB3	Intercept and trend	0	-2.226235	2.511470
	Intercept	0	-0.808668	0.653944
	None	0	0.459876	
LED	Intercept and trend	0	0.203275	4.623873
	Intercept	0	2.391558	5.719551
	None	0	-1.691920	

*(**) Significant at 10(5) per cent level.

*** Significant at one per cent level.

a At a 5(1)% significance level the McKinnon critical values are –3.63(-4.44) when a trend and a constant are included (τ_τ), -3.00(-3.77) when only a constant is included (τ_μ) and –1.96(-2.68) when neither is included (τ). The standard normal critical value is –1.703(-2.473).

b At the 5(1)% significance level the Dickey-Fuller critical values (for 25 observations) are 7.24(10.61) when a trend and a constant are included (Φ_3) and 5.18(7.88) when only a constant is included (Φ_1).

Table 6.2 Statistical properties of variables in first differenced form, 1980-2000

Series	Model	Lags	τ_τ, τ_μ, τ^a	Φ_3, $\Phi_1{}^b$
ΔBOP	Intercept and trend	2	-7.254052***	30.56257***
	Intercept	2	-6.437668***	33.21234***
	None	2	-6.658008***	
ΔLCOMPTAX	Intercept and trend	1	-7.371361***	28.08958***
	Intercept	1	-7.481063***	43.49622***
	None	1	-7.732246***	
ΔLCPI95	Intercept and trend	0	-4.557221	10.38425**
	Intercept	0	-4.686744***	21.96557***
	None	0	-4.824680***	
ΔLED	Intercept and trend	0	-3.082064	4.820445
	Intercept	0	-2.287041	5.230558
	None	0	-1.898857	
ΔGOVBAL	Intercept and trend	1	-3.936603**	5.951404
	Intercept	1	-4.282131***	9.168374***
	None	1	-4.483153***	
ΔDOMDEBT	Intercept and trend	0	-5.948542***	18.24422***
	Intercept	0	-6.145670***	37.76926***
	None	0	-6.307518***	
ΔNCAB3	Intercept and trend	0	-3.867946**	7.925621***
	Intercept	0	-4.087356***	16.70648***
	None	0	-3.679826***	
ΔEXTDEBT	Intercept and trend	0	-15.78625***	127.5372***
	Intercept	0	-16.28977***	265.3565***
	None	0	-15.94031***	
ΔLEXRATE	Intercept and trend	1	-5.825779***	14.79793***
	Intercept	1	-6.061359***	23.87193***
	None	1	-6.271037***	
ΔLGDPDEF	Intercept and trend	0	-4.734499***	11.26556***
	Intercept	0	-4.883367***	23.84728***
	None	0	-5.018944***	
ΔLGSTAX	Intercept and trend	1	-8.929510***	31.01976***
	Intercept	3	-3.012858*	36.48425***
	None	3	-2.856536***	
ΔLIITAX	Intercept and trend	0	-5.939815***	17.64963***
	Intercept	0	-6.108635***	37.31542***
	None	0	-6.295810***	
ΔLINFL1	Intercept and trend	2	-5.619301***	19.70048***
	Intercept	2	-5.638358***	26.14097***
	None	2	-5.933184***	
ΔLK	Intercept and trend	0	-4.089328**	8.417263**
	Intercept	0	-4.136721***	17.11246***
	None	1	-3.640496***	
ΔLL	Intercept and trend	0	-5.843479***	17.27435***
	Intercept	0	-5.890916***	34.70289***
	None	0	-6.072072***	
ΔLLABPROD1	Intercept and trend	1	-5.050229***	40.99532***
	Intercept	1	-5.277165***	61.03207***
	None	1	-5.344521***	
ΔLMGSRELP1	Intercept and trend	0	-5.627681***	15.87172***
	Intercept	0	-5.714419***	32.65458***
	None	0	-5.887492***	
ΔLNWAGES	Intercept and trend	1	-8.535959***	32.66631***

	Intercept	1	-8.444830***	47.77922***
	None	1	-8.719876***	
ΔLOINCTAX	Intercept and trend	0	-7.228017***	26.12884***
	Intercept	0	-7.390682***	54.62218***
	None	3	-4.298097***	
ΔLOTAX	Intercept and trend	0	-3.600418*	6.706827
	Intercept	0	-3.651990**	13.33703***
	None	0	-3.776493***	
ΔLPMGS1	Intercept and trend	0	-4.973702***	12.37308***
	Intercept	0	-5.135973***	26.37822***
	None	0	-5.289311***	
ΔLPW1	Intercept and trend	1	-5.256757***	10.90594***
	Intercept	1	-5.415845***	17.32061***
	None	1	-5.606983***	
ΔLPXGS	Intercept and trend	0	-8.164805***	34.35616***
	Intercept	0	-7.606986***	57.86623***
	None	0	-7.841387***	
ΔLRCUR	Intercept and trend	0	-5.583146***	15.77093***
	Intercept	0	-5.674147***	32.19595***
	None	0	-5.786141***	
ΔLRDD	Intercept and trend	1	-7.337548***	31.15524***
	Intercept	1	-7.198147***	45.36800***
	None	1	-7.430394***	
ΔLRGDP	Intercept and trend	1	-5.770603***	17.34311***
	Intercept	1	-5.238691***	22.10316***
	None	1	-5.435199***	
ΔLRGINV	Intercept and trend	1	-10.83305***	75.13648***
	Intercept	1	-10.85769***	110.8683***
	None	1	-10.93627***	
ΔLRGNP	Intercept and trend	0	-7.748922***	30.37467***
	Intercept	0	-8.000984***	64.01574***
	None	0	-8.153395***	
ΔLRM1	Intercept and trend	0	-5.805066***	17.19772***
	Intercept	0	-5.998954***	35.98745***
	None	0	-6.205730***	
ΔLRM31	Intercept and trend	0	-6.242058***	19.73975***
	Intercept	0	-6.339048***	40.18353***
	None	0	-6.413640***	
ΔLRMGS	Intercept and trend	0	-4.766668***	11.40382***
	Intercept	0	-4.910257***	24.11062***
	None	0	-5.019676***	
ΔLRPCONS	Intercept and trend	0	-5.492664***	15.09063***
	Intercept	0	-5.625581***	31.64717***
	None	0	-5.734521***	
ΔLRPINV	Intercept and trend	1	-7.196825***	18.47611***
	Intercept	1	-6.911644***	25.60151***
	None	1	-7.154420***	
ΔLRTSD	Intercept and trend	0	-6.393192***	20.52580***
	Intercept	0	-6.540929***	42.78375***
	None	0	-6.285225***	
ΔLRWAGES2	Intercept and trend	0	-4.808977***	11.56678***
	Intercept	0	-4.581319***	20.98848***
	None	0	-4.714392***	
ΔLRXGS	Intercept and trend	1	-7.682961***	21.47944***
	Intercept	1	-7.586279***	31.39041***
	None	1	-7.712139***	

ΔLRYD	Intercept and trend	0	-7.318394***	26.94928***
	Intercept	2	-5.001757***	24.37124***
	None	1	-4.080616***	
ΔLRUCC	Intercept and trend	0	-4.469635**	10.13285***
	Intercept	0	-4.377088***	19.15890***
	None	0	-3.773602***	
ΔLWDEMND	Intercept and trend	2	-6.681594***	20.71653***
	Intercept	2	-5.840700***	20.67769***
	None	2	-5.780435***	
ΔLXGSRELP1	Intercept and trend	1	-5.299615***	13.46284***
	Intercept	1	-5.474570***	21.56699***
	None	1	-5.664231***	
ΔLRWAGESUCC2	Intercept and trend	0	-4.804748***	11.65213***
	Intercept	0	-4.590040***	21.06847***
	None	0	-4.150798***	

*(**) Significant at 10(5) per cent level.

*** Significant at one per cent level.

a At a 5(1)% significance level the McKinnon critical values are –3.63(-4.44) when a trend and a constant are included (τ_τ), -3.00(-3.77) when only a constant is included (τ_μ) and –1.96(-2.68) when neither is included (τ). The standard normal critical value is –1.703(-2.473).

b At the 5(1)% significance level the Dickey-Fuller critical values (for 25 observations) are 7.24(10.61) when a trend and a constant are included (Φ_3) and 5.18(7.88) when only a constant is included (Φ_1).

6.4 ESTIMATION RESULTS OF INDIVIDUAL EQUATIONS

6.4.1 Estimation results of the real sector

6.4.1.1 Real domestic output

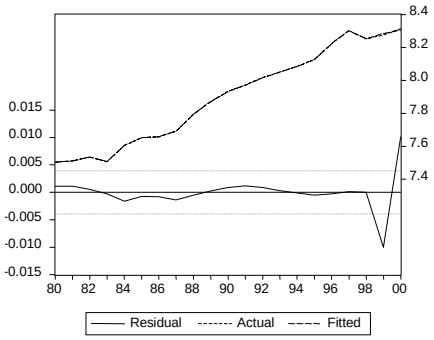
Estimation of the production function reveals that both capital and labour are important determinants of real domestic output. Labour appears to be a leading factor as judged by the magnitude of the coefficients and its statistical significance. Technological advancements exert a meagre effect and less significant influence on domestic output. It is evident from these results that the political instability of 1998 adversely affected the level of economic activity.

$$LRGDP = \underset{(-14.15)}{-3.830} + \underset{(35.06)}{0.893}LL + \underset{(2.39)}{0.046}LK + \underset{(1.02)}{0.001}TIME - \underset{(-25.33)}{0.121}DUM98 - \underset{(-11.48)}{0.049}DUM9920 \qquad (6.23a)$$

$\bar{R}^2 = 0.99 \quad S.E. = 0.004 \quad T = 21\,(1980 - 2000)$

The residuals of the above long-run equation are plotted in Figure 6.1 below and are indicative of stationarity by visual inspection. The stationarity of the residuals is confirmed by the Engle-Granger test for cointegration. Comparing the Engle-Granger test statistic of –7.160939 with the computed McKinnon critical value of –6.158925 leads to the rejection of the null hypothesis of no cointegration in favour of stationary residuals, and hence cointegration between the variables included in the long-run specification at one per cent level of significance and zero lags.[87]

Figure 6.1 Residuals for real GDP cointegration equation



With cointegration confirmed, the results of the second step, the error correction model, are presented below.

$$\Delta LRGDP = \underset{(1.93)}{0.001} + \underset{(83.06)}{0.89}\Delta LL + \underset{(3.43)}{0.06}\Delta LK - \underset{(-2.196)}{0.696}\hat{\varepsilon}_{-1} - \underset{(-84.05)}{0.12}DUM98 + \underset{(35.46)}{0.06}DUM99 - \underset{(-14.27)}{0.05}DUM20 \qquad (6.23b)$$

$\bar{R}^2 = 0.99 \quad S.E. = 0.001 \quad T = 20\ (1981 - 2000)$

[87] See McKinnon (1991) for the response surface of the critical values. The response surface for any number of regressors between one and six ($1 \le n \le 6$) excluding the constant and trend components can be obtained as $C(p) = \phi_\infty + \phi_1 T^{-1} + \phi_2 T^{-2}$ where p represents the percentage of the critical value and T the sample size.

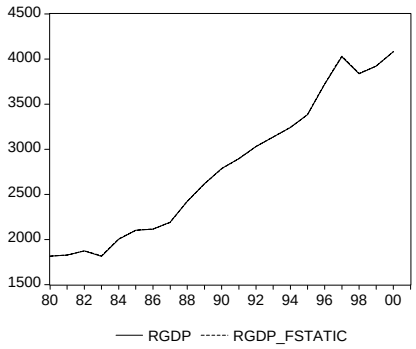
Table 6.3 Diagnostic tests: Real domestic output

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	9.516968	0.008579*
Serial Correlation	Ljung Box Q	Q(12)	7.8429	0.797
	Breusch-Godfrey	$N*R^2(2)$	6.148208	0.05
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.064623	0.799332
	White	$N*R^2(1)$	14.44239	0.107436
Misspecification	Ramsey RESET	LR(2)	115.9221	0.000000*
Parameter Stability	Recursive Estimates			

The estimation results of the error correction model for production are satisfactory in general. All included variables exhibit expected signs and magnitudes and are statistically significant. Diagnostic testing of the errors of this equation indicates that the residuals are free from the problems of heteroscedasticity and multicollinearity and that the equation is specified correctly. The RESET test and the Jarque-Bera test however suggest some error in the specification of the equation and non-normality of the distribution of the residuals.[88]

The solution of the long-run and short-run equations yields a series that tracks the trend of real GDP fairly well. This is shown in figure 6.2.

Figure 6.2 Static solution of real GDP



[88] An asterisk is used in all tables that display diagnostic tests to indicate the non-rejection of the hypotheses of non-normality of errors, no serial correlation, heteroscedasticity and the non-existence of misspecification errors.

6.4.1.2 Real private investment expenditure

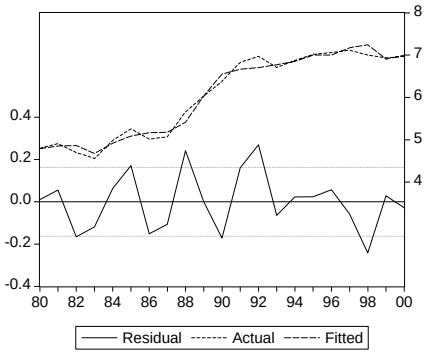
The following equation (6.24a) displays the estimation results of the long run equation for real private investment. Real output, as expected, influences the level of real private investment positively and significantly. Although insignificant, the real user cost of capital influences real private investment negatively as predicted by the neo-classical theory.

$$\begin{aligned} LRPINV = & \underset{}{-14.89} + \underset{(4.39)}{2.66}LRGDP - \underset{(-1.03)}{0.18}LRUCC - \underset{(-4.07)}{0.85}DUM8088 \\ & - \underset{(-2.09)}{0.41}DUM89 - \underset{(-1.34)}{0.21}DUM9697 - \underset{(-2.59)}{0.45}DUM9920 \end{aligned} \qquad (6.24a)$$

$$\bar{R}^2 = 0.97 \quad S.E. = 0.16 \quad T = 21\,(1980 - 2000)$$

The residuals of the above long run estimation are plotted in figure 6.3 below. While they portrayed the existence of cointegration, the Engle-Granger cointegration test was nevertheless performed for confirmation. With the Engle-Granger statistic of –5.503796, a conclusion of the presence of cointegration at the ten per cent level of significance was made. The resulting error correction model and accompanying diagnostic tests are presented in equation (6.24b) and table 6.4 respectively.

Figure 6.3 Residuals for the real private investment cointegration equation



$$\Delta LRPINV = \underset{(6.197)}{3.52}\Delta LRGDP - \underset{(-3.63)}{0.34}\Delta LRUCC - \underset{(-4.12)}{0.74}\hat{\varepsilon}_{-1} - \underset{(-2.53)}{0.13}DUM86$$
$$- \underset{(4.12)}{0.16}DUM8892 - \underset{(-1.76)}{0.15}DUM9697 + \underset{(2.49)}{0.36}DUM20 + \underset{(3.85)}{0.42}DUM9920 \qquad (6.24b)$$

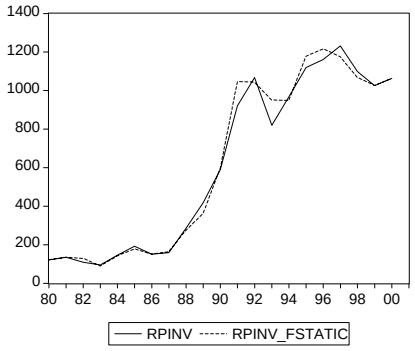
$\bar{R}^2 = 0.85 \quad S.E. = 0.09 \quad T = 20\ (1981 - 2000)$

Table 6.4 Diagnostic tests: Real private investment expenditure

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.153233	0.561796
Serial Correlation	Ljung Box Q	Q(12)	12.199	0.430
	Breusch-Godfrey	$N*R^2(2)$	0.354303	0.837653
Homoscedasticity	ARCH LM	$N*R^2(1)$	1.774496	0.182827
	White	$N*R^2(1)$	11.30765	0.502753
Misspecification	Ramsey RESET	LR(1)	5.241097	0.072763
Parameter Stability	Recursive Estimates			

Judging by the outcome of the diagnostic tests, the residuals of the short-run estimation appear to satisfy the classical OLS assumptions. Given this outcome, the short- and long-run equations are solved simultaneously. The solution shows that the estimated value of real private investment tracks the actual value fairly well. This outcome is shown in figure 6.4.

Figure 6.4 Statics solution of the private investment



6.4.1.3 Labour demand

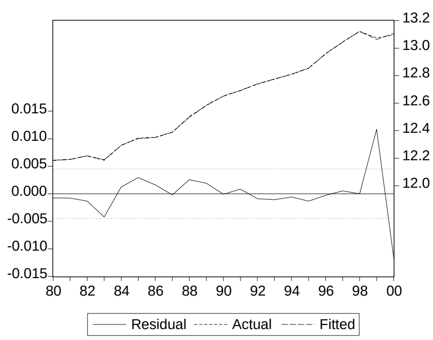
Labour demand is positively and significantly influenced to a large extent by real domestic economic activity and negatively affected by real wages. The coefficient for real wages is however relatively small. Both the user cost of capital and the ratio of real wages to the user cost of capital were tested as arguments in this equation, but did not perform well and hence were omitted.

$$\underset{(47.44)}{LL = 4.25} + \underset{(260.25)}{1.08LRGDP} - \underset{(-1.60)}{0.014LRWAGES} + \underset{(25.06)}{0.13DUM98} + \underset{(12.12)}{0.05DUM99} \qquad (6.25a)$$

$$\bar{R}^2 = 0.99 \quad S.E. = 0.005 \quad T = 21\,(1980-2000)$$

The residuals for the labour demand cointegration equation are plotted in figure 6.5 below and are shown to be stationary by the Engle-Granger test for cointegration. The test statistic for this test is –6.146177 at zero lags and the McKinnon critical value is –5.605, confirming cointegration at the one per cent level of significance.

Figure 6.5 Residuals of the labour demand cointegration equation



The results of the error correction model for labour demand are presented in equation (6.25b). In general, the estimation results of the labour demand equation appear as expected from *a priori* theory.

$$\Delta LL = \underset{(151.94)}{1.085}\Delta LRGDP - \underset{(-1.33)}{0.0054}\Delta LRWAGES2 - \underset{(-2.21)}{0.62}\hat{\varepsilon}_{-1} + \underset{(74.52)}{0.13}DUM98$$
$$- \underset{(-41.4)}{0.07}DUM99 + \underset{(13.99)}{0.05}DUM20 \qquad (6.25b)$$

$$\bar{R}^2 = 0.99 \quad S.E. = 0.002 \quad T = 20\ (1980 - 2000)$$

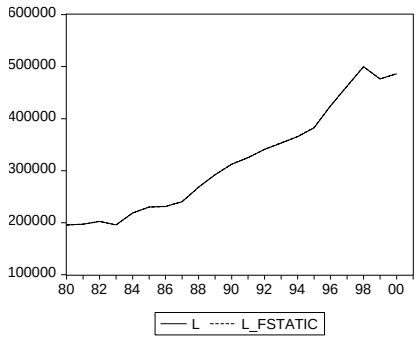
Table 6.5 Diagnostic tests: Labour demand

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.752103	0.686567
Serial Correlation	Ljung Box Q	Q(12)	8.8400	0.717
	Breusch-Godfrey	N*R^2(2)	0.0000	1.0000
Homoscedasticity	ARCH LM	N*R^2(1)	1.190685	0.275191
	White	N*R^2(1)	9.279124	0.411918
Misspecification	Ramsey RESET	LR(2)	129.6919	0.000000*
Parameter Stability	Recursive Estimates			

The residuals of this estimation were subjected to a host of diagnostic tests to assess whether they conform to the assumptions of the classical OLS regression analysis. The test results are reported in table 6.5 and show that the residuals satisfy all the requirements of OLS with the exception of the Ramsey RESET test that suggests the existence of misspecification errors in the equation.

Static solution of the labour demand sub-model yields the following plot, which shows that the overall combined fit of the long- and short-run equations and the actual series is satisfactory.

Figure 6.6 Static solution of labour demand



6.4.1.4 Real wages

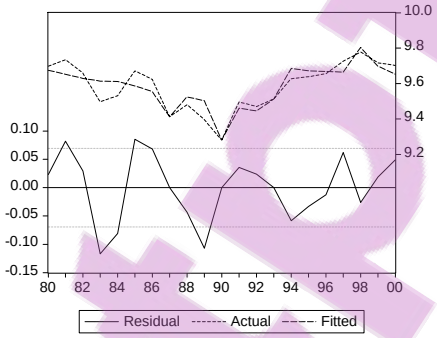
Estimation results of the long run equation for real wages are given in equation (6.26a) below. Labour productivity and consumer prices have a negative and highly significant influence on real wages.

$$\begin{aligned} LRWAGES2 = {} & 21.75 - 1.24LLABPROD1 - 0.19LCPI95 - 0.39DUM8092 \\ & \quad (4.06) \qquad (-2.13) \qquad (-3.96) \qquad (-4.30) \\ & - 0.12DUM87 - 0.20DUM90 - 0.18DUM93 \\ & \quad (-1.65) \qquad (-2.67) \qquad (-2.36) \end{aligned} \tag{6.26a}$$

$\bar{R}^2 = 0.72 \quad S.E. = 0.07 \quad T = 21\,(1980 - 2000)$

The Engle-Granger test confirmed the existence of cointegration in the residuals of the long run equation plotted in figure 6.7 below, hence the estimation of the ECM in equation (6.26b).

Figure 6.7 Residuals for the real wages cointegration equation



$$\begin{aligned} \Delta LRWAGES2 = {} & 0.43\Delta LCPI95 - 0.56\hat{\varepsilon}_{-1} - 0.18DUM83 - 0.23DUM90 \\ & \quad (4.12) \qquad (-2.38) \qquad (-2.21) \qquad (-1.81) \\ & - 0.23DUM87 - 0.18DUM89 - 0.09DUM99 \\ & \quad (-2.99) \qquad (-2.32) \qquad (-1.67) \end{aligned} \tag{6.26b}$$

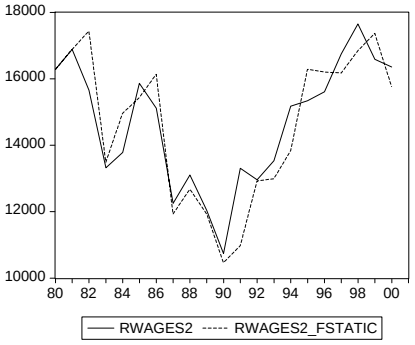
$\bar{R}^2 = 0.54 \quad S.E. = 0.07 \quad T = 20\,(1981 - 2000)$

Table 6.6 Diagnostic tests: Real wages

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.724259	0.422262
Serial Correlation	Ljung Box Q	Q(12)	10.535	0.569
	Breusch-Godfrey	$N*R^2(2)$	1.726630	0.421762
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.720400	0.396013
	White	$N*R^2(1)$	4.914977	0.841656
Misspecification	Ramsey RESET	LR(2)	1.160383	0.559791
Parameter Stability	Recursive Estimates			

Tests performed on the residuals show that none of the classical OLS assumptions are violated by the residuals.

Figure 6.8 Static solution of real wages



6.4.1.5 Real private consumption expenditure

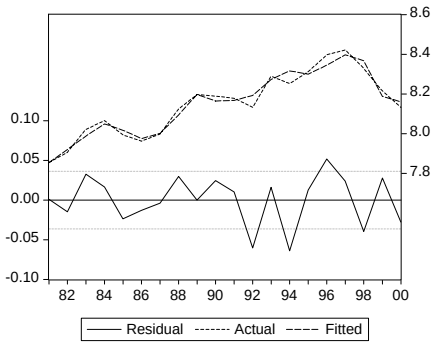
The estimation results of the long-run equation of real private consumption are given below. Real private consumption is positively and significantly influenced by disposable income as predicted by theory. The marginal propensity to consume out of disposable income is 0.24. It is also positively influenced by real wealth as represented by the real M3 money supply. The real rate of interest also plays a significant role in private consumption decisions in contrast to most empirical evidence applied to developing countries. It has a positive and significant influence.

$$LRPCONS = \underset{(4.81)}{0.33} + \underset{(1.60)}{0.24}LRYD + \underset{(4.396)}{0.25}LRM31 + \underset{(2.03)}{0.004}RTBRATE1 + \underset{(2.16)}{0.084}DUM89 - \underset{(-2.46)}{0.08}DUM99 \qquad (6.27a)$$

$\bar{R}^2 = 0.95 \quad S.E. = 0.04 \quad T = 20\ (1981 - 2000)$

A visual inspection of the plot of the residuals, presented in the figure 6.9 below, from the long-run equation suggests that there is cointegration among the included variables. Formal tests attest to the fact that the long-run equation cointegrates at the five per cent level of significance.

Figure 6.9 Residuals of the private consumption cointegration equation



Given cointegration in the long run equation, the ECM was formulated and estimated. The results of the ECM are given below.

$$\Delta LRPCONS = \underset{(1.51)}{0.29}\Delta LRYD + \underset{(4.03)}{0.35}\Delta LRM31 + \underset{(0.62)}{0.001}RTBRATE1 - \underset{(-2.02)}{0.64}\hat{\varepsilon}_{-1}$$
$$- \underset{(-1.70)}{0.068}DUM85 - \underset{(-2.28)}{0.097}DUM94 - \underset{(-1.47)}{0.029}DUM982 \qquad (6.27b)$$

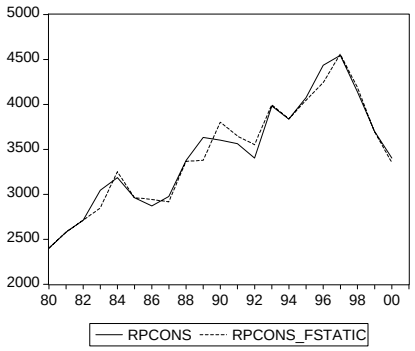
$\bar{R}^2 = 0.74 \quad S.E. = 0.04 \quad T = 19\ (1982 - 2000)$

Table 6.7 Diagnostic tests: Real private consumption expenditure ECM

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.485018	0.475918
Serial Correlation	Ljung Box Q	Q(12)	10.814	0.545
	Breusch-Godfrey	$N*R^2(2)$	2.081542	0.353182
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.035499	0.850554
	White	$N*R^2(1)$	10.20177	0.598265
Misspecification	Ramsey RESET	LR(1)	0.624837	0.731675
Parameter Stability	Recursive Estimates	Indicative of Stability		

The residuals seem to fulfil all the requirements of the OLS assumptions. With this in mind, the private consumption sub-model was then solved statically. The solution results produced a relatively good fit as presented in the figure 6.10 below.

Figure 6.10 Static solution of the private consumption



6.4.1.6 Consumer prices

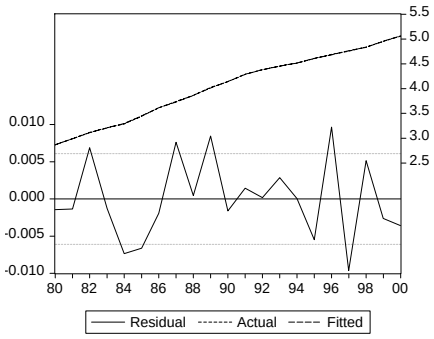
In the long run estimation, consumer prices are positively and significantly influenced by producer prices, excess demand, and the price of imports. The signs of all the variables in this estimation conform to theoretical expectations.

$$LCPI95 = \underset{(1.84)}{0.08}LGDPDEF + \underset{(2.51)}{0.006}LED + \underset{(21.50)}{0.91}LPMGS1 + \underset{(2.72)}{DUM9092} - \underset{(-11.02)}{0.05}DUM982 - \underset{(-3.86)}{0.03}DUM9697 \qquad (6.28a)$$

$$\bar{R}^2 = 0.99 \quad S.E. = 0.006 \quad T = 21\,(1980 - 2000)$$

The Engle-Granger test performed on the residuals of the long run estimation, plotted below, confirms that the variables included in the cointegration equation are cointegrated.

Figure 6.11 Residuals of the consumer prices cointegration equation



Estimation results of the ECM are shown in the equation (6.28b).

$$\Delta LCPI95 = \underset{(90.32)}{0.99}\Delta LPMGS1 - \underset{(-2.04)}{0.52}\hat{\varepsilon}_{-1} - \underset{(-1.96)}{0.01}DUM84 - \underset{(-6.93)}{0.04}DUM98 + \underset{(-3.39)}{0.01}DUM9697 \qquad (6.28b)$$

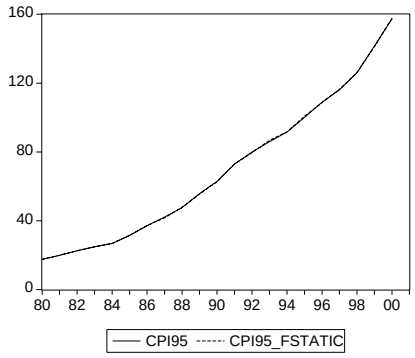
$$\bar{R}^2 = 0.97 \quad S.E. = 0.005 \quad T = 20\ (1981 - 2000)$$

Table 6.8 Diagnostic tests: Consumer prices

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.169349	0.918811
Serial Correlation	Ljung Box Q	Q(12)	19.878	0.069
	Breusch-Godfrey	N*R^2(2)	3.035607	0.219193
Homoscedasticity	ARCH LM	N*R^2(1)	0.830586	0.362103
	White	N*R^2(1)	5.226049	0.632399
Misspecification	Ramsey RESET	LR(2)	4.944282	0.084404
Parameter Stability	Recursive Estimates			

Tests on the residuals of the ECM, plotted in the graph above, show that none of the assumptions of OLS are violated by the residuals. The series that results from these estimations closely follows the actual trend of consumer prices.

Figure 6.12 Static solution of consumer prices



6.4.1.7 Producer prices

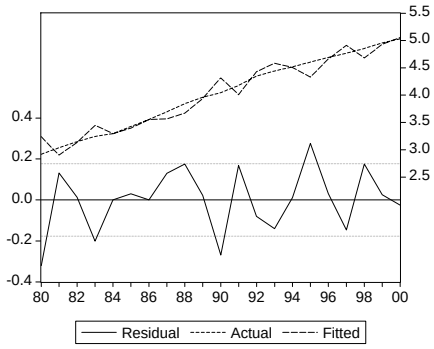
Estimation results of the cointegration equation for producer prices are given in equation (6.29a). In accordance to the results, producer prices are positively and significantly related to capacity utilisation and negatively to the ratio of real wages to the user cost of capital. The political disturbance of 1986 and the inception of the structural adjustment in 1988/89 tended to lower the producer prices. In contrast, the political riots of 1998 resulted in a hike of producer prices.

$$\begin{aligned} LGDPDEF = {} & \underset{(19.7)}{2.96}LCU2 - \underset{(-14.05)}{0.82}LRWAGESUCC2 - \underset{(-2.03)}{0.37}DUM84 + \underset{(-2.61)}{0.25}DUM86 \\ & - \underset{(-1.46)}{0.09}DUM8892 + \underset{(3.17)}{0.45}DUM99 \end{aligned} \qquad (6.29a)$$

$$\bar{R}^2 = 0.93 \quad S.E. = 0.18 \quad T = 21\,(1980 - 2000)$$

The Engle-Granger cointegration test revealed that the residuals of the long-run equation, plotted in figure 6.13, were cointegrated.

Figure 6.13 Residuals for the Producer Prices Cointegration Equation



The ECM results of the producer prices equation are presented in equation (6.29b).

$$\Delta LGDPDEF = \underset{(1.96)}{1.21} - \underset{(1.16)}{0.05}\Delta LRWAGES2(-1) - \underset{(-1.75)}{0.24}LCU2(-1) - \underset{(-1.51)}{0.05}\hat{\varepsilon}_{-1} - \underset{(-5.07)}{0.12}DUM84$$
$$+ \underset{(5.11)}{0.1}DUM92 - \underset{(-3.77)}{0.03}DUM9020 - \underset{(-1.44)}{0.03}DUM20 \qquad (6.29b)$$

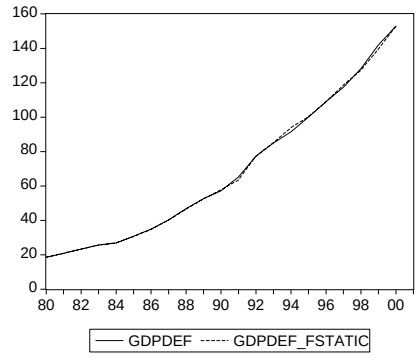
$$\bar{R}^2 = 0.74 \quad S.E. = 0.01 \quad T = 19\ (1982 - 2000)$$

Table 6.9 Diagnostic tests: Producer prices

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.690580	0.708015
Serial Correlation	Ljung Box Q	Q(12)	7.9471	0.789
	Breusch-Godfrey	$N*R^2(2)$	0.761864	0.683224
Homoscedasticity	ARCH LM	$N*R^2(1)$	1.243999	0.264702
	White	$N*R^2(1)$	11.41232	0.326309
Misspecification	Ramsey RESET	LR(2)	0.799391	0.670524
Parameter Stability	Recursive Estimates			

Diagnostic tests on these residuals show that none of the assumptions of OLS is violated by the residuals. The static solution of the long run and short run equations of producer prices yields a good fit between the estimated and actual values.

Figure 6.14 Static solution of producer prices



6.4.1.8 Export prices

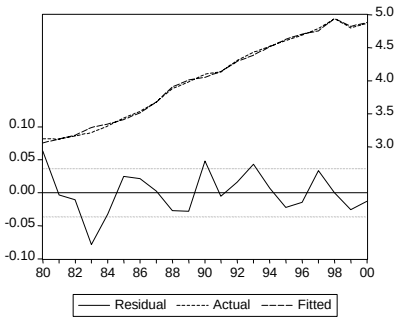
Results of the cointegration equation for export prices are given below. As predicted by theory, export prices are positively and significantly related to world prices and producer prices and negatively and significantly related to the nominal exchange rate. The political riots of 1998 tended to elevate export prices.

$$LPXGS = \underset{(-4.76)}{-1.57} + \underset{(4.92)}{0.47}LPW1 - \underset{(-5.62)}{0.43}LEXRATE + \underset{(14.07)}{0.87}LGDPDEF + \underset{(4.39)}{0.17}DUM98 \qquad (6.30a)$$

$$\bar{R}^2 = 0.99 \quad S.E. = 0.04 \quad T = 21\,(1980 - 2000)$$

The Engle-Granger cointegration test performed on the residuals of the long run equation shows that the variables included in the long run equation are cointegrated.

Figure 6.15 Residuals for the export prices cointegration equation



$$\Delta LPXGS = \underset{(9.10)}{0.898}\Delta LGDPDEF + \underset{(3.21)}{0.31}\Delta LPW1 - \underset{(-3.29)}{0.31}\Delta LEXRATE - \underset{(-3.32)}{0.89}\hat{\varepsilon}_{-1} + \underset{(4.0)}{0.15}DUM98 - \underset{(-6.22)}{0.21}DUM99 + \underset{(4.30)}{0.197}DUM20 \quad (6.30b)$$

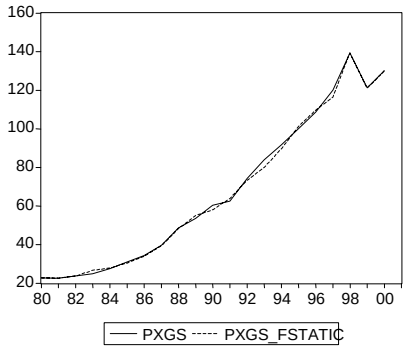
$\bar{R}^2 = 0.80 \quad S.E. = 0.03 \quad T = 20\ (1981 - 2000)$

Table 6.10 Diagnostic tests: Export prices

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.115401	0.572524
Serial Correlation	Ljung Box Q	Q(12)	6.4914	0.889
	Breusch-Godfrey	$N*R^2(2)$	1.582960	0.453174
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.171577	0.678714
	White	$N*R^2(1)$	6.009467	0.872732
Misspecification	Ramsey RESET	LR(2)	2.773061	0.249941
Parameter Stability	Recursive Estimates			

Diagnostic tests on residuals of export prices show that none of the assumptions of OLS analysis are violated and a static solution of the exports demand model gives a reasonable fit.

Figure 6.16 Static solution of exports price



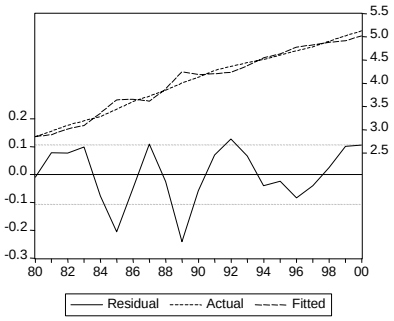
6.4.1.9 Import prices

Estimation results of the long run equation for import prices are presented in equation (6.31a). Import prices are positively and significantly related to world price and the nominal exchange rate.

$$LPMGS1 = \underset{(37.26)}{0.74}LPW1 + \underset{(2.54)}{0.205}LEXRATE - \underset{(-3.31)}{0.246}DUM8088 \qquad (6.31a)$$

$\bar{R}^2 = 0.98 \quad S.E. = 0.11 \quad T = 21\,(1980 - 2000)$

Figure 6.17 Residuals for import prices cointegration equation



The Engle-Granger test for cointegration shows that there is evidence of cointegration between the variables included in the long run equation, hence the estimation of the ECM in equation (6.31b). Estimation results of the ECM show that import prices are positively related to the own lagged values in addition to the nominal exchange rate.

$$\Delta LPMGS1 = \underset{(2.58)}{0.093} + \underset{(0.707)}{0.178}\Delta LPMGS1_{-1} + \underset{(1.73)}{0.086}\Delta LEXRATE - \underset{(-3.01)}{0.13}\hat{\varepsilon}_{-1} - \underset{(-2.24)}{0.027}DUM9298 \qquad (6.31b)$$

$\bar{R}^2 = 0.60 \quad S.E. = 0.02 \quad T = 19\,(1982 - 2000)$

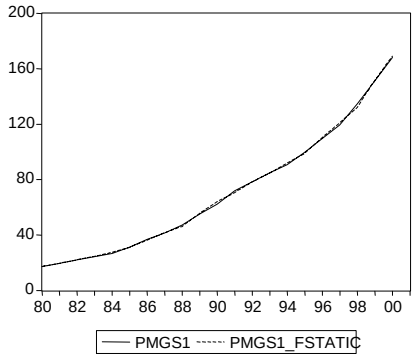
Table 6.11 Diagnostic tests: Import prices

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.577353	0.749254
Serial Correlation	Ljung Box Q	Q(12)	15.903	0.196
	Breusch-Godfrey	$N*R^2(2)$	3.518342	0.172188
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.017903	0.893559
	White	$N*R^2(1)$	7.819195	0.348807
Misspecification	Ramsey RESET	LR(2)	0.233820	0.889665
Parameter Stability	Recursive Estimates			

Diagnostic tests on the residuals of the ECM show that none of the OLS classical assumptions have been violated in this estimation. The solution of the equations of import

prices show that the estimations fit the actual series adequately. The estimated and actual series are plotted in figure 6.18.

Figure 6.18 Static solution of import prices



6.4.2 Estimation results of the external sector

6.4.2.1 Real exports of goods and services

The demand for real exports of goods and services is positively and highly driven by changes in world demand. The relative price of exports has a positive though less significant effect on the demand for exports. This indicates that a rise in the domestic price of exports relative to the world price will work to raise the value of exports as would be expected. It is also noteworthy that the institution of the sales tax in 1982 worked in favour of exports while the political instability of 1986 and 1998 adversely affected the performance of exports in international markets. The latter effects are evident from the short-run model presented in equation (6.32a).

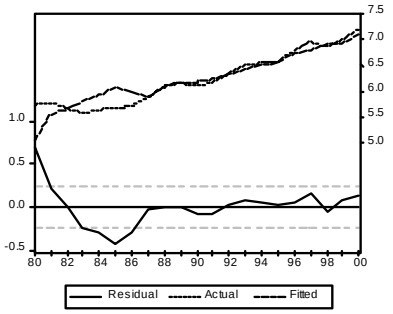
$$LRXGS = \underset{(9.086)}{0.59}LWDEMND + \underset{(1.53)}{0.15}LRXGSRELP1 + \underset{(1.64)}{0.28}DUM82 \qquad (6.32a)$$

$$\bar{R}^2 = 0.80 \quad S.E. = 0.23 \quad T = 21\,(1980 - 2000)$$

A plot of the residuals derived from the long run estimation is shown below. The stationarity feature portrayed in the plot is confirmed by a comparison of the Engle-

Granger test statistic of –4.167591 against the McKinnon critical value of –3.7553 at the ten per cent level of significance, hence the estimation of the ECM in equation (6.32b) below.

Figure 6.19 Residuals for the exports cointegration equation



$$\Delta LRXGS = \underset{(4.00)}{0.29}LWDEMND + \underset{(3.53)}{0.399}\Delta LRXGS_{-1} - \underset{(-5.0896)}{0.44}\hat{\varepsilon}_{-1} - \underset{(-4.26)}{0.14}DUM8086 - \underset{(-2.28)}{0.12}DUM90 + \underset{(2.39)}{0.097}DUM9697 - \underset{(-2.899)}{0.17}DUM98 + \underset{(3.74)}{0.14}DUM99 \quad (6.32b)$$

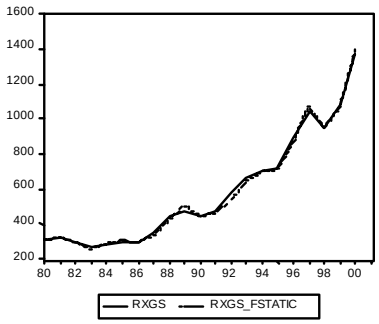
$$\bar{R}^2 = 0.79 \quad S.E. = 0.05 \quad T = 19\ (1982 - 2000)$$

Table 6.12 Diagnostic tests: Real exports of goods and services

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.487164	0.783815
Serial Correlation	Ljung Box Q	Q(12)	20.856	0.053
	Breusch-Godfrey	N*R^2(2)	8.180742	0.016733*
Homoscedasticity	ARCH LM	N*R^2(1)	0.089412	0.764926
	White	N*R^2(1)	7.076043	0.792892
Misspecification	Ramsey RESET	LR(1)	6.135586	0.013249*
Parameter Stability	Recursive Estimates			

The test results of the residuals of the ECM show some presence of serial correlation and misspecification errors, reflected in the Ljung Box Q and Breusch-Godfrey, and RESET tests, respectively. Other tests show that the residuals conform to other assumptions of the OLS assumptions.

Figure 6.21 Static solution of real exports model



6.4.2.2 Real imports of goods and services

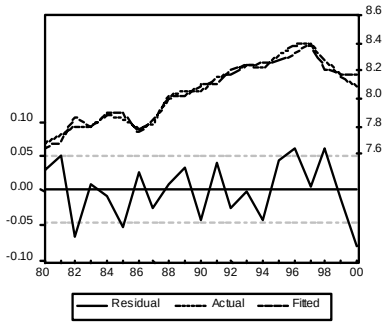
The estimation results of the long run equation for real imports of goods and services are given in equation (6.33a) below. The demand for imports of goods and services relies heavily on the level of national economic activity. A surge in the relative price of imports will lower the level of imports.

$$LRMGS = \underset{(16.64)}{1.49}LRGNP - \underset{(-5.80)}{0.94}LMGSRELP1 - \underset{(-1.48)}{0.055}DUM8384 - \underset{(-3.26)}{0.12}DUM8687 - \underset{(-2.27)}{0.07}DUM8890 \qquad (6.33a)$$

$$\bar{R}^2 = 0.96 \quad S.E. = 0.047 \quad T = 21\ (1980 - 2000)$$

Visual inspection of the residuals derived from the long run estimation plotted below suggests the existence of cointegration. The Engle-Granger test of cointegration confirms this.

Figure 6.22 Residuals of the imports cointegration equation



The resulting ECM estimation is presented in equation (6.33b).

$$\Delta LRMGS = \underset{(6.74)}{1.42}LRGNP + \underset{(0.83)}{0.75}LMGSRELP1 - \underset{(-4.46)}{1.48}\hat{\varepsilon}_{-1} - \underset{(-1.91)}{0.09}DUM83$$
$$- \underset{(-2.66)}{0.061}DUM86 - \underset{(-2.076)}{0.09}DUM20 \qquad (6.33b)$$

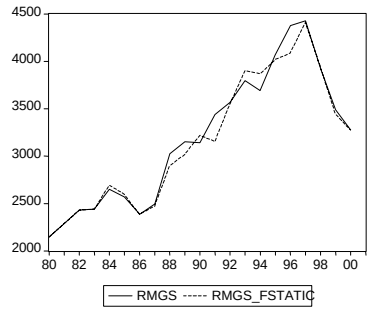
$$\bar{R}^2 = 0.70 \quad S.E. = 0.04 \quad T = 20\ (1981 - 2000)$$

Table 6.13 Diagnostic tests: Real imports of goods and services

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.774253	0.411838
Serial Correlation	Ljung Box Q	Q(12)	10.646	0.559
	Breusch-Godfrey	$N*R^2(2)$	0.00000	1.00000
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.591506	0.441837
	White	$N*R^2(1)$	5.405525	0.797623
Misspecification	Ramsey RESET	LR(2)	2.069368	0.355339
Parameter Stability	Recursive Estimates			

Tests on the residuals of the ECM, reported in table 13, reveal that they satisfy all the assumptions of the OLS regression analysis.

Figure 6.23 Static solution of real imports



6.4.3 Estimation results of the government sector

6.4.3.1 Individual income tax

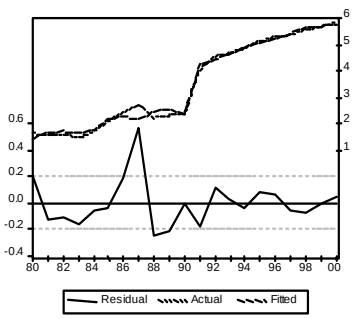
Results of the individual income tax long run equation are presented in equation (6.34a). Nominal wages take the lead and are highly significant in explaining changes in individual income tax. The reforms of the 1990s have also increased the individual income tax significantly.

$$LIITAX = \underset{}{-10.28} + \underset{(10.19)}{1.46}LNWAGES + \underset{(6.077)}{1.24}DUM9020 - \underset{(-5.69)}{1.397}DUM90 \qquad (6.34a)$$
$$\qquad\qquad (-8.53)$$

$$\overline{R}^2 = 0.99 \quad S.E. = 0.19 \quad T = 21\,(1980 - 2000)$$

The Engle-Granger test for cointegration reveals that there is cointegration among the variables included in the long-run equation, hence the estimation of the ECM presented in equation (6.34b) below.

Figure 6.24 Residuals for the individual income tax cointegration equation



$$\Delta LIITAX = \underset{(3.31)}{1.11}\Delta LNWAGES - \underset{(-3.78)}{0.88}\hat{\varepsilon}_{-1} + \underset{(6.21)}{1.33}DUM91 \qquad (6.34b)$$

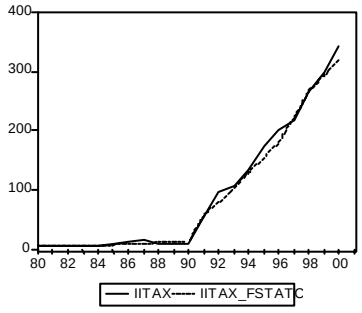
$$\bar{R}^2 = 0.81 \quad S.E. = 0.18 \quad T = 20\ (1981 - 2000)$$

Table 6.14 Diagnostic tests: Individual income tax

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	7.830645	0.019934*
Serial Correlation	Ljung Box Q	Q(12)	12.440	0.411
	Breusch-Godfrey	$N*R^2(2)$	5.860912	0.053373
Homoscedasticity	ARCH LM	$N*R^2(1)$	1.161500	0.281155
	White	$N*R^2(1)$	11.31184	0.045536*
Misspecification	Ramsey RESET	LR(2)	1.616328	0.445676
Parameter Stability	Recursive Estimates			

A battery of diagnostic tests to which the residuals of the ECM were subjected to, reveal that, the probability distribution of the residuals may not be normal as is required by the OLS estimations. In addition, a plot of the estimated and the actual series shows a reasonably close fit.

Figure 6.25 Static solution of individual income tax



6.4.3.2 Other income tax

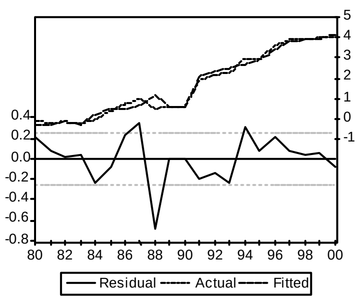
The estimation results of the long run equation for other income tax show that other income taxes depend positively and significantly on the level of economic activity as expected. According to these results, the reforms as represented by DUM89 and DUM90 had adverse effects on other income tax.

$$\underset{(-20.89)}{LOINCTAX = -38.48} + \underset{(21.64)}{5.089LRGDP} - \underset{(-3.74)}{0.99DUM89} - \underset{(-4.86)}{1.29DUM90} + \underset{(1.59)}{0.23DUM982} \qquad (6.35a)$$

$\bar{R}^2 = 0.98 \quad S.E. = 0.26 \quad T = 21\,(1980-2000)$

A plot of the residuals of the long run estimation of other income tax is given below. According to the Engle-Granger test for cointegration, these residuals are stationary, implying cointegration amongst the variables in the long run equation.

Figure 6.26 Residuals of other income tax cointegration equation



The error correction model for other income tax shows that the tax reforms of 1991 and 1994 have influenced other income tax positively and significantly. The political riots of 1998 had adverse effects on other income tax, while the reforms that started in 1999 under the SMP had a positive and significant effect.

$$\Delta LOINCTAX = \underset{(0.604)}{0.75\Delta LRGDP} - \underset{(-1.94)}{0.52\hat{\varepsilon}_{-1}} + \underset{(5.14)}{1.27DUM91} + \underset{(2.30)}{0.58DUM94} + \underset{(1.90)}{0.34DUM9598}$$

$$- \underset{(-0.696)}{0.22DUM98} + \underset{(0.35)}{0.061DUM99} \qquad (6.35b)$$

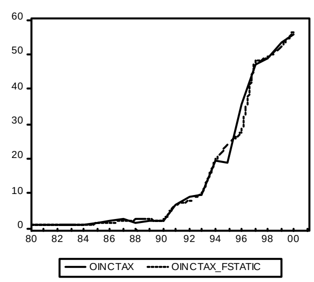
$\bar{R}^2 = 0.59 \quad S.E. = 0.24 \quad T = 20\,(1981-2000)$

Table 6.15 Diagnostic tests: Other income tax

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.246720	0.883945
Serial Correlation	Ljung Box Q	Q(12)	9.1917	0.686
	Breusch-Godfrey	$N^*R^2(2)$	1.239408	0.538104
Homoscedasticity	ARCH LM	$N^*R^2(1)$	9.564919	0.001983*
	White	$N^*R^2(1)$	10.46937	0.313839
Misspecification	Ramsey RESET	LR(2)	1.264993	0.531264
Parameter Stability	Recursive Estimates			

Tests performed on the residuals derived from the ECM show that they satisfy the OLS assumptions with the exception of the ARCH LM test that suggests that there is a presence of heteroscedasticity.

Figure 6.27 Static solution of other income tax



6.4.3.3 Company tax

The long run estimation results of the company tax equation show that the level of company tax is highly influenced by private investment.

$$LCOMPTAX = \underset{(-3.99)}{-2.51} + \underset{(10.64)}{0.96}LRPINV + \underset{(-2.29)}{0.40}DUM8090 - \underset{(-1.54)}{0.21}DUM9192 - \underset{(-1.28)}{0.18}DUM9697 \quad (6.36a)$$

$$\bar{R}^2 = 0.98 \quad S.E. = 0.16 \quad T = 21\,(1980-2000)$$

The residuals derived from the long run estimation above are shown in figure 6.28. In accordance with the Engle-Granger test, there is evidence of cointegration amongst the variables in the long-run equation.

Figure 6.28 Residuals of the company tax cointegration equation

The results of the ECM are given in equation (6.36b).

$$\Delta LCOMPTAX = \underset{(2.71)}{0.095} + \underset{(5.03)}{0.66}\Delta LRPINV - \underset{(-2.84)}{0.59}\hat{\varepsilon}_{-1} - \underset{(-2.36)}{0.31}DUM96 - \underset{(-1.20)}{0.16}DUM99 + \underset{(0.98)}{0.18}DUM20 \qquad (6.36b)$$

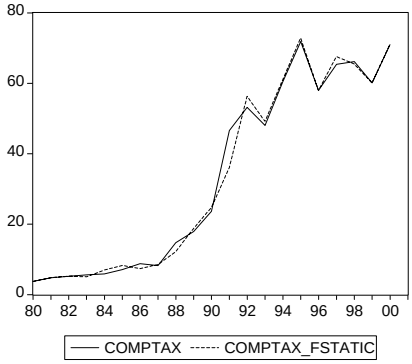
$\bar{R}^2 = 0.64 \quad S.E. = 0.13 \quad T = 20\ (1981 - 2000)$

Table 6.16 Diagnostic tests: Company tax

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	2.195205	0.333670
Serial Correlation	Ljung Box Q	Q(12)	14.582	0.265
	Breusch-Godfrey	$N*R^2(2)$	4.567699	0.101891
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.054637	0.815182
	White	$N*R^2(1)$	11.05232	0.136353
Misspecification	Ramsey RESET	LR(2)	16.49513	0.000262
Parameter Stability	Recursive Estimates			

Tests performed on the residuals of the ECM reveal that they conform to the classical assumptions of OLS. Results of the tests are given in table 6.16. The solution values of company tax closely track the actual series.

Figure 6.29 Static solution of company tax



6.4.3.4 Goods and services tax

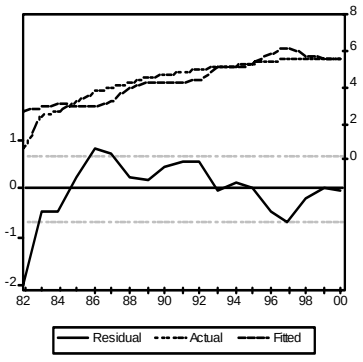
As expected, in the long run goods and services tax is positively and significantly influenced by private consumption expenditure and exports of goods and services.

$$LGSTAX = \underset{(-2.65)}{-31.53} + \underset{(1.89)}{3.29}LRPCONS + \underset{(2.91)}{1.44}LRXGS \qquad (6.37a)$$

$$\bar{R}^2 = 0.74 \quad S.E. = 0.68 \quad T = 19\ (1982 - 2000)$$

The Engle-Granger test for cointegration suggests that there is cointegration between the variables that are included in the long run estimation. A plot of the residuals of this estimation is given in figure 6.30 below.

Figure 6.30 Residuals for goods and services tax cointegration equation



The results of the error correction model show that private consumption has a positive and significant effect on goods and services tax.

$$\Delta LGSTAX = \underset{(6.28)}{0.41} + \underset{(1.90)}{1.46}\Delta LRPCONS - \underset{(-6.54)}{0.48}\hat{\varepsilon}_{-1} + \underset{(1.798)}{0.41}DUM92$$

$$- \underset{(-3.07)}{0.31}DUM9298 - \underset{(-1.82)}{0.21}DUM97 \qquad (6.37b)$$

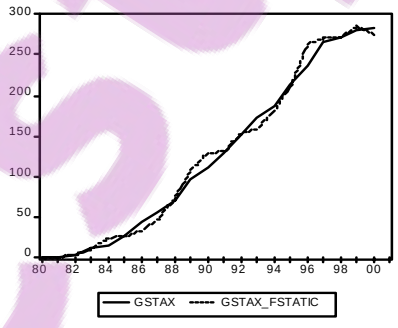
$$\bar{R}^2 = 0.77 \quad S.E. = 0.19 \quad T = 18\ (1983 - 2000)$$

Table 6.17 Diagnostic tests: Goods and services tax

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	3.595037	0.165710
Serial Correlation	Ljung Box Q	Q(12)	7.6366	0.813
	Breusch-Godfrey	$N*R^2(2)$	3.547477	0.169697
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.143988	0.704348
	White	$N*R^2(1)$	7.385435	0.495674
Misspecification	Ramsey RESET	LR(2)	18.05722	0.000120*
Parameter Stability	Recursive Estimates			

Tests performed on the residuals for the ECM show that the residuals satisfy the OLS assumptions with the exception of the Ramsey RESET test that suggests the existence of misspecification errors. The simultaneous solution of the long- and short-run equations for goods and services tax yield a close fit of the estimated series to the actual series.

Figure 6.31 Static solution of the goods and services tax



6.4.3.5 Other taxes

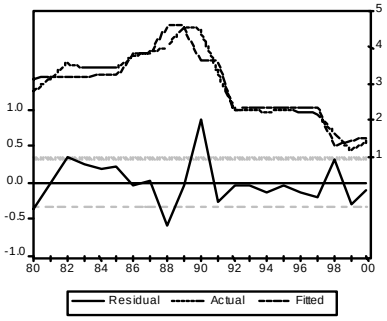
The long run estimation of the equation for other taxes shows that national output has a positive and significant impact on other taxes.

$$LOTAX = \underset{(25.02)}{0.39LRGNP} - \underset{(-2.41)}{0.73DUM8687} + \underset{(6.81)}{1.33DUM8691} - \underset{(-5.73)}{0.98DUM9020} - \underset{(-3.89)}{0.68DUM982} \qquad (6.38a)$$

$$\bar{R}^2 = 0.88 \quad S.E. = 0.34 \quad T = 21\,(1980 - 2000)$$

In addition to a plot of residuals shown in figure 6.29, the Engle-Grange test provided evidence of cointegration between the variables in the long run specification.

Figure 6.32 Residuals for other taxes cointegration equation



Results of the ECM are given in equation (6.38b) and show a positive and significant impact for the 1986 political disturbances. On the other hand, the reforms in 1992 and the political riots of 1998 had adverse effects on other taxes.

$$\Delta LOTAX = \underset{(3.52)}{2.46\Delta LRGNP} - \underset{(-7.97)}{0.96\hat{\varepsilon}_{-1}} + \underset{(3.85)}{0.295DUM86} - \underset{(-9.24)}{1.47DUM92} - \underset{(-3.67)}{0.41DUM9798} \qquad (6.38b)$$

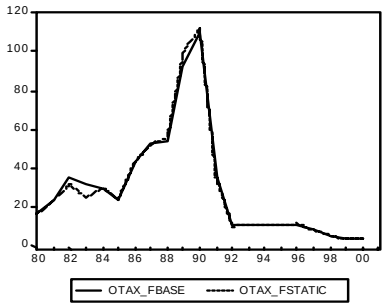
$$\bar{R}^2 = 0.88 \quad S.E. = 0.15 \quad T = 20\,(1981 - 2000)$$

Table 6.18 Diagnostic tests: Other taxes

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.130266	0.568285
Serial Correlation	Ljung Box Q	Q(12)	13.783	0.315
	Breusch-Godfrey	$N*R^2(2)$	3.864771	0.144802
Homoscedasticity	ARCH LM	$N*R^2(1)$	1.370482	0.241727
	White	$N*R^2(1)$	7.886550	0.342704
Misspecification	Ramsey RESET	LR(1)	3.077962	0.079360
Parameter Stability	Recursive Estimates			

Diagnostic tests performed on the residuals of the ECM reveal that the residuals are in line with all the classical OLS assumptions. It is also noteworthy that the estimated series tends to follow the actual series of other taxes well.

Figure 6.33 Static solution of other taxes



6.4.3.6 Government domestic debt

The estimation results of the long run government domestic debt equation are presented in equation (6.39a) below. The results suggest that a worsening of the government balance will induce a significant growth in government domestic debt as expected. In addition, an increase in the nominal Treasury bill rate will raise the level of domestic debt.

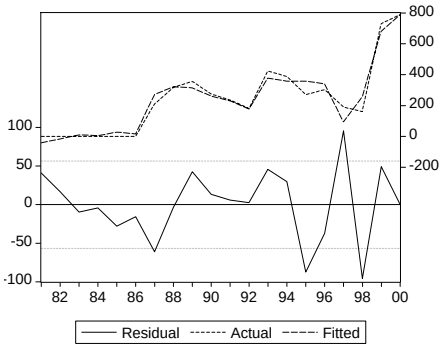
$$DOMDEBT = 284.73 - 0.78GOVBAL + 73.74LTBRATE - 241.02DUM8086 - 270.43DUM8092$$
$$(2.03) \quad (-5.96) \quad (1.29) \quad (-7.26) \quad (-6.64)$$
$$- 298.58DUM9798$$
$$(-6.02)$$

(6.39a)

$\overline{R}^2 = 0.94 \quad S.E. = 56.55 \quad T = 20\ (1981 - 2000)$

The Engle-Granger test shows that the residuals of the long run estimation are stationary, thus giving evidence of cointegration among the variables in the long run specification.

Figure 6.34 Residuals of the government domestic debt cointegration equation



$$\Delta DOMDEBT = 97.99LTBRATE - 1.026\Delta GOVBAL - 0.82\hat{\varepsilon}_{-1} - 266.82DUM8086 - 165.23DUM8892$$
$$(8.39) \quad (-4.76) \quad (-2.73) \quad (-6.62) \quad (-5.75)$$
$$- 270.99DUM95 - 440.21DUM9798$$
$$(-6.25) \quad (-7.46)$$

(6.39b)

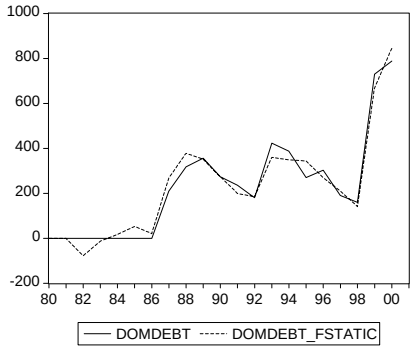
$\overline{R}^2 = 0.87 \quad S.E. = 56.15 \quad T = 19\ (1982 - 2000)$

Table 6.19 Diagnostic tests: Government domestic debt

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	0.946142	0.623086
Serial Correlation	Ljung Box Q	Q(12)	6.8751	0.866
	Breusch-Godfrey	$N*R^2(2)$	0.035300	0.982505
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.542822	0.461265
	White	$N*R^2(1)$	11.53680	0.399447
Misspecification	Ramsey RESET	LR(2)	8.270602	0.015998*
Parameter Stability	Recursive Estimates			

Tests performed on the residuals of the ECM show that they satisfy the assumptions of OLS except for the White test that shows that the residuals may be heteroscedastic, and the RESET test that shows that there is evidence of misspecification errors.

Figure 6.35 Static solution of government domestic debt



6.4.3.7 Government external debt

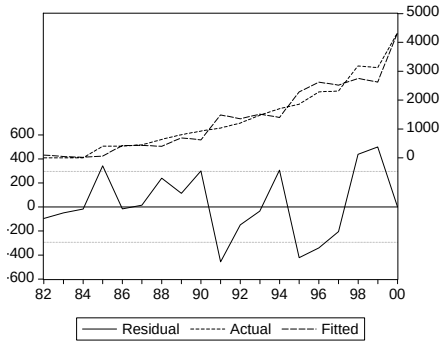
Estimation results of the long run equation for government external debt show that there is a negative and highly significant relationship between government external debt and the nominal current account balance.

$$EXTDEBT = \underset{(-22.04)}{-1.94}NCAB3 + \underset{(1.74)}{363.21}DUM8687 + \underset{(7.15)}{2215.14}DUM20 \qquad (6.40a)$$

$$\bar{R}^2 = 0.94 \quad S.E. = 294.73 \quad T = 19\ (1982 - 2000)$$

The Engle-Granger test confirms cointegration in the residuals of the long run specification above hence the estimation of the ECM in equation (6.40b).

Figure 6.36 Residuals for government external debt cointegration equation



$$\Delta EXTDEBT = \underset{(2.59)}{143.33} - \underset{(-1.57)}{0.52}NCAB3 - \underset{(-2.19)}{0.447}\hat{\varepsilon}_{-1} + \underset{(5.2)}{1410.62}DUM20 \qquad (6.40b)$$

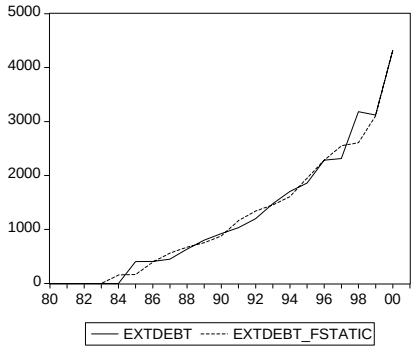
$\overline{R}^2 = 0.61 \quad S.E. = 202.63 \quad T = 18\ (1983 - 2000)$

Table 6.20 Diagnostic tests: Government external debt

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	18.56865	0.000093*
Serial Correlation	Ljung Box Q	Q(12)	8.5777	0.739
	Breusch-Godfrey	$N*R^2(2)$	3.907326	1.141754
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.012772	0.910020
	White	$N*R^2(1)$	2.509588	0.775050
Misspecification	Ramsey RESET	LR(2)	0.150258	0.927624
Parameter Stability	Recursive Estimates			

Diagnostic tests on the residuals of the ECM show that the residuals satisfy all the assumptions of OLS, with the exception of the Jarque-Bera test for normality that shows that the distribution of the residuals is not normal.

Figure 6.37 Static solution of government external debt



6.4.4 Estimation results of the monetary sector

6.4.4.1 Real currency

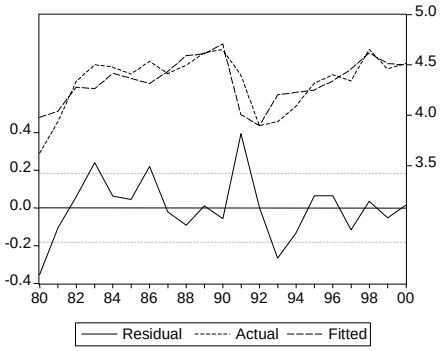
Equation (6.41a) gives the estimation results of the real currency demand cointegration equation. As expected *a priori*, the level of national economic activity positively and significantly influences the demand for real transaction balances. The long run income elasticity of demand for real currency is 2.06.

$$LRCUR = \underset{(-3.29)}{-13.23} + \underset{(4.35)}{2.06}LRGNP + \underset{(4.19)}{0.62}DUM8090 - \underset{(-1.23)}{0.24}DUM92 + \underset{(2.49)}{0.24}DUM982 \qquad (6.41a)$$

$\bar{R}^2 = 0.57 \quad S.E. = 0.18 \quad T = 21\,(1980 - 2000)$

The Engle-Granger cointegration test was performed on the residuals of the long run equation, plotted below. According to the test, the null hypothesis of no cointegration is rejected and a conclusion that the variables in the long run equation are cointegrated is drawn.

Figure 6.38 Residuals for real currency cointegration equation



The estimation results of the ECM are given in equation (6.41b) and show that the short-run income elasticity of demand for real currency is slightly higher at 2.12. While the cost of holding money represented by the rate of inflation also affects real currency positively as expected, the influence is less significant in statistical terms. In addition, political instability appears to induce a highly significant rise in the demand for transactions balances. This is shown by the coefficients of DUM86 and DUM98.

$$\Delta LRCUR = \underset{(5.52)}{2.12}\Delta LRGNP + \underset{(1.495)}{0.1}\Delta LINFL1 - \underset{(-6.35)}{0.85}\hat{\varepsilon}_{-1} + \underset{(3.61)}{0.27}DUM83$$
$$+ \underset{(2.88)}{0.10}DUM86 - \underset{(-4.67)}{0.25}DUM9192 + \underset{(5.09)}{0.39}DUM98 \qquad (6.41b)$$

$$\bar{R}^2 = 0.89 \quad S.E. = 0.07 \quad T = 19\ (1982 - 2000)$$

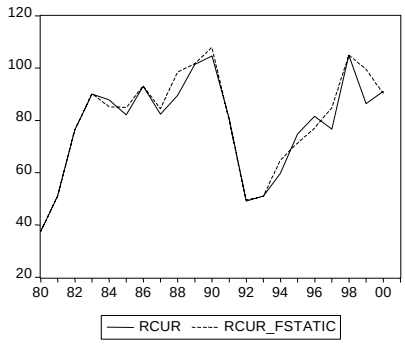
Table 6.21 Diagnostic tests: Real currency demand

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.757140	0.415377
Serial Correlation	Ljung Box Q	Q(12)	10.832	0.543
	Breusch-Godfrey	$N*R^2(2)$	0.200814	0.904469
Homoscedasticity	ARCH LM	$N*R^2(1)$	1.081250	0.298418
	White	$N*R^2(1)$	5.859204	0.826950
Misspecification	Ramsey RESET	LR(2)	0.509095	0.775267
Parameter Stability	Recursive Estimates			

An evaluation of the test results of the diagnostic tests performed on the residuals of the ECM shows that the residuals satisfy all the classical OLS assumptions. In turn, figure

6.39 shows that a plot of the actual real currency series against the series derived from the solution of the individual currency demand model is relatively satisfactory.

Figure 6.39 Static solution of real currency



6.4.4.2 Real demand deposits

The estimation results of the real demand deposits long run equation are displayed in equation (6.42a). As with the demand for currency, real national economic activity is the major driver of the demand for real demand deposits. Although the influence of the real Treasury bill rate is negligible, both in magnitude and in the statistical sense, its coefficient appears with the correct sign.

$$\underset{}{LRDD} = \underset{}{-13.24} + \underset{(-10.02)}{2.3}\,LRGNP - \underset{(-0.94)}{0.004}\,RTBRATE1 + \underset{(2.02)}{0.09}\,DUM86$$
$$- \underset{(-2.39)}{0.19}\,DUM90 + \underset{(3.0)}{0.12}\,DUM982 \qquad (6.42a)$$

$$\bar{R}^2 = 0.95 \quad S.E. = 0.08 \quad T = 20\ (1981 - 2000)$$

A plot of the residuals from the long run estimation shows that they are stationary. This is confirmed by the Engle-Granger cointegration test.

Figure 6.39 Residuals of the real demand deposits cointegration equation

Estimation results of the ECM in equation 6.55 show that the short run income elasticity of demand for real demand deposits is much smaller, at 0.35, than its long run counterpart. The influences of both national income and the rate of interest are however statistically insignificant in this equation.

$$\Delta LRDD = \underset{}{0.11} + \underset{(4.03)}{0.35}\Delta LRGNP - \underset{(0.93)}{0.004}RTBRATE1 - \underset{(0.082)}{1.1}\hat{\varepsilon}_{-1} - \underset{(-3.29)}{0.22}DUM83 - \underset{(2.56)}{0.27}DUM87 - \underset{(-3.16)}{0.22}DUM90 - \underset{(-2.61)}{0.16}DUM99 \quad (6.42b)$$
$$(-2.62)$$

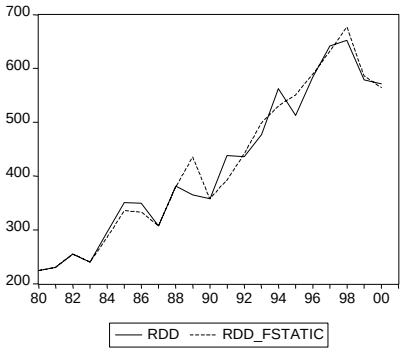
$$\bar{R}^2 = 0.57 \quad S.E. = 0.08 \quad T = 19\ (1982 - 2000)$$

Table 6.22 Diagnostic tests: Real demand deposits

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	10.55997	0.005093*
Serial Correlation	Ljung Box Q	Q(12)	10.044	0.612
	Breusch-Godfrey	N*R^2(2)	2.977960	0.225603
Homoscedasticity	ARCH LM	N*R^2(1)	0.603385	0.437289
	White	N*R^2(1)	9.345114	0.499694
Misspecification	Ramsey RESET	LR(2)	0.077017	0.962224
Parameter Stability	Recursive Estimates			

Diagnostic tests on the residuals reveal that they satisfy all assumptions of OLS regression analysis except for that of normality of the distribution. Figure 6.40 shows that the estimated series of real demand deposits tracks the actual series fairly closely.

Figure 6.40 Static solution of demand deposits



6.4.4.3 Real time and saving deposits

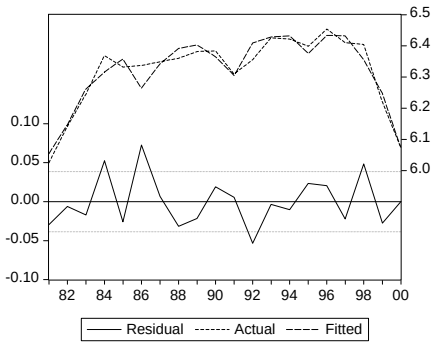
Estimation results of real time and saving deposits reveal that though with a smaller elasticity, national income is the major variable that explains changes in the real time and savings deposits. The sign of its coefficient follows theoretical predictions. In turn, the nominal Treasury bill rate positively and significantly influences the demand for this monetary aggregate.

$$LRTSD = \underset{(1.13)}{1.76} + \underset{(2.98)}{0.56}LRGNP + \underset{(3.98)}{0.009}RTBRATE1 - \underset{(3.86)}{0.147}DUM8084 - \underset{(-3.30)}{0.11}DUM9020 - \underset{(-2.81)}{0.07}DUM97 - \underset{(-3.57)}{0.17}DUM20 \quad (6.43a)$$

$$\bar{R}^2 = 0.90 \quad S.E. = 0.04 \quad T = 20\ (1981 - 2000)$$

Residuals derived from the long run estimation are presented in the graph below. The Engle-Granger conitegration test was used to confirm the existence of cointegration between the variables included in the long run estimation, hence the estimation of the ECM in equation (6.43b).

Figure 6.41 Residuals for the real time and saving deposits cointegration equation



$$\Delta LRTSD = \underset{(2.42)}{0.41}\Delta LRGNP + \underset{(1.83)}{0.031}RTBRATE1 - \underset{(-2.18)}{0.57}\hat{\varepsilon}_{-1} + \underset{(2.53)}{0.04}DUM8086$$

$$- \underset{(-1.29)}{0.034}DUM97 - \underset{(-2.26)}{0.10}DUM99 \qquad (6.43b)$$

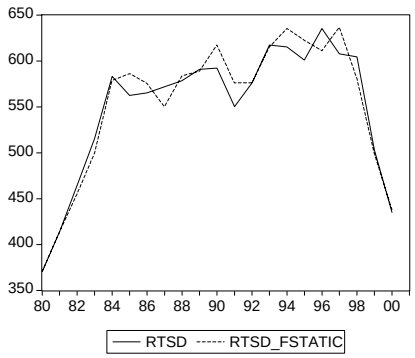
$$\bar{R}^2 = 0.80 \quad S.E. = 0.04 \quad T = 19\ (1982 - 2000)$$

Table 6.23 Diagnostic tests: Real time and saving deposits

Purpose of Test	Test	d.f.	Test Statistic	Probability
Normality	Jarque-Bera	JB(2)	1.224500	0.542130
Serial Correlation	Ljung Box Q	Q(12)	9.6730	0.645
	Breusch-Godfrey	$N*R^2(2)$	0.002249	0.998876
Homoscedasticity	ARCH LM	$N*R^2(1)$	0.032749	0.856394
	White	$N*R^2(1)$	13.31377	0.206654
Misspecification	Ramsey RESET	LR(2)	3.011547	0.221846
Parameter Stability	Recursive Estimates			

Diagnostic tests performed on the residuals of the ECM estimation show that they conform to the OLS assumptions. A solution of the equations for the real time and saving deposits is shown in figure 6.42.

Figure 6.42 Static solution of real time and saving deposits



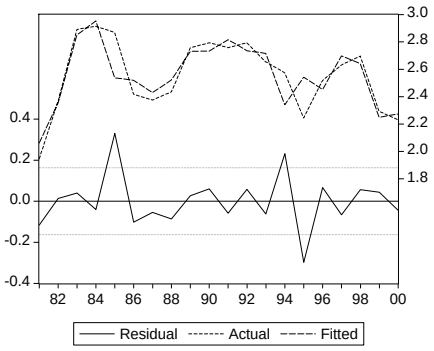
6.4.4.4 Nominal Treasury bill rate

Long run estimation results of the nominal Treasury bill rate show that the Treasury bill rate is related positively and significantly to real national output, the government budget balance and the rate of inflation.

$$\begin{aligned} LTBRATE = &-16.195 + \underset{(4.27)}{2.09}LRGNP + \underset{(1.33)}{0.001}RGOVBAL + \underset{(2.50)}{0.58}LINFL1 \\ &\underset{(-3.67)}{} \\ &+ \underset{(4.36)}{0.73}DUM8384 - \underset{(-2.39)}{0.34}DUM95 - \underset{(-1.28)}{0.19}DUM9697 - \underset{(-1.55)}{0.34}DUM99 \end{aligned} \tag{6.44a}$$

$\bar{R}^2 = 0.62 \quad S.E. = 0.16 \quad T = 20\ (1981 - 2000)$

Figure 6.43 Residuals for the nominal Treasury bill rate cointegration equation



In addition to the real government budget balance, the nominal Treasury bill rate is influenced positively and significantly by a one period lagged real national output, its own lagged values, the foreign (SA) short-term interest rate, and a one period lagged inflation rate in the error correction equation.

$$\begin{aligned} LTBRATE = &\underset{(3.096)}{1.67}\Delta LRGNP_{-1} + \underset{(20.45)}{0.84}LTBRATE_{-1} \\ &+ \underset{(3.76)}{0.028}RF + \underset{(-2.596)}{0.21}\Delta LINFL1_{-1} - \underset{(-3.69)}{0.74}\hat{\varepsilon}_{-1} - \underset{(-1.51)}{0.097}DUM95 \end{aligned} \tag{6.44b}$$

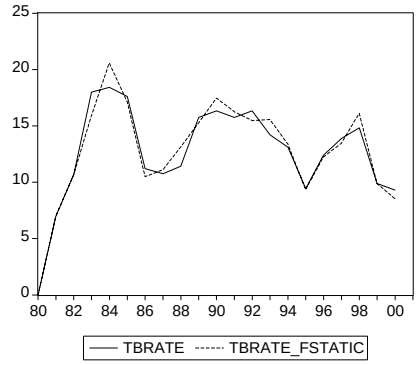
$\bar{R}^2 = 0.86 \quad S.E. = 0.10 \quad T = 19\ (1982 - 2000)$

Table 6.24 Diagnostic tests: Nominal Treasury bill interest rate

Purpose of test	Test	d.f.	Test statistic	Probability
Normality	Jarque-Bera	JB(2)	0.745857	0.688714
Serial Correlation	Ljung Box Q	Q(12)	8.1344	0.775
	Breusch-Godfrey	$N*R^2(2)$	2.741060	0.253972
Homoscedasticity	ARCH LM	$N*R^2(1)$	2.206887	0.137396
	White	$N*R^2(1)$	16.83918	0.112724
Misspecification	Ramsey RESET	LR(2)	9.725337	0.007730*
Parameter Stability	Recursive Estimates		Indicative of Stability	

Diagnostic tests on the residuals show that they do not violate any of the assumptions of classical OLS analysis, except for the test for misspecification errors. Moreover, the estimated series does not deviate significantly from the actual series.

Figure 6.44 Static solution of the nominal Treasury bill rate



6.5 CONCLUSION

This chapter has presented the estimation and test results of the behavioural equations of the model. These results have been assessed to a large extent on theoretical and statistical grounds. This entailed, first and foremost, inspection of the signs and magnitudes of the estimated coefficients. The statistical properties involved the significance of the individual explanatory variables in equations, the overall statistical performance of the individual regressions and the assessment of conformity of the equations to OLS assumptions. Most of the equations have performed well, both theoretically and statistically in both the long-run and short-run estimations. All the long-run estimations

exhibit cointegration properties, as judged by the Engle-Granger cointegration test, thus permitting estimation of the ECMs. In turn, the adjustment terms in the latter estimations are large enough and statistically significant to allow for adjustment to long-run equilibria. The solutions of the individual models, consisting of the long-run and short-run dynamic estimations, almost invariably produce a satisfactory fit of the estimated series to the actual series, indicating a good performance of the individual models. Further tests on the forecasting accuracy of the endogenous variables of the models are carried out in the next chapter.

It is evident from the results that the real aggregate output depends on labour, capital and technological advancements. It is however noticeable that labour has a more pronounced impact on changes in real aggregate output than capital. Private investment is explained by real output and the real user cost of capital. In turn, changes in the level of employment are driven by changes in real aggregate output with changes in real wages playing a less prominent role. Real wages depend to a large extent on labour productivity.

One of the salient features that emerges from the estimations results is that a more daring specification of the consumption function, that includes some form of a wealth variable and the rate of interest, is suitable for the economy of Lesotho as opposed to the case in many developing economies. In the prices sector, changes in the producer prices, the level of excess demand and import prices explain consumer prices. The latter two variables attest to the influence of demand pressures and high import content, and variations in consumer prices. Changes in producer prices rely heavily on capacity utilization and factor costs while export and import prices both rely heavily on world prices and the nominal exchange rate.

It is evident that the demand for real exports of goods and services is influenced mainly by world demand while the demand for imports is determined primarily by the national level of economic activity as is expected from theory.

With regard to the government sector, nominal wages tend to perform well as a base for individual income tax revenue while the level of real economic activity plays a major role in explaining changes in other income tax and other tax receipts. In contrast, goods and services taxes depend on real private consumption and real exports of goods and services, while company taxes depend highly on real private investment. The levels of domestic and external government debt are highly and directly related to developments in the government budgetary operations and the nominal current account balance respectively as well as the nominal rate of interest.

In the monetary sector, the level of real economic activity plays an important role in explaining changes in the levels of both narrow and broad money, with the rate of inflation and the rate of interest partly explaining the former and the latter respectively, as opportunity cost variables. The nominal Treasury bill rate of interest is linked to national real economic activity, the government budget balance, the rate of inflation and the South African interest rate.

It is noteworthy that a number of events, economic and otherwise, that occurred in the economy had significant effects on economic variables. These include political instability, economic reforms and major policy changes, the inception and phasing out of major activities of the LHWP, structural adjustment programmes and others.

In principle, these results indicate that fairly standard and rather parsimonious specifications are suitable for the economy of Lesotho as is the case with many small developing economies.

CHAPTER 7

MODEL SOLUTION AND EVALUATION

7.1 INTRODUCTION

One of the primary purposes of macroeconometric modelling is to explain the behaviour of endogenous variables in the context of the system. Apart from the statistical and theoretical criteria that must be satisfied by the individual behavioural equations, the overall simultaneous solution of the model is one of the ways of testing the reliability of the model by allowing it to replicate the economy for which it is designed (Ghartey and Rao 1990). This chapter seeks to present the solution of the model and evaluate its performance in terms of how well it tracks the time paths of the endogenous variables. In addition, the model is evaluated on the basis of its ability to forecast values of the endogenous variables beyond the sample period. The forecast accuracy of the model is evaluated on the basis of the four different criteria. The model is first solved for the period starting 1984 to 2000 and then from 1984 to 2001 to produce out-of-sample forecasts for 2001. The former is taken as the base or control run and is regarded as the benchmark against which other scenarios are compared.

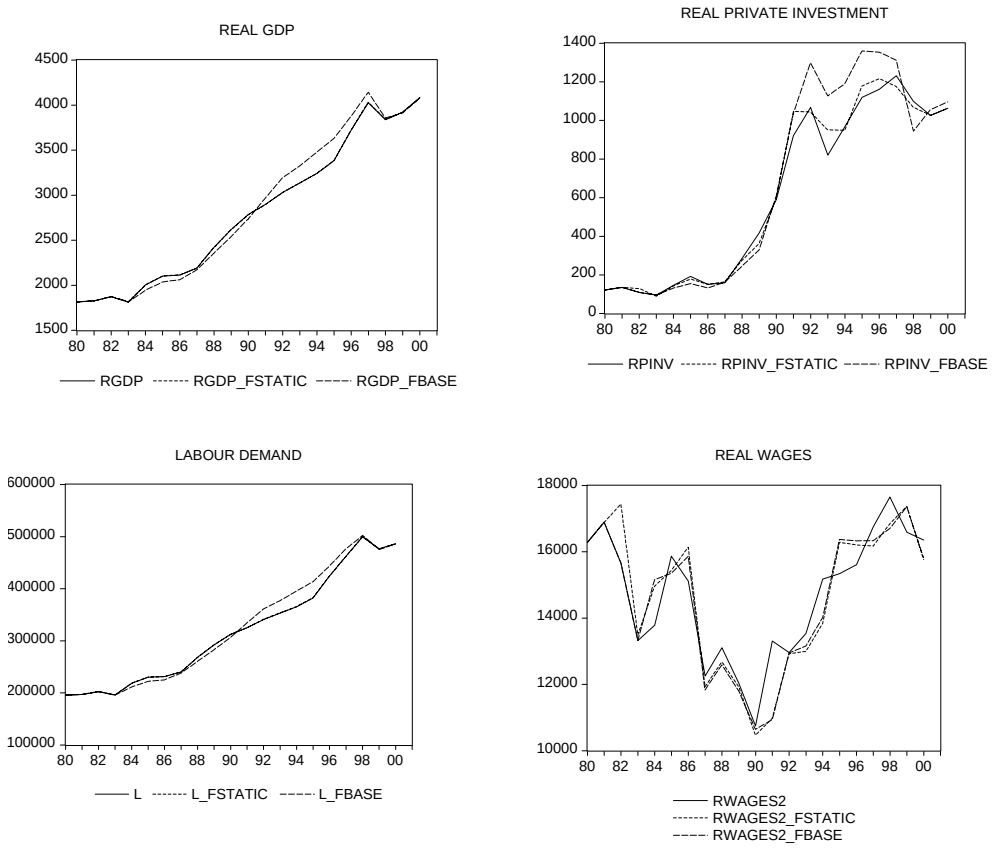
7.2 TRACKING PERFORMANCE OF THE MODEL

This section assesses the performance of the model in terms of tracking the actual series and hence the actual developments in the economy of Lesotho. This exercise is presented in two ways. First, a graphical presentation of this assessment is made both for in-sample and out-of-sample experiments. This is followed by a presentation and comparison of the figures of the actual with those of the static and dynamic solutions of the model.

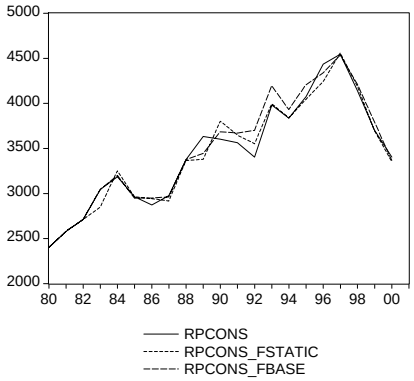
7.2.1 In-sample tracking performance

The simulation results of the model are also presented by way of graphical illustrations of the actual versus fitted values of the stochastic variables. This serves to indicate the ability of the model to track historical data. Figure 7.1 below shows the static (coded _FSTATIC) and dynamic solutions (coded _FBASE) and actual values for 25 endogenous variables determined stochastically in the model to assess the within-sample tracking performance of the model.

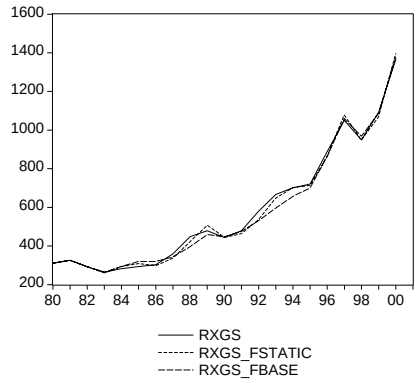
Figure 7.1 Dynamic simulation properties of the model (Within-sample, 1984-2000)



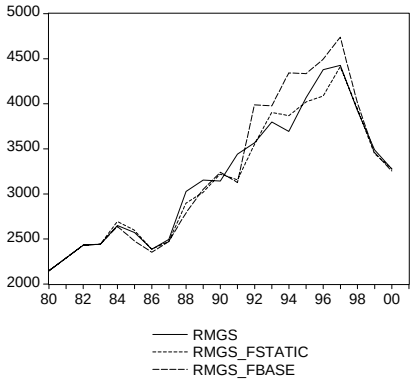
REAL PRIVATE CONSUMPTION



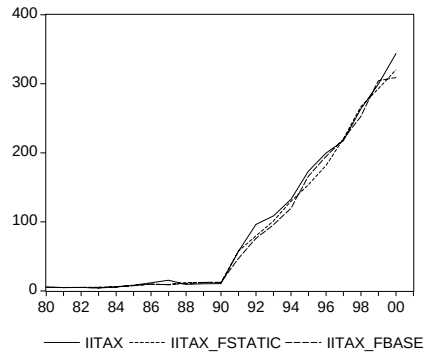
REAL EXPORTS OF GOODS AND SERVICES



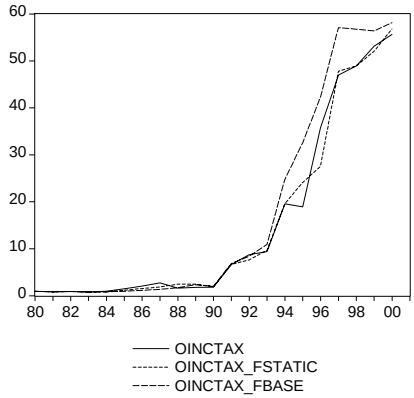
REAL IMPORTS OF GOODS AND SERVICES



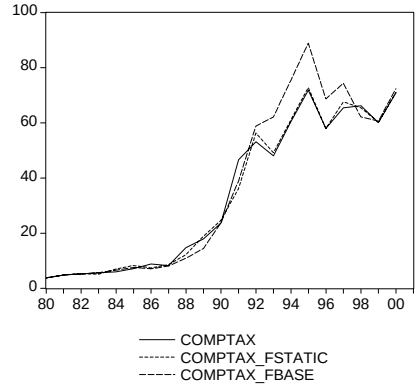
INDIVIDUAL INCOME TAX



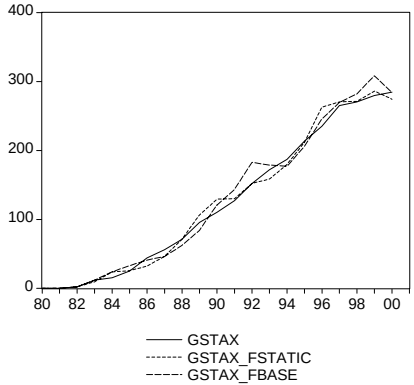
OTHER INCOME TAXES



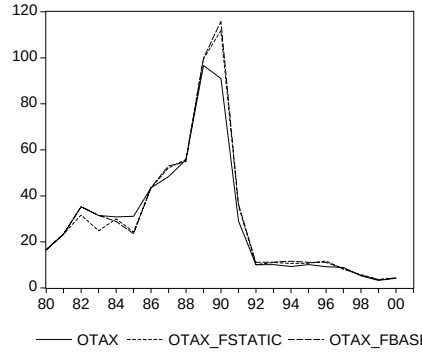
COMPANY TAX



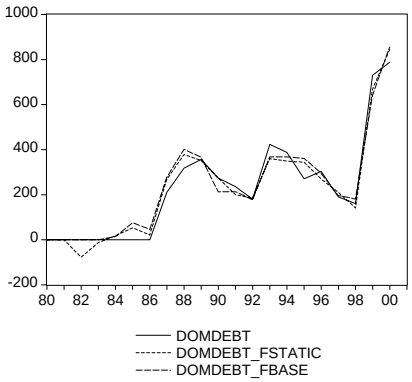
GOODS AND SERVICES TAX



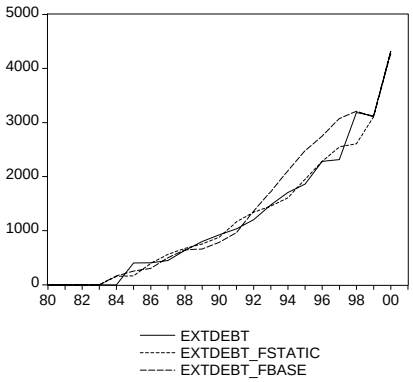
OTHER TAXES



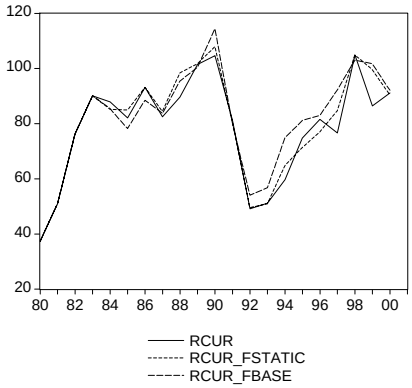
GOVERNMENT DOMESTIC DEBT



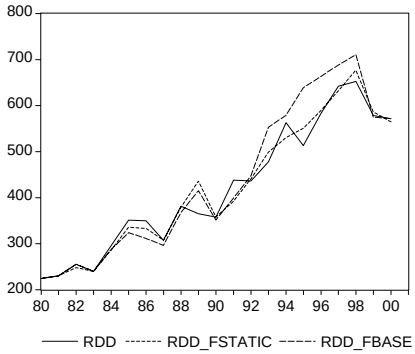
GOVERNMENT EXTERNAL DEBT



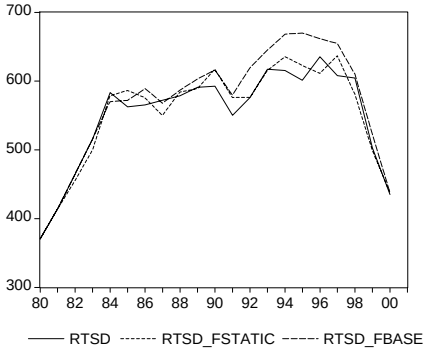
REAL CURRENCY DEMAND



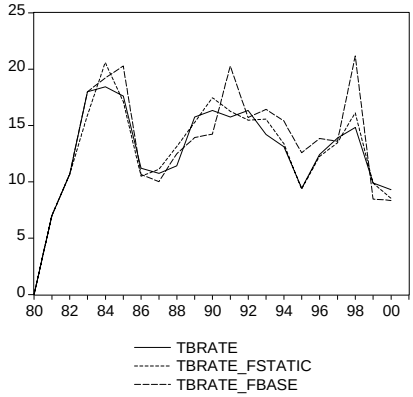
REAL DEMAND DEPOSITS DEMAND



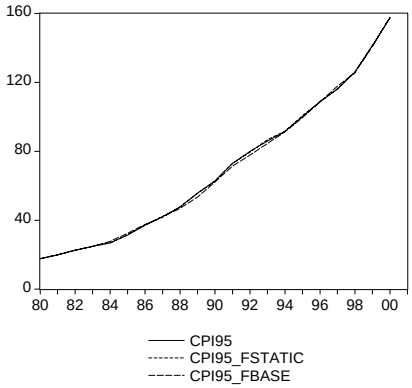
REAL TIME AND SAVING DEPOSITS DEMAND



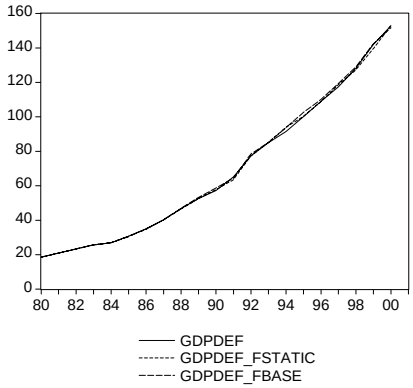
NOMINAL TREASURY BILL RATE

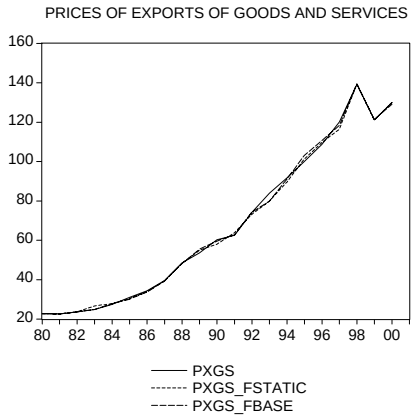


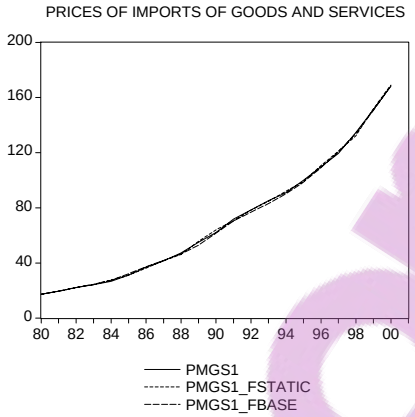
CONSUMER PRICE INDEX



PRODUCER PRICES





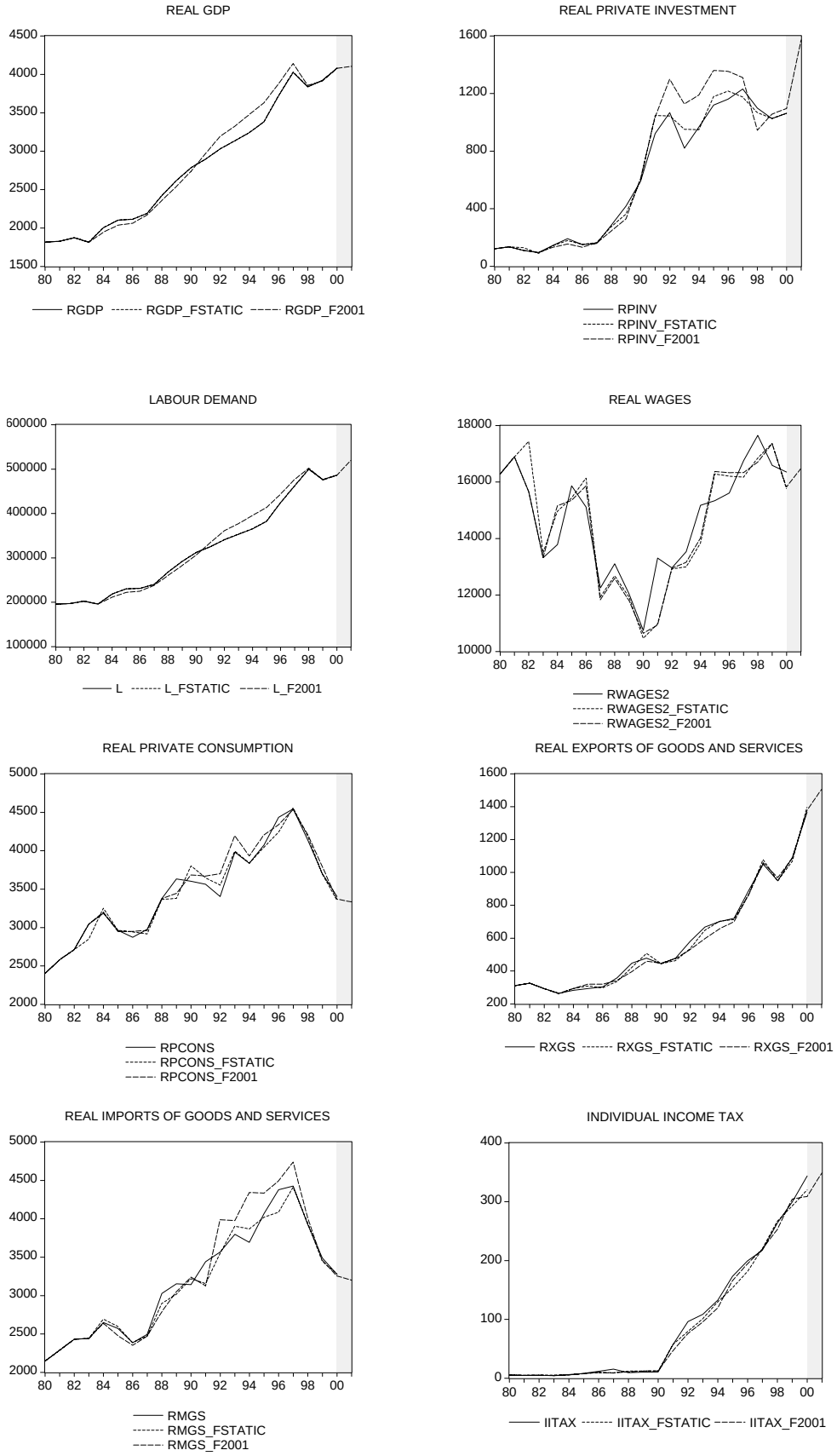


The actual series is plotted together with the static solution of the model as presented in the estimations of the individual behavioural equations in Chapter six, and the dynamic solution values of the model as a complete coherent system with closure rules as presented in section 5.5 of Chapter five. The dynamic system was solved from 1984 to 2000 because of the presence of lagged variables up to the second order in the ECMs. The graphical representations show that the tracking performance of the model within-sample was relatively satisfactory in general terms, indicating a good fit. Both the static and dynamic solution values tend to track the actual time paths of the variables closely. This is particularly true for real exports of goods and services, the consumer price index, the GDP deflator, export prices and import prices.

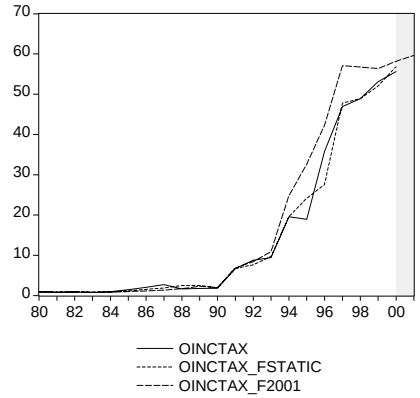
7.2.2 Out-of-sample tracking performance of the model

Figure 7.2 shows static and dynamic simulation experiments that assess the post-sample tracking performance of the model. In this experiment the model is made to produce values for one period ahead of the model sample, by assigning out-of-sample values for the extra period to all exogenous variables in the model. This exercise was performed by computing the average growth for each of the exogenous variables for the last five years of the sample period, from 1996 to 2000. The 2001 values were then computed by letting the last value in the sample grow by the five-year average growth rate. The model is then solved from 1984 to 2001 to solve for the 2001 values for endogenous variables.

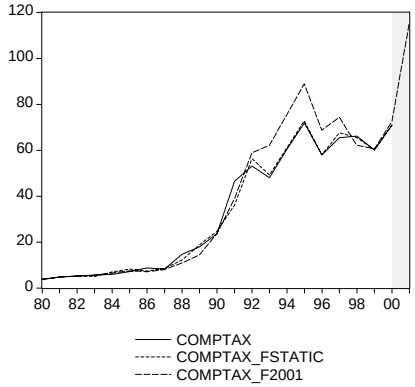
Figure 7.2 Dynamic simulation properties of the model (Post-sample, 1984-2001)



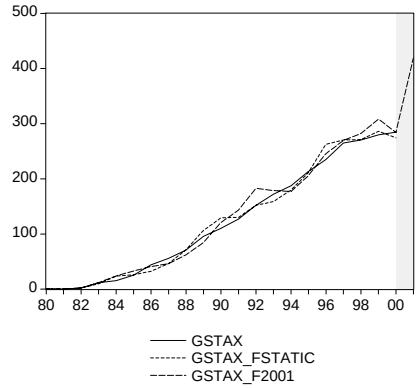
OTHER INCOME TAX



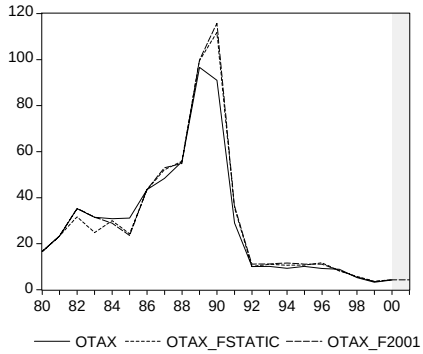
COMPANY TAX



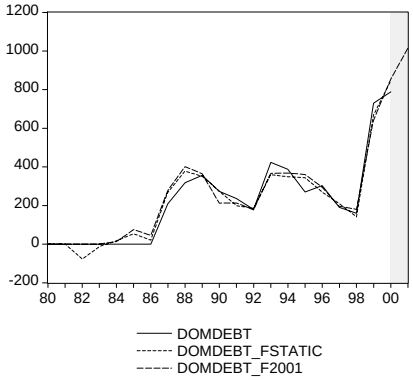
GOODS AND SERVICES TAX



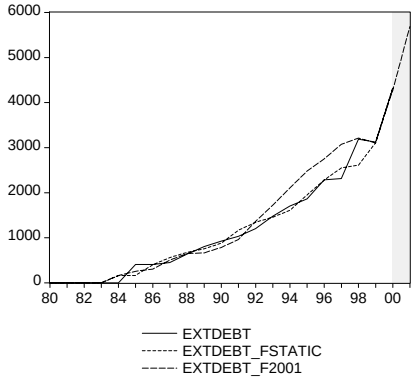
OTHER TAXES



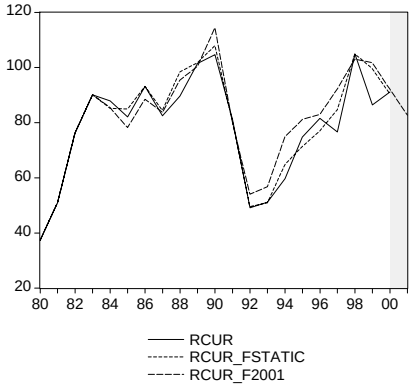
GOVERNMENT DOMESTIC DEBT



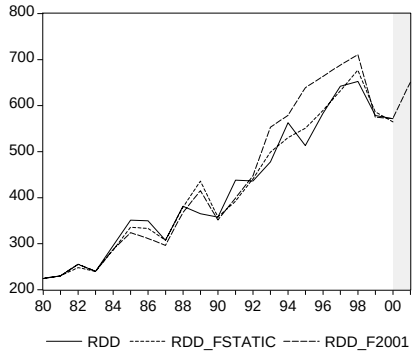
GOVERNMENT EXTERNAL DEBT

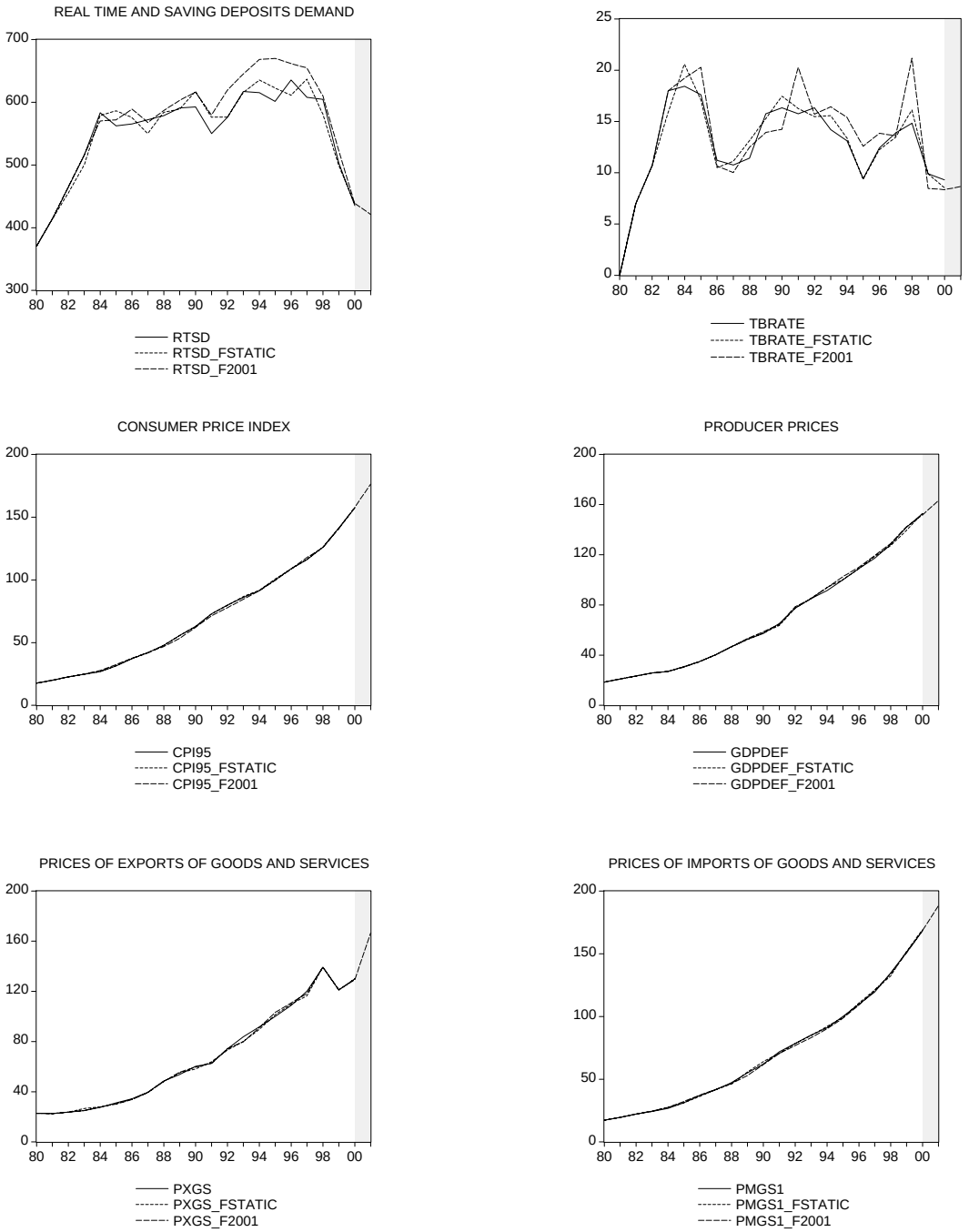


REAL CURRENCY DEMAND



REAL DEMAND DEPOSITS DEMAND





The forecasted period (2001) values are indicated by the shaded region, for each of the stochastic variables. The post-sample values seem to portray a smooth transition from 2000 into 2001 for almost all variables except for a few. This indicates a satisfactory predictive power of the model for at least a single period ahead. Formal tests for the forecasting performance of the model are carried out and reported in section 7.3 below.

The simulated results are compared against the actual and static values in table 7.1 below for 25 stochastically determined endogenous variables.

Table 7.1 Comparison of the actual values of the variables with the static and dynamic solutions of the model within and out-of-sample

Variable	Year	Actual	Static	Dynamic
RGDP	1996	3720.7	3724.7	3876.5
	1997	4023.8	4030.5	4142.2
	1998	3837.0	3839.1	3856.5
	1999	3920.3	3920.3	3912.7
	2000	4081.1	4081.1	4077.7
	2001			4102.9
L	1996	424323.2	423893.1	443599.4
	1997	461963	461776.7	476227.8
	1998	499602.8	499602.8	502077.6
	1999	476427.3	476427.3	475248.6
	2000	486072.6	486072.6	485578.4
	2001			519341.6
RPCONS	1996	4434.5	4240.7	4338.5
	1997	4544.3	4558.6	4536.3
	1998	4139.9	4189.4	4210.9
	1999	3700.2	3697.6	3793.1
	2000	3403.6	3356.0	3368.7
	2001			3331.9
RPINV	1996	1160.8	1216.6	1353.2
	1997	1231.1	1174.6	1310.8
	1998	1098.9	1067.5	944.7
	1999	1026.4	1026.4	1056.3
	2000	1062.7	1062.7	1095.5
	2001			1571.7
RXGS	1996	888.4	865.1	862.7
	1997	1050.2	1078.5	1059.2
	1998	948.7	948.7	968.8
	1999	1091.5	1068.2	1086.0
	2000	1365.9	1395.7	1377.2
	2001			1505.3
RMGS	1996	4378.2	4086.3	4494.9
	1997	4425.4	4410.3	4738.1
	1998	3923.8	3943.0	4008.2
	1999	3488.7	3445.2	3458.5
	2000	3276.1	3276.1	3253.9
	2001			3198.2
IITAX	1996	199.5	181.0	194.3
	1997	217.4	220.1	219.5
	1998	263.9	266.9	252.6
	1999	299.4	292.7	304.4
	2000	343.9	319.8	308.9

	2001			349.2
OINCTAX	1996	35.8	27.6	42.3
	1997	46.9	47.8	57.1
	1998	48.9	48.9	56.7
	1999	53.1	52.1	56.4
	2000	55.6	56.8	58.2
	2001			59.6
COMPTAX	1996	57.9	57.9	68.7
	1997	65.4	67.6	74.4
	1998	66.2	65.5	62.1
	1999	60.1	60.1	60.6
	2000	70.9	70.9	72.4
	2001			115.6
GSTAX	1996	235.2	262.6	245.6
	1997	264.9	270.5	269.7
	1998	270.5	271.1	282.1
	1999	279.8	286.0	308.2
	2000	284.6	274.2	283.9
	2001			418.9
OTAX	1996	9.2	11.6	11.1
	1997	8.9	8.1	8.2
	1998	5.2	5.7	5.4
	1999	3.3	3.6	3.5
	2000	4.2	4.3	4.2
	2001			4.2
DOMDEBT	1996	303.3	268.9	294.5
	1997	190.2	209.4	195.8
	1998	160.1	140.9	180.5
	1999	730.2	668.4	641.6
	2000	788.5	844.0	854.6
	2001			1014.0
EXTDEBT	1996	2283.6	2280.4	2749.9
	1997	2313.4	2548.4	3072.9
	1998	3185.1	2607.5	3209.9
	1999	3121.9	3103.6	3102.2
	2000	4319.6	4319.6	4270.6
	2001			5685.7
RCUR	1996	81.6	77.1	82.9
	1997	76.7	84.7	92.2
	1998	104.8	104.9	103.0
	1999	86.4	99.9	101.7
	2000	91.1	90.5	92.1
	2001			82.7
RDD	1996	582.9	589.0	663.3
	1997	641.9	631.8	688.0
	1998	652.6	676.9	710.8
	1999	578.6	586.1	574.4
	2000	571.6	564.2	571.6

	2001			650.7
RTSD	1996	635.4	611.1	661.5
	1997	607.8	636.8	654.5
	1998	604.5	581.1	610.2
	1999	503.1	499.1	522.7
	2000	434.9	438.4	438.5
	2001			420.9
TBRATE	1996	12.4	12.2	13.9
	1997	13.9	13.5	13.6
	1998	14.8	16.1	21.2
	1999	9.9	9.9	8.5
	2000	9.3	8.5	8.3
	2001			8.7
RWAGES2	1996	15611.9	16203.4	16328.9
	1997	16752.9	16173.2	16333.3
	1998	17649.6	16846.6	16704.0
	1999	16589.8	17366.5	17355.9
	2000	16353.7	15769.6	15821.8
	2001			16471.0
CPI95	1996	108.8	108.5	108.6
	1997	116.1	116.3	117.8
	1998	126.0	126.0	125.6
	1999	141.5	141.1	140.8
	2000	157.3	157.6	157.8
	2001			176.3
GDPDEF	1996	108.9	108.8	110.0
	1997	117.3	118.7	119.4
	1998	128.2	127.2	129.0
	1999	141.9	139.5	142.4
	2000	152.9	152.9	151.7
	2001			163.2
PXGS	1996	108.7	109.7	110.7
	1997	120.1	116.5	118.4
	1998	139.2	139.2	139.4
	1999	121.2	121.2	121.4
	2000	130.0	130.0	129.1
	2001			166.5
PMGS1	1996	109.7	110.6	109.0
	1997	119.5	121.1	120.7
	1998	134.7	132.3	133.9
	1999	151.2	151.8	150.6
	2000	168.3	169.1	168.5
	2001			188.1

A casual inspection of the simulated values of key macroeconomic variables such as GDP and its components shows that these variables are close to the observed values for both the static and dynamic solutions. This indicates that the model tracks historical

trends of these variables with a reasonable degree of accuracy. Major deviations are observed for individual income tax and goods and services tax from the 2000 to 2001 values. These are taken to reflect changes in the tax structures and administration resulting from the reforms enacted at that time.

7.3 EVALUATION OF THE FORECASTING PERFORMANCE OF THE MODEL

Four measures of forecast accuracy were used to evaluate the performance of the model over the entire sample period. These are the root mean square error (RMSE), the mean absolute error (MAE), the mean absolute percentage error (MAPE) and the Theil inequality coefficient (U).[89] According to these statistics, better performance is indicated by smaller values.

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[89] $RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(\hat{Y}_t - Y_t)^2}$

$MAE = \frac{1}{T}\sum_{t=1}^{T}\left|\hat{Y}_t - Y_t\right|$

$MAPE = \frac{1}{T}\sum_{t=1}^{T}\left|\frac{\hat{Y}_t - Y_t}{Y_t}\right|$

$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(\hat{Y}_t - Y_t)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(\hat{Y}_t)^2}\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t)^2}}$

where $\hat{Y}_t$ is the simulated value in period *t*, Y_t is the actual value in period *t* and *T* is the sample size (Pindyck and Rubinfeld 1991:338).

Table 7.2 Dynamic simulation accuracy of stochastic variables (1984-2000)

Stochastic variables		Simulation error statistics			
Variable name	Logarithmic form	Root Mean Square Error (RMSE)	Mean Absolute Error (MAE)	Mean Absolute Percentage Error (MAPE)	Theil Inequality Coefficient (U)
Real GDP	LRGDP	0.00.196	0.001560	0.019319	0.000202
Labour Demand	LL	0.003917	0.002219	0.017392	0.000155
Real private consumption	LRPCONS	0.030334	0.024695	0.301456	0.001861
Real private investment	LRPINV	0.132673	0.105053	1.798096	0.010850
Real exports of goods and services	LRXGS	0.215620	0.141625	2.383285	0.017224
Real imports of goods and services	LRMGS	0.028004	0.024240	0.300652	0.001741
Individual income tax	LIITAX	0.175840	0.125203	5.118650	0.022855
Other income tax	LOINCTAX	0.223185	0.159107	64.97430	0.049266
Company tax	LCOMPTAX	0.145090	0.103131	5.273880	0.022486
Goods and services tax	LGSTAX	0.621530	0.437233	22.88485	0.067762
Other taxes	LOTAX	0.293930	0.210570	7.627085	0.047642
Government domestic debt		45.59232	34.22939	11.55054	0.069940
Government external debt		270.4660	212.3313	17.28135	0.074910
Real currency	LRCUR	0.159279	0.114381	2.722212	0.018352
Real demand deposits	LRDD	0.064985	0.050059	0.846871	0.005397
Real time and saving deposits	LRTSD	0.031097	0.024869	0.392545	0.002460
Nominal treasury bill rate	LTBRATE	0.126440	0.092662	3.693430	0.024611
Real wages	LRWAGES2	0.056632	0.045487	0.474175	0.002954
Consumer price index	LCPI95	0.005158	0.004476	0.102349	0.000630
Producer prices	LGDPDEF	0.149249	0.113045	2.940956	0.018293
Export prices	LPXGS	0.031705	0.024786	0.656493	0.003887
Import prices	LPMGS1	0.098620	0.081300	2.083890	0.012026

All 25 endogenous variables have a Theil's U statistic less than 0.1. Only four variables have MAPE of higher than 10 per cent. In general, the performance of the model is poor according to the RMSE, MAE and MAPE for both government domestic and external debt; other income taxes, goods and services taxes in particular. Nevertheless, since the

proportions of these variables to national output and other key macroeconomic variables are small, their poor performance is assumed to affect the forecasts of the rest of the model only marginally. Overall, the statistics indicate that the model is able to track historical developments in the economy reasonably well with the exception of a few variables.

7.4 SUMMARY OF THE PERFORMANCE OF THE MODEL

The results of the dynamic solution of the model show that both the dynamic solutions capture the direction of the actual values of the endogenous variables in the model. In addition, dynamically solved values of the variables in the model do not deviate much from the values solved for in static scenarios. The evaluation of the forecast performance of the model using the MAE, MAPE, RMSE and the Theil inequality coefficient also affirm the relatively good performance of the model.

CHAPTER 8

POLICY SIMULATION EXPERIMENTS AND IMPACT ANALYSIS

8.1 INTRODUCTION

A second set of simulation experiments involves determining the sensitivity of endogenous variables of the model to changes in selected exogenous and policy variables. This is accomplished through impact multipliers that shed light on the dynamic properties of the model.[90] A number of policy shocks are considered for this exercise. In particular, the exercise deals with shocks emanating from both the demand side and the supply side. In addition the impacts of external shocks and a monetary policy shock are considered. The experiments are set such that sustained changes are made from 1988 to 2000 for each of the shock variables. The impacts of changes in these variables are presented in the form of percentage deviations from the base run.

Multiplier analysis is often considered relatively easy to pursue if the model is linear in both parameters and variables. In many cases however, some non-linearities are inherent in models. Under these circumstances, multipliers can be derived from either a linearised version of the reduced form of the structural model or by way of appropriately designed simulation experiments. Goldberger (1959:16-20) dwells on the procedure for computing impact multipliers for a non-linear system by means of linearising the non-linear structural relationship through the total differential with partial derivatives evaluated at the sample means of the variables. However, the multipliers derived in this way are valid only if the model consists of few non-linear equations, so that their linearization produces minimum loss of information. Moreover, the multipliers are valid only around a small neighbourhood of the sample means of the variables. This implies that the procedure can be counterproductive for fairly large models.

[90] See Challen and Hagger (1983).

For this reason, an alternative approach that computes the multiplier as the difference between the shocked run and the base run simulated solutions for an endogenous variable divided by the base run outcome is adopted in this study. This approach has a merit over the Goldberger method in that it captures variations in the multipliers from one period to another. This method has been widely adopted by researchers such as Challen and Hagger (1983:151-159), Brooks and Gibbs (1994), Randakuwa *et al*. (1995) and Musila (2002).

This chapter is dedicated to the presentation and analysis of the multiplier properties of the model starting with fiscal policy shocks, monetary policy shocks and external shocks, with the view of assessing the potency of these policies and shocks in the economy. The analysis dwells more on fiscal policy shocks and external shocks and less on monetary policy shocks. This difference in emphasis is prompted by the recognition of the institutional and structural constraints the economy faces in exercising the latter.

8.2 FISCAL POLICY SHOCKS

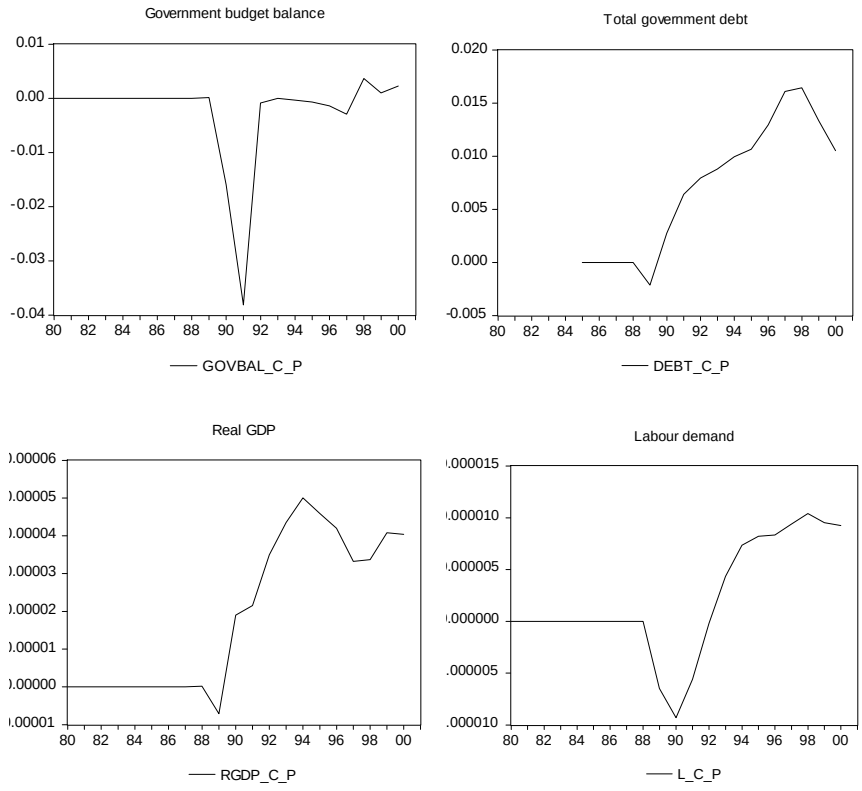
Fiscal policy shocks are presented in two parts, namely, government investment expenditure and government consumption shocks. The former represents a shock from the supply side of the economy and the latter represents a shock from the demand side. The basic idea is to compare the response of key macroeconomic variables to changes emanating from the supply side with similar changes from the demand side.

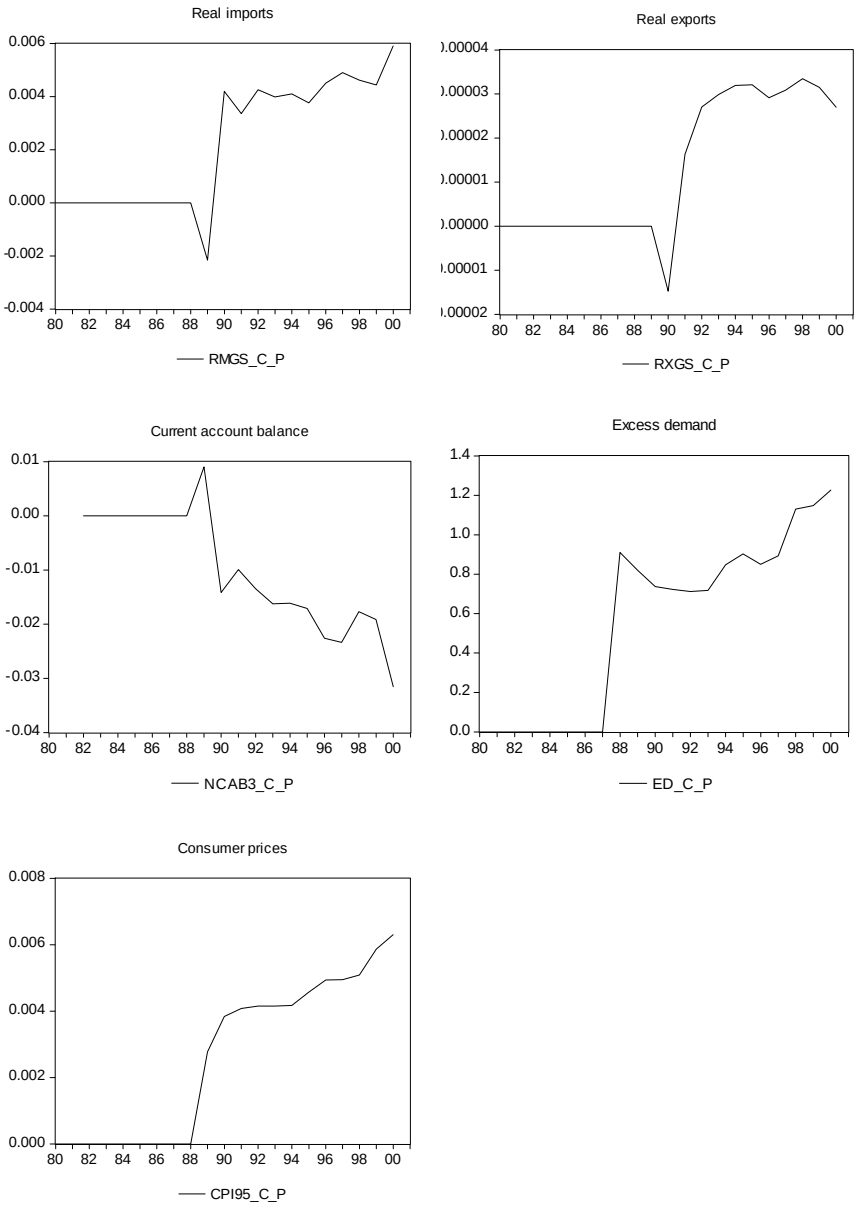
8.2.1 An increase in government consumption expenditure by 10 per cent

An increase in government consumption expenditures by 10 per cent amounts to an increase of roughly 46 million Maluti in 1988 using 1995 prices. The results of this simulation are depicted in figure 8.1 below, for a number of key macroeconomic variables and in terms of percentage deviations from the base run. As expected, the result of this fiscal stimulation is an immediate worsening of the government budget balance. This development is however temporary as the government budget balance recovers rapidly from this position. In line with this development, total government debt rises for

the entire simulation period, with the rate of increase declining towards the end of the sample. As expected real domestic output rises for most of the simulation period, reaching a peak in 1994. The increase in real GDP is however preceded by a slight fall in 1989. The trend of labour demand closely resembles that of real GDP. Real imports of goods and services fall and rise with increases in real income in the initial periods and stabilize afterwards. A relatively similar trend is observed with exports of goods and services. It is evident that exports rise by a smaller magnitude than imports, hence a deficit in the current account balance. Excess demand in the economy increased directly through the increase in government consumption. This in turn causes a surge in consumer prices over the entire period.

Figure 8.1 Simulation results of an increase in government consumption expenditure of 10 per cent

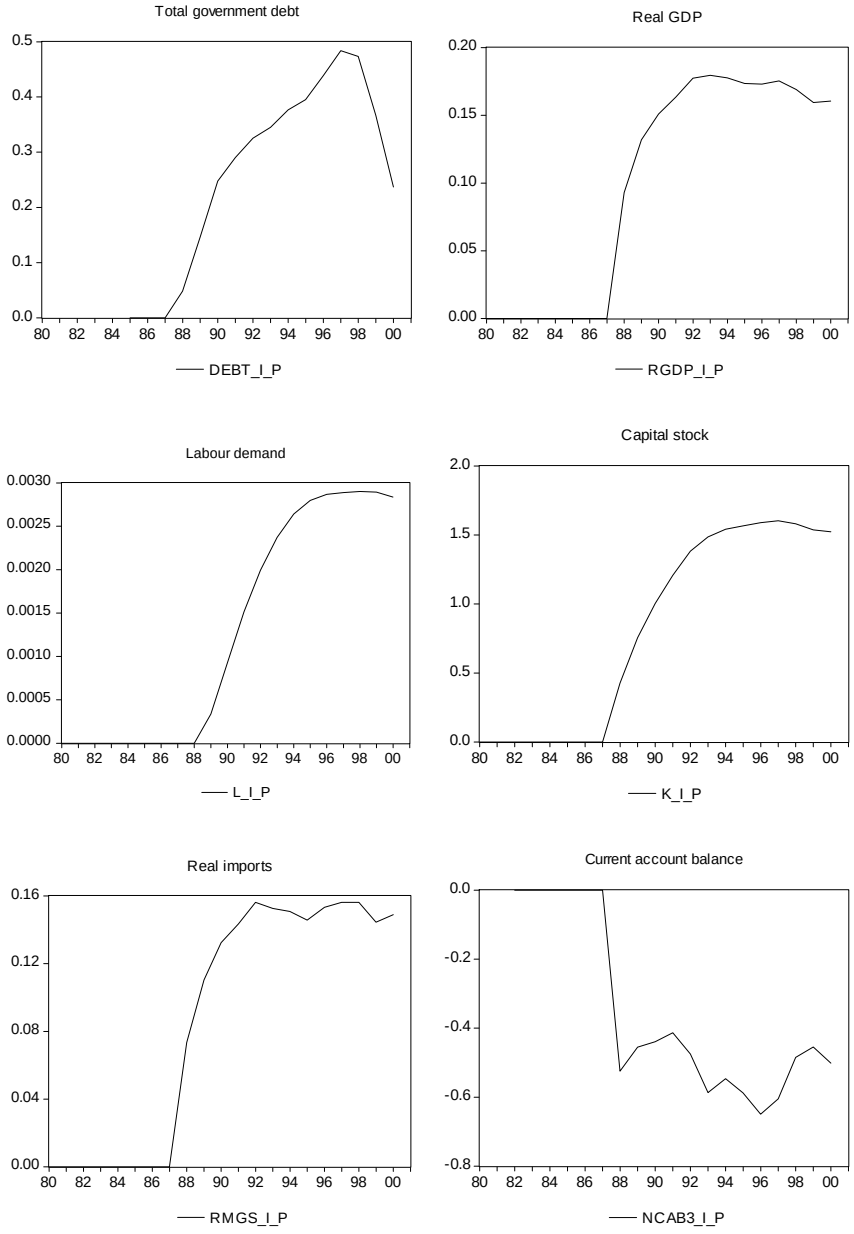




8.2.2 An increase in government investment expenditure by 10 per cent

In this scenario a rise in government investment expenditure is simulated by increasing this variable by 10 per cent from 1988 to 2000. The results of this simulation are displayed in figure 8.2.

Figure 8.2 Simulation results of an increase in government investment expenditure by 10 per cent



As in the case of government consumption expenditure, the immediate effect of an increase in government investment expenditure is a worsening of the government budget and an increase in total government debt in almost the same pattern as in the case of an increase in government consumption expenditure. This follows from the significant

dependence of domestic debt on the budgetary position of government. In comparison with an increase in government consumption expenditure of the same size, an increase in government investment expenditure brings about an increase in the overall level of economic activity of a higher magnitude. It is also notable that the increase in real GDP induced by a supply side shock is more sustainable compared to that of the increase in government consumption. A similar observation is made with the impact of an increase in government investment on labour demand and capital stock. Unlike in the case of a shock from the demand side, the increases in labour demand and capital stock are more stable and sustained for a longer period of time. Because of the strong dependence of imports on national income, real imports of goods and services rise with the rise in real domestic activity, while exports are hardly affected.

The results of this section confirm the ideology of supply side economics that shocks from the supply side bring about robust and sustained increases in real output while shocks from the demand side result in only temporary changes in real output with only sustained increases in the price level. Both policies have favourable results in terms of real output, but the effect of the supply side shock is more substantial in terms of output. An increase in government investment thus features more desirable outcomes as it also has robust and desirable impacts on the capital stock and employment.

8.3 MONETARY POLICY SHOCK

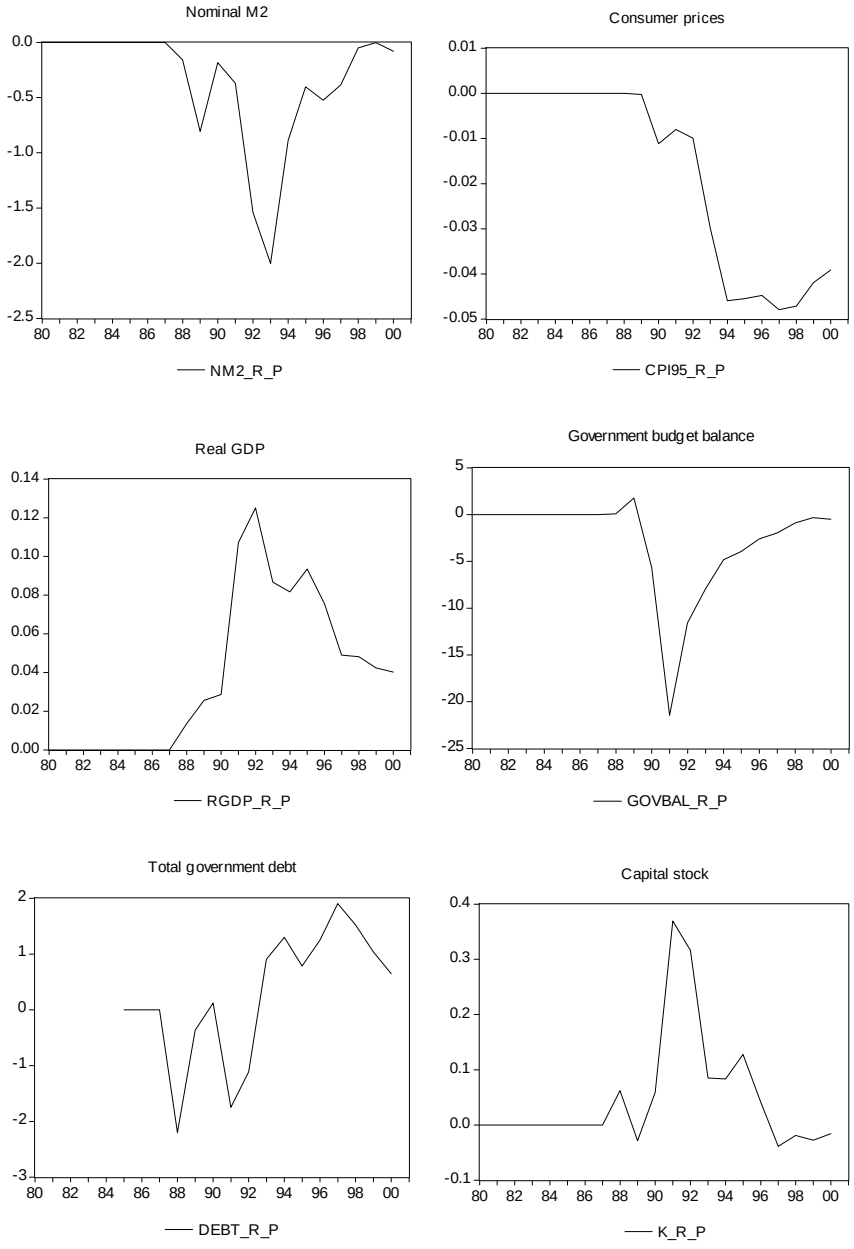
8.3.1 An increase in the nominal Treasury bill rate by 2 percentage points

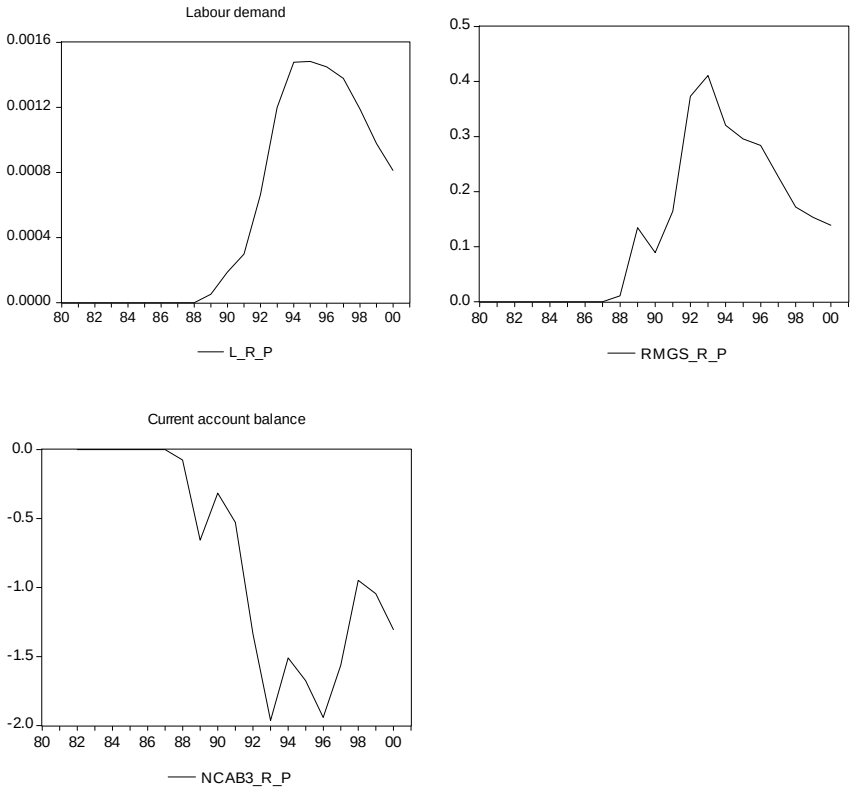
In agreement with the existing restrictions in exercising monetary policy by way of independent increases in money supply, a monetary policy shock is simulated in this study by increasing the nominal Treasury bill interest rate by two percentage points from 1988 to 2000.[91] Although changes in interest rates are said to largely follow similar changes in SA, the basis for this simulation is the fact that some changes in interest rates have been historically made without any corresponding changes in the SA money

[91] Because of the fixed exchange rate regime, money supply is assumed not to be available as an exogenous monetary policy instrument.

markets. The results of the increase in the Treasury bill rate are shown in figure 8.3 in terms of percentage changes from the base model.

Figure 8.3 Simulation results of an increase in the Treasury bill interest rate by two percentage points





The first effect of this policy is to lower the broad monetary aggregates, M2 and M3. This development is not sustained however, since the demand for demand deposits is negatively related to the Treasury bill rate of interest and the time and saving deposits are positively related to the Treasury bill rate. The increase in the interest rate induces a reduction in aggregate demand through investment and an increase through private consumption. The latter outcome is a result of the insensitivity of consumption to changes in the rate of interest and is indicated by the positive sign of the rate of interest in the consumption function, a result common in many developing countries. The final outcome is a fall in aggregate demand and hence, as expected, a fall in consumer prices. In turn, real output rises for the entire period though at a decreasing rate towards the end. This development is followed by trends in labour demand, capital stock and other components of aggregate demand. The increase in income induces a rise in imports and a deficit in the current account balance.

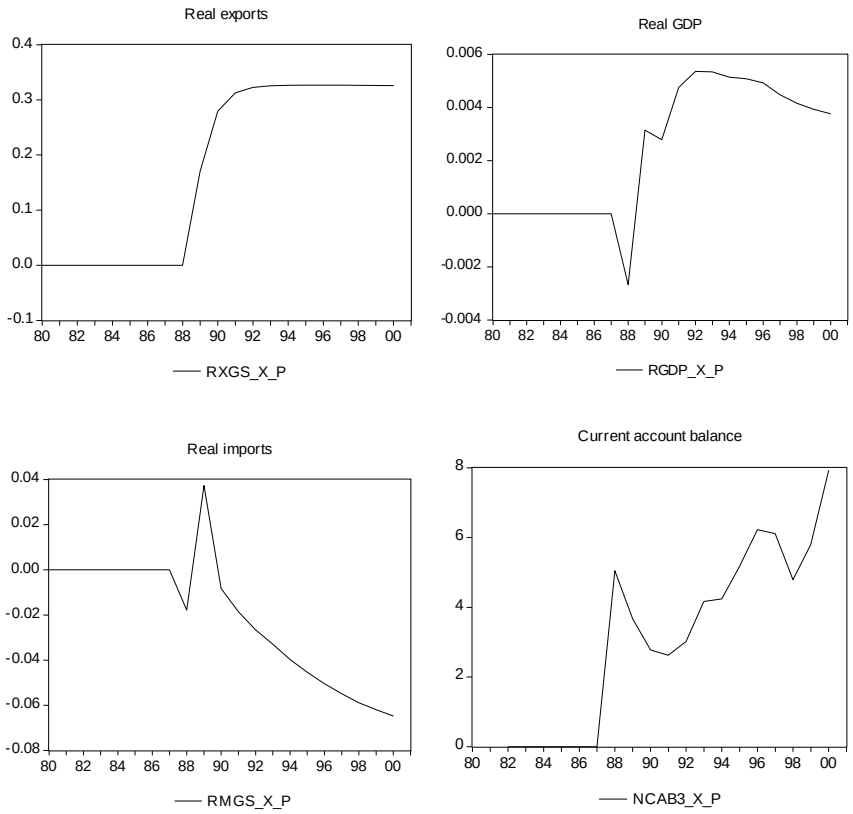
8.4 EXTERNAL SHOCK

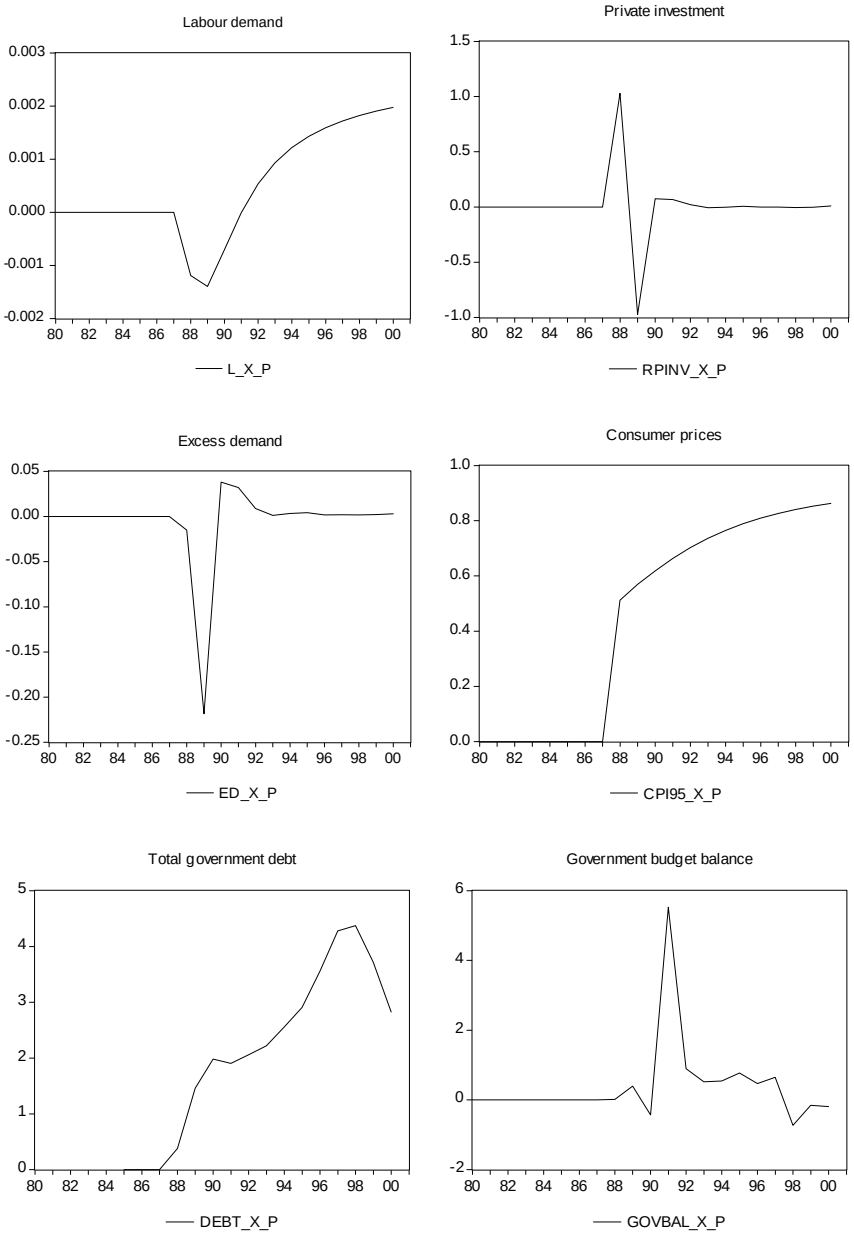
The effects of external shocks are simulated by a depreciation of the domestic currency. Given the high degree of openness of the economy, this shock is made to assess the susceptibility of the economy to external disturbances and to assess their potential impacts on the economy.

8.4.1 A currency depreciation of 5 per cent

A nominal exchange rate shock is simulated by a depreciation of the Loti against the US dollar by 5 per cent from 1988 to 2000. This is intended to entertain the belief that the Loti is overvalued in spite of the major depreciations in the 1990s. The results of this experiment are reported in figure 8.4.

Figure 8.4 Simulation results of a depreciation of the currency by five per cent





A depreciation of the currency by 5 per cent appears to encourage exports relative to imports as expected. The improvement in the competitiveness of exports is observed by way of a fall in export prices and a subsequent rise in exports. Correspondingly the depreciation of currency makes imports dearer, hence the rise in import prices and the fall in imports. This increase in exports is sufficient to curb the trend of deficits in the current account.

Due to the exchange rate depreciation, total government debt continues to increase steadily and tapers towards the end of the simulation period. A closer inspection of the debt variables reveals that it is the external debt component that stimulates an increase in total debt, as domestic debt falls in line with the slight improvement in the government budget deficit, following the depreciation.

However, the depreciation has some unpleasant costs to the economy. Consumer prices rise rather significantly for the entire period. This result is typical in highly open economies in which higher import prices that are triggered by a depreciation, are transmitted directly into higher domestic prices. Although real domestic output rises, the rate of increase is reduced towards the end through the inflation channel by which increased prices and costs of imported inputs reduce aggregate demand and output. A similar result was also obtained by among others Krugman and Taylor (1978), Edwards (1986) and Basdevant (2000). Developments in the level of employment closely track those of real domestic output. It is notable that changes in exchange rate have temporary effects on the capital stock, private investment, excess demand, the government budget balance and the overall balance of payments.

8.5 SUMMARY OF SIMULATION EXPERIMENTS

The simulations run in this chapter have assessed the potential effects of the two major policy options, fiscal policy, in the form of both demand and supply side shocks, and monetary policy. In addition, the simulation experiments have permitted a feel of the potential effects of shocks that are external to the economy. As expected, fiscal policy has far more potential than monetary policy in affecting key macroeconomic variables such as the level of economic activity, employment, the government budget position and the balance of payments. With regard to fiscal policy, a supply side shock in the form of an increase in government investment expenditure will affect the economy in a more pronounced way than an increase in government consumption expenditure. The route of increasing government investment expenditure has the advantage of boosting real output,

employment and capital stock in a robust and sustainable manner. The policy is however costly as it crowds out private investment.

Though only one avenue has been explored with regard to monetary policy owing to limited flexibility in this area, the results nevertheless indicate that the policy still has some degree of potency in affecting macroeconomic variables. Many of the variables assessed seem to be reasonably responsive to changes in the Treasury bill rate although most of the effects are only short-term.

It is evident from these experiments that Lesotho is highly susceptible to external shocks. Changes in the exchange rate appear to affect not only external sector balances remarkably, but also other internal key variables such as the level of employment, the government budget position, debt variables, monetary aggregates and prices. It is noteworthy that, among the policy scenarios explored in this study, consumer prices appear to be most responsive to changes in the exchange rate.

CHAPTER 9

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

9.1 INTRODUCTION

This chapter presents a summary of the study, the major conclusions drawn from it and their policy implications. This study set out to develop a medium scale macroeconometric model for the economy of Lesotho with the objectives of estimating the model and using it to perform dynamic policy simulation experiments with a view to determine and analyse the effects of different policy regimes on key macroeconomic variables and evaluating their implications for economic policy.

9.2 SUMMARY OF THE STUDY

The model developed in this study presents seven sectors namely, the production sector, the employment sector, the aggregate demand sector, the government sector, the balance of payments sector, the monetary sector and the price sector. The model has a total of 140 variables of which 36 are exogenous and 39 are dummy variables. It has 65 endogenous variables of which 22 are determined by stochastic behavioural equations. The model is estimated using time series data spanning the period 1980 to 2000 using the Engle-Granger two-step technique. Both the long-run and short-run versions of the equations are used in the solution of the model, which in turn is solved from 1984 to 2000 for the in-sample solution and 1984 to 2001 for the out-of-sample solution. This is because of the lags used in the ECMs. These are restricted to lags of the second order so as to preserve the degrees of freedom. The model is solved as a coherent system within-sample and out-of-sample using the Econometric Views software package. The performance of the model is evaluated by means of forecast accuracy statistics and by inspection of the plots of the actual series against the series generated by the solutions of the model. The tracking performance of the model and its forecasting accuracy is satisfactory as evaluated by means of the MAE, the MAPE, the RMSE and the Theil inequality coefficient.

The model covered both the supply and demand sides of the economy adequately, thus maintaining a balanced synthesis of the two sides. The level of disaggregation adopted in the model is considered sufficient to explore the necessary policy options and is dictated to a large extent by the availability of data. On the supply side, labour and capital are found to be important determinants of changes in the level of output as judged by their statistical significance. Private investment is determined to a large extent by the level of domestic output and the real user cost of capital. Employment is found to be determined to a large extent by real domestic output as well as real wages. According to the estimates of the model, the main determinants of real wages are labour productivity and consumer prices. On the demand side, disposable income, the level of wealth and the real rate of interest are the main determinants of private consumption. While world demand and the relative price of exports were found to be important in determining exports, import demand is determined mainly by national income and their relative price. Within the monetary sector, real national output plays a major role in determining the demand for the key monetary variables. For broader aggregates, the real rate of interest appeared to be a significant determinant. In the government sector real domestic and national outputs, exports of goods and services, nominal wages, real private investment and real private consumption perform well as bases for different types of tax variables. Changes in the GDP deflator are explained by changes in capacity utilization and real wages relative to the real user cost of capital. The CPI is determined to a large degree by changes in excess demand, changes in the GDP deflator and import prices. The GDP deflator, world prices and the nominal exchange rate determine export prices while import prices are largely determined by world prices and the nominal exchange rate.

A number of simulation experiments are performed to fulfil the policy analysis objective of the study. The impacts of policies are evaluated in terms of percentage deviations of the simulation paths from the baseline paths of the key macroeconomic variables. In addition, dynamic multipliers and elasticities are computed for each of the variables. Overall, policy analysis involved four simulation experiments. Two experiments with regard to fiscal policy are evaluated. These involve an increase in government

consumption expenditure by 10 per cent and an increase in government investment expenditure by 10 per cent. One simulation experiment that involves an increase in the nominal Treasury bill rate by 2 percentage points is performed with regard to monetary policy shocks. External shocks are simulated to portray the susceptibility of the domestic economy to shocks from the global economy. These are performed by applying a 5 per cent depreciation of the currency. The increases in the variables are made from 1988 to 2000.

9.3 MAIN FINDINGS OF THE STUDY

The following remarks can be made based on the estimated structure of the model and the impact analysis. An expansionary fiscal policy in the form of an increase in government investment expenditure is more potent that an increase in government consumption expenditure. The effect of both policies on the government budget position is only temporary. In addition the former policy tends to raise domestic output in a more robust manner than the latter. A notable outcome with regard to government investment expenditure is that it appears to have a substantial crowding out effect on private investment, a result which is not observed with regard to government consumption.

A monetary policy intervention in the form of a rise in the nominal interest rate has the effect of reducing major monetary aggregates. Some of the notable outcomes are an increase in domestic output, a reduction in consumer prices, an improvement in the current account balance and an increase in employment.

One of the outcomes of the analysis is that a depreciation of the currency is not very effective in improving the overall balance of payments position, although it improves the current account balance significantly through a sustained increase in exports. It is contractionary in the short run as it reduces output and employment in the early years of the simulation period. This is in contrast to the results of Elliot *et al*. (1986) and Musila (2002) for the Kenyan and Malawian economies respectively. In this particular case, a depreciation is inflationary towards consumer prices.

9.4 CONCLUDING REMARKS

The analysis in this study has provided a medium size coherent macroeconometric framework that can be used for policy analysis and short-term forecasting purposes with some degree of accuracy. The construction and estimation of this framework has attempted to incorporate as much available information as possible regarding the structure of the economy and the theoretical developments up to the level at which the data set could permit. It is noteworthy that the inconsistency of the data set has provided one of the major challenges in the construction and estimation of this framework. Nevertheless, this framework has been used in this study to assess the effects of both fiscal and monetary policy and external shocks on the economy. It is evident from the policy options explored in this study that fiscal policy remains the main and most potent policy instrument available to policy makers. In particular, the most notable outcome is that shocks from the supply side of the economy have far more robust impacts on key macroeconomic variables than shocks emanating from the demand side. It is also evident that the effectiveness of fiscal policy is not exclusive as monetary policy can still be used to some extent. A salient outcome of the policy simulation experiments is that Lesotho is highly vulnerable to external shocks, as they tend to work their way through virtually all sectors of the economy.

9.5 POLICY IMPLICATIONS

The following policy implications follow and can be highlighted from the impact analysis and the conclusions drawn in the preceding sections.

- Supply side shocks are more potent and affect key macroeconomic variables such as real output, employment and the level of capital stock in a more sustained and robust way than demand side shocks.

- A fiscal policy expansion that raises the level of government consumption expenditure has more detrimental effects as it proves to be inflationary.

- Monetary policy in the form of interest rates can still be used effectively as a policy tool, although constrained by the CMA arrangement. A rise in the nominal rate of interest works to discourage private investment in the long run, though the effect is marginal and short-term. Many of the impacts are temporary, except to the impact on prices.

- The economy of Lesotho is highly susceptible to external shocks. The effects of a change in the exchange rate have significant influences on the domestic economy. A depreciation of the currency is advantageous for the domestic economy as it boosts exports and discourages imports by making them dearer. This mechanism does not however work in favour of the balance of payments and the economy's external indebtedness as the rise in exports is not sufficient to change the deficit position of the overall balance of payments by much.

- It is noteworthy that domestic prices show a higher responsiveness to external shocks as compared to internal shocks. A depreciation tends to raise consumer prices, as higher import prices that follow a depreciation are passed directly onto the domestic prices.

9.6 AREAS FOR FURTHER RESEARCH

It is noteworthy that macroeconometric modelling is a continuous process. While the study has covered the major aspects of the tasks outlined in the objectives, and therefore presented a snapshot of the economy of Lesotho over the sample period and subject to constraints faced, acknowledgement is made here of areas that need further investigation. One of these is the need for improvements and extensions of the data base. The short span of data and its poor quality has presented a major obstacle in terms of estimation and ultimately the interpretation of coefficients and policy simulations, hence the liberal use of dummy variables in this study. Prominent perculiarities related directly to this problem relate to the signs and magnitudes of estimates such as the tax rates and the propensities

to consume and invest. These are almost invariably in turn blamed for some of the non-standard results obtained in simulation experiments and hence the instability portrayed by the model in this regard. The issue of data also restricted the scope for specification of some equations in the model. In some instances, proxies were used in place of variables at the expense of robust theoretical underpinnings. Because of this, it is deemed necessary to investigate some of the specifications further in later work.

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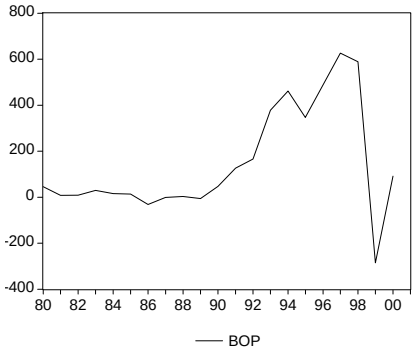
APPENDIX A

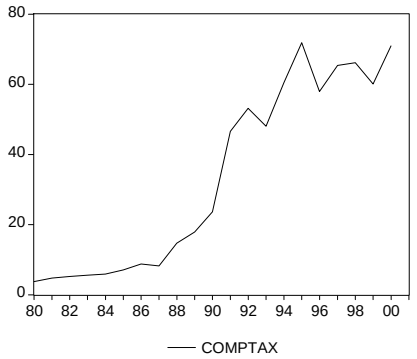
GRAPHICAL PRESENTATION OF VARIABLES USED IN THE MODEL

ENDOGENOUS VARIABLES

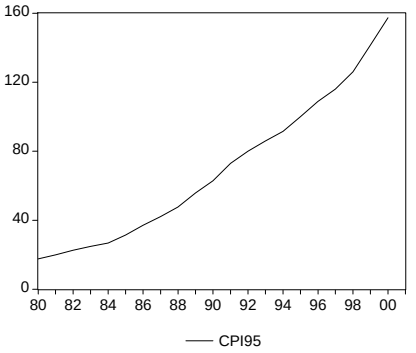
OVERALL BALANCE OF PAYMENTS



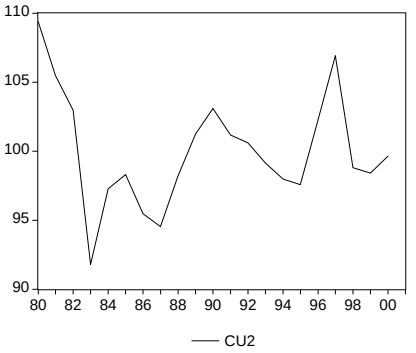
COMPANY TAX



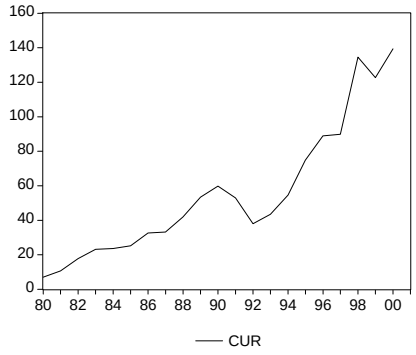
CONSUMER PRICE INDEX (1995=100)



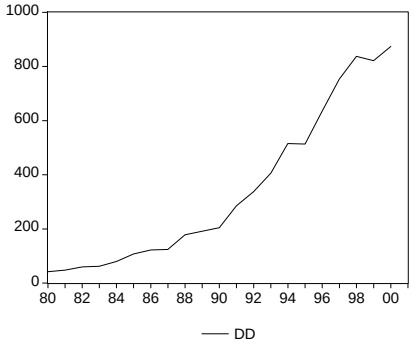
CAPACITY UTILIZATION



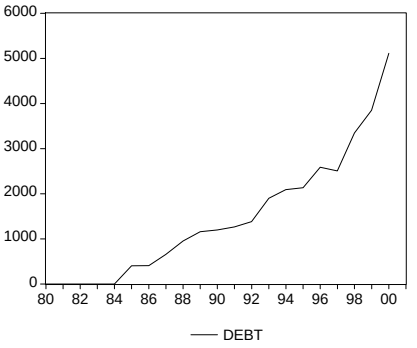
CURRENCY



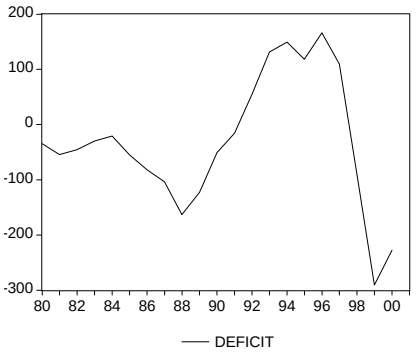
DEMAND DEPOSITS



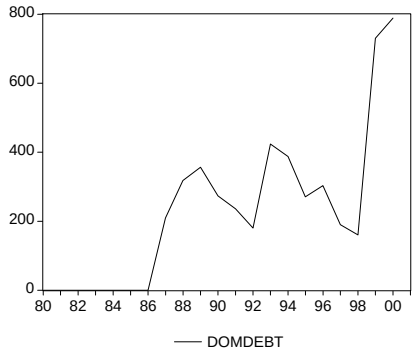
TOTAL GOVERNMENT DEBT



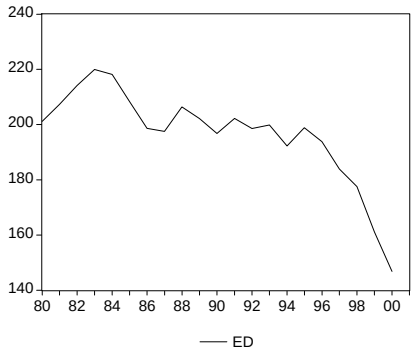
GOVERNMENT BUDGET DEFICIT



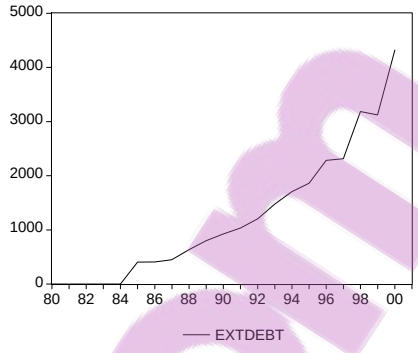
TOTAL GOVERNMENT DOMESTIC DEBT



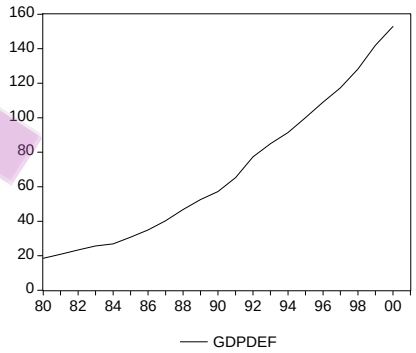
EXCESS DEMAND



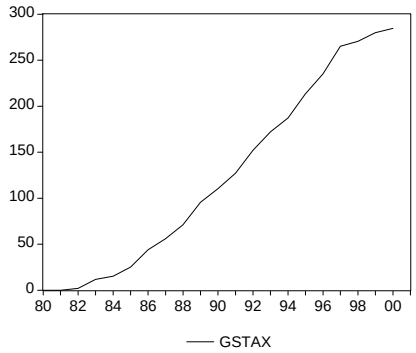
TOTAL GOVERNMENT EXTERNAL DEBT



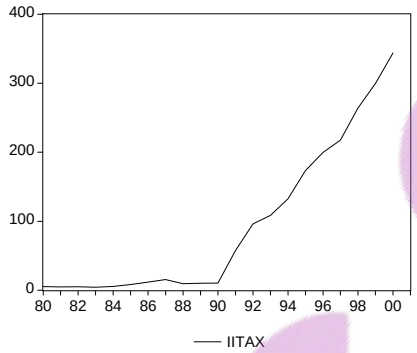
GDP DEFLATOR



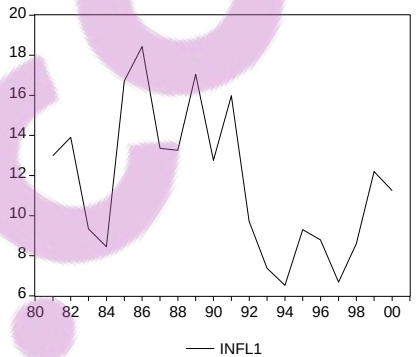
GOODS AND SERVICES TAX



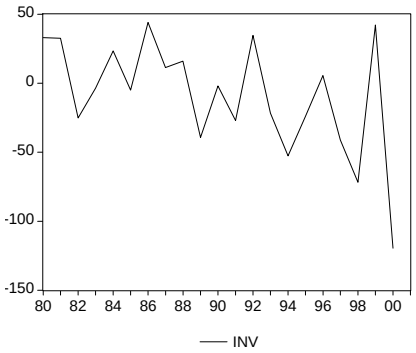
INDIVIDUAL INCOME TAX



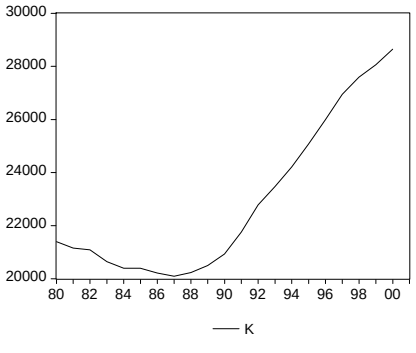
CPI INFLATION RATE



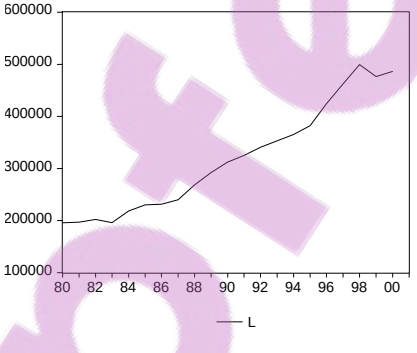
CHANGE IN INVENTORIES



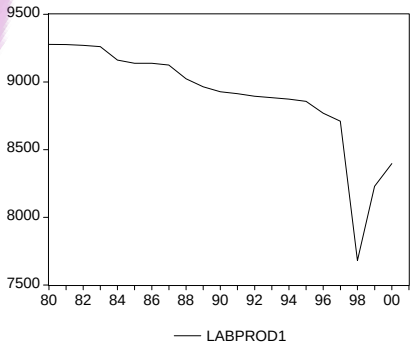
CAPITAL STOCK



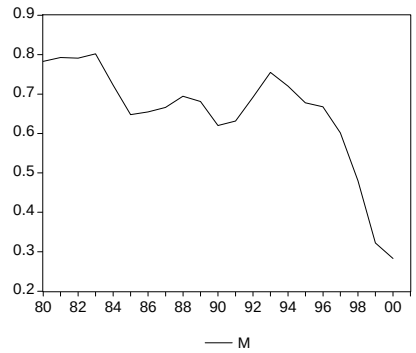
LABOUR



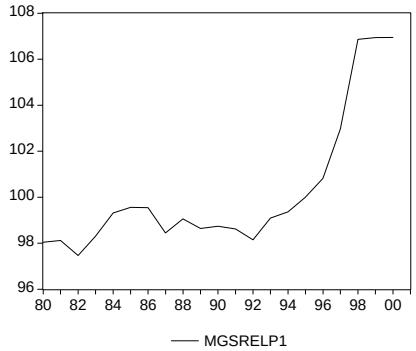
LABOUR PRODUCTIVITY



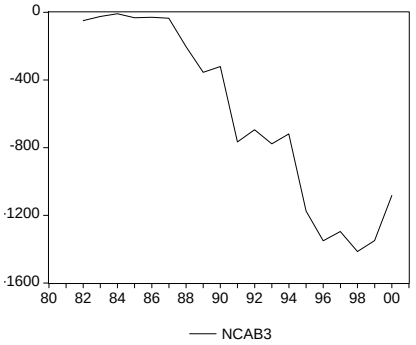
MONEY MULTIPLIER



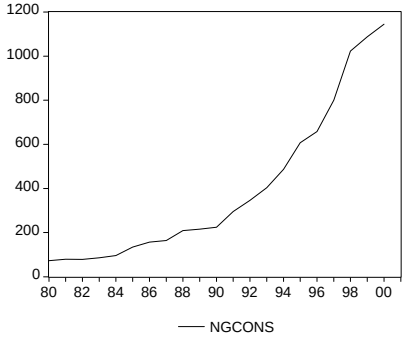
RELATIVE PRICE OF IMPORTS



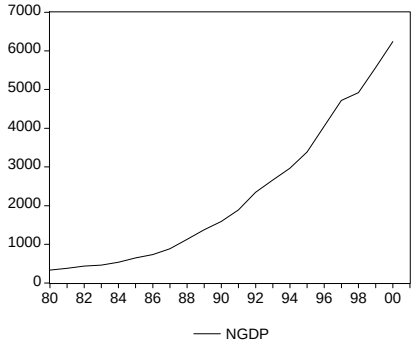
CURRENT ACCOUNT BALANCE



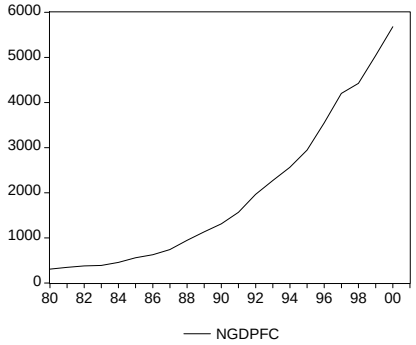
NOMINAL GOVERNMENT CONSUMPTION EXPENDITURE



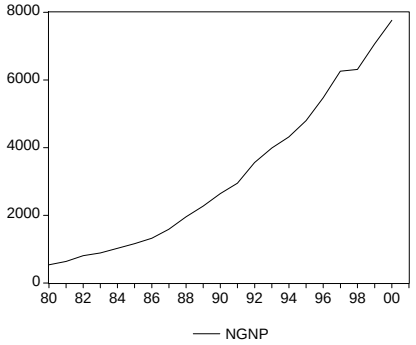
NOMINAL GDP AT MARKET PRICES



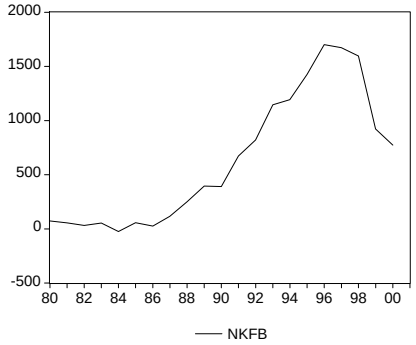
NOMINAL GDP AT FACTOR COST



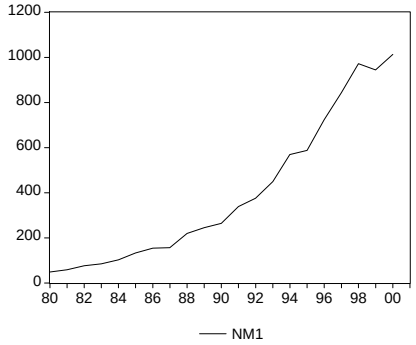
NOMINAL GNP



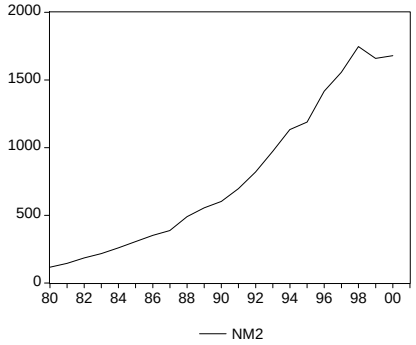
CAPITAL AND FINANCIAL BALANCE OF BOP



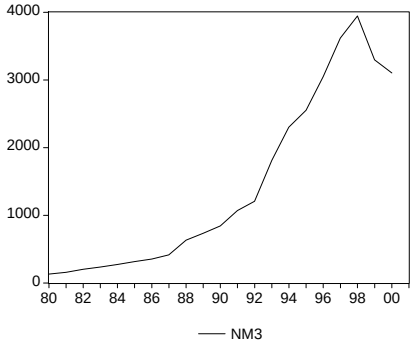
NOMINAL M1 MONEY SUPPLY



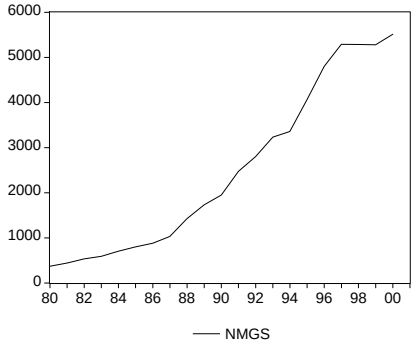
NOMINAL M2 MONEY SUPPLY



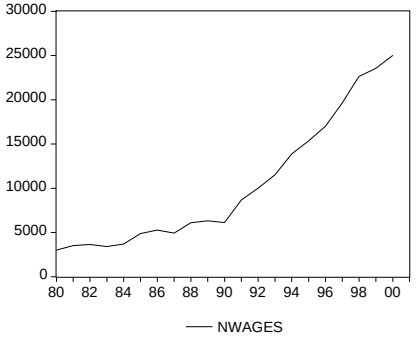
NOMINAL M3 MONEY SUPPLY



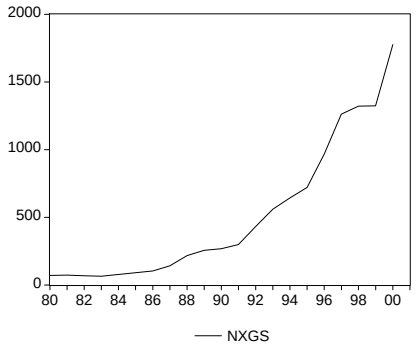
NOMINAL IMPORTS OF GOODS AND SERVICES



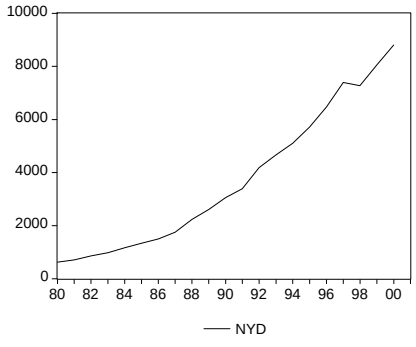
NOMINAL WAGES



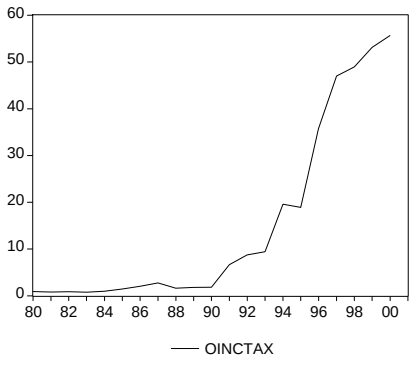
NOMINAL EXPORTS OF GOODS AND SERVICES



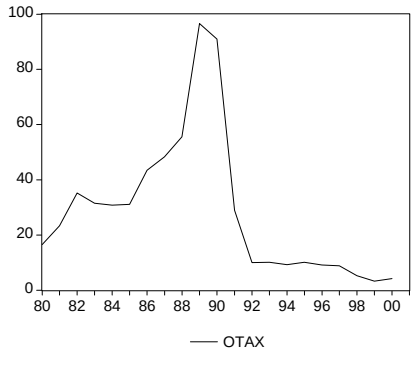
NOMINAL DISPOSABLE INCOME



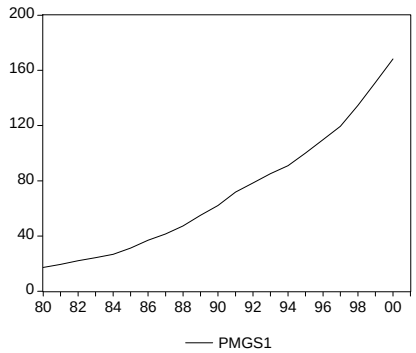
OTHER INCOME TAX



OTHER TAXES



IMPORT PRICES



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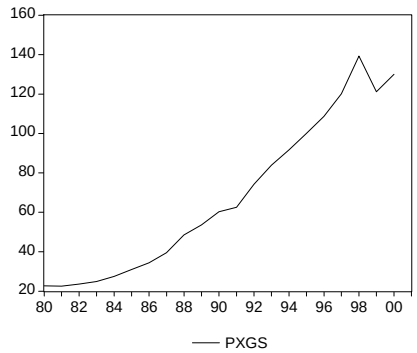
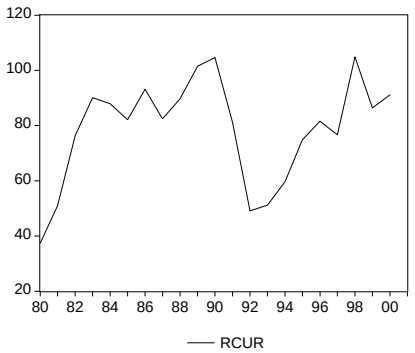
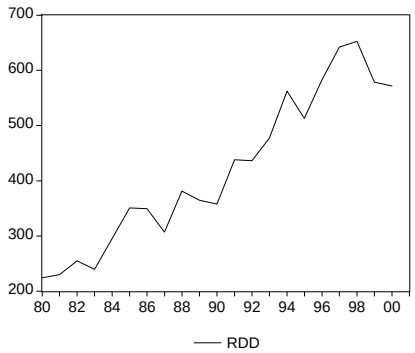


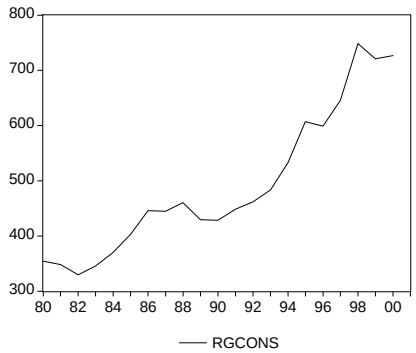
REAL CURRENCY



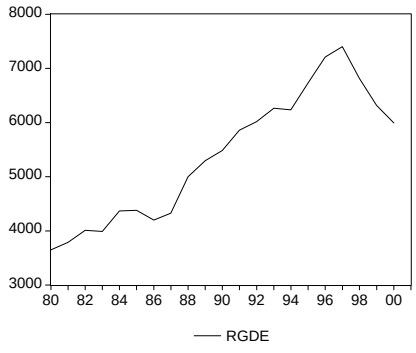
REAL DEMAND DEPOSITS



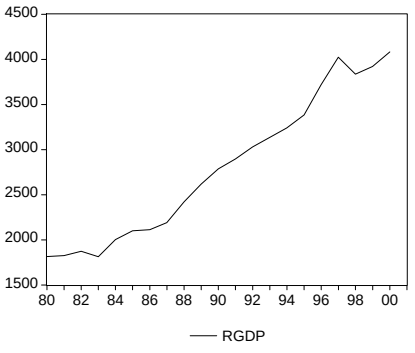
REAL GOVERNMENT CONSUMPTION



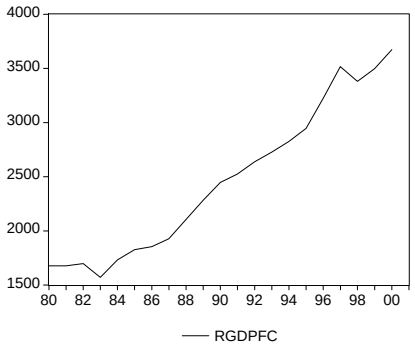
REAL GDE



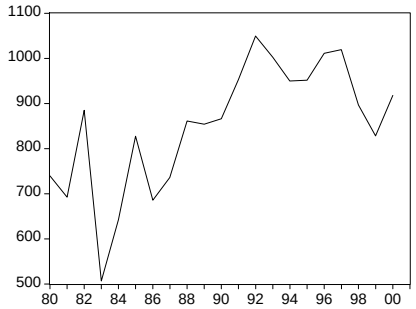
REAL GDP



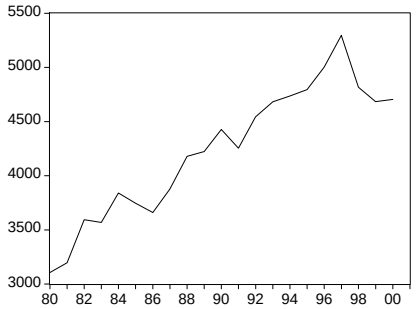
REAL GDP AT FACTOR COST



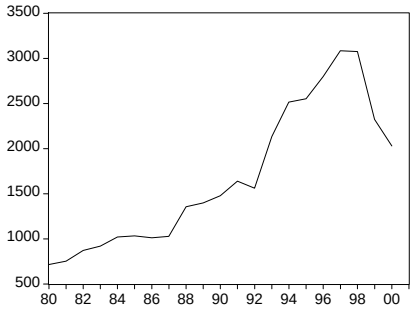
REAL GOVERNMENT INVESTMENT EXPENDITURE



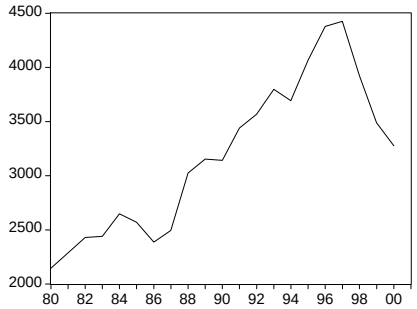
REAL GNP



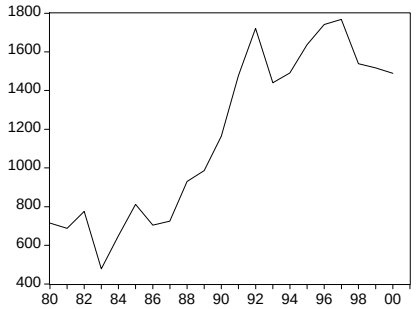
REAL M3 MONEY SUPPLY



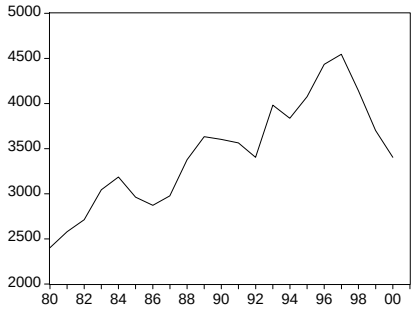
REAL IMPORTS OF GOODS AND SERVICES



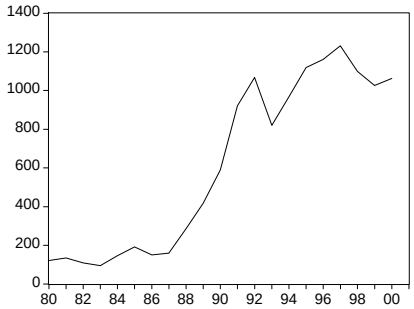
REAL NET TOTAL INVESTMENT



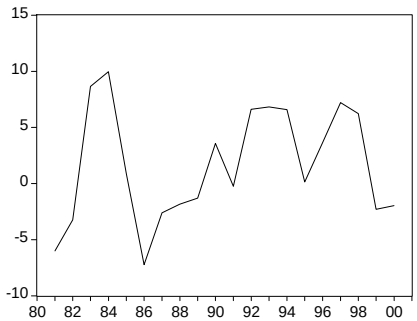
REAL PRIVATE CONSUMPTION EXPENDITURE



REAL PRIVATE INVESTMENT EXPENDITURE



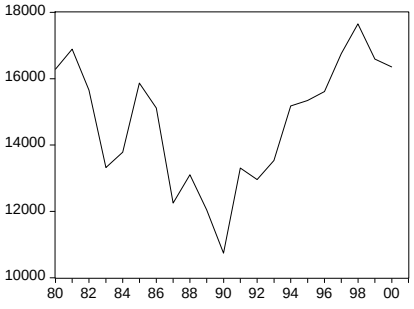
REAL TREASURY BILL RATE



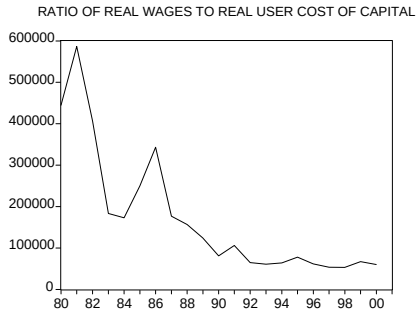
REAL TIME AND SAVING DEPOSITS

REAL USER COST OF CAPITAL

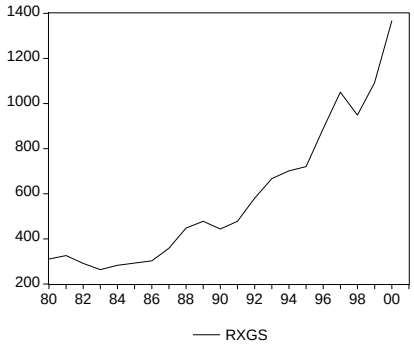
REAL WAGES



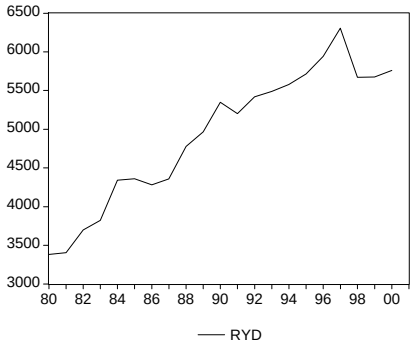
RATIO OF REAL WAGES TO REAL USER COST OF CAPITAL



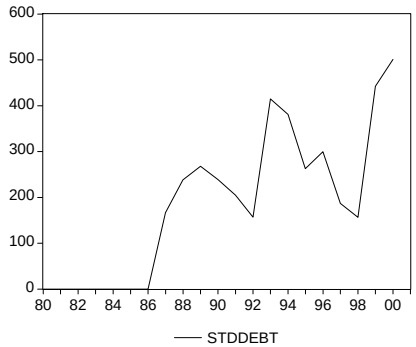
REAL EXPORTS OF GOODS AND SERVICES



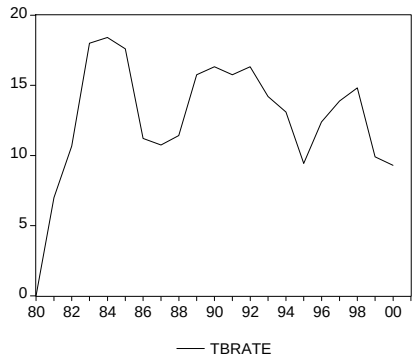
REAL DISPOSABLE INCOME



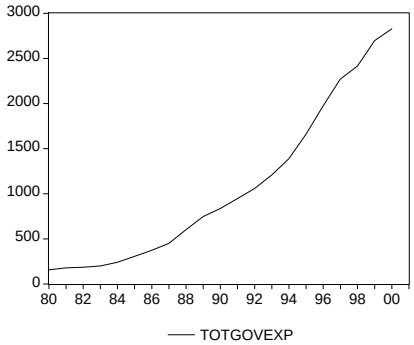
SHORT TERM GOVERNMENT DOMESTIC DEBT



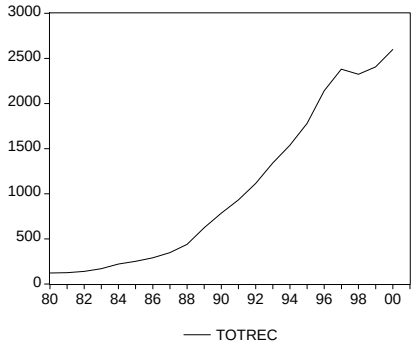
NOMINAL TREASURY BILL RATE



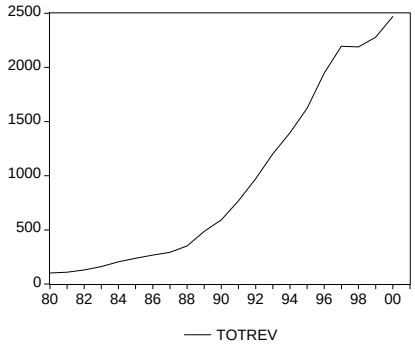
TOTAL GOVERNMENT EXPENDITURE



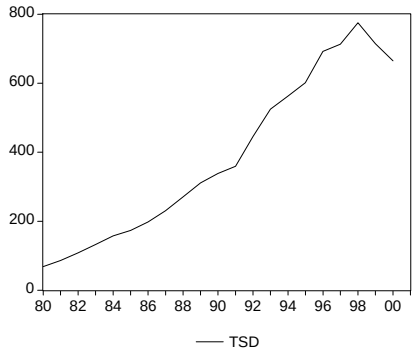
TOTAL GOVERNMENT RECEIPTS



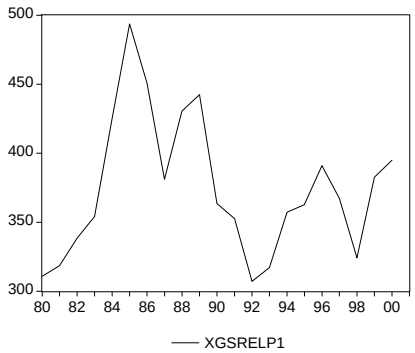
TOTAL GOVERNMENT REVENUE



TIME AND SAVING DEPOSITS

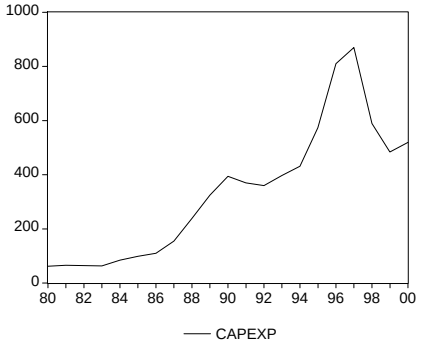


RELATIVE PRICE OF EXPORTS

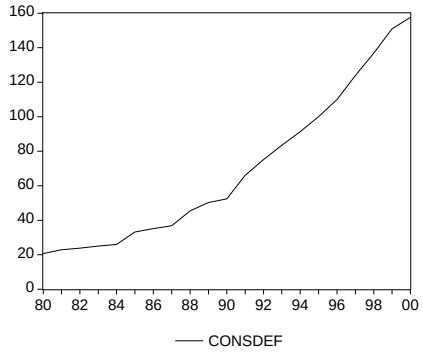


EXOGENOUS VARIABLES

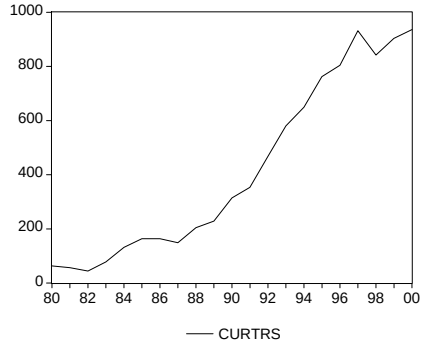
GOVERNMENT CAPITAL EXPENDITURES



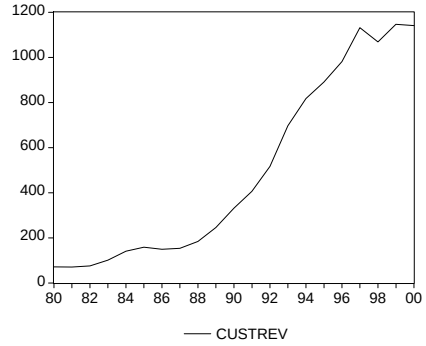
DEFLATOR FOR GOVERNMENT CONSUMPTION



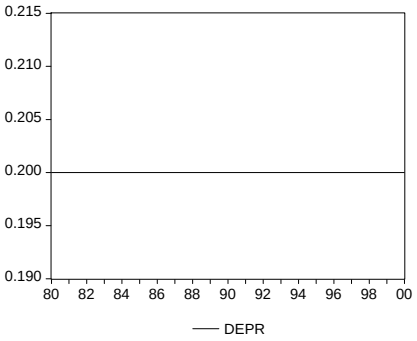
CURRENT TRANSFERS IN BOP



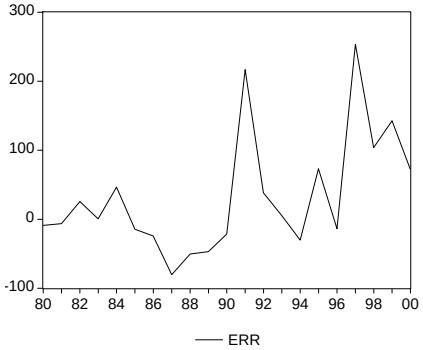
CUSTOMS (SACU) REVENUE RECEIPTS



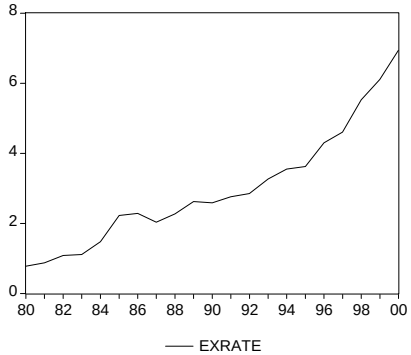
DEPRECIATION



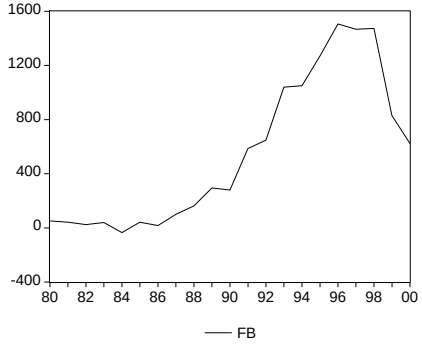
ERRORS AND OMISSIONS IN BOP



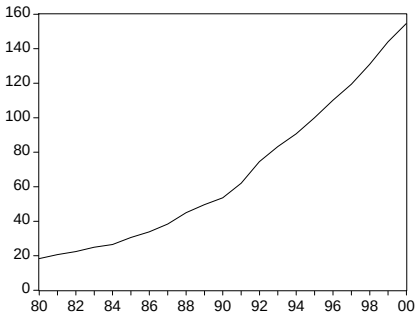
RAND-DOLLAR EXCHANGE RATE



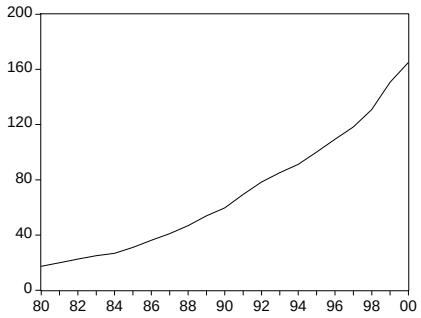
FINANCIAL BALANCE IN BOP



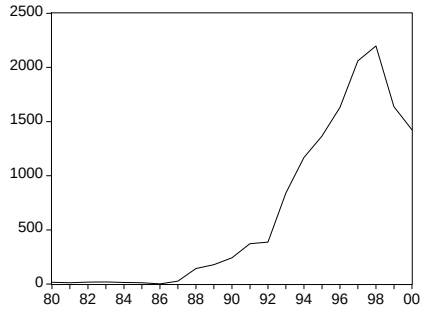
DEFLATOR FOR GDP AT FACTOR COST



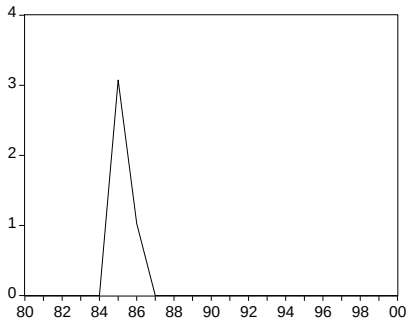
DEFLATOR FOR GNP



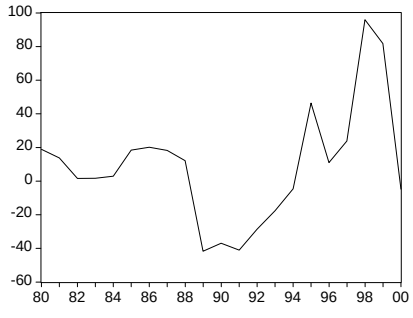
GOVERNMENT DEPOSITS



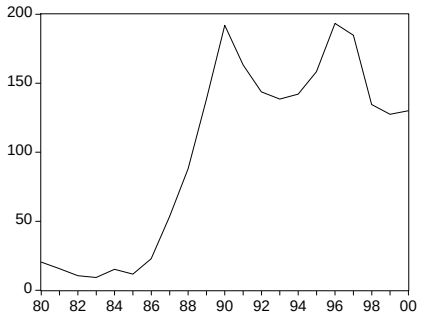
TOTAL GOVERNMENT EXPENDITURE RESIDUAL



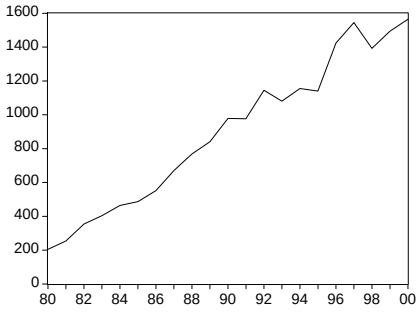
RESIDUAL FOR NOMINAL GOVERNMENT EXPENDITURE



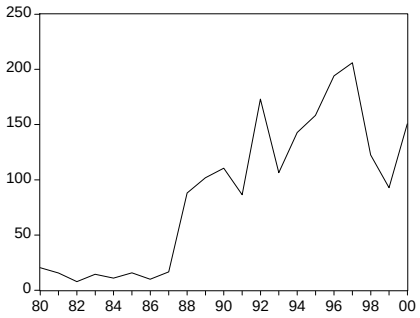
GRANTS



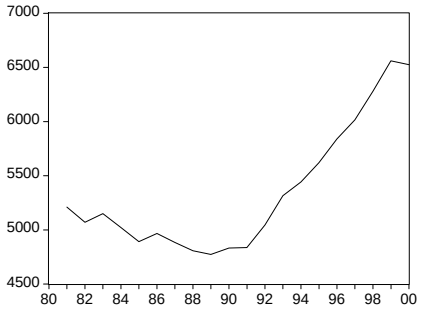
INCOMES BALANCE IN BOP



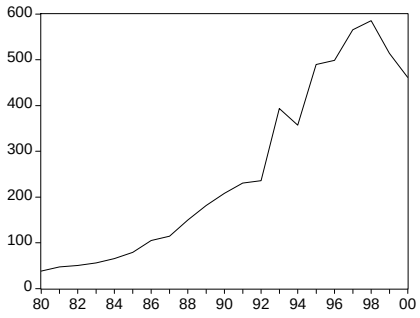
CAPITAL BALANCE IN BOP



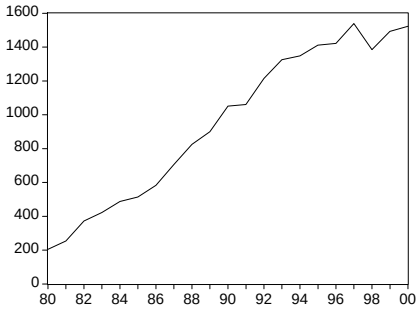
CAPITAL STOCK RESIDUAL



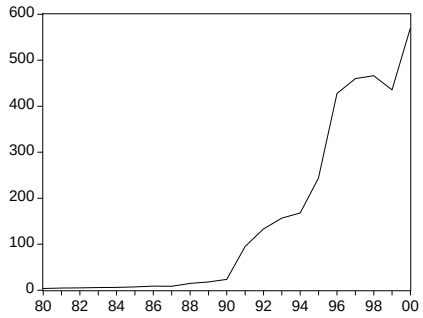
RESIDUAL FOR IMPORTS OF GOODS AND SERVICES



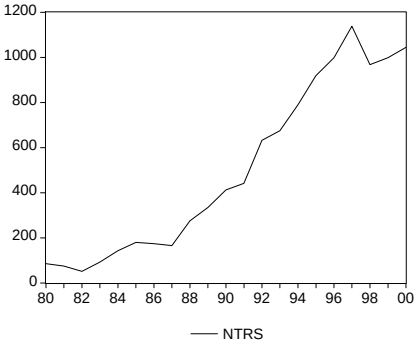
NOMINAL NET FACTOR INCOME FROM ABROAD



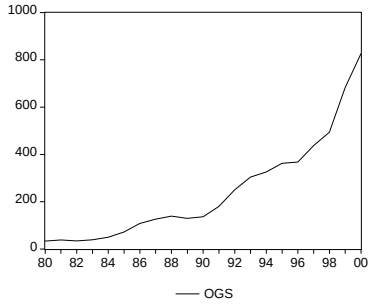
NON TAX REVENUE



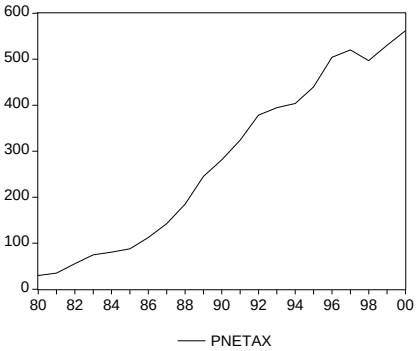
NET TRANSFERS



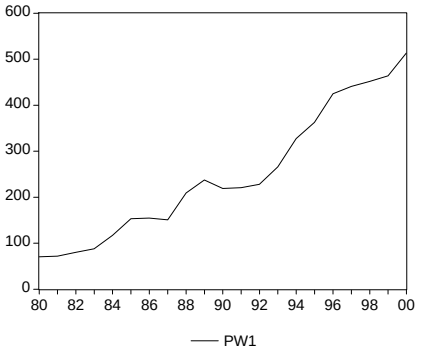
GOVERNMENT PURCHASES OF OTHER GOODS AND SERVICES



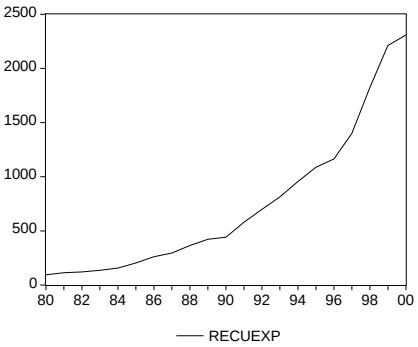
NET TAXES ON PRODUCTION AND IMPORTS



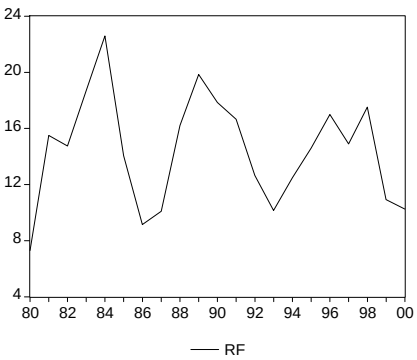
WORLD PRICES



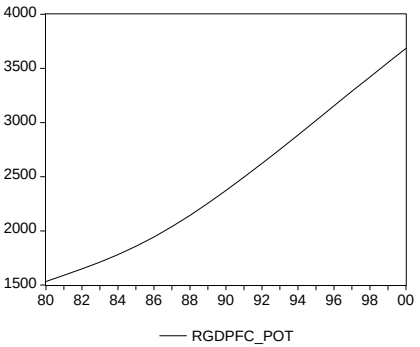
GOVERNMENT RECURRENT EXPENDITURE



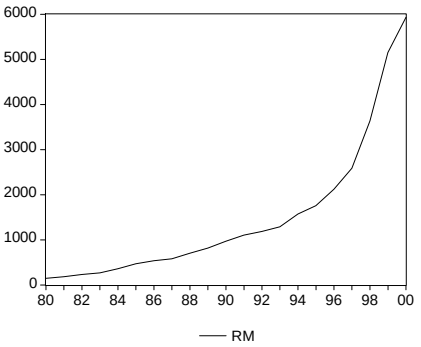
SA SHORT TERM INTEREST RATE



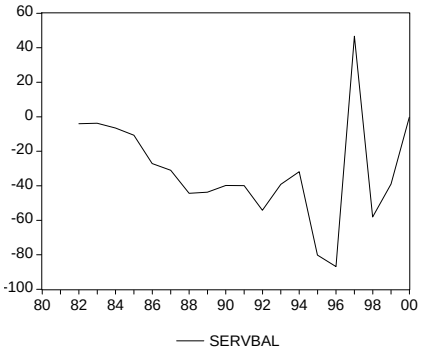
POTENTIAL REAL GDP AT FACTOR COST



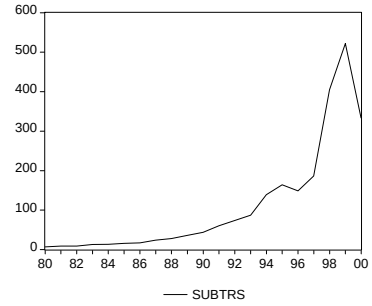
RESERVE MONEY



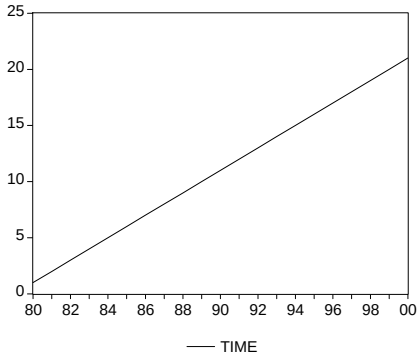
SERVICES BALANCES IN BOP



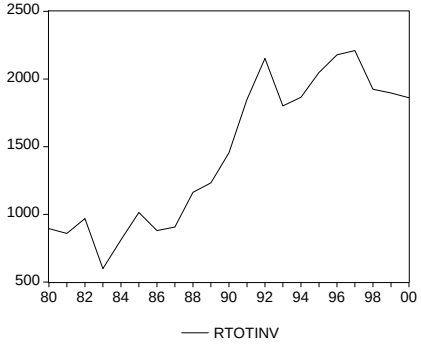
GOVERNMENT EXPENDITURE ON SUBSIDIES AND TRANSFERS



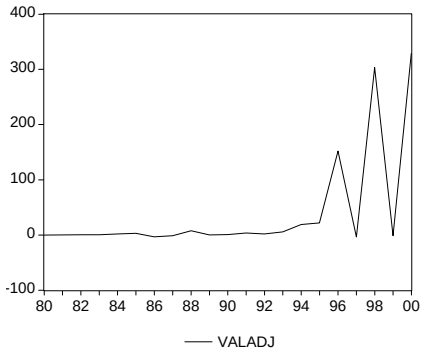
TIME



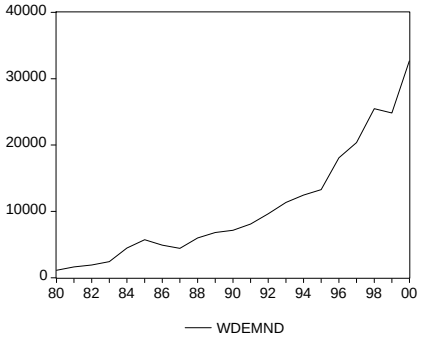
REAL TOTAL INVESTMENT



VALUATION ADJUSTMENT IN BOP



WORLD DEMAND



RESIDUAL FOR EXPORTS OF GOODS AND SERVICES