MACROECONOMICS AND MONEY IN DEVELOPING COUNTRIES: AN ECONOMETRIC MODEL FOR AN ASIAN REGION

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ABSTRACT:

This thesis is a contribution towards the macroreconomic and monetary analysis of developing countries. A fully-fledged macroeconometric model is theoretically specified, econometrically estimated and dynamically simulated for policy analysis. The model contains demand side, supply side, balance of payments accounts, government accounts and a financial sector. The model is tested using regional data consisting of seven Asian Developing Countries, namely, Fiji, India, Malayasia, Pakistan, Philippines, Sri Lanka, and Thailand. A regional econometric model for Asian LDCs was lacking in the realm of global econometric models and this study is an attempt to bridge this gap by building a first ever model for this region.

In the demand side of the model volume equations for consumption, investment, exports and imports and an equation for export prices are estimated. The supply side is derived from wage and price equations following a production function approach which is neo-classical in spirit. Inflation is modelled as a function of the divergence between demand and supply. Government accounts and the balance of payments accounts are fully specified.

Most of the existing macroeconomic models in LDCs context abstract from modelling a financial sector. The implicit reason for this is that financial sector in these economies is underdeveloped; therefore, little scope exists for monetary

policy instruments. We have developed a detailed bank based financial sector model where all the balance sheet flows of the Central Bank and commercial banks are at the centre stage. We show that monetary policy instruments are effective in affecting macro activity. The interlinkges between the financial and the real sector comes not through the cost of capital, rather it arises due to income-expenditure flows and the real financial asset stocks. Such linkages operate even if the financial sector is undeveloped.

The simulation of the trade block of the model shows that the Marshall-Lerner condition holds in the region. However, once wages and prices are endogenised, relative price effects die out very quickly. A set of fixed price Keynesian multipliers shows the plausibility of the model. Supply side simulation proves the long-run supply curve to be flatter than the short-run. An Assessment of non-lineraity shows that there is little; this means that the policy multipliers could be used as "ready-reckoners". Historical simulation shows a good tracking record.

Eleven policy shocks are simulated on the full model through open-loop dynamic simulations. The total fiscal multiplier is found to be 0.5, but prices rise and the trade balance worsens following a fiscal expansion. An increase in world trade brings favourable effects on income, prices and the trade balance. Nominal devaluation and a rise in world prices are not neutral in the full model due to the asset (credit availability) effect on capital stock. Increases in world interest rates are contractionary. Increases in the required reserve ratio and in the discount rate depress activity, increase prices, and worsen the trade balance. Interest rate shocks increase financial saving mobilisation and contribute to increase investment and activity, an outcome with a McKinnon-Shaw rationale.

Finally, the model is used for closed-loop simulation. Feedback control rules in terms of a reduction in government expenditure and real devaluation are designed in order to correct the external imbalance. The former is found to work effectively; however, any use of the latter would be of questionable value as prices explode following the endogenous real devaluation.

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As a Central Banker in my country, Nepal, I had long realised the shortage of quantitative macroeconomists in the Bank. I was determined to utilise any opportunity of further studies to build in this area. This thesis is the outcome of this desire. Besides, there was a prospect of this model being incorporated into the Global Econometric Model (GEM), developed and maintained at London Business School and National Institute of Economic Research, and put into active use.

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CHAPTER 1

Introduction

1.1 General Analytical Framework

A macroeconomic model is a mathematical representation of macroeconomic relationships. It is called macroeconometric when econometric techniques are used to quantify the magnitude of these relationships on the basis of historical data. Such models provide a framework for policy analysis and prediction, and hence have received a great deal of attention in recent years.

The use of large macroeconometric models is quite common in developed countries. For example, Her Majesty's Treasury (HMT) in the U.K. operates with a model commonly known as the "Treasury Model" which has 700 equations and 1000 variables. This is the largest model of the U.K. However, modelling is not only limited to government agencies; institutions like the London Business School (LBS), the National Institute of Economic and Social Research (NIESR), Liverpool University, Cambridge University, City Business University etc. have their own models for the UK economy. A comparative study of the UK models can be found in Wallis et al. (1985). Similarly, large econometric models can be found for US, Australia and other developed economies. As a matter of fact, almost every developed country has one such model.

Models are not only limited to individual country cases. Multi-regional models are also actively in use and form the basis of inter-regional and global policy analysis. A good coverage of such models on North-South macroeconomic interactions can be found in Currie and Vines (1988). Other models in this area are Multi-region Econometric Model (MULTIMOD), (Masson et al., 1990), Global Econometric Model (GEM) (London Business School, 1990), INTERLINK (OECD, 1988) etc. Hickman (1983) provides a good survey of a number of such models. However, not all the models surveyed in Hickman are econometric, some are input-output based and others are Computable General Equilibrium (CGE) type or hybrids for specific purposes.

However, the art of macroeconometric modelling seems to be largely confined to developed countries. Two factors can be cited for this. Firstly, the development and the testing of economic theories have utilised developed economies as their test case. Therefore, a direct application of these western economy based models are not wholly appreciated by the economic practitioners of both sides (ie., developed and developing countries). There is some strength in this argument as the economic institutions and structures are very different between the north and the south; we will take-up this issue below. Secondly, developing countries are constrained by the availability of time series and other information required to formulate such a model, therefore, the modelling exercise is lack-lustre. However, there are exceptions to this and some developing economies have good data bases and have developed their own macromodels (Ichimura and Ezaki, 1985; Agrawal, 1970).

Macroeconomic modelling covers a wide range of methodological approaches and analytical frameworks. This is natural because a realistic model must capture the structure, institutions and behaviour of the economy it models and, in fact, these factors differ not only across regions but also across the intra-region countries. However, it does not mean that a modelling exercise cannot and should not have a general analytical framework. As a matter of fact, though in general terms, a clear consensus seems to have emerged vis-a-vis a standard analytical framework of macroeconomic modelling in developed countries. A cursory look at the studies cited above would make this fact clear. This analytical framework has evolved around the standard IS/LM framework, but with significant modifications which can be outlined as follows.

In the IS part of the model relationships for consumer demand, fixed investment, stock building, exports and imports are endogenously determined; government expenditure, in most cases, is treated exogenously. Each component of expenditure is further segregated depending on the availability of data and the views of the modeller. For example, consumption expenditure can either be modelled at aggregate level or at disaggregated level as durables and non-durables. This is also the case with investment. Export and import volumes and prices are modelled separately. Thus, the IS part has remained fairly standard Keynesian, except that price flexibility is allowed for (which can be seen as flexible price IS). Also in recent modelling practice the wealth effect on consumption function is allowed for.

The LM part, on the other hand, has gone through significant changes over years. In Keynes' formulation only two assets viz., money and bonds were explicitly allowed for in the model as the sole financial assets. All other assets were conceived to be perfect substitutes to bonds. The nominal interest rate is determined as the function of demand and supply of money. The exchange rate was supposed to be officially managed. In modern formulations, however, a full financial sector is modelled where a range of assets are issued and traded. Assets are assumed to be gross substitutes and their demands are determined by a general portfolio approach. In this framework each asset is a function of its own return, the return on other assets, and the budget constraint of the asset holder. Exchange rates and interest rates are endogenously determined within the system in such a way that they depend on the demand and supply of assets both in domestic and foreign markets rather than merely on money. Linkages between the financial and the real sectors are specified through interest rates, exchange rates and wealth effects. Nobody believes in a mere interest rate linkage between the real and financial sectors of the economy.

Inflation is specified as a function of wages, prices and exchange rate relationships. Prices are generally modelled as a function of wages, import prices and tax effects. Aggregate supply is determined as a function of the real exchange rate and capital stock. Mostly the effects of technological change are assumed constant for simplicity. Output is viewed to be largely demand determined due to the production elastic industrial base. Expectations normally enter into the model through financial and labour markets. Expectations are formed either by a backward-looking or a forward-looking approach.

The above description characterises a standard framework commonly followed in the macroeconomic modelling of developed countries. It should be noted, however, that each macromodel does not cover all these aspects, as they differ in terms of their objectives and coverage.

It is well known that economic structures of developing countries are different from those of the developed. Therefore, it is argued that the analytical framework of the latter cannot be directly applied to the former. Klein (1965) in his article "What Kind of Macroeconometric Model for Developing Economies ?" points out that macromodels for developing countries must be tuned to capture the local institutions and behavioural differences. He argues that the Keynesian framework may only partially be applicable and suggests a serious modification in the modelling of the financial sector and the investment function. He further argues that the production sector should be segregated between traditional agriculture and the modern non-agriculture sector.

A promising case for a separate analytical framework for the financial sector of developing countries has also been made by the McKinnon-Shaw models of financial development (McKinnon, 1973 and Shaw, 1973). These models stress complementarity between financial savings and the level of investment and growth in developing countries and assign a positive role to the real interest rate in enhancing saving and investment. This is at variance with the standard economic hypothesis of a negative relationship between the real rate of interest and investment. This argument has further been strengthened by the works of Galbis (1977), Kapur (1983), Mathieson (1980), and Fry (1988).

The World Bank and the IMF have developed their own analytical frameworks for developing member countries. The basic macroeconomic models utilised by these institutions can be found in Khan et al. (1990). The Fund's main concern is to tackle the short-run payments problem and it follows the monetary approach to the balance of payments popularised by Polak (1957). The Bank, on the other hand, is concerned with medium term investment and growth issues and follows a two-gap type model assessing the domestic saving-investment gaps and the required inflow of foreign savings. The Khan et al.'s model is a direct merger (hybrid) of these two models.

At best the Bank and Fund - as is the Khan model - models are highly aggregative and more tuned to the assessment and preparation of the ground-work for their lending programmes, rather than a serious structural analysis of developing country macroeconomics. However, they point out the role of capital formation in the determination of output; and financial asset stocks are determined by the flow of funds identities. The approach is cursory and neglects the role of the public sector in capital formation, an important issue in developing economies. Similarly, there is no banking system (except the Central Bank), no role for interest rates and other monetary instruments and the monetary sector is very rudimentary.

The work of Allen et al. (1992) on "A Framework for Macroeconomic Analysis of Developing Countries" suggests the following points as the important features of macroeconomic modelling. (i) wealth effect on consumption function (ii) the interconnection of the capital stock with aggregate supply (iii) inflation as the function of divergence between demand and supply, which are both endogenously determined, and (iv) asset flow effects emerging out of a budget deficit and the current account of the balance of payments. In what follows we describe the objectives, motivation and the framework of our work in this context.

1.2 Objectives, Motivation and the framework

The objective of this dissertation is to develop a regional macroeconometric model and conduct policy analysis through dynamic simulations taking the developing countries of Asia as a test case. Our motive is to assess how the region responds to various stylized internal and external policy shocks. The corollary is a contribution towards the development of a fairly general framework for the macroeconomic analysis of developing countries in general and the Asian ones in particular.

The model's emphasises is on policy analysis rather than on forecasting. Our analytical approach incorporates all the points contained in Allen et al. (1992) and goes somewhat further in modelling a detailed financial sector which captures its institutional and functional characteristics in developing countries. In other words, we follow the spirits of the McKinnon-Shaw hypothesis, and the Klein argument.

Our sample countries consists of Fiji, India, Malaysia, Pakistan, Philippines, Sri Lanka, and Thailand. Individual country level data are aggregated and regional data are generated. The choice of the sample countries is purely guided by the availability of data. Data sources, aggregation techniques and assumptions employed for projections are given in the Data Appendix at the end of this dissertation.

The motivation for this regional study came from three quarters. Firstly, a regional macroeconometric model representating the Asian developing countries as a group is lacking in the realm of global econometric models. We wanted to contribute in this area and bridge this gap through this work. We recognise that some countries had to be dropped due to insufficient data. However, we hope that our sample will represent the collective behaviour of non-oil Asian developing countries fairly closely. So far as we know, this is the first ever study of this kind; ie., the modelling a group of Asian developing countries. Secondly, in our view, whatever global models vis-a-vis developing regions exit today all of them suffer from one common problem ie., the exclusion of a detailed modelling of the financial sector. We wanted to bridge this gap by developing a fully-fledged model for the financial sector. In so doing, we shall take into account the McKinnon-Shaw and the Klein argument discussed above.

And last but not least, we are motivated by the fact that our work is going to be incorporated into a global model and put into active use. The global model is the Global Econometric Model(GEM) of the London Business School.

This study is a complete stand-alone piece of research accomplished by myself. The stages of work involve specification of an accounting framework of the analysis, theoretical specification of the behavioural relationships, econometric estimation and testing, partial simulations, historical simulations, full model simulations and policy analysis, and the design of feedback control rules. A regional macroeconometric model for the whole of the Latin America region was being developed under the direction of Prof. David Vines and I have greatly benefited from that, particularly in the specification of the supply side of the model. However, my model differs from the Latin American model in at least two important respects. Firstly, as argued above my specification of the investment function is very different from the Latin American model. In my specification credit availability is allowed to affect private investment. Secondly, my model also goes beyond the Latin American model in specifying, testing and incorporating a detailed financial sector and simulating the financial policy instruments. However, we worked as a team for a short period (almost for the whole of my first year) and the benefit was that I could get the real sector data series from the team work. It has been duly recognised in the data appendix.

Thus, I have developed a fully-fledged model which consists of demand side, supply side, foreign trade and the balance of payments accounts, government sector and a financial sector. The specification of the demand side follows a standard IS relationship consisting of relationships for private consumption, investment, exports and imports functions, with government expenditure exogenous. The supply side consists of wage and price equations. Government accounts and the balance of payments accounts are fully specified. A full (bank based) financial sector is theoretically designed and empirically estimated. In what follows we provide the outline of this thesis.

1.3 The Outline

This study is divided into seven interrelated chapters and a data appendix, excluding the present one. A brief account of each chapter is as follows. Chapter 2 covers what we call the real sector of the model. Here we provide the accounting framework adopted for our model. The economy is divided into five sectors: non-bank private sector, government sector, monetary authorities, commercial banks and the rest of the world sector. The flow of funds among these sectors is discussed and their current account and capital account are specified. Then we move on to the theoretical specification of the demand side volume equations (viz., consumption, investment, exports and imports), price equation (export price), and the supply side (wage and price) equations. In specifying behavioural relationships, our approach has been to provide a brief theoretical survey of the area and to modify the model, where appropriate, for our purpose. Government accounts, and the balance of payments accounts are also fully discussed and specified in this chapter.

Chapter 3 specifies the financial sector of the model. The chapter starts with a brief overview of the developing country financial sector where we discuss its institutions and characteristics. We single-out the differences with the western (developed) financial sector, and argue a case for a different transmission mechanism, and a separate theoretical specification. Our financial system is essentially a bank based one where the accounting flows of the Central Bank and the commercial bank balance sheets are at the centre stage. It should be noted that the rudimentary state of money and capital markets in developing countries make the banking system the main constituent of the financial sector.

In the model, base money is endogenously determined by balance of payments flows and government borrowing from the Central Bank. The latter depends on the fiscal stance of the government, and hence endogenised as a function of the budget deficit. The Central Bank lending to deposit banks are assumed to be under the control of monetary authorities and treated as an exogenous monetary policy instrument.

The flow of commercial bank reserves is determined by the flow of base money and the changes in currency demand. Ceteris paribus, a rise in currency demand reduces bank reserves and vice versa. A currency demand function is specified as a positive function of income and negative functions of deposit rate and expected inflation. We also specify a free reserves demand function for banks as a negative function of the lending rate and a positive function of the discount rate.

The link between the financial and the real sector is not through the interest rate but through the flow of bank credits to the private sector and financial asset stocks. Real balances and real bank credits enter as arguments in the private sector consumption and investment functions, respectively. We argue on how the availability of bank credits affect private sector investment in these economies. Interest rate effects are not significant in consumption and investment functions, however, they affect the stock of bank reserves and the volume of bank credit. Ceteris paribus, a rise in deposit rates reduces the demand for currency and increases bank reserves. Similarly, a rise in the lending rate reduces the free reserves of the banking system and increases the credit multiplier and hence the volume of bank credits. Banks supply credit to the private sector and the latter adjusts to it. Banks are not constrained by demand determined deposits in their lending operations as the cost of borrowing from the informal market is higher than the bank lending rate.

This specification of the financial sector departs from the standard Keynesian model where the link between the financial and real sectors is the interest rate in the form of the cost of capital. However, in our model this is ruled out due to the institutionally pegged interest rate structures. In this context our model is very unKeynesian.

In chapter 4 we present the analytical results of the model. Both short and long run comparative statics are derived and discussed. The analysis is guided by two objectives. Firstly, we analyse short and long run effects of a particular policy change on income, prices and the trade balance. In so doing, we compute the total derivatives of changes in various policy variables, viz., government expenditure, world trade, nominal exchange rate, import prices, required reserves, Central Bank discount rate, and deposit and lending rates. This gives the analytical policy multipliers. Secondly, we use these policy multipliers to show how various policy objectives could be achieved. For example, we show how a reduction in government expenditure could be used to correct the adverse payment effects following a fall in the world demand for exports. Similarly, it is also shown that a devaluation and a rise in government expenditure can simultaneously be used to achieve a rise in activities, and a balance on the external accounts. We then move on to the stability analysis of the model. Our model proves to be dynamically stable.

Chapter 5 covers two empirical aspects of the model. Firstly, we present the empirical estimation of all the stochastic behavioural relationships of the model. In so doing, we provide a brief outline of the econometric strategy employed and set out for the discussion of the estimated results. Two popular methods of time series estimation viz., general-to-specific and the cointegration techniques are discussed. It is indicated that both of these methods lead to the same parsimonious error correction model. We also discuss their merits and demerits in the context of small samples. We employ both of these methods in our estimation. Unit root tests are performed and results reported. We also report a range of diagnostic tests for each equation. These test statistics are also discussed very briefly.

The second empirical aspect covered in this chapter is the partial simulations of the model. We compute both the open and closed economy Keynesian multipliers which are sensible. The trade block simulation confirms that the Marshall-Lerner condition holds. The supply side properties are also assessed and it is found that the long-run supply curve is flatter than the short-run.

In chapter 6 we lay the ground work for the full model simulations. A brief discussion of the meaning and role of dynamic stochastic simulations in economic policy analysis is given. Then we move on to tackle the issue of simulation specification. We spell-out the issues related with the generation of base run, simulation run and the method of multiplier computation. The nature, size and the types of policy shocks simulated as well as the modes (scenarios) of simulation runs are discussed. Historical simulation is accomplished which provides a good tracking record and hence the credibility of the model.

In chapter 7 we provide a detailed analysis of the full model simulation results. Altogether eleven internal and external policies are simulated. The full model is simulated in four structural modes which we call the simulation scenarios. In the first scenario, we exogenise financial variables and prices. This approximates the fixed price Keynesian world. In the second scenario financial effects are allowed, keeping prices fixed. In the third scenario prices are endogenised with fixed financial variables. The fourth and the final mode is the full model simulation where all endogenous variables are allowed to move. These structured shocks are important to assess the dynamic properties of the model. Our simulation results are sensible and are in conformity with economic theories.

Chapter 8 covers the design of feedback control rules. We specify feedback rules in terms of a reduction in government expenditure, and a real devaluation should the economy face a negative external shock. The base level current account balance is targeted following a negative shock.

In the end we provide a data appendix which explains the sources of data and the conversion method employed in the aggregation of individual country level data. This completes the dissertation.

1.4 Limitations

It is unavoidable in a work like this that many simplifying assumptions have to be made due to various reasons. Constraints in terms of resources, time and data availability always limit the scope of such a work. This is inherent in all model building.

A model attempts to explain a complex real world phenomenon by focussing on crucial relationships and excluding others considered to be less important. Given greater resources and time it would always be possible to expand the domain of such relationships, but the list could never be exhausted. A most generalised model would be one where everything depends on everything else. However, such a general model also produces the well known econometric problem of identification.

In what follows we pin-point, in our view, the main limitations of this study which could be interpreted as the scope for further studies.

(1) We argued above that the structure of developing economies differ from that of the developed economies and indicated that it would be a realistic approach to extend the production side of the model into a two sectoral model, at least, one being

agricultural and the other being industrial. Despite our appreciation of the issue we could not do this due to data problems. Production data disagregated in this way were simply not available.

(2) As stated above in our empirical model we disaggregate the economy into five sectors. In so doing, we have lumped the non-bank private sector, corporate sector and the business sector into a single "private sector". Though the corporate sector in these economies is very small, even then, we would have liked to disaggregate the non-bank private sector into household and business sectors. Again the data problem precluded this.

(3) Current practice in macroeconomic modelling shows an increasing emphasis on the role of expectational variables and forward looking expectation formation. The only expectational variable in our model is expected inflation which is backward looking. We abstracted from modelling expectations formation in a forward looking manner due to two reasons. Firstly, the literature has emphasised the role of expectations in financial markets, particularly in determining the rates of return on assets. Due to the underdeveloped nature of financial markets and instruments and the presence of officially controlled rates, asset prices are not determined by the supply and demand conditions in the markets where agents form expectations about the future. Therefore, a major link between expectations and the rest of the economy is missing in our region. However, we could have modelled

consumption function in a forward looking manner, but the simulation package precluded us from doing this. We wanted to use our model for policy simulations, but the package we relied on did not handle forward looking variables.

(4) Our econometric method may not satisfy a purist. The simultaneity problem is not addressed due to the acute problem of data points (degrees of freedom). The average sample size (except the government accounts) is from 1963-1985. Data on government accounts are available only from 1972. This may affect the quality of our estimated results.

(5) Our model of the financial sector is limited to the organised sector only. However, structuralists' financial sector models emphasise on the role of unorganised financial markets in these economies. A complete lack of data and information on unorganised markets precluded us from modelling this sector. However, Ghatak's study on several LDCs concludes that " the evidence suggests that the links between the organised and unorganised financial sector are rather weak in most LDCs, that the size of the latter is declining very slowly, and that the flow of funds between the two is not great" (Ghatak, 1983, P.46).

(6) Finally, control rules designed in the last chapter are only feedback rules. We do not consider experiments of simultaneously targeting the internal and external equilibrium. Only the external balance is analysed as the

target variable. We could not work on optimal control rules, again due to software problems.

CHAPTER 2

Specification of the Real Sector of the Model

Introduction

In this chapter we develop the behavioural relationships of the real sector of the model which will be used for subsequent estimation and simulation works using time series data. In specifying the structure of the economy and the behavioural relationships, we have made use of the fairly standard framework of macroeconomic modelling in LDCs (Park, 1973; Haque et al., 1990; Srinivasan, 1991; Masson et al., 1991).

Our model is of the Mundell-Flemming type, with one domestically produced good consumed both at home and abroad and one imported good. We appreciate that a three goods structure (exportables, importables and nontraded) would have been more appropriate, but data limitation precluded this. The model treats capital flows, exchange rates and interest rates as exogenous, which will be clear in the subsequent discussions.

The real sector contains four main blocks: aggregate demand, aggregate supply, government accounts and a balance of payments account. A separate chapter (ie., Chapter 3) is devoted to the specification of the money market and the financial sector.

In what follows, this chapter is organised into five sections. In the first section we set out the accounting framework adopted for the analysis. The second section describes aggregate demand and specifies private consumption, investment, exports (volume and price) and import relationships. Section three is devoted to the specification of the supply side where wage and price equations are specified and the supply side is derived. Section four specifies government accounts. In section five, balance of payments flows are discussed and specified. The chapter is closed with concluding comments.

Specification of each behavioural relationship is followed by a brief theoretical discussion and a short review of other works accomplished in the area. Throughout the discussion, unless otherwise specified, upper case letters denote variables in nominal terms and the lower case denote them in real terms.

2.1. The Accounting Framework

Data problems have limited the design of accounting framework used. Particularly, the separation of the household sector from the private sector, flows between private and public sectors, and flows between private sector and rest of the world sector could not be isolated.

The economy is segregated into five sectors: the private sector (including non-bank institutions such as pension funds, investment credit funds and other non-financial institutions), the government sector, the Central Bank, the commercial banks, and the rest of the world. All flows discussed, unless otherwise stated, are expressed in US dollars. Valuation effects are ignored while presenting these flows for simplicity. Throughout below the letter "δ" is used to denote change in or flow of a variable.

2.1.1 Flow of Funds in the Private Sector

The private sector is the sole recipient of all incomes generated in the economy (Y) and the non-interest factor service receipts from abroad (OFS). All interest receipts from abroad accrue to the government sector in our model. This is due to the restrictions in foreign transactions by the private sector. Income thus generated by the private sector is spent on tax payment (T), private consumption (C), private investment (Ip) and repayment of debt to the domestic banking system (δBLP). Any excess of income over expenditure (ie., saving) is reflected in the accumulation of financial assets by the private sector whereas the reverse is true when there is an excess of expenditure over income. These flows can be expressed in terms of following identity:

$$Y+OFS-T-C-I_p \equiv S \equiv \delta C_p+\delta TOTD+\delta GB_p-\delta BLP+\delta RFP \qquad (2.1)$$

The identity states that private sector financial savings must take the form of flows into currency (δCp), flows into bank deposits (δTOTD), flows into Government bonds (δGB_p), minus bank credit flows to the private sector (δBLP, ie. repayment of debt). δRFP is the residual or balancing item of the balance sheet. In specifying this identity we have assumed that the private sector cannot borrow from the government, from the Central Bank, from the non-bank domestic sector and from abroad. These issues are explained in Chapter 3 where a full model of the financial sector is developed. In what follows we suppress δGB_p as the government bond market is assumed to be nonexistent (of no significance) in our economy.

2.1.2 Flow of Funds in the Commercial Banks

The flow of funds identity for the commercial bank can easily be derived from its balance sheet as follows:

$$\delta TOTD+\delta CLB+\delta FBDB \equiv \delta RB+\delta FLDB+\delta BLP+\delta BLG+\delta RFDB \quad (2.2)$$

Identity (2.2) states that the sources of funds must be equal to their uses in the banking system. The sources of funds are the flow of deposits (δTOTD), the flow of credit from the Central Bank (δCLB), and any new foreign borrowing by the banks (δFBDB). The uses are additions to reserves (δRB), new foreign lending (δFLDB) and changes in the total domestic advances in the form of new lending to the private sector (δBLP) and to the government sector (δBLG). δRFDB is a balancing item which consists of changes in bank capital etc. In the model we exogenise δFBDB and δFLDB as the foreign exchange transactions are controlled by the authorities. It is also implicitly assumed that the whole of commercial bank deposits come from the private sector. In other words, government and foreign residents do not deposit in commercial banks.

2.1.3 Flow of Funds in the Central Bank

The flow of funds of the Central Bank can be illustrated by the following identity:

$$\delta RESCP+\delta CLB+\delta CLP+\delta CLG \equiv \delta BM+\delta GDCB+\delta PDCB+\delta FBCB+\delta RFCB \quad (2.3)$$

The left hand and the right hand side of the identity contain uses and sources of funds, respectively, for the Central Bank. The sources are changes in the base money (δBM), changes in the government deposit at the Central Bank (δGDCB), changes in the private sector deposit (δPDCB) at the Central Bank, and any new foreign borrowing by the Central Bank (δFBCB). δRFCB is the flow of funds' residual, a balancing item which captures item like changes in bank capital etc. Since we assume all foreign borrowing to be incurred by the government we suppress δFBCB. The uses of funds are changes in foreign reserves (δRESCP), lending to commercial banks (δCLB), and lending to the private sector (δCLP) and to the government sector (δCLG). However, δCLP and δPDCB are suppressed from the analysis as the private sector is assumed to be not transacting directly with the Central Bank.

2.1.4 Flow of Funds in the Government Sector

The flow of funds identity for the Government sector is as follows:

$$GCCP+Ig+AMT+INTR+INTRH-T-TRf \equiv \delta CLG+\delta GB+\delta BLG+\delta DOD-\delta GDCB+\delta RFGS \tag{2.4}$$

The left hand side of the identity shows income and expenditure on current account while the right hand side shows corresponding changes on the capital account.

The income on current account consists of tax revenue (T) and net transfer receipts from abroad (TRf). This is expended on government consumption (GCCP), government investment (Ig), amortization of foreign debt (AMT), net interest payment abroad (INTR) and interest payment for domestic debt (INTRH).

The difference between expenditure and income ie., the fiscal deficit, must be financed by corresponding changes in capital account stocks which involve borrowing from the Central Bank (δCLG), issuing bonds (δGB), borrowing from the deposit banks (δBLG), new borrowing from abroad (δDOD) and running down the deposits at the Central Bank (δGDCB). The flow of funds residual in the government account (δRFGS) represents the miscellaneous flows not specified explicitly and also balances the account.

2.1.5 Flow of Funds from the Rest of the World

Following identity states the transactions between domestic economy and the rest of the world.

$$X+TRf+OFS-M-INTR \equiv \delta RESCP+\delta DOD+\delta FBDB+\delta FBCB+\delta RFBOP \quad (2.5)$$

The left hand side of the identity states the current account balance of the balance of payments account. Current account receipts are exports of goods and non-factor services (X), net transfer receipts from abroad (TRf) and net non-interest factor services receipts (OFS). Payments include imports of goods and non-factor services (M) and net interest payments abroad (INTR). The right hand side shows how any deficit or surplus in the current account balance is reflected in the financial flows involving domestic residents and the rest of the world residents.

The current account imbalance must be financed by changes in the official foreign reserves (δRESCP), changes in the net foreign indebtness of the government (δDOD), changes in the foreign borrowing of the deposit banks (δFBDB) and the Central Bank (δFBCB). The residual (δRFBOP) is the errors and omissions of the balance of payments account. In the model we allow only δRESCP and δDOD, following our assumption that foreign transactions are restricted to government. It should be noted that the addition of amortization of foreign debt and net capital flows in the right hand side of the identity gives the overall balance of payments flows.

2.2. Aggregate demand

The real aggregate demand for domestic output is the sum of consumption, investment, government expenditure, and the trade balance expressed as:

$$y_t = c_t + i_t + g_t + x_t - m_t \qquad (2.6)$$

where y_t is real gross domestic product; c_t is real private sector total consumption expenditure; i_t is real gross domestic investment expenditure; g_t is real government expenditure on domestic goods and services; x_t is real exports of goods and non-factor services (nfs); and m_t is real imports of goods and nfs all expressed at time 't'. We work on GDP rather than on GNP figure for the reason of data limitations on factor service flows.

The components of aggregate demand (except g_t) are all behavioural relationships. In what follows we specify these relationships, in turn. We specify g_t as a combination of behavioural and exogenous flows (see section: 2.4).

2.2.1 Consumption Function

We begin the specification of the components of aggregate demand with the consumption function. It should be noted at the outset that it is customary to specify separate functions for consumer durables and non-durables in empirical work. However, in our case such a segregation of total private sector consumption expenditure does not exist. Therefore, we model the behaviour of the total private sector real final consumption expenditure.

The consumption function, as it stands today, stems from the Keynesian theory known as "Absolute Income Hypothesis (AIH)". This theory lays down several specific propositions regarding the private sector consumption behaviour. They are: real consumption is a function of measured income, marginal propensity to consume is positive but less than one, marginal propensity to consume is less than average propensity to consume, and as income rises the marginal propensity to consume falls.

However, it is well known that subsequent works of Kutznets (1942), Goldsmith (1955), and Brady and Friedman (1947) did not fully support these propositions. Their empirical findings suggested a long-run consumption function without an intercept and with a constant APC; whereas the short-run (ten to fifteen years) and the cross-sectional consumption functions with an intercept and a higher APC than MPC.

Then onwards, much of the work in this area has been concerned with providing a theoretical explanation for these apparent inconsistencies in the results obtained from different types of data. This has lead to the development of alternative theories of consumption function. They are "Relative Income Hypothesis (RIH)" (Duesenberry, 1949 and

Modigliani, 1949), "Permanent Income Hypothesis (PIH)" (Friedman, 1957), and "Life-cycle Hypothesis (LCH)" (Modigliani and Brumberg, 1954). These models reconcile, in one way or the other, the apparent inconsistencies shown by the short-run, cross-sectional and the long-run time series of consumption expenditure. Thomas (1984), Evans (1969), Mayer (1972), and Fisher (1987) provide a comprehensive review and testing of these theories.

The fundamental message inherent in these theories is that the scale variable for the real private consumption expenditure is not the "measured income" as suggested by AIH, but some secular or broader measure either in the form of permanent income or wealth.

As a matter of theory, one of the normal income hypotheses viz., either PIH or LCH is accepted as the proper application of the theory of consumer behaviour in developed countries. Hall (1978) argues in favour of LCH whereas Davidson et al. (1978) in one of their influential studies of UK consumption behaviour specify a PIH type relationship. It should be noted, however, that it is not easy to distinguish among these competing hypothesis empirically. All of them ie., RIH, PIH, LCH, Wealth Hypothesis (to be discussed below) and the "Habit Persistence Model of Brown (1952) lead to an estimating equation in which current consumption depends on current income and lagged consumption. This is the well known problem of observational equivalence in empirical work which we do not discuss here.

Under the LCH it is hypothesized that households plan their lifetime consumption pattern so as to maximise their total lifetime utility subject to their lifetime budget constraint. The future income stream and the life time (ie. death) of the consumer is assumed to be known with certainty. The possibility of a complete substitution between the present and the future consumption also implies the existence of a perfect capital market. In this framework the private sector real consumption expenditure is specified to be a function of real income and real wealth. Empirically, the model is estimated either as backward looking or as forward looking.

Hall (1978) has shown that in a forward looking optimisation framework, consumer expenditure is fully explained by measured income and lagged consumption. His main argument is that a distributed lag of income cannot and should not explain the current consumption as their effects are already taken into account by the rational consumers in their last period consumption.

However, people like Spiro (1962), Ball and Drake (1964), Clower and Johnson (1968) have developed the "Wealth Hypothesis" from a slightly different angle. They regard permanent income hypothesis as not addressing the issue of uncertainty. For example, in the life-cycle hypothesis households do not know with certainty the profile of their future income stream and the time of their death. Therefore, the argument is that consumers are short-sighted in the face of uncertainty and the principal motive for accumulating assets is not related to some lifetime plan as suggested by life-cycle hypothesis rather in terms of a broad "precautionary motive". Consumers safeguard against future uncertainty by accumulating assets. Thus, in this formulation, the future is allowed in the model without imposing on the consumer the rigourous intertemporal utility maximization as required by the life-cycle hypothesis.

It should be noted, however, that attempts have been made to extend the life-cycle hypothesis to encompass uncertainty (Merton, 1969; Dreze and Modigliani, 1972; Hall, 1978).

Empirical studies on private consumption expenditure in developing countries can be found, among others, in Rossi (1988), Lahiri (1989), Haque et al. (1990), Hurn and Muscatelli (1989). All of them follow a normal income approach but they differ in terms of backward and forward looking frameworks. Rossi models a forward looking behaviour whereas others resort to the backward looking. It seems to be in agreement that consumers in developing countries are liquidity constrained, therefore, a forward looking optimisation exercise is questionable in modelling the consumption behaviour.

In modelling private sector real consumption expenditure we follow broadly a life-cycle approach but backward looking. There are a number of factors which persuaded us to follow this approach.

Firstly, as already argued consumers are liquidity constrained (Rossi, 1988). This reduces the consumers' ability to substitute consumption temporarily and hence conduct the inter-temporal utility maximisation attributed under the forward looking framework. This liquidity constraint is attributed to a number of factors including capital market imperfections (Hayashi, 1985). Secondly, it has been shown that estimation methods are not very robust with forward looking variables (Muscatelli, 1988). This problem becomes even worse in our case where we have a small sample and data are aggregated across countries. Thirdly, our main purpose is to utilise this model for policy simulations. We run into software problem with the forward looking variables.

Theoretically, we specify the private sector real final consumption expenditure to be a function of real income (y), real stock of wealth (w), terms of trade (tmt), and domestic inflation (Dpc). This specification is similar to Hurn and Muscatelli (1989)[1]. The loglinear stochastic form of the equation can be expressed as:

$$\log c_t = \log \alpha_0 + \alpha_1 \log y_t + \alpha_2 \log w_t + \alpha_3 \log tmt_t + \alpha_4 \log Dpc_t + u_t \quad (2.7)$$

In this formulation αs directly give elasticities. We expect α_1, α_2 and α_3 to be positive as we hypothesize that consumption positively depends on real income, stock of wealth and the terms of trade. As the nominal income is deflated by the GDP deflator it does not take into account any income effects associated with the terms of trade. Therefore, we have included terms of trade as a separate argument.

The empirical results on the effect of inflation on private consumption expenditure is far from resolved. Deaton (1978) and Juster and Watchell (1972) found a negative relationship whereas Branson and Klevorick (1969) the opposite. However, *apriori*, we hypothesize domestic inflation to reduce the level of consumption, therefore, we expect $\alpha_4<0$.

The relationship as specified in (2.7) is a long-run one. A dynamic relationship is estimated which will be discussed at the estimation stage.

2.2.2 Investment Function

Unlike consumption function, the economics of investment had been widely discussed and analysed before the time of the General Theory and a thorough pre-Keynesian treatment can be found in Fisher (1907, 1930), Hawtrey (1913) and Clark (1917). In the discussion that follows we very briefly set out the main theories of investment and specify an appropriate one, for our purpose, taking into account the economic setting of the developing countries.

The earlier models of the investment function took the form of an accelerator principle which relates net investment (I^n) in fixed capital to changes in output. The simplest or naive form of the accelerator principle posits a certain fixed relationship between capital stock and output. Stated symbolically, $Kt/Yt = \alpha_6$. This gives $Kt = \alpha_6 Yt$ and $I^n = \alpha_6 \delta Y$; where K, Y and δ are the stock of capital, the level of output and a symbol for change, respectively.

Thus, the accelerator, when transferred from stock to flow terms, states that net investment is proportional to changes in output. Two points are worth noting. First, a static relationship implies an instantaneous adjustment of capital stock to its desired level. Second, if output were to remain constant at a high level, then net investment would immediately become zero.

However, its static nature and poor empirical performance (Kuznets 1935, 1961) led economists like Koyck (1954) and Chenery (1952) to modify it allowing dynamism. Such models generally take the form of a linear relationship between current net investment, and current and past changes in output which can be shown as:

$$I^n \equiv K_t - K_{t-1} = \Sigma^n{}_{i=0}\ a_i(\delta Y)_{-i} \qquad (2.8)$$

where a_i are a set of distributed lag coefficients which are expected to assume positive values and other variables are as defined above. Alternatively, either specifying net investment as the stock adjustment process between the desired and the actual capital stock as suggested by Goodwin (1951) and Chenery (1952) or applying the Koyck transformation on the desired capital stock as a function of distributed lag on output (Koyck, 1954); (2.8) can be expressed in an equivalent way as:

$$I^n = b_1 + b_2 y_t + b_3 K_{t-1} \qquad (2.8.a)$$

where b_1, is a constant and b_2 and b_3 are the accelerator and capital stock effects on investment. We expect $b_2 > 0$ and $b_3 < 0$. Thus, net investment is a positive function of the level of output and a negative function of existing capital stock.

Though formulations such as (2.8) and (2.8.a) have been criticised for their reliance on static expectations, nevertheless, they have remained popular primarily because they fit data well. Eisner and Strotz (1963) have provided theoretical support in an optimising framework.

However, it is not uncommon to come across an accelerator investment equation augmented by cash-flow terms. Basically two arguments are put forward for this. Firstly, changes in profits convey some new information about the future profitability of a firm, possibly increasing expected future output and boosting the optimal future path of the capital stock[2]. Secondly, it is argued that internal funds could be less costly than external finance as the market for borrowed funds is not perfect[3]. Therefore, it is argued that the availability of a larger amount of internal fund, by reducing the financing cost, increases investment demand.

The empirical specification of cash-flow (CF) augmented accelerator theory of investment is identical to 2.8 above, except that an additional distributed lag on the level of cash flow is included as an explanatory variable. Thus,

$$I^{n} \equiv K_t - K_{t-1} = \Sigma^n{}_{i=0} d_i (\delta Y)_{-i} + \Sigma^n{}_{j=0} h_j CF_{-j} \qquad (2.9)$$

Again allowing for a partial adjustment between the desired and the actual capital stock would require the insertion of lagged capital stock in the right hand side of (2.9).

Accelerator theory in general fails to address the role of the cost of capital which most economists consider crucial in the determination of investment. Jorgenson and Hall[4] have remedied this deficiency by developing the neoclassical theory of investment where the optimal combination of factor inputs is a function of their relative prices. This theory suggests that net investment is positively related to the expected output level and negatively related to the relative price of capital - that is the user cost of capital relative to the wage rate. Assuming a Cobb-Douglas production function and profit maximisation under competitive condition, the equilibrium demand for capital under neoclassical formulation can be expressed as:

$$K^d = \mu(pY^e/c) \qquad (2.10)$$

where,

K^d = desired capital stock

μ = share of capital in output
Y^e = expected level of output
p = price of output
c= user cost of capital

The user cost of capital, c, is the cost of using one unit of capital goods for one year. It's computation involves inclusion of interest costs, depreciation, various tax parameters, and inflation[5]. Assuming for the moment static expectations of future output changes and a partial adjustment of actual to desired capital stock, the dynamic formulation of Jorgenson's neoclassical net investment model becomes:

$$I^n = \Sigma^n{}_{i=0}\ \Phi_i \delta(pY/c)_{-i} + \beta_1 K_{t-1} \qquad (2.11)$$

where $\Phi_i>0$ and $\beta_1<0$. Thus, net investment depends positively on the distributed lag of changes in output, negatively on the distributed lag of the relative cost of capital and the lagged capital stock. In essence, both the accelerator and the neoclassical models are output based ones (Clark, 1979).

In contrast to output based models discussed above, there is a security-value model which attempts to explain investment on a financial basis in terms of portfolio balance. This is known as the "Q" model which is associated with Tobin[6]. The key point is the relationship between the market value of equity and the replacement cost of the outstanding capital stock. "Q" is nothing but the ratio of the market value of equity to the replacement cost of existing capital stock. It relates investment to this ratio. The argument is if the market value of a firm exceeds the replacement cost of its assets, then it can increase its market value by investing in more fixed capital and vice versa. A general dynamic specification of "Q" model takes following form:

$$I^n = \Sigma^n_{i=0}\tau_i Q_{-i}. \qquad (2.12)$$

where $I^n > 0$ iff $Q>1$ and $I^n = 0$ iff $Q=1$.

However, the "Q" model should be viewed as a supplement rather than a direct substitute for the earlier models as in this model also both investment and "Q" would rise with favourable expectation about future output (profitability) and prices.

Investment theories reviewed above, though popular[7] in modelling investment behaviour in developed economies, warrant significant modifications when one tries to estimate an empirical investment function for developing countries. This is due to a number of factors. Firstly, factors such as: the absence of well functioning financial markets, the relatively large role of government in the capital formation, distortions created by foreign exchange constraints and other market imperfections make a direct application of the standard theories of investment rather unrealistic.

Secondly, even if an attempt is made to adopt these standard models directly, severe data constraints on variables such as interest rates, capital stock etc. make it difficult. Furthermore, the observed interest rates in these countries are subject to official controls and often do not reflect the scarcity of capital, thereby making the application of the concept of the user cost of capital rather unrealistic.

Given these theoretical considerations and practical problems we specify a modified version of the neoclassical model for our empirical work. We hypothesize that net investment in our region depends on the level of output, the stock of capital, the cost of capital, and the flow of total bank credits[8].

The importance of bank credit in determining the level of investment can be argued for on several grounds. Firstly, bank credit affects the level of investment through the availability of investible funds. Newly emerging business firms in developing countries require a substantial amount of resources from financial system as they are inhibited in raising resources through equities and bonds due to the undeveloped state of domestic money and capital markets.

Secondly, unlike the well-established firms in developed countries one can not expect retained profits to be a good enough source of investible funds for firms or business houses in LDCs.

Thirdly, a clear consensus has emerged in recent years suggesting that, in contrast to developed countries, one of the principal constraints of investment in developing countries is the availability, rather than the cost, of financial resources. It is argued that money and capital are compliments in developing countries, rather than substitute as they are in developed countries, therefore, if real returns on holding money increases so will the level of investment over a significant range of investment opportunities (McKinnon, 1973 p.60). Similarly, the debt intermediation view of Shaw (1973) and the subsequent models of Kapur (1976), Mathison (1980), and Galbis (1977) also lend theoretical and empirical support to our hypothesis that bank financing of investment in developing countries is important.

Given these theoretical arguments, we now specify our loglinear stochastic investment equation as:

$$\log I^n_t = \log \alpha_8 + \alpha_9 \log y_t + \alpha_{10} r_t + \alpha_{11} \log \delta adv_t + \alpha_{12} \log k_{t-1} + u_t \qquad (2.13)$$

where I^n is net fixed investment defined as the first difference of the net fixed capital stock. As we do not have separate data on private capital formation and government capital formation, we estimate the total net fixed investment function. 'y' is the level of output proxied by real GDP. 'r' is the user cost of capital. δadv is the flow of total bank credit. α_{10} gives the semielasticity and the rest of the parameters give elasticities. Net investment is hypothesized to depend positively on output and the flow of bank advances and negatively on the user cost of capital and the available capital stock. Therefore, the expected signs of the partial derivatives are:

$\alpha_9>0$, $\alpha_{10}<0$, $\alpha_{11}>0$ and $\alpha_{12}<0$.

As noted above equation (2.13) postulates a long-run relationship. The estimation specifies a dynamic relationship.

The discussion so far has focused on the net investment and has ignored the replacement investment. We assume replacement investment to be a constant proportion of the beginning period capital stock and derive the gross fixed investment as[9]:

$$I^g = I^n + \alpha_{13} k_{t-1} \qquad (2.14)$$

where I^g is gross fixed investment (excluding inventories) and α_{13} is a constant rate of replacement investment. Finally, we derive the total gross investment including inventories (I^t) using a link equation which specifies a unit elastic relationship with respect to gross fixed investment, ie.,

$$\log I^t = \log \alpha_{14} + \log I^g. \qquad (2.15)$$

2.2.3 Export Volume Equation

Exports from developing countries are generally believed to be sensitive to changes in the level of income in developed countries. However, following the theory of demand, most empirical studies of international trade flows specify the volume of export demand as a positive function of foreign income or some measure of foreign demand and a negative function of relative price of exports. We follow the same standard approach in modelling our export volume. The loglinear stochastic export volume equation is:

$$\log x_t = \log \alpha_{15} + \alpha_{16}\log y_t^* + \alpha_{17}\log (px/px^*)_t + u_t \quad (2.16)$$

where x, y^* , px, and px^* are exports of goods in real terms, foreign income in real terms or some measure of scale variable, the price of exports, and foreign prices (ie., competitors prices in export markets), respectively. α_{15} is the intercept and α_{16} and α_{17} are the income and relative price elasticities of exports, respectively. We expect $\alpha_{16}>0$ and $\alpha_{17}<0$. u_t is a stochastic term, assumed to be white noise. Thus, the demand for exports depends positively on foreign income (or demand) and negatively on relative price of exports.

As already noted (2.16) represents the most widely used and tested relationship in both the developed and developing economies and can be found in, among others, Houthakker and Magee (1969), Khan (1974), Goldstein and Khan (1978), Taplin (1973), Bond (1985), Riedel (1988), Marquez (1990), Moran (1990), Muscatelli (1990), and Muscatelli et al. (1991, 1991b).

The specification of the right-hand side variables needs some explanation. The choice of scale variable (y^*) varies between studies, some authors (Goldstein and Khan, 1978; Aspe and Giavazzi, 1982; Riedel, 1988) use trade weighted world income as scale variable whereas others (Muscatelli et al., 1991, 1991b) use trade-weighted imports of export market as scale variable. Houthakker and Magee (1969) use an export-weighted GNP index of importing countries. Khan (1974) uses OECD real gross national product.

Muscatelli et al., Funke and Holly (1990), and Landesmann and Snell (1990) point out that since world trade has grown twice as fast as world income over recent years, the choice of world income instead of world imports will bias the estimate of elasticity of demand. It is also noted by Winters (1984) that the validity of using trade weighted imports rather than income depends on the assumption of separability. That is, consumers first determine the level of total expenditure on imports and subsequently determine how much to import from different foreign sources. For our purpose, we use the trade-weighted imports of our export markets as the scale variable.

The specification of relative price, as above, assumes price homogeneity to hold ie., ceteris paribus, an equi-proportionate rise in px and px^* leaves export demand unchanged. This homogeneity assumption follows naturally from the assumption that economic agents are rational and optimising (Moran, 1990).

We also assume lack of money illusion; that is doubling of all prices and money income will leave the quantity demanded unchanged. In what follows we specify export price (px) to be endogenously determined, however, we treat competitors' prices (px^*) as exogenous. This implies that our supply situation does not affect the world prices ie., a small country assumption.

The stylized findings of these studies have been that some LDCs' exports of manufacturing exhibit a high income elasticity and a low price elasticity. Though the total exports of LDCs region shows a lesser degree of sensitivity compared to manufactured exports, even then, the income elasticity is higher than the price elasticity.

The general conclusion derived from this is that LDCs can, if any thing, achieve very little by price manipulation. This led to the idea of export as an "engine of growth" and the fuel of the engine being the growth of demand coming from the richer north countries (Lewis, 1980).

However, Riedel (1984) provides empirical evidence that refutes the Lewis view that the relationship between prosperity in the north and export growth in the south is stable. Karvis (1970) criticises "engine of growth" view and concludes that trade expansion is a handmaiden of successful growth rather than an autonomous engine of growth.

The widely held low price elasticity view has also recently been challenged by Riedel (1988) and Athukorala and Riedel (1990). Their finding is that Hong Kong and South Korea face infinitely price elastic demand for their exports, thus, supply side factors determine export growth. However, a thorough assessment of Riedel's findings and the econometric problems associated with it can be found in Muscatelli et al. (1991a) who do not support the infinite price elasticity as suggested by Riedel but report a high price elasiticity of exports.

However, Muscatelli and Riedel analyse the case of so-called Newly Industrialising Economies (NIEs). Our sample constitutes less developed countries (LDCs) which are fundamentally different from these NIEs. Khan (1974) estimates income and price elasticities for 15 LDCs, and in most of the cases (14 out of 15) income elasticity is less than unity. Price elasticities are very low, too. These results are very different from those of the Muscatelli et al. (1991a) and Riedel (1988).

It should be noted, however, that with exception of Muscatelli et al. (1991b) the literature cited above are all based on individual country studies. We are modelling regional exports. Though the underlying theory remains the same, the magnitude of the effect of policy variables can be different compared to the individual country cases. For example, if a region devalues then it might show a different magnitude of impact than an individual country devaluation. Similarly, for a group of countries the income elasticity of demand for its exports might be different from that of a single country.

However, there is no lack of studies treating a number of countries as a group. We provide a summary of the findings of multi-country studies in table 2.1.

Table: 2.1

Income and Price Elasticities in International Trade: Some Multi-country Studies.

	Country Aggregation				Elasticity	
Author	Exporter	Importer	Data	Commodity	Income	Price
Bond (1985)	Non-OPEC LDC	Industrial	Annual 1967-81	All Goods	2.4	-0.8, -0.1
Goldstein Khan (1982)	Non-OPEC LDCs	Industrial	Annual 1963-81	Non-oil	1.3	0
Cline(1984)	World	Industrial	Annual 1961-81	Non-oil	3.1	0
Dornbusch (1985)	Non-OPEC LDCs	OECD	Annual 1960-83	Non-Oil	3.19	-0.5
Riedel (1984)	Non-OPEC LDCs	Industrial	Annual 1960-78	Non-fuel	1.27	0
Marquez McNeilly (1988)	Non-Oil	Industrial	Annual 1974-1984	Non-Oil	0.17 2.15	- -3.13
Masson et al. (1990)	LDCs	Industrial	Annual 1965-87	All Goods	0.46 1.14	-0.25 -0.74

The table shows that income and price elasticities are far from being uniform. This diversity is attributable to factors like: estimation method, dynamic formulation, data aggregation and the choice of exporting and importing countries. However, all studies echo the message that price elasticities are smaller compared to income elasticities. Note that Marquez and McNelly's price elasticity of -3.13 is for manufactured goods only.

The most important issue for us, at this stage, is the specification of the export function for LDCs. All the studies reviewed so far make use of the conventional wisdom of demand modelling as laid down in equation (2.16) above.

The relationship postulated in equation (2.16) above is a long-run one and static in nature. We estimate a dynamic relationship which is dealt in the estimation stage.

Equation (2.16) specifies the relationship for exports of goods. Exports of goods and non-factor services (xgn) is derived using a link equation of the form:

$$\log xgn = \log \alpha_{18} + \log x \qquad (2.17)$$

Equation (2.17) postulates a unit elastic relationship between the exports of goods and the exports of goods and non-factor services.

2.2.4 Export Price Equation

The standard approach in modelling export prices has been to specify an export supply function based on optimisation principles and normalisation in terms of export prices. Almost all references cited above follow this line. A typical loglinear export supply function in this framework (Dinenis and Holly, 1990) can be shown as:

$$\log x_t^s = \log \alpha_{19} + \alpha_{20} \log (p^x/p^d)_t$$
$$+ \alpha_{21} \log cu_t + \alpha_{22} \log(c/p^d)_t + u_t \qquad (2.18)$$

where p^x is the price of exports, p^d is the price of goods sold in domestic market which captures the substitution between foreign and domestic markets, cu_t is an index of productive capacity and c_t is some composite index of variable costs ie., raw material and labour cost etc. Thus, the volume of export supply is positively related with its price relative to the price of goods sold in the domestic markets (p^x/p^d), and the productive capacity; inversely related to its cost of production relative to the home prices (c/p^d). Therefore, the expected signs of the parameters are: $\alpha_{20} > 0$, $\alpha_{21} > 0$, and $\alpha_{22} < 0$. Equation (2.18) can readily be normalised in terms of p^x and an export price relationship can be specified and estimated.

However, this is not the only way to model export prices. For example, MULTIMOD derives export prices for LDCs as a linear combination of the rates of change of domestic prices and a weighted average of foreign export and output prices imposing a long-run unit elasticity of export prices with respect to domestic cost. It should also be noted that in most global models the export prices of developing countries are usually determined as a weighted average of commodity prices determined in world commodity markets and the prices of manufactured goods in the OECD countries.

Our specification of the export price equation is based on the assumptions that export prices are determined by the domestic costs of production and the capacity to produce exportables at home ie., some measure of capacity utilisation. Data limitations preclude us from a direct application of (2.18). We do not have separate measures of c and p^d; what we have is only the domestic absorption deflator (ph) which we use as a proxy for both. Our stochastic export price equation in log-linear form is expressed as:

$$\log p^x{}_t = \log \alpha_{23} + \alpha_{24} \log ph_t + \log \alpha_{25}\, cu_t + u_t \quad (2.19)$$

where p^x represents the export price of goods and ph is the home cost of production (both in common currency units). We hypothesize that export prices are governed by the domestic cost of production, therefore, the expected sign of α_{24} is positive and preferably unit elastic in the long run (though we do not impose this; the data accepts unit elasticity; see chapter 5). In the estimation stage ph is proxied by consumer expenditure deflator, due to the lack of data on appropriate variable ie., the production cost index of exportables only. The expected sign of α_{25} is negative as the higher capacity leads to higher level of supply and depresses prices.

Equation (2.19) postulates a long-run relationship, however, a dynamic formulation is specified at the estimation stage. It also specifies a functional relationship for the export prices of goods only, therefore, the export prices of goods and non-factor services (pxgn) is derived by using a link equation of the form:

$$\log pxgn_t = \log \alpha_{26} + \log px_t \qquad (2.20)$$

Equation (2.20) shows a unit elastic relationship of pxgn with respect to px.

2.2.5 Import Volume Equation

We specify our import demand function following the standard approach for modelling total imports in the literature of international trade. In this formulation, the volume of imports depends positively on the real income of an importing country and negatively on the relative price of imports (ie., a ratio of import price to price of domestically produced import competing goods) or the real exchange rate. Following this approach the standard import function can be expressed as:

$$m = f(y, pm/ph) \qquad (2.21)$$

where m, y, pm and ph are total imports in real terms, real income, import prices and the prices of import competing home goods. The expected sign of partials are $f1>0$ and $f2<0$.

It is not difficult to see the theoretical underpinnings for such a formulation. The theory of demand states that consumers allocate their income among consumable commodities with a view to maximising their utility subject to a budget constraint. In this optimising framework the demand for imports depends on income, the price of imports, and the price of import competing goods (Leamer and Stern, 1970)

One of the underlying assumptions of the standard approach is that imports are imperfect substitutes for domestic goods which gives rise to a finite price elasticity of demand. Furthermore, price homogeneity and lack of money illusion are commonplace assumptions which we retain.

A function such as (2.21) is the most stylized specification and can be found in, among others, Chenery and Strout (1966), Khan (1974), Houthakker and Magee (1969), Goldstein and Khan (1978), Magee (1975), Marquez and Mcneilly (1988), Khan and Knight (1988), and Marquez (1990).

However, in our specification, we modify the standard approach by including a lagged reserve term as an additional explanatory variable to capture the effect of import rationing in LDCs. No one denies that trade flows and particularly the imports are regulated in one way or other. They are more so in LDCs mainly due to the lack of foreign exchange. Therefore, any serious attempt to model imports in LDCs must take account of this fact. Our assumption in using the lagged reserve position is that authorities vary restrictions inversely with the country's capacity to import which is measured by the level of reserves.

There is considerable evidence which supports the view that the import capacity of many developing countries is constrained by the stock of real international reserves (Hemphill, 1974; Zaidi, 1984). However, studies differ in their use of proxy variables for import rationing. For example, Dutta (1964), Khan and Knight (1988), Islam (1961), and Turnovesky (1968) use measures like the level of international reserves, of export receipts, or overseas assets in their import equations.

A time trend is also included in empirical estimation to capture the effects of import substitution policies ie., to capture the secular decline in import to income ratio. Thus, on the basis of theoretical arguments above, our log linear stochastic import equation can be expressed as:

$$\log m_t = \log \alpha_{27} + \alpha_{28} \log y_t + \alpha_{29} \log rex_t + \alpha_{30} \log rescp_{t-1} + \alpha_{31} T + u_t \qquad (2.22)$$

where t is time subscript, m is the total imports of goods and non-factor services in real terms, y is the real income, rex is the real exchange rate (defined as the ratio of foreign prices to domestic prices in common currency units), and rescp is the real stock of international reserves (deflated by import prices). α_{27} is the intercept of the equation and α_{28} and α_{29} are income and real exchange rate elasticities of imports, respectively. α_{30} is the measure of the elasticity of imports with respect to foreign reserves.

It is hypothesized that lagged stock of reserves rather than the contemporaneous level affects the authorities' decision on the allocation of import-quotas and import-licensing which is a commonplace in LDCs. We expect $\alpha_{28}>0$, $\alpha_{29}<0$, $\alpha_{30}>0$ and $\alpha_{31}<0$. u is the stochastic term which is assumed to be well-behaved. Thus, an increase in real income and stock of international reserves increase the level of imports, however, a depreciation of the real exchange rate does the opposite.

The specification of the sign of α_{28} needs some explanation. We note that theoretically it is not binding that it should be positive and it is quite probable that $\alpha_{28}<0$ (ie., income elasticity of imports is negative). The reason for this is that the demand for imports constitutes an excess of domestic consumption over domestic production, and variations in the latter can dominate variations in the former and hence reduce the volume of imports. This line of arguments and mathematical derivation can be found in Johnson (1967), Ikema (1969), and Magee (1975). However, in our model we do not model imports as a residual of domestic demand and supply adjustments. Furthermore, there is overwhelming empirical support in favour of a positive income elasticity of imports, therefore, we retain our hypothesis of $\alpha_{28}>0$.

We have treated foreign price of imports as being exogenously determined. This implies that our region faces an infinite supply price elasticity of imports ie., a small country assumption.

We note that the specification (2.22) represents a long-run and static relationship. A rich dynamic specification implies the application of econometric theory and practice and that is what we will do in our estimation stage. The form of dynamism and the method of estimation will be discussed at the estimation stage.

2.3 Price Determination and Aggregate Supply

The specification of consumer price and wage equations which form the supply side of the model is adopted from Chris Allen (1989). The specification of supply side in this line could be found in Allen et al. (1992), Masson et al. (1988, 1991), Argy and Salop (1979) and Gordon (1985).

The key behavioural relationships in this sector are equations for prices and wages. The model directly models the price setting behaviour of a monopolistically competitive firm which makes its pricing decisions on the basis of maximising behaviour. The level of employment is not modelled explicitly but substituted out. The supply side is derived by substituting wage and price equations.

The price setting behaviour is specified as markup over variable costs (wage and import cost) which also depends on the level of capacity utilisation. An import to income ratio is also included to capture the rationing costs ie., the shadow price of imports. Thus, in loglinear form our stochastic price equation is:

$$\log p_t = \beta_0 + \beta_1 \log (p^* * e)_t + (1-\beta_1) \log w_t + \beta_2 \log (y/k)_t - \beta_3 \log(m/y)_t + u_t \quad (2.23)$$

where p is domestic price, p^* is foreign (import) price, e is nominal exchange rate, w is nominal wage rate, k is capital stock, m is volume of imports and y is output. u is the usual error term. All variables are measured at time 't'.

We expect $0<\beta_1<1$. The domestic price rises with the rise in wages and import prices but with the restriction that wage and import price elasticities sum to unity in the long-run. A lower level of capacity utilisation [proxied by an increase in (y-k)] increases the domestic price level through supply rationing, therefore, we expect $\beta_2 >0$. An increase in import to income ratio reduces pressure in domestic prices through a reduced level of shadow prices of material inputs, therefore, we expect $\beta_3<0$. This specification of price level is a standard one whereby prices depend on import costs, wage costs and the level of capacity utilisation at home. The price level also responds to imports as a source of supply in the short-run.

The wage equation is for real wages. It is assumed that in the long-run real wages depend on productivity. In the short-run, however, it might be affected by inflationary surprises. Expressed in loglinear form our stochastic wage equation is as follows:

$$\log (w-p)_t = \log \theta_0 + \theta_1 \log y_t - \theta_2 \log \delta p_t + u_t \quad (2.24)$$

We expect $\theta_1>0$ as an increase in productivity proxied by output increases real wage. We expect $\theta_2<0$ as real wages may reduce due to the inflation. Substituting eqn. (2.24) in to eqn. (2.23) and solving for aggregate supply we get:

$$\log y_t^s = \log \Omega_0 + \Omega_1 \log rex + \Omega_2 \log k_t + \Omega_3 \log m_t + \Omega_4 \,\delta\log p_t \quad (2.25)$$

where,

$rex = (e+p^*-p)$

$$\Omega_0 = -\frac{\beta_0+\theta_0(1-\beta_1)}{\theta_1+(1-\beta_1)+\beta_2-\beta_3}; \qquad \Omega_1 = -\frac{\beta_1}{\theta_1(1-\beta_1)+\beta_2-\beta_3};$$

$$\Omega_2 = \frac{\beta_2}{\theta_1(1-\beta_1)+\beta_2-\beta_3}; \qquad \Omega_3 = \frac{\beta_3}{\theta_1(1-\beta_1)+\beta_2-\beta_3}; \text{ and}$$

$$\Omega_4 = \frac{\theta_2(1-\beta_1)}{\theta_1(1-\beta_1)+\beta_2-\beta_3}.$$

Thus, aggregate supply is a positive function of capital stock (k), imports (m), and inflation (δp), and a negative function of the real exchange rate. Ceteris paribus, real exchange rate appreciation increases aggregate supply by reducing the cost of imported factor inputs. However, the inflation term and imports are assumed to affect aggregate supply only in the short-run. Therefore, by setting 'δp' and 'm' to zero we arrive at the long-run supply function which becomes a positive function of capital stock and a negative function of the real exchange rate.

Normalising the equation (2.25) in terms of domestic prices it could easily be shown that prices depend on demand and supply factors. Fixing the imports (m) and inflation term (δp) and ignoring the intercept term the supply side equation can be rewritten as:

$$\log p_t = \log e_t + \log p_t^* + \alpha_1(\alpha_2 \log y_t - \log k_t) \qquad (2.26).$$

where;

$\alpha 1 = \Omega_2/\Omega_1$ and $\alpha_2 = 1/\Omega_2$

Equation (2.26) shows that an increases in output/capital ratio (y-k), and foreign prices increase the domestic price level. A devaluation also does the same. However, an equi-proportionate increase in both output and capital stock will not leave the price level unchanged - it will increase due to the positive income elasticity of wages ie., the labour market constraint.

2.4 Government Sector

We specify a simple government accounting framework whereby government revenue and government expenditure are derived. Nominal government receipts are derived as a constant fraction of GDP at market prices which can be expressed as:

$$GR = k_1 * (gdp * PY). \qquad (2.27)$$

where GR is government revenue, gdp is measured at constant price and PY is GDP deflator.

Total government expenditure (GE) in nominal term consists of nominal government consumption expenditure (GCCP), nominal government investment (ITG), amortisation of foreign debt (AMT), net interest payment abroad (INTR) and domestic debt servicing (INTRH). Thus, the total government expenditure can be expressed as:

$$GE = GCCP + ITG + AMT + INTR + INTRH \qquad (2.28)$$

Real government consumption expenditure (gc) is exogenously determined. Nominal government consumption expenditure is derived as:

$$GCCP = gc * PY \qquad (2.29)$$

Amortisation is assumed to be a fixed proportion of outstanding foreign debt which can be expressed as:

$$AMT = k_2 * DOD(-1) \qquad (2.30)$$

where k_2 is a constant rate of debt amortisation and DOD is stock of outstanding foreign debt which is exogenously determined in the model.

The calculation of net interest payment abroad involves three steps. Firstly, total interest obligation abroad is derived as the sum of a weighted average of the distributed lag of LIBOR on outstanding debt stock. Secondly, interest earnings from reserves invested abroad are calculated as the product of current LIBOR and the lagged reserve stock. Finally, net interest payments abroad are derived as the difference between the first and the second. Formally it can be expressed as:

$$INTR = w \Sigma^{n}{}_{i=0} LIBOR_{-i}\ DOD(-1) - LIBOR * RESCP(-1) \quad (2.31)$$

Note that w is a variable weight (see estimation in Chapter 5).

Only interest payments are considered for domestic debt. This implies that domestic debt is rolled over. The interest payment for domestic debt is calculated as follows:

$$INTRH = r * HDN(-1) \quad (2.32)$$

where r is an appropriate interest rate (ie., interest rate on government bond) which is exogenously determined; HDN is the outstanding domestic debt stock.

The government budget deficit (GBD) is given by:

$$GBD = GE - GR. \quad (2.33)$$

It is assumed that a fixed proportion of GBD is financed by borrowing from the Central Bank (NCLG). This issue will be discussed at length in chapter 3. This completes the specification of government accounts.

2.5 Balance of Payments at Current Prices

The balance of payments expressed in terms of changes in reserves is derived as:

$$\delta RESCP = CBV + \delta DOD - AMT + OLTF + OCF \qquad (2.34)$$

where CBV denotes current account balance, δDOD is new foreign borrowing, AMT is amortization of foreign debt, OLTF is the net long-term capital inflows, and OCF is the net other capital inflows.

The current account balance (CBV) is derived as:

$$CBV = XGNV - MGNV - INTR + OFS + CT \qquad (2.35)$$

where XGNV is total exports of goods and non factor services (nfs) at current prices, MGNV is total imports of goods and nfs at current prices, INTR is the net interest payments abroad, OFS is net non-interest factor service receipts, and CT is net current transfer from rest of the world.

XGNV and MGNV are derived as follows:

$$XGNV = xgn * pxgn \tag{2.36}$$

$$MGNV = mgn * pmgn \tag{2.37}$$

2.6 Summary and Concluding Remarks

In this chapter we have set out the general accounting frameworks for our macromodel. We also specified the behavioural relationships determining aggregate demand and supply sides of the economy. Government accounts and the balance of payments accounts are also specified.

In some cases data constraint has limited the robustness of our behavioural relationships. This is more so in the government accounting relationships. A tax function could not be specified due to the shortage of sensible data points. Instead, a total (nominal) revenue function is specified as a constant proportion of nominal GDP. In the model, real government consumption, nominal exchange rate and capital flows are treated exogenously.

In specifying these behavioural relationships our approach has been to give a brief theoretical description, and modify the model, where appropriate, for our purpose. In this concluding section we provide only those behavioural equations and identities which are directly related to our model. We have flushed all the expository relationships. This is done for the ease of future reference. In presenting the model equations below, each coefficient is appropriately signed so that one could directly infer the direction of the effect of each explanatory variable on the associated dependent variable. Also note that we have re-numbered the equations for simplicity.

(1) $y_t = c_t + i_t + g_t + x_t - m_t$

(2) $\log c_t = \log \alpha_0 + \alpha_1 \log y_t + \alpha_2 \log w_t$
$+ \alpha_3 \log tmt_t - \alpha_4 \log Dpc_t + u_t.$

(3) $\log I^n_t = \log \alpha_8 + \alpha_9 \log y_t - \alpha_{10} r_t$
$+ \alpha_{11} \log \delta adv_t - \alpha_{12} \log k_{t-1} + u_t$

(4) $I^g = In + \alpha_{13} k_{t-1}$

(5) $\log I^t = \log \alpha_{14} + \log I^g$

(6) $\log x_t = \log \alpha_{15} + \alpha_{16} \log y^* - \alpha_{17} \log (px/px^*)_t + u_t$

(7) $\log xgn = \alpha_{18} + \log x$

(8) $\log p^x_t = \log \alpha_{23} + \alpha_{24} \log ph_t - \log \alpha_{25} cu_t + u_t$

(9) $\log pxgn_t = \log \alpha_{26} + \log px_t$

(10) $\log m_t = \log \alpha_{27} + \alpha_{28} \log y_t - \alpha_{29} \log (e*p^*/p)_t$
$+ \alpha_{30} \log rescp_{t-1} - \alpha_{31} T + u_t.$

(11) $\log p_t = \beta_0 + \beta_1 \log (p^* * e)_t + (1-\beta_1) \log w_t$
$+ \beta_2 \log (y/k)_t - \beta_3 \log (m/y)_t + u_t$

(12) $\log (w/p)_t = \log \theta_0 + \theta_1 \log y_t + \theta_2 \log \delta p_t + u_t$

(13) $\log y^s = \log \Omega_0 - \Omega_1 \log (e*p^*/p)_t + \Omega_2 \log k_t$
$+ \Omega_3 \log m_t + \Omega_4 \log \delta p_t$

(14) $\log p_t = \log e_t + \log p_t^* + \alpha_1(\alpha_2 \log y_t - \log k_t)$

(15) $GR = k_1*(gdp * PY).$

(16) $GE = GCCP + ITG + AMT + INTR + INTRH$

(17) $GCCP = gc * PY$

(18) $AMT = k_2 * DOD(-1)$

(19) $INTR = w \Sigma^n{}_{i=0} LIBOR_{-i}DOD(-1) - LIBOR*RESCP(-1)$

(20) $INTRH = r * HDN(-1)$

(21) $GBD = GR - GE$.

(22) $\delta RESCP = CBV + \delta DOD - AMT + OLTF + OCF$

(23) $CBV = XGNV - MGNV -INTR + OFS + CT$.

(24) $XGNV = xgn * pxgn$

(25) $MGNV = mgn * pmgn$

With the exception of equations (13) and (14), which are redundant, we have 23 relationships in all. Of which, seven are what we call the serious behavioural equations. They are consumption, investment, exports, export price, imports, wage and domestic price equations. The rest are four link equations, four proportional relationships and eight accounting identities and definitions.

NOTES

1/ In the empirical estimation of the private consumption function the real interest rate is often included as an argument with a negative expected coefficient. In our case, however, the real deposit rate coefficient turned out to be insignificant with a perverse (ie. positive sign), therefore, we dropped it. Hurn and Muscatelli (1989) do not mention about the possible interest rate effect.

2/ For discussion along this line see Klein, (1950). However, we note that empirical investigation by Yehuda Grunfeld (1960) supports a version of "Q" theory rather than that of Klein's.

3/ Duesenberry has been a proponent of this view (Duesenberry, 1958). However, for a rigourous empirical testing in support of this proposition see Fazzari et al., 1988.

4/ See, for example, Hall and Jorgenson (1971)

5/ For their depreciation formula see Hall and Jorgenson (1971).

6/ see Tobin J. 1968 and 1982.

7/ The most popular of these is the neoclassical model associated with Jorgenson (1967) and Hall and Jorgenson (1971).

8/ We note that foreign loans also feature in the investment function of LDCs. On the role of foreign capital in domestic investment see Tun Wai and Wong (1982). They raise the theoretical possibility of an ambiguous sign of foreign capital on domestic private investment, however, they expect it to be positive and so does their empirical finding. However, in our empirical estimation it turned out to be insignificant, therefore, excluded.

9/ It has been argued that replacement investment may not be a constant proportion of capital stock, see for example, Feldstein and Foot (1971). However, we retain the assumption of proportional relationship: (1) for simplicity and (2) following the argument of Clark (1979) that a proportional representation of replacement investment may still be reasonable if a higher capital stock implies higher replacement investment.

CHAPTER 3

THE FINANCIAL SECTOR

Introduction

In this chapter we specify the model for the financial sector. As will be clear from the discussion that follows our specification differs significantly from the stylized models of the financial sector in developed countries. This is due to the profound differences between the financial structures of developed and developing countries which have received wide attention in the literature.

Our model specification is geared to capture the monetary and financial characteristics of developing economies. In the model, the market for government securities does not exist as the volume of securities traded is insignificant. Interest rates are exogenously determined as authorities fix a range of interest rates including deposit and lending rates. The Central Bank discount rate does not affect general interest rates as a range of interest rates in LDCs are administered separately by the authorities. However, it affects the reserve position of the commercial banks as the borrowing cost of reserves goes up.

The high powered money is endogenously determined through the interaction of the balance of payments and the fiscal stance of the government. The Central Bank lending to government is dominated by the borrowing requirement of the government and the former adjusts passively to the latter. The stock of money is defined broadly and determined endogenously within the flow of funds framework.

Deposit banks are assumed to face a horizontal credit demand curve as their lending rate is below the curb market rate. Deposit bank reserves are derived as the difference between the stock of base money and the stock of currency at the hand of the non-bank private sector.

These are some of the characteristics of our financial sector model. This chapter is organised as follows: the first section provides a summary overview of the monetary and financial sectors of LDCs. In the sections that follow we set out the model. The chapter is closed with brief concluding remark.

3.1 Financial Sector in LDCs an Overview:

Monetary and fiscal policies are accorded prominent roles in the pursuit of macroeconomic stabilisation in both the developed and developing countries. A successful operation of monetary policy requires a developed state of financial institutions, markets and instruments. This infrastructure does exist in developed countries whereas it is lacking in the developing countries (LDCs).

In countries with a developed financial markets, a broad consensus does appear in the transmission mechanism of monetary policy (Tobin, 1978; Laidler 1978; Blanchard, 1980; Monteil; 1991). It is postulated that monetary effects are transmitted to the real sector through the portfolio reactions of asset holders. Following a monetary shock, asset holders change the relative demand for financial assets which, in turn, affects the rate of return on both the financial and the real assets and hence aggregate demand.

In brief, an open market purchase by the Central Bank leaves the private sector with excess money in its portfolio relative to other assets. In re-establishing portfolio equilibrium, agents increase the demand for other financial assets. This pushes up the market price of all assets and depresses their rate of return. The consequence is that the market prices of durable goods such as physical capital etc. exceed their replacement costs; as a result, private agents attempt to increase their stock of such assets by increasing their demand for newly produced units. In this way, open market purchase results in an increase in aggregate demand.

However, this cost of capital effect of monetary policy in affecting the aggregate demand is less persuasive in the context of developing countries given the rudimentary structure of their financial markets. The menu of financial assets available to private sector is limited in developing countries. Organised security markets are either very small or nonexistent which precludes the Central Bank from operating its open market operations. More than 80.0 percent of government securities are held by the banking system and particularly the Central Bank. Though private security markets exist, again because of their narrowness, these markets hardly perform any significant role in saving mobilisation and their allocation to investment.

Physical assets such as land, buildings and precious metals are directly held by savers as inflation hedges and safe investment which need lumpier investment and are less responsive to changes in monetary policy instruments. The only (main) financial assets widely held by the private sector are currency (notes and coins), bank deposits and bank credits (which forms the liability of private sector).

Interest rates are controlled by authorities and do not reflect the market price of respective financial assets. The structure of interest rates in the organised sector is highly diversified reflecting various tax privileges and concessionary rates to particular sectors of the economy. Moreover, ceilings on interest rates and credit volumes are commonplace. The former, on the one hand, works as a form of financial tax to the net creditor to the banking system and on the other, as a subsidy to the net borrower (Montiel 1991; Agenor et al., 1991). Not surprisingly, changes in the rates in the organised market hardly reflect money market conditions. Credit ceilings and the suppressed interest rates produce a fringe of unsatisfied borrowers and lenders which form the basis of the existence of the "curb" market.

The parallel existence of "curb" markets exacerbate the financial disintermediation in the modern sector of the economy. A significant proportion of borrowing and lending takes place in unorganised markets where the respective rates of return (interest rates) are market determined and normally tend to be higher than the officially repressed rates. These markets are largely outside the bounds of monetary authorities posing a serious problem to the effectiveness of monetary instruments. However, this does refute the fact that these markets tend to be affected by the conditions in the formal sector.

The control on capital movement and foreign exchange transaction is another facet of financial repression in developing countries. The private sector is prohibited from holding foreign exchange which precludes it from holding foreign assets in its portfolio. Authorities determine the amount of foreign currency sales in the official market, using a rationing rule on the quantum and composition of private consumption imports, after provisions have been made for imports of intermediate goods and government imports. Though, all imports are regulated through an import licensing system, the obvious candidate for rationing, in terms of the availability of foreign exchange, is imports of consumables. Therefore, there always exists an unsatisfied demand for foreign exchange in this market.

This gives rise to a parallel market for foreign exchanges known as "black market" where the exchange rate is market determined and normally tends to be higher compared to that of official rates, though, the former also depends on the condition in official market. Thus, essentially the exchange rate system, in these economies, consists of an official market which coexists with an illegal parallel market for foreign exchange.

The difference between the official and unofficial foreign exchange rates gives rise to a rate of premium to the transactors in the unofficial sector; who depending on these premiums enter into activities like over-invoicing of imports and under-invoicing of exports. These premiums coupled with tariffs and exchange control give rise to activities like trade deflections and smuggling of exports and imports.

The coexistence of organised and unorganised financial markets in developing countries are typical feature of financial "dualism". Given this dualism and the poor structure of the organised sector, the monetary transmission mechanism specified above in the context of developed economies may not be a proper one to track the path of monetary impulses on the real sector in developing countries.

However, a simple financial structure does not mean that monetary policy is ineffective. What differs is the transmission mechanism of monetary policy instruments and the process of asset stocks determination. It is argued that monetary effects are more direct in LDCs than in developed economies as the impact of a change in the quantity of money will not be mingled and defused among various money substitutes but will be transmitted direct to the market for real assets (Rhomberg, 1965; Park, 1973). This follows from the fact that in the absence of a variety of financial assets the only alternative of holding money as a form of wealth would be real assets.

In this context, a typical financial structure for developing countries would be one in which wealth holders can hold domestic currency, bank deposits, foreign currency available through parallel market, bank and curb market loans, land and other forms of physical assets in which savings are held. The menu of assets can be financed by wealth holders' net worth and borrowing from banks and curb markets.

In this framework, the use of open market operations by the Central Bank would be extremely limited due mainly to the lack of organised securities' market. However, other policy instruments such as administered interest rates, the required reserve ratio, the Central Bank credit to the banking system, exchange rate etc. can be used by the authorities (as these policy changes simultaneously affect both the organised and unorganised sectors) and their effects on the overall economy can be assessed. A model to specify the monetary transmission in this line has been theoretically designed by Montiel (1991). A similar model in spirit but quite restricted in scope is tested by Van Wijnbergen (1983).

In what follows we develop a model of the financial sector which tries to capture the features discussed above, but is limited in its scope to the organised sector only. We are unable to incorporate the unorganised sector in our model due to data limitations. It should be noted that our specification of the model is guided, inter-alia, by the availability of data.

The purpose is to assess how monetary policy instruments impinge on the real sector even if they are taken in isolation from the unorganised sector. The essence is to incorporate the financial sector into our macromodel. In our model, private consumption expenditure is driven by real wealth which is proxied by the stock of broad money in real terms. Investment is driven, among other things, by the volume of bank lending. Thus, any development in the financial sector directly affects these two important sources of aggregate demand. Furthermore, the supply side is also affected via investment and hence the stock of capital. The budgetary position and the external payments situation produce monetary consequences which also affect monetary aggregates and hence aggregate demand. Therefore, the specification of a financial sector model and the analysis of monetary policy instruments are vital in the context of developing a fully-fledged macroeconomic model of the economy. Now, we turn to the specification of the model.

3.2 THE MODEL

3.2.1 Specification of Money Supply Process

The stock of money supply at any point of time (M_t) is broadly defined to include total deposits (demand and time deposits) and currency outside banks.

$$M_t \equiv Cp_t + TD_t \qquad (3.1)$$

where t is a time subscript, Cp stands for currency in circulation outside the banking system and TD stands for total deposits of the banking system. This is an identity and does not spell out the economics behind the determination of money supply.

Broadly speaking, there are three alternative but related theoretical approaches to the analysis of money supply process. These approaches may be termed: (i) the formula approach or the multiplier approach; (ii) the profit maximising approach; and (iii) the flow of funds approach.

In the money multiplier approach the main determinant of the stock of money is high powered money. Causality runs from the latter to the former. The total stock of money is determined as the product of the stock of high powered money and the money multiplier. It is postulated that there always exists a fixed multiplier relationship between monetary base and total money stock. In such a model, money stock is seen as the outcome of an interaction between the monetary authorities, as suppliers of the monetary base, and the non-bank private sector as the demander of it.

This approach takes high powered money to be exogenously determined and under the control of monetary authorities as it forms the monetary liability of the Central Bank. The formula applied for the derivation of the multiplier may be simple or complex but it is based on the assumption that the various ratios which enter into the formula are constant or predictable. We do not follow this approach in modelling money supply as we regard the assumption of exogeneity for the monetary base to be unconvincing. This point will be made clear as we proceed.

The profit-maximising approach focuses upon the profit-maximising strategies of banks whose liabilities constitute the largest proportion of money supply. Assuming that banks are profit-maximisers, their behaviour can be analysed in the conventional framework of the theory of firm and the volume of their liabilities, and hence the money supply must be consistent with their profit maximising behaviour. In such a model, asset and liability management of banks, which embody their profit maximising behaviour, would be an integral part of the money supply process.

This approach is inappropriate for us for at least two reasons. Firstly, in our financially repressed economy the free play of banks as profit maximisers would be an unrealistic proposition. This is because commercial banks are constrained in terms of credit ceilings, interest rate ceilings and a hosts of other controls. Furthermore, banks are directed by the authorities to extend credits in certain areas of the economy - the so-called preferred sectors - no matter how the profitability of banks is affected. In fact, banking institutions are treated as an integral part of the whole development process and financial development is viewed as a supply-leading phenomenon. By its very nature, a supply-leading financial system can not initially operate in a profit maximising framework (Patric, 1980).

Secondly, in our region, currency in circulation outside the banking system (C_p) constitutes a high proportion of the money supply. The average currency to money supply ratio for narrow money (currency plus demand deposits) and broad money (currency plus total bank deposits) are 59.0 and 38.0 percents for the 1961-1985 period. This makes the portfolio behaviour of deposit banks alone deficient for the analysis of money supply process. It is because a significant proportion of money supply, ie., the currency in circulation, is outside the banking system and commercial banks can do little to affect this portion of money stock by their independent action.

The approach we follow is the 'flow of funds' approach. Despite its similar methodological foundations to that of multiplier approach, it allows greater flexibility in the process of money supply determination. Under this approach, both the money supply and high powered money are simultaneously determined as the outcome of a complex and interdependent behaviour (portfolio decisions) of banks, the Central Bank, the non-bank private sector and the government sector as each attempt to determine their portfolio optimally. This is a more generalised approach to money supply determination in the sense that it incorporates both the financial and the real sectors of the economy and all the financial flows that accrue within.

Given this theoretical motivation, we now turn to the analysis of the determination of base money.

3.2.2 Determination of Base Money (BM)

The stock of monetary base or high powered money is defined as the sum of bank reserves, comprising balances with the Central Bank and vault cash, and cash held by the non-bank public. In a fractional reserve system based on a cash reserve ratio, high powered money can be defined as the monetary liability of the Central Bank against the private sector (banks and non-banks) in the form of notes and coins (C) and bankers' balances (BB).

Currency in circulation (C) and bankers' balances at the Central Bank (BB) identify the "uses" of the high powered money whereas corresponding changes in the assets of the Central Bank identify the "sources" of high powered money. By definition liabilities must be equal to assets and the latter comprise Central Bank's loans to the government either in the form of government bonds or advances, (CLG), loans to the banking system (CLB) or foreign exchange reserves (F). Thus, from the sources side high powered money is determined by any financial flows or transactions which directly or indirectly induce changes in the Central Banks' assets.

We rely on International Financial Statistics (IFS) as the source of our data which reports the balance sheet of the monetary authorities rather than that of the Central Bank. Monetary authorities comprise Central Bank and, to the extent that they perform monetary authorities' function, currency boards, exchange stabilisation funds and treasuries. Therefore, following the IFS data description pattern, the sources of high powered money comprise net changes on foreign assets (NFA), net claims on government (NCLG) and claims on deposit money banks (CLB) of monetary authorities.

In our case, the Central Banks of respective countries are primarily accredited with discharging the functions of monetary authorities. However, in so far as the difference between monetary authorities' balance sheet and that of the Central Bank with respect to the determination of base money is concerned, one point should be noted. That is, foreign assets of the monetary authorities include IMF reserve tranche position whereas the Central Bank's foreign assets do not. Other balance sheet flows are the same. Therefore, we use the term monetary authority and the Central Bank interchangeably.

The 'uses' of high powered money holds as defined above. Foreign assets comprise holdings of gold, SDRs, and financial instruments (irrespective of currency denominations) for which non-resident economic agents, including international financial institutions are ultimate obligators (for concepts and definition of this see IFS Supplement on International Liquidity, 1987, pp. vii-ix). Net items are computed by deducting the corresponding liability items from the respective asset items of the balance sheet.

This allows us to express any changes in base money in terms of movement in net assets position of the Central Bank. Thus, from the balance sheet of the monetary authorities the stock of high powered money can be defined as:

$$BM \equiv NFA + NCLG + CLB + OFN \qquad (3.2)$$

Identity (3.2) explicitly shows that any change in the net assets position of the monetary authorities or the Central Bank produces a direct and positive change in base money. OFN is 'other items net' of the balance sheet which comprises, inter alia, capital and reserves of the Central Bank. We treat this variable as a balancing item and exogenously determined.

Throughout below, the letter "δ" indicates change in or flow of, a variable over period t, and is measured as the first difference of the value of variable concerned. The expression "X(-1)" denotes the lag of variable X and the order of lag being the number expressed within the parentheses.

Following this notation, the corresponding flow of high powered money can be expressed as:

$$\delta BM \equiv \delta NFA + \delta NCLG + \delta CLB + \delta OFN \qquad (3.3)$$

Now, we turn to the analysis of each component of the sources of high powered money specified in identity (3.2) and their corresponding flows. It has a direct relevance in our modelling of the financial sector as the Central Bank and deposit banks constitute the sole financial institutions and the flow of base money is one of the determinants of the flow of banking systems' reserves which in turn determines their lending activities. These points will gradually be made clear as we proceed.

3.2.3 Determination of Net Foreign Assets (NFA)

The flow of foreign exchange reserves excluding Gold ($\delta RESCP$) constitutes the main determinant of foreign assets of any economy. Foreign reserves are primarily influenced by the variations in the external position of the economy ie., by the fluctuations in exports, imports and capital movements. Monetary authorities have little control over this source of base money. In our model, it is endogenously determined by the overall balance of payments position which comprises both the current account and the capital account balances. Thus, the flow of foreign exchange reserve is expressed as:

$$\delta RESCP \equiv CBV + \delta DOD + AMT + OLTF + OCF \qquad (3.4)$$

where CBV, δDOD, AMT, OLTF, and OCF denote the current account balance, new borrowing from abroad, amortization, other long term flows and other capital flows net, respectively. This is nothing but the balance of payments flows which we specified in section 2.5 in the last chapter. The counterpart stock of RESCP is given by:

$$RESCP \equiv \delta RESCP + RESCP(-1) \qquad (3.5)$$

The difference between the stock of foreign exchange reserves (RESCP) and the foreign assets of monetary authorities is that the former is a measure of foreign assets of the whole monetary system whereas the latter is that of the Central Bank (or monetary authorities) alone. However, in developing countries where transactions in foreign exchange are restricted and controlled by authorities these two series move very closely. Furthermore, the foreign exchange reserves constitute the main component of foreign assets, therefore, NFA is derived using a link equation of the following form:

$$NFA = k_1 + RESCP \qquad (3.6)$$

The above equation specifies a linear relationship between NFA and RESCP. The counterpart flow of NFA is defined as:

$$\delta NFA \equiv NFA - NFA(-1) \qquad (3.7)$$

3.2.4 Determination of Net Central Bank Lending to Government (NCLG)

In developing countries the extent and the volume of Central Bank lending to the government is not decided by the lender but by the borrower. The Central Bank has virtually has control over its credit flow to the government and it can not act independently on the basis of its target for the monetary base. Instead, Central Bank credit to government is dominated by the budgetary operations of the government. Taking this into account we specify NCLG as a fixed proportion (based on the historical average) of fiscal deficit as follows:

$$\delta NCLG \equiv k_2 * GBD \qquad (3.8)$$

We note that government deficit is the difference between total government outlays and total receipts as specified in equation 2.33 in the previous chapter. Given the flow of net Central Bank credit to government, the stock counterpart is defined as:

$$NCLG \equiv \delta NCLG + NCLG(-1) \qquad (3.9)$$

3.2.5 Determination of Central Bank Lending to Deposit Banks (CLB)

Central Bank lending to commercial banks is one of the actively used monetary policy instruments in developing countries (Park, 1973). The Central Bank tries to control the volume of deposit bank reserves by manipulating its credit flows to the latter. We regard this instrument to be under the control of monetary authorities and treat it as exogenously determined in the model.

It is obvious from the foregoing analysis that changes in high powered money are brought about by the overall functioning of the economy encompassing the efficacy of: fiscal policy in terms of government's budget constraint, monetary policy in terms of the Central Bank loan to deposit banks and exchange rates and other trade policies in terms of reserve flows.

Our analysis also shows that the assumption of the exogeneity of base money, a basic foundation of multiplier theory, is ill-founded at least for our economy. This is because authorities cannot nullify the changes in base money coming from its sources side by market intervention in the form of open market operations and buying and selling of foreign exchange. This is purely because of the lack of securities markets. This possibility exists in developed countries whereas the same does not apply in the case of LDCs. This completes the determination of base money and its components, now, we turn to the specification and analysis of the demand functions for monetary assets in our model.

3.2.6 Demand for Monetary Assets

As already made clear, this model is confined to the organised financial sector. We discussed the fact that the market for securities is either non-existent or of very limited significance. We also noted that the exchange restriction on foreign transaction precludes the private sector from holding foreign assets. In such a situation, the only financial assets available to the non-bank private sector are currency and bank deposits. In what follows we specify these relationships.

We differentiate between the demand for currency and demand for bank deposits as the former is not interest bearing and is widely demanded for transaction purposes, whereas the latter bears an interest rate and is demanded as an instrument of saving. The use of bank cheques as a means of payment is confined to the modern sector of the economy in LDCs. Total deposits, on the other hand, consist of a transaction component (demand deposits) and a saving component (time deposits).

We specify a currency demand function in our model. Any changes in the stock of currency demand directly affects deposit bank reserves for any given stock of base money and hence the volume of bank advances.

Demand for currency is essentially a stock demand. We specify the real stock of currency demanded to be a positive function of the level of transaction proxied by real GDP. Currency does not bear an explicit rate of return to its holder, however, its real worth in terms of its purchasing power depletes with higher rates of inflation. Therefore, we expect currency demand to vary inversely with the expected rate of inflation. If the rates of return on alternative assets are high, the private sector is assumed to economise on its transaction balances, therefore, we hypothesize currency demand to be a negative function of the deposit rate. There are reasons for treating deposit rates as the appropriate rate of return for currency holdings.

Even if the deposit rates are repressed, mostly they tend to be higher than the rates on government securities and more close to the free market rates. Rates on treasury bills are lower compared to bank deposit rates and the rates on long-term bonds. The bank deposits are also more liquid than government securities due to the lack of security exchange markets. Therefore, given the higher rate of return on holding deposits and the better liquidity, deposit rates are the appropriate measure of opportunity cost for currency holdings in these economies.

Furthermore, government securities are not widely available in the vast rural areas of these economies due to lack of proper institutional arrangements. Mostly, banking institutions in the urban sector hold these securities. On the other hand, bank deposits as instruments of saving are widely available even in the rural areas due to the extended network of branch banking. This, naturally, makes deposit rates as the appropriate alternative rate of return for currency holdings in these areas.

A lagged dependent variable is included among regressors to allow for partial adjustment in our currency demand function. Thus, our currency demand function is as follows:

$$\log cp_t = \log \phi_0 + \phi_1 \log y_t + \phi_2 \pi^e{}_t + \phi_3 r_t + \phi_4 \log cp_{t-1} + u_t \qquad (3.10)$$

where t is time subscript, cp is real stock of currency demanded, y is real GDP, π^e is expected inflation, r is the interest rate on time deposit and cp_{t-1} is a lagged depended variable. In empirical estimation we use interest rate on one year time deposits. The equation is estimated in semi-log-linear form as it directly gives us the elasticity of the dependent variable with respect to the independent variable of our interest. Expected inflation (π^e) and the interest rate are in percentage terms, therefore, their coefficients represent semi-elasticities. Given the theoretical arguments above, the expected signs of partial derivatives are:

$\phi_1 > 0$; $\phi_2 < 0$; $\phi_3 < 0$ and $\phi_4 > 0$.

Demand for deposits is also a stock demand. Interest rate on deposits are determined by the authorities, therefore, banks cannot use the deposit rates as an active instrument of deposit mobilisation. We assume that the volume of deposit is determined by the banking system through its credit creation as follows:

$$TD \equiv RB + ADV - CLB + ONF \qquad (3.11)$$

where TD is total deposits, ADV is total lending of the banking system, and RB is total bank reserves as the sum of vault cash and their deposits at the Central Bank. CLB is the borrowing from the Central Bank and ONF is the other net flows, a balancing item of the deposit banks' balance sheet. Identity (3.11) is simply the balance sheet of the banking system. It postulates that total deposits, being the main liabilities of banking system, must equal its net assets.

3.2.7 Flow of Bank Reserves

The flow of reserves in the banking system is determined by the flow of high powered money less the flow of currency in circulation outside the banking system. Thus,

$$\delta RB \equiv \delta BM - \delta Cp \qquad (3.12)$$

where δRB is the flow of reserves in deposit banks and δBM and δCp are the flow of high powered money and the flow of currency outside the banking system, respectively. Identity (3.12) postulates that whatever high powered money is injected into the economy all of it will find its way to deposit bank reserves except for the amount leaked to the non-bank private sector in the form of cash. We have already discussed how the flow of high powered money is determined in the economy. We have also specified a demand function for currency.

3.2.8 Flow of Bank Advances

As the bank lending rate is lower than the unorganised money market lending rate, we assume that banks face a horizontal demand curve for their advances. Put differently, banks are assumed to be fully loaned up. In such a situation, the volume of credit depends on the supply side factors which determine the banking system's capacity to expand total credit.

The supply side factors which shape the size of bank credits are, obviously, the stock of bank reserves (RB), banks' access to Central Bank credit (CLB) and the statutory reserve ratio stipulated by the Central Bank. Any increase in the first two increases the supply capacity of banks whereas any rise in the third does the opposite. Therefore, we derive the flow of total bank credits from the supply side through a credit multiplier process:

$$\delta ADV = [(1-ARR)/ARR] * \delta RB + \delta CLB + \delta ONF \qquad (3.13)$$

where the term within the parentheses[1] is deposit banks' credit multiplier, and ARR is the average reserve ratio defined as the ratio of total bank reserves to total bank deposit liabilities. ARR is equal to the sum of the required reserve ratio (RRR) and the free reserve ratio (FRR) which can be expressed as:

$$ARR \equiv FRR + RRR \qquad (3.14)$$

Required reserve ratio is the statutory minimum reserve ratio determined by the Central Bank which must be maintained by deposit banks against their deposit liabilities. There is no uniformity among nations as to which deposit liabilities, aggregate or some partial aggregate of it, should be used as the basis of determining the required reserve ratio. Policies and rationale behind them differ, however for our purpose, we reckon it to be total bank deposit liabilities.

Required reserve ratio is one monetary policy instrument actively used to influence the volume of bank credits by the Central Bank. The higher the ratio is the lower will be the credit multiplier, and hence the total volume of bank credit, and vice versa. Since the determination of the required reserve ratio falls entirely under the jurisdiction of the Central Bank we assume it to be exogenously determined in our model.

Unlike the minimum required reserves, banks are free to determine the volume of their free reserves. Free reserves do not bear a rate of return to banks rather they are idle liquid assets.

The Central Banks, in these economies, have the legal rights to ensure through checks and supervisions that banks abide by the stipulated required reserves at all times. Any failure to do so by banks entails a high penalty on the part of banks. Banks cannot transact on required reserves, therefore, they need free or excess reserves for transaction purpose. Whilst it may be argued that the reserve ratio is a tax on banks and they try to minimise their holding of non-interest bearing free reserves, but banks need to have enough cash for daily transactions. Since the inter-bank loan market is not developed, the only option available for banks is to maintain some excess reserves. Now, we turn to the specification of banks demand for free reserves.

3.2.9 Banks' Demand for Free Reserves

In the face of any short fall on their reserves, banks incur cost which is heavier the higher is the Central Bank's discount rate. Consequently, banks opt for their own reserve build-up rather than borrowing from the Central Bank. Therefore, we expect a positive relationship between the Central Bank discount rate and deposit banks' excess reserves. This point can be explained from the Central Bank's policy point of view as well. The Central Bank actively uses the discount rate as one of the celebrated monetary policy instruments in affecting the lending activities of banks. When the Central Bank increases its discount rate the obvious indication is that authorities are opting for a tight monetary condition in the economy and they want to squeeze the volume of total bank credit.

Theoretically, an increase in the discount rate increases the holdings of free reserves by banks either as a consequence of the reduced demand for bank credits which is due to the increased cost of new borrowing from banks (the implied assumption, here, is that deposit banks react by increasing their lending rate when discount rate goes up) or due to the reluctance of deposit banks to tighten their free reserve position in the face of an increased cost of borrowing from the Central Bank. The former is the usual transmission mechanism of the discount rate in developed countries like UK where, as and when, authorities increase the discount rate, deposit banks react by increasing their deposit and lending rates. The net effect of the Central Bank policy action, in such a situation, depends on the elasticities of demand and supply of both the deposits and credit in the economy, rather than on the Central Bank action alone. If the private sector's demand for credit is inelastic to interest rate changes but the demand for deposit is elastic then deposit banks can thwart the policy intent of the Central Bank and vice versa. However, the practice in developed economies shows that a rise in the discount rate ultimately leads to a fall in the private sector demand for bank credit and hence the total bank lending.

The line of transmission mechanism outlined above does not apply in developing countries where interest rates are determined by the authorities which precludes deposit banks from an active management of their assets and liabilities in the face of any such action. Authorities can and often do simply raise the discount rate leaving other rates unchanged. In this framework we assume that deposit banks react by increasing their excess or free reserves in the face of any rise in their borrowing cost ie., the discount rate. This raises the average reserve ratio and reduces the credit multiplier (see equation 3.13) and hence the volume of total bank credit. Thus, the effect of an increase in the discount rate is contractionary on bank lending in developing countries as well, but the process is different. The channel of effect works not through the range of interest rate effects but more directly through the average reserve ratio and the credit multiplier.

The bank lending rate is the rate of return foregone while keeping excess reserves. In other words, it is the opportunity cost of excess reserves. Therefore, we expect an inverse relationship between the bank lending rate and the demand for free reserves. Commercial banks try to economise on free reserves when the opportunity cost goes up.

We assume that banks follow a partial adjustment process when out of equilibrium reserves position and include a lagged dependent variable among other arguments. Given, these theoretical arguments we specify the following demand function for bank free reserves.

$$FRR_t = \phi_5 + \phi_6 \, DISCR + \phi_7 \, LR + \phi_8 \, FRR_{t-1} + u_t \qquad (3.15)$$

where , FRR, DISCR, and LR are free reserve ratio, discount rate, and banks' lending rate. The lagged dependent variable is included in the argument to allow for the partial adjustment of free reserves demand. The expected signs of partial derivatives are:

$\phi_6>0$; $\phi_7<0$; and $\phi_8>0$.

3.2.10 Derivation of Expected Inflation

Expected inflation enters as an argument in our currency demand function. Expected inflation is not an observable variable, neither do we have any form of survey data for it, therefore, we need to estimate this series using some theory of expectation formation. In modelling expected inflation, we follow the adaptive expectation mechanism popularised by Cagan (1956). This hypothesis postulates that individuals use information on past forecasting errors to revise current expectations. This gives us the following hypothesis on expected inflation:

$$\pi^e_t = \beta\pi_t + (1-\beta)\pi^e_{(t-1)} \qquad (3.16)$$

where, π^e_t and π_t are expected and actual contemporaneous inflation rates, respectively. Equation (3.16) states that economic agents will adapt their expectation in the light of past experience and particularly they will learn from their mistakes. The expectation gets adjusted each period by some proportion (β) of the discrepancy between the latest observation π_t and the expectation for that period formed at the beginning of the period $\pi^e{}_{(t-1)}$. The adjustment coefficient is β; a high value of β implies substantial and rapid adjustment in expectations, and a low value implies slowly changing expectations. If $\beta=1$ then the actual series and expected series coincide and all previous history is irrelevant. If $\beta = 0$ expectations are static in the sense that once they are formed they continue unchanged. It is generally hypothesized that $0 \leq \beta \leq 1$. The problem with equation (3.16) is that it is still not estimable directly as π^e appears on the right hand side. However, there are ways to estimate it. One widely known way is the Koyck's transformation (Koyck, 1954). Another way is to assume $\pi^e{}_{(t-1)} = \pi_{(t-1)}$ and proceed for estimation which is essentially a weighted average of the current and the past inflation rates. We follow the latter technique.

3.3 Summary and Concluding Remarks

In this chapter we developed a model for the monetary sector. In so doing, we provided a concise description of the nature of the financial system in developing countries. We argued that financial institutions, instruments and markets are far from adequately developed. A wide range of official controls both on volume and prices in the financial sector are commonplace. It precludes the financial sector from functioning in a market based equilibriating mechanism.

It is argued that the monetary sector in LDCs needs a different modelling strategy which can capture the channels of transmission mechanisms of monetary instruments. A realistic model should try to capture the direct monetary flows associated with the fiscal deficit and the external payments deficit. The model should also take into account the horizontal credit demand curve which the deposit banks face, and emphasize on the supply side factors of affecting the determination of bank advances. Furthermore, price variables such as the exchange rate and interest rates must be treated exogenously. At the same time the traditional monetary policy instruments, such as the statutory required reserve ratio, the discount rate, institutionally pegged interest rates, and the Central Bank lending to commercial banks which are in wide use should also be allowed their explicit roles in the model. Our model precisely captures these characteristics.

In our real sector model presented in the last chapter we have shown how real balances and the flow of real bank advances affect the components of aggregate demand ie., the real consumption and investment expenditures. In this chapter we have shown how the evolution of these asset stocks are governed, *inter alia*, by income and expenditure flows which accrue within the real sector. In other words, fiscal position and the external payments position directly affect the monetary sector in the model. Thus, real and monetary sectors are interdependent.

In what follows, for the ease of reference, we provide the list of financial sector equations. Note that coefficients are appropriately signed to represent their effect on dependent variables.

$$M_t \equiv Cp_t + TD_t \qquad (3.1)$$

$$BM \equiv NFA + NCLG + CLB + OFN \qquad (3.2)$$

$$\delta BM \equiv \delta NFA + \delta NCLG + \delta CLB + \delta OFN \qquad (3.3)$$

$$\delta RESCP \equiv CBV + DISB + AMT + OLTF + OCF \qquad (3.4)$$

$$RESCP \equiv \delta RESCP + RESCP(-1) \qquad (3.5)$$

$$NFA = k_1 + RESCP \qquad (3.6)$$

$$\delta NFA \equiv NFA - NFA(-1) \qquad (3.7)$$

$$\delta NCLG \equiv k_2 * GBD \qquad (3.8)$$

$$NCLG \equiv \delta NCLG + NCLG(-1) \qquad (3.9)$$

$$\log cp_t = \log \phi_0 + \phi_1 \log y_t - \phi 2\ \pi^e$$
$$- \phi 3\ r_t + \phi_4 \log cp_{t-1} + u_t \qquad (3.10)$$

$$TD \equiv ADV + RB - CLB + ONF \qquad (3.11)$$

$$\delta RB \equiv \delta BM - \delta Cp \qquad (3.12)$$

$$\delta ADV = [(1-ARR)/ARR] * \delta RB + \delta CLB + \delta ONF \qquad (3.13)$$

$$ARR \equiv FRR + RRR \qquad (3.14)$$

$$FRR_t = \phi_5 + \phi_6 DISCR_t - \phi 7 LR_t + \phi 8 FRR_{t-1} + u_t \qquad (3.15)$$

$$\pi_t{}^e = \beta\pi_t + (1-\beta)\pi^e{}_{(t-1)} \qquad (3.16)$$

In the model there are sixteen relationships, of which, three are behavioural equations and the rest are link equations, proportional relationships and identities. In the next chapter we assemble the full model bringing both the real and the financial sectors together and set out for comparative statics and stability analysis of the full model.

Notes

1/ The credit multiplier is derived as follows. From eqn. (3.11) TD = RB + ADV + CLB + ONF. Setting, ARR= RB/TD and manipulating we get TD=RB/ARR. Now it is easy to see that substituting it in the balance sheet identity gets us: ADV = [(1-ARR)/ARR] * RB + CLB+ OFN.

CHAPTER 4

Comparative Statics and Stability Analysis of the Model

Introduction

In this chapter we analytically develop the model specified in earlier two chapters. This is important to understand the workings of the model. This is accomplished through comparative static analysis. We also assess the dynamic stability of the model.

The analytical approach we follow closely resembles to Allen et al. (1992b). However, our model is different from Allen et al. at least in two important respects. Firstly, we model the monetary sector and allow explicit roles to monetary policy instruments in the model. Secondly, our specification of the investment function is also different. We allow bank advances to affect investment. These two additions change the feature of our model and produce some new results.

This chapter is divided into five sections. In the first section we present a simplified version of our full model which will be used for subsequent analytical purpose. In the second section we solve the model for short-run comparative statics and analyse the effects of different policy shocks on three macro-variables viz., output, prices, and the trade balance. In the third section the model is solved for its long-run outcomes. Given our assumptions on the long-run behaviour of the capital stock and of the asset accumulation process, the long-run comparative statics are derived and discussed.

The fourth section is about the stability analysis of the model. We assess the dynamic stability of our model in this section. Section five provides summary and concluding remarks. At the end of the chapter we provide a mathematical appendix relating to the derivation of short-run and long-run reduced form equations.

Variable definitions

a : real money stock, broadly defined

b : base money (nominal stock)

c : real private consumption

e : nominal exchange rate (units of domestic currency per unit of foreign currency)

f : trade balance

g : real government expenditure, net of transfer

h : stock of domestic debt (nominal)

i : real investment

j : total deposits (nominal stocks)

k : real capital stock

l : total bank advances (nominal stock)

m : real imports

o : nominal money stock (broadly defined)

p : domestic prices

p* : world prices

q : total bank advances (real stock)

r* : world interest rate

r_d : discount rate

r_j : deposit rate

r_l : lending rate

s : stock of foreign reserves (nominal)

Γ : income elasticity of tax

u : stock of currency outside the banking system (real)

v : stock of currency outside the banking system (nominal)

w : stock of deposit bank reserves (nominal)

x : real exports

y : real gdp

y^d : real disposable income

z : export market potential (world trade variable)

ϵ : required reserve ratio

π^e : expected inflation

4.1 The Model

Unless otherwise defined, in what follows, all the relationships are defined in natural logs.

$$y = c_b\, c + i_b\, i + g_b\, g + x_b\, x - m_b m \tag{4.1}$$

$$c = c_1\, (y_b - T_b\Gamma) y + c_2\, a - c_3\, \theta \tag{4.2}$$

$$dk/dt = \tau_1 (y-k) - \tau_2\, r^* + \tau_3\, q \tag{4.3}$$

$$g = g \tag{4.4}$$

$$x = z + x_2\theta \tag{4.5}$$

$$m = m_1 y - m_2\theta \tag{4.6}$$

$$p = e + p^* + \alpha_1 (\alpha_2 y - k) \tag{4.7}$$

$$dh/dt = -y_{1b}\Gamma y + g_{1b} g - s_b r^* s \tag{4.8}$$

$$ds/dt = x_{1b} z + \beta_3 (e+p^*-p) - m_{1b} m_1 y + s_{1b} r^* s \tag{4.9}$$

$$db/dt = n + s_{2b}x_{1b}z + s_{2b}\beta_3\ (e+p^*-p) - (s_{2b}m_{1b}m_1 + h_{1b}y_{1b}\Gamma)y$$
$$+h_{1b}g_{1b}g - h_{1b}s_b r^*s + s_{2b}s_{1b}r^*s \qquad (4.10)$$
$$w = h_b b - v_{2b}\ v \qquad (4.11)$$
$$u = \delta_1 y - \delta_2 r_j - \delta_3 \pi^e \qquad (4.12)$$
$$l = \phi_1 w - \phi_2 r_d + \phi_3 r_l - \phi_4 \epsilon \qquad (4.13)$$
$$j = w_b w + l_b l \qquad (4.14)$$
$$o = j_b j + v_{1b}\ v \qquad (4.15)$$
$$v = u + p \qquad (4.16)$$
$$q = l - p \qquad (4.17)$$
$$a = o - p \qquad (4.18)$$

where,

parameters with subscripts "b" are share parameters which result from the log approximation of a linear relationships and are defined as:

$c_b = c/y$; $i_b = i/y$; $g_b = g/y$; $g_{1b} = g/h$;

$h_b = b/w$; $h_{1b} = h/b$; $j_b = j/o$; $l_b = l/j$;

$m_b = m/y$; $m_{1b} = m/s$;

$s_b = r^*s/h$; $s_{1b} = r^*s/s$; $s_{2b} = s/b$;

$T_b = T/y^d$; $v_{1b} = v/o$; $v_{2b} = v/w$;

$w_b = w/j$; $x_b = x/y$; $x_{1b} = x/s$;

$y_b = y^d/y$; $y_{1b} = \Gamma y/h$;

$\beta_3 = (x_{1b}x_2 + m_{1b}m_2)$;

$\theta = (e+p^*-p)$

These set of equations represent a simplified version of the full model we developed in chapters two and three. We use this version of the model for analytical purposes. The model forms a simultaneous system of eighteen equations in eighteen dependent variables which can be solved for any endogenous variable. Before presenting the comparative statics and stability analysis of the model a brief description of each equation is in order.

Equation (4.1) is the familiar income identity expressed in log-linear form. Equation (4.2) shows real private sector consumption to depend on post tax income, stock of real wealth and the real exchange rate. A real devaluation would mean a deterioration in the terms of trade, therefore, the real exchange rate enters with a negative sign.

Equation (4.3) is the net investment function which shows investment expenditure to be determined by a stock adjustment process to a desired level of capital stock which depends on the level of output, the cost of capital and the availability of bank credit. In this analytical model, a world interest rate is used as a proxy of the user cost of capital as the domestic real interest rates are insignificant empirically. In the empirical estimation, however, there is no cost of capital effect in this model (see Chapter 5). Net investment is assumed to be homogeneous in the output-capital ratio. Government expenditure is exogenously determined in equation (4.4).

Equations (4.5) and (4.6) are standard export and import volume equations. Export volume depends on world trade and the real exchange rate[1]. Export volume is assumed to be unit elastic with respect to world trade in the long-run, therefore, we have suppressed the coefficient on this variable (z) for analytical simplicity. Import volume is determined by real income and the real exchange rate. At the estimation stage, however, we allow for a time trend and a lagged reserve term[2].

Equation (4.7) is the reduced form supply side equation normalised on prices. This is familiar from (2.27)[3]. Ceteris paribus, prices would rise by one for one to any nominal devaluation and/or a rise in foreign prices, leaving the aggregate supply unchanged. However, in the short-run, when capital stock is fixed prices may not rise - one for one- following a devaluation, due to the fall in real asset stocks (viz., a and q) which depress the demand pressure.

Similarly, in the long-run movements in output and capital stocks are important to determine the effects on domestic prices. Any increase in the capital-output ratio raises the price level due to demand pressure. Ceteris paribus, an equiproportionate rise in output and capital stock will not leave the price level unchanged, rather increase it as the output elasticity is greater than the capital stock elasticity. It should be noted that α_1 is the ratio of capital stock elasticity to real exchange rate elasticity of aggregate supply and may be greater than unity. As a matter of fact, we assume it to be greater than unity. α_2, on the other hand, is the reciprocal of capital stock elasticity of aggregate supply and resumes a value of greater than unity as $\delta y^s/\delta k < 1$. This obviously gives $\alpha_1\alpha_2 > \alpha_1$.

Equation (4.8) shows the evolution of domestic debt. It consists of government borrowing from the Central Bank and deposit banks. Government borrowing from deposit banks is treated as exogenously determined. Total tax revenue is endogenously determined as a function of income (Γy). Γ is the income elasticity of tax. We have separately reported the net interest earning from abroad (r^*s). It is obvious that domestic debt increases with the size of budget deficit.

Equation (4.9) shows the evolution of foreign reserves. It depends on the trade balance and net interest receipts from abroad[4]. The trade balance, in turn, depends on the real exchange rate, real income and export market potential ie., the world trade. It should be noted that $(x_2+m_2) > 1$ ensures that the Marshall-Lerner condition holds in our model.

Equation (4.10) shows the evolution of base money. Base money is affected by foreign reserves and domestic debt of the authorities. Trade flows and foreign borrowing determine foreign reserves. Foreign borrowing is exogenously determined in the model. Foreign reserves are assumed to be fully monetised. Domestic debt is assumed to be less than fully monetised. In our model the government can borrow domestically only from the banking system viz., from the Central Bank and the commercial banks. In the empirical model 49.0 percent (historical average) of government budget deficit is assumed to be borrowed from the Central Bank. This is fully monetised. We have treated borrowing from commercial banks to be exogenously determined and do not allow for its monetisation in the model.

The term 'n' in (4.10) signifies the monetisation ratio of domestic debt which is less than unity due to our treatment of government borrowing from the commercial banks. For analytical simplicity we assume the same monetisation ratio, n, for both the domestic debt and foreign reserves in this analytical model. However, in the empirical model we treat them separately.

In equation (4.11) we specify the stock of deposit bank reserves. It is the difference between the stock of base money and the stock of currency held by the non-bank private sector.

Equation (4.12) is the demand for currency (real stock) function which we specified in (3.10). The private sector demand for currency depends positively on income and negatively on deposit rates and expected inflation.

In equation (4.13) total bank lending is determined. The volume of bank lending is a positive function of bank reserves and lending rates but a negative function of the discount rate and required reserves. ϕ_1 is the reserve elasticity of bank advances.

Equation (4.14) shows how total deposits are determined. It states that the total deposit liabilities of the banking system must be equal to its total assets in terms of reserves and lending. This is true from the balance sheet of the commercial banks.

Equation (4.15) defines the nominal stock of money. Money stock is broadly defined as the sum of total deposits of commercial banks and currency outside the banking system. Equation (4.16) defines nominal stock of currency outside the banking system. Equations (4.17) and (4.18) define the real stocks of bank lending and money broadly defined, respectively. This completes the description of each equation of the model. Now, we turn to the comparative static analysis.

4.2 Short-run Comparative Static Analysis

In comparative static analysis we consider the effects of changes in exogenous variables g, z, p^*, e, r^*, ϵ, r_d, r_l, and r_j on output, prices and trade balance. In the short-run, we assume capital stock (k) and the stock of nominal financial assets ie. the stock of foreign reserves and domestic debt, as given. This implies that we fix dynamic equations (4.8)-(4.10) in the short-run analysis. However, real asset stocks change following price changes. The comparative statics derived are discussed in turn as follows:

4.2.1 Effects of government spending and world trade

The effects of an increase in government spending and world trade on output, prices and trade balance are given by the following set of total derivatives:

$$dy/dg = k_1k_2g_b > 0 \tag{4.19}$$

$$dy/dz = k_1k_2x_b > 0 \tag{4.20}$$

$$dp/dg = dp/dz = \alpha_1\alpha_2k_1k_2g_b > 0 \tag{4.21}$$

$$dp/dg = dp/dz = \alpha_1\alpha_2k_1k_2x_b > 0 \tag{4.22}$$

$$df/dg = -k_1k_2g_b[m_1+\beta_3\alpha_1\alpha_2] < 0 \tag{4.23}$$

$$df/dz = 1 - k_1k_2x_b[m_1+\beta_3\alpha_1\alpha_2] > 0 \tag{4.24}$$

where,

$k_1 = 1/ [1-c_bc_1(y_b-T_b\Gamma)-i_b\tau_1+m_bm_1]$

$k_2 = 1/[1+k_1\{\phi_1v_{2b}(\beta_2l_b+i_b\tau_3)(\delta_1+\alpha_1\alpha_2)+\alpha_1\alpha_2(\beta_1+\beta_2+i_b\tau_3)\}]$

$\beta_1 = (x_bx_2+m_bm_2-c_bc_3) > 0$

$\beta_2 = c_bc_2$

$k_1 > 1$; $0 < k_2 < 1$; and $k_1 > k_2$

k_1 is the short-run fixed-price Keynesian multiplier which depends on various elasticities and ratios. The relevant elasticities are: income elasticity of consumption, income elasticity of tax, income elasticity of imports, and output elasticity of investment. Similarly, the relevant ratios are the ratios of the components of aggregate demand to the total income. k_1 is invariably positive.

k_2 is a kind of price and nominal asset related multiplier which erodes the value of real financial assets. Beside k_1, k_2 depends on the real exchange rate elasticity of net exports, wealth elasticity of consumption, exchange rate elasticity of consumption, reserve elasticity of bank advances, bank credit elasticity of investment, income elasticity of currency demand, income elasticity of prices etc. It also depends on various ratios such as investment to output ratio, lending to deposit ratio etc. k_2 is positive and less than one ie., $0 < k_2 < 1$, therefore, it reduces the multiplier value associated with changes in any exogenous variable. In fact k_2 resumes a very small value which is evident from the multiplier expression itself. It is indicative of the fact that when price flexibility and asset effects are allowed in the model, the strength of the fixed price Keynesian multiplier is greatly reduced.

It is obvious from (4.19)-(4.22) that increases in government spending and world trade increase output and prices. Both effects are identical except that the ratio of government expenditure to income and the ratio of exports to income are important in determining their respective effects. Prices rise purely due to the diminishing returns on labour productivity caused by the fixed capital stock. The signs of these multipliers are unambiguously positive. It should also be emphasised that increases in government spending and world trade are likely to raise output less than proportionately in this model. This is because k_2, g_b and x_b are all less than unity, therefore, the size of the multipliers are likely to be less than unity.

Two factors determine the results. The first is the orthodox multiplier-accelerator mechanism captured by k_1. The second is the real asset effects emanating from price changes and nominal asset changes which is captured by k_2. Changes in nominal asset stocks can occur only through a change in the transaction demand for currency as the stock of base money is given.

Whether prices rise more than proportionately to output depends on the size of $\alpha_1\alpha_2$, ie. the income elasticity of prices. If $\alpha_1\alpha_2>1$, then prices rise more than proportionately to output and vice versa. We have already shown the possibility of $\alpha_1\alpha_2 > 1$ in our model, therefore, it is likely that prices rise more than proportionately to output. Real exchange rate appreciates following the rise in prices.

Wages are unit elastic with respect to prices and the latter is also affected by the former but less than proportionately due to the real exchange rate appreciation. Following a rise in output, prices rise due to demand effects; but wages rise more than proportionately due to real wage resistance and productivity effects. Thus, in our model an increase in government consumption expenditure, among other things, increases the level of real wages.

The trade balance worsens following the increase in government spending strictly due to the increase in absorption and poorer competitiveness. In a standard Mundell-Flemming open economy model, the monetary effects of balance of payments ensures neutrality in trade balance, however, in our short-run analysis we have fixed these effects. This issue will be further tackled in the long-run analysis where we shall show how we could reconcile our model with the Mundell-Flemming model.

In the event of a world trade shock, however, the direct improvement in exports results surplus in the trade balance.

Leakages to savings and taxes are important for this. k1k2 is sufficiently small to ensure (4.24) to be positive.

These comparative statics can be used for some policy analysis. Let us think of a scenario of slump in world trade. Also assume that the government responds by rising its expenditure to mitigate the depressing effects of the slump in export demand. How does this economy respond ? Assuming $g_b \approx x_b$ if world trade declines and government spending increases by an equal magnitude, then the net effect on this economy would be a net trade deficit equal to the rise in government spending in magnitude; leaving output and prices unchanged. This is evident from the comparative statics above.

On the other hand, if world trade rises and government spending declines by the same magnitude, then the net effect on the economy is a net trade balance surplus, leaving output and prices unchanged. If the world trade is rising by x percent, then a fiscal spending rule of $\{(1-wx_b)/wg_b)\}x$ percent could be devised which ensures a continuous maintenance of trade balance with a rise in output and prices. It should be noted that "w" represents the trade balance multiplier associated with government spending. Also note that the magnitudes of exports and government expenditure are also important.

4.2.2 Effects of Nominal Devaluation and World Prices

The effects of nominal devaluation and an increase in world prices are given by following total derivatives:

$$dy/de = dy/dp^{*} = -k_1k_2[(\beta_2+i_b\tau_3) + \phi_1v_{2b}(\beta_2l_b+i_b\tau_3)] < 0 \tag{4.25}$$

$$dp/de = dp/dp^{*} = 1-\alpha_1\alpha_2k_1k_2[(\beta_2+i_b\tau_3)+\phi_1v_{2b}(\beta_2l_b+i_b\tau_3)] > 0 \tag{4.26}$$

$$df/de = df/dp^{*} = k_1k_2[(\beta_2+i_b\tau_3)+\phi_1v_{2b}(\beta_2l_b+i_b\tau_3)(\beta_3\alpha_1\alpha_2+m_1)] > 0 \tag{4.27}$$

Nominal devaluation and an increase in world price increase domestic prices and depress both the stock of real balances and the volume of real bank credit. This leads to a fall in output as private consumption and investment fall. In the simplest open economy Keynesian model a devaluation increases activity through a reduction in real wages which produces positive demand effects, but the formulation of supply side does not allow this to happen in our model. There is no money illusion on the part of labourers in our model.

In an open economy Mundell-Flemming model, a devaluation and an increase in world prices show a neutrality effect on output and proportionality on prices. However, in our model output declines and prices rise by less than proportionately. This is precisely because of falling real asset stocks which depress consumption and investment. If we set these real asset effects to zero (ie., $\tau_3=\beta_2=0$) in (4.25) and (4.26), then both the neutrality and the proportionality effects hold even in our model. Thus, devaluation is contractionary in our model as in Krugman and Taylor (1978).

The trade balance improves due to the combined effects of reduced domestic absorption and increased competitiveness. The improvement in competitiveness is obvious as prices rise less than proportionately following a nominal devaluation. Since k_1k_2 resume a very small value, the whole expression in (4.27) resumes a positive, but less than unity value.

The identical effect of nominal devaluation and world price rises is due to the fact that both affect the real exchange rate identically.

The nominal exchange rate and government spending multipliers can also be put into some policy analysis. For example, ceteris paribus, it can be shown from (4.23) and (4.27) that a x percent rise in g would require a $[g_b/\{\beta_2+i_b\tau_3+\phi_1v_{2b}(\tau_3i_b+\beta_2l_b)\}]x$ percent devaluation to maintain a continuous trade balance. However, note that the net effect on output would be contractionary by $k_1k_2[g_b-\{\beta_2+i_b\tau_3+\phi_1v_{2b}(\beta_2l_b+i_b\tau_3)]$. This expression is negative because $g_b<[\{\beta_2+i_b\tau_3+\phi_1v_{21}(\beta_2l_b+i_b\tau_3)]$; ie., the whole expression in the right hand side is greater than g_b ie., the ratio of government expenditure to output (GDP), which is less than unity. Since k_1k_2 is small the overall effects are going to be small, but contractionary. Thus, in our model a simultaneous rise in government expenditure and devaluation would be contractionary in the short-run. This is due to the depression in real asset stocks. A price rise erodes the real value of asset stocks and reduces the aggregate demand. We reiterate the fact that capital stock and reserve effects are fixed in this analysis.

4.2.3 Effects of World Interest Rates

The effects of a rise in the world interest rates on output, prices and trade balance are given by following total derivatives:

$$dy/dr^* = \quad -k_1k_2i_b\tau_2 < 0 \qquad (4.28)$$

$$dp/dr^* = \quad -\alpha_1\alpha_2k_1k_2i_b\tau_2 < 0 \qquad (4.29)$$

$$df/dr^* = \quad k_1k_2i_b\tau_2[m_1+\beta_3\alpha_1\alpha_2] > 0 \qquad (4.30)$$

The rise in the world interest rate depresses investment and hence the level of output. Prices fall purely because of the fall in activities, as capital stock is assumed to be fixed in the short-run. It should be noted that τ_2 is the interest rate semi-elasticity of investment. The trade balance improves following the reduced level of absorption and prices. The signs of all the multipliers are unambiguous.

4.2.4 Effects of Required Reserve Ratio

The effects of an increase in required reserve ratio on output, prices and trade balance are given as follows:

$$dy/d\epsilon = -k_1k_2\phi_4(\beta_2j_bl_b+\tau_3i_b\ ) < 0 \qquad (4.31)$$

$$dp/d\epsilon = \quad -\alpha_1\alpha_2k_1k_2\phi_4(\beta_2l_bj_b+\tau_3i_b) < 0 \qquad (4.32)$$

$$df/d\epsilon = \quad k_1k_2(\beta_2l_bj_b+\tau_3i_b)\phi_4[m_1+\beta_3\alpha_1\alpha_2] > 0 \qquad (4.33)$$

An increase in the required reserve ratio reduces output through the reduced flows of money stock and bank lending which depress private consumption and investment spending. The overall effects depend on the sensitivities of bank advances on required reserves (ϕ_4), of consumption and investment on real balances (β_2) and real bank credit (τ_3), respectively. It also depends on various monetary and credit ratios and multipliers, as is evident from the multiplier expression itself.

Prices fall precisely due to the fall in demand. Increased competitiveness and reduced absorption help improve the trade balance. ϕ_4 is the required reserve elasticity of bank advances. The required reserve ratio affects two components of aggregate demand viz., consumption and investment. All the policy multipliers are unambiguous in their sign.

4.2.5 Effects of the Discount Rate

The following total derivatives give the multipliers associated with an increase in the discount rate:

$$dy/dr_d = -k_1k_2\phi_2(\beta_2 j_b l_b+\tau_3 i_b) <0 \qquad (4.34)$$

$$dp/dr_d = -\alpha_1\alpha_2k_1k_2\phi_2 (\beta_2 j_b l_b +\tau_3) <0 \qquad (4.35)$$

$$df/dr_d = (\beta_2 j_b l_b+i_b\tau_3)k_1k_2\phi_2[m_1+\beta_3\alpha_1\alpha_2] >0 \qquad (4.36)$$

The channels of effects of the required reserve ratio and the discount rate are similar. A rise in the discount rate increases the free reserves of the banking system and reduces the credit multiplier. Consequently, the volume of bank lending and money stock contracts and hence the level of output. Prices fall following the fall in activities. An improved competitiveness and a reduced absorption improves the trade balance.

The relative strength of the required reserves and the discount rate depends on the size of ϕ_4 and ϕ_2 which are the required reserve ratio and the discount rate elasticities of bank lending, respectively. If $\phi_4 > \phi_2$, then the required reserve ratio effect is dominant over the discount rate and vice versa. In our empirical model the required reserve effect is stronger as the analogue of ϕ_4 is greater than the analogue of ϕ_2.

4.2.6 *Effects of Interest Rates*

In this analytical model we provide a separate statement of the multipliers associated with the deposit and lending rates. However, in the simulation of the full model, interest rates are shocked simultaneously by an equal magnitude. Following total derivatives provide the effects of increases in interest rates on output, prices and trade balance.

$$dy/r_j = k_1 k_2 \delta_2 \phi_1 v_{2b}(\beta_2 j_b l_b + \tau_3 i_b) > 0 \qquad (4.37)$$

$$dp/dr_j = \alpha_1 \alpha_2 k_1 k_2 \delta_2 \phi_1 v_{2b}(\beta_2 l_b j_b + \tau_3 i_b) > 0 \qquad (4.38)$$

$$df/dr_j = -k_1 k_2 \phi_1 \delta_2 v_{2b}(\beta_2 l_b j_b + \tau_3 i_b)[m_1 + \beta_3 \alpha_1 \alpha_2] < 0 \qquad (4.39)$$

$$dy/dr_l = k_1 k_2 \phi_3 (\beta_2 j_b l_b + \tau_3 i_b) > 0 \qquad (4.40)$$

$$dp/dr_1 = \alpha_1\alpha_2 k_1 k_2 \phi_3 (\beta_2 j_b l_b + \tau_3 i_b) > 0 \qquad (4.41)$$

$$df/dr_1 = -k_1 k_2 \phi_3 (\beta_2 j_b l_b + \tau_3 i_b)[m_1 + \beta_3 \alpha_1 \alpha_2] < 0 \qquad (4.42)$$

Increases in deposit and lending rates increase output through their effects on the stock of financial assets and hence on consumption and investment.

A rise in the deposit rate reduces private sector demand for currency and raises the deposit banks' reserves. This leads to a net increase in financial asset stocks; bank lending rises by a multiple of the credit multiplier. A rise in the lending rate, on the other hand, reduces free reserves of the banking system and increases the credit multiplier. Notice that these effects work independently of any "coupon" effect of higher interest receipts on private sector demand which is absent in our model.

Thus, both help increase the volume of bank lending and money stock which drive consumption and investment. Prices rise purely due to demand effects. The trade balance deteriorates due to the rise in absorption and loss in competitiveness.

Here our model is very unorthodox as interest rates are positively associated with money stock and bank lending. This is due to the credit rationing and a controlled interest rate structure. Our model is clearly in line with the hypothesis of financial repressionists. This issue has already been discussed in chapter three. However, we will take up this issue further in section 4.3.6 below.

4.2.7 Summary of the Short-run Analysis

The results of the short run analysis can be summarised as follows. An increase in government spending raises output and prices but worsens the trade balance. A rise in world trade has the same effects except that it improves the trade balance. Increases in world price and devaluation are contractionary. Prices rise but the trade balance improves. Increases in the required reserve ratio and discount rate depress output and prices, but improve the trade balance. An interest rate rise increases output and prices, but worsen the trade balance. These analytical results are consistent from a theoretical point of view. For ease of reference, a qualitative summary of these results are presented in table 4.1 below.

Table: 4.1

Qualitative Results of Short-run Comparative Statics

Effect on			
Effect of	y	p	f
g	+	+	-
z	+	+	+
e	-	+	+
p*	-	+	+
r*	-	-	+
ϵ	-	-	+
rd	-	-	+
rj	+	+	-
rl	+	+	-

The table (4.1) clearly shows that, in the short-run, the model is fully demand driven. Increases in demand are associated with increase in prices and a deterioration in the trade balance and vice versa. This is in perfect coherence with the fixed supply side analysis.

4.3 Long-run Comparative static Analysis

In the long-run we set dk/dt and db/dt equal to zero in (4.3) and (4.10) and solve for capital stock and income, respectively. Then we simultaneously solve for y, p and f. This implies that capital stock, domestic debt, and foreign reserves are assumed to be fully adjusted in the long-run. The resulting comparative statics are reported below. One simplification is made for analytical tractability. We have suppressed the coupon effects (ie r* term) in equation (4.10). This does not affect the quality of our results.

4.3.1 Effects of Government Spending and World Trade

The effects of increases in government spending and world trade are given by the following total derivatives:

$$dy/dg = \frac{h_{1b}g_{1b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \frac{\beta_3 s_{2b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} * \frac{dp}{dg} \qquad (4.43)$$

substituting for dp/dg gives,

$$dy/dg = \frac{h_{1b}g_{1b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} \left[1 - \frac{\beta_3 s_{2b}D_3D_1\alpha_1\{(\alpha_2-1)-\mu_2D_2\}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\ \Gamma)} \right]$$

$$- \left[\frac{\beta_3 s_{2b}D_3D_1\alpha_1\mu_2\phi_1 g_b}{j_b(w_b+l_b\phi_1)\beta_2}\right] >0 \qquad (4.43.1)$$

$$dy/dz = \frac{s_{2b}x_{1b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} \left[1 - \frac{\beta_3 s_{2b}D_3D_1\alpha_1\{(\alpha_2-1)-\mu_2D_2\}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} \right]$$

$$- \left[\frac{\beta_3 s_{2b}D_3D_1\alpha_1\mu_2\phi_1 x_b}{j_b(w_b+l_b\phi_1)\beta_2}\right] >0 \qquad (4.44)$$

$$dp/dg = \frac{D_3D_1\alpha_1h_{1b}g_{1b}\ [(\alpha_2-1)-\mu_2D_2]}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} + \frac{D_3D_1\alpha_1\mu_2\phi_1g_{1b}]}{j_b(w_b+l_b\phi_1)\beta_2} >0 \quad (4.45)$$

$$dp/dz = \frac{D_3D_1\alpha_1s_{2b}x_{1b}[(\alpha_2-1)-\mu_2D_2]}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} + \frac{D_3D_1\alpha_1\mu_2\phi_1x_{1b}}{j_b(w_b+l_b\phi_1)\beta_2} >0 \quad (4.45)$$

$$df/dg = \frac{-m_{1b}h_{1b}g_{1b}m_1}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} + \left[\frac{m_{1b}m_1s_{2b}\beta_3}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \beta_3\right]*dp/dg \quad (4.47)$$

substituting for dp/dg and simplifying we get:

$$df/dg = -h_{1b}\left[\frac{m_{1b}m_1g_{1b} + \beta_3y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)}\right]*\left[\frac{D_3D_1\alpha_1h_{1b}g_{1b}}{} \{(\alpha_2-1)-D_2\mu_2\}\right.$$

$$\left. + \frac{D_3D_1\alpha_1\mu_2\phi_1g_b}{j_b(w_b+l_b\phi_1)}\right] \qquad (4.47.1)$$

$$df/dz = \frac{x_{1b}h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \frac{\beta_3h_{1b}y_{1b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)}[D_3D_1s_{2b}x_{1b}\{\alpha_2-1)-\mu_2D_2$$

$$+ \frac{D_3D_1\alpha_1\mu_2\phi_1x_{1b}}{j_b(w_b+l_b\phi_1)\beta_2}] >0 \qquad (4.48)$$

where,

$$D_1 = \frac{s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)(1-\alpha_1\mu_2)+\alpha_1(\alpha_2-1)s_{2b}\beta_3} > 0$$

$$D_2 = \frac{\phi_1(1-v_{2b}j_bw_b\delta_1)}{j_b(w_b+l_b\phi_1)} > 0$$

$$D_3 = \frac{j_b(w_b+l_b\phi_1)k_3\beta_2\sigma}{j_b(w_b+l_b\phi_1)\beta_2[k_3\sigma-\alpha_1\mu_2D_1D_2\beta_3]+[\alpha_1\mu_2D_1\phi_1\{\beta_1+\beta_2-(v/o)\sigma\}]} > 0$$

$$k_3 = \frac{1}{1-c_bc_1(y_b-t_b\Gamma)+m_bm_1} > 0$$

Note that

$\sigma = (s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)$,

$\mu_1 = \tau_2/\tau_1$,

$\mu_2 = \tau_3/\tau_1$, and

$v/o = v_{2b}j_bw_b$ ie., the ratio of currency to money stock in nominal terms.

D_1 is a kind of price multiplier associated with income and capital stock. We arrive at this multiplier by substituting for income and capital stock in the price equation. Since $\alpha1(\alpha2-1) > 0$; it is $\alpha_1\mu_2 < 1$ which ensures D_1 is positive. This holds because μ_2, the long-run credit elasticity of capital stock is small.

D_1 shows that a higher level of income is associated with a higher level of prices. An increase in output increases prices, but a rise in capital stock depresses it. An equiproportionate rise in output and capital stock is not invariant to prices; prices will rise due to the rise in real wages occasioned by the increase in labour demand associated with a fixed labour supply.

D_2 is a kind of income multiplier which shows that, in equilibrium, a higher level of income must be associated with a higher stock of financial assets. It is the coefficient of the income term in the reduced form financial asset equation normalised on bank lending. D_2 is positive. It is already noted that solution of $v_{2b}l_bw_b$ gives currency to money ratio. The positive value of D_2 requires that the product of income elasticity of currency demand and currency to money ratio (ie., $v_{2b}l_bw_b$) be less than unity, which is satisfied in our model.

D_3 is the full long-run price multiplier which includes D_1, D_2 and other parameters as evident from the multiplier expression itself. Two conditions ensure that D_3 is positive. First, it requires that $k_3\sigma > \alpha_1\mu_2D_1D_2\beta_3$ which is likely to be satisfied as D_1, D_2 and μ_2 assume small values. The second condition requires that $(\beta_1+\beta_2) > (v_{2b}j_bl_b)\sigma$ which is also satisfied as the first term, the elasticity of aggregate demand, (total injection), should be greater than elasticity of leakages (ie sum of import elasticity and marginal tax rate). D_3 captures the whole range of income, capital stock and asset stocks effects on prices subjected by a change in any exogenous variable. Put differently, in the model, any policy changes can affect prices through demand and supply forces, but not otherwise.

One important point should be noted here. It is the presence of μ_2, ie., the long-run effect of bank advances on capital stock which depresses the price multiplier through its supply side effects and turns D_3 to be less than unity. It can be seen from the multiplier expression itself that if we set this effect (μ_2) equal to zero then D_3 ie., the long-run price multiplier, resumes a value of unity.

Increases in government spending and world trade increase output as they inject assets into the system. To stop this, leakages in terms of taxes and imports must rise by the magnitude of injection, which do not happen. The multipliers reported in (4.43.1) and (4.44) are positive. Neglecting the last terms in both the expressions, since they resume very small values, the positive sign of the multipliers are assured by $(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma) > \beta_3D_3D_1\alpha_1(\alpha_2-1)$ which is satisfied as D_1 D_3 assume small values. Note that government expenditure and world trade multipliers differ in terms of their respective ratios to output and other ratios as evident from the multipliers.

Prices rise as the demand side effects dominate the supply side effects. The price multiplier reported in (4.45) is positive since $(\alpha_2-1) > \mu_2D_2$; this is again due to the small values μ_2 and D_2 resume. It is also evident that even in the long-run, prices rise by less than proportionately to the rise in government spending. k_3 is the long-run Keynesian multiplier.

An increase in government spending worsens the trade balance, but by less than one-for-one because of the higher tax revenue. The trade balance worsens due to poorer competitiveness and increased absorption. The multiplier in (4.47) is negative as $\beta_3 > m_{1b}s_{2b}m_1\beta_3/\sigma$ and dp/dg is positive.

The monetary approach to the balance of payment says that in the long-run the external account must be at balance otherwise the resulting monetary flows associated with the balance of payments disturb the stock equilibrium of the private sector. This analysis assigns the balance of payments theory a unique self-correcting mechanism which is associated with the private sector's expenditure behaviour. The private sector is assumed to have a desired net wealth to income ratio. If the external account is in surplus then the increase in high powered money associated with it increases the asset stocks of the private sector. This raises the net asset/income ratio of the private sector; consequently, private sector expenditure increases and the balance of payments surplus reduces and vice versa. Thus, according to the monetary approach, the balance of payments is characterised by an automatic self-correcting mechanism.

However, the monetary approach assumes a balanced government budget. If we relax this assumption then it is not at all necessary that the external account should affect private sector asset stocks. A government budget surplus/deficit, corresponding to the balance of payment surplus/deficit, may leave the private sector asset stocks unchanged; consequently, the balance of payments looses its self-correcting characteristic. The balance of payments deficit could be matched by a government budget deficit. However, it should be noted that a limit to run such a deficit by the authorities is always set by the level of foreign exchange reserves.

Currie (1976) and McCallum and Vines (1981) have shown this point. This is exactly what happens in our model. The government budget deficit sustains the long-run current account deficit.

Turning to an increase in world trade, this improves the trade balance as the direct increase in exports more than offsets the rise in imports following income expansion. The trade balance multiplier given in (4.48) is positive. Some simplification shows that leakages in tax revenue is sufficient for the trade balance to improve.

The policy analysis carried out in the short-run scenario above equally applies in the long-run as well as far as the fiscal and the world trade multipliers are concerned. Ceteris paribus, an equiproportionate rise in government spending and a fall in world trade would result in a trade balance deficit with income and prices unchanged and, vice versa. Given the behaviour of the world trade, a fiscal rule can be devised such that a maintained trade balance and expansion in activities could be achieved. We have already shown how to do this in the short-run analysis, and the identical procedure applies here as well.

4.3.2 Effects of Nominal Devaluation and World Prices

The effects of nominal devaluation and increase in world prices on output, prices and trade balance are given by the following total derivatives.

$$dy/de=dy/dp^*= \frac{\beta_3 s_{2b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \frac{\beta_3 s_{2b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} * \frac{dp}{dp^*} \qquad (4.49)$$

substituting for dp/dp* we get,

$$dy/de=dy/dp^*= \frac{\beta_3 s_{2b}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)}[1 - D_3D_1 + \frac{D_3D_1 s_{2b}\alpha_1\beta_3\{(\alpha_2-1)-D_2\mu_2\}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)}$$

$$+ \frac{D_3D_1\alpha_1\mu_2\phi_1 k_3\beta_1}{j_b(w_b+l_b\phi_1)\beta_2}] >0 \qquad (4.49.1)$$

$$dp/de = dp/dp^* = D_1D_3 [1 + \frac{\alpha_1\beta_3 s_{2b}\{(\alpha_2-1)-D_2\mu_2\}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)}$$

$$+ \frac{\alpha_1\mu_2\phi_1\beta_1}{j_b(w_b+l_b\phi_1)\beta_2}] >0 \qquad (4.50)$$

$$df/de=df/dp^*= \frac{\beta_3 h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \frac{\beta_3 h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} * \frac{dp}{dp^*} \qquad (4.51)$$

or,

$$df/de=df/dp^*= \frac{\beta_3 h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} - \frac{\beta_3 h_{1b}y_{1b}\Gamma}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} *$$

$$D_3D_1 [1 + \frac{\alpha_1\beta_3 s_{2b}\{(\alpha_2-1)-D_2\mu_2\}}{(s_{2b}m_{1b}m_1+h_{1b}y_{1b}\Gamma)} + \frac{\alpha_1\mu_2\phi_1\beta_1}{j_b(w_b+l_b\phi_1)\beta_2}] \qquad (4.51.a)$$

Increases in world prices and nominal devaluation increase output due mainly to persistent real devaluation. It is evident from (4.49) that if prices rise proportionately following a nominal devaluation than the output effects would be neutral. This would be a standard Monetary Approach to the Balance of Payments outcome.

However, in our model, prices rise less than proportionately following a devaluation. This is due to the supply side effects associated with the bank advances. In the longer run, in this model, a devaluation has the effect of increasing real asset stocks which affects both consumption and investment and reallocates resources from consumption to investment. This raises the equilibrium capital stock and depresses domestic prices. It is precisely due to this reason that prices rise less than proportionately following a devaluation in our model. This can be proved in our analytical results by suppressing the effect of bank advances on capital stock. If we set $\mu_2 = 0$ in (4.50) than dp/de resumes a value of unity, ie., prices rise proportionately. When dp/de=1, then dy/de=0. In this situation a devaluation is neutral with respect to output and trade balance, and proportional with respect to prices. Analytically it can be shown as follows.

In (4.50) if we set $\mu_2=0$, then we are left with the expression:

$$dp/de = dp/dp^* = D_1 \ [1 + \frac{\alpha_1 \beta_3 s_{2b}\{(\alpha 2-1)\}}{(s_{2b}m_{1b}m_1+h_{ib}y_{1b}\Gamma)} \qquad (4.50.a)$$

Imposing the same constraint D_1 becomes:

$$D_1 = \frac{(s_{2b}m_{1b}m_1+h_{ib}y_{1b}\Gamma)}{(s_{2b}m_{1b}m_1+h_{ib}y_{1b}\Gamma) + \alpha_1(\alpha_2-1)s_{2b}\beta_3} \qquad (4.50.b)$$

Note that as already discussed $D_3 = 1$ when we set μ_2 to null. Now, one can easily see by substituting (4.50.b) in to (4.50.a) and solving for dp/de which gives dp/de = 1.

The trade balance improves due to the improvement in competitiveness. Again, it is obvious from (4.51) that if prices rise proportionately then the effect on trade balance would be neutral. Thus, in this model, room for a real devaluation exists following a nominal devaluation even in the long-run, and this is due to the role of bank advances on capital formation. Credit availability matters in the model. It should also be noted that the output effects of nominal devaluation and a world price rise are very different (quite opposite) from their short-run effects. In the short-run output effects were contractionary.

The condition that $[1+\alpha_1\beta_3s_{2b}(\alpha_2-1)] > D_2\mu_2$ is sufficient to ensure that (4.50) is positive. It is not difficult to see that $0 < dp/de < 1$ from (4.50) as D_3D_1 pre-multiplies the whole expression. Since $0 < dp/de < 1$, from (4.49) we can infer that (4.49.1) is positive which is the output effect. The trade balance improves following the improvement in competitiveness. Now, it is easy to visualise that (4.51) and (4.51.1) are positive.

4.3.3 Effects of World Interest Rates

The effects of a rise in world interest rates on output, prices and trade balance are give by following total derivatives:

$$dy/dr^* = -\beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_1 \;/\; (s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma) < 0 \qquad (4.52)$$

$$dp/dr^* = D_3 D_1 \alpha_1 \mu_1 > 0 \qquad (4.53)$$

$$df/dr^* = -\beta_3 \Gamma D_3 D_1 \alpha_1 \mu_1 \;/\; (s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma) < 0 \qquad (4.54)$$

Higher world interest rates (a proxy of the cost of capital) depress output and increase prices through negative supply side effects as they reduce the equilibrium level of capital stock. μ_1 is the long-run real interest rate elasticity of capital stock. An increase in the world interest rate increases the user cost of capital and depresses the equilibrium capital stock. This reduces the aggregate supply. The multipliers in (4.52), (4.53) and (4.54) are unambiguous in their sign. The trade balance worsens precisely because of the deterioration in competitiveness.

4.3.4 Effects of the Required Reserve Ratio

The effects of an increase in the required reserve ratio on output, prices and trade balance are given by the following total derivatives:

$$dy/d\epsilon = \frac{-\beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_4 w_b}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)(w_b + l_b \phi_1)} < 0 \qquad (4.55)$$

$$dp/d\epsilon = \frac{D_3 D_1 \alpha_1 \mu_2 \phi_4 w_b}{(w_b + l_b \phi_1)} > 0 \qquad (4.56)$$

$$df/d\epsilon = \frac{-\beta_3 s_{2b} \Gamma}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)} \left[\frac{D_3 D_1 \alpha_1 \mu_2 \phi_4 w_b}{(w_b + l_b \phi_1)}\right] < 0 \qquad (4.57)$$

An increase in the required reserve ratio depresses output. This is because a high required reserve ratio reduces the stock of financial assets and depresses the level of consumption and the equilibrium capital stock. The output multiplier in (4.55) is unambiguously negative. Prices rise following the negative supply side effects caused by the fall in capital stock. The multiplier in (4.56) is also unambiguously positive. The trade balance worsens as the supply side effects dominate the demand side effects in the trade sector. In other words, the deterioration in competitiveness is stronger than the fall in income which causes the trade balance to worsen. This is evident from the fact that $(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma) > \beta_3 s_{2b}$ which implies that the multiplier expression in (4.56) is greater in absolute value than the expression (4.55).

4.3.5 Effects of the Discount Rate

The effects of an increase in the discount rate on output, prices, and trade balance are given by following total derivatives:

$$dy/dr_d = \frac{-\beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_2 w_b}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)(w_b + l_b \phi_1)} < 0 \qquad (4.58)$$

$$dp/dr_d = \frac{D_3 D_1 \alpha_1 \mu_2 \phi_2 w_b}{(w_b + l_b \phi_1)} > 0 \qquad (4.59)$$

$$df/dr_d = \frac{- \Gamma \beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_2 w_b}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)(wb + \phi_1 l_b)} < 0 \qquad (4.60)$$

Commercial banks maintain a higher level of free reserves following a rise in the discount rate. Consequently, the credit multiplier falls and hence the volume bank credits. This leads to a reduction in the equilibrium assets and capital stocks. As a result, output falls and prices rise due to the negative supply side effects. The trade balance worsens due to poorer competitiveness. All the multipliers are unambiguous in their sign.

4.3.6 Effects of Interest Rates

We have reported the comparative statics associated with lending and deposit rates separately. The effects of the rise in interest rates on output, prices and the trade balance are given as follows:

$$dy/dr_1 = \frac{\beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_3 w_b}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)(w_b + l_b \phi_1)} > 0 \qquad (4.61)$$

$$dp/dr_1 = \frac{- D_3 D_1 \alpha_1 \mu_2 \phi_3 w_b}{(w_b + \phi_1)} < 0 \qquad (4.62)$$

$$df/dr_1 = \frac{\Gamma \beta_3 \; s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_3}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)(w_b + \phi_1 l_b)} > 0 \qquad (4.63)$$

$$dy/dr_j = \frac{\beta_3 s_{2b} D_3 D_1 \alpha_1 \mu_2 \phi_1 v_{2b} \delta_2}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)} [1 - \frac{l_b \phi_1}{(w_b + l_b \phi_1)}] > 0 \qquad (4.64)$$

$$dp/dr_j = D_3 D_1 \alpha_1 \mu_2 \phi_1 v_{2b} \delta_2 \; [\frac{l_b \phi_1}{(w_b + l_b \phi_1)} - 1] \quad < 0 \qquad (4.65)$$

$$df/dr_j = \frac{\Gamma \beta_3 s_{2b} [D_3 D_1 \alpha_1 \mu_2 \phi_1 v_{2b} \delta_2}{(s_{2b} m_{1b} m_1 + h_{ib} y_{1b} \Gamma)} \{1 - \frac{l_b \phi_1}{(w_b + l_b \phi_1)}\}] > 0 \qquad (4.66)$$

Increases in deposit and lending rates increase output and depress prices from their positive supply side effects. Higher interest rates are associated with higher level of equilibrium asset stocks and capital stocks. A general increase in interest rates increases the financial saving mobilisation of the banking system and hence the volume of deposits and credits. This in turn increases the level of consumption and capital stock.

The trade balance improves following the improvement in competitiveness. The sign of the multipliers associated with the lending rates are unambiguous. The sign specifications of the deposit rate requires that $(w_b+l_b\phi_1) > l_b\phi_1$ which is easily satisfied.

However, these interest rates effects must be viewed in the light of repressed rates in the organised financial sector. If they are raised sufficiently to the level of unorganised sector rates or to the level of the true cost of capital, then the outcomes may change completely. Firstly, in such a situation, investment expenditure would not remain insensitive to the domestic interest rates as it did in our model, rather we expect a negative relationship between the real rate of interest and the level of investment. Secondly, our assumption of ready made demand for bank credits may not hold as the interest rate premium (in the form of low rate when borrowed from bank) will cease to exist for the bank borrowers when interest rates are high and competitive. This leads to a situation whereby banks may not be in a position to raise their reserves and lending by simply raising their deposit rates (either by authorities' or bank action) due to the interest sensitive demand for their assets and liabilities.

Therefore, our analytical results of positive interest rate effects on income, prices and trade balance must be viewed in the context of financial repression ie., as long as these rates are below the market determined rates. When interest rates resume the level of market determined rates we expect a standard outcome of a negative relationship between interest rates and investment.

4.3.7 Summary of the Long-run Analysis

In the long-run, increases in government spending, world trade, world prices and a devaluation increase output and prices. The trade balance improves except for government spending. The output effects of world prices and devaluation are different (quite opposite) from the short-run outcomes. It is because of the fixed supply side in the short-run.

Increases in world interest rates and required reserve ratio depress output, increase prices and worsen the trade balance. Again, price and trade balance effects are different from the short-run outcomes, due to the supply side effects in the long-run. A rise in interest rates increases output, reduces prices and improves the trade balance. This outcome is in line with the arguments put-forward by the financial repressionists. The short-run and long-run outcomes on prices and the trade balance are different. We report these analytical results qualitatively in table 4.2 below for the ease of reference.

Table: 4.2

Qualitative Results of Long-Run Comparative Statics

	Effect on		
	y	p	f
Effect of			
g	+	+	-
z	+	+	+
e	+#	+	+
p*	+#	+	+
r*	-	+#	-#
ϵ	-	+#	-#
rd	-	+#	-#
rj	+	-#	+#
rl	+	-#	+#

# indicates that these effects are different in direction from their short-run counterparts.

Unlike in the short-run analysis, model is not driven by the demand side factors alone in the long-run. Supply side effects are very prominent on price and trade balance. Another notable difference is that devaluation is expansionary from its supply side effects. However, this effect vanishes once the effect of bank advances on capital stock is fixed.

4.4 Stability Analysis

There are two dynamic equations in the system: capital stock and the stock of base money which are given in (4.3) and (4.10). It should be noted that by combining (4.8) and (4.9) we arrive at (4.10), therefore, (4.10) incorporates both δh and δs. Substituting for q in (4.3) from (4.17) we present these dynamic equations below for ease of reference. Stability requires that the characteristic roots of the dynamic equations be negative or have real parts.

$$dk/dt = \tau_1\ (y-k) - \tau_2\ r^* + \tau_3\ (1-p) \qquad (4.3.a)$$

$$db/dt = n+[\ z+ \beta_3\ (e+p^*-p) - (m_1+\Gamma)y + g_{1b}g\ ] \qquad (4.10.a)$$

Substituting for y and p from (4.80) and (4.81) (see appendix 4.A) in the equations for evolution of capital stock (4.3.a) and base money (4.10.a), we can write the following differential equation system in matrix form:

$$\begin{bmatrix} dk \\ db \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} K \\ b \end{bmatrix} \qquad (4.67)$$

where,

$$a_{11} = [\tau_1-\tau_3\phi_1 v_{2b}(\delta_1+\alpha_1\alpha_2)]\ [k_1k_2\{-i_b\tau_1+(\beta_1+\beta_2+i_b\tau_3)\alpha_1 +\beta_2 j_b l_b\phi_1 v_{2b}\alpha_1 + i_b\tau_3\phi_1 v_{2b}\alpha_1\} +(\tau_3\phi_1 v_{2b}-\tau_1)] \quad <0 \quad (4.68)$$

$$a_{12} = [\tau_1-\tau_3\phi_1 v_{2b}(\delta_1+\alpha_1\alpha_2)]\ [k_1k_2h_b\{\beta_2 j_b(w_b+l_b\phi_1)+i_b\tau_3\phi_1\}+ \tau_3\phi_1 h_b] <0 \qquad (4.69)$$

$$a_{21} = -[(m_1+\Gamma)+\beta_3\alpha_1\alpha_2][k_1k_2\{-i_b\tau_1+(\beta_1+\beta_2+i_b\tau_3)\alpha_1+\beta_2 j_b l_b\phi_1 v_{2b}\alpha_1 +i_b\tau_3\phi_1 v_{2b}\alpha_1\}+\beta_3\alpha_1] \quad <0 \quad (4.70)$$

$$a_{22} = -[(m_1+\Gamma)+\beta_3\alpha_1\alpha_2]k_1k_2h_b[\{\beta_2 j_b(w_b+l_b\phi_1)+i_b\tau_3\phi_1\}] <0 \quad (4.71)$$

The sign of the element a_{11} is negative which can be specified analytically. Two conditions are required for this. The first condition is that $\tau_1 <[\tau_3\phi_1 v_{2b}(\delta_1+\alpha_1\alpha_2)]$ which is obviously satisfied; this makes the term within the first parenthesis [.] negative. The second condition is $\tau_3\phi_1 v_{2b}>\tau_1$ (see the last term in a_{11}) which is also easily met. Thus, it is proved that $a_{11} <0$.

The element a_{12} is also invariably negative as it is premultiplied by a negative expression. We have proved above that $[\tau_1-\tau_3\phi_1 v_{2b}(\delta_1+\alpha_1\alpha_2)] <0$. This proves $a_{12} <0$. By the same token, a_{21} is negative which can easily be inferred. Note that it is also pre-multiplied by a negative expression. Though $i_b\tau_1$ term appears with a negative sign within the second parenthesis, but it is not enough to turn the whole expression inside the parenthesis into positive. A close look would show that a_{22} is unambiguously negative.

The characteristic matrix of (4.67) is given by:

$$\begin{bmatrix} dk \\ db \end{bmatrix} = \begin{bmatrix} a_{11}-w & a_{12} \\ a_{21} & a_{22}-w \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad (4.72)$$

The characteristic equation is:

$$h_0 w^2 - h_1 w + h_2 = 0 \qquad (4.73)$$

where;

$h_0 = 1$

$h_1 = (a_{11} + a_{22})$

$h_2 = (a_{11}a_{22} - a_{21}a_{12})$

According to the Routh-Hurwtiz theorem (see Gandolfo, 1971, pp. 239-241) the stability of roots could be checked by means of inequalities involving the coefficients of characteristic equations. The necessary and the sufficient condition for stable roots are:

$h_1 > 0$

$h_1 h_2 > 0$;

Given that the first condition is satisfied, both of these conditions can be expressed in equivalent ways as:

$h_1 > 0$

$h_2 > 0$; and

$h_1 > 0$ requires that $(a_{11} + a_{22}) < 0$.

$h_2 > 0$ requires that $(a_{11}a_{22} - a_{21}a_{12}) > 0$.

The first condition (ie. $h_1 > 0$) is easily satisfied as both of the elements a_{11} and a_{22} are negative and the sum of two negative terms is always negative. The satisfaction of second condition (ie., $h_2 > 0$) requires that $a_{21}a_{12} > a_{11}a_{22}$ in absolute terms. It should be noted that the sign assignment of the second condition for stability is not easy analytically. Therefore, we evaluated them by substituting average values of the relevant ratios and the estimated long-run values of the parameters obtained in chapter 5. The stability condition is found to be satisfied. It should be noted that though the signs of a_{11}, a_{12}, a_{21}, a_{22} and the first condition of stability was specified above analytically without much difficulty, even then we evaluated them by substituting the relevant ratio and parameter values. This also confirms our analytical results. Therefore, we conclude that the model is dynamically stable. These parameter values are reported in appendix: 4.A. It would have been nice to be able to obtain analytical stability conditions with economic interpretation. However, this proved too difficult due to the complexity of the model with the financial sector included.

4.5 Summary and Concluding Remarks

In this chapter we analytically developed a simplified version of the full model developed in earlier two chapters. We analysed the possible macroeconomic consequences of various domestic policy changes and foreign shocks both in the short and long run. In the short-run analysis, the supply side effects are largely assumed to be given and the model is essentially demand driven. Capital stock, foreign reserves and domestic debt were treated as state variables. In the short-run, nominal asset stock can change only through changes in currency demand. However, price changes do affect the stock of real financial assets.

In the long-run, the supply side fully responds in the model. The system is solved with the assumption that capital stock, foreign reserves and domestic debt achieve their steady state values. The fiscal deficit and the balance of payments effects are transmitted into financial asset stocks. This treatment of short-run and long-run analysis obviously produce different policy multipliers, which we explained above.

The major difference between the model analysed in this chapter and the standard Keynesian model, as represented by the Hicksian IS/LM framework, involved the treatment of money and finance and the specification of the investment function. The institutional pegging of nominal interest rates, absence of money market with market clearing interest rates made the LM part of the IS/LM framework inapplicable in our model. In the IS relationship real balances affect private sector consumption expenditure. Bank lending affects the investment function. The budget deficit and the balance of payment deficit directly affect the monetary flows.

Our model replaces the traditional security based financial system with a bank based one. Banking systems' liabilities are the only financial assets available to the private sector. Interest rates do not link the monetary and the real sectors, rather they affect financial asset stocks and these asset stocks, in turn, affect the real spending of the private sector. Thus, a bank based but repressed financial system, a direct role of credit availability on investment function and a different transmission mechanism of interest rates are the distinguishing feature of this model.

Various policy measures considered above show different short-run and long-run effects. Particularly, the differences of the effects of monetary policy instruments on prices and trade balance in these two scenarios are prominent. In the model, the supply side effects of monetary policy instruments are effective in the long-run as opposed to the demand side effects in the short-run.

In the analytical model we also considered some policy analysis in terms of managing the economy. For example, our comparative statics show the required rate of devaluation associated with a given rate of increase in the government spending to keep the trade balance in balance. Similar other policy exercise are performed. The assessment of the stability of equilibrium shows the model to be dynamically stable.

An analytical model provides insights of the important relationships and the workings of a representative empirical model. To face reality, we must turn to the empirical model building and confront the validity of our theoretical insights empirically. This is what we will accomplish in the next chapter.

Notes

(1) As the competitors' price is assumed to be exogenously determined, any movement in real exchange rate is identical to a movement of the relative price of exports.

(2) We have not included lagged reserves term as an argument in the import equation in this analytical model as we fix this term in the full model simulation. However, we allow it in the estimation stage. A detailed account of the motivation for fixing the reserves term in the import equation and the imports to income ratio term in the price equation while conducting the simulations is given in Chapter 6 under the sub-title *Simulation Specification*.

(3) In presenting the supply function in this form we have fixed the import and inflation surprise terms, therefore, it should be viewed as a "longer run" relationship, whereby that we mean a period which is long enough for prices to have had time to adjust but short enough for the adjustment of capital stock and asset stocks. This is clearly an abstraction.

(4) In this formulation exogenous capital flows are held fixed and, therefore, not included explicitly. However, in the empirical model they are included. For obvious reasons it does not affect our analytical results.

Appendix: 4.A

A. Derivation of short-run reduced form equations

Upon repeated substitution of the system of equations given in (4.1) - (4.18) we arrive at the following set of equations on y, p, l, m, a, and q for the short-run analysis.

$$y = k_1[x_b z + \beta_1(e+p^*-p)+\beta_2 a+g_b g-i_b\tau_2 r^*-i_b\tau_1 k+i_b\tau_3 q] \quad (4.74)$$

$$p = e + p^* + \alpha_1(\alpha_2 y-k) \quad (4.75)$$

$$l = \phi_1[n+h_b(h+s)] - \phi_1 v_{2b}[\delta_1 y- \delta_2 r_j -\delta_3\pi^e + p] - \phi_2 r_d +\phi_3 r_1 - \phi_4\epsilon \quad (4.76)$$

$$m = j_b(w_b+l_b\phi_1)[n+h_b(h+s)]-[j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}]^* [\delta_1 y-\delta_2 r_j-\delta_3\pi^e+p]-j_b l_b\phi_2 r_d+j_b l_b\phi_3 r_1-j_b l_b\phi_4\epsilon. \quad (4.77)$$

$$a = m - m\ p \quad (4.78)$$

$$q = l - l\ p \quad (4.79)$$

Normalising m = l = 1 and substituting (4.78) and (4.79) in to (4.74) and further substitution of (4.75), (4.76) and (4.77) in to (4.74) gives the following two reduced form equations on y and p for the short-run.

$$\begin{aligned} y = {} & k_1k_2\ [x_b z+\beta_1(e+p^*)+g_b g-i_b\tau_2 r^* -i_b\tau_1 k] \\ & - k_1k_2[(\beta_1+\beta_2+i_b\tau_3)+\beta_2\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\}+i_b\tau_3\phi_1 v_{2b}] [e+p^*-\alpha_1 k] \\ & + k_1k_2\beta_2\ [j_b(w_b+l_b\phi_1)\{n+h_b(h+s)\}-\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\} \\ & \{-\delta_2 r_j-\delta_3\pi^e\}-j_b l_b\phi_2 r_d+j_b l_b\phi_3 r_1-j_b l_b\phi_4\epsilon] \\ & + k_1k_2 i_b\tau_3[\phi_1\{n+h_b(h+s)\}-\phi_1 v_{2b}\{\delta_2 r_j-\delta_3\pi^e\}-\phi_2 r_d+\phi_3\epsilon] \end{aligned} \quad (4.80)$$

$$\begin{aligned} p = {} & e+p^* +\alpha_1\alpha_2 k_1k_2\ [x_b z+\beta_1(e+p^*)+g_b g-i_b\tau_2 r^* -i_b\tau_1 k] \\ & -\alpha_1\alpha_2 k_1k_2[(\beta_1+\beta_2+i_b\tau_3)+\beta_2\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\}+i_b\tau_3\phi_1 v_{2b}]^* \\ & [e+p^*-\alpha_1 k] \\ & +\alpha_1\alpha_2 k_1k_2\beta_2\ [j_b(w_b+l_b\phi_1)\{n+h_b(h+s)\}-\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\}^* \\ & \{-\delta_2 r_j-\delta_3\pi^e\}-j_b l_b\phi_2 r_d+j_b l_b\phi_3 r_1-j_b l_b\phi_4\epsilon] \\ & + \alpha_1\alpha_2 k_1k_2 i_b\tau_3[\phi_1\{n+h_b(h+s)\}-\phi_1 v_{2b}\{-\delta_2 r_j-\delta_3\pi^e\}-\phi_2 r_d+\phi_3\epsilon] \\ & -\alpha_1 k \end{aligned} \quad (4.81)$$

B. Derivation of the long-run reduced form equations

Following set of equations describe the system for the long-run:

$$a = (1/k_3\beta_2)y - (1/\beta_2)[x_b z+\beta_1(e+p^*-p)+g_b g] \qquad (4.82)$$

$$m = a + p \qquad (4.83)$$

$$q = l - p \qquad (4.84)$$

$$(h+s) = \{1/[h_b j_b(w_b+l_b\phi_1)]\}[m-j_b(w_b+l_b\phi_1)n+\{j_b(w_b+l_b\phi_1)v_{2b}- v_{1b}\}\{\delta_1 y-\delta_2 r_j-\delta_3\pi^e+p\}+j_b w_b\phi_2 r_d-j_b w_b\phi_3 r_1+j_b l_b\phi_4\epsilon. \qquad (4.85)$$

$$l = \phi_1[n+h_b(h+s)] - \phi_1 v_{2b}[\delta_1 y- \delta_2 r_j -\delta_3\pi^e + p] - \phi_2 r_d +\phi_3 r_1 - \phi_4\epsilon \qquad (4.86)$$

$$y = [1/(s_{2b}m_{1b}m_1+h_{ib}y_{1b}\Gamma)]\ [n + s_{2b}x_{1b}z + s_{2b}\beta_3(e+p^*-p) + h_{1b}\ g_{1b}g\ ] \qquad (4.87)$$

$$p = e + p^* + \alpha_1(\alpha_2 y-k) \qquad (4.88)$$

$$k = y - \mu_1 r^* + \mu_2 q \qquad (4.89)$$

Note that $\mu_1 = \tau_2/\tau_1$, and $\mu_2 = \tau_3/\tau_1$.

The reduced form long-run equations on y and p are as follows:

$$\begin{aligned}
y = {} & 1/\sigma\ [n+ s_{2b}x_{1b}z + \beta_3 s_{2b}\ (e+p^*)+ h_{1b}g_{1b}g] \\
& -[\beta_3 s_{2b}D_3D_1/\sigma][e+p^*+\alpha_1(\alpha_2-1)\{1/\sigma(n+ s_{2b}x_{1b}z + \beta_3 s_{2b}\ (e+p^*)+ h^{1b}g^{1b}g\}+\alpha_1\mu_1 r^*] \\
& + [D_3D_1\alpha_1\mu_2\beta_3 s_{2b}/\sigma]\ [D_2/\sigma\ \{n +s_{2b}x_{1b}z +\beta_3 s_{2b}(e+p^*) +h_{1b}\ g_{1b}\ g] \\
& +[D_3D_1\alpha_1\mu_2\beta_3 s_{2b}/\sigma]\ [\phi_1 n+\{\phi_1 h_b/(h_b j_b(w_b+l_b\phi 1))\} <-(1/\beta_2)\{x_b z+\beta_1(\ e+p^*)+g_b g\}>] \\
& +[D_3D_1\alpha_1\mu_2\beta_3/(m_1+\Gamma)][\{\phi_1 h_b/(h_b j_b(w_b+l_b\phi 1))\} \\
& <-j_b(w_b+l_b\phi_1)n+\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\}\{\delta_2 r_j-\delta_3\pi^e\}+ j_b l_b\phi_2 r_d-j_b l_b\phi_3 r_1+j_b l_b\phi_4\epsilon>] \\
& +[D_3D_1\alpha_1\mu_2\beta_3/(m_1+\Gamma)][-\phi_1 v_{2b}\{\delta_2 r_j-\delta_3\pi^e\}-\phi_2 r_d+\phi_3 r_1-\phi_4\epsilon]
\end{aligned} \qquad (4.90)$$

$$p = D_3D_1[e+p^*+\alpha_1(\alpha_2-1)\ \{1/\sigma(n + s_{2b}x_{1b}z + \beta_3 s_{2b}(e+p^*) + h_{1b}g_{1b}\ g\} + \alpha_1\mu_1 r^*]$$

$$- D_3D_1\alpha_1\mu_2\ [D_2/\sigma\{n + s_{2b}x_{1b}z + \beta_3 s_{2b}(e+p^*) + h_{1b}g_{1b}g]$$

$$-D_3D_1\alpha_1\mu_2[\phi_1 n+\{\phi_1 h_b/(h_b j_b(w_b+l_b\phi 1))\}$$

$$<-(1/\beta_2)\{x_b z+\beta_1(e+p^*)+g_b g\}>]$$

$$-D_3D_1\alpha_1\mu_2[\{\phi_1 h_b/(h_b j_b(w_b+l_b\phi 1))\}$$

$$<-j_b(w_b+l_b\phi_1)n+\{j_b(w_b+l_b\phi_1)v_{2b}-v_{1b}\}\{-\delta_2 r_j-\delta_3\pi^e\}+$$

$$j_b l_b\phi_2 r_d - j_b l_b\phi_3 r_1 + j_b l_b \phi_4\epsilon>]$$

$$- D_3D_1\alpha_1\mu_2[-\phi_1 v_{2b}\{-\delta_2 r_j-\delta_3\pi^e\}-\phi_2 r_d+\phi_3 r_1-\phi_4\epsilon\ ] \qquad (4.91)$$

C. List of Parameter Values Used to Evaluate the Roots

$k_1 = 1.1$	$k_2 = 0.1$	$c_1 = 0.7$
$\Gamma = 0.2$	$\tau_1 = 1$	$\tau_3 = 0.1$
$m_1 = 2.0$	$\phi_1 = 1$	$\beta_1 = 0.29$
$\beta_2 = 0.09$	$\beta_3 = 2.86$	$\delta_1 = 2.5$
$\alpha_1 = 1.4$	$\alpha_2 = 2.9$	$c_b = 0.73$
$y_b = 1.2$	$T_b = 0.17$	$i_b = 0.1$
$m_b = 0.19$	$v_{2b} = 5.95$	$l_b = 1.17$
$x_b = 0.14$	$j_b = 0.67$	$w_b = 0.092$
$h_b = 7.0$		

CHAPTER 5

Estimation and Testing of Empirical model

Introduction

In this chapter we set out the empirical testing of the theoretical relationships developed in our model. Since most of the theoretical underpinnings have already been discussed at length, our approach would be to directly address the empirical issues. Accounting identities have already been specified in theoretical chapters, therefore, we will refrain from discussing them as well.

The empirical model differs from the analytical model at least in two respects. Firstly, a greater degree of disaggregation is done in the empirical model. Secondly, we presented a static analytical model, but the empirical model allows for dynamics in all the estimated relationships.

Equations are estimated with annual data covering the period from 1961-1985. Sample size is relatively small, but we are constrained by the unavailability of data. Almost all data series are derived from either IMF or the World Bank sources. Data sources, forecasting and conversion methods are given in data appendix at the end of this dissertation.

The rest of the chapter is planned as follows. In the first section we briefly discuss our estimation strategy ie., the econometric strategy employed. In the second section unit root tests are reported. In the third section we present the empirical estimates of our stochastic relationships. The fourth section covers some partial simulations. And the chapter is closed with concluding remarks. Variable definitions are provided in appendix 5.A at the end of the chapter.

5.1 Econometric Strategy

Several distinct methodologies for econometric analysis have been developed in recent years. The most common, in specifying the dynamic relationships, are "general-to-specific" and the "cointegration" approaches.

The former methodology is also dubbed as the London School of Economics (LSE) tradition and could be found in the works of Sargan (1964), Davidson et al. (1978), Hendry (1979 and 1985), Davidson and Hendry (1981), Hendry and Richard (1982), Harvey (1981) and Mizon and Richard (1986); to name but a few.

The latter approach also known as the Engle-Granger two-stage procedure originated out of the works of Granger (1983) and Engle and Granger (1987). This approach is increasingly becoming popular in time series modelling. The works of Sargan and Bhargava (1983), Bhargava (1986), Banarjee et al. (1986), Phillips and Ouliaris (1987), Engle and Yoo (1987), Phillips and Perron (1988), Perron (1988), Johansen (1988), Engle and Yoo (1989) have significantly contributed to the development of this approach. A good survey of this approach, among others, can be found in Muscatelli and Hurn (1992).

The "general-to-specific" approach starts with all the explanatory variables postulated by economic theory in a relationship. Given that agents will normally be operating in a dynamic environment it allows for all the possible lag lengths on lagged dependent and other exogenous variables. Following Cuthbertson et al. (1992) the real world process of generating Y_t can be stated as:

$$Y_t = a_0 + \Sigma_{i=1}{}^{n} a_i Y_{t-i} + \Sigma_{k=1}{}^{m} \Sigma_{i=0}{}^{n} b_{ki} X_{kt-i} + u_t \quad (5.1)$$

Equation (5.1) is a general ADL representation and depicts the dependent variable Y_t to be a function of its lagged values of the order of n and a vector of explanatory variables X which are m in numbers each with n lags. The X is assumed to be weakly exogenous and u_t is a white noise disturbance term. The general-to-specific approach takes (5.1) as the maintained hypothesis and a search for a parsimonious representation, also known as Error Correction Model (ECM), begins by sequentially imposing economically meaningful restrictions and deleting insignificant X and lags. Each stage of parameterisation is tested, consequently, the resulting ECM equation passes rigourous diagnostic checks. In this process importance is attached to the theoretically desirable long-run properties of the relationship.

The Engle-Granger two-stage procedure, on the other hand, takes a different approach which can be described as follows. In the first stage, a prior levels regression is performed and the hypothesis of a unique cointegration vector is tested. The test of the uniqueness of the cointegrating vector is due to Johansen (1988). This static regression, known as the cointegrating regression, is used as the long-run relationship. In so doing it should be ensured that all the variables entering this regression be integrated of the same order. Standard unit root tests viz., Dickey-Fuller (DF, Dickey and Fuller, 1979, 1981), Augmented Dickey Fuller (ADF), Cointegrating Regression Durbin-Watson (CRDW), and Z type tests due to Perron (1988) are employed to test the order of integration of single series. This is by no means the exhaustive list of unit root tests. Engle-Granger (1987) alone provide seven such tests.

In the second stage, a dynamic model is estimated utilising the residuals of the first stage as the error correction term. However, it should be noted that while testing the stationarity of the first stage residuals we have to use different critical values of above tests, as opposed to the critical values employed, in testing the order of the integration of a series. These critical values are provided by Engle and Granger (1987). Mackinnon (1991) provides the response surface estimates of the critical values for DF and ADF statistics. For a dependent variable Y_t in terms of a vector of explanatory variables X_t this procedure can be shown as follows:

In the first stage a static OLS of Y_t on X_t is performed:

$$Y_t = \beta X_t + e_t \qquad (5.2)$$

In the second stage a dynamic relationship is formulated as:

$$\delta Y_t = A(L)\delta Y_{t-1} + B(L)\,\delta X_{t-1} + \phi\,(Y - \beta X)_{t-1} + v_t \qquad (5.3)$$

where A(L) and B(L) are finite order lag polynomials and δ is the difference operator. A parsimonious ECM representation of (5.3) is specified by employing the testing procedures similar to that of "general-to-specific" approach. Since all the variables in (5.3) are stationary, one can employ the standard method of statistical inference (e. g. standard 't' test) in order to specify a preferred model. Application of OLS in (5.2) also gives super-consistent estimates (Engle and Granger, 1987; Stock, 1987).

One important implication of these two approaches is that the "two-stage" procedure, in essence, imposes the long-run parametric values on the short-run relationships whereas in the "general-to-specific" *both the short-run and the long-ru* properties are interdependent. However, asymptotically both of these approaches are expected to yield the same error-correction model, but in finite samples this may not be the case. We do not go into any further details of these procedures as this can be found in the references cited above.

One cannot say, *a priori*, whether one or the other approach is preferable. The "general-to-specific" approach has an important defect, namely, the asymptotic distribution of estimated parameters is non-normal. This problem arises when series with different orders of integration are included together in an estimating equation, which is better known as the problem of 'unbalanced' regression (Banerjee et al., 1993). This is exactly what happens in a general-to-specific ECM equation. Variables in first differences and levels appear in a regression equation. The consequence is that the conventional inference procedure using the standard 't' and 'F' statistics for the null hypothesis of interest remain no longer valid. As a matter of fact, these tests become grossly misleading as they tend to be biased in favour of rejecting the null (Banerjee et al., 1993).

On the other hand, the two-stage procedure suffers from small sample bias; the estimate of co-integrating parameter might be substantially biased in finite samples. Furthermore, power of the test statistics is low when the sample size is small (less than 100). Therefore, whether a practitioner should follow one or the other approach is far from resolved.

We have a fairly small sample size, therefore, resorting to two-stage procedure is less appealing to us. The super-consistancy property of the two-stage approach is greatly reduced in our case due to the limited data points. We also face the problem of the low power of the test statistics due to our data points. If our sample size were of reasonable length ie., in the vicinity of 100, we might have been more interested in using the two-stage procedure.

It is also argued that as long as the chosen set of variables in a general-to-specific regression equation produce a stationary residual series ie., cointergate themselves, we need to worry less about the degree of integration of individual series (Dolado et al., 1990). Though the problem of non-standard distribution still remains, but given the problems of small sample bias and low power of the unit root tests, there might be few advantages in sticking to the two-stage procedure. Therefore, given the small sample size, our preference is in the general-to-specific approach.

Despite our choice of general-to-specific approach, we estimate consumption, imports and price equations by means of two-stage procedure. The reason for so doing relates to the fact that the Asian model constructed here is part of a broader research project. The final product will be incorporated into a global model. Other regional models forming the parts of the global model viz., model for the Latin America region and Africa region contained in Srinivasan and Vines (1990) utilise two-stage estimates of these relationships. Therefore, it was decided that we also make use of our two stage estimates for these functions in our model. The aim was to maintain a methodological uniformity across the regional models[1].

Our model forms a simultaneous system of equations, however, the issue of simultaneity remains unadressed. In a fairly large model such as ours, system approach are largely avoided on account of impracticability. Instead OLS or IV methods are used. We resort to OLS as the method of estimation. IV was avoided due to the problems of small sample bias and finding adequate instruments. It is well known that IV estimates are, in general, biased in finite samples and their variances are difficult to establish (Johnston, 1985). A reduced form estimation to circumvent the problem of simultaneity is eschewed for not being informative for the structural features of the model.

Before directly embarking on the estimation of stochastic equations we first visualised the plots of explanatory variables against dependent variables to understand the nature of series and watch out for any outliars. Then, we studied the time series properties of our data employing unit root tests. However, we report unit root test statistics of only those variables which are included in the "two-stage" procedure. The functional form is assumed to be log-linear. A useful property of this functional form is that the calculated coefficients directly yield point elasticities.

When we move from a general dynamic model to a restricted parameterisation we assess the validity of our model through a range of diagnostic test statistics commonly used in applied econometrics work. We set out a brief outline of these tests below barring ourselves from the discussion of their theoretical derivation.

Testing Restriction: any restrictions we imposed in a relationship are tested and retained only if they are data acceptable. These restrictions can be either exclusion restrictions or a priori linear restrictions on parameter values. Simple exclusion restrictions can be judged from the standard t test, however, a set of linear restrictions must be assessed from a more general test. We apply the F-test which is a special version of the likelihood ratio test for this purpose.

Testing Serial Correlation: it is well known that any model we adopt should be characterised by a white noise error process. There are several test statistics in detecting the serial correlation process (Johnston, 1985; Greene, 1990). One of the earliest and most popular test is DW test due to Durbin and Watson (1950). We do not rely on this test due to its well-known shortcomings. We rely on a more general test of autocorrelation commonly known as LM test for serial correlation due to Breusch (1978) and Godfrey (1978). We report the F version of this test as Kiviet (1986) has shown that, in small samples, this version is generally preferable to LM version. We also report the Ljung-Box test statistics to detect serial correlation in the error series of DF equation. It has been shown in Harvey (1981) that the Ljung-Box test is likely to perform better than the Box-Pierce test in small samples.

Testing for Normality of Residuals: the use of OLS and the validity of most test statistics depends on the assumption that residuals of the estimated equations are normally distributed. We resort to the most commonly used test statistic known as the Bera-Jarque test (Bera and Jarque, 1982; Spanos, 1986). This test involves testing whether the third and the fourth moment of the residuals in an estimated equations are significantly different from the properties of normal distribution.

Testing Heteroscedasticity: we apply two tests for the detection of heteroscedasticity. The first is the common Breusch-Pagan test which tests that explanatory variables might have caused the heteroscedasticity (Johnston, 1985). Secondly, We also report the ARCH process due to Engle (1982). In this formulation heteroscedasticity is assumed to be caused by the past values of the squared errors. We report the Breusch-Pagan test in "F" form. The ARCH is in Chi Square form.

Testing Functional Form: we assume a log-linear functional form. However, there exists a fairly general test of functional misspecification known as RESET test due to Ramsey (1969). In this test the alternative model is a higher order polynomial. We report this test statistic as well.

Testing structural stability: we assess the parameter stability of each specified relationship by utilising the Chow test type one (Chow, 1960). In applying this test we follow a general approach of leaving some of the end of period sample observations (years) and thus splitting the whole samples into two. This gives us the three models; one full sample which is called the restricted and the two subsamples called unrestricted models. In so doing it is ensured that the deleted end of period observations (number of years in our case) be greater than the total number of regressors inclusive of the constant term in the equation.

An alternative test of structural stability is to visualise the plots of CUSUM and CUSUM Square plots due to Brown et al. (1975). This is based on resursive estimation and testing of parameter stability and shows the point of time of any structural breaks in the estimated relationship.

Though we do not report these plots for the reason of space limitation, we assess the recursive errors of our estimated equations and invariably indicate their performance in the discussion that follows. Particularly, we will indicate if plots of recursive residuals cross the 5.0 percent significance boundary.

A related test is the predictive failure test also known as Chow's second test. This test essentially tests the equality of variance in two samples. We report this statistic as well. We also report the F statistics which tests the joint significance of regressors (excluding the intercept).

Unless otherwise specified, we apply the usual five percent significance level in interpreting the significance or insignificance of a test statistic. This completes the description of our estimation strategy and testing procedures.

Now, we turn to the presentation and analysis of our empirical equations:

5.2 Unit Root Tests

Below we provide the test statistics of unit root tests involving various data series of our model. As explained above, we have limited our reporting to those series which are utilised in "two-stage" modelling procedure.

Table 5.1: Testing for I(0)

Variables	Tests Statistics		
	DF	ADF(2)	CRDW
cons	0.53	0.72	0.03
yd	0.32	0.92	0.02
(pxgn-pmgn)	-0.91	-0.20	0.18
ced	-0.28	-0.45	0.05
rex	-0.64	-0.90	0.12
mgn	-0.58	-0.23	0.05
m2	1.09	1.09	0.12
(y-k)	-1.56	-2.48	0.08
nw	-0.13	0.17	0.07
(pmgnl-nw)	-2.00	-1.78	0.65
(ced-nw)	-2.15	-2.10	0.80

Sample 1962-1985.

The 5.0 percent critical values are -2.99, -3.0 and 0.72 for DF, ADF and CRDW, respectively. Critical Values for DF and ADF are computed using MICROFIT386 (Pesaran and Pesaran, 1991). CRDW is taken from Banerjee et al. (1993). CRDW should be interpreted with care as it relates to two variables and 50 observations.

All the test statistics are insignificant at 5.0 percent significance level judged from their critical values, therefore, we can not reject the null that all the series are I(1). In other words, none of these series are I(0).

Table 5.2: Testing for I(1)

Variables	Test Statics		
	DF	ADF(2)	CRDW
cons	-5.59	-2.64	2.39
yd	-4.95	-3.31	2.15
(pxgn-pmgn)	-3.72	-3.43	1.59
ced	-4.25	-2.51	1.73
rex	-2.89	-2.38	1.14
mgn	-3.83	-2.43	1.59
m2	-3.10	-2.99	1.23
(y-k)	-4.39	-2.70	1.89
nw	-5.00	-3.10	2.32
(pmgnl-nw)	-3.76	-3.13	1.76
(ced-nw)	-4.00	-3.22	1.89

We can clearly reject the null of I(2) and conclude that all series are I(1).

5.3 Empirical Estimation

Notation and abbreviations

Every where below lower case represents natural logs.

ARCH = ARCH test for heteroscedasticity.

DP = Data Period

ECM = Residual Series from the Cointegrating Regression.

$F(v_1, v_2)$ = 'F' Test for Joint Significance of Regressors.

Hetero $F(v_1, v_2)$ = Brusch-Pagan 'F' Statistics for detecting heteroscedasticity.

Normality Test = Test proposed by Bera and Jarque.

Rsq = Rsquire

Rbsq = Adjusted R square

RESET = Ramsey's RESET test for functional misspecification

SE = Standard error of regression

DF = Dickey-Fuller test

ADF = Augmented Dickey Fuller test

CRDW = Cointegrating Regression Durbin Watson Statistic

RCO = Ljung-Box Statics for residuals series of DF equation with order of autocorrelation within parentheses.

Serial F(v_1, v_2) = Brusch-Godfrey F statistic for the detection of serial correlation.

Chow F(v_1, v_2) = Chow test for parameter stability

Predictive failure F(v_1, v_2) = Chow test for predictive accuracy

"t" ratios are given within the parentheses below the relevant variables. v_1 and v_2 are degrees of freedom of 'F' statics. Numbers inside [.] are theoretical critical values. All estimations are done with the package MICROFIT386.

5.3.1 Private consumption

As discussed in chapter 2, the private sector real consumption expenditure is hypothesized to depend on real private sector disposable income, real wealth stock and the terms of trade. Due to data limitations we have used real GDP and Real M2 as the measure of real income and real wealth variables. The Engle-Granger two stage procedure is used to estimate the consumption function.

The cointegrating regression is as follows:

$$cons = 2.5821 + 0.6988\ yd + 0.1173\ (m2-pc) + 0.1556\ (pxgn-pmgn)$$

DF = -3.16; [-4.5]

CRDW = 1.25; [0.89]

RCO = 0.16 (1); 0.4 (2); 2.5 (3); and 2.9 (4).

The second stage dynamic estimation is:

$$\delta cons = \underset{(2.28)}{0.0212} + \underset{(4.94)}{0.6848}\ \delta yd + \underset{(2.04)}{0.1012}\ \delta(pxgn-pmgn) - \underset{(-2.84)}{0.1651}\ \delta ced - \underset{(-3.39)}{0.6739}\ ecm(-1)$$

Rsq = 0.79

Rbsq = 0.75

SE = 0.003

Mean of dependent variable = 0.038

F(4, 19) = 18.35; [2.9]

Hetero F (1, 22) = 0.008; [4.30]

ARCH Chi(1) = 1.46; [3.84]

ARCH Chi(2)= 4.3; [5.99]

Serial F(4, 15) = 1.84; [3.06]

RESET F(1, 18) = 0.24; [4.41]

Normality B-J Chi(2) = 1.6; [5.99]

Chow F(5, 14) = 0.98; [2.96]

Predictive Failure F(6,13) = 0.78; [2.92]

DP = 1962-1985

The first stage estimation shows sensible and correctly signed long-run elasticities. The long-run income and wealth elasticities are 0.7 and 0.12, respectively. The terms of trade also shows a long-run effect on consumption and the elasticity is 0.16. DF critical values are computed by using the response surface estimates given in Mackinon (1991) using MICROFIT386. ADF statistics rejects cointegration but CRDW accepts, therefore, we accept that the ECM term is stationary ie., the variables in the static regression are cointegrated. Bhargava (1986) demonstrates that CRDW has excellent power properties relative to alternative tests when the error term is a stationary first order autoregressive process. The Ljung-Box test statistics for residual autocorrelation are reported for cointegrating regression DF residuals. RCO shows DF errors to be stationary, therefore, ADF bears little meaning and hence not reported.

The second stage dynamic specification is also encouraging. A note-worthy point is that the short-run and the long-run income elasticities are very similar, but the wealth effect is not significant in the short-run. This is a sensible outcome. We expect the wealth effect on consumption to be gradual and, if anything, income contributes to the accumulation of wealth in the long-run. Therefore, we expect both the long-run and the short-run income elasticities to be of similar magnitude. The inflation effect is negative and significant in the short-run. The terms of trade effect is also correctly signed and significant. The ECM term is correctly signed and highly significant. Given the size of the ECM coefficient the speed of adjustment is sensible.

We have reported a number of diagnostic test statistics. The equation explains 75.0 percent (Rbsq = 0.75) of the variations in the rate of change of real private sector consumption expenditure.

The standard error of the equation is 0.3 percent. Both the Breusch Pagan and ARCH tests show residuals to be homoscedastic. The LM test statistic for serial correlation is insignificant and indicates that residuals are white noise. The B-J test shows residuals to be normally distributed. The RESET test indicates that the model is not functionally misspecified. The equation also shows parameter stability and predictive accuracy as the chow tests are highly insignificant.

5.3.2 Investment

In our theoretical specification net investment is hypothesized to depend on the level of output, the stock of capital, the cost of capital and the availability of credits (ie., real bank lending). The empirical estimation is as follows:

$$\underset{}{\delta k} = \underset{(-1.24)}{-0.0348} \; \underset{(3.36)}{+0.5362}\, \delta k(-1) \; \underset{(2.36)}{+0.130}\, \delta yd \; \underset{(-2.92)}{-0.106}(k-y)_{-1}$$

$$+ \underset{(1.95)}{0.0103}\,(adv-pc)$$

Rsq = 0.69

Rbsq = 0.62

Standard error = 0.005

Mean of dependent variable = 0.057

F(4, 17) = 9.51; [2.76]

Hetero F (1, 20) = 0.017; [4.36]

ARCH Chi(1) = 0.58; [3.84]

ARCH Chi(2) = 4.88; [5.99]

Serial F(4, 13) = 0.16; [3.18]

RESET F(1, 16) = 0.40; [4.49]

Normality B-J Chi(2) = 0.23; [5.99]

Chow F(5, 12) = 1.06; [3.03]

Predictive Failure F(6,11) = 0.86; [3.0]

DP = 1963-1984

Net investment depends positively on changes in real output, lagged investment and real bank credits and negatively on capital stock. The user cost of capital proxied by the domestic real interest rate (real lending rate) turned out to be insignificant, therefore, deleted. Thus, in this economy, the cost of capital measured by the organised sector real interest rate is not effective in affecting the net investment. It may be due to the repressed domestic interest rates which hardly represent the true cost of capital. We have already argued that it is the availability of credits rather than the cost which matters in these economies.

In this context, an obvious and perhaps the best candidate for the cost of capital in these economies would have been the prevailing interest rates in the unorganised markets. This is a formidable source of fund to the private sector investors in LDCs. However, data problem precluded us from its use.

Net investment is homogeneous to capital-output ratio; correctly signed and significant. Homogeneity restriction is tested, found to be data acceptable, and imposed. In the long-run, net fixed capital stock is unit elastic with respect to the level of output. The long-run elasticity of real bank advances is 0.1. It is surprising that the real stock of bank credits, rather than the flow term turned out to be significant and we have retained it.

The equation explains 62.0 percent of variations in net fixed investment. The standard error of regression is 0.5 percent. All the diagnostic test statistics are satisfactory and show the statistical soundness of our estimated equation.

The rate of depreciation is assumed to be a fixed proportion of the lagged capital stock. Gross investment is derived allowing for capital consumption allowances.

$$ifn = \delta k + 0.133\ k(-1)$$

Total investment (inclusive of inventories) is derived using a link equation. Data accepts unit elasticity between gross fixed investment and total investment:

$$it = ifn + 0.1316$$

5.3.3 Exports

The volume index of exports of goods is modelled as a function of export market potential and relative price of exports. The estimated dynamic equation is as follows:

$$\delta xgi = \underset{(2.38)}{2.3673} + \underset{(2.69)}{0.9376}\ \delta s - \underset{(-2.54)}{0.7202}\ \delta(pxa-pxac)$$

$$- \underset{(-2.51)}{0.1953}\ (xgi-s)-1 - \underset{(-2.38)}{0.5090}\ (pxa-pxac)_{-1}$$

Rsq = 0.43

Rbsq = 0.41

Standard error = 0.04

Mean of dependent variable = 0.05

F(4,15) = 25.37; [3.06]

Hetero F (1, 22) = 3.24; [4.41]

ARCH chi(1) = 0.37; [3.84]

ARCH Chi(2) = .48; [5.99]

Serial F(4, 11) = 2.27; [3.36]

RESET F(1, 14) = 6.14; [4.60]

Normality B-J Chi(2) = 4.96; [5.99]

Chow F(5, 10) = 1.04; [3.33]

Predictive Failure F(6,9) = 1.11; [3.37]

DP = 1966-1985

The estimated equation is consistent with our theoretical specification discussed in chapter two. All the coefficients are correctly signed and highly significant judged from their respective "t" statistics. The export of goods is unit elastic with respect to foreign demand (s; a market share weighted volume index of imports of export markets) in the long-run. The homogeneity restriction is found to be data acceptable, therefore, imposed.

It should be noted, however, that in most cases empirical estimates cited in Table: 2.1 of Chapter 2 show a export demand elasticity of more than unity for LDCs. The only exception is the IMF estimate which shows less than unit elasticity. Our result of unit elasticity is not surprising in this context.

As one would expect, the short-run elasticities of relative price and export market potential are smaller compared to their respective long-run values. The long-run relative price elasticity is 2.61.

The equation explains 41 percent of the variation in rate of change of export volume index. Since the dependent variable is the rate of change we reckon the magnitude of Rbsq to be satisfactory. All test statistics except the REST test are satisfactory at 5.0 percent significance level or more. All the homogeneity restrictions pass the tests.

The failure of the RESET test indicates functional misspecification essentially due to the under parameterisation of the true model. The consequence is that the point estimates will generally be biased unless the included and excluded regressors are orthogonal. However, if these two sets of regressors are highly correlated then the problem is less serious. The problem with the RESET test is that it indicates model to be misspecified but does not help us necessarily in choosing a better alternative. However, an obvious remedy of this problem is to include additional regressors and re-estimate the equation. But it may give rise to the problem of multicollinearity. Since we have a small sample and the estimated parameters are theoretically consistent, we decided to use the above equation even if it fails the RESET test.

Index of exports of goods and non-factor services is derived using a link equation of the following form:

$$xgni = xgi - 0.0299$$

The volume index of exports of goods and non-factor services is converted to appropriate level terms as:

$$XGN = const * \exp(xgni)$$

5.3.4 Export Prices

In chapter two we theoretically specified export prices to be a positive function of the domestic cost of production and a negative function of the capacity utilisation index. Two proxies of capacity index are used. The first proxy is computed as follows:

The following regression is performed:

$$y = \alpha + \beta y_{t-1} + \phi I^{g}$$

where y is real GDP and I^g is gross fixed investment.

Capacity Utilisation is constructed as:

$$cu_t = y_t / y_t$$

This capacity utilisation term did not turn out to be significant in estimation, therefore, dropped. We also tried using the capital stock index as another proxy, but again this turned out to be insignificant. Therefore, we dropped the capacity utilisation term and retained absorption deflator as the only explanatory variable for export prices. The estimated equation is as follows:

$$\underset{}{\delta pxa} = \underset{(-3.515)}{-0.0599} + \underset{(8.16)}{1.4775}\,\delta pab - \underset{(-5.27)}{0.6019}\,(pxa-pab)_{-1}$$

Rsq = 0.93

Rbsq = 0.91

Standard error = 0.04

Mean of dependent variable = 0.0751

F(2, 10) = 69.1; [4.10]

Hetero F (1, 11) = 0.25; [4.48]

ARCH Chi(1) = 0.3; [3.84]

ARCH Chi(2) = 5.32; [5.99]

Serial F(4, 6) = 3.41; [4.53]

RESET F(1, 9) = 0.17; [5.12]

Normality B-J Chi(1) = 0.09; [5.99]

Chow F(3, 7) = 2.64; [4.35]

Predictive Failure F(5, 5) = 5.23; [5.05]

DP = 1973-85

The equation explains 93.0 percent of the total variations in the export prices of goods. Export prices are unit elastic with respect to the domestic cost of production in the long-run. All the diagnostic test statistics except the predictive failure test are satisfactory and pass the test at 5.0 percent or more significance level. Judged from its critical value the predictive failure test is slightly less than the 5.0 percent critical value. This is due to the outliar in 1982. The predictive failure test is calculated leaving the end of period five observations for prediction, ie., estimating the equation for 1972-1980 period. However, if we cover this outliar in our estimation ie., estimating for 1972-1982 period and predict for remaining three years the test statistic improves. The resulting predictive failure F(3, 7) turns out to be 4.16 which is insignificant compared with the 5.0 percent critical value [4.35]. Therefore, we do not regard the marginal failure of the predictive test statistics to be serious.

Export prices of goods and non-factor services is derived using a link equation of the form:

$$pxgn = pxa + 0.4467 - 0.0507\ T + 0.0015\ T*T - 0.08\ DMYOIL$$

5.3.5 Imports

The theoretical specification of imports of goods and non-factor services is discussed at length in Chapter 2. The total real imports of goods and non-factor services is hypothesized to be a positive function of real income and a negative function of the real exchange rate. A lagged reserve term is included with an expected positive sign to capture the rationing effects on imports. A time trend is included to capture the effects of import substitution policies (the secular decline of import to income ratio) over time, with an expected negative sign.

The two-stage Engle-Granger procedure is used to estimate the import function. The first stage cointegrating regression is as follows:

$$mgn = -17.1885 + 2.3570\ yd - 0.2606\ rex + 0.1187\ rescp(-1) - 0.0601\ T$$

DF = - 2.4; [-5.2], CRDW = 0.87; [0.89]

RCO: 0.1(1); 0.11(2); 0.18(3); 0.3(4)

The second stage dynamic specification is:

$$\underset{}{\delta mgn} = \underset{(2.43)}{0.4192}\ \delta mgn(-1) + \underset{(2.36)}{0.6364}\ \delta dyd - \underset{(-2.72)}{0.3717}\ \delta rex - \underset{(-3.7)}{0.5551}\ ecm(-1)$$

Rsq = 0.53

Rbsq = 0.43

Standard error = 0.05

Mean of dependent variable = 0.04

Hetero F (1, 22) = 1.33; [4.30]

ARCH Chi(1) = 0.57; [3.84]

ARCH Chi(2) = 3.71; [5.99]

Serial F(4, 11) = 0.58; [3.36]

RESET $F(1, 14) = 0.310$; [4.60]

Normality B-J $Chi(2) = 0.59$; [5.99]

Chow $F(4, 11) = 0.16$; [3.36]

Predictive Failure $F(5, 10) = 0.34$; [3.33]

DP = 1967-1985

The first stage estimation depicts sensible results. The coefficients are correctly signed. DF rejects cointegration but the CRDW test statics is very close, therefore, we take the variables in first stage to be cointegrated. The long-run income elasticity of imports is 2.36, well above its short-run value as one would expect. The long-run exchange rate elasticity is 0.26. As hypothesized the real stock of lagged reserves is significant in the long-run. Though the coefficient is small, the time trend is significant with a correct sign. It shows that import substitution has taken place over time.

The second stage shows that the reserve term is not significant in the short-run. The real exchange rate elasticity is higher in the short-run compared to the long-run. It may be due to the fact that people are more sensitive to relative price change in the short-run and gradually adjust, to some extent, in the long-run. The lagged dependent variable is significant and correctly signed. All the parameter values are sensible and the ECM term is highly significant and correctly signed. All the diagnostic test statistics reported are satisfactory.

5.3.6 *Import prices*

Import price of goods in US $ terms is exogenously determined in the model. Import price of goods and non-factor services in US $ terms is derived using a link of the following form:

pmgn = pma + 0.241

Import price in local currency terms is derived by multiplying the import prices denominated in US $ by the nominal exchange rate:

pmgnl = pmgn + ex

5.3.7 *Other prices*

The real exchange rate: It is defined as the ratio of import prices in home currency terms to home goods prices.

rex = pmgnl-ced

Other Deflators: A common deflator, ie., consumer expenditure deflator, is used to deflate government consumption, investment, and home goods. This is due to the unavailability of separate deflator series.

5.3.8 The Consumer Expenditure Deflator

Our theoretical specification in chapter two states domestic prices to be a function of wages, material (import) costs, output to capital ratio and imports to output ratio. The two-stage Engle-Granger approach is used in estimation. The first stage estimation is as follows:

$$ced = nw - 0.79077 + 0.4519\ (pmgnl-nw) + 1.2995\ (y-k) -0.3410\ (m-y) + 0.1756\ D67$$

DF = -2.20; [-5.2]

CRDW = 1.62; [1.05]

RCO: 0.83(1); 0.83(2); 1.08(3); 1.1(4)

The second stage dynamic ECM estimation is as follows:

$$\underset{}{\delta ced} = \delta w \underset{(-2.32)}{-0.0205} \underset{(15.98)}{+0.7303}\delta(pmgnl-w) \underset{(-2.1)}{-0.1762}ecm(-1) \underset{(3.5)}{+0.1420}\ D67$$

Rsq =0.94

Rbsq = 0.93

SE = 0.039

Mean of dependent variable = 0.0059

F (3, 17) = 85.86 [3.20]

Hetero F (1, 19) = 5.8; [4.38]

ARCH Chi(1) = .004; [3.84]

ARCH Chi(2) = 0.52; [5.99]

Serial F(4, 13) = 1.67; [3.18]

RESET F(1, 16) = 15.9; [4.49]

Normality B-J Chi(2) = 0.61; [5.99]

Chow F(4, 13) = 0; [3.18]

Predictive Failure F(5, 12) = 1.26; [3.11]

DP = 1965-1985

The homogeneity restriction is imposed with a view to improve the estimates (in support of this type of restrictions see Hallman, 1987). It should be noted that in the two stage procedure only dynamic homogeneity is testable and one has to resort to Johansen procedure to employ such a test in the cointegrating equation. We have not utilised the Johansen procedure in any of our estimation.

The first stage estimation shows sensible parameter estimates and all coefficients are correctly signed. Again, DF statistics rejects cointergration but CRDW does not. Therefore, we take that static regression to be cointegrated. RCO shows that DF errors are white noise. The output to capital ratio can be seen as an indicator of capacity utilisation and hence resumes a positive sign. Prices fall with a reduced level of import rationing, therefore, import to output ratio resumes a negative sign. It should be noted that due to data limitations, we have used the national accounts aggregate measures of imports of goods and non-factor services, though the imports of raw materials only would have been more appropriate. A rise in import cost pushes the domestic price level. A dummy variable for an inflationary upsurge in 1967 improved the result.

The second stage also shows sensible results. The equation explains 94.0 percent of the total variations in the rate of a change of prices. Surprisingly, the import rationing term is not significant in the short-run. We would expect a gradual effect of capacity utilisation term on prices, therefore, its insignificance in the short-run is not unusual. The ECM term is correctly signed and significant, but its absolute value suggests a very slow price adjustment process.

All the test statistics are satisfactory except for the Heteroscedasticity and RESET tests which fail at 5.0 percent significance level. We have already explained the implications of the failure of RESET test. Following the same arguments we utilise this result. The problem of heteroscedasticity does not affect the unbiasedness property of OLS estimators, however, the reliability of 't' statistics and hence the derived inference are reduced. The econometric solution to this is to resort to Feasible General Least Square (FGLS) since we do not know the form of heteroscedasticity. However, the FGLS is only asymptotically efficient, therefore, give our sample size it is not appealing.

5.3.9 Wages

Wage equation is adopted from Chris Allen (1989). We replicated the results and reported some additional diagnostic statistics. The real wage is modelled as a function of productivity and inflation surprises. In the long-run wages are determined by productivity as proxied by GDP, but in the short-run inflationary expectations do affect it. In other words, real wage bargaining is assumed to take place on the basis of productivity and expected inflation.

$$w = ced \; -2.7603 + \underset{(-3.41)}{} \; 0.3121 \, yd(-1) \underset{(4.66)}{} - 0.8625 \, \delta_3 ced \underset{(-3.5)}{} - 0.3081 \, D75 \underset{(-4.6)}{}$$

Rsq = 0.79

Rbsq = 0.75

SE = 0.08

Mean of dependent variable = 0.84

F (3, 17) = 21.13; [3.59]

Hetero F (1, 19) = 0.04; [4.38]

ARCH Chi(1) = 0.61; [3.84]

ARCH Chi(2) = 0.74; [5.99]

Serial F(4, 13) = 1.7; [3.18]

RESET F(1, 14) = 5.5; [4.60]

Normality B-J Chi(2) = 0.25; [5.99]

Chow F(4, 13) = 0; [4.60]

Predictive Failure F(5, 12) = 1.88; [3.11]

DP = 1964-1984

Coefficients are correctly signed and statistically significant. Price homogeneity is imposed. Output elasticity is 0.31. The short-run dynamics are important as the $\delta_3$ced term resumes a high value. All the diagnostic tests except the RESET test are satisfactory. As explained before we utilise this equation despite the failure of RESET test. A significant dummy for 1975 with negative sign suggests that there was a major reduction in real wages during the first oil shock.

5.3.10 Aggregate Supply

The derivation of supply side is familiar from section 2.3 and equation (2.25) in Chapter 2. Substituting wage and price equation and solving for output gives the following aggregate supply side equation:

$$y^s = 1.27 - 0.25\ rex + 0.72\ k + 0.19\ m + 0.26\ \delta_3\ ced.$$

Thus, aggregate supply is a positive function of capital stock, imports and inflationary surprises, but a negative function of the real exchange rate. An appreciation of the real exchange rate increases aggregate supply through a reduction in import costs. In the full model simulation we fix the import term.

5.3.11 Government Accounts

Government Revenue

Government revenue is modelled as a fixed proportion of GDP at market prices. Data limitation precluded us from modelling tax function in any rigourous way, for example, allowing for tax collection lags etc. So,

$$GR = 0.16\ YDCP$$

Government Expenditure

Total government expenditure is composed of government consumption expenditure, investment expenditure (assumed to be a fraction of total investment), amortization of external debt, and servicing of internal and external debts. All are expressed in nominal terms. Real government consumption expenditure is assumed to be exogenous. Domestic debt is assumed to be rolled over.

$$GE = GC * PGC + 0.38 (IT * PK) + AMT + INTR + r * HDN(-1)$$

Amortization

A fixed proportion of outstanding external debt is assumed to be amortised every year.

$$AMT = 0.0806 DOD (-1)$$

Interest Obligation

Net interest payments abroad are derived by subtracting interest receipts on reserve holdings from interest dues on outstanding loans. The latter is calculated as a four year weighted distributed lag of LIBOR on outstanding debt. The former is calculated at the rate of current LIBOR on lagged reserves holdings.

$$INTR = DOD(-1) *.01 *0.73 * LIBOR$$
$$+0.27 *.01 *\{0.25 \textstyle\sum_{i=1}^{4} LIBOR_i\} -LIBOR * RESCP(-1) *.01$$

5.3.12 Net Foreign Assets

The stock of net foreign assets is assumed to depend linearly on the stock of foreign reserves and derived using a link equation of the following form:

$$NFA = RESCP - 692$$

5.3.13 Net Central Bank Lending to Government

In chapter three we showed that the Central Bank cannot exercise its discretion on the volume of its credits to the government. It adjusts passively as a residual source of financing the government budget deficit. A fixed proportion of the government budget deficit is assumed to be borrowed from the Central Bank, thus:

$$\delta NCLG = 0.49 * GBD$$

5.3.14 Demand for Currency

The real stock of currency demanded by the non-bank private sector is hypothesized to be a positive function of real income, and a negative function of expected inflation and deposit rates. These theoretical specifications are already discussed in section 3.2.6 in Chapter 3. The estimated equation is as follows:

$$\underset{}{cpk} = \underset{(-1.71)}{-3.017} \underset{(2.096)}{+0.3399\,yd} \underset{(6.97)}{+0.8714\,cpk(-1)} \underset{(-4.56)}{-0.9555\,\pi^{e}} \underset{(-1.08)}{-0.0372 depor}$$

Rsq = 0.97

Rbsq = 0.96

SE = .04

Mean of dependent variable = 5.35

F (4, 18) = 126.31; [2.93]

Hetero F (1, 21) = 0.76; [4.32]

ARCH Chi(1) = 0.03; [3.84]

ARCH Chi(2) = 0.31; [5.99]

Serial F(4, 14) = 0.64; [3.11]

RESET F(1, 17) = 0.30; [4.45]

Normality B-J Chi(2) = 1.99; [5.99]

Chow F(5, 13) = 0.62; [3.03]

Predictive Failure F(6, 12) = 0.51; [3.0]

DP = 1963-1985

A simple partial adjustment process explains the data well. The equation explains 97.0 percent of the variations in the real stock of currency demanded. All the regressors are jointly highly significant. The short-run income elasticity of currency demand is 0.34, but the long-run is 2.64. The long-run expected inflation elasticity is 1.1. The coefficient of lagged dependent variable is significant, and it indicates that 23.0 percent of the discrepancy between the desired and the actual real currency stock is eliminated in a year. The coefficient of the deposit rate is correctly signed, but statistically insignificant. However, we have retained it for simulation purpose. All the diagnostic tests reported are satisfactory.

5.3.15 Demand for Free Reserves

We have theoretically specified the banking system's free reserves to be determined by the discount rate and the lending rate. The estimated equation is as follows:

$$\underset{}{FRRP} = \underset{(3.72)}{8.4567} + \underset{(2.48)}{0.6140}\, DISCR - \underset{(-3.7664)}{0.7429}\, LR + \underset{(2.47)}{0.4355}\, FRRP(-1)$$

Rsq = 0.84

Rbsq = 0.81

SE = 0.54

Mean of dependent variable = 2.78

F (3, 17) = 29.42; [3.59]

Hetero F (1, 19) = 0.87; [4.38]

ARCH Chi(1) = 0.28; [3.84]

ARCH Chi(2) = 2.82; [5.99]

Serial F(4, 13) = 0.38; [3.18]

RESET F(1, 16) = 1.64; [4.49]

Normality B-J Chi(2) = 1.62; [5.99]

Chow F(4, 13) = 1.53; [3.18]

Predictive Failure F(5, 12) = 1.18; [3.11]

DP = 1965-1985

The equation explains 84.0 percent of the variations in the free reserve ratio of the banking system. Both the discount rate and lending rates are statistically significant and correctly signed. Since the coefficient of the lending rate is greater than that of the discount rate, an equiproportionate rise in both of these rates will reduce free reserves and increase the stock of money. As already explained in the preceding chapter this outcome must be viewed in the context of institutionally pegged interest rate structures. Our estimated equation fits the data well and passes all the diagnostic tests satisfactorily. The coefficient on lagged dependent variable is significant and shows that about 56.0 percent of the discrepancy between desired and actual reserves is adjusted in a year.

5.3.16 Expected inflation

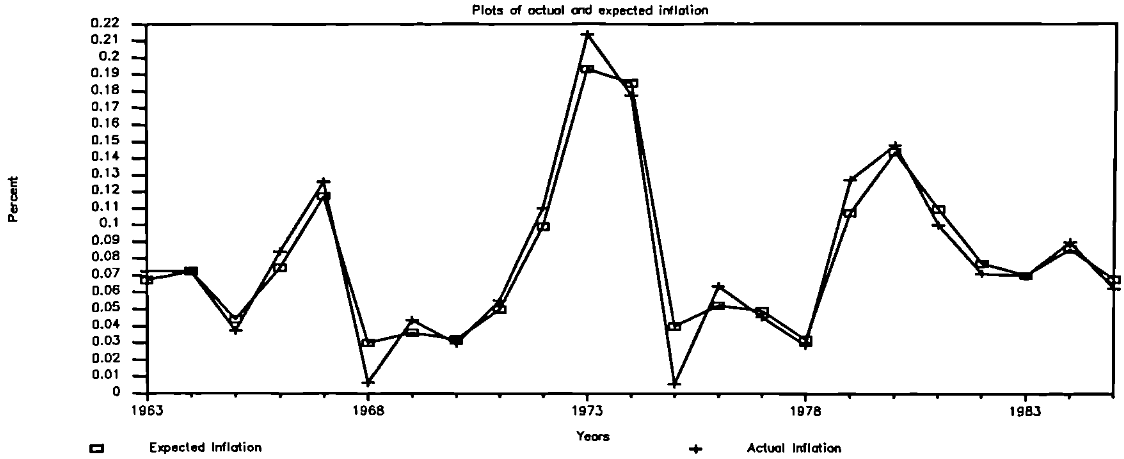
Expected inflation is modelled adaptively ie., a weighted average of current and past inflation rates. Econometric estimation could not produce a satisfactory equation in terms of diagnostic checks and of the fit of the estimated series vis-a-vis actual rate of inflation (visualised from the plots of actual and fitted values). Therefore, we imposed coefficients on current and past inflation rates to derive a series for expected inflation. The specified relationship imposes a unit elastic relationship between expected inflation and actual inflation in the long-run. The equation is as follows:

$$\pi^e = 0.8\ \delta ced + 0.2\ \delta ced(-1)$$

The plots of actual and fitted rates of inflation are given in fig. 5.1

FIG. 5.1

Plots of actual and expected inflation



5.4 Partial Simulations

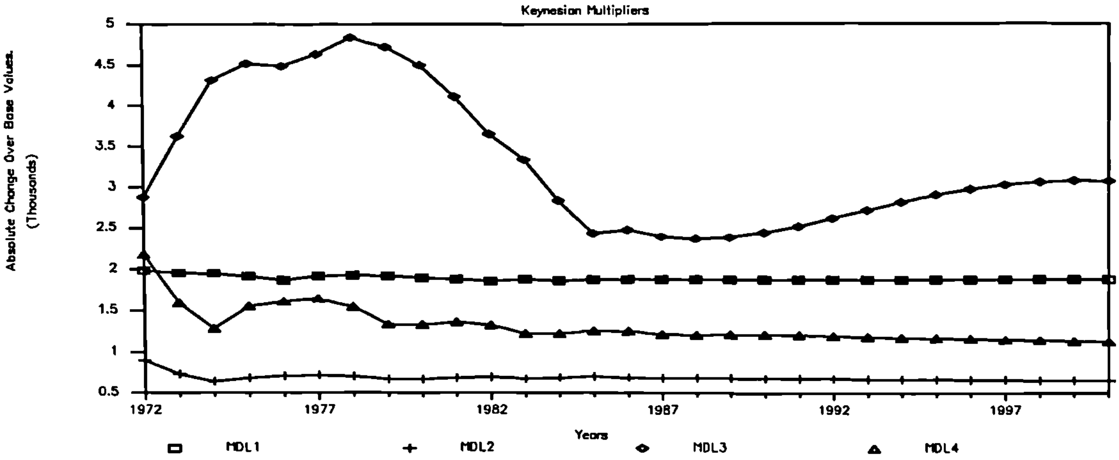
Partial simulation is the first step in the process of assembling and simulating the full model. Partial Simulation, by its very nature, does not fully represent the reality of the full model. However, it is important on at least in two counts. Firstly, it is useful to know the dynamic properties of the model in a simplified way. For example, we can compute the open economy and closed economy Keynesian multipliers and see the sensibility of our model. Secondly, there are certain policies which can better be assessed in a partial simulation framework. For example, questions such as: does the Mashall-Lerner condition holds in this economy? how do prices respond to nominal devaluation? what are the properties of short-run and long-run supply curves? etc. can best be answered by resorting to partial simulation.

5.4.1 Keynesian Multipliers

A full set of Keynesian multipliers are plotted in fig. 5.2.

FIG. 5.2

Keynesian Multipliers



The multiplier outcomes are associated with the following specifications. The fiscal multiplier with only consumption and income endogenous is given by MDL1. The impact multiplier is 1.98 and the long-run multiplier is 1.877. The result is smooth.

MDL2 shows the multiplier outcome with the import equation and GDP identity only. Leakages in imports reduce the overall size of multipliers. Multiplier outcomes are sensible.

In MDL3 we present the closed economy multipliers. Only consumption, investment and GDP are endogenised in this run. The impact and long-run multipliers are 2.9 and 2.7, respectively. The accelerator effect and the absence of leakages in imports produce high multipliers. Initially multipliers pick-up due to the accelerator effects but, in the long-run, equilibrium in capital stock stabilises the outcome.

The full Keynesian multipliers with consumption, investment, imports and GDP identity is given by MDL4 in the graph. The impact and long-run multipliers are 2.2 and 1.2, respectively. As theory suggests the closed economy multipliers are bigger than the open economy ones.

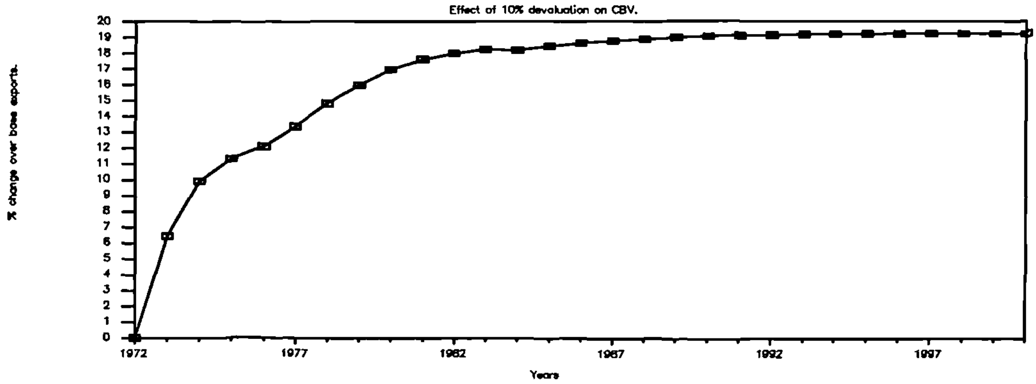
5.4.2 Marshall-Lerner Condition

In this section we are interested to assess the effects of exchange rate changes on trade sector. The Marshall-Lerner condition says that, starting from a balanced current account, and assuming perfectly price-elastic supply curves for exports and imports, the sum of price elasticities of demand for exports and imports must exceed unity for a rise in the real exchange rate to generate a current account surplus. In what follows we assess through exchange rate simulation whether the Marshall-lerner condition holds in our model.

Ceteris paribus, the effects of a 10.0 percent rise in nominal exchange rate on trade balance is plotted in fig. 5.3. It is evident that the Marshall-Lerner condition holds. In the long-run, current account balance improves by 19.26 percent, following a 10.0 percent devaluation, thereby, giving the sum of relevant trade elasticities to be 1.926.

FIG. 5.3

Effect of 10% devaluation on CBV.

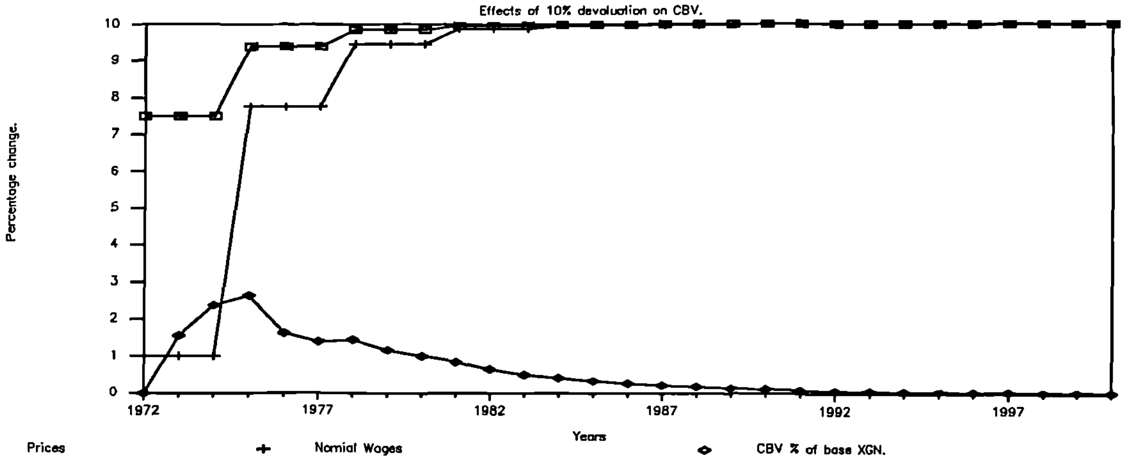


This outcome is sensible as the long-run real exchange rate elasticity of net exports of goods is 2.3 in our empirical model.

In fig. 5.4 we show the outcome of the same exchange rate shock with endogenous wages and prices. Note that output and capital stock are fixed. Wage and price endogeneity quickly neutralise the relative price effect of nominal exchange rate devaluation. In the long-run wages and prices rise by the same proportion of devaluation, and the effect on current account balance dies away. This is a sensible outcome. Further results on exchange rate effects are analysed at greater detail in the full model simulation.

FIG. 5.4

Effects of 10% devaluation on CBV.



5.4.3 Supply side Simulations

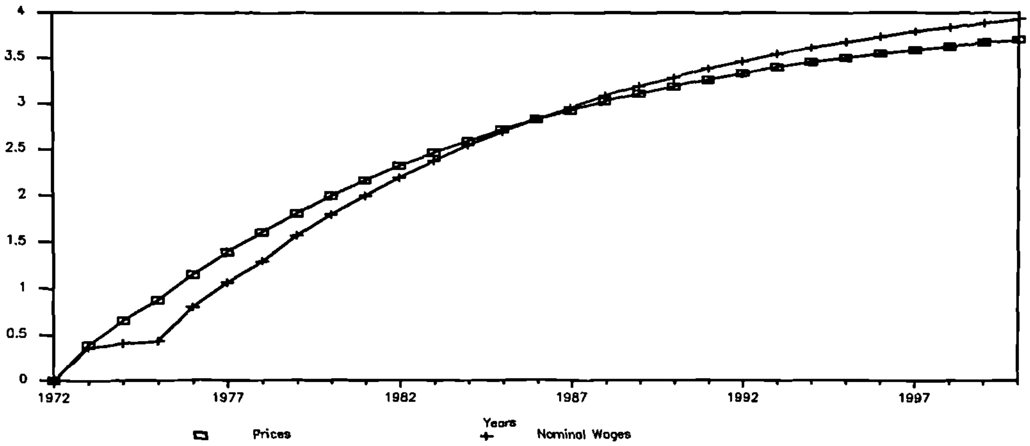
In this section we assess the short-run and the long-run properties of the aggregate supply curve. We consider the effect of an increase in output on prices with capital, imports and nominal exchange rate fixed. This essentially gives us the short-run supply curve. The supply side equation is given in section 5.3.10. In the long-run, the $\delta_3$ced term must converge to zero. Therefore, a one percent increase in output will require a 4.0 (=1/0.25) percent appreciation in the real exchange rate. For this to happen, prices must go up by 4.0 percent since nominal exchange rate is exogenous in the model.

Wages are unit elastic with respect to prices and the income elasticity of wage is positive (0.312). Therefore, the nominal wage rate must go up by 4.3 percent. These analytical results are confirmed by our simulation outcomes. However, the adjustment process is very slow see fig. 5.5. The slow adjustment is due to the low coefficient on ECM term (-0.176) associated with our price equation. This can be attributed to the controlled wage and price regimes and weak labour unions.

Fig. 5.5

Effects of 1.0 percent increase in output on prices

(K, MGN and EX fixed)



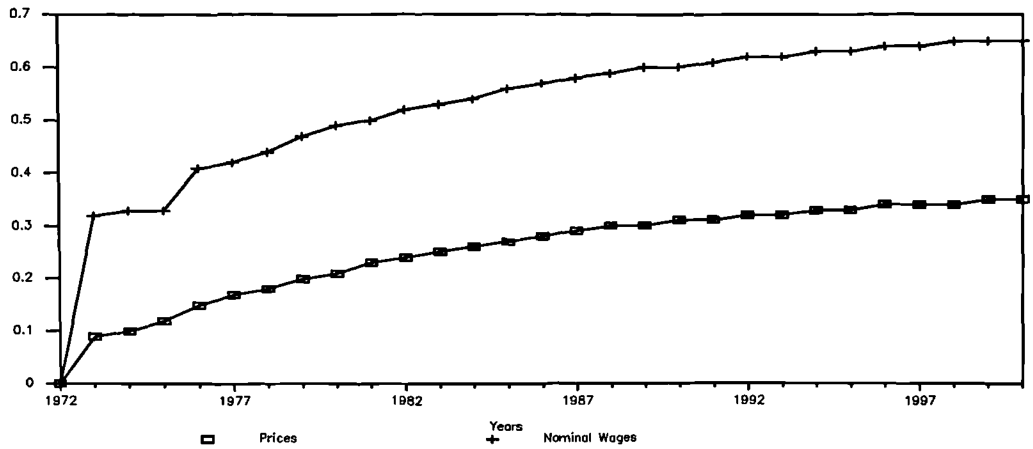
To specify the log-run supply curve y, k, and m were raised by the same proportion (ie 1.0%) with a fixed nominal exchange rate and the effect on prices is analysed. An equal percentage change in y, k, and m gives the following reduced supply function (as β_2 and β_3 drops from the supply equation; see eqns. 2.23 and 2.25 in chapter two):

$$y^s = 1.42 - 2.64 \text{ rex} + 2.67\ \delta_3 \text{ ced.}$$

The real exchange rate must be appreciated by 0.37 (=1/2.64) percent following these shocks and this is possible only through price rise. Simulation results confirm this (see fig. 5.6). It indicates that the long-run supply curve is flatter than the short-run. Nominal wages rise by more than the rise in price level, due precisely to increased output effects.

FIG. 5.6

Effects of 1.0 percent increase in Y, K, and MGN on prices with EX fixed.



It should be noted that these supply side simulations must be viewed in their restrictive context as the demand side factors are fixed.

5.5 Summary and Concluding Remarks

In this chapter we estimated the behavioural relationships of our theoretical model. In so doing we provided a brief account of the econometric methodology and the diagnostic tests employed. We also put the estimated model through some partial simulation exercises.

Unit root tests suggested that all the time series employed in the two-stage estimation process are integrated of order one. This appeals to the superconsistancy property of OLS and a valid error correction representation, but with the qualification of small sample bias. Our ADL approach also produces sensible equations. All in all, our theoretical model passes the empirical test satisfactory.

The partial simulations show sensible outcomes and model properties. The time profile and the multiplier outcomes of the shocks are sensible. The long-run supply curve is flatter than the short-run. The Marshall-Lerner condition holds in the trade sector, but wage and price endogeneity quickly neutralise the relative price effects of nominal devaluation.

Common to all the results reported in this chapter is the fact that they are based on small sample. This might affect the overall quality of our results.

In the following chapter we set out our full model simulation strategy. We assess the tracking performance of the model through historical simulations. We also assess the problem of non-linearity through simulation exercises.

Notes

1/ As a check, we also estimated these equations following the general-to-specific approach and compared the point estimates. Whilst, the long-run point estimates of the consumption function are quite close, results on the import and the price equations are not as encouraging; results we would expect in small samples.

APPENDIX - 5A.

Notation and Definition of Variables Used

(Variables are measured in millions unless otherwise specified)

Endogenous Variables:

ADV	Total bank advances (credits), current US $
ADVK	Total bank advances (credits), constant US $
AMT	Amortization of debt, current US $
ARRP	Average reserve ratio of deposit banks, in percent
BM	Base money, current US $
CBV	Current Account Balance, current US $
CED	Index of consumer expenditure deflator, local currency units
CONS	Private final consumption, constant US $
CP	Currency in circulation in domestic economy outside banking system, current US $
CPK	CP in constant US $
FRRP	Free reserve ratio of deposit banks in percent.
GBS	Government budget surplus, current US $
GCCP	Government consumption, current US $
GE	Government expenditure, current US $
GR	Government revenue, current US $
HDN	Government's domestic debt, current US $
IF	Gross fixed investment, constant US $
INTR	Interest obligation abroad, current US $
IT	Total investment (gross), constant US $
ITCP	IT in current US $
K	Net fixed capital stock, constant US $

M2	Money stock (broadly defined), current US $
M2KP	M2 in constant US $
MGN	Imports of goods and non-factor services (nfs), constant US $
MGNV	MGN in current US $
NCLG	Net central bank lending to government, current US $
NFA	Net foreign assets, current US $
NW	Index of nominal wages, local currency terms
PAB	Absorption deflator, US $ terms
PC	Private consumption deflator, US $ terms
PGC	Government consumption deflator, US $ terms
PHL	Price deflator of home goods, in local currency terms
PIE	Expected inflation, percent
PK	Investment deflator, US $ terms
PMGN	Unit value index (UVI), imports of goods and nfs, US $ terms
PMGNL	UVI, imports of goods and nfs, local currency units
PXA	UVI, exports of goods, US $ terms
PXGN	UVI, exports of goods and nfs , US $ terms
PY	GDP deflator, US $ terms
RB	Deposit bank reserves, current US $
RESCP	Foreign exchange reserves, current US $
REX	Real exchange rate index
TOTD	Total deposit liabilities of deposit banks, current US $
XGI	Volume index, exports of goods
XGN	Exports of goods and nfs, constant us $
XGNI	Volume index, exports of goods and nfs

XGNV	Exports of goods and nfs, current US $
YD	GDP at market prices, constant US $
YDCP	YD at current US $

Exogenous Variables:

BLG	Deposit bank lending to government, current US $
CLB	Central bank lending to deposit banks, current US $
CT	Net current transfer from ROW, current US $
D67	Dummy set to unit for 1967
D75	Dummy set to unit for 1975
DEPOR	Interest rate on time deposits, percent
DISB	New foreign borrowing, current US $
DISCR	Discount rate
DMYOIL	Dummy set to unity for 1973 & 1974
DOD	Public and publicly guarantied debt outstanding, current US $
EX	Index of nominal exchange rate expressed in terms of units of local currency per unit of US $
GC	Government consumption expenditure, constant US $
LIBOR	LIBOR in percent
LR	Deposit bank lending rate in percent
OCF	Other capital flows, in current US $
OFN	Other net flows (net non-monetray liability) of monetary authorities' balance sheet, current US $
OFS	Net other factor services, in current US $
OLTF	Other long-term capital flows, net, in current US $
ONF	Other net flows of deposit banks, current US $
PMA	UVI, import of goods, in US $ terms

PXAC	UVI, exports of goods, a weighted average of competitors
RRRP	Required Reserve Ratio in Percent
S	Index of export market potential
T	Time trend
USFINF	One period ahead US inflation rate.

CHAPTER 6

Simulation Specification, Linearity and Tracking Performance

Introduction

In the foregoing chapter we empirically estimated and tested the model. In this chapter we lay-out the ground work for full model simulations. This chapter is organised in eight sections which are as follows:

In the first section we very briefly discuss the meaning of a dynamic simulation and its role in economic policy analysis. In the second section we discuss the technical details of simulation specification. Section three deals with the calculation of policy multipliers. In the fourth section we discuss the nature and the types of policies chosen for simulation. Section five deals with simulation scenarios. In section six some symmetry and non-linearity assessments are accomplished. Section seven covers the historical simulation results. And finally, the chapter is closed with short concluding remarks.

6.1 Meaning and Importance of Simulation

Simulation can be defined as the operation of a numerical model that represents the structure of a dynamic process. For given values of the initial conditions, parameters and exogenous variables, a simulation represents the behaviour of the process over time. In recent years it has evolved as one of the most interesting and powerful tools for analysing economic problems.

Simulation is also important in analysing and understanding the overall properties of a mathematical model. The test of any model depends not only on how it performs in terms of an individual equation but also on how it fares as a complete system in predictive and simulation tests. It is quite possible that individual equations may fit the data well and show a very good statistical fit, but when all equations are solved jointly, errors may accumulate and a bad fit may be obtained. In a good model, however, we expect these solution paths for various endogenous variables to approximate quite closely their actual paths. Simulation is vital for this type of assessment and validation of the model.

When a model is linear and static, it is not very difficult to derive its reduced form and solution paths for endogenous variables by substituting successive sets of values of the exogenous variables (Spivey and Wrobleski, 1979).

However, when the model is non-linear as most macroeconometric models are - as is our model - an analytical solution for all the endogenous variables will ordinarily be unobtainable and resort must be sought to some numerical solution technique (Sowey, 1973; Challen and Hagger, 1983). In this context, our analytical model developed in Chapter 4 must be viewed as a simplified version of the full model where we flush out all the dynamics precisely because of the problem of analytical intractability.

In practice a dynamic simulation is used as a means for the analysis and the validation of a dynamic non-linear model. It displays the model's inherent dynamic characteristics and provides a more exacting test of stability.

When shocks are administered on policy instruments, simulation enables the effects of these implied economic policies to be explored, compared and contrasted through the dynamic policy multipliers they produce. Dynamic multipliers are a period-by-period response rate of endogenous variables to exogenous shifts in levels, flows or parameters. They measure the response along the transient path to final equilibrium positions (Fromm and Taubman, 1968). This is in contrast to the static multipliers which just give the equilibrium responses of the endogenous variables to exogenous changes. They are also different from the partial elasticities since all endogenous variables are now allowed to change.

Simulation models are being increasingly used in the design of public policy (Greenberger et al., 1976 and Pindyck and Rubinfeld, 1981). It enables us to assess the response of a system following a policy shock. For example, we can predict how a change in one policy variable such as government expenditure is likely to affect, over time, other variables like GDP and its components; prices, external payment etc. Thus, simulation models can provide valuable information for policy making. Several types of such policy simulations can be conducted and the response of the overall system observed in each case. This is one of the main motives behind the full model simulation in the next chapter.

6.2 Simulation Specification

In conducting our simulation exercise we follow a standard approach to dynamic stochastic simulation. To start with, we solved the model in single equation mode and examined the residuals on an equation by equation basis over the simulation period. The objective behind this is to judge how accurately we are able to replicate the residuals of each behavioural relationship over the estimation period. Once these residuals are reckoned to be sensible we "fixed" them as constant adjustments. The difference between "actual" and "forecast solution" constitutes the "constant adjustment".

In a policy simulation such as this it is customary to "fix" constant adjustments at their base level so that they do not influence the after shock outcome on endogenous variables (Vines et al. 1983; Wallis, 1984; and Cuthbertson and Taylor, 1987). The software "Semafore - PC Version" of LBS (London Business School) was used in the running of all these simulations.

The constant adjustments, thus fixed, are included in equations while "unfixing" the model. Unfixing is the opposite from exogenising in that it removes any data fixes (ie., historical observations) from behavioural variables and ensures that equations will be used in the subsequent simulation. In most of the behavioural equations the constant adjustments were included multiplicatively.

Once the model is unfixed, the base run (also known as the 'controlled' run) is generated. The package solves the model using Guass-Seidel iteration procedure. The convergence criteria is fixed to be 0.0001 ie., one hundredth of a percent. It should be noted that putting the price block first in the system of equations helped solve the model. This is not surprising as the Gauss-Seidel method is sensitive to the normalisation rule and the sequence of the equations. That is, a system may not converge when it is written in a particular way but it may converge when written in a different but algebraically equivalent way.

After generating the base run we perturbed the relevant policy variable by a given (measured) shock and computed the 'new solution' run often known as a "simulation run". The perturbation took the following three forms depending on the "nature" of the variable in question.

Firstly, where the policy variable is exogenous such as government expenditure, nominal exchange rate etc., a given shock is directly administered to the base value of the variable. Exogenous variables are easiest to act upon as by shocking them neither the properties of the model are affected nor the problem of feedback arises from the rest of the model.

Secondly, where the variable to be perturbed is behavioural such as consumer price index (CED) or money stock (M2), we shocked the constant adjustment. It should be noted that the dynamic structure of these equations can magnify these shocks. Though it is possible to compute and administer the adjusted residuals in such a way that the endogenous variable being shocked would shift by a known factor at each time, but it is not done as this operation was not straightforward in the package we relied on.

Lastly, in certain runs, we exogenised some of the behavioural variables and shocked them. That is, the variable is set equal to its base value and the relevant behavioural equation is deleted from the model and shocked. The obvious example being the shock on CED when the price block is fixed. Again the "health warning" is that this type of shock might affect the properties of the model. However, though used sparingly, it is not an uncommon technique (LBS Semafore-User Guide, 1990).

In the full model simulation we have fixed two empirical variables, namely, reserves (RESCP) term in the import volume equation and the import to income ratio (m/y) term in the price equation. The motivation for fixing these terms is as follows. First, both of these terms capture rationing effects in the relevant behavioural equations of interest. These are *ad hoc* empirical terms and are by-products of *ad hoc* administrative rationing rules. One cannot guarantee that such rationing rules always persist in any economy. Rationing rules switch following changes in policy regimes. Therefore, we decided to fix these terms in the simulation exercise to ensure theoretical coherence.

Second, although this thesis is a stand alone piece of research, we have indicated elsewhere that it is a part of a larger research initiative. Other regional models designed for Latin America and Africa (Srinivasan and Vines 1990) contain these rationing terms and they too have fixed these terms in their simulations. As a result, we decided that fixing these terms in our simulations would maintain uniformity across regional models. It should also be emphasised that this strategy allows a valid comparison of policy outcomes across regional models which would be an interesting agenda for future work.

Of course, it is always possible to simulate the full model without fixing these terms. A comparison of simulation outcomes shows that unfixing these terms does not change the characteristics of the model; only the magnitude of effects are changed and these changes are at best marginal. We would assume, therefore, that fixing these terms has no cost in terms of model quality. We have appended these comparative results at the end of Chapter 7 in Appendix 7A. In so doing, we also provide a concise description of the transmission mechanism when these terms are unfixed in the model and analyse the outcomes on income, prices and the current account balance following various policy shocks.

6.3 Multiplier Calculation

Once the new solution is computed by applying a measured shock, the effect of each shock is derived by comparing the results of this new solution run with the base run. When a variable is perturbed in absolute terms, the relevant multipliers are defined as the ratio of the difference between simulation run and base run to the size of the shock. More formally it can be shown as:

$$M = (Y^{shock} - Y^{base})/(X^{shock} - X^{base}).$$

where M is the multiplier value and X and Y are the respective values of the exogenous and endogenous variables. If the shock is a policy instrument then these multipliers are in fact the policy multipliers describing the response of endogenous (target) variables to a unit shock in policy instruments.

However, when the shock is administered in percentage terms (such as a 10% rise in interest rates or a 10% nominal devaluation) the outcomes are reported as the percentage difference from the base run of the target variable. That is:

$$\text{Percentage Effect} = [(Y^{shock} - Y^{base})/Y^{base}] * 100.$$

In such a shock, the ratio of the percentage effect to the size of the shock, in each period, represents the elasticities which are analogous to the multipliers.

While the procedures of calculating the multipliers are quite straightforward, however, it must be noted that the system being non-linear, the multiplier values obtained are not necessarily independent of the size of the shock administered. We will take up this issue below under "symmetry and non-linearity assessment" of the model.

6.4 Nature and Types of Policy Shocks

Altogether eleven different internal and external policy instruments have been simulated. These simulations are conducted over a period of 29 years from 1972-2000, the latter half of which is a forecast track computed on the assumptions described in the Data Appendix.

A practical issue associated with a simulation exercise is the nature of the shocks imposed, ie., whether a shock should be absolute or proportionate. The reason being that the base run values of exogenous variables might be trending and/or fluctuating over time. The consequence is that an absolute shock will represent a varying proportion of the base run values and this matters when the system is non-linear. Some investigators try to eschew this problem by administering only an 'impulse' shock in the exogenous variable. Alternatively, it is recommended, in some quarters, that the shock be a constant percentage of the base run value of exogenous variable (Challen and Hagger, 1983).

For our purpose, the size, the direction and the nature of each policy shock is chosen, keeping in mind the ease of multiplier computation, interpretation and the nature of the policy variable being shocked. We reckon that the price variables make sense if they are shocked in percentage terms and the variables such as government expenditure and money supply in absolute terms.

Another related issue is the time profile of the shock itself. That is, whether a shock should be temporary or permanent ? We have preferred a permanent shock as it directly gives the total multiplier, instead of having to accumulate the whole range of effects over-time if it were a temporary shock. The only exception is the money supply shock which is temporary. The variables chosen for simulation and the nature and the size of each shock are as follows:

6.4.1 The Internal Policy Shocks

(1) Fiscal Shock: A permanent increase of \$ 1.0 billion in government consumption expenditure in real terms (GC).

(2) Exchange Rate Shock: A permanent devaluation of 10 % in the nominal exchange rate (EX).

(3) Supply Shock: A permanent 5.0% increase in the multiplicative constant adjustment of price (CED) equation.

(4) Money Supply Shock: A temporary \$ 1.0 billion increase in the additive constant adjustment of money supply (M2) equation.

(5) Required Reserve Ratio Shock: A permanent 1.0 % point increase in the required reserve ratio (RRR) of commercial banks.

(6) Discount Rate Shock: A permanent 1.0 % point increase in the central bank discount rate to commercial banks (DISCR).

(7) Interest rate shock: A permanent 10 % increase in both the deposit and lending rates, and

(8) Central Bank Lending to Commercial Banks: A permanent 10 % reduction in the central bank lending to deposit banks (CLB).

6.4.2 The External Policy Shocks

(1) The World Trade Shock: A permanent rise of 5.0 percentage point in export market potential (S).

(2) Import Price Shock: A permanent rise in import prices (PMA) by 5.0 percent, and

(3) Foreign Interest Rate Shock: A permanent 1.0 percent point increase in LIBOR.

A few words of explanation on the policy instruments chosen for simulation are worth stating. All the domestic policy instruments selected for simulation are both widely used and advocated in LDCs. Almost all of them are exogenous variables. Government expenditure, exchange rate, interest rates and required reserve ratio are all under the control of authorities. Only the adverse supply shock and money supply are endogenous variables.

Our selection of external shocks are stylized ones. World trade, import costs and world interest rates are the prominent external macro variables which feature in the literature of open economy macroeconomics. We have employed both the percentage and percentage point shocks. This is done to facilitate the comparison of our results with similar policy simulations accomplished in some other models. However, when we apply a percentage point shock we also report the size of the shock in terms of average percentage change to the base value of the variable to facilitate analytical understanding.

6.5 Simulation Scenarios

These policy simulations were conducted in a structured way under different scenarios. That is, we gradually build up towards the full model simulation starting from a more or less "Keynesian tradition" with exogenous price and financial variables. Then, we progressively, go on endogenising financial variables and price block in the model. This approach is adopted in order to assess the internal dynamics of the model as well as the effects of different sectors in the model. These scenarios are:

(a) Model Name: MDL5

In this run the domestic price level (CED), nominal money stock (M2) and bank credits (ADV) are exogenised. This is reckoned to represent more or less a Keynesian world of fixed prices.

(b) Model: MDL6

In this run financial variables (M2 and ADV) are endogenised with fixed prices. This implies that any movement in M2 and ADV is tantamount to movements in their real magnitudes.

(c) Model: MDL7

In this run domestic price level is endogenised keeping financial variables in nominal terms (M2 and ADV) fixed. Note that domestic price movement affects the real magnitudes of M2 and ADV.

(d) Model: MDL8

This is the full model run. No endogenous variable of the system is exogenised.

Eleven policy shocks under four policy scenarios involve 44 simulation runs. Reporting all the endogenous variables of the model is not sensible both because of space limitation and the analytical importance. Therefore, our approach has been to present the short and long run effects of each policy shock on key macro variables in tabular form. These variables are income, current account balance, and domestic price level. We also present the time profile of these variables and asset stocks in respective figures.

In describing our simulation results we have placed more emphasis on the results of the full model. Where possible, a comparison is made with the results of a similar simulation accomplished in some other models. Also, due exposition is given to all the partial runs and a comparison is made across alternative runs for policy evaluation.

6.6 Linearity and Symmetry Experiment

It is suggested that one should conduct the linearity and/or asymmetry tests (assessments) to understand the local and global properties of the model before it is used for any serious policy analysis (Zellner and Peck, 1973). It is of interest from an economic point of view to find out whether the model produces symmetric responses to symmetric shocks on controlled policy variables or not. In other words, does a one billion increase in government consumption expenditure produce the same absolute change in the level of income as does a one billion reduction in government consumption expenditure? If the response is symmetric then the results can be used as "ready reckoner".

Four dynamic simulations were run to assess the symmetric characteristics of our model. They are ± 1.0 billion change in government consumption expenditure, ± 5.0 percentage point change in world demand for domestic exports, ± 5.0 percent change in nominal exchange rate and ± 1.0 percentage point change in the required reserve ratio. The effects of these policy shocks on income, domestic price level and the current account balance are studied.

The results are plotted in figures 6.1-6.4. These plots show that the model produces a remarkable degree of symmetrical response to symmetric shocks, therefore, the dynamic multipliers can be used as "ready reckoner". A high significance is attached to these multipliers as a preliminary guide to policy. It is sometimes suggested that "...politicians should carry pocket cards as 'ready-reckoners'..." (Klein, 1979, pp. 321)

We also assessed the seriousness of non-linearity in our model by subjecting different sizes of shocks. We plot outcomes of a 1.0 and a 3.0 billion increase in government consumption expenditure in figure 6.5. The outcomes are not sensitive to the sizes of the shocks indicating that non-linearity is not that serious and does not distort the simulation outcomes. This supports the evidence contained in Fair (1984, p. 256) that macroeconometric models are really not that non-linear and the conclusions derived from the analysis of a linear models closely proximate those for non-linear models.

6.7 Tracking Performance of the model

Before putting the model to any serious policy simulation it is customary to assess the historical tracking performance of the model. This is one way of establishing some initial credibility for, and confidence in, the model at hand (Klein, 1979).

In the specification stage, each stochastic equations was tested through a barrage of statistical tests and the final version adopted stood these tests quite well as reported in Chapter 5. This implies that these stochastic equations, in isolation, replicated the behaviour of each endogenous variables quite satisfactorily over the sample (estimation) period. However, as is well recognised, this does not imply that the model as a whole will be able to predict accurately the values of the endogenous variables in historical simulation.

A number of factors are responsible for this. Firstly, the model as a whole will have a dynamic structure which tends to be much richer than that of any single equation of the system. Therefore, even if all individual equations fit the data well and are statistically significant, we cannot be sure that the model as a whole, when simulated, will reproduce those data series equally closely. It is possible that the historical simulation may track some of the variables quite closely, and others poorly.

Secondly, equations in the model are jointly determined, therefore, the disturbances of each equation feed through a number of other equations. As a result, small errors in each equation can be magnified into large simulation errors and hence a poor tracking record. It is only by chance that errors across equations may cancel out each other. A case in point, in our model, is the specification of the money stock. Base money is determined endogenously through the balance of payments and the government budgetary position. The former in turn is determined by several stochastic equations viz., export of goods and non-factor services, export prices, imports of goods and non-factor services etc., each of which involves a degree of stochastic errors. Consequently, our money stock might be vulnerable to these errors and this will affect the whole model.

Thirdly, when the model is subjected to dynamic simulation, errors may accumulate not only across equations but also over time. This will not only affect predictions within that period but also in subsequent periods. Stock variables, which are determined by endogenous flows and the lagged stock, are particularly vulnerable to this kind of errors. Again, variables like bank advances, foreign reserves and money stock etc., are points in case.

Finally, and perhaps most importantly, it is a fact that an econometric model's solution is conditional upon the values of the exogenous variables. If any other than the actual values of the exogenous variables are used to solve the model then any resulting error in the solution may be attributable either to the model or to the incorrect values of the exogenous variables. This implies that the model's performance can only be established when actual values of the exogenous variables are used, ie., an ex-post simulation is conducted.

In so doing, the model is cleared of any errors associated with the projection of exogenous variables. For this reason, a vast majority of evidence on the credibility of macroeconometric models comes from ex-post simulations (McNess, 1981)

Though, the possibility of errors and poor tracking performance exists in a dynamic model, it is expected that a good and a credible model should track the solution paths of endogenous variables quite closely. If it does not, then the credibility of the model is greatly reduced.

It is, therefore, reasonable to believe that a model which passes the test in an historical context and, hence, has presumably captured the leading attributes of the economy's underlying structure, will yield reliable forecasts and policy inferences than a model that has not been so validated. Therefore, it is considered to be the "acid" test for a macroeconometric model to be able to track the historical time paths of its endogenous variables reasonably well when it is subjected to dynamic simulation. The following quote from Challen and Hagger (1983, pp. 164) further stresses this view:

> *Most system-builders would regard the ability of the system to track the historical time paths of its endogenous variables, the system's within sample tracking performance, as the most important of all the evaluation procedures...Until such time as an assessment of the within sample tracking performance of the whole system is made, the system builder has no way of knowing how the system will perform - notwithstanding a high degree of confidence in the quality of its individual equations.*

However, in recent years the view on the usefulness of the within-sample simulation for model selection and validation is not without question. Klein (1979, pp. 312) explicitly writes that:

Such (ex post) simulations play a significant role, but I can not accept the proposition that they are as good as genuine ex ante forecasts for the purpose of model validation. The reason for this is that ex post extrapolations have limited usefulness. It is frequently of interest to ask questions of what was or might have been, but it is far more significant to ask of what will be.

Thus, Klein categorically prefers the analysis of the *ex ante* forecast errors over the *ex post* as the basis of model validation. Arguments against *ex post* simulation as an approach to model validation can also be found in Hendry and Richard (1982), Pagan (1989) and Smith (1990). However, an interesting argument contrary to that of Klein and others who prefer *ex ante* approach can be put forward as follows:

The traditional approach to model validation dismisses ex ante evidence because...an expert forecaster, skilled at choosing future values of exogenous variables, might be able to generate an accurate forecast with a poor model while a poor forecaster might generate an inferior forecast with the model that best represents the structure of the economy (McNees, 1981, pp. 409).

Thus, it seems that there is not a clear agreement as yet to the approach of model validation. The problem becomes even more acute when models differ widely in terms of their structures and the underlying assumptions vis-a-vis endogenous and predetermined variables.

In what follows we present the results of a dynamic historical simulation of our model for the period of 1972-1985. The reason for not going further back in time is that government account statistics are available only from 1972. Given the importance of *ex post* simulations and a widely held practice of reporting it in applied model building, we feel that it would be proper to divulge this vital piece of information vis-a-vis our model as well.

The common approach in evaluating the tracking performance of a large econometric model is to select a few "key" endogenous variables and present some descriptive statistics of their goodness of fit. A graphical presentation of the observed and the simulated series is also common practice. A number of criteria are employed to assess the goodness of fit of the simulated series vis-a-vis its observed values. The most common are root-mean square error (RMSE), root-mean-square-error percent (RMSEP), mean simulation error (MSE) and mean-simulation error percent (MSEP). These statistics are defined as follows:

$$RMSE = [1/T * \Sigma^{T}_{t=1} (y^{at} - y^{st})^{2}]^{0.5}$$

$$RMSEP = [1/T * \Sigma^{T}_{t=1} (y^{at} - y^{st})^{2}/y^{at}]^{0.5}$$

$$MSE = 1/T * \Sigma^{T}_{t=1} (y^{at}-y^{st})$$

$$MSEP = 1/T * \Sigma^{T}_{t=1} [(y^{at}-y^{st})/y^{at}]$$

where y^{at}, y^{st} and T are actual and simulated values of variables and the number of periods used for simulation, respectively. Thus, RMSE and RMSEP give a measure of the deviation of the simulated variable from its actual value in absolute and percentage terms, respectively. A perfect track record would give zero value on all the statistics but they would take on higher values as the tracking becomes worse. However, the problem with these statistics is that there is no upper bounds for them. The obvious trouble with MSE and MSEP is that they may give a false picture of the accuracy of simulation when large positive simulation errors cancel out large negative errors. Similarly, one big spike in the simulated series might be enough to give a worse RMSEP and undermine the whole tracking record scenario.

Another useful statistic often used in evaluating the historical simulation is Theil's inequality coefficient (U). Unlike the above statistics U is defined in such a way that it ranges between an upper and a lower bound of unity and zero, respectively. This is defined as:

$$U = \frac{[1/T * \Sigma^{T}_{t=1} (y^{at} - y^{st})^2]^{0.5}}{[1/T * \Sigma^{T}_{t=1} (y^{at})^2]^{0.5} + [1/T * \Sigma^{T}_{t=1} (y^{st})^2]^{0.5}}$$

If there is a perfect fit then U = 0 as $y^{at} = y^{as}$. If U=1, on the other hand, the predictive performance of the model is as bad as it could possibly be. The "U" statistic can be decomposed such that it gives some useful information on the sources of errors (Theil, 1966). However, we do not go into any of its further details as our main motive is limited to the revelation of the tracking record of our model rather than conducting a thorough and rigourous tests of model validation. For our purpose, we report "RMSEP" and "U" statistics of some of the key endogenous variables. They are Given in Table 6.1.

Table 6.1

Root Mean Square Error Percent (RMSEP) and Theil's Inequality Coefficient (U) for Selected Variables

Variables	RMSPE	U
Consumer Price Deflator (CED)	0.0688	0.0347
Nominal Wages (NW)	0.1456	0.0544
Export Prices (PXA)	0.1210	0.0678
Gross Domestic Product (GDP)	0.0356	0.0162
Private Consumption (CONS)	0.0456	0.0200
Net Fixed Capital Stock (K)	0.0375	0.0151
Exports of Goods and Non-factor Services (XGN)	0.1333	0.0590
Imports of Goods and Non-factor Services (MGN)	0.0951	0.0382
Current Account Balance (CBV)	4.14[2]	0.1352
Total Bank Advances (ADV)	0.1976	0.0620
Total Bank Deposits (TOTD)	0.2512	0.0746
Nominal Money Stock (M2)	0.1797	0.0620
Private Sector Demand for Currency (CP)	0.0869	0.0519
Free Reserve Ratio of Deposit Banks (FRR)	0.1581	0.0656

Plots of the actual and simulated values of these variables are also presented in figures 6.6-6.19. These plots are important, among other things, to assess how far the model is able to capture the turning points in the time path of endogenous variables, which is yet another important criterion to judge the tracking performance of the model.

The historical simulation on the three price variables viz., CED, NW and PXA show quite a good fit judging from their plots shown in figs. 6.6-6.8. PXA shows some under prediction in the latter part of the simulation period. All these seem to have picked the turning point quite successfully. Theil's U statistics and MRSEP are below 0.07 and 0.15, respectively, for these variables. Thus, judged from these statistics we reckon the historical fit to be good. The historical simulation replicates the GDP series quite successfully except for one or two small spikes. The RMSEP and U statics are 0.035 and 0.016, respectively. The outcome is plotted in fig. 6.9.

Among the components of aggregate demand, the capital stock shows the best replication (fig. 6.11). The RMSEP and the U statistics are 0.037 and 0.015, respectively. The fit for XGN and MGN suffer from some persistent bias as their plots in figures 6.12 and 6.13 show. MGN shows a mild but sustained upper bias whereas XGN suffers from both the lower and upper bias. However, judged from their RMSEP and U statistics the average simulation errors on both of these series are not very high. The U statistics is 0.038 and 0.059 for MGN and XGN, respectively and the RMSEP is below 0.14. The private sector consumption shows few small spikes otherwise the replication is quite good (fig. 6.10). The RMSEP and U statistics are 0.04 and 0.02, respectively.

The current account balance shows the poorest tracking performance of all the variables assessed. In most of the simulation period the outcome is over-prediction of the current account deficit (fig 6.14). This is not surprising given the biasness in MGN and XGN. The U statistic is 0.13, the highest among all the series.

The financial variables show mixed results. The currency demand shows increasing down-ward bias in the latter part of the simulation period (fig. 6.19). The RMSEP and the U statistics are 0.086 and 0.052, respectively. Free reserve ratio fails, in some counts, to capture the sharp spikes in actual series (fig. 6.18). However, the error measure statistics are not very high. The rest of the financial variables viz., ADV, TOTD and M2 show considerable resemblance to one another (figs. 6.15-6.17). Their plots show some under-prediction both in initial years and in the latter parts of the simulation period. This might be due to the accumulation of errors both across the stochastic equations and over the time period as discussed at the beginning of this section. Again, judged from their average error measures as reported in table 6.1 we reckon their tracking performance to be satisfactory.

To sum up, we regard the tracking performance of our model as good. A comparison of the error statistics and the plots of the outcomes of our model with similar models developed and tested by Blondol (1986) and Srinivasan (1991) also proves this fact. Our historical simulation fares very favourably compared to these models.

6.8 Summary and Concluding Remarks

In this chapter we explained the meaning and the significance of dynamic simulation. We also discussed its role in the assessment of the dynamic structure of the model and the policy multipliers. The technical details of simulation specifications and the policy instruments chosen were also discussed.

The assessment of the symmetric response and non-linearity revealed that our model does not suffer from these problem and the policy multipliers can be used as "ready-reckoner".

We assessed the tracking performance of the model as well. Our model satisfactorily simulates the historical values of almost all the 'key' endogenous variables. Thus, judged from its tracking record we find our model to be credible and satisfactory.

In the next chapter we turn to the analysis of the dynamic response of the model following changes in various policy variables and consider whether their effect is in agreement with that of economic theories. This is another criterion of testing the validity of a model.

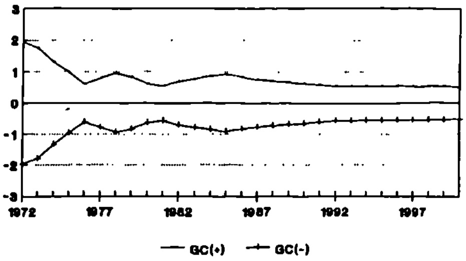
Notes

1/ The reserves term captures the import rationing occasioned by the foreign exchange reserves position. The ratio of imports to income captures the effects of supply rationing on prices.

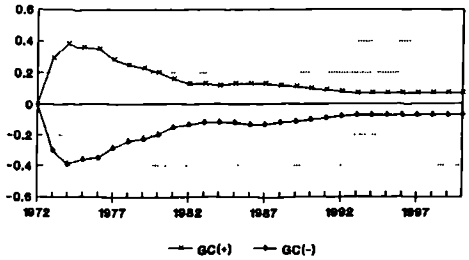
2/ Spikes in the historical simulation results lead to an astronomically high value of this statistic which has no meaningful interpretation. This is one instance of the weakness of a measure like MSEP.

FIG 6.1

Symmetric Response of the Model.
Effect of a 1.0 bn. Symmteric Increase
In GC on GDP (Abs. diff. from base).



Symmetric Response of the Model.
Effect of a 1.0 bn. Symmteric Change In
GC on CED (% diff. from base)



Symmetric Response of the Model.
Effect of a 1.0 bn. Symmteric Change In
GC on CBV (Abs. diff. from base '000')

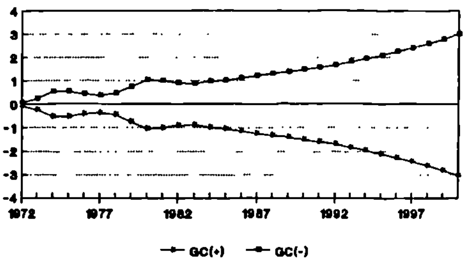
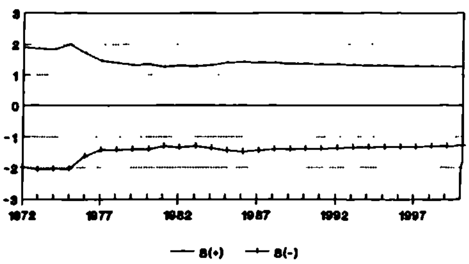
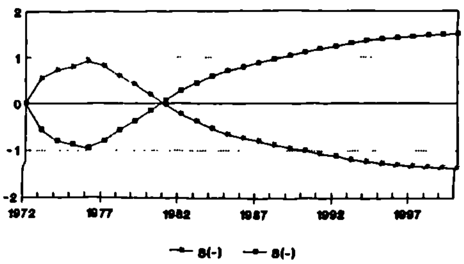


FIG 6.2

Plot of Symmetric Response of the Model.
Effect of a 5% Pt. Symmetric Shock In S
on GDP (% diff from base level).



Plot of Symmetric Response of the Model.
Effect of a 5% Pt. Symmetric Shock In S
on CED(% diff from base level).



Plot of Symmetric Response of the Model.
Effect of a Symmetric 5% Pt. Shock In S
on CBV(Abs. diff. from base in '000')

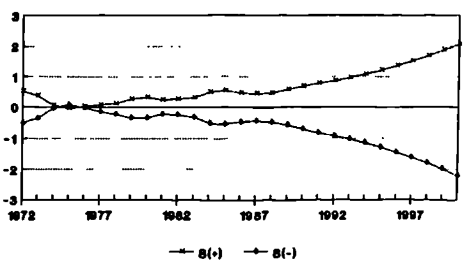
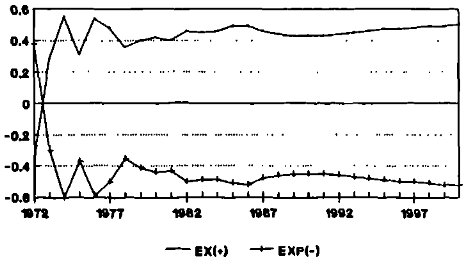
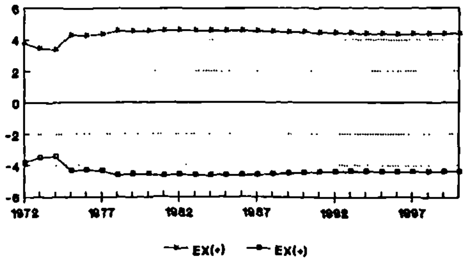


FIG 6.3

**Plot of Symmetric Response of the Model.
Effect of a 5% Symmetric EX shock on GDP
(% diff. from base)**



**Plot of Symmetric Response of the Model
Effect of a 5% Symmetric EX shock on CED
(% diff. from base)**



**Plot of Symmetric Response of the Model.
Effect of a 5% Symmetric EX shock on CBV
(Abs. diff. from base)**

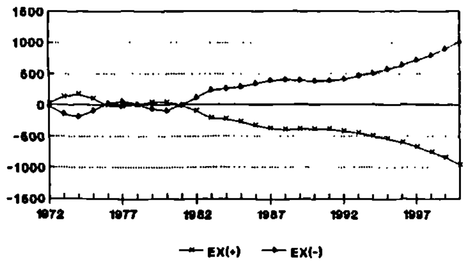
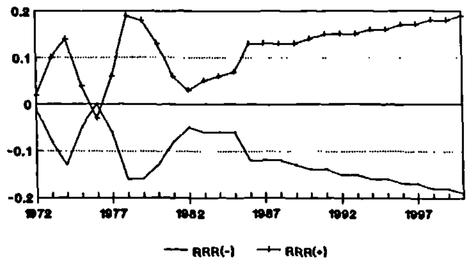
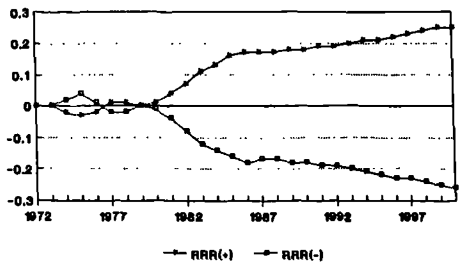


FIG 6.4

**Plot of Symmetric Response of the Model.
Effect of a Symmetric 1.0% Pt. Shock in
RRR on GDP (% diff. from base)**



**Plot of Symmetric Response of the Model.
Effect of a Symmetric 1.0% Pt. Shock in
RRR on CED (% diff. from base)**



**Plot of Symmetric Response of the Model.
Effect of a Symmetric 1.0% Pt. Shock in
RRR on CBV (Abs. diff. from base)**

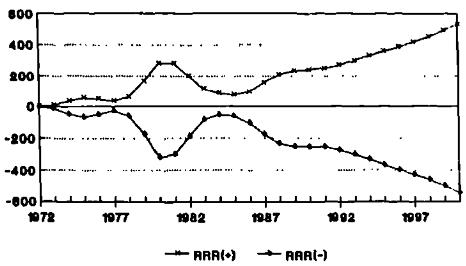
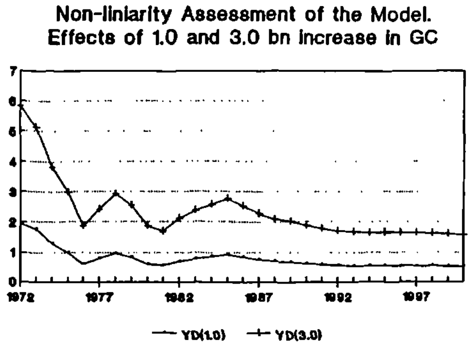
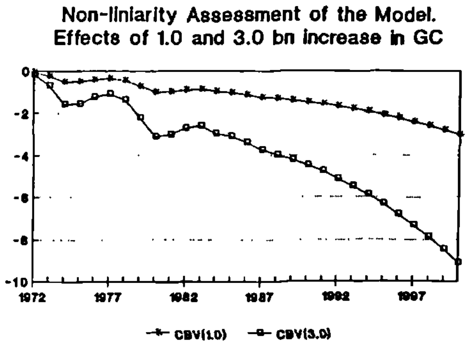


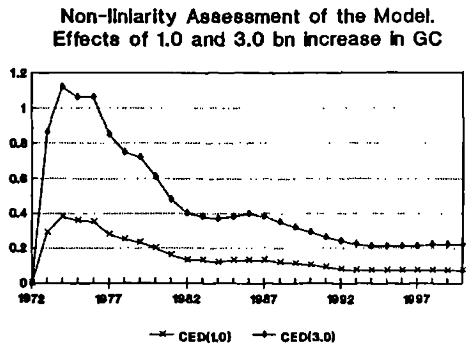
FIG 6.5



Non-liniarity Assessment of the Model.
Effects of 1.0 and 3.0 bn increase in GC
YD(1.0)
YD(3.0)



Non-liniarity Assessment of the Model.
Effects of 1.0 and 3.0 bn increase in GC
CBV(1.0)
CBV(3.0)



Non-liniarity Assessment of the Model.
Effects of 1.0 and 3.0 bn increase in GC
CED(1.0)
CED(3.0)

Tracking Record of the Consumer Price Deflator (CED).

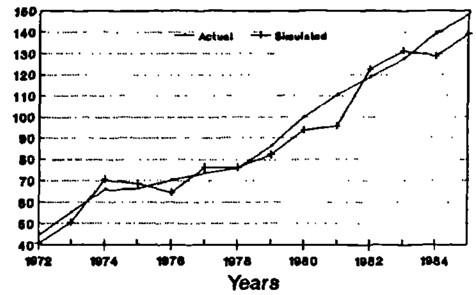


FIG. 6.6

Tracking Record of Nominal Wage (NW).

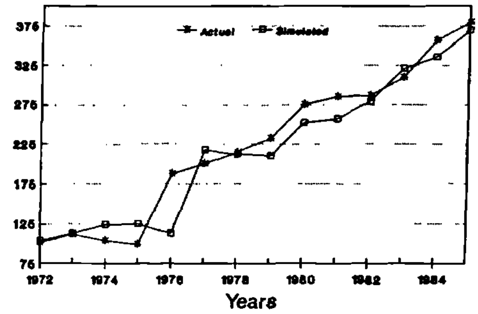


FIG. 6.7

Tracking Record of Export Prices (PXA).

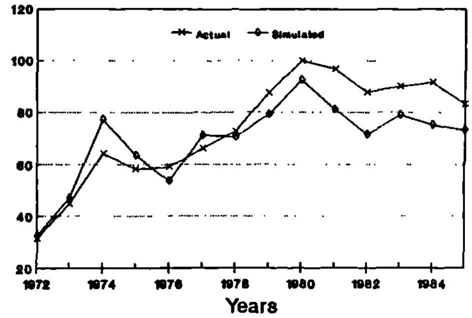


FIG. 6.8

Tracking Record of GDP
(in Billion of US $)

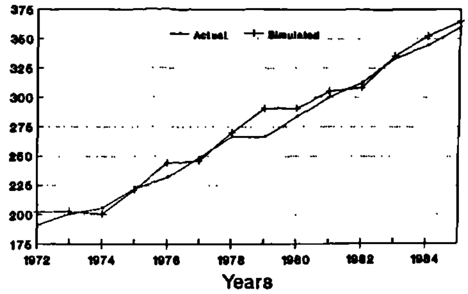


FIG 6.9

Tracking Record of Private Consumption Expenditure (CONS, in Billion of US $)

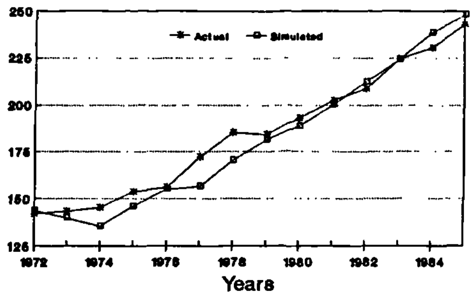


FIG 6.10

Tracking Record of Capital Stock
(K, in Billion of US $)

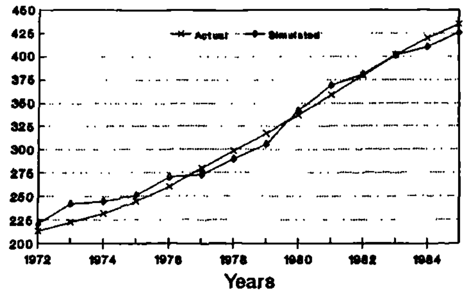


FIG 6.11

Tracking Record of Exports of Goods and Non-factor Servics (in bn. of US $).

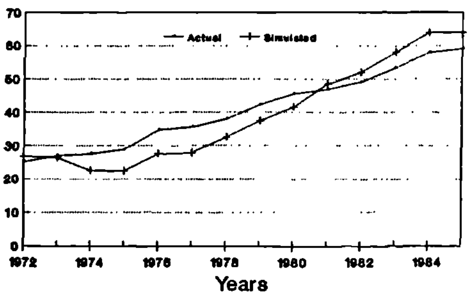


FIG. 6.12

Tracking Record of Imports of Goods and Non-factor Servics (in bn. of US $).

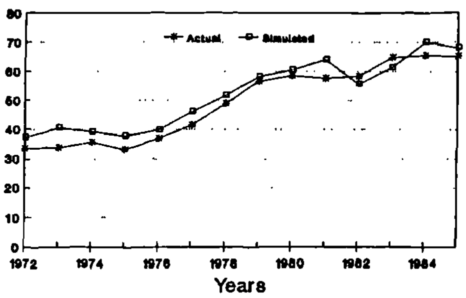


FIG. 6.13

Tracking Record of Current Account Balance (CBV, in bn. of US $).

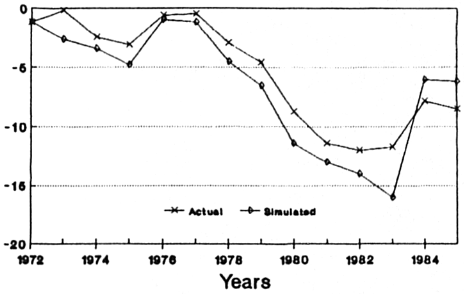


FIG. 6.14

Tracking Record of Total Bank Advances (ADV) of Deposit Banks (in bn. of US $).

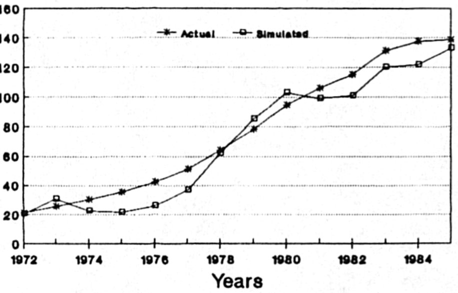


FIG. 6.15

Tracking Record of the Total Bank Deposits (TOTD, in bn. of US $)

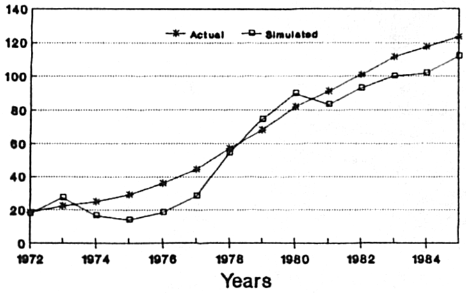


FIG 6.16

Tracking Record of the Money Stock (M2, in bn. of US $)

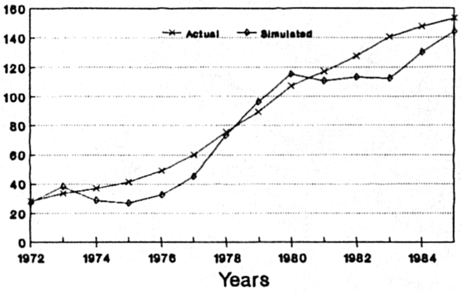


FIG 6.17

Tracking Record of Free Reserve Ratio (FRR) of Deposit Banks.

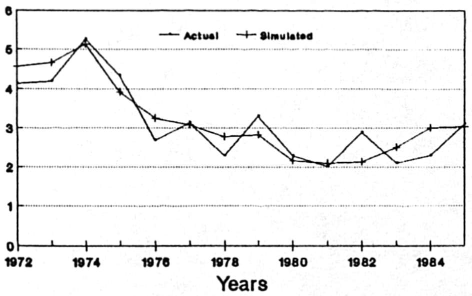


FIG. 6.18

Tracking Record of the Private Sector Currency Demand (CP, in bn. of US $)

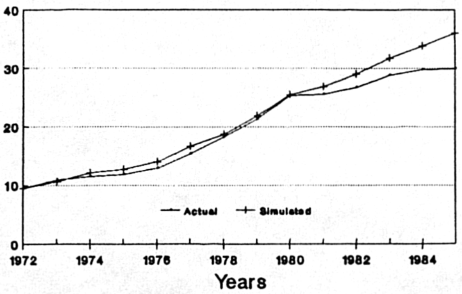


FIG 6.19

CHAPTER 7

SIMULATION OF THE FULL MODEL

Introduction

In chapter five we conducted some partial simulations in our model. We assessed the possible role of devaluation, computed Keynesian multipliers, and performed some supply side experiments. The outcomes were sensible. In the preceding chapter, among other things, we performed *ex post* simulations to establish the credibility of our model. We found the tracking performance to be satisfactory and concluded that our model successfully captures the underlying structures of the economy we are modelling. Now, in this chapter we move one step further and put our model through various policy simulations. We will accomplish this through "open-loop dynamic stochastic simulations". The open-loop simulation gives the response of a system following any stimuli assuming that the controller does not exercise any control rule. When such stimuli consist of policy variables or parameters, then it represents a policy response.

This chapter is organised as follows. In the section that follows we discuss the "tuning" of the model. Then we move to address the simulation results. As already explained, we conduct eleven policy simulations. Each simulation is discussed separately. Finally, the chapter is closed with concluding remarks.

(7.1) Tuning of the Model

It is already discussed in the preceding chapter that the structural richness of a multi-equation model is more appealing and attractive, but it may pose difficulties in the process of its construction, validation, and use. Even if the structural stochastic equations that make up the model have an excellent statistical fit, when they are put together and simulated, there is no guarantee that the results would be satisfactory. The results may turn out to be meaningless both in terms of economic theory and empirical observation.

Such an outcome is possible if the dynamic behaviour is unstable. To put it in mathematical jargon, if some of the characteristic roots are greater than unity or are complex, then the model will show instability or sinusoidal solution. In such a situation, any change in exogenous policy variables will not produce any meaningful result. The problem of instability is more likely in a multi-equation model than in a single equation model.

Therefore, it is generally recommended that one should analyse the stability conditions when dealing with a multi-equation model. We accomplished this task in chapter four but with a simplified version of the model. When a model becomes larger its dynamic behaviour becomes more difficult and less straightforward. Moreover, non-linearity makes this task even more difficult. Even if the characteristic roots of the model are determined (using iterative technique), we can not say with precision how these characteristic roots are related to all the individual coefficient in the model (Pindyck and Rubinfeld, 1981). This clearly poses a problem in identifying the cause (which equation and which parameter is the source of problem) should the model exhibit oscillation. However, when faced with the problem of this nature, the performance of the model could be improved through "tuning and adjusting" of the model which is quite common in modelling practice. Several types of adjustments can be made in a model (ibid, pp. 401). Sometimes a minor change in the structure (adjusting) of the model or the coefficient (tuning) of an individual equation might stabilise the outcome.

When we simulated our full model administering a fiscal shock of 1.0 billion the model produced an oscillatory or sinusoidal outcome. Therefore, a search exercise with respect to different "would be suspect" equations and their parameters is conducted through repeated simulation exercises. The search exercise involved trial-and-error experiments with different parameter values and the analysis of the sensitivity of the model. After experimenting with parameter changes it was, finally, identified that the wealth elasticity of the consumption function and the bank advances elasticity of investment function had made the model oscillatory. We "tuned" these parameters by reducing them to a half of their original estimated values. Vines et al. (1983) elaborate on such tuning.

It is normally recommended that if one were to adjust parameters, then the approach should be to start with the statistically insignificant parameters. However, in practice, it is not always possible to abide by such a rule as, in many cases, the parameter causing the problem might well happen to be a statistically significant one. The whole idea of 'tuning' in a multi-equation model is more concerned with a stable outcome for the system rather than a particular structure of any single equation.

In a single equation model, one does not have to worry much about the dynamic interactions among equations. However, in a simulation model, one is also concerned with the dynamic interaction of the equations which form the model. However statistically sound an equation might be, if we know for sure (after search for the causes of instability) that its structure or some parameter values are the cause of model instability then the statistical soundness of that single equation losses its appeal in a multi-equation framework. The concern for the system's stability becomes more important and hence needs tuning and adjusting. It might well be the case that the particular equation or equations causing the problem happen to be dynamically misspecified. Thus, a modeller might want to either restructure or tune the equation even though it has a very satisfactory statistical fit.

For our purpose, once we tuned these parameters the outcomes were sensible, therefore, we imposed these restrictions and retained the tuned equations for simulation exercise. Subsequently, we also tested these restrictions and, interestingly, found them to be data acceptable. We emphasise that the subsequent testing is not meant for the rationalisation of 'tuning' rather just to evaluate if the data accept the imposed constraints. We reiterate that the motivation of tuning stems from the overall performance of the model and it is not just the imposition of data acceptable restrictions. If required, tuning is justifiable even if the restriction happens to be data unacceptable (Pindyck and Rubinfield, 1981).

Now, we turn to the analysis of dynamic simulation outcomes of our model.

7.2 Simulation Results

7.2.1 Fiscal Expansion

Fiscal policy may be defined as the manipulation of government expenditure and taxes for the purpose of influencing aggregate demand. In a simple IS-LM framework a fiscal expansion, whether in the form of increases in the flow of government expenditure or reduced taxation, shifts the IS curve to the right, increasing aggregate demand. However, this seemingly direct efficacy of fiscal expansion is not without question.

Monetarists believe that a pure fiscal policy does not matter for aggregate real demand, nominal income, and price level. They believe that the course of aggregate demand, stochastic influence aside, depends solely on the path of the quantity of money somehow defined. Any fiscal action unaccompanied by an accommodating monetary policy is impotent. Therefore, for them, a fiscal expansion can be effective, if and only if, it can produce monetary consequences. However, the increase in the monetary aggregate may frequently in practice be associated with budget deficit, therefore, the alleged impotency of fiscal policy involves variation in government expenditure, transfer payments and taxes in such a way that it leaves the quantity of money or its time path unchanged.

Non-monetarists, on the other hand, argue that only a zero interest elasticity of demand for money will give rise to a fiscal multiplier of zero, that is, turn fiscal policy impotent and hence support the contention of monetarists.

In numerous occasions, however, theoretical reasons and empirical evidence have been offered against this alleged impotency of fiscal policy. There is by now an overwhelming accumulation of empirical evidence against this (Tobin and Buiter, 1976, Fand 1970, and Artis 1979). One of the classic works in this area is by Blinder and Solow (1973, 1974}.

Friedman who took this (monetarist) stance himself estimated a non-zero (-0.15) interest elasticity of money demand function (Desai 1981). Thereafter, his contention has been - demand for money is not interest inelastic in the sense of zero elasticity but that the function has a very low elasticity; the curve is not vertical but pretty steep (Ibid). The debate, later on, shifted from interest elasticity of money demand function to the net wealth effect of fiscal expansion (Friedman 1972, Tobin 1972). The fact is that monetarists have more or less disvowed it on both counts (Blinder and Solow, 1973). However, it should be noted that the net wealth debate raised by Barrow (1974) depicts the possibility of the null effect of fiscal expansion.

Thus, the lack of empirical support for a vertical LM curve and the growing consensus that a fiscal expansion, if any thing, adds to the net wealth (we note the analysis of Blinder and Solow that if the net wealth effect is not sufficiently expansionary then the fiscal expansion would be destabilising) has made it obvious that a shift in the IS curve - which could be brought about by an increase in the rate of government expenditure or transfers or by a reduction in the flow of tax revenues - will raise aggregate demand.

So, the issue now is not whether *fiscal policy* matters or not. It is a reliable tool of demand management. However, it should be noted that the extent to which a fiscal expansion led increase in demand evokes an increase in supply depends on how close the economy is to its productive capacity. If production is supply constrained then neither fiscal policy nor monetary policy can increase output through new demand. No one denies that at full employment any rise in government expenditure whether it is financed by a pure fiscal policy or a monetary policy generates 100.0 percent crowding out.

The recent literature on economic policy has emphasised the importance of the method of financing fiscal expansion (government expenditure) when determining its effect on the rest of the economy. Obviously, a fiscal expansion can be financed from various sources. It has become clear that the multiplier effect of a fiscal expansion cannot be defined until the government budget constraint is introduced into the analysis and the sources of financing are known. Therefore, the value of the multiplier given by the textbook analysis (which ignores the government budget constraint) is in general incorrect (Christ 1979, Tobin and Buiter 1976 and Artis 1979). We do not go any further on these theoretical issues; if one desires so he is referred to Cook and Jackson (1979).

For the simulation of fiscal expansion in our model, we increase government consumption expenditure. It is an exogenous variable in our model and the built in assumption is that it is partially financed from the Central Bank borrowing. We have assumed on the basis of historical experience that 49.0 percent of the fiscal deficit is financed from Central Bank borrowing. The rest of the financing is assumed to be exogenous.

Before analysing the simulation outcomes of fiscal expansion under different policy scenarios, we give a concise description of its transmission mechanism in our model. Fiscal expansion affects the model in several ways.

An increase in real government consumption directly increases the level of aggregate demand through the income identity. This rises the level of consumption, investment and imports. The rise in imports worsens the trade balance and hence the reserve position. A fiscal expansion also increases the government budget deficit, though by less than the increase in government expenditure due to the endogeneity of government revenue. This leads to increased borrowing from the Central Bank.

Changes in reserves and borrowing from the Central Bank directly affect base money. Falling reserves and increasing Central Bank borrowing exert opposite effects on base money, the former contractionary and the later expansionary. Thus, the net effect on base money depends on the relative strength of the depletion of reserves and the accretion in the government borrowing from the Central Bank.

Any change in base money directly affects the deposit bank reserve position. However, it is also affected by the demand for currency. A fiscal expansion increases the demand for currency through an increase in income. This reduces the level of deposit bank reserves.

Any change in the deposit bank reserve position directly affects the credit creating capacity of banks through the credit multiplier. The bank credit multiplier is determined by the portfolio decision of deposit banks and the monetary policy objectives of the Central Bank. The level of bank credit, in turn, affects the level of investment in our model and hence the level of income.

Furthermore, the flow of total bank lending, as described above, determines the total deposit liabilities. This with the currency demand determines the wealth stock which is proxied by the real stock of money (M2) in our model. The latter drives consumption function through the wealth effect.

Moreover, a rise in income also produces domestic price effects. Theoretically, the price effect could go either way. On the one hand, increased demand pressure could raise prices, on the other, the increased capital stock could depress it. In our empirical estimation the capital stock is unit elastic with respect to output in the long-run. However, prices are less than unit elastic with respect to capital stock whereas the income elasticity is higher than unity. Therefore, a fiscal expansion raises the domestic price level.

Supply responds to the movements in the real exchange rate and the capital stock. Any movement in the domestic price level affects the real exchange rate. Following a fiscal expansion - to the extent capital stock builds-up and real exchange rate appreciates - that depress prices through favourable supply side effects.

Any rise in the price level sets-off a self propagating wage price spiral which is embedded in our wage and price equations. Price movement affects the model through different channels. An increase in the domestic price level raises the relative price of exports and depresses the level of exports. It also increases the level of imports through real exchange rate appreciation. The terms of trade improves but not by enough to reverse the depressing influence of a general price rise.

All these effects accentuate the pressure on the reserve position and hence on base money. However, an increase in the domestic price level increases the rate of expected inflation which in turn reduces the demand for currency. A fall in currency demanded, *ceteris paribus*, increases the deposit bank reserves. This again sets into motion the effects associated with bank advances and money stock.

Thus, a fiscal expansion affects the model in different ways. The first round effects are reflected in income identity and its components. *This is followed by price and real asset* effects etc.

This completes a brief description of the transmission mechanism of fiscal expansion in our model. We, now, turn to the analysis of the simulation outcomes.

In table 7.1 (see p. 245) we present the short-run and long-run effects of this shock on output, current account and domestic prices. In figures 7.1a-7.6b we plot the outcomes of a permanent fiscal expansion of 1.0 billion on some of the key endogenous variables of our model. They are output, current account balance, domestic prices, real money stock, real bank advances and real currency stock. Figures represent different policy scenarios.

(7.2.1.a) Money, Prices and Total Bank Lending Exogenous

We simulate the full model with money (M2), prices (CED) and total bank lending (ADV) exogenised in the run marked as MDL5. This is supposed to represent more or less a Keynesian world of fixed prices. One of the purposes of this run is to compare the outcome of the full model with that of the Keynesian multipliers which we derived through partial simulation in MDL4 (see Chapter: 5; Fig. 5.2).

As expected, this simulation reproduces the partial simulation results of the Keynesian multiplier (compare Figure 5.2 with Figure 7.1a). The short-run output multiplier is 1.8 and in the long-run it stabilises at 0.9[1]. The fiscal multiplier peaks immediately following the shock and gradually stabilises at the long-run level. The multipliers are plotted in fig. 7.1a which shows a stable time profile.

Despite fixed prices, the small long-run fiscal multiplier is due to the leakages, over time, through taxes, savings and imports following the rise in income. It should be noted that the short-run income elasticity of imports is 0.63

and the long-run is 2.3, which causes a higher level of leakages in the long-run for any rise in the level of income and hence a smaller long-run multiplier.

In proportionate terms (not reported here), the impact effect on output is 0.94 percent but the long-run is only 0.10 percent. Despite the long run output multiplier of 0.9, the long-run proportionate rise is smaller because of the highly upward trend in base run output.

Increased government expenditure, as expected, increases the level of income, consumption, investment and imports. In this run exports are not moving as the price block is exogenised.

The current account balance deteriorates which is exactly what one would expect at the aftermath of such a Keynesian expansion. In the short-run, the current account balance worsens by 0.66 percent of the base run exports, however, in the long-run it stabilises at 1.0 percent. The dynamic outcomes on the current account balance are plotted in Fig 7.2a. Fixed exports and an increased imports are the main reasons behind the current account deficit.

Though the fiscal multiplier is small in the long-run, the current account deficit deteriorates by more as the drain of foreign reserves implies a higher loss of net interest receipts relative to base.

The fiscal expansion also increases the budget deficit which, in turn, increases the government borrowing from the Central Bank. A fall in foreign reserves and a rise in government borrowing from the Central Bank produce monetary (base money) effects which affects the level of bank reserves and hence the stock of money and bank advances. These, again, affect the level of consumption and investment in the model. However, in this run we have exogenised financial variables, therefore, this channel of repercussion is, for the time being, precluded. We shall allow for and discuss these effects as we proceed.

To summarise; the net outcome of a permanent rise in government consumption expenditure, in this run, is a permanent rise in activity and a permanent fall in the current account balance.

(7.2.1.b) Exogenous prices, Endogenous Money and Total Bank Lending

In this run, marked *MDL6, we have retained the fixed* price character of the model but endogenised money and total bank lending. One of the objectives of this run is to see how the effects of a fiscal expansion changes once financial variable are allowed for in the model. In other words, it is to see if the financial consequences associated with the government budget constraints and the balance of payments affect the outcomes. The answer is "yes" as far as our model is concerned.

Compared to the run MDL5 both the short and long run fiscal multipliers are higher in this run. The short-run fiscal multiplier is 2.0 and the long-run is 1.0. The higher level of activities is due to the rise in real asset stocks which drive private sector consumption and investment expenditure. The multiplier outcomes are plotted in Fig. 7.1.a. The mild fluctuations in the multiplier outcomes are caused by the cycles in the real asset stocks. However, in the long-run these cyclical patterns of the fiscal multiplier die out and the model stabilises.

The increase in government borrowing from the Central Bank, following the fiscal expansion, outweighs the reserve losses. This leads to an increase in the flow of base money. Demand for currency in the private sector goes-up with income. To the extent demand for currency rises that neutralises the expansionary effect of base money on bank reserves. However, at the beginning, the rise in the demand for currency is not enough to neutralise the expansionary effect of base money on bank reserves, consequently, bank reserves go up and so do the level of bank credits and deposits. It should be noted that in our model credit expansion determines the stock of deposits. Therefore, the rise in deposits and currency demanded increase the stock of wealth (M2). The increases in bank credits and money stock drive-up both the private sector investment and the consumption expenditure which results in a higher fiscal multiplier.

The outcomes on real money stock and bank advances are plotted in figs. 7.4.a and 7.5.a, respectively. It is evident that real asset stocks rise in the short and long runs but they show some cycles in the interim period following the patterns on bank reserves. We have also plotted the behaviour of the real stock of currency in fig. 7.6.a which obviously reflects transaction demand.

One point should be noted that in this run apart from the leakages in the form of taxes, savings and imports the leakage in terms of increased currency demand also forces the long-run fiscal multiplier to stabilise at a lower level compared to its impact effect. The current account balance worsens by 0.73 and 1.05 percents relative to the base exports in the short and long runs, respectively (fig. 7.2a). Compared to MDL5 both the short and long run deterioration in the current account is higher. This is due to the behaviour of income.

To summarise, with fixed prices, the endogeneity of financial variables exert more expansionary effect on the level of output. The current account worsens by more due to the rise in income.

(7.2.1.c) Exogenous Money and Total Bank Lending; Endogenous Prices

Compared to the pure Keynesian case, MDL5, we have endogenised prices in this run, marked MDL7. We can visualise how the model responds in the absence of Keynesian price stickiness. The short-run fiscal multiplier is 1.8 and in the long-run it stabilises at 0.7. The impact multiplier is exactly equal to the fixed price run (MDL5) due to the lagged adjustment of prices, but the long-run multiplier is, as expected, smaller because of the depressing effect of prices. The dynamic fiscal multipliers are plotted in fig. 7.1b.

A fiscal expansion raises the domestic price level as shown in fig. 7.3b. In the short run prices rise by 0.27 percent (this is the second year effect as in the first year the price rise is zero as it responds with lag) and in the long-run it stabilises at 0.02 percent. It is the dominant income effect over the capital accumulation effect that causes domestic prices to rise. However, in the long-run the price level shows a tendency to revert to the base level as capital stock builds up in response to a higher demand.

A higher domestic price level depresses net exports as the relative price of exports goes up and the real exchange rate appreciates. The long-run relative price elasticity of exports and the real exchange rate elasticity of imports are 2.6 and 0.26, respectively. Moreover, a higher price level depresses consumption and investment through adverse asset effects (as real asset stocks fall with exogenous nominal stocks and rising prices). We have plotted the outcomes on real M2, real ADV and real CP in figures 7.4b, 7.5b and 7.6b, respectively. It is evident that real M2 and ADV fall due to price rises but real CP rises following the rise in transaction demand for currency. All these depress the long run fiscal multiplier of this run compared to the price exogenous case.

Though the terms of trade improves this is not sufficient enough to reverse the depressing effects of a domestic price rise. The effect on current account balance is, as expected, negative. The current account deficit goes up by 0.72 and 1.14 percent in the short and long runs, respectively (fig. 7.2b). Compared to the fixed price case, except for the impact effect (the first year effect are identical), the current account deficit worsens by more throughout the simulation period. This is due to the price endogeneity. Exports fall throughout due to the rise in their relative prices.

To conclude, price endogeneity depresses the level of activities and worsens the external position than otherwise would have been; a theoretically consistent outcome.

(7.2.1.d) Endogenous Money, Prices and Total Bank Lending

This run, marked MDL8, is the full model simulation. No endogenous variable of the system is exogenised. In this run a fiscal expansion produces an impact multiplier of 2.0 and the long-run multiplier stabilises at 0.5. The dynamic multipliers are plotted in fig. 7.1b. The long-run multiplier is small but positive as it reflects the extent to which fiscal shock has been crowded out by the consequent reductions in other components of aggregate demand. We shall take-up this issue of crowding out in the final section of this analysis.

These multiplier outcomes are very similar to the multipliers of some of the U.K. models reported in Wallis (1984, 1985). They are also similar to models designed by Blondol (1986), and the Nordic macro models reported in Lybeck (1984).

We do not conjecture that these models are similar in structure to our model or that they have been standardised for the purpose of comparison. Models differ in terms of their purpose, size, method of estimation, data base and assumptions regarding exogenous and endogenous variables (for a detailed discussion of these issues see Lybec et al., 1984, Wallis 1985 and Dolde, 1980). However, the point we are trying to make here is that, despite differences in details, the general picture that emerges in these models is similar to our model. The dynamic multiplier properties exhibit a greater degree of similarity.

Taking UK models reported in Wallis (1985) as an example, a fiscal expansion financed by money creation with fixed interest rates and exchange rates shows different magnitudes of long-run fiscal multipliers ranging from 1.41 in the London Business School (LBS) Model to 0.44 in Liverpool Model (LPL). The important point to note is that no model produces a result of 100% crowding-out, therefore a fiscal expansion, if any thing, is expansionary. Ormerod (1979) in a similar exercise reports a long-run multiplier of almost unity.

The Blondol model also shows a short-run multiplier of almost unity and a long-run multiplier of 0.75. Nordic models reported in Lybec show higher long-run multipliers than that of ours. Despite their differences in magnitudes, the dynamic multipliers are throughout positive and stable. This is what happens in our model as well.

The domestic price level goes up by 0.29 percent in the short-run and stabilises at 0.07 percent in the long-run. This is due to the demand effects dominating the supply side effects. In the first year price response is zero due to lagged adjustment. These outcomes are plotted in fig. 7.3b.

There is not an easy way to compare our results with the aforementioned UK models as the price effect of a fiscal expansion are acutely diverse among these models. Wallis (1985) reports this diversity to be ranging from -0.4 percent in Cambridge Model to 22.3 percent in City University Business School Model for an identical fiscal shock. Blondel does not report this variable. Nordic models report effect on inflation rather than on domestic price level. Though price effects and inflation effects are not directly comparable, however, we note that of the five models, three Nordic models show very modest inflation effects ranging from 0.1 to 0.8 percent in the long run. Ormerod (1979) also reports a very modest price effect of 0.1 percent.

The current account worsens by 0.73 percent and 1.1 percent relative to the base run exports in the short and the long run, respectively (see fig. 7.2b). This is due to increased absorption and poorer competitiveness. The coupon effect - associated with net interest payments abroad - also contributes to the deficit in the long-run.

Fiscal expansion also raises the government budget deficit. In our model this deficit is partially (49%) financed by Central Bank borrowing. To the extent the budget deficit is financed by injecting the new money, base money increases. However, as noted above, any loss on foreign exchange reserves reduces the level of base money.

The fiscal shock, in our model, generates a flow of base money in such a way that it is very marginally positive reflecting the theoretical underpining that the payment deficit is financed by an equivalent budget deficit leaving the private sector asset stocks unchanged.

However, the deposit bank reserves are depleted due the rise in demand for currency (fig. 7.6b). This is the transaction demand for currency. This reduces the volume of bank advances and the stock of money in nominal term. The ensuing price rise depresses them further in real terms (fig. 7.4b and 7.5b). Consequently, consumption and investment are depressed. However, the real asset stocks show a trend of reverting to the base level following the weaker and weaker effects of currency demand in the long-run.

Thus, in this full model a permanent increase in government expenditure increases the level of activities permanently. The domestic price level goes up permanently and so does the current account deficit. Private sector real asset stocks show a trend of reverting to the base level. The current account balance is financed by the fiscal deficit. The long-run fiscal multiplier stabilises at almost one fourth of the impact multiplier.

Following a fiscal expansion both private consumption and investment are crowded out. Private sector consumption falls due to the reduced wealth stock which is due to increases in the price level and the demand for currency. Though interest rates are exogenous, crowding out of private investment is caused by the reduced level of bank advances. As one would expect, crowding out is not hundred percent.

Notes

1/ Notice that the multiplier values of MDL4 and MDL5 are slightly different due to the restrictions on the coefficients of wealth and real bank advances in MDL5. In MDL4 no such restrictions are imposed. When imposed it produces exactly the same results as the MDL5.

Table 7.1

Effect of a Fiscal Expansion.

(A Permanent Increase of US $ 1.0 Billion in Government Consumption in Real Terms)

Model Name	Additional Exogenous Variables	Effect on		
		Output	Prices	Current Account
MDL5	Money, Price & ADV	1.8	0.0	-0.66
		0.9	0.0	-1.04
MDL6	Prices	2.0	0.0	-0.73
		1.0	0.0	-1.05
MDL7	Money & ADV	1.8	0.27	-0.72
		0.7	0.02	-1.14
MDL8	Non	2.0	0.29	-0.73
		0.5	0.07	-1.10

Notes:

1. Output is measured as the absolute difference from the base level. Price is measured as the percentage difference from the base level. The current account balance is expressed as the percentage difference relative to base exports.

2. The first year impact is given as the short-run effect. For each run, the short-run and long-run effects are reported in the first and second rows respectively.

Effect of a Fiscal Expansion on GDP.
Abs. Difference from Base Run.

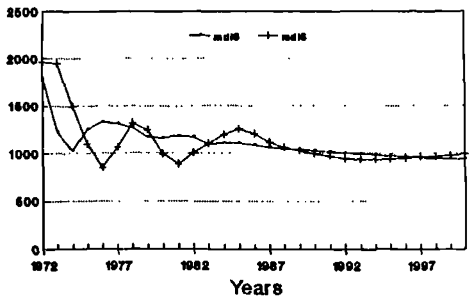


FIG 7.1a

Effect of a Fiscal Expansion on GDP.
Abs. Difference from Base Run.

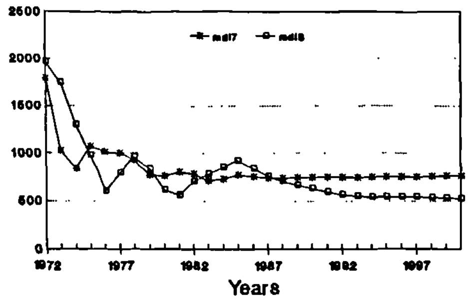


FIG. 7.1b

Effect of a Fiscal Expansion on CBV.
Relative to Base Run Exports (%)

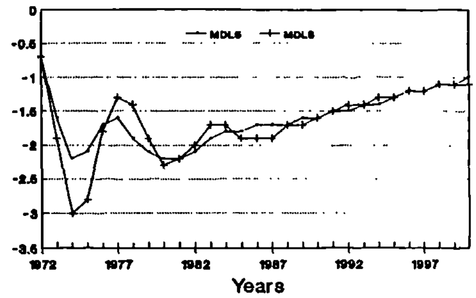


FIG 7.2a

Effect of a Fiscal Expansion on CBV.
Relative to Base run Exports (%)

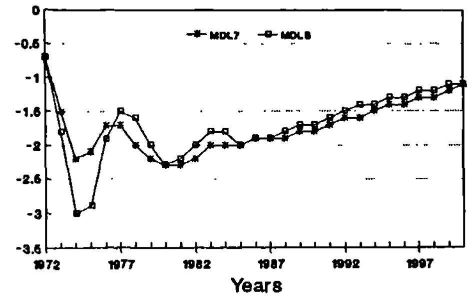


FIG 7.2b

Effect of a Fiscal Expansion on
Domestic Price Level (%)

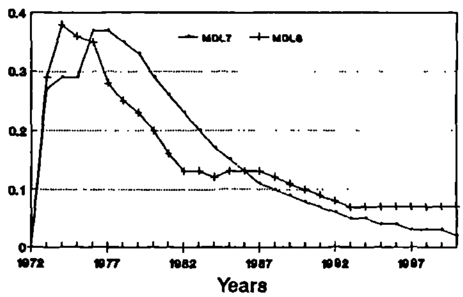


FIG: 7.3b

Effect of a Fiscal Expansion on Real M2
% Change from Base Level.

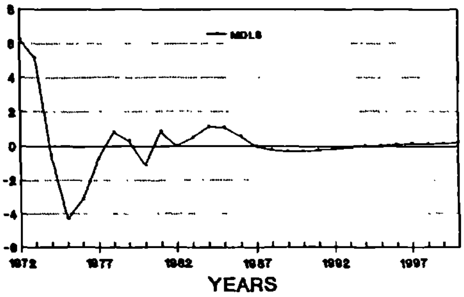


FIG. 7.4a

Effect of a Fiscal Expansion on Real M2
% Change from Base Level.

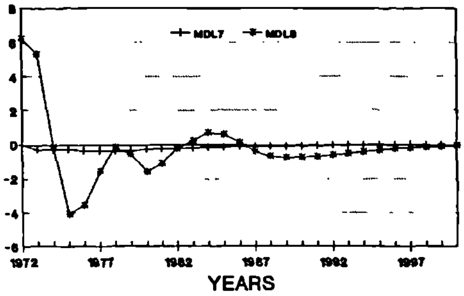


FIG 7.4b

Effect of a Fiscal Expansion on Real ADV
% Difference from Base Level.

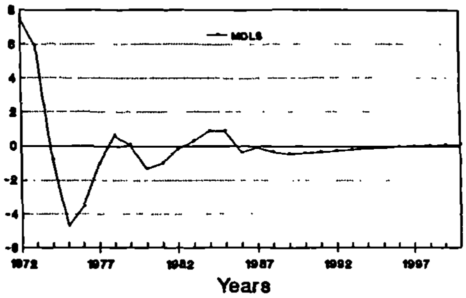


FIG. 7.5a

Effect of a Fiscal Expansion on Real ADV
% Difference from Base Level.

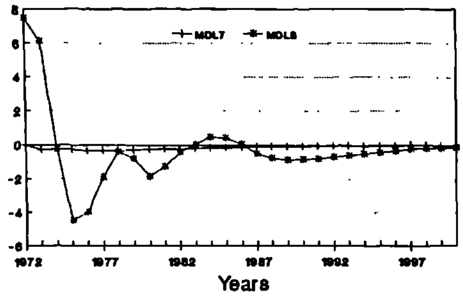


FIG 7.5b

Effect of a Fiscal Expansion on Real CP.
% Difference from Base Level.

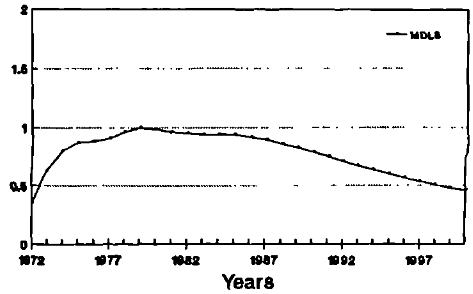


FIG 7.6a

Effect of a Fiscal Expansion on Real CP.
% Difference from Base Level.

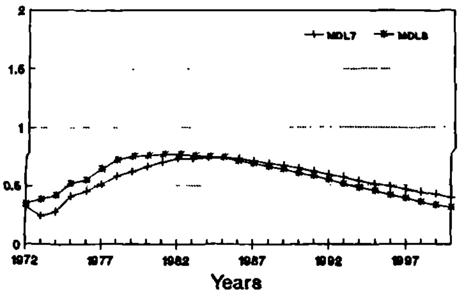


FIG 7.6b

(7.2.2) Devaluation of Nominal Exchange Rate

Currency devaluation has remained as one of the important policy instruments in balance of payments theory. Theoretical treatment of currency devaluation generally concludes that it improves the payments position and stimulates economic activity. The argument is that devaluation, by increasing the price of foreign goods relative to domestic goods, produces an excess demand for domestic goods at home and abroad and hence improves the trade balance and the level of activities. The implied assumption in this argument is that the Marshal-Lerner condition holds. However, an exception is the Monetary Approach to the Balance of Payments which claims the effects of devaluation to be temporary on the balance of payments.

In reality both the home goods output and the domestic price level rise following a devaluation. Therefore, a parallel argument is that even if the elasticity conditions are met, devaluation might be contractionary due to the depressing effects of the domestic price rise which ensues.

The theoretical analysis on this aspect of devaluation can be found in Hirschman (1949) who pointed out that devaluation might be contractionary if initially trade is not in balance (ie., if the trade deficit is high). Cooper (1971) also confirmed this view. The argument is that devaluation gives with one hand by raising export prices while taking away with the other by raising import prices. Therefore, if imports exceed exports at the time of devaluation, then the net result is a reduction in real income.

A devaluation might be contractionary in other counts as well. Diaz-Alejandro (1963) showed that the distributional effects of devaluation might be contractionary. The argument is that a devaluation, by increasing the prices of tradeables, increases the profit of capitalists by more than that of wage earners. As the marginal propensity to consume tends to be lower in the former group, aggregate demand and output decline. It is also true that devaluation increases government revenue through fiscal drag and that the short-run marginal propensity of government saving is almost unity. This also turns devaluation contractionary. A similar contractionary effect of devaluation both in terms of its fiscal and the monetary effects can be found in Krugman and Taylor (1978).

Despite such views on the possible contractionary effects of devaluation, it still commands a prominent role in the theories of balance of payments. The general perception is that it is expansionary (Currie, 1976). The balance of payments theories ranging from the elasticity approach to the monetary approach (at least five different approaches are specified; Johnson, 1972) assign some role to devaluation as a policy instrument, though, the perceived long-run efficacy and the transmission mechanism are different.

Models differ on how a system reacts, but in general whether devaluation is expansionary or contractionary depends, among other things, on the specification of the model and the values of different parameters of the system. For example, if one finds that distributional effects are negligible or the marginal propensities of consumption of profit earners and salaried group are the same, then devaluation might not be contractionary from its distributional side. Similarly, if trade elasticities are high, price adjusts sluggishly or wages are less than fully indexed to prices and an adequate supply capacity exists in the economy then devaluation will, if any thing, be expansionary. We limit ourselves to this point as far as the theoretical discussion on devaluation is concerned.

Now, we turn to the analysis of the simulation outcomes of nominal exchange rate devaluation in our model. In so doing, we first set out a concise description of the transmission mechanism of nominal exchange rate devaluation in our model. It is an exogeneously determined policy variable in the model.

Firstly, an increase in the nominal exchange rate (devaluation), *ceteris paribus*, depreciates the real exchange rate. The latter affects the level of net exports and hence the level of income. As the Marshall-Lerner condition holds in our model and the distributional effects are absent, a real devaluation is expected to bring a net surplus on current account balance and an increase in the level of income.

Secondly, a real devaluation reduces the terms of trade and depresses the level of private consumption. However, to the extent the devaluation raises the domestic price level, the terms of trade effect is neutralised as export prices are driven by domestic cost.

Thirdly, a devaluation increases the domestic price of imports which feeds into our price equation and sets into motion wage-price dynamics. Wages are unit elastic with respect to prices and the latter is also affected by the former, though the long-run elasticity is below unity.

Fourthly, any price rise following a devaluation, inter alia, reduces the real stock of wealth and depresses the level of private consumption. This is the effect which the monetary approach of the balance of payments emphasises. However, in addition, a price rise in our model reduces real bank advances and depresses investment. Fifthly, any domestic price rise increases the demand for currency and affects deposit bank reserves.

These are some of the direct effects of an exchange rate devaluation in our model. Other effects better known as "reversal effects" (Diz-Alejandro, 1963) follow subsequently. For example, a devaluation led surplus in the balance of payments generates monetary consequences and affects the whole model, again, through consumption and investment functions. By the same token, the government budgetary position does not remain unaffected when both activities and prices change following a devaluation. This in turn affects the government borrowing from the central bank and hence base money and bank reserves.

However, how far an exchange rate policy would be successful in bringing about the desired policy effects depends, inter alia, on the behaviour of the domestic price level. If nominal devaluation brings about a real devaluation (ie., if price level does not rise proportionately following a devaluation), then it would be effective through relative price changes. On the other hand, if domestic prices rise quickly and proportionately, then a devaluation would not be an attractive and viable policy option for the authorities. The worst scenario could be the one if devaluation raises prices more than proportionately. It may happen so due to the collapsing supply side. In this case income will collapse and the improvement in the current account will be achieved at the cost of a reduced level of activities.

We shall return to these issues of endogeneity and exogeneity of domestic price level and the effect of a nominal exchange rate devaluation on major macro variables as we deal subsequent runs.

In figures 7.7a-7.12b we plot the outcomes of a permanent nominal exchange rate devaluation by 10.0 percent on different key endogenous variables *under different policy scenarios.*

These variables involve output, current account balance, real money stock, real bank advances, the stock of currency demanded by the private sector and the domestic price level. In table 7.2 (see page 265) we present the short run and the long run effects of this shock.

(7.2.2.a) Money, Price and Total Bank Lending Exogenous

In this Keynesian experiment (MDL5), a permanent nominal exchange rate devaluation of 10.0 percent leads to a real devaluation of 10.0 percent as prices are fixed. Consequently, relative price of exports fall proportionately which raises the level of exports. Exports of goods and non-factor services go up by 10.67 percent in the short-run and in the long-run it stabilises at 28.16 percent higher relative to the base level. This rise in exports is sensible since the long run relative price elasticity of exports of goods is 2.6.

Income goes up by 2.04 percent in the short-run and it stabilises at 5.6 percent in the long-run. The dynamic effects of devaluation on income are plotted in fig. 7.7a. The time profile is stable. It is the rise in exports that causes the rise in activities. The full adjustment of exports to relative price changes and the accelerator effects result in a higher long-run effect on output.

Devaluation shows a contractionary impact effect on consumption and imports. The former is due to the loss in the terms of trade and the latter due to the real exchange rate depreciation. However, both consumption and imports increase quickly following the rise in income. Consumption revives immediately in the second year whereas imports revive in the third year. It is plausible as the real exchange rate elasticity of imports is higher (0.26) than the terms of trade elasticity of consumption (0.15).

As expected, in this fixed price experiment, devaluation brings an improvement in the current account balance (see fig. 7.8a). On impact, the current account goes into deficit which is the "J" curve effect.

However, the current account balance improves quickly (second year), and stabilises at 8.29 percent relative to base exports in the long-run. Coupon effects associated with the net interest payments abroad also help improve the current account in the long-run. Plots of the current account balance show a sensible time profile.

To summarise, in this world of fixed prices, a permanent nominal devaluation brings a permanent increase in the level of activities and a permanent improvement in the current account balance.

(7.2.2.b) Exogenous Prices, Endogenous Money and Total Bank Lending

In this run (MDL6) prices are exogenised but financial variables (M2 and ADV) are allowed for. The objective is to see how the endogeneity of financial variables alter the results. As prices are fixed, a devaluation of the nominal exchange rate brings one to one depreciation in the real exchange rate. Consequently, exports increase exactly by the same magnitude as it did in the earlier run (MDL5).

The endogeneity of financial variables alter the outcomes. Income increases by 1.84 percent on impact and in the long-run it stabilises at 6.5 percent. The outcomes are plotted in fig 7.7a. Notice that compared to MDL5 the impact effect is smaller but the long run effect is higher. In MDL5 the contractionary factor on impact was merely the fall in the terms of trade. However, in this run there are additional factors at work. They are the reduced level of real balances and bank advances which depress private consumption and investment and hence lead to a smaller impact multiplier.

In this run, the financial consequences of both the balance of payments and the government budget constraints are fully at work. On impact, current account balance deteriorates by 1.24 percent; but in the long run it stabilises at 3.43 percent above the base exports. The outcomes are plotted in fig. 7.8a and show a stable time profile.

The "J" curve effect reduces the level of foreign reserves and hence increases the pressure on base money. This is further increased when the endogenous rise in government revenue and the fall in net interest payment abroad reduces the government budget deficit and hence borrowing from the Central Bank.

As a result, base money contracts in the short-run. Currency demand rises following the rise in income as the former is basically a transaction demand. Fig. 7.12a plots this outcome. The rise in currency demand and the fall in base money depress the deposit bank reserves. Consequently, on impact, bank credit contracts by a multiple of the credit multiplier. Money stock follows suit except to the extent that it is mitigated by the rise in currency demand. All these reduce the real asset stocks on impact and hence a contractionary effect on the level of activities.

However, the current account balance improves at the beginning of the second year. Consequently, bank reserves go up and so do real asset stocks. Figures 7.10a and 7.11a show the outcomes on real money stock and real bank advances, respectively. As a result, private sector consumption and investments are reinforced by these financial effects and hence in the long-run activity expands by a greater amount.

To summarise, the fixed price robustness of nominal exchange rate devaluation is further reinforced by the financial consequences of the balance of payments surplus and hence a further rise in the level of income is attained in the long-run. However, the current account improves by less due to the expansion in income.

(7.2.2.c) Exogenous Money and Total Bank lending; Endogenous Prices

In this run (MDL7) we have endogenised the domestic price level keeping financial variables (ADV and M2) fixed. As expected, the domestic price level rises following the devaluation. On impact, it goes up by 7.50 percent and in the long-run it stabilises at 11.36 percent. Outcomes on prices are depicted in fig. 7.9b which are stable.

Thus, in this run, domestic price level goes up by more than the rate of nominal devaluation. This outcome is due to the falling capital stock. This is the sort of contractionary effects Krugman and Taylor (1978) discuss. Note that the monetary consequences of the balance of payments are exogenised. The chain of effects can be summarised as follows; a devaluation increases the price level and depresses real asset stocks. As a result, the level of income and capital stock fall. The fall in capital stock is further reinforced by the perverse flexible accelerator following the fall in income. This leads the supply side to collapse putting further pressure on prices, consequently, prices rise more than proportionately in the long-run. However, results show that this process does not lead to a cumulative collapse of the model rather the outcome stabilises in the long-run. The edge for stability comes from two quarters.

First, falling output help neutralise the long-run rise in domestic prices through reduced demand pressure. Second the real exchange rate appreciation generates a positive supply response. These effects help prevent the system from a cumulative collapse.

Thus, in our model, with the fixed nominal asset stocks and endogenous prices, a nominal devaluation fails to bring a relative price change in the long-run. In fact, as we saw, relative price moves into the opposite direction in the long-run. However, favourable relative price effects do appear, albeit weakly, for a considerable period of time. It takes almost eight years for domestic prices to rise by 80.0 percent of the devaluation. This shows that wage-price spiral does not work very rapidly.

Exports rise as long as the relative price effects are favourable. As the relative price deteriorates exports fall. The impact effect on the level of income is negative. Income falls by 0.67 percent on impact. At least three factors are responsible for this outcome. Firstly, with the exogenous nominal money balances, real balances fall depressing consumption. Secondly, real bank advances fall which depresses investment expenditure. Thirdly, the loss in the terms of trade depresses private consumption as long as nominal devaluation is not either offset or excelled by domestic price rises. All these jointly produce contractionary effects on impact. In the long-run output falls by 1.0 percent following the deterioration in the supply side (fig. 7.7b).

In figures 7.10b and 7.11b we plot the outcomes on real money stock and real bank credits. It is evident that both show a smooth decline following the rise in the prices level. Since the nominal stock of financial assets are fixed in this run, these are perfectly sensible outcomes.

The real stock of currency outside the banking system is plotted in fig. 7.12b. It falls through-out which is what one would expect when prices are rising with a fixed nominal currency stock.

The current account balance improves both in the short and long run. In the short run it improves by 0.47 percent and in the long run by 2.33 percent relative to base exports (fig 7.8b). The long-run improvement is mainly because of the fall in the level of output.

To conclude, in this run a permanent nominal exchange rate devaluation is contractionary in the long-run. The rise in prices overwhelm the rate of devaluation. The current account improves at the cost of the reduced level of activities. Thus, the effect on external payment position does not arise from the relative price changes as one would normally expect, rather from the loss in activities.

(7.2.2.d) Endogenous Money, Prices and Total Bank Lending

In this full model run, marked MDL8, a permanent devaluation of nominal exchange rate is contractionary on impact. However, except on impact, activities rise throughout the simulation period. Income falls by 0.68 percent on impact but in the long-run it stabilises at 0.98 percent above base level. The dynamic output effects are plotted in fig. 7.7b which shows a stable time profile and a quick resumption of the long-run value. The contractionary impact effect is due to the combination of depressed real asset stocks and "J" curve effects following the devaluation. The long-run effect, on the other hand, is due to the improvement in competitiveness and the injection of new assets into the system.

As already discussed in the analytical chapter, the price level does not go up proportionately in this full model. In the short-run, the domestic price level goes up by 7.5 percent and in the long-run it settles at 8.6 percent. This is due to the increase in capital stock. Outcomes on prices are plotted in fig. 7.9b. The improvement in relative prices contributes to net exports and hence to the level of income. We have already shown in our analytical chapter that setting the effect of the stock of real bank advances on capital stock produces proportionality effects on prices.

A devaluation improves the current account only for the first few years. On impact, the current account improves by 0.48 percent relative to base exports. However, in the long-run the current account stabilises at a small deficit of the order of 0.67 percent relative to base exports (fig. 7.8b). It should be noted that in our analytical model df/de >0; ie., a devaluation improves the trade balance. The trade balance is measured at constant prices. Our simulation results confirm this; outcomes show that real exports rise more than real imports.

However, in nominal terms both the trade balance and the current account worsen in the long-run. This is due to the rise in import costs. Imports are highly inelastic as the long-run real exchange rate elasticity is merely 0.26. Exports are highly price elastic with a long-run relative price elasticity of 2.6, but the relative price effects are very weak in the long-run. Thus, the outcome is that exports do not rise significantly nor do imports fall significantly but import costs increase by the full extent of the devaluation. In fact, imports are rising due to the rise in income. Therefore, the current account measured in nominal terms goes in to deficit.

In figures 7.10b and 7.11b we plot the outcomes on the real stock of money and the real bank advances, respectively. On impact real balances fall by 7.0 percent but it recoups immediately in the second year and stabilises at 9.8 percent above the base level in the long-run. The real bank advances falls by 7.6 percent on impact. It also recoups immediately in the second year and stabilises at 7.6 percent in the long-run. Both of these variables depict a sensible time profile. It is precisely these rises in real asset stocks which drive up activities.

Real asset stocks are primarily driven by the rise in base money which is due to the rise in fiscal deficit. As government investment expenditure follows the total investment expenditure, the former rises. With a current account deficit, net interest payment abroad rises which increases the government expenditure. In the long-run fiscal deficit is further reinforced by the domestic debt servicing.

The capital stock rises both because of the positive flexible accelerator and the financial consequences of the balance of payments and the government budget constraints. The effect of the flexible accelerator on investment is obvious when income is rising. As discussed above the net effect of the balance of payments and the government budget constraint, in this run, is an expansion of the base money.

Though the demand for currency rises (fig. 7.12b) following the rise in income, this is not enough to nullify the expansionary effect of base money on deposit bank reserves.

The existence of the long-run competitiveness in our model is at variance with the standard Monetary Approach to the Balance of Payments (MAB). According to MAB devaluation should be neutral in the long-run and domestic prices should rise by the same proportion as the nominal devaluation. This is, however, not happening in our model due to the behaviour of capital stock. The rise in capital stock prevents domestic prices from rising through its supply side effects. We do not take this result as a surprise as MAB assumes a fixed capital stock whereas we do not.

We ran an alternative simulation equivalent to MAB version of our model fixing capital stock. It produces exactly those outcomes as predicted by MAB. In the long-run, domestic prices rise by the same proportion of devaluation (ie., 10%).

The long run output and current account effects of nominal devaluation are zero.

This non-neutrality outcome of devaluation in our model is not unusual. In the Scandinavian models discussed in Lybek et al. (1984) a devaluation shows both the expansionary and contractionary outcomes depending on the assumption of a particular model. Those models which assume that relative price effects are not retained in the long-run produce contractionary effects following a devaluation. This is similar to our MDL7.

However, of the five models three assume that the relative price effect is retained after a devaluation and these models produce more expansionary outcomes than ours. In UK models discussed in Wallis et al. (1984), a five percent permanent appreciation of the exchange rate brings a permanent fall in income in almost all models except the City University one. The long-run contraction ranges from 0.01 to 1.3 percent. To the extent that these models are linear, results can be interpreted as "ready-reckoners" and hence a devaluation is expansionary (in fact, they are claimed to be proper to use as "ready-reckoner"). Srinivasan (1991) showed a small contractionary output effect for a similar shock in his Latin American model.

To summarise, in this full model a nominal devaluation is mildly expansionary in the long-run. Particularly, the supply side response prevents prices from rising proportionately.

Furthermore, private consumption and investment are being reinforced by the financial consequences of the balance of payments and the government budget constraints. In the long-run the current account shows a mild deficit. When capital stock is fixed the model produces perfect results as predicted by MAB, ie., long-run neutrality on output and current account balance and proportionality in respect of the domestic price level.

Table 7.2

Effect of a Nominal Exchange Rate Devaluation.

Model Name	Additional Exogenous Variables	Effect on		
		Output	Prices	Current Account
MDL5	Money, Price & ADV	2.04 5.66	0.0 0.0	-1.38 8.29
MDL6	Prices	1.84 6.54	0.0 0.0	-1.24 3.43
MDL7	Money & Prices	-0.67 -1.0	7.50 11.36	0.47 2.33
MDL8	Non	-0.68 0.97	7.5 8.68	0.48 -0.67

Notes:

1. A permanent increase in nominal exchange rate index by 10.0 Percent.

2. Output and prices are measured as the percentage difference from the base. The current account balance is expressed as the percentage change relative to base exports.

3. First year impact is given as the short run effect. For each run, short-run and long-run effects are reported in the first and the second rows, respectively.

Effect of 10% Nominal Devaluation on GDP
% Diference from Base Level.

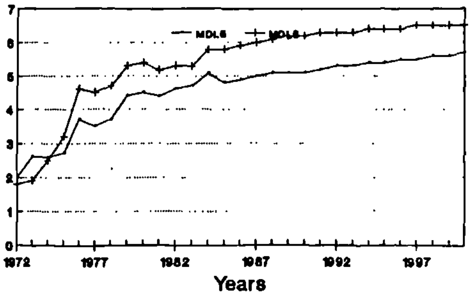


FIG. 7.7a

Effect of 10% Nominal Devaluation on GDP
% Diference from Base Level.

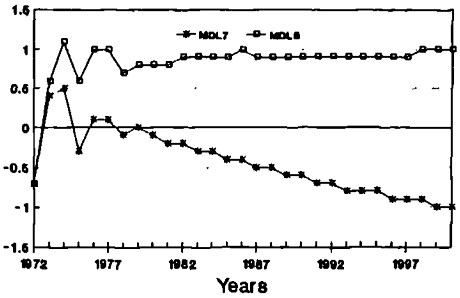


FIG. 7.7b

Effect of a 10% Noml. Devaluation on CBV
Relative to Base Run Exports (%).

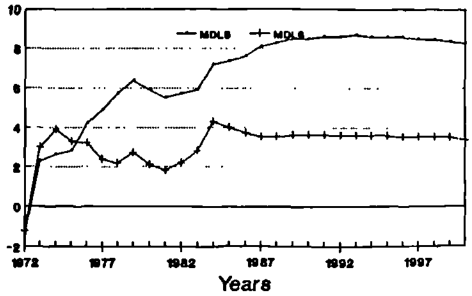


FIG 7.8a

Effect of a 10% Noml. Devaluation on CBV
Relative to Base Run Exports (%).

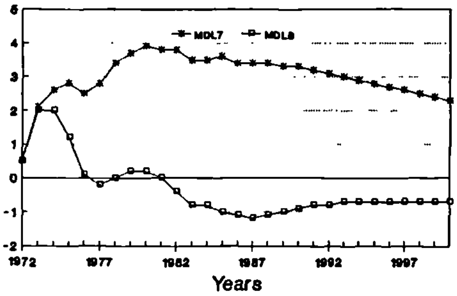


FIG 7.8b

Effect of 10% Noml. Devaluation on
Domestic Price Level (%)

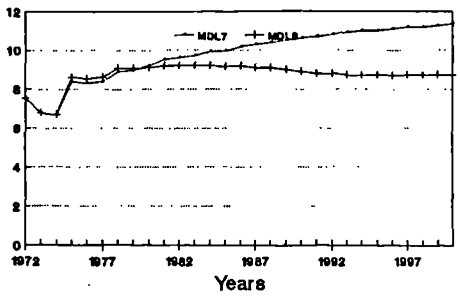


FIG. 7.9b

Effect of a 10% Devaluation on Real M2.
% Change from Base Level.

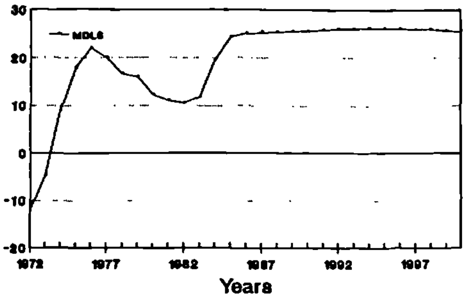


FIG. 7.10a

Efect of a 10% Devaluation on Real M2.
% Change from Base Level.

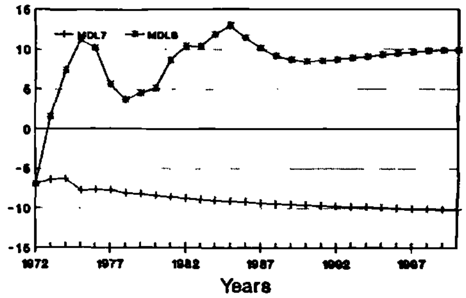


FIG. 7.10b

Effect of a 10% Devaluation on Real ADV.
% Change from Base Level.

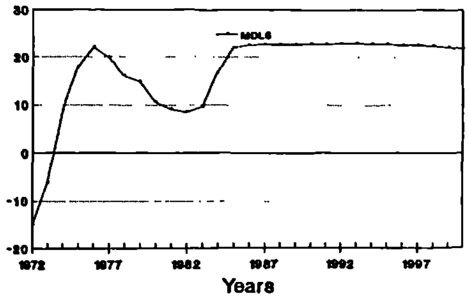


FIG 7.11a

Effect of a 10% Devaluation on Real ADV.
% Change from Base Level.

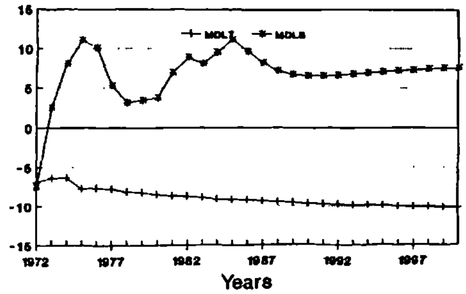


FIG 7.11b

Effect of 10% Devaluation on Real CP.
% Difference from Base Level.

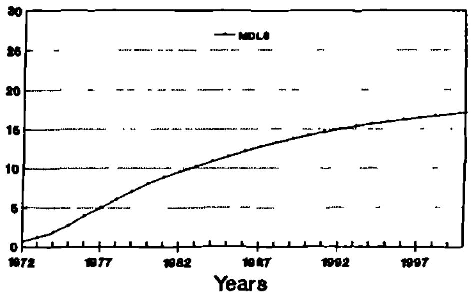


FIG. 7.12a

Effect of a 10% Devaluation on Real CP.
% Difference from Base Level.

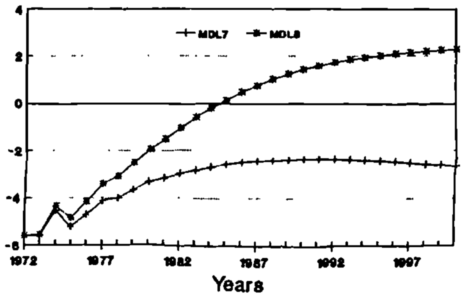


FIG. 7.12b

(7.2.3) Adverse Supply Shock

An adverse supply shock is administered in the simulation by increasing the multiplicative constant adjustment of price equation.

An adverse price shock affects our model in several ways. To start with, it sets into motion a wage-price dynamics which pushes domestic prices even at higher level. This rise in prices generates several effects, as already discussed in various counts. Firstly, the relative price of exports goes up and the real exchange rate appreciates. As a result, net exports fall and so does the level of income. The supply side responds following a real exchange rate appreciation, but the real exchange rate elasticity of aggregate supply is smaller than that of the aggregate demand. Therefore, the net effect is a reduction in the level of activities. However, to the extent income falls that will help neutralise the magnitude of current account deficit.

Secondly, the terms of trade improve as the nominal exchange rate and the foreign prices are fixed. To the extent the private sector consumption responds to the terms of trade effect, it helps to neutralise the contractionary effects. However, it is not enough to turn the activity into the expansionary direction.

Thirdly, any increase in domestic price level reduces real money balances and depresses consumption. The same is true with the real stock of bank credits and the level of investment.

Fourthly, any rise in domestic price level increases the demand for currency. This reduces the level of bank reserves for any given level of base money and produces real asset effects.

These are some of the direct effects of an adverse supply shock. Other indirect effects follow subsequently. For example, any change in the level of activities produce both budgetary as well as the balance of payments consequences. Similarly, a rise in domestic price level does not leave government revenue and expenditure unaffected. These, in turn, jointly determine the level of base money and bank reserves. As a result, money stock and bank credits are affected and hence the level of consumption and investment expenditure and so on. Now, we turn to analyse the simulation outcomes of a permanent rise in the price level in our model.

Table 7.3 (see p. 278) contains the impact and total multipliers of the shock on relevant endogenous variables. In figures 7.13a-7.18b we plot the outcomes of a permanent rise in the multiplicative constant adjustment of price equation by 5.0 percent on output, the current account balance, the domestic price level, real money stock, real bank advances and real currency stock, respectively.

(7.2.3.a) Money, Price and Total Bank Lending Exogenous

In this run, marked MDL5, a permanent 5.0 percent rise in domestic price level brings a contractionary effect on the level of income.

In the short-run, income falls by 1.75 percent and in the long run it stabilises at 2.6 percent below the base level. The dynamic outcomes on income are plotted in fig. 7.13a which shows a stable time profile.

Since we have exogenised the effects associated with real asset stocks in this run, it is the fall in exports that causes the contraction of activities.

The increase in domestic price level raises the relative price of exports, consequently, exports fall substantially. On impact exports of goods and non-factor services fall by 5.0 percent and in the long run it stabilises at 11.9 percent below the base level. This long-run fall is plausible as the long-run relative price elasticity of exports of goods is 2.6.

However, over time, the depressing effect on income is further reinforced by a negative flexible-accelerator. The only expansionary effect of the domestic price rise is through improvement in the terms of trade. However, we cannot expect this to nullify the contractionary effect associated with a general price rise. This is what exactly happens in the model.

Since the behavioural relationships on wages and prices are exogenised, a wage-price spiral does not take place. Therefore, the domestic price level increases by 5.0 percent throughout which is the magnitude of shock itself (fig. 7.15a).

The impact effect on current account balance is favourable indicating income effect dominating the price (substitution) effects in the trade sector. It is also due to the reverse "J" curve effect following a real exchange rate appreciation. In the short run, current account improves by 1.27 percent relative to base exports. However, it quickly goes into deficit and remains so throughout due to the adverse price developments. In the long-run, deficit is further reinforced by a process of cumulative reserve loss - a reduced level of reserves leads to a reduced level of interest earnings and hence to a further reduction in reserves. In the long-run, the current account balance worsens by 3.9 percent relative to base exports. These outcomes are plotted in fig. 7.14a which shows a stable time profile.

To conclude, a permanent rise in prices depresses output and worsens the current account balance permanently.

(7.2.3.b) Exogenous Prices, Endogenous Money and Total Bank Lending

In this run (MDL6) we endogenise total bank advances and money stock keeping the price block fixed. Since the wage-price spiral is not allowed for, prices do not explode. Domestic price level moves exactly the same way as it did in MDL5 and so does the level of exports. Income falls by 1.63 percent in the short-run. In the long run it stabilises at 2.9 percent below the base level. In figure 7.13a we plot this outcome. As expected, the endogeneity of financial variables affect the outcomes. The short-run effect is less contractionary but the long-run effect is more contractionary compared to MDL5.

In the short-run export prices exert a strong effect. Though export volume falls following the rise in relative prices, export revenue rises in the short-run. As a result, despite the rise in imports, the current account improves and hence the stock of foreign reserves. This is a plausible outcome which is exactly the reverse of "J" curve effect following a real exchange rate appreciation. Government revenue falls due to fall in income, consequently, borrowing from the central bank rises with fiscal deficit.

Both of these effects increase base money. Deposit bank reserves rise as the rise in base money is further reinforced by the fall in currency demand caused by the fall in income. As a result, both money stock and bank advances rise, in the short-run, encouraging private sector consumption and investment. It is precisely because of this real asset effects the impact effect is less contractionary.

However, this expansionary real asset effect does not remain for long. Beginning the fourth year both the base money and the deposit bank reserves start to decline relative to their base level. This is due to the full adjustments of exports to relative price changes. Net interest payments abroad increases which drains the reserves. This deterioration in international reserves overwhelms the rise in government borrowing from the central bank. Consequently, base money declines. The fall in currency demand is not enough to compensate this, as a result, bank reserves fall and so do the real money stock and bank advances. They cause long-run output effect to be more contractionary than in the MDL5. The time profile of real money stock, real bank advances and the real currency stock are plotted in figures 7.16a, 7.17a and 7.18a, respectively. All the real asset stocks stabilise at a reduced level relative to base in the long-run.

The current account improves in the short-run by 1.18 percent relative to the base exports. However, in the long-run it stabilises at 2.3 percent below the base exports. Despite fall in income, this deterioration in current account balance is indicative of the fact that relative price (substitution) effects dominate the income effects in the trade sector. It is plausible as the prime mover, in this run, is the price variable rather than income. The outcomes on current account balance are plotted in fig. 7.14a.

The endogeneity of financial variables affect the outcomes on current account balance as well. On impact the current account improves by a lesser extent than MDL5 as the endogeneity of financial variables cause lesser falls in output in the short-run. However, in the long-run the current account deteriorates by less again reflecting the higher fall in income due to the fall in real money stock and real bank credits.

To conclude, the endogeneity of financial variables do alter the outcomes. However, the nature of the effects remains the same. A negative supply shock reduces the level of activities and worsens the current account balance.

(7.2.3.c) Exogenous Money and Total Bank Lending; Endogenous prices

In this run, marked MDL7, we have endogenised prices. A permanent supply shock of 5.0 percent (increase in multiplicative constant adjustment) sets a process of wage price spiral which pushes prices up by 5.0 and 70.0 percent in the short and long run, respectively (fig. 7.15b). This price explosion is caused, among other things, by the nature of the shock as discussed in section 6.2. As we have shocked the multiplicative constant adjustment of a dynamic equation, the shock magnifies over the time. Secondly, the rapid fall in capital stock reinforces this process through a negative supply side effect. In the long-run capital stock stabilises at 19.0 percent below the base level. This fall in capital stock is due to the fall in income and real bank advances.

Though the real exchange rate appreciates rapidly following the price explosion, this can not improve the supply response as the responsiveness of aggregate supply is almost one third (0.25) compared to that of capital stock (0.72).

Income falls by 1.77 percent in the short-run and in the long-run it goes down by 17.7 percent below the base level. The outcomes are plotted in fig. 7.13b. It shows a continuous decline which is again due to the nature of the shock. The rapid fall in exports and asset stocks are responsible for this decline in income. As expected, consumption and imports fall following the fall in income. The fall in imports in the face of real exchange rate appreciation indicates that income effect rather than the substitution effect is dominant. Similarly, declining consumption indicates a feeble terms of trade effect relative to income effect following the price explosion.

The outcomes on financial assets are plotted in figures 7.16b, 7.17b and 7.18b. These outcomes are sensible as the real stock of financial assets are falling reflecting the effect of price rise. However, the real stock of currency reflects the reduced transaction demand as well.

The initial improvement in current account balance by 1.28 percent relative to base exports points out the dominant output effect. However, in the long-run as the price level explodes following a wage price spiral the price effect dominates the income effect and the current account goes into deficit. In the long-run, the current account deficit goes up by as much as 39.0 percent relative to base exports (fig. 7.14b).

To conclude, price endogeneity aggravates the wage-price spiral. Prices explode, output declines and the payments position worsens.

(7.2.3.d) Endogenous Money, Prices and Total Bank Lending

In this full model (MDL8), a permanent 5.0 percent increase in the multiplicative constant adjustment is contractionary throughout. Results echo all the outcomes discussed in the earlier run. However, in this run these contractionay effects are further reinforced by the monetary consequences of the balance of payments.

Output declines by 1.65 percent in the short-run and in the long-run by 24.0 percent (see fig. 7.13b and table 7.3). This fall in output is mainly because of the drastic fall in exports caused by adverse price developments in the trade sector. This is further reinforced by adverse real balance effects and the reduced level of real bank advances.

In the short-run prices go up by 5.05 percent but in the long-run they rise by as much as 82.0 percent (fig. 7.15b).

In this run prices and income fall steadily without receding which is a worrying feature of the model. However, as already explained, this is due to the way we have administered the constant adjustment shock in the model. We have increased the constant adjustment of a dynamic equation which implies that this shock will be magnified till the very end of the simulation period.

The current account shows improvement in the short-run again due to the dominant income effect over relative price effects in the trade sector. However, in the long-run adverse price effects dominate and hence the current account goes into deficit (see fig. 7.14b). In this run, the wage-price spiral has been reinforced by the contractionary monetary consequences of the balance of payments. A fall in the reserve position dominates the developments in base money, consequently, base money declines. Though, currency demand declines following the fall in real income this is not enough to offset the fall in deposit bank reserves brought about by the falling base money. This contraction in deposit bank reserves reduces the credit creation capacity of banks. Consequently, the flow of bank advances and money stock decline accentuating the negative spiral in consumption and investment.

We have plotted the outcomes on real money stock, real bank advances and real stock of currency in figures 7.16b, 7.17b and 7.18b, respectively. All the financial stocks register a decline.

To conclude, in this full model, an adverse supply shock is aggravated by the wage-price spiral in the long-run. Consequently, both wages and prices go up. Output contracts rapidly and payments problems worsens.

Table 7.3

Effect of a Supply Shock

Model Name	Additional Exogenous Variables	Effect on		
		Output	Prices	Current Account
MDL5	Money, Price & ADV	-1.75	5.0	1.27
		-2.60	5.0	-3.87
MDL6	Prices	-1.63	5.0	1.18
		-2.90	5.0	-2.23
MDL7	Money & ADV	-1.77	5.05	1.28
		-17.30	70.26	-39.63
MDL8	Non	-1.65	5.0	3.29
		-23.82	82.0	-0.72

Notes:

1. A permanent increase of 5.0 percent in the constant adjustment of price equation. In model MDL5 and MDL6 this shock is equivalent to an exogenous shock in price variable, however, in MDL7 and MDL8 this is a shock in the multiplicative constant adjustment of price equation.

2. Output and price are measured as the percentage difference from the base level. The current account balance is expressed as percentage change relative to base exports.

3. The first year effects are given as the short run effects. For each run, impact effect and long run effect are given in the first and second rows, respectively.

Effect of 5.0% Increase in CED on GDP.
(% Difference from Base Level).

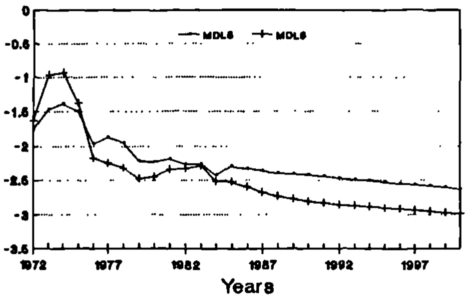


FIG 7.13a

Effect of 5% Increase in Const. Adj. of
CED on GDP (% Difference from Base)

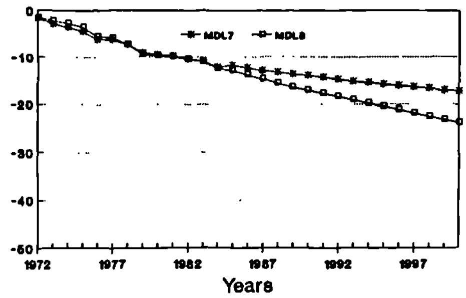


FIG 7.13b

Effect of a 5% Inc. in CED on CBV.
(% Change Relative to Base Exports).

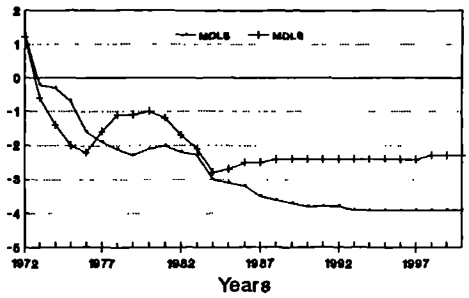


FIG. 7.14a

Effect of 5% Inc. in const. Adj. of CED
on CBV(% Change Relative to Base Export)

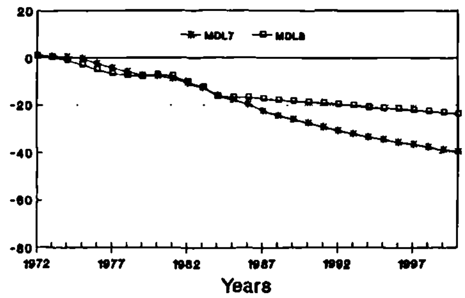


FIG. 7.14b

Effect of 5% Increase in CED on CED.
(% Difference from Base).

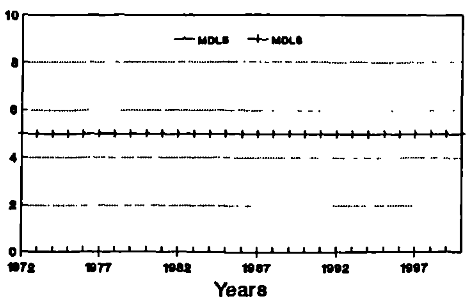


FIG 7.15a

Effect of 5% Inc. in Const. Adj. of CED
on CED (% Difference from Base)

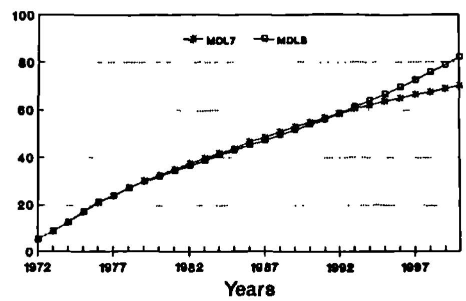


FIG 7.15b

Effect of a 5% Inc. in CED on Real M2.
(% Difference from Base Level).

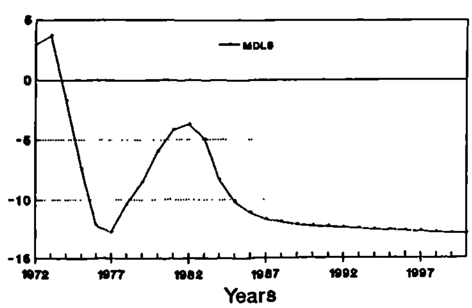


FIG. 7.16a

Effect of 5% Inc. in Const. Adj. of CED
on Real M2 (% Diff. from Base Level)

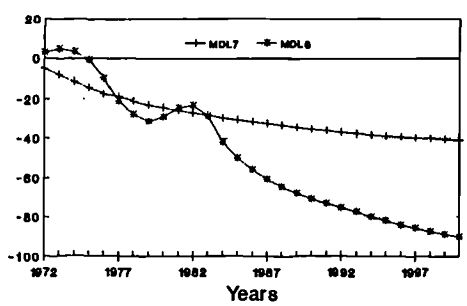


FIG. 7.16b

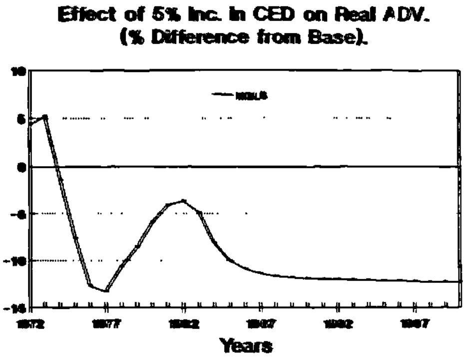


FIG 7.17a

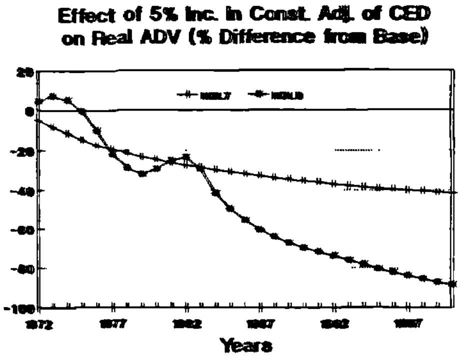


FIG 7.17b

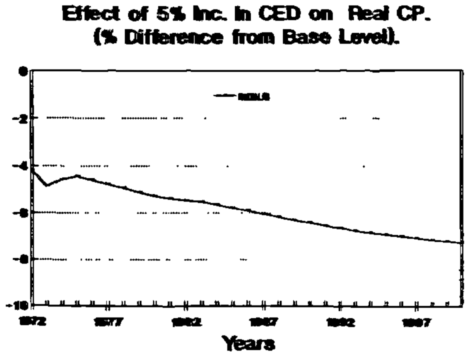


FIG. 7.18a

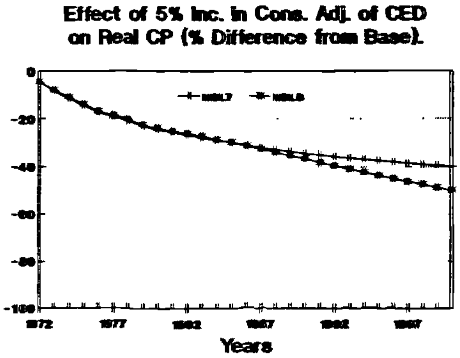


FIG. 7.18b

(7.2.4) Money Supply Shock

We have used the real stock of money (broadly defined) as the proxy of the real stock of private sector financial wealth. It enters into our model as an argument of the consumption function. Any increase in real money stock increases private consumption and hence the level of income and vice versa.

In figures 7.19a-7.21b we plot the outcomes of a temporary rise of 1.0 billion in the additive constant adjustment of money supply equation on different endogenous variables of our interest. In table 7.4 (see page 283) we report the short-run and long-run effects of this shock on income, domestic price level and current account balance.

(7.2.4.a) Money, Prices and Total Bank Lending Exogenous

In this run marked MDL5, any rise in nominal money stock is equivalent to a rise in the real money stock as the price level is exogenous. A temporary increase in the nominal money stock by one billion does not bring any perceptible effect in the level of activities in the long-run.

The impact effect is zero due to the lag of adjustment. The wealth variable must work out its effect on income through the consumption function, therefore, a lagged effect is plausible. It shows a mild increase (multiplier of 0.2) in activity in the second year. This is due to the real balance effect on private consumption expenditure. The dynamic multipliers are plotted in fig. 7.19a.

However, it is interesting to note that this output effect dies out immediately, the year after. This outcome is theoretically consistent as the effect of one shot "helicopter money" scenario is only temporary as far as the level of real activity is concerned. This theoretical argument is very much embedded in the Monetary Approach of the Balance of Payments (MAB).

We expect the domestic price level to rise at the aftermath of such a shock. However, this point will be taken up in the relevant runs where the price level is endogenous.

As expected, extra money leaks abroad through reserve losses turning the current account balance in to deficit, a standard MAB outcome. The impact effect on the current account balance is zero, again due to adjustment lags. However, in the second year it goes into deficit by 0.2 percent relative to base exports. The current account deficit persists as the reserves drain permanently reduce the interest earnings from abroad. The magnitude of the long-run deficit is marginal (0.01 percent of base exports). The time profile of the current account balance is plotted in fig. 7.20a. Note that the asset effects on private sector expenditure are not allowed in this run, therefore, the balance of payments is not self-correcting as the MAB predicts.

(7.2.4.b) Exogenous Prices; Endogenous Money and Total Bank Lending

In this run (MDL6) both the total bank lending and money is endogenised keeping the price level fixed. The endogeneity of financial variables produce different results. Initially output rises following a rise in money stock. But it falls immediately thereafter, following a fall in asset stocks caused by the loss in reserves. However, in the long-run a temporary rise in money stock is neutral to output (fig. 7.19a).

The impact effect on current account is zero. It shows a marginal deficit beginning in the second year. The saw tooth cycles in the short-run are due to the behaviour in income. Again, in the long-run the current account returns to its initial position. The long-run self-correcting effect is obvious as the balance of payments effects on asset stocks are allowed for in this run. The outcomes on the current account are plotted in fig. 7.20.a.

(7.2.4.c) Exogenous Money and Total Bank Lending; Endogenous Prices

Price endogeneity (MDL7) shows a moderate increase in domestic price level following a temporary shock in the nominal money supply. The impact effect on prices is zero, again due to the lag involved in the adjustment. Any price effect following monetary shock must come through the income effect.

The price effect is shown in the second year; it goes up mildly by 0.04 percent (fig. 7.21.b). However, this price effect also dies out very quickly as there is no perceptible effect on aggregate demand.

The current account goes into deficit due to the reasons explained earlier. In this run, the extent to which prices rise that depresses exports through the rise in relative price of exports. However, prices rise very marginally. It is the fall in exports as well as the coupon effect associated with the net interest payments abroad that marginally worsen the current account balance even in the in the long-run (fig. 7.21a). Again asset effects on the private sector is exogenised, therefore, there is no long-run neutrality.

(7.2.4.d) Endogenous Money, Prices and Total Bank Lending

In this full model (MDL8) too, a temporary nominal monetary shock echoes most of the results discussed in earlier runs. No lasting effects on output occur. The impact effect is zero. An output multiplier of 0.2 is depicted in the second year, an outcome similar to other runs (fig. 7.19b). Towards the end of the simulation period a very marginal (0.07) fall in output is depicted. This is due to the fall in exports and the coupon effects associated with net interest payments abroad.

The domestic price effect appears in the second year. The difference from other runs is that a longer price effect is shown in this run, though the magnitude of the effect is very marginal (fig. 7.21b). This is due to the reserve related contraction in the stock of capital. As expected, the current account goes into deficit due to the factors explained earlier (fig. 7.19b).

To summarise, a temporary rise in nominal money stock generates the outcomes as predicted by the MAB. The income effect is very short-lived and no perceptible effects occur. Domestic prices rise following this shock and the current account deteriorates permanently.

Table 7.4

Effect of Increase in Nominal Money Stock

Model Name	Additional Exogenous Variables	Effect on Output	Effect on Prices	Effect on Current Account
MDL5	Money, Price & ADV	0.0	0.0	0.0
		0.0003	0.0	-0.01
MDL6	Prices	0.0	0.0	0.0
		-0.003	0.0	0.0
MDL7	Money & ADV	0.0	0.0	0.0
		0.002	0.0	-0.01
MDL8	Non	0.0	0.0	0.0
		-0.07	0.01	-0.01

Notes:

1. A temporary increase of US $ 1.0 billion in nominal money Stock (M2). In MLD5 and MDL7 this shock is administered by a temporary 1.0 bn. increase in the base value of money stock. However, in MDL6 and MDL8 it is an increase in the additive constant adjustment of M2 equation.

2. Output *is measured as the absolute difference from base* normalised by the shock itself. This essentially gives the output multiplier of a temporary increase in nominal money stock. Price is measured as the percentage difference from the base. The current Account balance is expressed as percentage change relative to base exports.

3. The first year impact is given as the short run effect. For each run, impact effect and long-run multiplier are reported in the first and the second rows, respectively.

Effect of a Temporary 1.0 bn. Increase
In M2 on GDP (Multipliers)

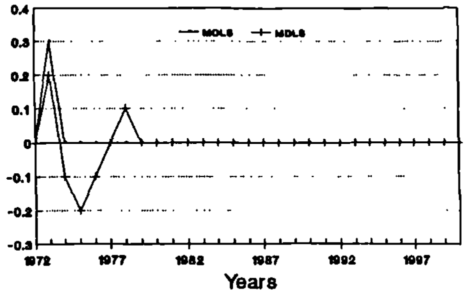


FIG. 7.19a

Effect of a Temporary 1.0 bn. Increase
In M2 on GDP (Multipliers)

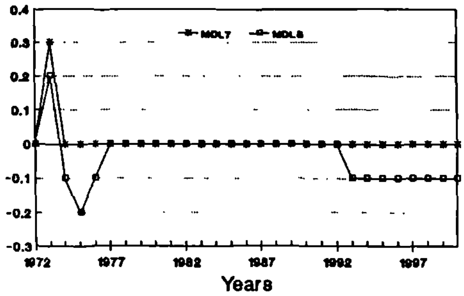


FIG. 7.19b

Effect of a Temporary Insrease of 1.0 bn
In M2 on CBV(% diff. from base exports).

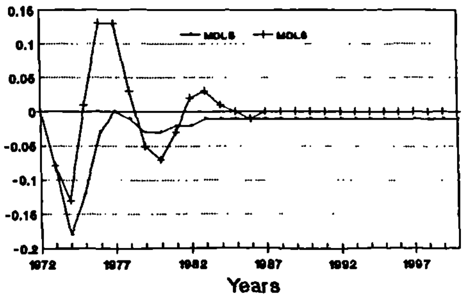


FIG. 7.20a

Effect of a Temporary Insrease of 1.0 bn
In M2 on CBV(% diff. from base exports).

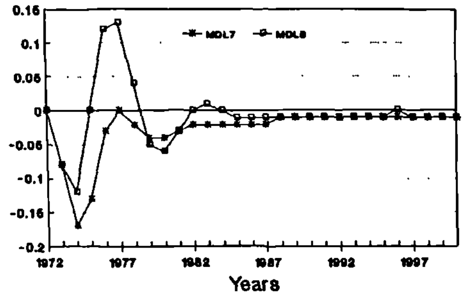


FIG. 7.20b

Effect of a Temporary 1.0 bn. Increase
In M2 on Price Level(% diff. from base).

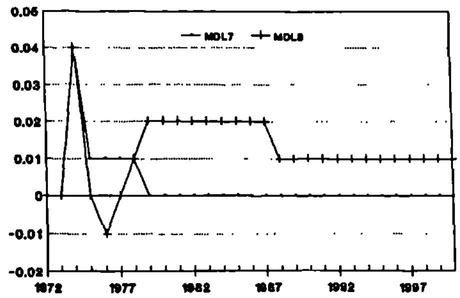


FIG 7.21b

7.2.5 Increase in Required Reserve Ratio

The required reserve ratio is one of the important monetary policy instruments in our model. Authorities manipulate this policy instrument with a view to affect directly the flow of bank advances. *Ceteris paribus*, a higher required reserve ratio is an indication of tighter monetary policy and vice versa.

A change in the required reserve ratio affect the economy through changing deposit banks' balance sheet items. An increase in the required reserve ratio forces banks to maintain a higher level of reserves (ie., reduces the credit multiplier as the average reserve ratio goes up) which reduces the flow of bank advances. It should be noted that the required reserve ratio directly affects the magnitude of the bank credit multipliers and not the flow of bank reserves. The flow of bank reserves is determined by the difference between the flow of base money and the flow of currency demand of the non-bank private sector which we have already discussed.

A higher required reserve ratio affects, *inter alia*, the profitability of banks as well. However, we do not analyse this aspect of the Central Bank policy action in our model. We are just concerned with the macroeconomic consequences of such a policy action.

The effect of a higher required reserve ratio on the rest of the economy is contractionary. Firstly, it reduces the flow of bank advances (credits) and that depresses the level of investment in our model through adverse credit availability effect. Secondly, a fall in bank advances implied by a higher required reserve ratio will act to the detriment of the growth in deposits as the multiple expansion of reserve related credits that generate deposits work in the opposite direction. This brings a reduction in the volume of total deposits and hence on the stock of money supply (financial wealth) which, in turn, depresses consumption.

Thus, it is the fall in consumption and investment following a rise in the required reserve ratio that reduces the level of income. The resultant fall in income generates a whole range of effects in the model as described in the earlier shocks. We shall address these issues as we deal with each shock under different policy regimes. We now turn to these issues.

Table 7.5 contains the impact and the long-run effects of a permanent one percentage point (roughly 10.0 percent in average) rise in the required reserve ratio on relevant endogenous variables of the model. In figures 7.22-7.27 we plot the time profile of different endogenous variables following a required reserve ratio shock. Unlike other policy shocks we run only two versions of our model viz., MDL6 and MDL8 as far as financial policy shocks are concerned. It is because of the obvious reason that financial variables are exogenised in other two versions viz., MDL5 and MDL7.

Table 7.5

The effect of an Increase in the Required Reserve Ratio (RRR)

(A Permanent Increase of 1.0 Percentage Point Increase in RRR

Model Name	Additional Exogenous Variables	Effects on				
		Output	Prices	Current Account	ADVK	M2KP
MDL6	Prices	-0.01	0.0	0.01	-1.01	-0.76
		-0.05	0.0	0.28	-1.06	-0.75
MDL8	Non	-0.01	0.0	0.01	-1.01	-0.76
		-0.18	0.25	0.19	-1.70	-0.88

Notes:

1. Output, prices, bank advances (ADVK) and money stock (M2KP) are measured as the percentage difference from the base. The current account balance is expressed as percentage change relative to base exports.

2. The first year impact is given as the short run effect. For each run, the impact effect and the long-run effects are reported in the first and the second rows, respectively.

(7.2.5.a) Exogenous Prices; Endogenous Money (M2) and Bank Advances (ADV)

In this run, marked MDL6, a permanent one percentage point (11.7 percent at 1980 level) increase in the required reserve ratio reduces the level of activities. On impact, income falls marginally by .01 percent and in the long-run it stabilises at .05 percent below the base level. These dynamic output outcomes are plotted in fig. 7.22.

The contraction in activity occurs mainly due to two reasons. Firstly, the increase in the required reserve ratio reduces the credit multiplier, and hence the level of bank lending. This reduces the level of investment. Secondly, total deposit liabilities are directly related to any change in bank advances. Therefore, a fall in bank advances reduces the volume of deposit liabilities and hence the stock of money supply. This, in turn, depresses private consumption.

The fall in income brings about an improvement in the current account balance. Consequently, the current account balance improves by .01 percent and 0.28 percent relative to the base run exports in the short and long run, respectively. Note that prices are fixed in this run, therefore, exports are not moving but imports are falling following the decline in income. The outcomes on the current account balance are plotted in fig. 7.23 and show a stable time profile.

Government expenditure falls both because of the fall in the net interest payments abroad and government investment expenditure (as it follows total investment). Government revenue also falls, following the fall in income, but by less than proportionately to the fall in government expenditure. Consequently, the government's fiscal position improves, which reduces its borrowing from the Central Bank.

Though government borrowing from the Central Bank falls, base money expands due to the improvement in international reserves following the current account surplus. Currency demand falls due to the fall in income. Both the rise in international reserves and the fall in currency demanded increase the flow of deposit bank reserves.

However, bank advances fall because of the fall in the credit multiplier following the rise in the required reserve ratio. On impact bank advances fall by 1.01 percent and in the long run it stabilises at 1.06 percent below the base level. The maximum contraction in bank advances is depicted to be 3.29 percent in the simulation period. The outcomes are plotted in fig. 7.26.

Money supply falls by 0.76 and 0.75 percent in the short and long run, respectively, relative to the base level (fig. 7.25). This fall in real balances depresses private consumption. The time profile of both the bank advances and the money supply show a stable outcome.

It should be noted that both the real bank advances and real money stock show some cyclical behaviour in the initial years. It is mainly because of the cyclical magnitude of the base run credit multiplier. The base run credit multiplier fluctuates between 7.5 and 12.2 over the simulation period. Since the required reserve ratio is one of the actively used policy variables, there is no surprise in its differing magnitudes as authorities manipulate it over time. Therefore, our imposition of a permanent one percentage point increase in the required reserve ratio as the policy shock produces different magnitudes of changes in the credit multipliers. Following the shock, the required reserve ratio rises between a maximum and a minimum of 26.31 and 11.73 percent, respectively. Herein lies the reason for the fluctuation in bank advances and money stock. It is precisely the fluctuation in the credit multiplier that results in the oscillation of the bank advances and the money stock.

Secondly, it should be noted that real money stock becomes marginally positive during 1981-1984 when deposit bank reserves (not reported here) also shows the highest rate of growth. The implication is that the contractionary effect of a rise in the required reserve ratio depends on other factors as well. For example, there might be occasions where money supply might go up if the fall in the credit multiplier is overwhelmed by the rise in deposit bank reserves, either due to a build-up in international reserves or due to a rise in government borrowing from the central bank or a combination of both. This is what has happened in our model. The mechanism can be explained as follows:

The increased required reserve ratio reduces the level of income working through credit multiplier which in turn improves the current account balance and hence international reserves. This rise in international reserves increases the base money and the flow of bank reserves which might reverse the effect of increased required reserve ratio. However, except for these few years, an increase in the required reserve ratio reduces the stock of money and bank advances. This is what one would expect.

(7.2.5.b) Endogenous Money, Prices and Total Bank Lending (ADV)

In this full model simulation (MDL8) a permanent rise in the required reserve ratio by one percentage point reduces income by 0.01 and 0.18 percent in the short and long run, respectively. The outcome on income is plotted in figure 7.22 which shows a stable time profile.

Compared to the MDL6, the endogeneity of prices brings a greater fall in income in the long-run which is an expected outcome. This is due to the fall in exports caused by price rises which further depresses the real asset stocks.

It is the fall in capital stock that causes domestic prices to rise. Initially, domestic price falls, indicating that the decelerating demand effect is dominating the worsening supply effect. However, after a few years (beginning in the sixth year) the supply effect dominate and prices start to rise. In the long-run prices go up by 0.25 percent (fig. 7.24).

The current account balance improves in the short-run due to the fall in activities. It improves by 0.01 percent relative to base run exports. The current account does improve in the long-run also by 0.19 percent, (fig. 7.23) but due a different reason which is as follows.

In the analytical model it was shown that trade balance improves in the short-run but worsens in the long-run following a required reserve ratio shock. However, in the simulation outcomes the current account shows improvement even in the long-run. Three factors should be taken in to account to reconcile these results. Firstly, in the analytical model the trade balance is analysed in real terms. Our simulation result confirms that the trade balance in real terms improves in the short-run and worsens in the long-run, a perfect tally with our analytical results. Secondly, when it comes to the nominal magnitude the scenario changes ie., in the long-run the trade balance goes into surplus because of the improvement in the terms of trade. It should be noted that export price has gone up whereas import prices are fixed. Thirdly, the coupon effect associated with the net interest payments abroad helps the current account to improve in the long-run. It is because the thin long-run negative supply effect (notice the marginal price effects) on trade balance is neutralised to a large extent by the improvements in net interest receipts from abroad following the rise in the short-run reserve position.

Though the rise in foreign exchange reserves and the fall in currency demanded increases the flow of deposit bank reserves, bank advances decline throughout due to the fall in credit multipliers. On impact, bank advances falls by 1.01 percent and in the long run it stabilises at 1.17 present below the base level (fig 7.26). Similarly, money supply falls by 0.75 and 0.8 percent in the short and the long run, respectively (fig. 7.25). Currency demanded falls following the fall in transaction demand. Outcomes on real currency stocks are plotted in fig. 7.27.

To conclude, a permanent increase in the required reserve ratio results in a permanent reduction in real credit flows, and real balances. Consequently, private sector consumption and investment expenditures fall which in turn causes real income to fall permanently. The current account balance improves due to the fall in activities. Domestic prices rise permanently in the long run following the fall in capital stock. These outcomes in our model corroborates the outcomes of a required reserve shock in other models designed and tested by Blondol (1986) and Adams (1992). In Blondol's model a 10% increase in required reserve ratio contracts income by 0.6 percent in the long-run. Adam shows an even stronger contractionary effect of required reserve shock on income.

Effect of a Perm. 1.0 Percentge Point Increase in RRR on GDP(% diff from base)

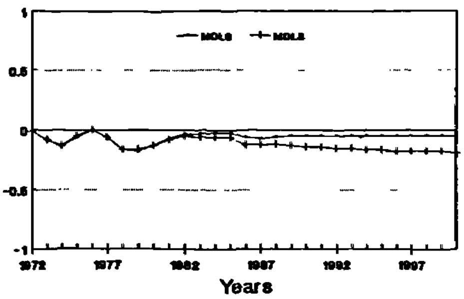


FIG. 7.22

Effect of a Perm. 1.0 Per Point Increase in RRR on CBV(% diff. from base exports)

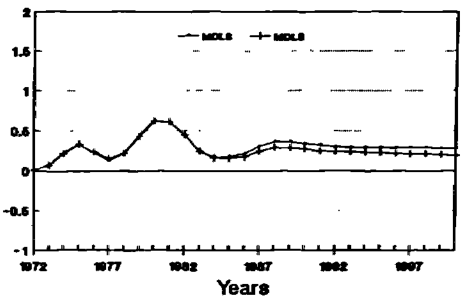


FIG. 7.23

Effects of a Perm. 1.0 Percentage Point Increase in RRR on CED(% diff from base)

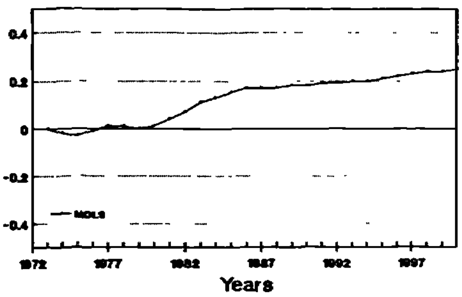


FIG 7.24

Effect of a Perm. 1.0 Per Point Increase in RRR on Real M2 (% diff. from base).

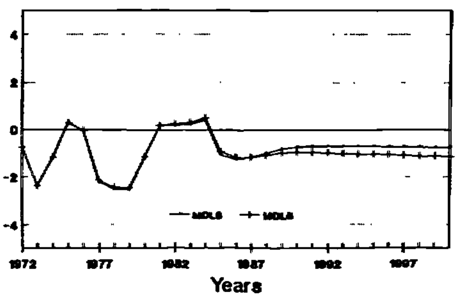


FIG. 7.25

Effect of a Perm. 1 Per. Point Increase in RRR on Real ADV (% diff. from base).

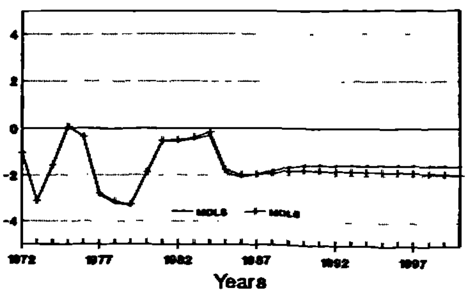


FIG. 7.26

Effect of a Perm. 1 Per. Point Increase in RRR on Real CP (% diff. from base).

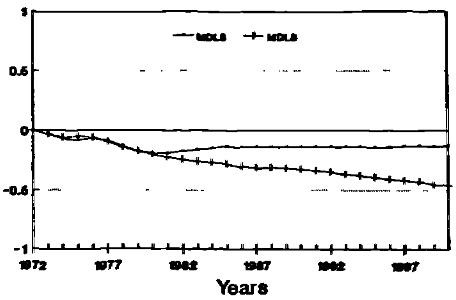


FIG. 7.27

(7.2.6) Increase in Discount Rate

The discount rate is another monetary policy instrument often used by the monetary authorities to affect the course of bank lending and hence the stock of money. It is the rate at which Central Bank is prepared to lend to the banking system when the latter is short of funds. This rate is normally charged by the Central Bank while discounting the eligible assets of the banking system. However, these assets are specified by the monetary authorities and in most cases they include government securities, commercial bills, promissory notes etc.

Thus, the discount rate determines the cost of borrowing of the banking system from the Central Bank. In developed economies, any change in the discount rate affects the market expectations vis-a-vis interest rates, exchange rates etc., and produces a wider implication on the demand for different types of financial assets, and hence their market prices.

In developing economies, however, such a pervasive effect can hardly be expected as their financial markets are at the rudimentary stage. The anticipated mechanism in these economies is that a rise in the discount rate increases the deposit banks' cost of borrowing from the discount window of the Central Bank which directly affects (ie. increases) bank reserves and depresses the volume of bank lending. Thus, it is not the cost of borrowing to private sector that rations the volume of bank credits, rather it is the increase in idle (required) reserves of the banking system that depress the volume of bank lending.

We note that in these economies interest rates are exogenously determined by the authorities therefore deposit banks cannot involve in interest rate management following a rise in the discount rate. Nor does private sector face an increased rate of interest unless authorities directly increase the lending rates of deposit banks.

In our model the discount rate enters as an argument in the deposit banks' demand for free reserves function. A rise in the discount rate, *ceteris paribus*, increases the deposit banks' demand for free reserves as the cost of borrowing goes up. This raises the average reserve ratio and reduces the credit multiplier of the banking system. This, in turn, reduces the credit creating capacity of deposit banks for any given level of reserves. As a result, the volume of bank advances and money stock fall. This depresses the consumption and investment expenditures and hence the level of income. This income effect, in turn, produces a range of effects as discussed above on several counts.

We now turn to the analysis of the simulation outcomes of a permanent 1.0 percentage point increase in discount rate. In Table 7.6 we present the short-run and long-run effects of this shock on different endogenous variables of our model. The time profile of these variables are plotted in figures 7.28-7.33.

Table 7.6

Effect of an Increase in Discount Rate (DISCR)

Model Name	Additional Exogenous Variables	Effects on				
		Output	Prices	Current Account	ADVK	M2KP
MDL6	Prices	-0.01	0.0	0.01	-0.59	-0.44
		-0.05	0.0	0.30	-1.75	-0.83
MDL8	Non	-0.01	0.0	0.01	-0.59	-0.44
		-0.20	0.27	0.21	-1.86	-0.96

Notes:

1. Effect of a permanent increase of 1.0 percentage point increase in DISCR. Output, prices, bank advances (ADVK) and money stock (M2KP) are measured as the percentage difference from the base level. The current account balance is expressed as percentage change relative base exports.

2. The first year impact is given as the short run effect. For each run, the impact effect and long-run effects are reported in the first and the second rows, respectively.

(7.2.6.a) Exogenous Prices; Endogenous Money (M2) and Bank Advances (ADV)

In this run, marked MDL6, a permanent 1.0 percentage point increase in the discount rate, as discussed above, produces contractionary effects. A one percentage point shock amounts to 11.0 percent on average.

First, it depresses bank lending and money stock as the magnitude of credit multipliers is reduced. A rise in the discount rate compels banks to maintain a higher proportion of their would be lending in the form of liquid assets (reserves) which depresses the amount of bank lending. Bank advances fall by 0.59 percent and 1.75 percent in the short and long run, respectively. The outcomes are plotted in figure 7.32. Following this, money stock falls by 0.44 and 0.83 percent in the short and long runs, respectively (fig. 7.31). Consumption and investment expenditures fall. Consequently, income falls by 0.01 percent on impact and in the long-run it stabilises at 0.05 percent below the base level. The time profile of income variable is plotted in fig. 7.28 which shows a stable outcome.

The current account balance improves by 0.01 percent on impact and by 0.3 percent in the long-run relative to base exports (fig. 7.29). This is precisely because of the fall in absorption.

The flow of deposit bank reserves rise due mainly to the improved external payments position and the reduced currency demand. Currency demand falls due to the fall in transaction demand. The outcomes on currency stock are plotted in fig. 7.33.

The flow of deposit bank reserves rises, but not by enough to counterbalance the contractionary effect associated with an increase in the discount rate. However, to the extent that the flow of deposit bank reserves rises that mitigates the extent of contraction in bank lending. All in all, the net outcome is contractionary.

To conclude, a rise in the discount rate is contractionary. Bank lending and the money stock fall. The payments position improves at the cost of reduced level of activities.

(7.2.6.b) Endogenous Money, Prices and Total Bank Lending (ADV)

Full model (MDL8) simulation also produces anticipated results. Outcomes are similar to that of earlier runs except that the endogeneity of domestic price level reinforces the contractionary effects. As a result bank lending and money stock fall by more and so do the level of activities.

The domestic price level goes up by 0.27 percent in the long-run mainly because of the fall in capital stock (fig. 7.30). This depresses the level of exports which reinforces the contractionary effect already in operation following the rise in discount rate. Bank lending falls by 0.59 in the short-run and stabilises at 1.86 in the long-run (fig. 7.32). The decline in money stock is 0.44 and 0.96 percent in the short and long runs, respectively (fig. 7.31). Income falls by 0.01 and 0.2 percent in the short and long runs, respectively. These dynamic outcomes are plotted in fig. 7.28.

Analytically it was shown in chapter four that the trade balance, measured in real terms, improves in the short-run but worsens in the long-run following a rise in the discount rate. Our simulation results confirm this. The trade balance in real terms improves in the short-run and worsens in the long-run. This is because the absorption effect is stronger in the short-run but the price effect (ie. supply side effects) is stronger in the long-run.

However, the current account, measured in nominal terms, improves due to the terms of trade effects on the trade sector and the coupon effects associated with the short-run improvement in the trade balance as already discussed under the required reserve shock. A rise in export prices with fixed import prices improves the terms of trade. The improvement in current account is 0.01 and 0.21 percent in the short and long run, respectively (fig. 7.29).

To conclude, a permanent rise in discount rate produces theoretically consistent results. Bank lending and the money stock fall permanently and so does the level of income. The trade balance in real terms worsens. The current account improves permanently due to fall in activities and coupon effects. However, it should be noted that the channel of this effect is not through a general rise in interest rates as it normally happens in the case of developed economies rather it is due to the reduction in bank lending and real balances. These outcomes are broadly similar to that of an increase in the required reserve ratio. It is not surprising as their channel of effects are similar. Our simulation outcomes are very similar to that of Adams (1992).

Effects of a Perm. 1 Per. Point Increase
In DISCR on GDP (% diff. from base)

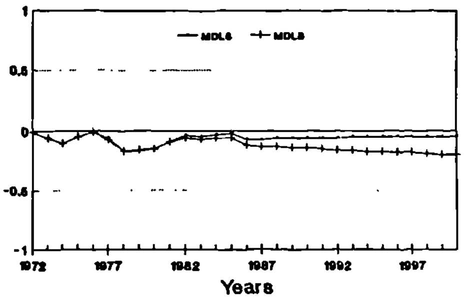


FIG 7.28

Effect of a Perm. 1 Per. Point Increas
In DISCR on CBV(%diff from base exports)

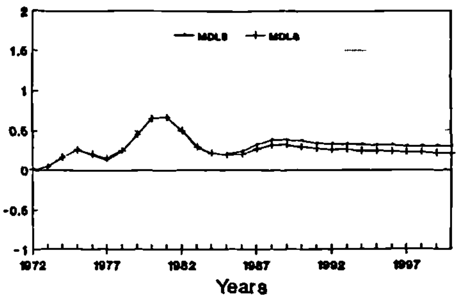


FIG 7.29

Effect of a Perm. 1 Per. Point Increase
In DISCR on CED (% diff. from base).

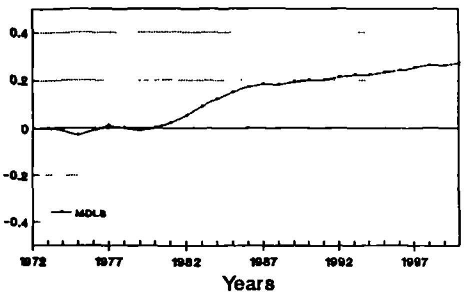


FIG. 7.30

Effect of a Perm. 1 Per. Point Increas
In DISCR on Real M2 (% diff. from base)

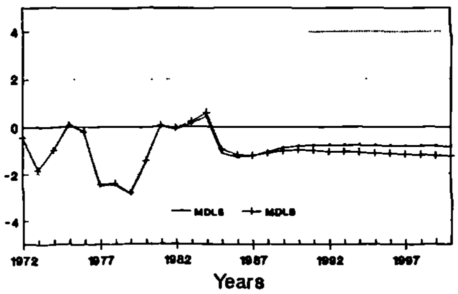


FIG. 7.31

Effect of a Perm. 1 Per. Point Increase
In DISCR on Real ADV (% diff. from base)

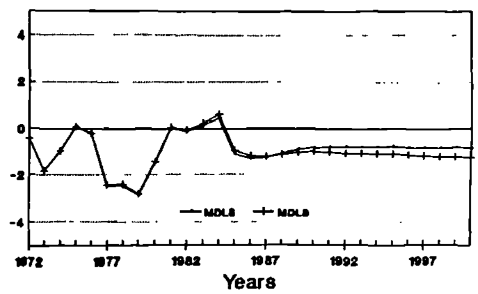


FIG 7.32

Effect of a Perm. 1 Per. Point Increase
In DISCR on Real CP (% diff. from base).

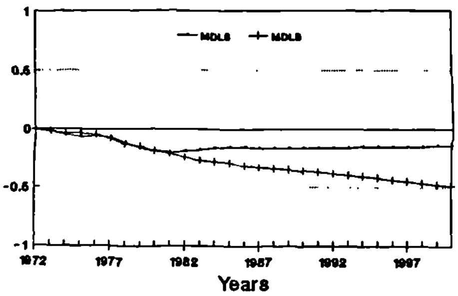


FIG. 7.33

(7.2.7) Increase in Interest Rates

Interest rates are exogenously determined policy variables in our model. They are determined by the monetary authorities. In this simulation we have increased both the deposit and lending rates by 10.0 percent, simultaneously. As already noted, domestic interest rates turn out to be insignificant in the empirical estimation of our investment function. Therefore, there is no cost of capital effect in this model.

Whether the interest rate is a casual factor for the determination of aggregate saving is empirically controversial (Chandavarkar, 1971), however, it seems fairly in agreement that it does work as a causal factor for the mobilisation of financial savings (Diaz-Alejandro, 1985). Thus, a rise in interest rates, *ceteris paribus*, increases financial savings in the form of increased holdings of interest bearing financial assets by the savers. This is the precise role which the deposit rate plays in our model.

A rise in the deposit rate, in our model, reduces the demand for currency and increases deposit bank reserves at any given level of base money. This increases the volume of bank lending and total deposits via credit multiplier effects. The corollary is that both the demand and supply of deposits would rise as savers switch from currency to bank deposits.

The stock of money rises as the bank-reserves related expansion in money stock involves a multiplier effect whereas the fall in currency demand causes a mere one-to-one fall in money stock. Thus, the net outcome of a rise in deposit rate is a net expansion in bank advances and money stock.

The lending rate, on the other hand, affects the bank credit multiplier through the demand for free reserves. The opportunity cost of free reserves is proxied by the lending rate, therefore, as the lending rate goes up so does the pressure on free reserves (as banks are inclined to lend more). This causes a rise in credit multiplier as the average reserve ratio declines.

Thus, the net effect of a general interest rate rise in our model is expansionary. A rise in the deposit rate increases the flow of deposit bank reserves by reducing the volume of currency demanded. A rise in the lending rate further contributes to it by increasing the size of the credit multiplier. This expansionary effect of a rise in general interest rates is due to the institutionally pegged interest rate structures.

A number of financial development models developed in the context of LDCs lend support to these outcomes. Models developed by Mckinnon-Shaw (1973), Galbis (1977), Mathison (1980), Kapur (1983) and Fry (1988) stress the role of financial liberalisation (which mostly take the form of liberalised interest rates) in the process of capital formation and growth in LDCs. The message is that the removal of financial controls leads to a higher equilibrium level of interest rates and a reduced level of required reserves which influence economic growth via both the quantitative and the qualitative changes in savings and investment. Consequently, financial savings, investment and activities go up.

However, the alternative school, known as "Neo-structuralist", criticise this view (Van Wijnbergen, 1982, 1983; and Taylor, 1983). The neo-structuralists stress the links between organised and the curb money markets, on the one hand, and between these markets and the business sector, on the other. Van Wijnbergen (1983) shows that an increase in the deposit rate leads to a greater substitution from the curb market loans than from the currency component of money stock into time deposits. Therefore, the net outcome of an interest rate rise is contractionary because the curb market does not require maintain the required reserves.

We do not intend to pursue this matter any further here. We merely wanted to point out that economists have made a strong and promising case for an unorthodox role of interest rate policy in LDCs. It would suffice to say that our modelling strategy follows the line of financial repressionists. This has been given added importance in that it has been subsequently adopted by financial institutions such as the IMF and the World Bank as a crucial, and in most cases a precondition, policy prescription for LDC member countries seeking their financial support. Now we turn to the analysis of simulation outcomes.

The impact and long-run effects of a permanent 10.0 percent increase in interest rates on different endogenous variables are reported in Table 7.7. The time profiles of these variables are plotted in figures 7.34-7.39.

(7.2.7.a) Exogenous Prices; Endogenous Money (M2) and Bank Advances (ADV)

As expected, in this run with fixed prices (MDL6), a permanent rise in interest rates is expansionary. On impact, income goes up by 0.17 percent and in the long-run it stabilises at 0.39 percent. These dynamic outcomes are plotted in figure 7.34 which show a stable time profile. The rise in activities is due to the increase in real asset stocks following the rise in interest rates. As already explained, a rise in interest rates increases both the magnitude of the credit multiplier and the flow of bank reserves which in turn increases the flow of bank advances and money stock.

Figure 7.39 shows how demand for currency falls due to the rise in the deposit rate even if income is rising. Demand for currency declines by 3.3 percent on impact and in the long-run it stabilises at 28.8 percent below the base. This obviously indicates that income effects are overwhelmed by price effects as far as currency demand is concerned. This causes a rise in the flow of bank reserves.

The outcomes on real money stock and bank advances are plotted in figures 7.37 and 7.38, respectively. The initial cyclical behaviour is, as already explained in section 7.2.5a, due to the oscillation on the base run values of credit multipliers. In the long-run, however, this cyclical pattern dies out.

The current account balance goes into deficit precisely due to the rise in absorption. On impact, the current account deteriorates by 0.12 percent and in the long-run by 2.35 percent relative to base exports (fig. 7.35). The higher long-run deterioration in current account is due to the cumulative decline in net interest receipts from abroad.

To conclude, a general rise in interest rate increases the level of activities through increased financial saving mobilisation. The external payments situation worsens due to the increase in absorption. However, we stress that the expansionary effect of a general interest rise is due to the institutionally pegged interest rate regime.

(7.2.7.b) Endogenous Money, Prices and Total Bank Lending (ADV)

In this full model marked MDL8 a permanent 10 .0 percent rise in interest rates increases income by 0.17 percent in the short-run and by 1.29 percent in the long-run (fig. 7.34).

Prices fall due to the positive supply side effects. Capital stock rises faster than income which brings prices down. Consequently, domestic prices fall by 1.62 percent in the long-run (fig. 7.36). However, initially as long as demand effects dominate the supply effects, domestic prices show a marginal increase. The long-run fall in domestic prices reinforce the expansion in income via rise in exports, therefore, income rises by more compared to earlier run (MDL6).

Currency demand declines due to a rise in the opportunity cost of holding it. In fig. 7.39 we plot the outcomes on currency demand. Money stock and bank advances rise mainly because of the multiplier effect. Outcomes are plotted in figures 7.37 and 7.38.

The current account goes in to deficit following the rise in income. Favourable price effects are at work in the long-run but the income effect dominates the trade sector which is why the current account goes into deficit. The current account deficit is 0.12 percent on impact but in the long-run it stabilises at 1.89 percent relative to the base exports (fig. 7.35). Compared to MDL6, the current account deficit is smaller mainly due to the favourable price developments.

To summarise, a permanent rise in interest rates produce a permanent rise in income in our model. Real bank lending and money stock increase permanently. The price level decelerates due to the rise in capital stock. External payment position worsens permanently due to the rise in absorption. Similar income and credit effects are reported by Adam (1992) in a similar interest rate shock in his model.

Table 7.7

Effects of an Increase in Interest Rates

Model Name	Additional Exogenous Variables	Effects on				
		Output	Prices	Current Account	ADVK	M2KP
MDL6	Prices	0.17	0.0	-0.12	19.17	14.75
		0.39	0.0	-2.35	16.58	8.95
MDL8	Non	.17	0.0	-0.12	20.18	14.75
		1.29	-1.62	-1.89	28.54	9.44

Notes:

1. Effect of a permanent 10.0 percent increase in deposit and lending rates and the cost of capital. Output, prices, bank advances (ADVK) and money stock (M2KP) are measured as the percentage difference from the base. The current account balance is expressed as percentage change relative to base exports.

2. First year impact is given as the short run effect. For each run, the impact effect and long-run effects are reported in the first and the second rows, respectively.

Effect of a Permanent 10% Increase in Interst Rates on GDP (% diff. from base)

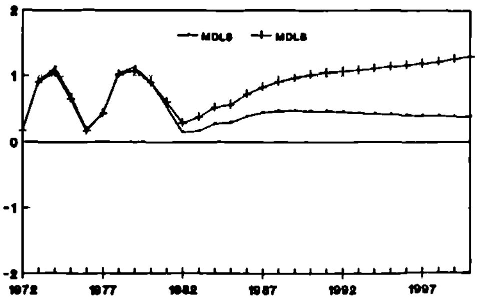


FIG. 7.34

Effect of a 10% Increase in Interest Rates on CBV (% diff. from base exports)

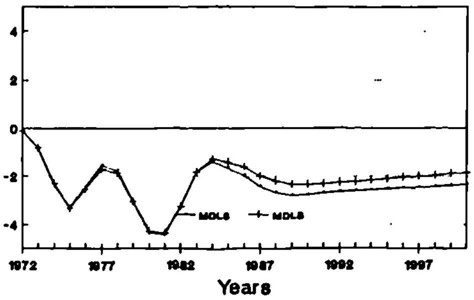


FIG. 7.35

Effect of a Perm. 10% Increase in Interest Rates on CED(% diff from base).

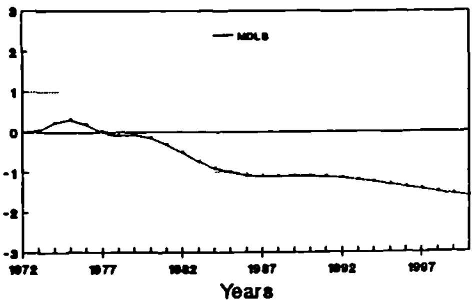


FIG. 7.36

Effect of a 10% Increase in Interest Rates on Real M2 (% diff from base)

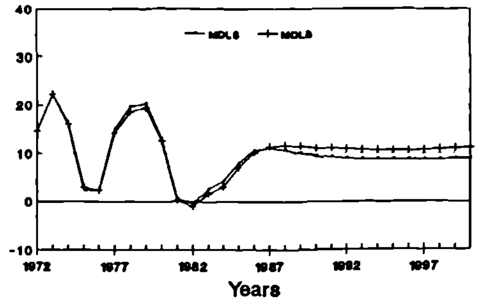


FIG 7.37

Effect of a 10% Increase in Interest Rates on Real ADV (% diff from base).

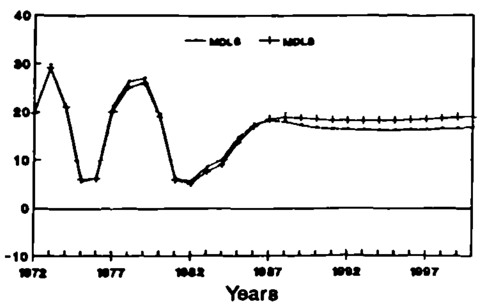


FIG 7.38

Effect of a 10% Increase in Interest Rates on Real CP(% diff from base).

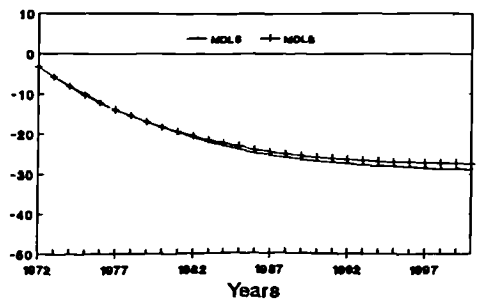


FIG. 7.39

(7.2.8) Reduction in the Central Bank Lending to Deposit Banks

Central Bank lending to the banking system is regarded as one of the most important and powerful instrument of monetary policy in developing countries (LDCs). It is claimed that this instrument is equivalent to open market operations for LDCs (Dorrance, 1965). This is so because it is the only instrument through which the Central Bank can exercise its discretionary control on the volume of base money. In the absence of a developed securities market the Central Bank can not undertake any serious open market operations in these economies.

Ceilings on "Central Bank lending to deposit banks" and "credit ceilings" to the public and the private sectors often feature in the financial programming of the IMF for these economies. These policies are used as measures for mitigating the adverse external payments situation. The obvious theoretical motivation behind this is the monetary approach to the balance of payments (MAB).

Central Bank lending to the banking system raises both the assets and the liabilities of the latter. It enters as reserves in the asset side and as the borrowing from the Central Bank in the liability side of deposit banks. The corollary is that it enters in the form of loans to the banking system in the asset side and as an increase in base money in the liability side of the Central Bank balance sheet.

Thus, a change in the Central Bank lending to deposit banks affects bank advances in two ways. Firstly, to the extent that the base money and hence the bank reserves change that leads to a direct change in bank advances through the credit multipliers. Secondly, there is also a direct one to one change in the liability of deposit banks following borrowing from the Central Bank which must also be matched by a simultaneous change in assets, ie., the bank advances. Therefore, any change in the Central Bank lending to deposit banks (CLB) affects bank advances differently from that of other components of base money (eg. the Central Bank lending to government, NCLG). Put differently, both the CLB and the NCLG affect the base money and hence the bank reserves identically, but their effects on bank advances are different. If the bank credit multiplier is "m" than any rise in NCLG, *ceteris paribus*, raises bank advances by m*NCLG whereas any rise in CLB raises it by more ie., by (m+1)*CLB.

It is obvious from the discussion above that any change in the Central Bank lending to deposit banks produces changes in the stock of money and bank advances. These, in turn, affect the private sector consumption and investment expenditure and hence the level of income. This sets into motion a whole range of effects in the model.

Now, we turn to the analysis of the simulation outcomes of a permanent 10.0 percent reduction in the Central Bank lending to deposit banks. As usual, the short-run and the long-run outcomes are reported in Table 7.8. The time profile of the outcomes are plotted in figures 7.40-7.45.

Table 7.8

The Effects of a Reduction in Central Bank Lending to Deposit Banks.

Model Name	Additional Exogenous Variables	Effects on				
		Output	Prices	Current Account	ADVK	M2KP
MDL6	Prices	-0.07	0.0	0.05	-5.33	-3.99
		-0.02	0.0	0.11	-0.53	-0.25
MDL8	Non	-0.07	0.0	0.05	-5.33	-3.99
		-0.08	0.12	0.06	-0.74	-0.47

Notes

1. A permanent reduction of 10.0 Percent in the Central Bank lending to deposit banks (CLB). Output, prices, bank advances (ADVK) and money stock (M2KP) are measured as the percentage difference from the base level. The current account balance is expressed as percentage change relative base level exports.

2. The first year impact is given as the short run effect. For each run, the impact effect and the long-run effects are reported in the first and the second rows, respectively.

(7.2.8.a) Exogenous Prices, Endogenous Money and Bank Advances

In this run, marked MDL6, a permanent 10.0 percent reduction in the Central Bank lending to deposit banks, as expected, brings a contractionary effect on the level of activities. Income falls by 0.07 percent in the short-run and in the long-run it stabilises at 0.02 percent below the base level (see fig. 7.40). This is due to the fall in bank lending and money stock following the fall in the Central Bank lending to deposit banks. Bank lending falls by 5.33 and 0.53 percent in the short and the long runs, respectively. The decline in real money stock is 3.99 and 0.25 over the same period. These outcomes are plotted in figures 7.43 and 7.44. In the initial years both the real bank advances and the real balance exhibit swings which are caused by the swings in bank reserves following the income effects on trade sector. However, in the long run these swings settle and a sensible time profile is achieved.

The current account balance improves following the fall in activities. The short-run and long-run magnitudes of improvement are 0.05 and 0.11 percent, respectively relative to the base exports (see fig. 7.41). The higher magnitude of long-run improvement is due to the improvement in the net interest receipt from abroad following the improvement in the international reserve position. As widely criticised, our model supports the view that IMF policy improves the external payment position at the cost of a loss in activities.

(7.2.8.b) Endogenous Prices, Money and Bank Advances

The outcomes of full model simulation are broadly similar to the earlier run (MDL6) except that price endogeneity works in a contractionary direction due to relative price changes and a reduction in exports. Income falls by 0.07 and 0.08 percent in the short and long run, respectively (fig. 7.40). The impact effect is identical to the fixed price run as the price effect involves lags in adjustment. The higher contraction in the long-run is due to the fall in exports following adverse relative price developments.

As capital stock falls rapidly compared to income, prices rise in the long-run. However, in the short-run, as long as the contraction in income supersedes the fall in capital stock, prices decelerate marginally. The long-run fall in price is 0.12 percent (fig. 7.42). This causes real exchange rate to appreciate and relative export prices to rise affecting net exports adversely.

The time profile of bank lending and money stock are plotted in figures 7.43 and 7.44. Compared to MDL6 both fall by more in this run in the long-run.

The current account improves by 0.05 and 0.06 percent in the short and long runs, respectively (fig. 7.42). A moderate fall in current account compared to MDL6 is due to the fall in activities.

To conclude, a permanent reduction in central bank lending brings a permanent fall in income via reductions in private sector consumption and investment expenditures. This so happens as bank lending and real balances fall permanently. The current account improves largely at the cost of lost activities. Domestic prices rise in the long-run as the fall in capital stock causes supply to contract.

Effect of a Perm. 10% Reduction in CLB
on GDP (% diff. from base level).

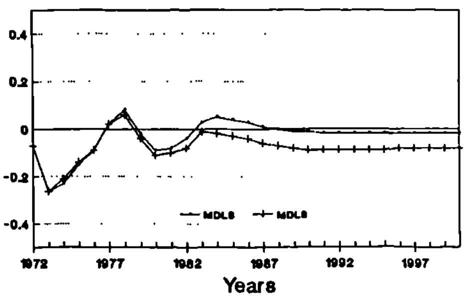


FIG. 7.40

Effect of Perm. 10% Reduction in CLB
on CBV (% diff. relative to base export)

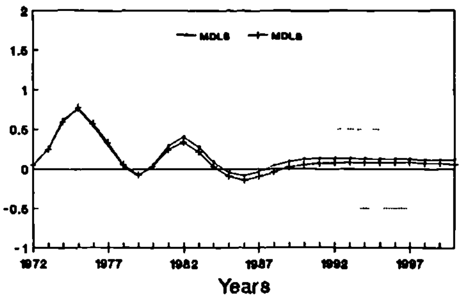


FIG. 7.41

Effect of a Perm. 10% Reduction in CLB
on CED (% diff. from base)

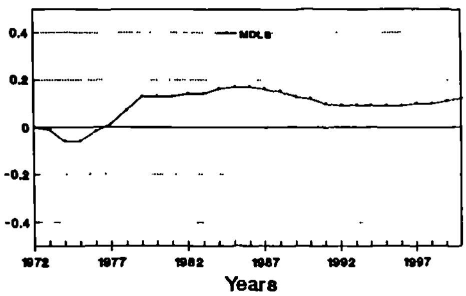


FIG. 7.42

Effect of a Perm. 10% Reduction in CLB
on Real M2 (% diff. from base).

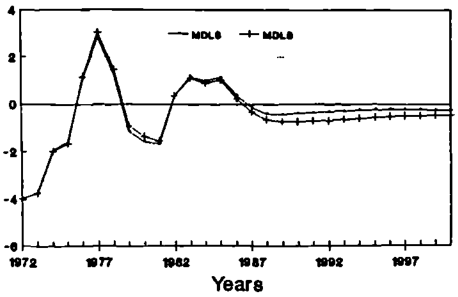


FIG. 7.43

Effect of a Perm. 10% Reduction in CLB
on Real ADV (% diff. from base).

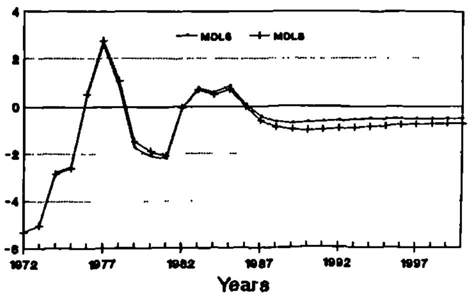


FIG. 7.44

Effect of a Perm. 10% Reduction in CLB
on Real CP (% diff. from base).

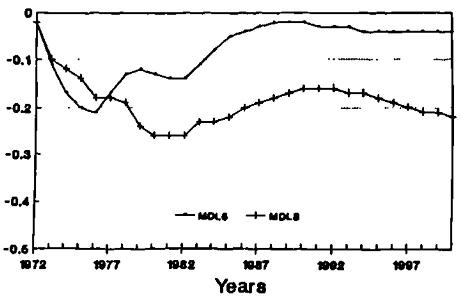


FIG. 7.45

(7.2.9) Increase in World Demand

In this simulation we show the effects of an improvement in the external economic environment by increasing the world demand. Rest of the world variables are assumed to be constant so that the simulation represents the effects of a boost to regional export demand. In this simulation, a permanent increase in world demand by 5.0 percentage point is administered. However, before analysing the simulation outcomes under different policy scenarios, a brief outline of the transmission is in order.

To start with, a rise in foreign demand or an increase in export market potential(S) affects our model through export volume equation. Exports of goods are unit elastic with respect to foreign demand in the long run. Therefore, an increase in foreign demand increases exports and hence the level of income through income identity. This is further accompanied by a multiplier-accelerator effect on investment. Imports also rise following the rise in the level of activities, but by less than the rise in exports. Increased exports and reduced net interest payments abroad improves the current account balance.

The government's budgetary position improves due to the endogenous rise in government revenue and a fall in net interest payments abroad. The latter is due to the gradual build-up in foreign reserves following the export boom. The ensuing government budget surplus also reduces the level of government borrowing from the Central Bank and hence the level of domestic debt servicing. This further contributes to the improvement in fiscal balance. Consequently, the government budget goes into surplus.

Base money increases as the rise in net foreign assets more than offsets the fall in the government borrowing from the central bank. This drives-up the deposit bank reserve position. Though, demand for currency rises following the rise in income, it is also overwhelmed by the rise in base money. Hence, the net effect is a rise in deposit bank reserves. This leads bank advances to go up by a multiple of the credit multiplier. Consequently, real balance and real bank advances rise. This again sets in to motion a chain of effects through increased private sector consumption and investment.

Furthermore, an export boom led increase in activity produces domestic price effects. However, as discussed under fiscal shock, the direction of price change may go either way. It very much depends on the combined effects of the changes in activities (demand side effects) and the evolution of capital stock and the movement in real exchange rate (supply side effects).

To the extent that supply side effects are overwhelmed by demand side effects, the domestic price level increases and vice versa. The income elasticity of price is higher than the capital stock elasticity in our model, therefore, a fall in price is possible if and only if the rate of capital accumulation exceeds that of the expansion in activities, following a particular shock.

In the full model, however, demand pressure is dominant at the beginning, therefore, domestic price rises. This leads to an appreciation of the real exchange rate which dampens the rise in exports as well as encourages imports. In the long run, however, increased capital stock reverses this process. Whether the price level fully reverses to base level or otherwise depends on the specification of a particular run. Therefore, price endogeneity does not necessarily reduce the level of activity following a boom in foreign demand. In subsequent simulation runs, it will be clear that once financial effects are allowed for in the model, the reserve related expansion leads to a strong build up in capital stock thereby reducing the domestic price level. This leads to a further rise in income due to favourable price effects in the trade sector.

In figures 7.46a-7.51b we plot the effects of a permanent 5.0 percentage point increase in world demand for our exports on different endogenous variables of our interest. Table 7.9 gives the short run and long run effects of this shock on these variables.

(7.2.9.a) Money, Prices and Total Bank Lending Exogenous

In this run, marked MDL5, a permanent increase in world demand by 5.0 percentage point increases income by 1.68

percent in the short-run (impact effect). Over the years the income effect is positive but gradually declines and stabilises at 0.3 percent above the base level in the long-run (fig. 7.46a). Two factors are responsible for this.

Firstly, the nature of our shock is such that (since it is percentage point) over the year the size of the shock declines, therefore, the activity effect shows a gradual decline. Secondly, the declining proportionate rise in the long-run activity is, as already discussed, due to the trending base output.

The rise in activity is due to the rise in exports. In this run exports go up by 7.15 percent in the short run and in the long run by 1.29 percent. As expected, consumption and imports go up following a rise in income, however, the current account balance improves due to a export boom. The current account improves by 5.96 percent in the short run, and in the long run it stabilises at 2.17 percent relative to base exports (fig. 7.47a). The time profile of the outcome is sensible.

Government revenue goes up following a rise in income. Though government investment follows total investment, the level of government expenditure declines due to fall in debt servicing cost both at home and abroad. The latter is due to a build-up of foreign reserves and the former is due to the reduced domestic borrowing implied by the reduced level of the budget deficit.

Thus, in this fixed price experiment, an increase in foreign demand brings all the niceties of increased level of activities and an improvement in the current account position. A permanent rise in world demand brings a permanent balance of payment surplus and a permanent rise in activities.

(7.2.9.b) Exogenous Prices; Endogenous Money and Total Bank Lending

In this run (MDL6) we have endogenised financial variables keeping the price level fixed. The increase in world demand increases the level of income by 1.91 and 0.46 percent in the short and long run, respectively. The output effect shows a gradual deceleration due to the causes explained in the earlier run. The dynamic multipliers of this run are plotted in Fig. 7.46a. The time profile is smooth and stable. Compared to the earlier run (MDL5) both the short and long run output effects are higher. This is because of the rise in real balances and real bank advances following the rise in bank reserves. The outcomes on real balance and the real stock of bank advances are plotted in figures 7.49a and 7.50a, respectively.

Deposit bank reserves go up as the rise in international reserves overwhelm both the rise in currency demand from the private sector and the fall in government borrowing from the Central Bank. Put differently, in this run, the monetary consequences of the balance of payment exerts an expansionary effect which is a missing component in the earlier run (MDL5).

Currency demand rises following the rise in income; government borrowing from the Central Bank has fallen due to the endogenous rise in government revenue. The time profile of private sector currency demand is plotted in fig. 7.51a.

The current account balance goes into surplus by 5.86 percent and 0.3 percent in the short and long run, respectively (fig. 7.47a). Both of these magnitudes are less than that of MDL5 mainly due to the higher level of activities in this run.

A parallel rise in income and current account surplus is due to the fact that the export boom is the prime mover. At this stage one may think - is it not possible that the income expansion is sufficiently large to raise imports beyond the increase in exports leaving us with a net deficit? This is impossible because income will rise only when there is an increase in demand for domestic goods. In other words, aggregate spending by domestic residents rises only in response to induced increase in income. Therefore, we must have an improvement in net exports if we are to sustain the higher level of income. Thus, increased world demand raises equilibrium income and improves the current account balance.

To conclude, the endogeneity of financial variables alter the magnitude of simulation results. In our model, given fixed prices, a permanent rise in world demand results in a higher level of activity and a lower level of external surplus when money and bank advances are endogenised compared to their exogeneity.

(7.2.9.c) Exogenous Money and Total Bank Lending; Endogenous Prices

In this run (MDL7) price endogeneity is allowed for keeping financial variables fixed. The effect of a permanent 5.0 percentage point increase in export demand on income is 1.68 percent and 0.2 percent in the short and long run, respectively. The outcomes are plotted in fig 7.56b. The plot shows a stable time profile and a quick resumption of the long-run value.

In this run domestic prices rise modestly. As reserve effects are barred from affecting investment function, capital stock accumulates through the flexible-accelerator but by less than the rise in income. Consequently, though modest, prices rise all along. The price level increases by 0.5 percent in the short run and 0.06 in the long run (fig. 7.48b).

The domestic price rise causes the relative price of exports to rise and the real exchange rate to appreciate causing exports to contract and imports to expand. Real wealth stock and real bank advances are falling following the price rises (figs. 7.49b and 7.50b, respectively). Consequently, this run witnesses the smallest rise in both the level of exports and the level of activities compared to the earlier runs.

As expected, the increase in foreign demand improves the current account balance. It goes into surplus by 5.96 percent in the short-run and by 1.93 in the long-run (fig. 7.47b). Again, the overall outcome of a permanent increase in the world demand is a permanent increase in the level of activities and a permanent improvement in the current account balance. However, price endogeneity has contractionary effect as far as the level of activity is concerned.

(7.2.9.d) Endogenous Money, Prices and Total Bank Lending

In this full model (MDL8) simulation, an increase in foreign demand increases the level of income by 1.91 and 1.26 percents in the short and long run, respectively (fig. 7.46b). In this run, the long-run rise in activity is higher compared to any other runs as the export boom is reinforced by the monetary effects of the balance of payment surplus.

In the short-run exports go up by 7.15 percent and in the long-run stabilise at 4.76 percent. As a consequence, the current account goes into surplus by 5.8 and 0.76 percents relative to base exports in the short and long runs, respectively. These outcomes are plotted in figure 7.47b. The balance of payments surplus produces expansionary monetary consequences. Bank reserves go up and so do the stock of money and the total bank advances (fig. 7.49b and 7.50b). The former reinforces the process of capital formation and the latter enhances the level of private sector consumption. This further contributes to an expansion in income.

Over the years, capital stock builds up sufficiently to reduce the domestic price level. As a result, the domestic price level starts to fall from the 10th year and stabilises at a reduced level in the long-run (see fig. 7.48b). This results in a real exchange rate depreciation and a fall in the relative price of exports which further encourages net exports.

In the long-run, both the domestic price level and the real exchange rate go down by 1.40 percent. This is the main reason, in this run, for the long-run exports to stabilise at remarkably higher level compared to other runs. Prices endogeneity encourages exports and hence the level of income through real exchange rate depreciation.

Our results are broadly in unison with the results reported in some of the UK models in Wallis (1985) and in Latin American model designed by Srinivasan (1991). In these models, too, an increase in foreign demand for domestic exports produces an expansion in income, a surplus in balance of payments and a fall in the domestic price level.

The main points of this full model simulation can be summarised as follows. An increase in foreign demand increases the level of activity and improves the current account balance. In the long run, the boom in export market is reinforced by the monetary consequences of the balance of payments surplus. However, long-run stability is achieved through increasing leakages in terms of increased imports, saving, taxes and a rising demand for currency following the rise in income.

Table 7.9

Effect of an Increase in World Demand.

Model Name	Additional Exogenous Variables	Effect on		
		Output	Prices	Current Account
MDL5	Money, Price & ADV	1.68	0.0	5.96
		0.25	0.0	2.17
MDL6	Prices	1.91	0.0	5.80
		0.46	0.0	0.30
MDL7	Money & ADV	1.68	0.00	5.96
		0.20	0.06	1.93
MDL8	Non	1.91	0.0	5.80
		1.26	-1.38	0.76

Notes

1. Effect of a permanent increase of 5.0 percent point in export market potential (s). Output and Price are measured as the percentage difference from the base run. The current account balance is expressed as the percentage change relative to base export.

2. The first year impact effect is given as the short run effect. For each run, short and long run effects are given in the first and second rows respectively.

Effect of a Prem. 5% Per. Point Increase
In S on GDP (% diff. from base)

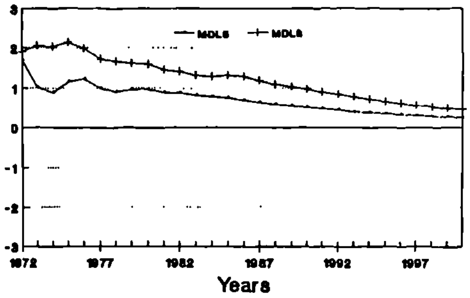


FIG. 7.46a

Effect of a Prem. 5% Per. Point Increase
In S on GDP (% diff from base)

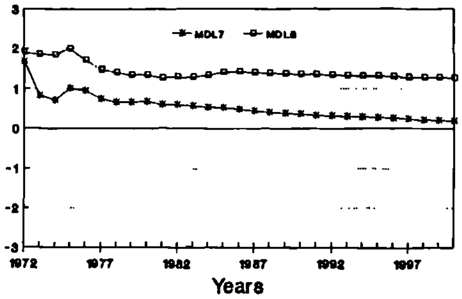


FIG. 7.46b

Effect of a Perm. 5 Per. Point Increase
In S on CBV(%diff from base)

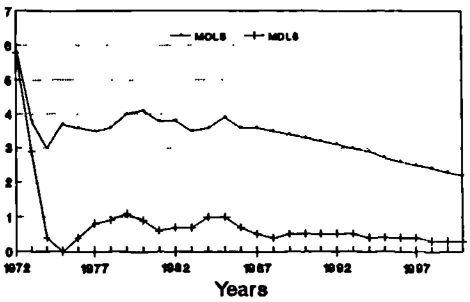


FIG 7.47a

Effect of a Perm. 5 Per. Point Increase
In S on CBV (%diff from base)

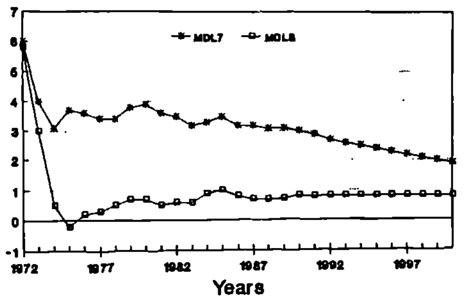


FIG. 7.47b

Effect of a Perm. 5 Per. Point Increase
In S on CED (% diff from base)

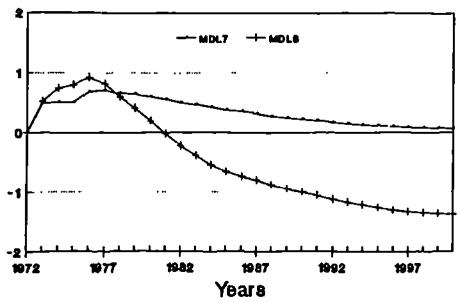


FIG. 7.48b

Effect of a Perm. 5 Per. Point Increase
In S on Real M2 (% diff. from base)

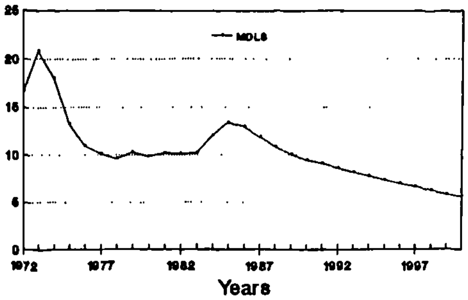


FIG 7.49a

Effect of a Perm. 5 Per. Point Increase
In S on Real M2 (% diff. from base)

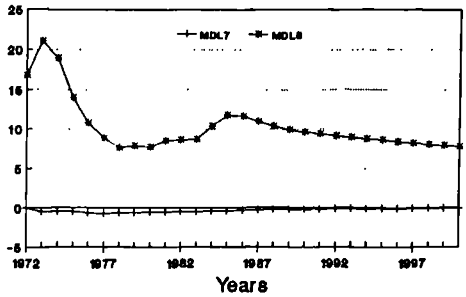


FIG 7.49b

Effect of a Perm. 5 Per. Point Increase
In S on Real ADV (% diff. from base).

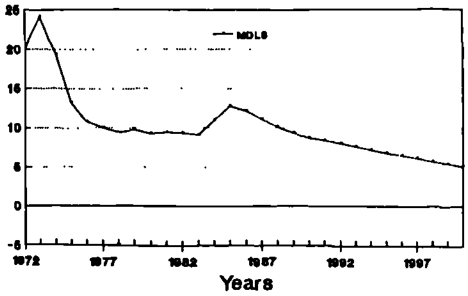


FIG. 7.50a

Effect of a Perm. 5 Per. Point Increase
In S on Real ADV (% diff. from base).

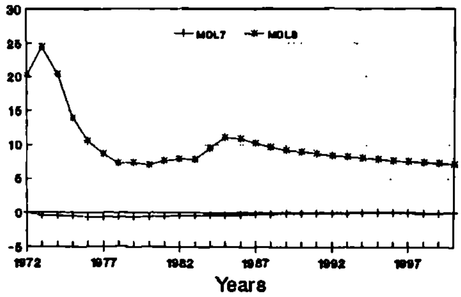


FIG. 7.50b

Efect of a Perm. 5 Per Point Incresase
In S on Real CP (% diff. from base)

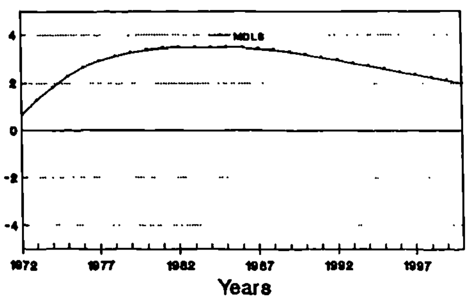


FIG. 7.51a

Efect of a Perm. 5 Per Point Incresase
In S on Real CP (% diff. from base)

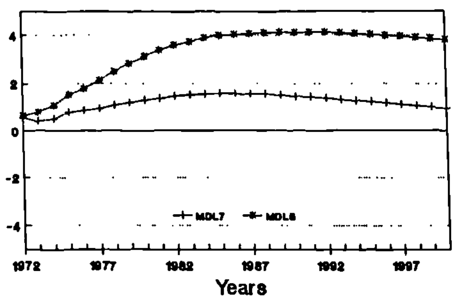


FIG. 7.51b

(7.2.10) Import Price Shock

In this simulation we consider the effects of a rise in world prices by increasing import prices. The rest of the world variables are assumed to be constant. An increase in import price affects the model in a number of ways. A brief account of the transmission mechanism is in order.

Firstly, domestic prices in our model are determined by, inter-alia, import prices in local currency terms. Any increase in import prices, *ceteris paribus*, increases domestic prices and sets a process of wage price spiral. Consequently, both the domestic wages and prices go up.

Secondly, in the model the real exchange rate is defined as the ratio of import prices in local currency units to domestic prices. Thus, any increase in import prices, *ceteris paribus*, depreciates the real exchange rate. This obviously has implications for imports. However, to the extent any rise in import prices drives up the domestic price level, the effect on real exchange rate will be neutralised. Thus, the net effect on the real exchange rate depends on the relative strength of the rise in import prices and domestic prices which follow subsquently.

Thirdly, export prices are driven by the domestic cost factor. To the extent that a rise in import prices raises the domestic price level (and hence the domestic cost of home goods), the relative price of exports goes up. Consequently, exports fall and hence the level of income.

Fourthly, any increase in import prices, *ceteris paribus*, reduces the terms of trade and depresses the level of consumption. Again, to the extent that domestic prices increase following the rise in import prices, the effect on terms of trade will be neutralised.

Fifthly, to the extent domestic prices rise following the rise in import prices, the stock of real balances and real bank credit would fall, thereby depressing private sector consumption and investment, respectively.

And finally, any rise in the domestic price level increases the stock of currency demanded by the private sector. This reduces bank reserves at any given level of base money. A similar effect occurs through an expected inflation effect of the domestic price rise.

This completes a brief sketch of the transmission mechanism of import prices in our model. Other effect show up when the level of income and balance of payments are affected. Now, we turn to the analysis of simulation outcomes of an import price shock under different policy scenarios.

In table 7.10 we report the short-run and long-run effects of a permanent 5.0 percent increase in import prices. In figures 7.57a-7.62b we plot the simulation outcomes on different endogenous variables of the model.

(7.2.10.a) Exogenous Money, Prices and Total Bank Lending

In this run, marked MDL5, a permanent increase of 5.0 percent in import prices brings a marginally positive output effect on impact, but activities quickly fall and remain so throughout. The positive impact effect is due to the fall in leakages (imports) caused by the depreciation of real exchange rate following the increase in import prices. The long-run contraction in activities is due to terms of trade losses which depresses consumption. In the long-run, the fall in output stabilises at 0.02 percent below the base level. As the base GDP is trending, the proportionate fall in output following the shock shows a gradual decline. These output effects are plotted in fig. 7.57a and show a stable time profile.

The current account worsens despite a fall in income. This is due to the price inelastic imports. When import prices rise so does the level of imports in nominal terms (despite import falls in real terms) and hence the current account deficit. In other words, import volume responds less than proportionately following a change in import prices (ie. real exchange rate). This is obvious as the long-run real exchange rate elasticity of imports is merely 0.26. We note that in this run exports do not move as prices are exogenised. This adverse payment situation is further augmented by the cumulatively falling net interest earnings from abroad. In figure 7.53a we plot the outcomes on the current account balance which shows a stable time profile. On impact, the current account goes into deficit by 3.48 percent and in the long-run it stabilises at 7.7 percent relative to the base exports.

To conclude, in this run a permanent rise in import prices reduces the level of activities and worsens the current account balance permanently.

(7.2.10.b) Exogenous Prices, Endogenous Money and Total Bank Lending

In this run (MDL6) with fixed price and endogenous money and bank advances, a rise in import price depresses output all along. In the short-run output declines by 0.2 percent and in the long-run by 1.40 percent. Compared to the earlier run (MDL5), output declines by a higher magnitude both in the short and long run, respectively.

This is due to the fall in real asset stocks following a payments deficit which depress the level of private consumption and investment expenditures. These financial effects were not at work in MDL5.

The fall in the real stock of financial assets is due to the monetary consequences of the balance of payments which works in a contractionary direction. Exports do not move as prices are not moving. The current account goes into deficit due precisely to the factors explained in the earlier run.

Consequently, the current account balance deteriorates by 3.32 percent and 0.74 percent in the short and long run, respectively (fig. 7.53a). Again, this outcome is different from that of the MDL5 largely because of the behaviour of income variable. A higher degree of contraction in income leads to a smaller degree of deterioration in the current account balance.

The demand for currency declines (see fig. 7.57b) following the reduced level of transaction demand. However, this is not enough to turn the flow of deposit bank reserves positive. Consequently, bank advances and money stock fall causing output to contract. The time profile of real balance and real bank advances are plotted in figures 7.56a and 7.57a, respectively. Both of these variables fall throughout.

To conclude, the endogeneity of financial variables reinforces the contractionary effects of a permanent rise in import prices. Real asset stock fall due to loss in international reserves following a permanent deterioration in the current account balance.

(7.2.10.c) Exogenous Money and Total Bank Lending; Endogenous prices

In this run with endogenous price (MDL7) we expect domestic prices to rise following the increase in import prices. This is exactly what our simulation results show.

Domestic prices rise by 3.77 percent in the short-run and by 4.49 percent in the long-run (fig. 7.54b). The long-run partial elasticity of domestic price with respect to import prices is unity, however, in the simulation outcome, domestic price rises by less than one for one rise in import prices. The obvious reason for this is the falling demand effect arising out of the fall in output level.

The rise in import prices exerts contractionary effect on output. Consequently, income declines by 1.3 percent in the short-run and by 2.38 percent in the long-run. The endogeneity of domestic price level causes a higher level of contraction compared to the earlier two fixed price cases. It is because of the fall in exports.

We note that nominal stock of financial variables are fixed in this run and all the changes in real magnitudes are due to price changes. The behaviour of real asset stocks are plotted in figures 7.55b, 7.56b and 7.57b, respectively.

The current account balance deteriorates by 2.55 percent in the short-run and by 10.46 percent in the long-run (fig. 7.53b). Despite a higher fall in real income, the current account position deteriorates by a higher magnitude due to the loss in exports following poorer competitiveness. It also indicates that in the long-run, price effects dominant the income effects in the trade sector.

To conclude, a foreign price rise is more contractionary when the domestic price is endogenised than otherwise. A permanent rise in import prices reduces the level of activities, increases domestic prices and worsens the external payment situation, permanently.

(7.2.10.d) Endogenous Money, Prices and Total Bank Lending

In this full model a permanent rise in import price is more contractionary compared to any of the earlier runs. Output falls by 1.96 and 5.85 percent in the short and long-run, respectively (fig. 7.52b). The highest fall in output, in this run, is due to the contractionary financial effects associated with the balance of payments and the government budget constraints. This output effect is very similar to the one shown by Srinivasan (1991) in his model for a similar shock.

The deterioration in the current account reduces the stock of base money. Demand for currency from the private sector falls following the fall in income, but not by enough to reverse the fall in bank reserves. Consequently, the stock of nominal bank credit falls by a multiple of the credit multiplier. The nominal stock of money also falls. This decline of financial asset stocks in nominal terms are further aggravated in real terms by the increasing price level. Consequently, private sector consumption and investment are depressed and hence the level of activities. Figures 7.55b, 6.56b and 6.57b show the outcomes on real financial stock variables.

The domestic price level goes up by 3.77 percent in the short-run and in the long-run by 8.16 percent (fig. 7.54b).

The current account balance remains at deficit throughout the simulation period. The impact and long-run effects on current account deficit are 2.05 and 1.96 percent relative to base exports (fig. 7.53b).

Thus, in this full model a permanent increase in foreign price (import price) brings all the unpleasant outcomes. Output falls permanently. The domestic price and external payments situation worsens permanently.

Table 7.10

Effect of an Increase in Import Prices

(A Permanent Increase of 5.0 Percent in Import Prices)

Model Name	Additional Exogenous Variables	Effect on		
		Output	Prices	Current Account
MDL5	Money, Price & ADV	0.02	0.0	-3.48
		-0.02	0.0	-7.80
MDL6	Prices	-0.20	0.0	-3.32
		-1.40	0.0	-0.74
MDL7	Money & ADV	-1.30	3.77	-2.55
		-2.38	4.49	-10.46
MDL8	Non	-1.96	3.77	-2.05
		-5.85	8.16	-1.96

Notes

1. Output and Price are measured as the percentage difference from the base level. The current account balance is expressed as the percentage change relative to base exports.

2. The first year effect are given as the short run effect. For each run, impact effect and long run effect are given in the first and second rows, respectively.

Effect of a Permanent 5.0% Increase in PMA on GDP (% diff. from base).

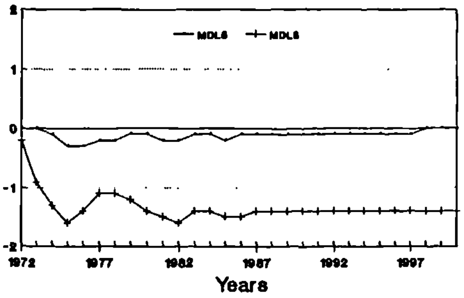


FIG. 7.52a

Effect of a Permanent 5.0% Increase in PMA on GDP (% diff. from base).

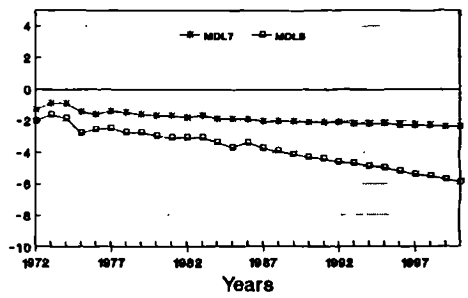


FIG. 7.52b

Effect of a Permanent 5.0 % Increase in PMA on CBV (% diff. from base exports).

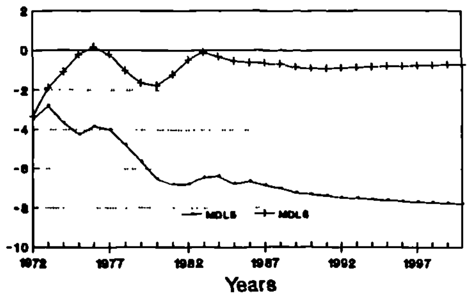


FIG 7.53a

Effect of a Permanent 5.0 % Increase in PMA on CBV (% diff. from base exports).

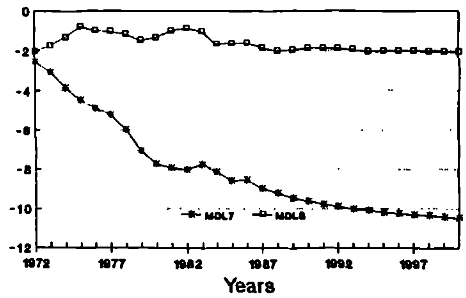


FIG 7.53b

Effect of a Perm. 5.0% Increase in PMA on CED (% diff. from base)

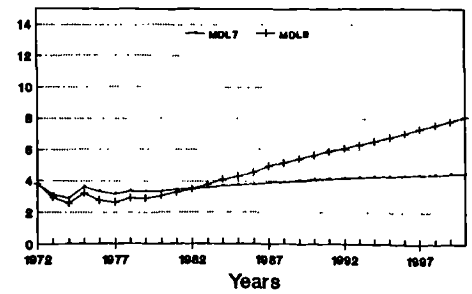


FIG. 7.54b

Effect of a Perm. 5.0 % Increase in PMA
on Real M2 (% diff. from base)

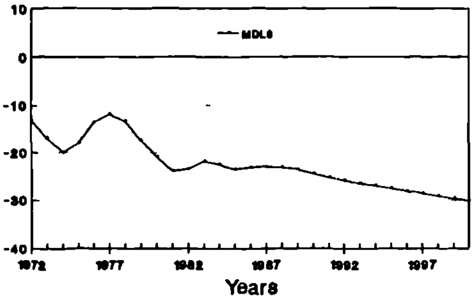


FIG. 7.55a

Effect of a Perm. 5.0 % Increase in PMA
on Real M2 (% diff. from base)

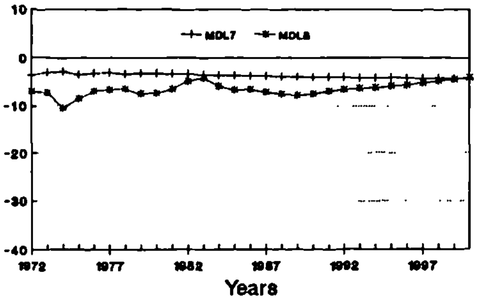


FIG. 7.55b

Effect of a Perm. 5.0% Increase in PMA
on Real ADV (% diff. from base).

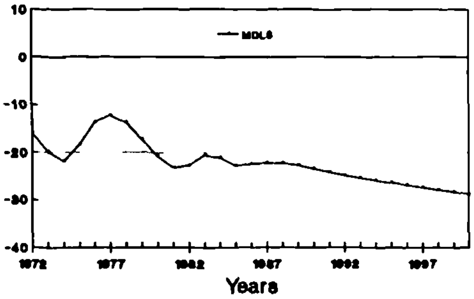


FIG 7.56a

Effect of a Perm. 5.0% Increase in PMA
on Real ADV (% diff. from base).

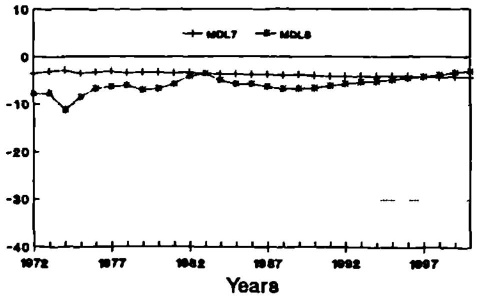


FIG 7.56b

Effect of a Perm. 5.0% Increase in PMAP
on Real CP (% diff. from base)

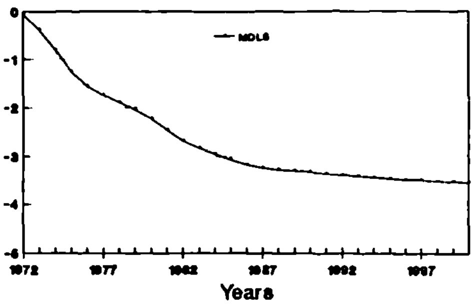


FIG. 7.57a

Effect of a Perm. 5.0% Increase in PMA
on Real CP (% diff. from base)

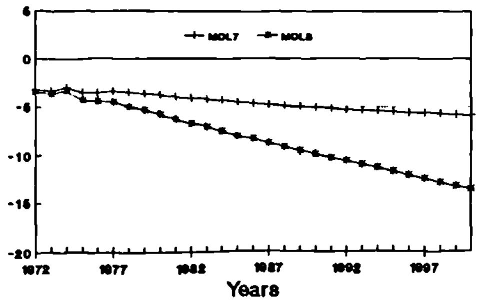


FIG. 7.57b

(7.2.11) Increase in Foreign Interest Rate

A rise in the world interest rates raises the cost of debt servicing as well as the interest earnings from reserves invested abroad. The net effect on the domestic reserves' position depends on the relative size of the stock of foreign debt and the stock of reserves invested abroad. If the former is larger than the latter, then a rise in foreign interest rates drains reserves from the economy and vice versa.

The effects of world interest rates on domestic economy are transmitted through the international reserves which affects the stock of base money and hence the level of real asset stocks. Therefore, the relevant runs for this policy shock are MDL6 and MDL8. The impact and total multiplier of this shock are reported in Table 7.11.

(7.2.11.a) Exogenous Prices, Endogenous Money and Total Bank Lending

In the run MDL6, income falls by 0.02 percent on impact and in the long run stabilises at 0.11 percent below base level (fig. 7.58a). This fall in output is due to the reserves related contraction in real asset stocks viz., real balances and real bank lending.

The current account deteriorates by 0.58 and 0.78 percent in the short and long run, respectively. This is due to the out-flow of reserves in the form of increased interest payments abroad following the rise in the world interest rates. Outcomes are plotted in fig. 7.58b.

(7.2.11.b) Endogenous Money, Prices and Total Bank Lending

In the full model simulation (MDL8), income falls by 0.02 percent and 0.25 percent in the short and long run, respectively. This higher contraction in the long-run activities is due to the rise in prices which depresses the net exports.

Prices rise due to the fall in the capital stock. In the short-run, domestic price level decelerates as long as the reduced demand effects prevail over the adverse supply side effects. In the long-run, however, price level stabilises at 0.36 percent above the base level (fig. 7.58c). The current account balance deteriorates. On impact, it falls by 0.58 percent and in the long-run it falls by 0.88 percent relative to the base run exports.

To conclude, a rise in foreign interest rates reduces the level of activities, worsens the domestic price situation and the external payments position. The level of activities is adversely affected as real asset stocks are depressed which depresses consumption and investment expenditures. Domestic price level worsens due to negative supply side effects. Payments position worsens mainly because of the adverse relative price effects in the trade sector and the rise in the cost of external debt servicing.

Table 7.11.

Effect of an Increase in Foreign Interest Rate.
(A Permanent Increase in LIBOR by One Percentage Point)

Model Name	Additional Exogenous Variables	Effects on		
		Output	Prices	Current Account
MDL6	Prices	-0.02	0.0	-0.58
		-0.11	0.0	-0.78
MDL8	Non	-0.02	0.0	-0.58
		-0.28	0.36	-0.88

Notes:

1. Output and prices are measured as the percentage difference from the base. The current account balance is expressed as the percentage change relative to base exports.

2. First year impact is given as the short-run effect. For each run, short-run and long-run effects are reported in the first and second rows, respectively.

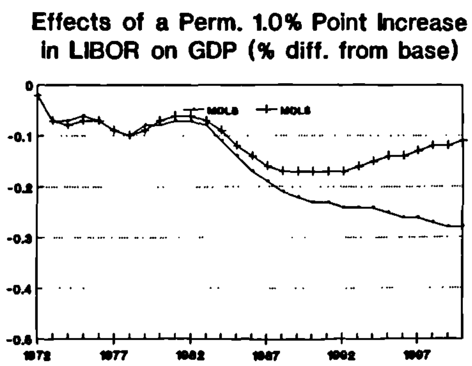


FIG. 7.58a

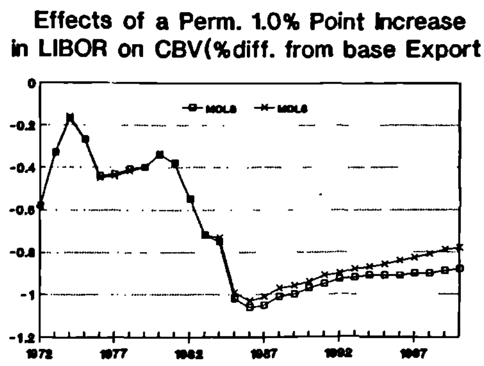


FIG. 7.58b

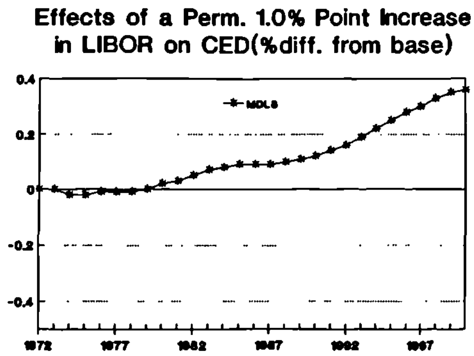


FIG. 7.58c

(7.3) Summary and Concluding Remarks

In what follows we provide a general conclusion of this chapter. In this chapter we studied the overall properties of our empirical model through simulation and dynamic multiplier analysis. We simulated eleven different policies under four broad policy scenarios and analysed the outcomes. These scenario analyses are important to understand the dynamic structure of our model. As such, these four different scenarios are equivalent to four different kinds of models or four sectoral analyses.

Our simulation results stand the tests of economic theories and empirical observations which is an encouraging outcome. The multiplier properties of our model are not at odds with the "generally accepted" propositions regarding economic response patterns, provided by or predicted by economic theories. Policy multipliers result in signs and magnitudes that are plausible and satisfactory. As the specification of structural relationships has a firm foundation on economic theory, this property should be inherent in the model structure if economic theories are any guide to the specification of behavioural relationships.

Results shed light on how policies perform differently when variables like prices, bank credits, money stock etc. are allowed to vary or otherwise. The common result was that price endogeneity showed a depressing effect in all runs but one. The full model run with an increase in foreign demand showed long-run deceleration in the domestic price level mainly due to the strong build-up in capital stock. Another common result was that financial consequences amplified the effects of any shock. A successful convergence of all these runs in itself shows the simulation ability of our model. There was no evidence for instability of the system once we "tuned" two parameters for the possible sinusoidal outcome in the fiscal shock. The linearity assessment of the model, in the last chapter, showed that policy multipliers can be used as "ready-reckoners".

A fiscal expansion is far from producing a 100% crowding out in our model. The domestic price level increases in the interim period but reverses in the long-run mainly because of the supply side effects. However, fiscal expansion resulted in a permanent worsening of the budget deficit and the current account balance. Therefore, the authorities can rely on this policy only in the absence of external constraints.

An exchange rate devaluation shows that it is not a panacea unless authorities are firm in controlling domestic prices. In the full model, nominal devaluation is mildly expansionary, but it fails to bring an improvement in the current account balance, a crucial policy objective of devaluation. Any improvement in the current account is short-lived. As far as economic policy making is concerned, our model shows that devaluation is effective if and only if relative price effects could be maintained ie., only if a firm control on domestic prices is possible after devaluation.

Otherwise domestic prices follow the nominal devaluation. A simulation run fixing the capital stock brought about the results claimed by the Monetary Approach to the Balance payments, ie., real output and current account balance are invariant to nominal devaluation in the long run and domestic prices rise by the rate of devaluation.

An adverse supply shock in the form of an increased domestic price level brings entirely unfavourable effects. Output falls, the current account deteriorates and the domestic price level explodes. The wage-price spiral causes the domestic price level to explode; consequently net exports collapse following adverse relative price developments. Financial consequences magnify this process.

A once and for all increase in money supply had no long run output effects. However, the domestic price level shows a mild increase and the current account goes into deficit.

Monetary policy instruments are effective in influencing the level of activities. A rise in required reserves reduces the level of activities through adverse credit availability and real balance effects. The domestic price level goes up mildly in the long-run. A similar outcome is caused by a rise in the discount rate. An increase in deposit and lending rates is expansionary through increased financial saving mobilisation and the increased credit multipliers. A reduction in Central Bank lending to deposit banks is contractionary. Thus, all in all, financial policies may be important in influencing the macroeconomic activities. Therefore, neglecting the financial sector in the macroeconomic modelling of LDCs is not without cost.

Similarly, other policy simulations also convey important policy messages. For example, a rise in world demand for exports brings all the niceties of increased income, improved current position etc. On the other hand, increases in world prices and world interest rates depress activities, increase prices and worsen the current account position.

Appendix 7A

In what follows we provide the comparative results of the full model simulations when the reserves term (RESCP) in the import equation and the import to income ratio (m/y) term in the price equation are fixed and unfixed, respectively. The results show that the fundamental model characteristics are not affected. Only the magnitudes of effects are affected marginally.

We provide comparative results of the fixed and unfixed models following fiscal expansion, exchange rate shock, required reserve shock, discount rate shock and the world trade shock. An outline of the transmission mechanism of these two terms in the model is also provided. All policy shocks are identical to those contained in the full model simulation.

We also re-run the historical simulations. Outcomes change very marginally, therefore, we maintained the results reported in Chapter 6 which pertain to the fixed run. However, we report the re-run results as well.

Fiscal Shock:

Income Effect: Following a fiscal expansion foreign reserves fall. Unfixing the reserve term in import equation reduces imports. This has expansionary effect on income since imports are falling compared to the situation when the reserve term was fixed. However, a fall in imports reduces the imports to income ratio. This leads prices to rise. Prices go up by a higher magnitude than when the import to income ratio was fixed. This has depressing effects. Exports fall following a rise in domestic prices. As long as the real exchange rate appreciates following the price rise, imports starts to rise. However, net exports fall following a real exchange rate appreciation. Thus, two opposing forces are at work. A reduction in imports following the unfixing of reserve term is expansionary but the price rise which follows following the unfixing of imports to income ratio is contractionary. Therefore, the net effect on output depends on the relative strength of these two effects. The simulation results show that output effects in both of these runs are very similar (Table 1). The constrained model outcomes show stronger short-run dynamics. However, this disappears fairly quickly and the long-run outcomes are smooth and very similar in both models. It indicates that the positive and negative effects largely cancel out. The impact multipliers are 2.0 and 1.9 in fixed and unfixed runs, respectively. For the same run, total multipliers are 0.5 and 0.6. Thus, unfixing these two terms changes the outcomes very marginally.

Price Effect: Impact effect is similar but the long-run effect is slightly stronger when we unfix these terms. This is a sensible outcome. As the output effect is similar, the rise in price level is due to the rationing effect following the fall in imports to income ratio. It should also be noted that even if the output effect is marginal, since it is expansionary, if any thing, it would contribute to price rise.

Current Account Effect: Impact effect is very similar but in the long-run current account settles at a lower level of deficit. In other words, following the unfixing of these two terms the current account improves in the long-run. This is due to the fall in imports. Though the net exports are falling following the adverse price developments, the direct fall in imports is stronger. Therefore, the current account improves.

Exchange Rate Shock:

Output Effects: The impact multipliers are identical. In the long-run, however, activities stabilise at a slightly lower level when these terms are unfixed. The long-run rise in activities are 0.97 and 0.79 percents in the fixed and unfixed models, respectively (Table 2). This outcome can be explained as follows. Following the exchange rate shock, the reserve position improves. This raises imports in the unfixed model which is contractionary. In the meantime, however, the rise in import to income ratio depresses the domestic price level. Real exchange rate depreciates, consequently, net exports improve. Again the opposing forces as described above are at work. On balance, the reserve related increase in imports dominate the price led improvement in net exports, consequently, in the long-run, activities are reduced. It should be noted that both imports and income are rising, therefore, the net rise in import to income ratio would not be substantial which is why the reserve related import effect is dominant.

Price Effects: Impact effects are identical. Even in the long-run, the magnitude is not much different. In the long-run prices rise by 8.68 and 8.79 percents in the fixed and unfixed runs, respectively. Thus, the long-run rise in prices are very marginal. This also proves our earlier argument that the rise in imports to income ratio is not substantial.

Current Account Effects: The impact effects are identical. However, in the long-run the current account position shows an improvement when these terms are unfixed. The current account deficit is 0.67 and 0.04 percent of base exports in the fixed and unfixed model. Despite reserve related rise in imports, current account balance improves in the long-run due mainly to the reduced level of activities. It should be noted that income elasticity of imports is quite high ie., 2.4. The product of the income elasticity of imports and the rate of decline in income gives a factor of -0.43 by which imports have to fall. This is further augmented by the coupon effect associated with the improving net interest payments abroad following the fall in imports. This explains the long-run improvements in current account balance.

Required Reserve Ratio Shock:

Output Effects: The transmission mechanism of required reserve ratio is through real asset stocks which is thoroughly discussed in the full model simulation. Impact effects on output in both the fixed and unfixed models are identical (Table 3). In the long-run output shows a slightly higher degree of contraction ie., by 0.09 percentage point. Output declines by 0.19 and 0.28 percent in the fixed and unfixed runs, respectively. A rise in required reserve ratio reduces real asset stocks and hence the level of income. Following the fall in income, reserves improve. This improvement in reserves increases imports when this term is unfixed. This has a contractionary effect, therefore, income falls in the long-run.

Price Effects: Impact effects are identical. In the long-run, however, comparatively domestic price level rises in the unfixed model. As imports to income ratio is rising one would perhaps be wondering as to why the price level stabilised at a higher level instead of a decline. This is because of the fall in capital stock. A fall in real asset stocks reduces the equilibrium capital stock and raises the domestic price level. It should also be noted that the capital stock elasticity of aggregate supply is almost three times (0.72) that of the real exchange rate elasticity (0.25).

Current Account Effects: Again impact effects are identical. In the long-run improvement in current account balance is slightly smaller precisely because of the adverse price development ie., the rise in the domestic price level.

Discount Rate Shock:

Output Effects: Impact effects are identical in both the fixed and unfixed models (Table 4). In the long-run, however, output falls by slightly (0.1 percentage point) more in the unfixed run. The long-run output effects are -0.2 and -0.3 percent in the fixed and unfixed runs, respectively. This is due to the rise in imports following the unfixing of the reserve term in the import equation. It should be noted that a rise in discount rate reduces the real asset stocks and the level of income. The latter improves the reserve position. The transmission mechanism of discount rate is similar to that of the required reserve ratio.

Price Effects: Again the impact effects are identical. In the long-run, however, price rises by more in the unfixed run. Prices rise by 0.27 and 0.42 percents in the fixed and unfixed runs, respectively. This is mainly due to the fall in capital stock occasioned by the fall in real asset stocks.

Current Account Effects: Impact effects are identical. In the long-run current account surplus is smaller in the unfixed run. The current account improves by 0.21 and 0.09 percents in the short-run and long-run, respectively. The reduced level of surplus in the unfixed model is due to the adverse price development. It was already shown that prices rise by more in the unfixed model.

World Trade Shock:

Output Effects: Impact effects are identical but output increases by more in unfixed model in the long-run (Table 5). This is due to the depreciation of real exchange rate following the fall in domestic price level. Though imports rise following the unfixing of reserves but price related net export effects are stronger in this shock. Note that the long-run fall in price is quite substantial. Prices fall by 1.38 percent and 2.46 percent in the long-run in fixed and unfixed runs, respectively.

Price Effects: Impact effects are similar. But as noted above, in the long-run, prices fall quite rapidly in the unfixed run. This is mainly due to the unfixing of imports to income ratio and the higher level of capital stock. Capital stock is building following the rise in income. Imports to income ratio is rising which further depresses price level.

Current Account Effects: Impact effects are identical, however, in the long-run improvement in the current account is smaller in the unfixed model. In the long-run, the current account improves by 0.76 and 0.57 percent, respectively. Despite a favourable price development, the current account improves by less in the long-run due mainly to the rise in activities.

Historical Simulations:

In tables 6.1 and 6.2 we provide comparative historical simulation results. Table 6.1 provides the results when these terms are fixed (ie. the results contained in chapter 6) and table 6.2 contains results when reserves term and imports to income term are unfixed. Results do not change substantially.

Goodness of fit statistics are slightly poor in almost all cases except the Theil's Inequality Coefficients for the current account balance when both of these terms are unfixed.

Conclusion

The simulation results presented above show that by fixing the reserve term in the import equation and import to income ratio in the price equation do not change the nature and the characteristics of our model. The direction of effects of all the policy shocks on income, prices and current account balance remain identical. Only the magnitudes of effects change which are also marginal at best. Therefore, fixing these terms do not cost in terms of the model characteristics. Our evaluation shows that historical tracking record is also not affected by unfixing these terms.

Table 1

Effects of 1.0 billion Increase in GC

Years	YDF	YD	CEDF	CED	CBVF	CBV
1972	1961.47	1876.36	0	0	-0.73	-0.7
1973	1745.25	1329.56	0.29	0.31	-1.84	-1.63
1974	1300.13	842.8	0.38	0.28	-2.96	-2.37
1975	983.5	558.13	0.36	0.16	-2.92	-1.92
1976	607.39	390.14	0.35	0.13	-1.92	-0.92
1977	795.97	705.19	0.28	0.09	-1.45	-0.51
1978	962.22	893.69	0.25	0.11	-1.58	-0.61
1979	839.16	806	0.23	0.15	-1.98	-0.94
1980	617.28	632.75	0.2	0.15	-2.28	-1.17
1981	564.66	592.72	0.16	0.13	-2.2	-1.1
1982	703.22	638.03	0.13	0.12	-2.01	-0.91
1983	785.13	652.25	0.13	0.13	-1.79	-0.78
1984	856.53	705.09	0.12	0.13	-1.84	-0.69
1985	918.78	736.56	0.13	0.14	-1.98	-0.72
1986	840.13	673.81	0.13	0.15	-1.94	-0.74
1987	762.16	628.81	0.13	0.15	-1.92	-0.71
1988	708.13	605.81	0.12	0.14	-1.82	-0.64
1989	667.44	592.5	0.11	0.14	-1.73	-0.57
1990	628.66	581.28	0.1	0.13	-1.65	-0.53
1991	592.63	564.94	0.09	0.13	-1.57	-0.49
1992	565.25	548.69	0.08	0.13	-1.51	-0.47
1993	551.44	538.75	0.07	0.13	-1.44	-0.44
1994	547.19	534.56	0.07	0.12	-1.38	-0.41
1995	546.25	534.81	0.07	0.12	-1.33	-0.38
1996	546.00	538.75	0.07	0.12	-1.28	-0.36
1997	543.94	546.63	0.07	0.12	-1.23	-0.33
1998	539.31	560.38	0.07	0.12	-1.19	-0.31
1999	532.00	582.63	0.07	0.11	-1.14	-0.29
2000	521.88	615.56	0.07	0.11	-1.1	-0.26

Notes

(1) Letter 'F' stands for results with 'Reserve' term in import equation and 'm/y' term in price equation are fixed. The other column gives the results when these terms are unfixed.

(2) YD denotes real GDP measured as the absolute difference from base.

(3) CED denotes domestic price level measured as percentage difference from base.

(4) CBV denotes current account balance measured as percentage difference from base exports.

Table 2

Effects of 10.0 percent devaluation of nominal exchange rate.

Years	YDF	YD	CEDF	CED	CBVF	CBV
1972	-0.68	-0.7	7.5	7.5	0.48	0.49
1973	0.55	0.48	6.83	6.86	2.02	2.07
1974	1.07	0.98	6.73	6.9	2	2.06
1975	0.58	0.49	8.58	8.81	1.16	1.12
1976	1.03	0.9	8.51	8.62	0.05	-0.06
1977	0.95	0.78	8.64	8.67	-0.21	-0.22
1978	0.71	0.55	9.11	9.06	0	0.1
1979	0.79	0.65	9.08	8.95	0.22	0.4
1980	0.82	0.66	9.12	8.98	0.2	0.47
1981	0.77	0.6	9.23	9.1	-0.04	0.32
1982	0.88	0.7	9.2	9.07	-0.42	0.02
1983	0.87	0.7	9.21	9.1	-0.78	-0.23
1984	0.9	0.73	9.21	9.11	-0.78	-0.22
1985	0.94	0.76	9.18	9.09	-0.98	-0.36
1986	0.95	0.78	9.16	9.08	-1.1	-0.43
1987	0.9	0.74	9.12	9.06	-1.15	-0.44
1988	0.87	0.71	9.05	9.01	-1.09	-0.36
1989	0.85	0.7	8.97	8.96	-0.97	-0.24
1990	0.85	0.7	8.9	8.92	-0.86	-0.13
1991	0.85	0.7	8.83	8.88	-0.79	-0.07
1992	0.86	0.71	8.78	8.85	-0.75	-0.05
1993	0.87	0.72	8.74	8.83	-0.72	-0.04
1994	0.89	0.73	8.71	8.81	-0.7	-0.03
1995	0.9	0.75	8.69	8.8	-0.68	-0.03
1996	0.92	0.76	8.68	8.8	-0.67	-0.03
1997	0.94	0.77	8.67	8.79	-0.67	-0.03
1998	0.95	0.78	8.67	8.79	-0.67	-0.03
1999	0.96	0.79	8.68	8.79	-0.67	-0.04
2000	0.97	0.79	8.68	8.79	-0.67	-0.04

Notes

(1) Letter 'F' stands for results with 'Reserve' term in import equation and 'm/y' term in price equation are fixed. The other columns give the results when these terms are unfixed.

(2) YD denotes real GDP measured as the percentage difference from base.

(3) CED denotes domestic price level measured as percentage difference from base.

(4) CBV denotes current account balance measured as percentage difference from base exports.

Table 3

Effects of a permanent 1.0 Percentage point Increase in Required Reserve Ratio.

Years	YDF	YD	CEDF	CED	CBVF	CBV
1972	-0.01	-0.01	0	0	0.01	0.01
1973	-0.08	-0.08	0	0	0.07	0.07
1974	-0.13	-0.13	-0.02	-0.02	0.22	0.22
1975	-0.05	-0.05	-0.03	-0.03	0.34	0.32
1976	0	0	-0.02	0	0.24	0.22
1977	-0.06	-0.07	0.01	0.03	0.15	0.11
1978	-0.16	-0.17	0.01	0.03	0.22	0.16
1979	-0.16	-0.17	0	0.02	0.43	0.35
1980	-0.13	-0.15	0.01	0.04	0.62	0.51
1981	-0.08	-0.1	0.04	0.07	0.61	0.48
1982	-0.05	-0.08	0.07	0.11	0.44	0.3
1983	-0.06	-0.09	0.11	0.15	0.24	0.12
1984	-0.06	-0.09	0.13	0.17	0.16	0.02
1985	-0.06	-0.1	0.16	0.19	0.15	0.01
1986	-0.12	-0.16	0.17	0.21	0.17	0.05
1987	-0.12	-0.17	0.17	0.21	0.24	0.13
1988	-0.12	-0.17	0.17	0.22	0.29	0.18
1989	-0.13	-0.18	0.18	0.24	0.29	0.18
1990	-0.14	-0.19	0.18	0.25	0.27	0.15
1991	-0.14	-0.2	0.19	0.26	0.25	0.13
1992	-0.15	-0.21	0.19	0.28	0.24	0.12
1993	-0.15	-0.21	0.2	0.29	0.24	0.11
1994	-0.16	-0.22	0.21	0.31	0.23	0.11
1995	-0.16	-0.23	0.21	0.32	0.23	0.1
1996	-0.17	-0.24	0.22	0.34	0.22	0.1
1997	-0.17	-0.25	0.23	0.35	0.21	0.09
1998	-0.18	-0.26	0.24	0.37	0.21	0.08
1999	-0.18	-0.27	0.25	0.38	0.2	0.08
2000	-0.19	-0.28	0.25	0.4	0.19	0.07

Notes

(1) Letter 'F' stands for results with 'Reserve' term in import equation and 'm/y' term in price equation are fixed. The other column gives the results when these terms are unfixed.

(2) YD denotes real GDP measured as the percentage difference from base.

(3) CED denotes domestic price level measured as percentage difference from base.

(4) CBV denotes current account balance measured as percentage difference from base exports.

Table 4

Effects of a permanent increase in Discount Rate by 1.0 percentage point

Years	YDF	YD	CEDF	CED	CBVF	CBV
1972	-0.01	-0.01	0	0	0.01	0.01
1973	-0.06	-0.06	0	0	0.04	0.04
1974	-0.1	-0.1	-0.01	-0.01	0.16	0.16
1975	-0.05	-0.05	-0.03	-0.02	0.26	0.25
1976	-0.01	-0.01	-0.01	0	0.2	0.18
1977	-0.07	-0.07	0.01	0.02	0.15	0.12
1978	-0.17	-0.17	0	0.02	0.25	0.2
1979	-0.16	-0.17	-0.01	0	0.46	0.38
1980	-0.15	-0.16	0	0.02	0.65	0.55
1981	-0.09	-0.12	0.02	0.05	0.66	0.52
1982	-0.06	-0.09	0.05	0.1	0.5	0.35
1983	-0.07	-0.11	0.09	0.14	0.3	0.18
1984	-0.06	-0.1	0.12	0.17	0.22	0.07
1985	-0.06	-0.1	0.15	0.19	0.19	0.04
1986	-0.12	-0.16	0.17	0.21	0.2	0.07
1987	-0.13	-0.17	0.18	0.21	0.27	0.14
1988	-0.13	-0.18	0.18	0.23	0.32	0.19
1989	-0.14	-0.19	0.19	0.25	0.32	0.19
1990	-0.14	-0.2	0.2	0.26	0.29	0.17
1991	-0.15	-0.21	0.2	0.28	0.27	0.14
1992	-0.16	-0.22	0.21	0.29	0.26	0.13
1993	-0.16	-0.23	0.22	0.31	0.26	0.13
1994	-0.17	-0.24	0.22	0.32	0.25	0.12
1995	-0.17	-0.25	0.23	0.34	0.25	0.12
1996	-0.18	-0.26	0.24	0.36	0.24	0.11
1997	-0.18	-0.27	0.25	0.37	0.23	0.1
1998	-0.19	-0.28	0.26	0.39	0.23	0.1
1999	-0.2	-0.29	0.26	0.41	0.22	0.09
2000	-0.2	-0.3	0.27	0.42	0.21	0.09

Notes

(1) Letter 'F' stands for results with 'Reserve' term in import equation and 'm/y' term in price equation are fixed. The other column gives the results when these terms are unfixed.

(2) YD denotes real GDP measured as the percentage difference from base.

(3) CED denotes domestic price level measured as percentage difference from base.

(4) CBV denotes current account balance measured as percentage difference from base exports.

Table 5

Effects of a 5.0 percentage point increase in Foreign Demand (S)

Years	YDF	YD	CEDF	CED	CBVF	CBV
1972	1.91	1.93	0	0	5.8	5.79
1973	1.85	1.88	0.53	0.58	3.02	2.79
1974	1.83	1.87	0.74	0.66	0.45	0.01
1975	1.99	2.02	0.8	0.53	-0.15	-0.52
1976	1.7	1.74	0.92	0.49	0.15	0.02
1977	1.46	1.53	0.82	0.23	0.34	0.37
1978	1.4	1.53	0.6	-0.08	0.47	0.54
1979	1.33	1.53	0.42	-0.29	0.72	0.7
1980	1.34	1.56	0.19	-0.51	0.71	0.56
1981	1.27	1.5	-0.02	-0.72	0.54	0.38
1982	1.31	1.57	-0.22	-0.93	0.59	0.49
1983	1.28	1.57	-0.38	-1.09	0.63	0.64
1984	1.32	1.67	-0.54	-1.25	0.91	0.9
1985	1.4	1.76	-0.65	-1.36	1.03	0.9
1986	1.42	1.79	-0.73	-1.45	0.83	0.67
1987	1.4	1.79	-0.8	-1.55	0.7	0.51
1988	1.38	1.8	-0.88	-1.65	0.66	0.48
1989	1.37	1.8	-0.95	-1.75	0.71	0.51
1990	1.36	1.81	-1.01	-1.85	0.75	0.56
1991	1.35	1.81	-1.07	-1.94	0.77	0.58
1992	1.33	1.82	-1.13	-2.02	0.77	0.59
1993	1.32	1.82	-1.18	-2.1	0.76	0.59
1994	1.31	1.83	-1.23	-2.17	0.77	0.6
1995	1.30	1.84	-1.27	-2.24	0.77	0.6
1996	1.29	1.85	-1.3	-2.29	0.77	0.6
1997	1.28	1.86	-1.33	-2.34	0.77	0.59
1998	1.27	1.87	-1.35	-2.39	0.77	0.59
1999	1.27	1.88	-1.37	-2.42	0.76	0.58
2000	1.26	1.89	-1.38	-2.46	0.76	0.57

Notes

(1) Letter 'F' stands for results with 'Reserve' term in import equation and 'm/y' term in price equation are fixed. The other column gives the results when these terms are unfixed.

(2) YD denotes real GDP measured as the percentage difference from base.

(3) CED denotes domestic price level measured as percentage difference from base.

(4) CBV denotes current account balance measured as percentage difference from base exports.

Table 6.1

Results of the full model with (RESCP) and (m/y) terms fixed

Root Mean Square Error Percent (RMSEP) and Theil's Inequality Coefficient (U) for Selected Variables

Variables	RMSPE	U
Consumer Price Deflator (CED)	0.0688	0.0347
Nominal Wages (NW)	0.1456	0.0544
Export Prices (PXA)	0.121	0.0678
Gross Domestic Product (GDP)	0.0356	0.0162
Private Consumption (CONS)	0.0456	0.0200
Net Fixed Capital Stock (K)	0.0375	0.0151
Exports of Goods and Non-factor Services (XGN)	0.1333	0.0590
Imports of Goods and Non-factor Services (MGN)	0.0951	0.0382
Current Account Balance (CBV)	4.1	0.1352
Total Bank Advances (ADV)	0.1976	0.0620
Total Bank Deposits (TOTD)	0.2512	0.0746
Nominal Money Stock (M2)	0.1797	0.0620
Private Sector Demand for Currency (CP)	0.0869	0.0519
Free Reserve Ratio of Deposit Banks (FRR)	0.1581	0.0656

Table 6.2

Results of the full model with (RESCP) and (m/y) terms unfixed.

Root Mean Square Error Percent (RMSEP) and Theil's Inequality Coefficient (U) for Selected Variables

Variables	RMSPE	U
Consumer Price Deflator (CED)	0.070	0.033
Nominal Wages (NW)	0.152	0.064
Export Prices (PXA)	0.130	0.073
Gross Domestic Product (GDP)	0.04	0.021
Private Consumption (CONS)	0.0456	0.020
Net Fixed Capital Stock (K)	0.069	0.0313
Exports of Goods and Non-factor Services (XGN)	0.138	0.070
Imports of Goods and Non-factor Services (MGN)	0.103	0.042
Current Account Balance (CBV)	4.30	0.080
Total Bank Advances (ADV)	0.231	0.120
Total Bank Deposits (TOTD)	0.297	0.16
Nominal Money Stock (M2)	0.204	0.110
Private Sector Demand for Currency (CP)	0.0903	0.0544
Free Reserve Ratio of Deposit Banks (FRR)	0.1581	0.0656

Chapter 8

External Shock and Closed-loop Simulations

Introduction

In the preceding chapter we showed how macroeconomic policy works in terms of its transmission mechanism in our model and analysed the magnitude of policy multipliers through dynamic open-loop simulations. The issue was to assess the effects of different policy changes on the economy assuming that the authorities do not react following any such shocks. However, in reality, policy analysis is not carried out in a vacuum, authorities do react in such situations with a view to affect the course of the economy in a desired (targeted) direction.

In this chapter we turn to this issue and try to address the question of the design of macroeconomic policy rules. However, we confine ourselves in the design of policy rules should the economy face a negative external shock ie., a fall in the world demand for its exports.

In section 7.2.9 of the foregoing chapter, we discussed the effects of a permanent rise in world trade by 5.0 percentage points. In the full model, this leads to a permanent rise in activities, an improvement in the current account and a fall in domestic prices. Activity rises following the increases in aggregate demand and asset accumulation caused by the booming export sector.

The current account balance improves following a direct rise in exports. Prices fall in the long-run due to the rise in capital stock. Thus, an increase in world trade brings considerable benefits to the domestic economy.

However, now we analyse the reverse scenario ie., the consequences of a slump in export demand on the domestic economy. Then we move on to design appropriate feedback rules for the correction of this external imbalance.

This chapter is organised as follows. In the first section we very briefly discuss the effects of a slump in world trade on the domestic economy. In the second section we provide a brief discussion of the methodological issues in the design of control rules and the methodology we follow. In the third section the feedback rule on expenditure reducing policy is specified and the outcomes are discussed. In section four, we design a feedback rule on expenditure switching and discuss its outcome. The chapter is concluded with brief closing remarks.

8.1 The Effects of a Negative External Shock

A permanent 5.0 percentage point fall in world demand reduces the level of output permanently as the level of aggregate demand and real asset stocks fall. Income falls by 1.98 and 1.29 percent in the short and long run, respectively (fig. 8.2). Since we impose a percentage point shock, the long-run fall in output is smaller than the short-run. The current account worsens due to the fall in exports. In the short-run the current account deteriorates by 5.77 percent relative to base exports and in the long-run it stabilises at 0.8 percent (fig. 8.1). Domestic prices go up by 1.51 percent in the long-run due to the fall in the capital stock. Notice that, as long as demand pressure dominates the price sector, prices fall (fig 8.3). In the long-run, it is the fall in capital stock that pushes prices up. All these happen at the absence of any policy response from the authorities. Now, we turn to the design of control rules.

8.2 Design of Control Rules

Following Stevenson et al. (1988) we distinguish between two strands of literature in the design of control rules. The first emanated from the works of Phillips (1954, 1957) which is concerned with the relative effectiveness of different types of feedback or closed-loop policy rules which authorities may employ to achieve their policy objectives. In this framework one does not involve in the optimisation of control rules adopted.

In contrast, the second approach to control rule design assumes that policy-makers operate with some objective (or social welfare) function in their mind and they select the control rules in such a way that it maximises their objective function. In essence, policy makers are assumed to undertake an explicit optimisation exercise and pick-up an optimal rule from within a given class of policies.

In what follows, in designing our closed-loop simulation, we follow a simple approach. First, we confine ourselves to target 'only the external balance' which is assumed to be controlled by one instrument at a time (viz., expenditure cutting and expenditure switching, alternatively). We abstract from the stylized exercise of simultaneously targeting the external and the internal equilibrium, employing both the expenditure switching and cutting policies.

Vines et al. (1983, p. 163) point out that there is an ambiguity in the term 'targets' as used by the economists. It can mean either some new level of certain variables or the base-run level itself. For our purpose, we use the latter meaning ie., we assume that authorities target the pre-shock level of current account following a slump in world trade.

We also abstract from optimisation exercise and design a simple feedback rule. Weale et al. (1989, pp. 331-333) argue in support of simple feedback rules which give both satisfactory dynamics to the controlled economy and the realisation of the desired values of the target variables. Chirstodoulakis and Levine (1987) show that in some cases a simple feedback rule can produce better results than the optimal rule when the economy is subjected to unforeseen changes.

We follow the principles of proportional, derivative and integral rules as the general guide-line in designing our feedback rules. Weale et al. (1989) have shown that there is no hard-and-fast answer in the designing of feedback rules; what is required is 'enlightened trial-and-error' method. We follow their approach. A thorough account of the application of feedback control rule in this light can be found in Vines et al. (1983) and Westaway (1985). A short but sharp theoretical exposition can also be found in Stevenson et al. (1988). Now, we turn to the design and analysis of expenditure cutting and expenditure switching rules for our model.

8.3 Negative External Shock and the Expenditure Cutting Rule

The expenditure cutting rule says that government expenditure is reduced when current account goes into deficit and vice versa. As argued above, after some experimentation the fiscal rule is specified to be:

$$GC = GC^{b} + .9\ (CBV - CBV^{b}) + .3\ (\Sigma^{t}_{(t=1)} CBV - \Sigma^{t}_{(t=1)} CBV^{b})_{-1} \quad (8.1)$$

where the superscript 'b' indicates the base value throughout the discussion. Note that government consumption expenditure in real terms (GC) was treated as exogenous policy variable in open-loop simulation. It is an endogenous policy instrument here. In this experiment we have scaled the current account balance by the government expenditure deflator to remedy the price effects. Equation (8.1) is a combination of proportional and integral rules as discused in Phillips (1954, 1957) and Weale (1989).

The feedback rule says that when current account deficit increases relative to base, government expenditure is reduced relative to base. The response rate being determined by proportional and integral factors.

The proportional rule says that when the current account is different from base, government expenditure is different from base with a proportionality factor of 0.9. In essence one chooses this factor keeping in view the multiplier effect of the instrument on the target variable. In our model a 1.0 billion increase in government consumption expenditure worsens the current account balance by roughly the same magnitude in the long-run as does a 5.0 percentage point slump in the world trade. This explains the proportional factor 0.9.

As is well known the proportional rule suffers from two defects. First, a complete realisation of the target requires a proportional factor of infinity if one were to rely merely on this rule. Secondly, the stronger the proportional rule and the longer the time lag involved the higher tends to be the cyclical fluctuation in the time path of target variable.

The last term in equation (8.1) is the integral factor. When the accumulated deficit is different from base government expenditure is different from base. The integral factor is 0.3. It is the integral rule which leads to the final attainment of the target. It is because the persistent accumulation of error increases the magnitude of corrective action over time. It is obvious that the bigger the integral factor the quicker the resumption of the target value. However, it should be noted that a bigger integral factor aggravates the cyclical fluctuations in the time path of the target variable and this is where a judicious approach is needed in the selection of appropriate proportional and integral factors. One chooses this factor as a small fraction of the size of the proportional factor as it reinforces the cyclical fluctuations in the time path of target variables.

Quite often, in applied works, a derivative rule is also applied to smooth the fluctuations in the time path of the target variables, but this is not found to be necessary in our specification (as will be evident that results are pretty smooth).

Notice that we have allowed a lag only in the integral rule. This implies that authorities instantaneously react to external imbalances in terms of proportional rule, however, they set their total realisation rule on the basis of the last period accumulated errors. We acknowledge that an instantaneous reaction rule is an heroic assumption when, in actual life, authorities face lags in receiving information, in decision making and in implementation. However, we leave out a thorough assessment of lag structure for future work. Now, we turn to the analysis of the closed-loop outcomes.

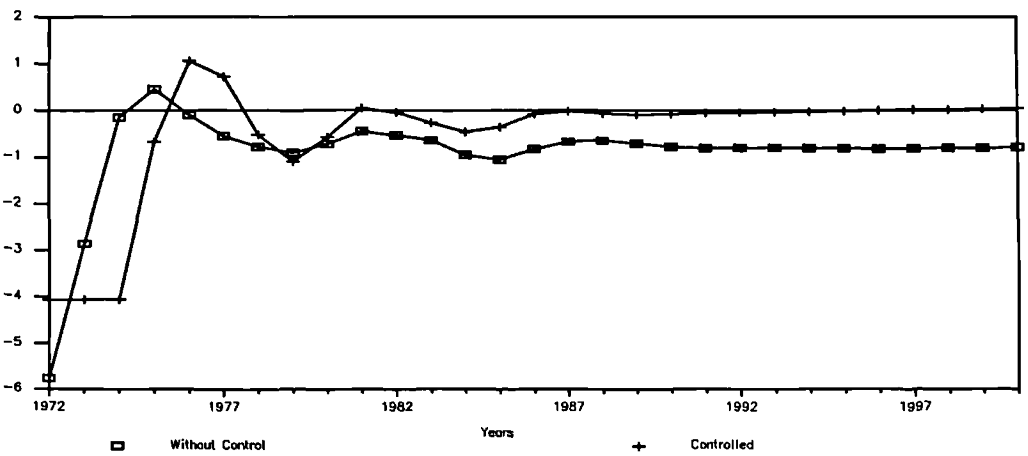
In figure 8.1 we plot the outcomes on the target variable ie., the current account. The forecast period for closed-loop starts from 1974. It is evident from the plots that the closed-loop simulation attains current account balance (our target objective) when the economy faces of a slump in the world demand for exports. A complete correction in external payments is quite rapid and remains stable throughout. It is the fall in government expenditure that corrects the deterioration in the current account.

Notice that in the absence of the feedback rule the current account settles at deficit all along. The initial short-lived positive spikes are due to strong short-run contractionary effects ie., the initial sharp fall in income (fig. 8.2). Income falls sharply due to the collapse in exports. Consequently, imports fall sufficiently, in the short-run, for the current account to improve. But these spikes die out very quickly and the outcome on the current account stabilises following the stability in income.

FIG. 8.1

Time Profile of Current Account

(Percentage difference relative to base exports)

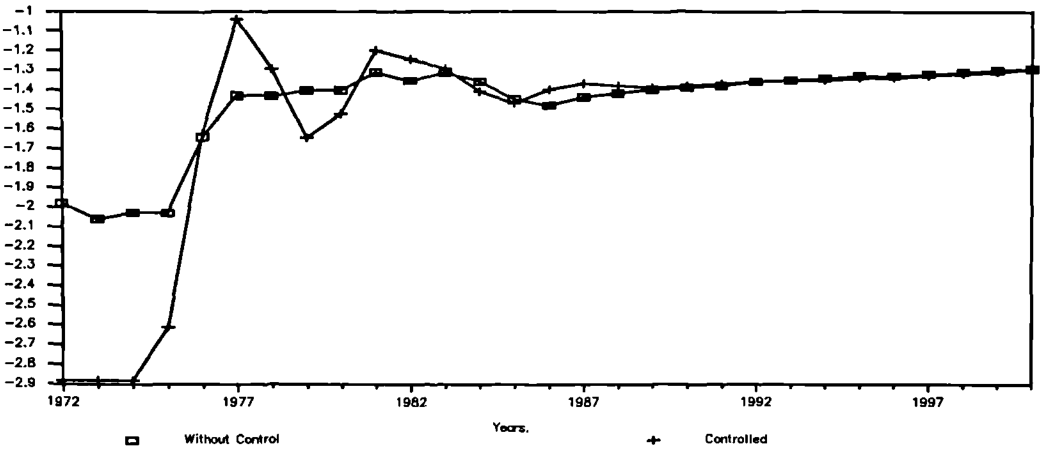


In figure 8.2 we plot the effects on output. In the short-run output falls rapidly in the 'controlled' run compared to the 'uncontrolled' run. This is due to the fall in government expenditure following the feedback rule. However, implementation of the control rule makes little difference on output in the long-run. This long-run behaviour of output can be explained as follows.

Firstly, under the closed-loop simulation the improvement in the balance of payments and the associated asset effects neutralise, to a larger extent, the contractionary effects of the reduction of government expenditure. Secondly, the domestic price rise is relatively smaller in the closed-loop simulation. This encourages the net exports. In addition leakages are reduced in the long-run. Thus, these effects neutralise the possible contractionary effects of a expenditure cutting feedback rule in the long-run. Therefore, output shows a similar behaviour to the open-loop simulation in the long-run.

FIG. 8.2

Time Profile of Output
(Percentage difference from base)

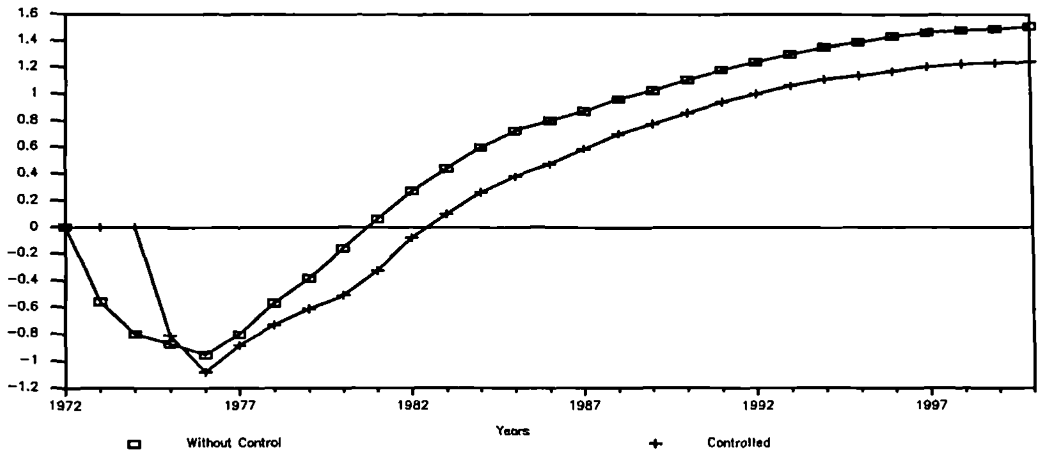


The time profile of domestic price level is plotted figure 8.3.

FIG. 8.3

Time Profile of Price Level

(Percentage difference from base)

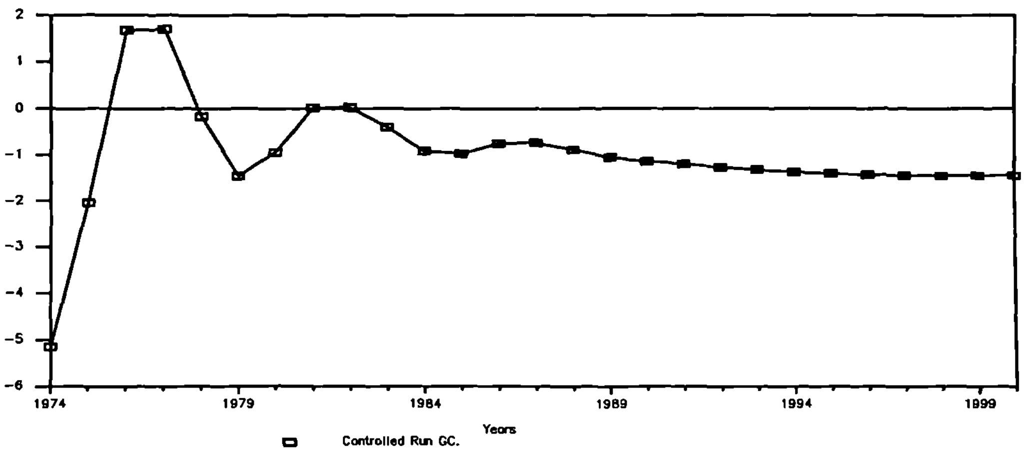


Prices rise in the long-run due to the fall in capital stock. However, prices rise by less in the 'controlled' run. This is due to the relatively smaller fall in capital stock compared to the 'uncontrolled' run. The relative improvement in the balance of payments and the associated monetary flows increase asset stocks and hence the capital stocks. In other words, the fall in the asset stocks caused by the balance of payments deficit in open-loop simulation are checked in the closed-loop simulation by the balanced external payments rule. As expected government expenditure falls following the feedback rule. The time profile is plotted in figure 8.4.

FIG. 8.4

Time Profile of Government Expenditure

(Percentage difference from base)



To conclude, expenditure cutting policy ensures the achievement of the current account balance satisfactorily. Output falls by more in the short-run, but the long-run effect is similar to 'uncontrolled' run. Prices rise by less than the 'uncontrolled' run. Government expenditure declines.

8.4 Negative External Shock and the Expenditure Switching Rule

The expenditure switching rule consists of depreciating the real exchange rate when the balance of payments goes in to deficit. It should be noted that a mere reliance on the expenditure switching rule may correct the balance of payments deficit, but it triggers inflation at the same time, requiring a higher and higher level of currency depreciation. At times it may not be politically feasible.

We solved the model in fixed real exchange rate mode while specifying this feedback rule. A real depreciation requires a more than proportionate nominal devaluation following any price rise. Following the design procedure already discussed the expenditure switching feedback rule is specified to be:

$$EX = EX^b + (CED-CED^b) - \delta(CED-CED^b) + 0.3(\Sigma^t_{t=1}CBV - \Sigma^t_{t=1} CBV^b) \quad (8.2)$$

The second term in the right hand side of (8.2) ensures the fixed real exchange rate rule ie., the nominal exchange rate is adjusted one-for-one to any changes in the domestic price level. The derivative rule on price level with a negative derivative factor was necessary for the convergence of the model. The model did not converge without such a rule on the rate of change on prices. The unitary derivative factor was chosen after several successive experiments to dampen the exploding current account balance towards the end of the simulation period.

The last term in (8.2) is the integral rule with an integral factor of 0.3. Experiments with the proportional rule on the current account balance did not affect the results. Therefore, there is no proportional factor.

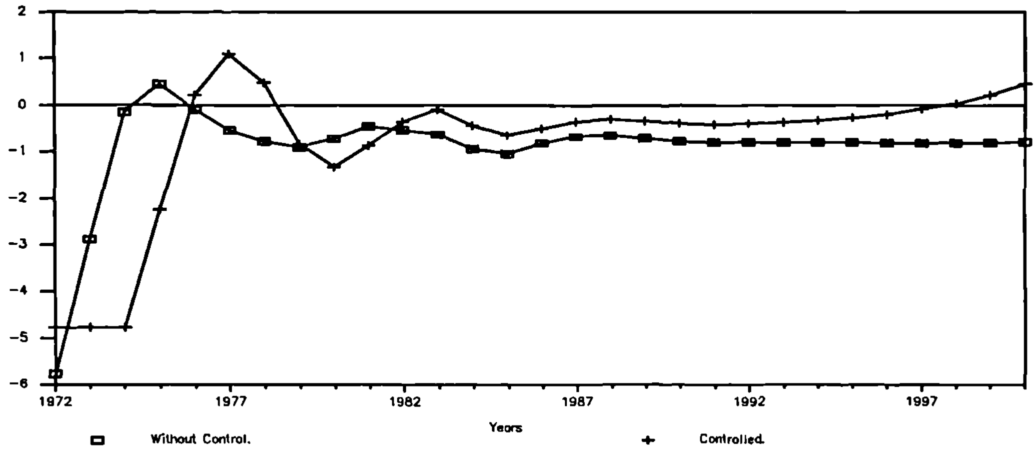
The proportional rule alone is not sufficient to correct the balance of payments. It is the proportional plus the integral factor that ensures the attainment of the target ie., the elimination of any error between the targeted and observed values of the target variable.

In figure 8.5 we plot the outcomes on current account balance of both the closed-loop and open-loop simulations following a 5.0 percentage point drop in the demand for exports. Results show that expenditure switching policy takes long time to correct the current account imbalance.

FIG. 8.5

Time Profile of Current Account

(Percentage difference relative to base exports)



One can impose a quick correction of errors by increasing the size of the integral factor but, as already explained, it might produce unstable cycles in the time path of the target variables. At the same time, one should also be careful about the plausibility and feasibility of such policy parameters. The point is that these proportional and integral factors determine the size and track of the authorities' policy instruments and hence should be sensible. Our efforts to impose a quick resumption of the balance of payments equilibrium by increasing the size of the proportional factor turned out to be unsuccessful as the outcome was an exploding current account balance towards the end of the simulation period.

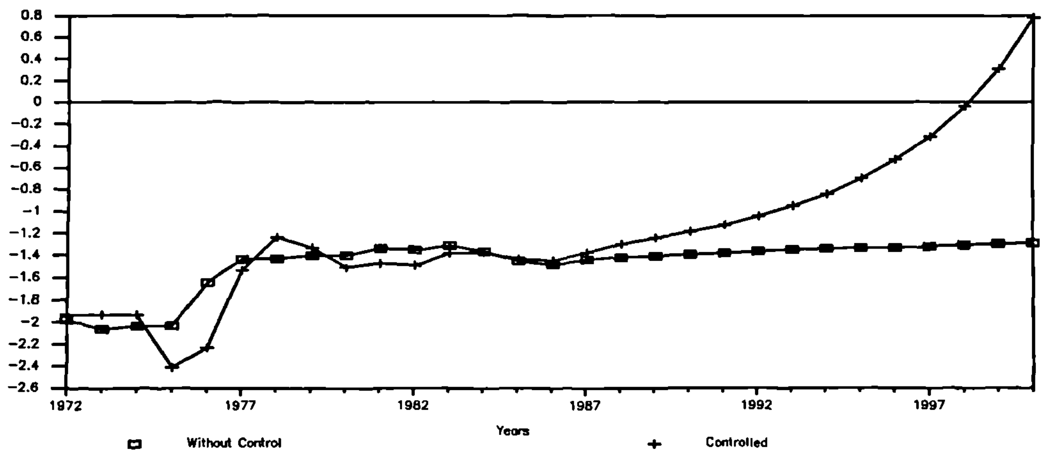
In the long-run, the expenditure switching rule does attain the target (ie., correction in the balance of payments)

This is primarily due to the real exchange rate depreciation. However, the outcome shows an increasingly surplus trend particularly when it approaches the end of the simulation period. The outcomes do not dampen-off around the targeted values of the target variable as the expenditure cutting policy showed and we would have liked them to be. This is not an entirely unexpected outcome as a mere reliance on expenditure switching policy might cause instability through triggering inflation. However, this experiment should be taken as informative. In figure 8.6 we plot the outcome for activity.

FIG. 8.6

Time profile of GDP.

(Percentage difference from base)



Output rises in the 'controlled' run following the real exchange rate depreciation. This is sensible, but again the end-of-period trend is worrying. This exploding trend in output is not surprising as the real exchange rate elasticity of net exports is 2.3. Though the supply side responds unfavourably following a rapid depreciation of real exchange rate, the size of its effect is small (0.25) relative to net exports.

Prices overshoot following the devaluation of exchange rate. It increases by almost 30.0 percent by the turn of the simulation period and shows a steeply upward trend (fig. 8.7). Figure 8.8 shows the time profile of price level, nominal exchange rate and real exchange rate in the 'controlled' run. All show exploding trends towards the end of simulation period.

FIG. 8.7

Time Profile of Price Level

(Percentage difference from base)

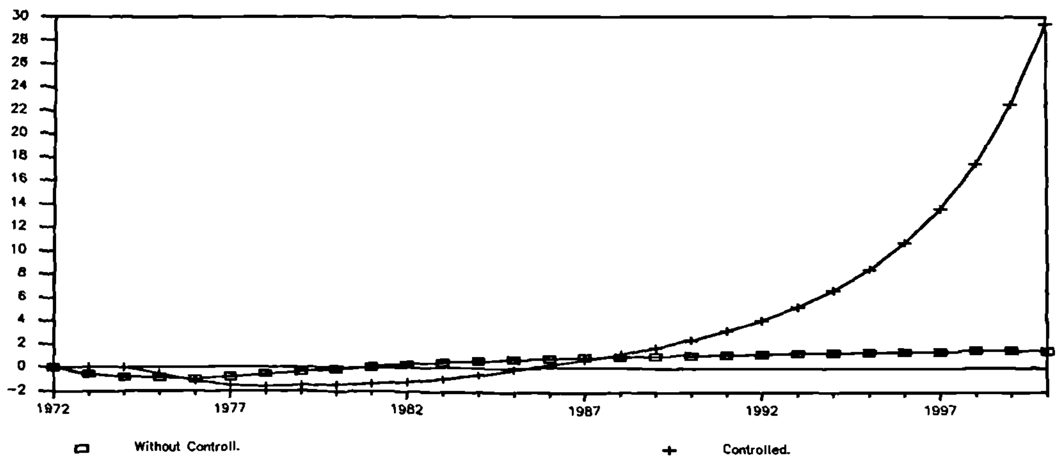
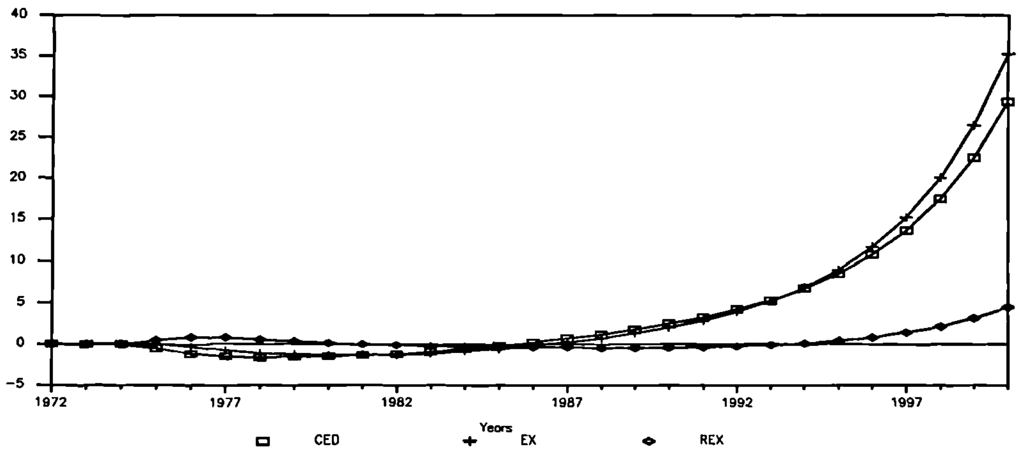


FIG. 8.8

'Controlled' Run Outcomes.

Prices, Nominal Exchange Rate and Real Exchange Rate

(Percentage difference from base)



8.5 Summary and Concluding Remarks

In this chapter we performed some control experiments based on simple feedback rules. We designed feedback rules in terms of expenditure cutting and expenditure switching policies when authorities face an external payments problem.

Our analysis shows that an expenditure cutting rule successfully corrects the balance of payments deficit as targeted. To some extent, it also reduces the upward pressure on the domestic price level than otherwise would have been. However, there is cost in terms of the fall in output associated with this rule. But these multiple objectives could be addressed within a multiple targets and instruments framework of economic policy design, which is well-known in the literature of macroeconomic stabilisation.

Expenditure switching policy, on the other hand, does not show an encouraging outcome. As it stands, we can not argue in its favour as far as our model is concerned. It also calls for a serious questioning of political feasibility, as inflation is triggered. However, it might prove to be useful when applied in a multiple target and instruments framework or in connection with expenditure cutting policy.

Data Appendix

Data series required to build a regional econometric model for the developing countries of Asia simply did not exist. Therefore, the first task was to construct the required data set for subsequent empirical works. In this process we are confronted with three interrelated tasks. First, identification of appropriate sources of country level data. Second, transformation of country level data into regional aggregates. And third, data projection to generate a time series of appropriate length for policy simulations. In what follows we discuss these issues in turn.

Sources of data

Data series on individual country basis are gathered from different publications of the World Bank and the IMF. They do publish different types of regional aggregates as well, however, they were not appropriate for our present needs.

Regional totals are derived through aggregation. Our work in this regard is made immensely easy by the data bank developed by a team working on econometric modelling under Prof. David Vines. This data bank, developed by Mr. T. G. Srinivasan, contained most of the real sector series used in our model and we have utilised them. These series constitute data on components of GDP, wages and prices, the balance of payments flows and government accounts. The data bank utilises the World Bank sources. In fact, individual country level data series were directly supplied by the World Bank (for detail see T.G Srinivasan, 1991).

However, the data bank did not contain time series on monetary and financial sector variables. We collected, compiled and aggregated data series of financial sector variables. The same aggregation procedure contained in the data bank are followed. For the ease of reference we provide the method of aggregation as we proceed.

We used various issues of the International Financial Statistics Year-book (IFS) as the source of individual country level data. In what follows we provide a detail account of the series used from the IFS.

(a) Exchange rates and interest rates

(i) Exchange rates: "rf" series of exchange rate which is expressed in terms of national currency units per US dollar is used in all cases except for Fiji. The "rf" series is not reported for Fiji rather "rh" is reported. For our purpose a reciprocal of "rh" is calculated and used. Though both the "rf" and "rh" are not strictly reciprocal for one another, even then, it serves our purpose without any serious deficiency. For the concept and computation of these exchange rate series see IFS Supplement on Exchange Rates, 1985.

(ii) Discount Rate: the end of period discount rate reported in line 60 of IFS is used as the relevant discount rate fixed by the Central Bank.

(iii) Deposit and Lending Rates: Lines 60l and 60p are used as the deposit and lending rates, respectively, for deposit banks. While compiling Indian interest rate series, various issues of the Reserve Bank of India Bulletin are also used.

(b) Balance Sheet Items of Monetary Authorities

In deriving the relevant data on balance sheet items of the monetary authorities following series of IFS were used:

(i) Net Foreign Assets (NFA): this is derived as the difference between gross foreign assets (line 11) and foreign liabilities (line 16c) of monetary authorities.

(ii) Net Central Bank Lending to Government (NCLG): it is derived as the difference between monetary authorities' claim on government (line 12a) and the latter's deposit on the former (line 16d). In developing countries, most of the Central Bank lending to Non-monetary Financial Institutions (line 12f) and Non-financial Public Enterprises (line 12c) are extended under government guarantee. By and large these institutions are publicly owned and a financial provision for them in government budgets is a commonplace. Therefore, to the extent monetary authorities' claims on these institutions are reported in IFS we have lumped them under the claims on government. However, it should be noted that these latter claims of monetary authorities are not sizeable compared to its claims on government.

(iii) Central Bank Lending to Deposit Banks (CLB): it is taken from line 12e.

(iv) Base Money or High Powered Money (BM): it is derived from line 14.

(v) Currency with the Private Sector (Cp): it is derived from line 14a. It comprises bank notes and coins accepted as legal tender in the domestic economy, excluding money held by the monetary system, central government, and the non-residents.

(c) Balance sheet items of Commercial Banks

Following data series from IFS are used to derive the balance sheet items (series) of deposit money banks:

(i) Deposit Bank Reserves (RB): it is taken from line 20 of IFS. Reserves of deposit banks comprise currency holdings or vault cash and deposit with the Central Bank.

(ii) Deposit Bank's Lending to Government (BLG): it is taken to be line 22a.

(iii) Bank Lending to Private Sector (BLP): it is line 22d in the IFS. However, for our purpose we have defined BLP as the total advances of commercial banks excluding advances to government (BLG). Therefore, to the extent data on deposit bank lending to Official Entities (line 22bx), Non-financial Public Enterprises (line 22ca) and Other Financial Institutions (line 22f) are reported in the IFS, we have lumped them under BLP. However, it should be noted that data reporting on the institutional lending of deposit banks is still paltry in the sense that they cover a very short period.

(iv) Demand deposit (DD): it is taken to be line 24 of the IFS.

(v) Time and Saving deposit (TD): it is taken to be line 25 of IFS. Total deposits (TOTD) consists of Demand and Time deposits.

(vi) The Central Bank Lending to Deposit Banks (CLB): IFS reports it under two headings. Firstly, it is reported under Monetary Authorities' claim on deposit banks (line 12e). Secondly, it is reported under deposit banks' balance sheet as credit from Monetary Authorities in line 26g. To the extent these two series differ we have overwritten 26g by 12e.

Principles of Data Aggregations

The country level data were aggregated to derive the regional data. This task is completed in four stages. In the first stage all variables except inflation are expressed in US $ terms to arrive at regional totals at current $ price. In the second stage we derive the inflation variable. Obviously, it has to be in local currency terms. We derived regional price indices as a suitably weighted aggregate of the sample countries' price indices in local currency terms. In the third stage we computed price indices in US $ terms. And finally in the fourth stage, we deflated current price $ variables by $ price indices to arrive at the constant price variables expressed in US $ terms. A brief account of these conversion formula is as follows:

Regional Current Price Variables

All the country level relevant variables are converted in to US $ terms deflating by the average annual official exchange rates. These are then summed up to arrive at regional total in current US $ terms. Expressed symbolically:

$$_{\$}X_t^{A}=\sum_{i=1}^{k} {}_{L}X_{it}/e_{it}$$

where;
e is nominal exchange rate expressed in terms of units of local currency per US $.
k is the number of countries in the region.
Subscript $ denotes the variable to be measured in dollars.
Superscript A denotes the aggregate for the region.
Subscript L denotes the variable in local currency terms.
t is the time subscript.

Regional Price Indices in Local Currency Terms

Regional price indices are calculated as the geometric mean of corresponding country level local currency price indices using the current dollar values of appropriate variables as weights. For instance, to compute the regional consumption deflator, the nominal private consumption in US $ of the individual countries are used as the relevant weights. Expressed symbolically:

$$ {}_L\overset{A}{P}_t = \prod_{i=1}^{k} ({}_LP_{it})^{\Phi_{it}} $$

Where Φ is the weight calculated as:

$$ \Phi_{it} = (X_{it} / e_{it}) \Big/ \sum_{i=1}^{k} (X_{it}/e_{it}) $$

It should also be noted that the weights of different countries are updated every year.

Regional Price Indices in US $ Terms

These are derived as the geometric mean of the corresponding country level $ price indices using an appropriate variable's current dollar values as weights. Dollar price indices, on the other hand, are derived by deflating the respective local currency price indices by corresponding nominal exchange rate indices. Symbolically it can be expressed as:

$$ {}_\$\overset{A}{P}_t = \prod_{i=1}^{k} ({}_LP_{it}/e_{it})^{\Phi_{it}} $$

where

$$ {}_LP_{it} = {}_LX_{it}/{}_L\overset{b}{X}_{it} $$

This is price index in local currency terms of a sample country in the region. Φ_{it} is as described above.

Data Projection

As the balance of payments data are available only since 1970, the full model can only be simulated between 1972 and 1985 after allowing for lag structures. However, for the assessment of the long-run properties of the model a longer track for simulation would be desirous, therefore, we decided to project the variables of the model from 1986 to 2000. The real sector variables were already projected in the data bank for a period of 1986 to 2000. We utilised them in our model. It should be noted that the data bank draws on the projection made by the International Monetary Fund (IMF) up to 1994 (see the "World Economic Out Look", October, 1989).

However, we had to project rest of the variables of the model. We also made use of the assumptions of the IMF projections. In what follows we provide the assumptions made in projecting the data. The numbers appearing in front of the variables represent assumed annual compound growth rates of the respective variables.

Rest of the World Variables

Prices 3.3 %

Nominal Variables 6.3 %

Import Volumes 6.0 %

Domestic Variable

Real Exchange Rate 0

Terms of Trade 0

Real Wage 0

Export Volumes 8.2 %

Import Volumes 7.9 %

Other GDP components, real 6.5 %

Nominal Variables in $ terms 9.8 %

Price in local Currency terms 6.3%

Prices in US $ terms 3.3%

Amortization 6.2%

Interest payments 6.3%

Debt Stock 6.2 %

Data series are projected over 1986 to 2000 by applying a constant rate to 1985 base values. Most of the assumptions are based on the IMF projections up to 1994 for LDCs and Industrialised Countries reported in the World Economic Outlook, October 1989.

Rest of our assumptions are as follows

LIBOR is kept at 4.2 percent over the projection period. Inflation is based on the average rate of five years. Real Government Consumption is a residual in GDP identity. Disbursement of loans is a residual in debt evolution identity. Reserves are residual in the balance of payment identity.

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