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Empirical Macro Models for Developing Countries The Case of Latin America

Thirumalai Gopalan Srinivasan

A thesis submitted in fulfilment of the requirement for the degree of Doctor of Philosophy at the University of Glasgow, Department of Political Economy, May 1991.

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I was motivated to pursue this research after a series of lectures on open economy macroeconomics by David Vines and a research agenda on macroeconmic models for developing countries expounded by him in 1986. Besides, there was the prospect of our research output being incorporated into the Global Econometric Model (GEM), developed and maintained at London Business School and National Institute of Economic and Social Research, and thus put to active use.

There are many persons without whose help this work would not have been possible. First and foremost my debt to Prof. David Vines is immense. His supervisory contribution was very valuable. Apart from all the encouragement he has given me, he initiated me into analytical economic dynamics and simulation methods. Above all, he made me appreciate the essence of modelling: relevant simplification. Materials appearing in Chapters 2 on theoretical framework and Chapter 6 on full model simulation results draw upon working papers (Srinivasan and Vines, 1989 and 1990) which I have coauthored with David Vines. I am also thankful to Andrew Stevenson for helping me to appreciate better the links between fiscal deficit and base money creation.

The econometric model that has been assembled adopts price and wage equations of Christopher Allen at LBS and consumption and import equations of Anton Muscatelli and Stanly Hurn at

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I have been fortunate to depend on one data source for all our empirical work. The World Bank has kindly provided the data sets in electronic media for our use.

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CONTENTS

SUMMARY

This research seeks to contribute to several important aspects of building empirical macroeconomic models of LDC regions in a North-South context, choosing the Latin American region as a test-bed. Contributions cover a new theoretical framework, first ever construction of a regional data base within an accounting framework, applied econometric investigation on export volumes and prices for the region, partial and full model validation of the macro model assembled, simulations under external and internal shocks, and finally, policy choices to cope with negative external shocks.

The theoretical framework outlined combines important features monetary approach to balance of payments, "two-gap analysis", and new-classical supply side. This framework distinguishes itself from other contemporary research by specifying a richer supply side which allows for wage pressure, allowing for wealth effects and fully investigating the stability of adjustment process. The effects of expenditure cutting and switching policies to cope with a negative external shock are considered. It is demonstrated that avoidance of a cumulative collapse following an adverse external shock depends on

monetary channels of balance of payments remaining open, diminishing returns to capital operate in the short run, and existence of scope for positive inflation tax.

The study treats Latin American countries as one regional economy by aggregating data of individual countries. Principles of aggregating data of individual countries for different types of variables are laid out and the generated data is laid out in terms of an accounting framework. Data series are also projected up to 2000 to provide a long track of 29 years for simulations which follow later.

Original econometric work consists in estimating equations for export volume and prices, which is very much in the tradition of global modelling, and, modelling aggregate investment for the region.

A prototype full macro model is assembled for the Latin American region by using own work and also adopting econometric contributions from others. First, partial model simulations are performed to understand the underlying structural features. Aggregate demand bloc is simulated to reveal the size, plausibility and time pattern of Keynesian multipliers. This reveals a multiplier of 1.6 and a 11 year cycle generated by the multiplier-accelerator process. Aggregate supply bloc is simulated to exhibit the nature of supply response which shows that supply elasticity with respect to real exchange rate is about .2 and it is unkeynesian in the sense that there is little scope for action by inflationary surprises. Trade bloc is simulated to check whether Marshall-Lerner conditions are satisfied. Current account balance does improve upon devaluation with an elasticity of 2, but once prices and output are endogenized very soon the improvements are lost. Then, full model simulations are conducted in open loop mode to study the response of the regional economy to both external and internal shocks. These simulations show sensible and stable outcomes.

Finally the Latin American model is simulated in "closed loop mode" to illustrate the use of the model built for policy analysis. Fiscal and exchange rate policy choices in the face of a negative external shock are investigated. The policy seeks to correct external imbalance. A qualified conclusion is drawn that expenditure cutting works as desired but exchange rate policy sets up severe cycle in current account balance.

CHAPTER 1

INTRODUCTION

1.1 Motivation

The 1980's saw a great surge in the interest of academic and professional economists alike in studying the problem of macro economic management in developing countries. Development economists had already established a persuasive case for outward orientation in development strategy. But opening up and more immediate linking with world which had witnessed monumental change in the integration of world financial and capital markets poses new challenges to macroeconmic management in developing countries, as witnessed in the infamous debt crisis of early 1980's. A rapid transmission of business cycles in OECD to developing countries will call for active demand management in the latter. Stabilizing the current account and domestic output in the face of external shocks to trade volumes, import prices and interest and exchange rates requires a better understanding of the macroeconmic transmission mechanisms in the developing countries. Fiscal and monetary policy reactions in OECD countries (North) in pursuit of their individual or collective interests might impose undesirable externalities on developing countries (South). For a study of these externalities and also an examination of the ways response of South to these shocks may feed back on North (See Kanbur and Vines, 1987 and Molana and Vines, 1988), one requires a study of global economy in terms of a model. For example, tight money policies in North may drive up global interest rates , which might mean higher real interest rates if commodity prices are not buoyant. Then, South may be forced to cut investment in order to adjust to the deterioration current account balances. This decline in productive capacity in commodity producing sectors might reopen inflationary pressures in North. Such key issues which arise in modelling global macroeconmic interactions are discussed in Currie and Vines(1988).

1.2 State of Art

There are more than a dozen global models actively in use as surveyed by Hickman(1983). Only a few of these are macroeconometric models, the rest of them are general equilibrium type or input-output based or hybrids for specific purposes. Among macroeconometric models LINK system is reckoned to be too complicated (has 6000 variables) for insightful policy analysis. Therefore we examine specification of South in only three global macroeconometric models: Multi-region Econometric MODel (MULTIMOD), (Masson *et al* , 1988), Global Econometric Model (GEM) (London Business School (LBS), 1990), and INTERLINK (OECD, 1988). These three models are currently being maintained and improved on a regular basis. The last two of these models feature only trade sector of developing countries for not the accidental reason that the main link between countries has been traditionally trade. Appendix 1A to this chapter provides a detailed comparison of these leading world models MULTIMOD, INTERLINK and GEM, in respect of their specification of developing countries. Here we may briefly note that none of these models at present are concerned with inflation or output effects in South with the exception of MULTIMOD. All the three leave very little scope for policy instruments at the hands of South. There are some differences between these models with respect to the disaggregation of traded goods. MULTIMOD distinguishes exports and imports by three commodity categories unlike the other two which model total exports and imports. Our research effort , though it models only total exports and imports in company with GEM and INTERLINK, seeks to contribute to study of domestic variables in South as well, in ways more comprehensive and different than MULTIMOD.

1.3 Objectives

The task of adding small empirically founded macroeconomic models of developing countries to global models is a huge one. For a start, not only is the theoretical structure of such models is unsettled, but data gaps are daunting. This has to be followed by applied econometric work on essential behavioural relationships in the model. Given the potential complexity of interlinkages simulation studies need to be done to explore and validate model properties in terms of economic theory. In the end, the models are to be inserted into a suitable global model. One obviously requires a team of researchers to work on these issues. This thesis seeks to address all but the last of these issues , but restricts to one LDC region: Latin America. Here, I present work done by me in outlining a theoretical framework, constructing data sets, econometric modelling of *selected* blocks of the model and exploring the model properties and finally applying the model for policy design. What is presented thus is a complete research work, through all its stages, of a stand-alone model of Latin America. It may be mentioned that GEM encapsulating this Latin American model is at present undergoing rigourous tests at London Business School, see LBS (1990,1991).

1.4 An Overview

As stated in the last section this thesis reports research work done sequentially on various stages of building macroeconometric models for developing countries. Accordingly, the chapters that follow describe individually, theory, data, applied econometric work, simulation results and policy analysis.

Chapter 2 sketches a simple theoretical framework with which we describe the underlying macroeconomic structure of developing countries. The central theme through out this chapter is finding the consequences of a negative external shock and how policies might be designed to cope with it. Our specification distinguishes from contemporary research work on macro economic models for developing countries by specifying a richer supply side which incorporates mechanisms for wage pressure, allowing for wealth effects and fully investigating the stability of adjustment processes. The focus is to describe the interactions between the three gaps of current account deficit, excess demand and budget deficit. Outcomes in terms of inflation and output are investigated under three policy regimes of unchanged real exchange rate, an expenditure switching policy and a combined expenditure switching and cutting policy. Time profile of outcomes in the short run, intermediate run and long run are distinguished. In the long run it is established that only severe restriction of government expenditure can prevent inflationary pressures from re-emerging. As regards the stability of the implied adjustment process, it is demonstrated that a cumulative collapse need not follow a negative external shock provided a set of three conditions are met: monetary channels of influence of balance of payments must be open, there are diminishing return to capital in the short run and there is scope for inflation tax.

Chapter 3 deals with the issues in construction of data set required for our study and performance of essential consistency checks in terms of an accounting framework. This remedies the problem of not having a published source of data which can provide all the necessary time series on a regional basis for our work. Choice of countries taken to represent Latin American region is explained first. Then how the short gaps in time series which still remained were filled, is explained and documented. The issue of generating regional or 'area' totals from country level information is described next, for different categories of variables. National accounts data thus assembled for 26 years 1961 to 1985 is barely sufficient for empirical work. If balance of payments of statistics and government accounts were available for the same period, one could have mounted a simulation study over the same period. In the absence of this and our desire to investigate long run stability of our annual model, one way out is to extend the simulation track into future. The methods used to project the model variables up to 2000 and thus provide a 29 year simulation track are described. Finally an accounting framework to lay out variables in a consistent basis is outlined. Besides, some special data construction issues concerning generation of government accounts and capital stock series are taken up in the appendixes to this chapter.

Chapter 4 concerns with the econometric issues of modelling export volume and price equations for Latin America. This is in the received tradition of modelling export volume and price equations in global models. Econometric modelling of dynamic specification uses current error correction framework. We find that export volumes are unit elastic with respect to size of export market and elasticity with respect to relative export price is around 2.5. Export prices are unit elastic with respect to home costs. The short and long run responses to relative price changes accord with a priori expectation and reported work of others. It may be mentioned that the export sector equations taken together with the adopted import volume equations do suggest that Marshall-Lerner conditions are satisfied: a devaluation will go to improve trade balance if output and prices can be held constant.

Chapter 5 assembles a full macroeconometric model for Latin America and mainly examines partial model properties as a means of validation in terms of economic theory. In the end, with a view to provide a measure of overall 'fit' of the model, tracking properties of a dynamic simulation over a estimation period are reported. First there is a brief description equation by equation of key elasticities, short and long run properties and evaluation by econometric criteria. Then, model properties of groups of equations gathered into aggregate demand, aggregate supply and trade sector are probed by means of simulation methods to reveal their short and long run properties. As regards aggregate demand, we find a Keynesian multiplier of about 1.6 which is also echoed in our studies for other developing country regions (not discussed here); private consumption and import functions interact to produce some saw-tooth dynamics which turns into 11 year damping smooth cycles once we include investment function.

On the aggregate supply characteristics, we find that it is very unkeynesian: higher output very quickly requires a higher real exchange rate. A five percent appreciation in real exchange rate will produce a one per cent increase in supply. This supply elasticity of 0.2 is very low compared to what one finds typically in Asia. Trade sector characteristics revealed are that a one percent devaluation will produce a two percent improvement in current account, if output and prices are fixed; once we endogenize the supply side we find that by the sixth year real exchange rate devaluation disappears and so does any improvement to current account.

Chapter 6 reports full model properties under internal and external shocks to Latin American economy. These simulations do not build in automatic policy responses and as such project what may happen if no policy intervention takes place. We investigate the consequences of seven different shocks to the Latin American economy, three of which originate abroad and four internally. The external shocks studied are a slump in export market, an increase in import price and an increase in interest rate. The four domestic shocks considered are a fiscal expansion, an adverse supply shock, devaluation and monetary expansion. The effects of each of these shocks are modelled in a structured way by progressively endogenizing prices and money. The general conclusions that emerges are that the model is well behaved in the sense that it agrees with economic theoretic intuitions. Details on time profile of effects and "ready-reckoners" in the form of effects on output, prices and current account balance are provided for each shock.

Chapter 7 illustrates the use of our empirical model for policy analysis in the context of a negative external shock. Here the objective is limited to the pursuit of one target with one instrument at a time, unlike the theoretical model outlined in Chapter 2, due to software limitations. The efficacy of expenditure cutting and switching policies in pursuit of current account balance target is examined. This is done by means of designing a feed back control rule which alternatively adjusts fiscal expenditure and exchange rate.

1.5 Limitations

There are many limitations that we can recognize which we have been unable to remedy for a variety of reasons. These relate to all four aspects of our study: theory, data, econometric work, empirical policy analysis. The enunciation of these limitations may also be interpreted as scope for further work.

Our theoretical approach presented in Chapter 2 could be extended and modified in useful ways. Analysis presented in terms of our theoretical framework could be extended to include growth issues by adding a target for output; alternative assignment of expenditure switching and cutting could have been done, with further investigation of scope for instability. The framework could be modified to account for some essential complementarities between public and private investment, and, imports and capital formation.

Data base for our modelling has been the best possible given that it came from the World Bank with its huge data gathering resources. But even then, it must be said that government finance statistics time series for most developing countries is too short for sensible econometric investigations. There are discontinuities in statistical methodologies even for a single country over time, leaving aside the vexing problem of non-uniform methods across countries. At the level of individual researcher, there is very little that can be done in this regard. Some countries report financial year data and some calendar year. We have not accounted for this complication in our data construction. It is hoped that in an annual model aggregated over countries this problem would not seriously bias the results. Any 'fix' to this problem will have to arbitrary. To the extent data series are polluted due to these reasons, our results are tentative.

Our econometric methods may not satisfy a purist. We did not attempt simultaneous equation methods to estimate the full model. Apart from the degrees of freedom problem, the useful division of labour in the team could have been compromised for the huge task we had on our hands. Even if one estimates single equations, it perhaps would have been worthwhile to have a pooled cross-section and time series study, which will minimize aggregation biases which might arise due to our prior aggregation of data series. This would have taken more time to do but it would have created practical problems in maintaining the model over time, as in that case the modelling institution will have to maintain all time series on all countries.

The policy analysis presented in the last chapter is sketchy. Here software limitations precluded efficient search of feed-back rules. We could not program control rules with real exchange rate as an instrument to target current account balance; even 'Type -2' fixes (see Wallis *et al* (1987)), which mean that one can fix an endogenous or exogenous variable to track another endogenous variable, could not be attempted. Optimizing procedures by means of which we could have explored the trade-offs in moving instruments with an explicit welfare function could not be attempted for the same reason.

THE SPECIFICATION OF THE SOUTH IN SOME WORLD MODELS

VARIABLE	MULTIMOD	INTERLINK	GEM	OURS
1. Absorption (real)				
1.1. Consumption	Total Consumption (Private & Public) is modelled as an ECM. $C^T = f$ (real NNP, real Debt). Note that Debt is deflated by the absorption deflator.	Not Modelled (N.M.)	N.M.	Private Consumption is modelled as an ECM . $C^P = f$ (real GDP, wealth, terms of trade) short-run influence of inflation too. Public Consumption in exogeneous.
1.2. Investment	Determined as a residual from Gross domestic expenditure identity	N.M.	N.M.	Private Investment is an ECM. Public Investment is a policy variable possibly depending on size of Capital stock and real exchange rates.
2. Exports (real)				
2.1. Commodities	Exports Volume is set equal to demand from industrial economies. Note that industrial economies are assumed not to produce commodities.			
2.2. Oil	Same as for commodities, the only difference is that oil is produced also in the industrial economies.	Total exports (goods & services) are modelled as a function of market growth and price competitiveness.	Total Exports (goods only) is modelled as an ECM; explained by export market growth, ratio of export to import prices and a time trend.	Total Exports (goods & services) is modelled. In phase I of our work it is exogeneous, in phase II it is supply determined.
2.3. Manufacturers	A function of import of manufacture (volume) by industrial economies, Competitiveness of manufacture exports and a time trend.			

VARIABLE	MULTIMOD	INTERLINK	GEM	OURS
3. Imports (real)		Only total imports modelled.	Only total imports modelled.	Only total imports modelled.
3.1. Oil	Share of oil in total imports is exogeneous and this share is applied to the total imports to get oil imports.	Determined as a dynamic function of export revenues adjusted for net transfers. A maximum lag of 2½ lapses between receipt of export revenues and its spending.	An ECM formulation; explained by the sum of export receipts and invisibles deflated by the import prices.	An ECM formulation; a function of Gross domestic expenditure and the real exchange rate.
3.2. Manufactures	Determined as residual after oil imports are subtracted from total imports.			
Imports Total	Value of imports is a residual from current account balance import prices are set as shown below; and therefore Import (real) is set equal to its value divided by its price.			
4. Prices				
4.1. Exports				
4.1.1. Commodities	Market clearing prices are set to balance volume demanded by industrial economies to the supply from developing countries. Supply depends on capital stock. Only how flow equilibrium considered. No interest rate effects. Only one aggregate commodity price index.	Stock equilibrium approach. Four commodity groups (food, minerals & oil, agriculture & raw materials and tropical beverages). Interest rate effects present. ARIMA for expected prices. Reduced form estimated.	An ECM formulation; Food, Agriculture, non-food and metals as sub groups. No interest rate effects. Real prices are modelled. Short-run factors are oil prices and US effective exchange rate; in the long run world industrial production and time trend prevail. Reduced form approach.	RE models with stock equilibrium approach. Ref: Commodity Model Work. Structural form is estimated.
4.1.2. Oil	A function of GNP deflators of industrial economies, i.e. real price of oil is exogoneous.	In constant relation to manufacturing prices.	A rule of thumb links world oil prices to world manufacturing price.	Exogeneous (strategic).

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VARIABLE	MULTIMOD	INTERLINK	GEM	OURS
4.1.3. Manufacturers	A function of real effective rate and domestic capacity exchange utilisation in manufacturing which in turn depends on capital stock.	Price takers; industrial economies' manufacture prices and developing countries' export manufacture prices 'move broadly in line'.	One world price. (Price takers)	Exogeneous (from model of the North).
Total Export Prices	A weighted average of the above	A Weighted average.	1980 weighted average.	Exogeneous in macro models - Commodity prices from Commodity Models - Manufactured prices (?).
4.2 Imports				
4.2.1. Oil	One world price (as for exports)	One world price	One world price	One world price
4.2.2. Manufactures	A function of industrial economies' manufacturing export prices.	Weighted average of suppliers' prices.	One world price of manufactures; a weighted average of price of manufacture exports of ten industrial countries.	One world price. (?)
Total Import Price	A current weighted average as above.	(A weighted average?)	1980 weighted average of oil and non-oil prices.	Exogeneous (comes from model of North).
4.3. Aggregate Price Index for the Domestic Economy	GDP deflator is an implicit one Price of manufactured exports serves as proxy for the price of domestic production. Export prices and price of manufactufing thus fix the price of GDP. A loose equation?	N.M.	N.M.	Inflation is determined by the real exchange rate and capacity utilization index.* Consumer prices are determined as a function import and home prices. [*Ref: similar general specification for advanced countries in MULTIMOD].
4.4 Exchange Rate	Endogenous , but not clear how it is determined.	N.M.	N.M.	A policy reaction function depending on BOP condition. focus is on real exchange rate.
5. Output, Supply				
5.1. Non-tradeables	Change in non-tradeables output is a linear function of change in total consumption.	N.M.	N.M.	Capacity is a function of capital stock in NT sector.

VARIABLES	MULTIMOD	INTERLINK	GEM	OURS
5.2. Exports				
5.2.1. Commodities	As in 2.2.1. and supply is determined by capital stock in commodity production.	Implicit in the reduced from for price determination.		
5.2.2. Oil	As in 2.2.2., Output by non-oil South is a fixed share of all south. Requires no capital.	N.M.	N.M.	
5.2.3. Manufacturing	As in 2.2.3 and note that output and prices are jointly determined by world demand and domestic capacity.	N.M.		As in 2.2.3.
6. Net Factor Income Invisibles	US nominal interest rate is the yield on net foeign Assets (NFA) and NFA is set as: $NFA = NFA_{-1} + \Delta NETDEBT$	Detailed modelling by currency denomination in an investment income block. Proportions of assets in different currencies are assumed. Capable of analysing interest and exchange rate effects.	Invisibles in total, are modelled as a simple average of previous four periods' values.	Exogoneous (or as in GEM?)
7. Net Capital Inflows	Assets and liabilities separately modelled.	Exogoneous	N.M.	Passive in phase I, in phase II interest rate is made endogenous as default risk increases. Default risk is proxied by the debt service ratio.
(ΔNETDEBT)	Δ Assets depend upon export, investment income receipts, new loans; a desired ratio of assets to import ratio is also a factor. Δ Debt is a forward looking variable depending upon export growth prospects for the next 5 years and a debt interest exports.			

VARIABLE	MULTIMOD	INTERLINK	GEM	OURS
	Imports are ratio. (See above) by debt availability.			
8. <u>Investment Allocation Among Domestic Sectors</u>	Assumes that non-traded sector needs no investment. In the primary commodity production sector, investment covers depreciation and increases above this if the price of commodity exports relative to manufacture rises; Investment of manufacturing is residual.	N.M.	N.M.	Policy determined.
9. <u>Stock of Wealth</u>	N.M.	N.M.	N.M.	Wealth consists of physical capital and money stock. Accumulation of physical capital is policy determined as above. Money stock evolves by the government deficit and BOP surplus. While government expenditures are exogeneous, revenues are dependent on the level of activity.

CHAPTER 2

EXTERNAL ADJUSTMENT, INFLATION AND CAPITAL DECUMAULATION

A THEORETICAL FRAMEWORK FOR LDCs

2.1 Introduction

It has become customary to think of the problem of macroeconomic adjustment to an external shock in debt constrained LDCs as requiring a mixture of:-

a. closing the "domestic savings gap";

b. closing the "external savings gap";

c. closing the "government savings gap".

Recent experience in Latin America suggests that this process may cause an unwanted and possibly destabilising reduction in domestic investment.

This chapter explores the interconnections between these four phenomena and seeks to draw out the implications for macroeconomic policy. The aim is to suggest an analytical framework for policy discussion , guide the formulation of the empirical model and help in understanding simulation properties of a more complex empirical model, which is discussed in the rest of the thesis.

In the 1960s, studies of the first two gaps led to a spate of two-gap models in which the involuntary rationing of investment was seen to play a role in the closing of these gaps. Our concern is to extend this well known discussion in two important ways:

i. To show formally how, closing the first two gaps may involve deflation and the loss of output and employment. This is the opposite of "adjustment with growth", and formalises a common Latin American complaint against IMF type adjustment programmes.

ii. To show formally how failure to close the government savings gap may cause the domestic savings gap to continually re-open in a way which generates continuing inflation. This illustrates the view that the Latin American "foreign debt crisis" may in fact be a domestic debt crisis - of the government (cf. Cohen, 1988).

Contemporary research in macroeconomic adjustment in developing countries can be found in Taylor (1989), Haque, *et al* (1990) and Carbo (1989). Our research is distinct in specifying a richer supply side, incorporating wealth effects and exploring dynamics of adjustment. The structure of the model is described in the following section. Although it is simple the model contains several of dynamic processes which if simultaneously interacting would make analysis intractable. Accordingly, in Section 2.3, a short-run solution is presented, on the assumption that inflationary expectations are constant and that slowly changing financial and physical assets are held constant. Then in Section 2.4 an "intermediate run" analysis is presented on the assumption that the financial wealth effects are allowed for. In Section 2.5 issue of longer-run adjustment of capital is considered. The focus for comparative exercises is an adverse shock to the export potential. Under each section we consider the effects of three alternative policies: a constant real exchange rate policy, an expenditure switching policy which seeks to correct external imbalance, and, an expenditure switching and cutting policy which corrects both the external and internal imbalances. Dynamic stability properties of the model also are investigated in each of these sections.

2.2 Sketch of the Analytical Model

We make a number of simplifications in setting out the model. We have a one sector model with particular features that relate the model to highly inflationary Latin American economies. The real exchange rate, which is defined as the ratio of import prices to home prices both measured in local currency, is treated as a policy instrument. This would imply that the nominal exchange rate is indexed to domestic output prices , thus, managed as a crawling peg. Similarly real interest rate is also treated as an instrument in the hands of government, which requires that nominal interest rate is indexed to compensate for domestic price inflation. The model could be extended in the direction of the currency substitution along the lines of Calvo and Rodriguez (1977) and exchange rate crises literature as discussed in Flood and Garber (1984), but this is not done, in line with our inability to model capital flight in our empirical model.

In setting out the model, a number of empirical assumptions are also made about relative parameter values. These require to be verified in empirical work, presenting a number of important checks to be carried out at estimation stage deriving from the theoretical analysis of the model's overall structure. To formulate such restrictions constitutes a major part of the reason for this preliminary analytic investigation.

The model equations are set out as linear relationships; the variables must be interpreted as small deviations around equilibrium values with the parameters being the appropriate first partial derivatives. Thus while we perform comparative static exercises and examine dynamic stability, we assume the existence of an equilibrium. While presenting comparative static results, standard notations of calculus are used for expository convenience. Also, we talk only about local stability around initial equilibrium values, as model specification is to be understood as linearized version of more complex functional forms. The comparative static properties of the model are evaluated only with reference to a shock in export market potential to focus on external adjustment issues.

Variable Definitions

y : real gdp (volume measure)

c : real private consumption

j : real investment

g : real government consumption

x : real exports

m : real imports

a : real asset holdings of private sector

k : real capital stock

z : real foreign reserves in foreign currency

f : real foreign aid, in foreign currency

t : tax rate

θ = : real exchange rate, ratio of foreign to home prices

π = rate of inflation (of domestic output prices, p)

r : real home interest rate

r* : real foreign interest rate

s : export market potential

q : real external debt service

b : real internal debt of government

clg: real central bank lending to government

m_b : real base money

Aggregate Demand

$$y = c + j + g + x - m \tag{2.1}$$

$$c = \gamma_1 (1 - t)[y + \alpha r a)] + \gamma_2 a - \gamma_3 \theta \tag{2.2}$$

$$j = \xi_1 (y - k) - \xi_2 r \tag{2.3}$$

$$x = \chi_1 s + \chi_2 \theta \quad (2.4)$$

$$m = \mu_1 y - \mu_2 \theta \quad (2.5)$$

Equation 2.1 shows the components of demand for output in real terms.

Equation (2.2) shows real consumption expenditures as influenced by post tax income(which includes real interest receipts on bonds), real wealth and real exchange rate. This specification is closer to life cycle theories of consumption, but backward looking. The term in real wealth is limited in scope to real money as in LDCs we conjecture that few competing financial assets to money can be found and data deficiencies rule out accounting of personal sector physical wealth. Real exchange rate depreciation has a negative effect on private consumption through the channel of any deterioration in terms of trade.

Equation (2.3) shows investment as a partial adjustment process of actual capital stock adjusting to a desired capital to output ratio which depends on the real interest rate. This specification is neo-classical in spirit. For simplicity in the algebraic model, we assume a desired capital to output ratio of unity at the initial interest rate (although this is not assumed in the empirical model).

Equations (2.4) and (2.5) are standard export and import functions in volume terms popular in empirical trade literature. Export volumes depend on market potential and real exchange rate. This can mean either that export supply is perfectly elastic or that we are looking at a reduced form specification. Imports depend upon incomes and real exchange rate. Common to both export and import volume equations is the belief that the economy that we model is too small to affect its terms of trade.

These five equations may be solved to show output as a positive function of government spending, real assets, which stimulate consumption, and of the real exchange rate, which stimulates net exports. Also an increase in the rate of interest or in the existing capital stock depresses investment and so output. This solution will be performed explicitly in the next section.

Aggregate Supply

$$y^s = \psi_1 k - \psi_2 \theta \tag{2.6}$$

$$\pi = \rho(y - y^s) + \pi^e \tag{2.7}$$

$$\dot{\pi}^e = \phi(\pi - \pi^e) \tag{2.8}$$

This is a reduced form of a wage price process with four features.

i) Aggregate supply equation is derivable from a restricted cost function of a representative firm operating with fixed capital stock and imported raw material costs. For a given capital stock and labour force, the supply of output can only be increased by an appreciation of the real exchange rate which cheapens imported raw material costs and hence improves profitability (Equation 2.6).

ii) The economy has an underlying core or expected inflation π^e, which workers write into their contracts. It is postulated that this core inflation can be made a backward looking average of divergence between actual and core inflation rates in the past (Equation 2.8).

iii) For a given real exchange rate, θ, and for a given capital stock, k - and thus a given supply y^s - output can only be increased as a result of unanticipated inflation (Equation 2.7).

iv) Using equations (2.6) - (2.8) we can see that, in the face of excess demand, inflation accelerates.

Balance of Payments

$$\dot{z} = (\chi_2 + \mu_2)\theta - \mu_1 y + \chi_1 s + f - q + r^* z \tag{2.9}$$

This equation shows the evolution of foreign reserves. This depends upon the trade balance, which we have expressed in terms of the real exchange rate and output, debt service payments and interest receipts on reserves. In what follows we will assume that availability of new borrowing from abroad is fixed and therefore any payment deficit is financed by drawing down on reserves.

Note that

$$\chi_2 + \mu_2 > 0$$

corresponds to the version of the Marshall Lerner condition appropriate for this model, which holds. In what follows we define

$$\sigma = \chi_2 + \mu_2$$

Monetary Sector and Government's Budget Constraint

A simplified balance sheet of the central bank is:

$$\dot{M}_b + \dot{GD} = \dot{CLG} + \dot{Z} \qquad (i)$$

where M_b is the monetary base which, in the absence of a banking system assumed for simplicity, also is the money stock held by private sector, GD is the government deposits with the central bank, CLG is the central bank lending to the government and Z is the stock of foreign reserves.

Government's overall expenditure consists of consumption expenditure, interest payments on outstanding bonds and debt service on foreign debt. Government revenues are derived from taxing private income. We assume for simplicity that all foreign debt is owned and serviced by the government; home debt, B, is perpetually rolled over; and all foreign unilateral transfers accrue to government. Any government deficit is financed by issuing currency (borrowing from central bank), or home debt.

Letting upper case letters give nominal magnitudes, the government's budget constraint is:

$$\frac{C\dot{L}G + \dot{B}}{P} = g + (r+\pi)b + q - f - t[y + (r+\pi)b] - r^{*}z \tag{ii}$$

Money Holdings of the Private Sector

By setting change in government deposits to zero in (i), we derive:

$$\dot{M}_b = C\dot{L}G + \dot{Z} \tag{iii}$$

By substituting for CLG from equation (iii) and Z from equation (2.9), and writing in real terms, we get

$$\frac{\dot{M}_b}{P} = g + (r+\pi)b - t[y + (r+\pi)b] - \frac{\dot{B}}{P} - \mu_1 y + X_1 s + \sigma\theta \tag{iv}$$

Private Sector Real Wealth

Private sector wealth consists of money and bonds, in incremental terms:

$$\frac{\dot{A}}{P} = \frac{\dot{M}_b}{P} + \frac{\dot{B}}{P} \qquad (v)$$

Using equation (iv) above, we get:

$$\frac{\dot{A}}{P} = g + (r+\pi)b - t[y + (r+\pi)b] - \mu_1 y + X_1 s + \sigma\theta \qquad (vi)$$

Thus we see in equation (vi) that, private financial wealth increases whenever government's expenditure in the domestic market exceeds its revenue receipts from the domestic private sector and when there is a trade surplus vis a vis the rest of the world.

Noting that

$$\dot{a} = \frac{\dot{A}}{P} - a\pi$$

and assuming that a constant proportion α of real wealth ,a, is held as indexed bonds and initially there is no inflation for simplicity, we can write down the following equation for the evolution of private sector real wealth.

$$\dot{a} = g + \alpha r(1-t)a - (t+\mu_1)y + \chi_1 s + \sigma\theta - a_0[1-\alpha(1-t)]\pi \qquad (2.10)$$

Evolution of Physical Capital

$$\dot{k} = \gamma_1(y-k) - \gamma_2 r \qquad (2.11)$$

This equation repeats the investment equation as a capital stock evolution equation. We abstract here from depreciation (although the empirical model does not).

Thus we have a set of 11 equations (2.1 to 2.11) in 17 unknowns. Policy instruments available are four: g, r, t and θ . Predetermined variables are two: s and f. Therefore we can solve for the remaining 11 unknowns:

$y, y^s, c, j, x, m, \pi, \pi^e, a, k, and\ \dot{z}$

2.3 The Short Run

We now consider the determination of output and inflation in the short run, for given values of the exogenous variables, for given values of the state variables (inflationary expectations, π^e real assets, a, capital, k, and foreign debt z) and for given values of the policy instruments (the real interest rate, r, the real exchange rate, θ , government expenditure, g, and the tax rate, t). We also set $\phi \to 0$.

We begin by determining the short run level of output. From equations (2.1) to (2.5) to give

$$y = \gamma_1(1-t)[y + \alpha r a] + \gamma_2 a - \gamma_3 \theta + \xi_1 y - \xi_1 k - \xi_2 r$$
$$+ g + \chi_1 s + \chi_2 \theta - \mu_1 y + \mu_2 \theta \qquad (2.12)$$

Linearizing the gross interest receipts term ra as $a_0 r$ and $r_0 a$, and ignoring the second term as being insignificant in linearization because the variables are already in deviation from equilibrium form (additions to asset stocks are treated as small relative to changes to interest rates) enables us to write:

$$y = \lambda\{\gamma_2 a - \xi_1 k - [\xi_2 - \gamma_1(1-t)\alpha a_0]r + \bar{g} + \chi_1 s + (\chi_2 + \mu_2 - \gamma_3)\theta + f\} \qquad (2.13)$$

where

$\lambda = 1/[1 - \gamma_1(1-t) - \xi_1 + \mu_1]$

is the Keynesian multiplier, which we assume to be positive.

Equation (2.13) shows demand for output as a function of exogenous variables, state variables and policy instruments, through the operation of the Keynesian multiplier, λ . A depreciation of the real exchange rate increases output if $\chi_2 + \mu_2 - \gamma_3 > 0$, which we assume to be the case. This assumption means that real income loss due to real depreciation is outweighed by beneficial stimulus on output of increase in net exports.

Figure 2.1 shows this short run determination of output at y_0 , for a given real exchange rate θ_0 and a given rate of core inflation. We call this locus yy. A reduction in foreign demand for exports, i.e. a fall in s, shifts the yy line to the left and lowers output. The same is true of a reduction in government spending or an increase in the real interest rate.

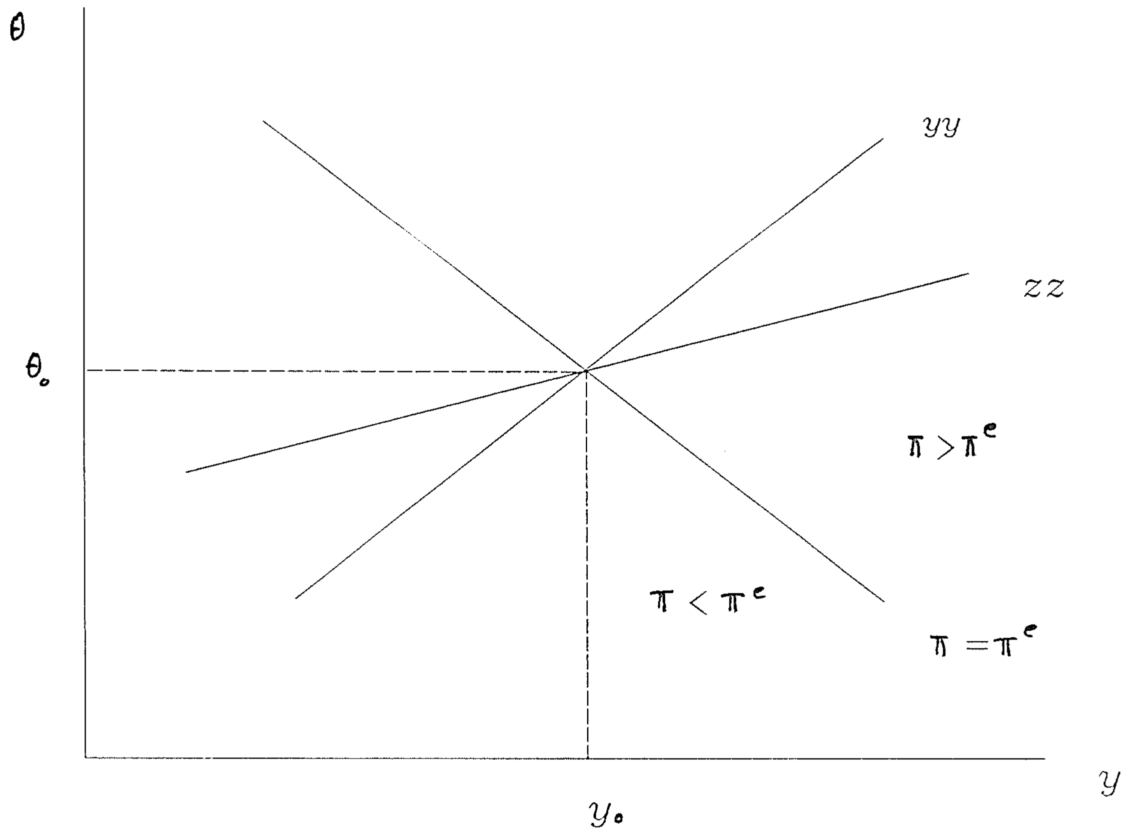


Figure 2.1

Output and Real Exchange Rate in the Short Run

Next we solve for inflation in the short run. Setting $\phi \to 0$ in equation (2.8) and using (2.7) we have

$$\pi = \pi^e + \rho[y - \psi_1 k + \psi_2 \theta] \qquad (2.14)$$

This equation shows inflation as a function of output (which we have determined above), the state variables π^e and k, and the policy instrument θ. It is also depicted in Figure 2.1. We depict along $\pi\pi$ combinations of y and θ compatible with some reference value of inflation π^e. To the right of the π-π line, $\pi > \pi^e$ and vice versa.

An increase in the policy variable g, or a reduction r or t will increase π because these changes increase y. An increase in θ (a devaluation of the real exchange rate) will increase π both because aggregate demand rises and aggregate supply shrinks because the depreciation of the real exchange rate increase imported input costs.

Suppose that there are two objectives of policy. The first, we call "external balance", and corresponds to the evolution of external indebtedness at a desired rate - i.e. an outcome in which $\dot{z}$ is no greater than or no less than this particular value.

The second we call internal balance and corresponds to inflation taking place at a particular desired target rate.

We assume that policy is adjusted so as to always exactly achieve its targets immediately, i.e. in the short run. We do not believe that policy is actually conducted in this way. The purpose of this exercise is pedagogical. We wish to show how, used this way, the model achieves the results which are familiar from the literature. An alternative description of policy is pursued later.

From equation (2.10) we may determine a locus for external balance. We take as given two key exogenous influences: the extent of foreign aid and the scale effect in the foreign demand schedule for exports. We also take as given debt interest payments - a function of the predetermined debt stock and interest rates: we do not consider options of debt default or partial servicing.

Given the desired accumulation of foreign reserves $\dot{z}^*$ which may or may not be $\dot{z}=0$, , we have an external balance locus, zz.

$$\theta=[\mu_1 y-\chi_1 s-f-r^* z+\dot{z}^*]/\sigma \tag{2.15}$$

The locus is upward sloping as shown in Figure 2.1.

We may prove that the external balance locus is flatter than the output determination locus yy in $y\theta$ space. We have, from (2.13) that

$$\frac{dy}{d\theta}\Big|_{yy}=(\sigma-\gamma_3)\lambda$$

whereas from (2.15)

$$\frac{dy}{d\theta}\Big|_{z=z^*}=\sigma/\mu_1$$

We need to show that

$$\frac{dy}{d\theta}\Big|_{yy} < \frac{dy}{d\theta}\Big|_{zz}$$

After substituting for λ from the expression below equation 2.13, we may rewrite this as

$$-\mu_1\gamma_3 < \sigma[1-\gamma_1(1-t)-\xi_1]$$

Since it is reasonable to suppose that the closed economy multiplier:

$$\frac{1}{[1-\gamma_1(1-t)-\xi_1]}$$

is positive, it follows hat the zz locus is flatter than the yy locus. To the right of this locus balance of payments is in deficit and to the left it is in surplus. Figure 2.1 is drawn so that initially, before any negative external shock, external balance is achieved at $y_o\theta_o$. The figure is also drawn on the assumption that, at the initial level of the exchange rate, θ_0, the rate of inflation is exactly equal both to expected inflation and to desired inflation π^* . The initial equilibrium before the adverse external shock arrive is shown as point A in Figure 2.1.

For short run comparative static analysis we need to confine our attention to essentially three equations: 2.13 to 2.15.

Effects of a Constant Real Exchange Rate Policy

Now let foreign demand for exports, s fall permanently. From equations (2.13) and (2.15), we can deduce that this shifts yy and zz upwards. The locus yy shifts up because for any given level of output, the slump in demand for exports has to be made good by a more depreciated real exchange rate which will stimulate exports and boost domestic demand by import substitution. For analogous reasons, zz locus also shifts up as a more depreciated real exchange rate is required at every level of output to maintain external balance. These shifts are displayed in Figure 2.2.

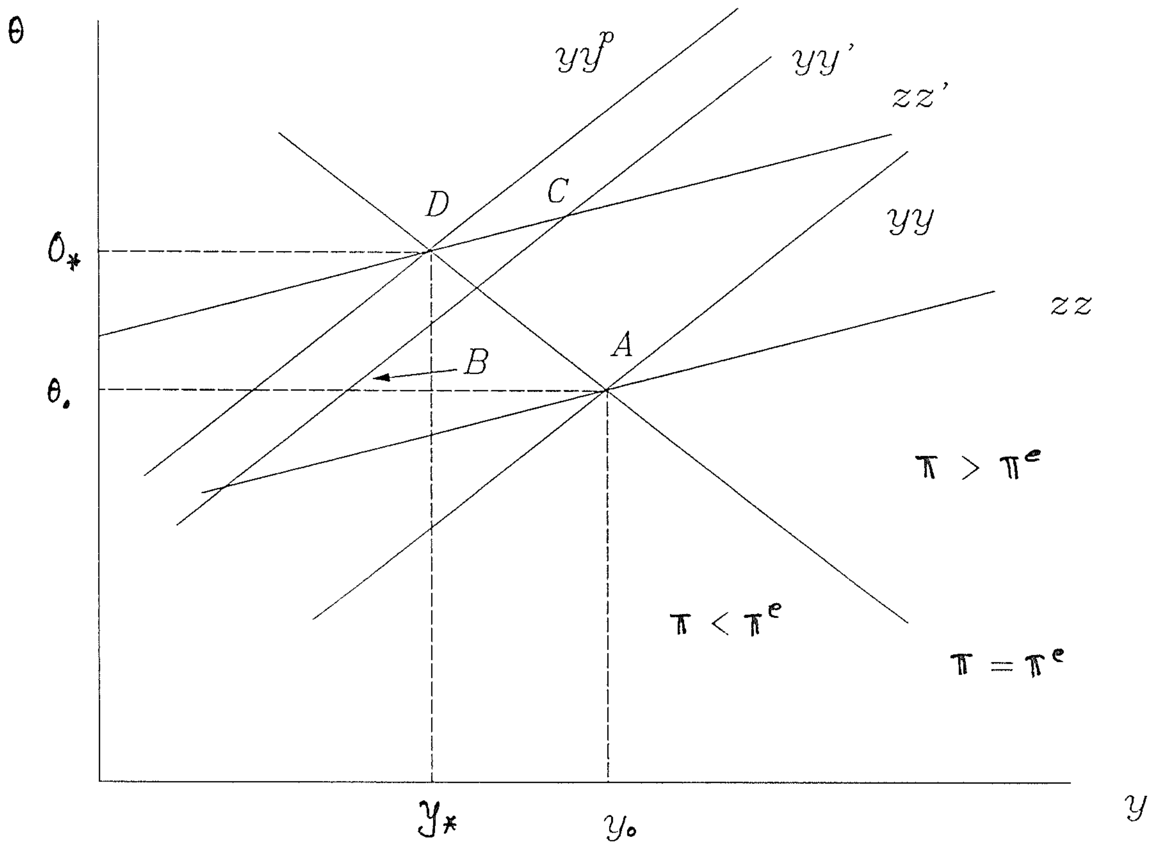


Figure 2.2

Coping with Negative External Shock in the Short Run

With an unchanged real exchange rate policy, the economy will be at point B as shown in Figure 2.2. This will result in a continuing loss of foreign reserves (we are to the right of the new zz locus), lower output (we are to the left of the old yy line) and lower inflation (we are to the left of $\pi - \pi$ locus. Inflation is lower because demand pressure is less.

Formally, we solve the following three equations:

$$dy = \lambda \chi_1 ds$$

$$d\pi = \rho dy$$

$$d\dot{z} = -\mu_1 dy - \chi_1 ds$$

The comparative static results are:

$$\frac{dy}{ds} = \lambda \chi_1 > 0$$

$$\frac{d\pi}{ds} = \lambda \chi_1 > 0$$

$$\frac{d\dot{z}}{ds} = (1 - \lambda \mu_1)\chi_1 > 0$$

It must be noted that (here and in discussion to follow), with a negative external shock, s falls and so all comparative static signs are reversed.

Effects of an Expenditure Switching Policy

Now we suppose that we want to preserve external balance by depreciating the real exchange rate. The new yy and zz lines intersect to the right of their previous position at point C. A more depreciated real exchange rate $\theta = \theta_1$ is observed. As drawn inflation increases since we are now shown to be to the right of the $\pi = \pi^*$ line. In predicting that inflation will increase we have assumed that the contractionary effect on consumption of depreciation of real exchange rate (γ_3) is small relative to its contractionary effect on aggregate supply. This assumption , which is applicable to our discussion in the next section too , is reasonable in the light of the fact that the proportion of imported goods in production is likely to be higher than in final private consumption in developing countries.

When compared with unchanged real exchange rate policy, now we find that output has recovered somewhat, but still less than the pre-shock situation, due to negative inflation effects on aggregate demand. Though external balance has been achieved by real exchange rate depreciation we find that inflation is higher. In terms of Figure 2.2 the effects of this switching policy are depicted at point C.

Analytically, we solve for the following three equation:

$$\begin{bmatrix} 1 & -\lambda(\sigma-\gamma_3) & 0 \\ -\mu_1/\sigma & 1 & 0 \\ -\rho & \rho\psi_2 & 1 \end{bmatrix} \begin{bmatrix} dy \\ d\theta \\ d\pi \end{bmatrix} = \begin{bmatrix} \lambda\chi_1 \\ -1/\sigma\chi_1 \\ 0 \end{bmatrix} ds$$

The comparative static results are:

$$\frac{dy}{ds} = \frac{\lambda\gamma_3\chi_1}{\Delta} > 0$$

$$\frac{d\theta}{ds} = -\frac{\chi_1[(1-\lambda\mu_1)/\sigma]}{\Delta} < 0$$

$$\frac{d\pi}{ds} = -\frac{\chi_1\rho[\psi_2(1-\lambda\mu_1)-\lambda\gamma_3]}{\Delta} < 0$$

where,

$$\Delta = [(1-\lambda\mu_1(1-\gamma_3/\sigma))] > 0$$

Effects of an Expenditure Switching and Cutting Policy

The policy problem in the short run context is thus clearly explained. The real depreciation which would correct the external deficit is not consistent with the maintenance of inflation at its desired level. Figure 2.2 shows clearly that expenditure switching policy of raising θ above θ_o to correct the deficit $\pi > \pi^e$. As a result, a measure of expenditure reduction is necessary along with the expenditure switching caused by the depreciation, to ensure that the desired inflation rate $\pi = \pi^e$ is maintained. Such an outcome is depicted in the Figure 2.2 , through the shift of yy', by policy, to yy^p. External balance and the desired real exchange rate are regained at y^*, θ^*. shown as point D in Figure 2.2.

The required expenditure-reducing policy could involve either monetary contraction (an increase in real interest rates) or fiscal contraction. Here we solve for the outcomes assuming that fiscal contraction is used.

We use equations 2.13 to 2.15 with the proviso that the change in inflation should be zero which is achieved by cutting government expenditure. We have the following system of three equations.

$$\begin{bmatrix} 1 & -\lambda(\sigma-\gamma_3) & -\lambda \\ 1 & \psi_2 & 0 \\ -\mu_1/\sigma & 1 & 0 \end{bmatrix} \begin{bmatrix} dy \\ d\theta \\ dg \end{bmatrix} = \begin{bmatrix} \lambda\chi_1 \\ 0 \\ -\chi_1/\sigma \end{bmatrix} ds$$

The comparative static results are:

$$\frac{dy}{ds} = \frac{\chi_1 \psi_2}{(\sigma + \mu_1 \psi_2)} > 0$$

$$\frac{d\theta}{ds} = -\frac{\chi_1}{(\sigma + \mu_1 \psi_2)} < 0$$

$$\frac{dg}{ds} = \frac{\chi_1 [\psi_2 (1 - \mu_1 \lambda) - \lambda \gamma_3]}{(\mu_1 \psi_2 + \sigma)\lambda} > 0$$

How do the output and real exchange rate movements compare under "switching and cutting" compare with "switching only" ? Under a negative external shock and a switching and cutting policy which seeks to preserve external and internal balance, we can show using the comparative static results presented above that , output is more depressed because, to prevent inflation, demand has to be brought in line with supply and the real exchange rate is less depreciated (point D is to the south west of point C in Figure 2.2) because government expenditure cuts reduce the work for the instrument of depreciation to align demand with external balance.

All of this is well known. (See for example, Corden (1988)). Problems within this short run framework include the following:-

i) The Marshall Lerner conditions may not hold by much, i.e. σ may be small, meaning that a large real depreciation may be required.

ii) The effects of this real depreciation on inflation may be great so that ψ_2 is large, and the $\pi = \pi^e$ line is quite flat. As a result a large fall in real output may be needed to contain the inflationary pressure resulting from depreciation.

2.4 The Intermediate Run

We now move on to consider intermediate run dynamics caused by the accumulation of financial assets by the private sector. We also postulate that in the intermediate run private agents do not make expectational errors in anticipating inflation. That is we set $\phi \to \infty$ in equation 2.8. This is in accord with the relative speeds of adjustment in our empirical model. (In this chapter we do not examine outcome under constant nominal assets or nominal exchange rates as done in the simulations). For deriving comparative static properties, we need to look at the dynamic variables assets, a , and inflation, π , when they have reached their equilibrium.

As before we will investigate comparative static results under alternative policy regimes: constant real exchange rate, a switching policy to maintain external balance and a switching and cutting policy which maintains both external and internal balances.

The Determination of Output and Inflation in the Intermediate Run

In the intermediate run equilibrium, $\pi = \pi^e$ and so output is given from the supply side of the model, using equations (2.7) and (2.8) as

$$y = \psi_1 k - \psi_2 \theta \tag{2.16}$$

But we must now consider the determination of demand in equation (2.13). For given values of the exogenous variables and policy instruments, if output is to equal, and to continue at, a level equal to that given by supply in (2.14), this implies that real financial assets must be such that

$$a = \{y/\lambda + \xi_1 k + [\xi_2 - \alpha a_0(1-t)]r - g - \chi_1 s - (\sigma - \gamma_3)\theta\}/\gamma_2$$

Real financial assets must adjust via price flexibility to make demand just equal to supply. This also implies, in the absence of other changes, that $\dot{a} = 0$.

Now consider the evolution of real financial assets held by the private sector, as shown in equation (2.10). This is

$$\dot{a} = g + \alpha a_0(1-t)r - (t+\mu_1)y + \chi_1 s + \sigma\theta - a_0[1-\alpha(1-t)]\pi \tag{2.10}$$

Now we require that $\dot{a} = 0$. But output y is determined by supply conditions as in (2.14) and so for a given value of θ, we obtain the result that

$$\pi = \{g + \alpha a_0(1-t)r - (t+\mu_1)y + \chi_1 s + \sigma\theta\}/a_0[1-\alpha(1-t)] \tag{2.17}$$

This has a simple interpretation. The budget deficit and current account surplus inject financial assets into the system. By contrast inflation erodes the real value of financial assets. But real assets must not change over time - since demand must not change over time. Thus the rate of inflation must be just such as to give an inflation tax which ensures that these two factors cancel.

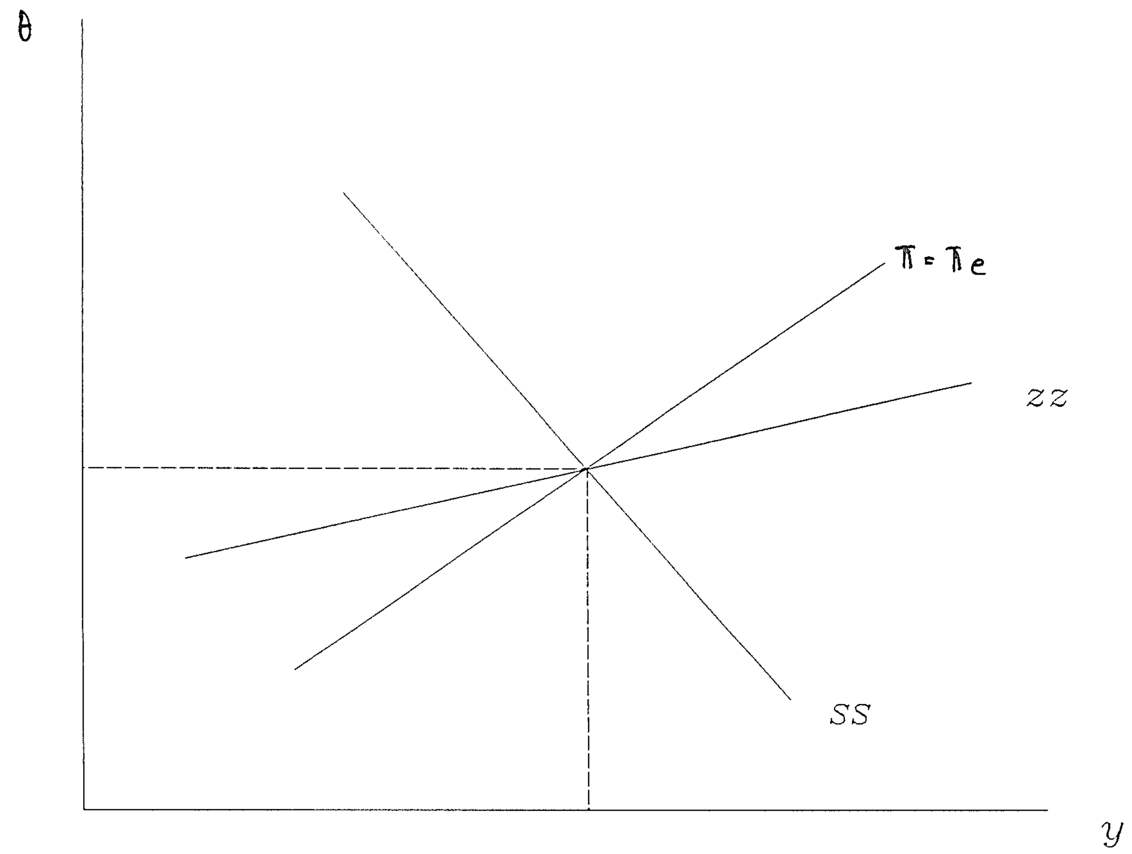


Figure 2.3

Output and Real Exchange Rate in the Intermediate Run

Figure 2.4 illustrates. The ss line now shows supply of output, and is derived from equation (2.16). (It contrasts with yy in Figure 2.1 which showed demand for output.) The larger is θ the smaller is y, because of the effects, already discussed, of a lower profitability. Inflation determination is also described, using equation (2.17). It is clear that a depreciation of the real exchange rate causes a higher rate of inflation. This is because it both increases the supply of financial assets, by increasing the current account surplus, and reduces the level of output supplied, thus increasing the budget deficit. A larger inflation tax thus emerges to equate demand to supply. We plot a locus for a reference level of inflation π^e This slopes *upwards* because a depreciated real exchange rate increases the current account surplus; this requires (if inflation is not to increase) a smaller budget deficit which, if g and t are given requires a *higher* level of output. It is now the case that to the right of the π^e line $\pi < \pi^e$ and above it $\pi > \pi^e$.

We also may plot in Figure 2.3 the same external balance schedule used in Section 2.3. This is derived from equation (2.15) and depicted as zz. It shows combinations of the real exchange rate and output consistent with external balance. The zz locus is flatter than the π_R locus, since from (2.17)

$$\frac{dy}{d\theta}\Big|_{\pi=\pi_R} = \frac{\sigma}{(t+\mu_1)}$$

whereas from equation (2.15)

$$\frac{dy}{d\theta}\Big|_{\dot{z}=\dot{z}^*} = \frac{\sigma}{\mu_1}$$

The intersection of zz and ss shows the determination of output such that the external balance objective is satisfied. We have drawn the figure such that at the initial level of the real exchange rate, $\theta = \theta_o$, and the initial level of output, $y = y_o$, both external balance and inflation are achieved.

Stability Analysis in the Intermediate Run

We can now investigate convergence to intermediate run equilibrium. The two dynamic variables in the intermediate run: real assets and inflationary expectations. We derive the dynamic equations by substituting for output (2.13) and inflation (2.7) in the equations for the evolution of real assets (2.10) and inflationary expectations (2.8). We obtain the following second order simultaneous differential equation system after some manipulations.

$$\begin{bmatrix} \dot{a} \\ \dot{\pi}^e \end{bmatrix} = \begin{bmatrix} -\zeta_{11} & -\zeta_{12} \\ \zeta_{21} & 0 \end{bmatrix} \begin{bmatrix} a \\ \pi^e \end{bmatrix} + constants$$

where,

$\zeta_{11}=(t+\mu_1)\lambda\gamma_2$ $\zeta_{12}=a_0[1-\alpha(1-t)]$

$\zeta_{21}=\rho\phi\lambda\gamma_2$

The trace of the transition matrix is negative. A sufficient condition for stability is that ζ_{12} is positive so that the determinant of the transition matrix is positive. To see the economic interpretation of this sufficient condition for stability, we need to look at the terms constituting ζ_{12}. On the one hand, inflation erodes the real value of financial assets by an amount $a_0\pi$. On the other hand inflation entails real interest payments on home debt by the amount $\alpha a_0(1-t)$. For stability we require that the first effect dominates the second such that inflation can transfer real resources to government. Figure 2.4 shows the phase diagram for the two dynamic variables π^e and a in the intermediate run.

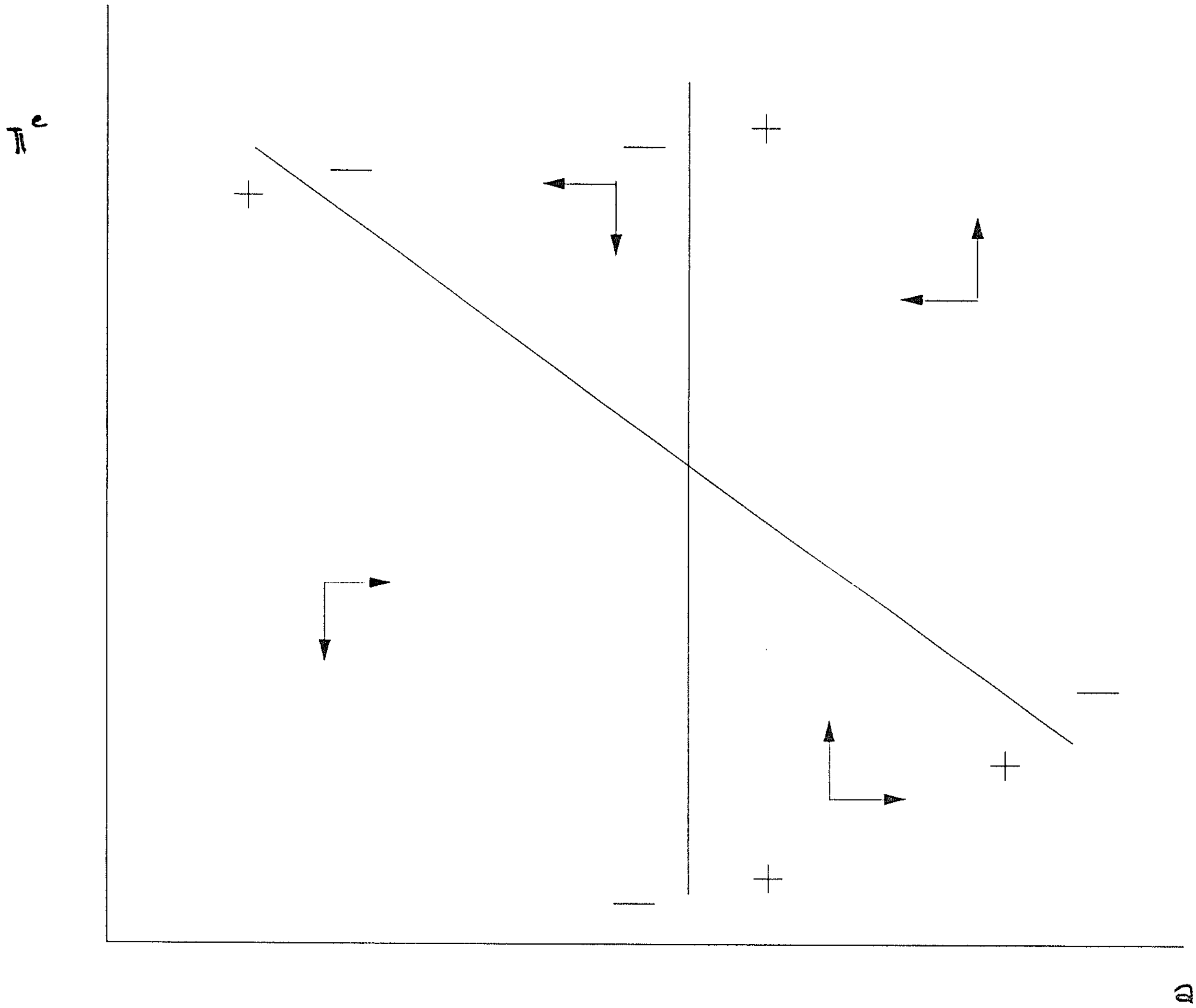


Figure 2.4

Stability Analysis in the Intermediate Run

Now consider the same negative external shock discussed in Section 2.3. Figure 2.5 shows consequences of and policy responses to the negative external shock.

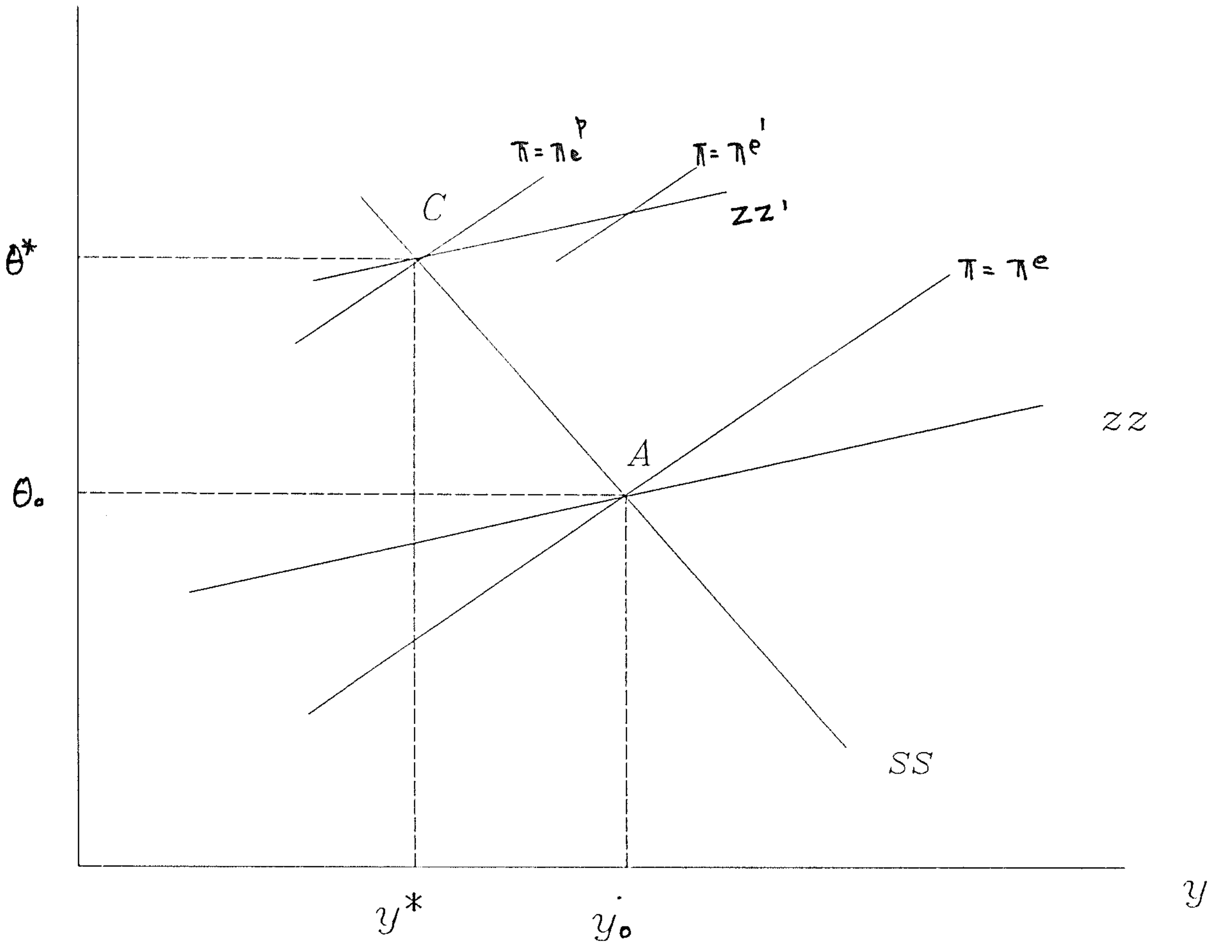


Figure 2.5

Coping with Negative External Shock in the Intermediate Run

As before this shifts the zz line upwards to zz'. It also shifts the π^e line upwards to π_1^e by exactly the same amount.

This is because a depreciation of the real exchange rate which would restore external balance would also leave the injection of real financial assets exactly unaltered. Formally, the external balance schedule shifts up , at a given y, by

$d\theta = \chi_1/\sigma > 0$

But from (2.17) this change in θ would give

$d\pi = -\chi_1 ds + \sigma d\theta = 0$

It is easy to see that under constant real exchange rate policy output does not change, because it is set by productive capacity. Inflation falls because to maintain the pre-shock level of output with a slump in export market requires a boost to demand which is achieved by a higher real wealth, requiring a lower inflation tax. Note however, that balance of payments gap emerges and reserves begin to fall. This can be seen in terms of Figure 2.5 that the old equilibrium point A now lies to the south east of both the new zz and $\pi - \pi$ locus.

Formally we can write the comparative static results a follows.

$$\frac{dy}{ds} = 0$$

$$\frac{d\pi}{ds} = \frac{\chi_1}{[a_0 - b_0(1-t)]} > 0$$

$$\frac{d\dot{z}}{ds} = \chi_1 > 0$$

Effects of an Expenditure Switching policy

Restoration of external balance requires a depreciation of the real exchange rate. In terms of Figure 2.5, we move to point C from A. Inflation definitely *rises* (we are to the right of new $\pi-\pi$ line). This is a consequence of the fact that output falls as supply shrinks with a depreciation in real exchange rate and the attendant opening of budget deficit gap injects extra financial assets into the system.

Formally, the outcomes are found by solving the following three equations.

$$\begin{bmatrix} 1 & -\sigma/(t+\mu_1) & a_0^*/(t+\mu_1) \\ -\mu_1/\sigma & 1 & 0 \\ 1 & \psi_2 & 0 \end{bmatrix} \begin{bmatrix} dy \\ d\theta \\ d\pi \end{bmatrix} = \begin{bmatrix} \chi_1/(t+\mu_1) \\ -\chi_1/\sigma \\ 0 \end{bmatrix} ds$$

The comparative static results are:

$$\frac{dy}{ds} = \frac{\chi_1 \psi_2}{(\sigma+\mu_1\psi_2)} > 0$$

$$\frac{d\theta}{ds} = -\frac{\chi_1}{(\sigma+\mu_1\psi_2)} < 0$$

$$\frac{d\pi}{ds} = -\frac{\chi_1 \psi_2 t}{a_0^*(\sigma+\mu_1\psi_2)} < 0$$

where,

$$a_0^* = a_0[1-\alpha(1-t)]$$

These are the same changes in the real exchange rate and in output which would have achieved external and internal balance in the short-run. That is they would have closed the foreign savings gap and the domestic savings gap. But they do not close the government "savings gap"; because output falls a budget deficit opens up. As a result the inflation rate increases.

Effects of an Expenditure Switching and Cutting Policy

Suppose that the initial reference inflation level π^e is also the desired inflation level, and that it is desired to prevent an increase in inflation. To avoid this increase in intermediate run inflation, something must be done to close the budget deficit just discussed. From equation (2.17) a reduction in government spending would shift the π_1^e line to the left, closing the public sector savings gap and lowering inflation back on target as required.

It is straightforward to solve from (2.15) to (2.17) for the reduction in g which would be required

$$\frac{dg}{ds} = \frac{\chi_1 \psi_2 t}{(\sigma + \mu_1 \psi_2)} > 0$$

Note that comparative static results for output and real exchange rates remain unchanged as in the expenditure switching policy, as output continues to be governed by the supply side and the associated potential balance of payments deficit also remains to be the same as under the expenditure switching policy.

Notice that the above analysis abstracts from the endogeneity of the proportion, α, of private sector assets bearing a real interest rate indexed to inflation. One would expect that $d\alpha/d\pi > 0$. But this effect would only increase the potential instability. The analysis also abstracts from two potentially destabilising effects: the Cagan effect the Oliviera Tanzi effect. Cagan effect indicates that if the authorities do not index interest rates to inflation, inflation will start a "flight into goods". Tanzi effect can lead to instability in that an increase in the inflation rate may reduce the effective tax rate if taxes are not indexed sufficiently rapidly to inflation. These effects and endogeneity of decision to hold bonds will contribute to instability because they might curb the capacity of government to obtain positive inflation tax.

It is worth now drawing attention to the difference between the short run and the intermediate run outcomes of our policy experiments. In the short run external adjustment is obtained and inflation is prevented by a combination of devaluation and demand policy (fiscal or monetary) to bring demand into line with a reduced supply. In the intermediate run demand has already been brought into line with the reduced supply by inflation, but fiscal adjustment is necessary to prevent inflation by ensuring that there is no deficit at the new lower level of output. When we turn to the longer run we see that the reduction of output will lead to a decumulation of capital, a further reduction in supply and hence further pressure on inflation.

2.5 The Long Run

We now consider the longer run effects of capital accumulation upon supply. The basic idea is to trace out the implications of the fact that as output falls the capital stock will fall, which further reduces output, possibly in a cumulatively unstable process.

Consider again the supply side of the model. We have from (2.6)

$$y = \psi_1 k - \psi_2 \theta$$

and also from (2.11)

$$\dot{k} = \xi_1 (y - k) - \xi_2 r$$

For a given real rate of interest, and given real exchange rate, this gives a capital accumulation process which may be written as

$$\dot{k} = \xi_1 [\psi_1 k + \psi_2 \theta - k] - \xi_2 r$$

or

$$\dot{k} = \xi_1 (\psi_1 - 1) k - \xi_2 \theta - \xi_2 r$$

This process on its own is stable, providing only that $\psi_1 < 1$. The meaning of this is simply as follows. A unit fall in output will cause an equiproportionate fall in the desired stock of capital. As long as $\psi_1 < 1$, that in turn causes a less than proportional further fall in output. If this is not the case, then, for a given value of the real exchange rate, θ, there will be no limit to the fall in capital, and output, caused by the initial fall in output. The fact that when capital rises output rises less than proportionately (i.e., diminishing returns to capital) is a reduced form property which follows from the underlying behaviour of producers and workers. The structural equations which result in this reduced form aggregate supply equation are discussed in Chapter 5. We may be foreshadow a discussion to come later in Chapter 5 that at any given real exchange rate, output will rise less than proportionately to capital stock only when workers claim an increase in their real wages in step with increase in output. Thus, stability of capital stock accumulation process is contingent upon pro-cyclical real wage movements: real wages rise in boom and fall in slump.

The Determination of Inflation in the Longer Run

The manner in which inflation is determined in the longer run is very similar to that discussed in Section 2.3. However the long run supply schedule which replaces (2.16) is that which rules when capital has adjusted to its desired value.

Since at the initial interest rate the desired capital to output ratio is unity, this may be written as

$$y = \psi_1[y - \xi_2/\xi_1 r] - \psi_2\theta$$

or

$$y = -\xi_2^* r - \psi_2^* \theta \tag{2.18}$$

where,

$$\xi_2^* = \frac{\xi_2}{\xi_1(1-\psi_1)} \qquad \psi_2^* = \frac{\psi_2}{(1-\psi_1)}$$

Notice that the aggregate supply curve is now much flatter in (θy) space: the reduction in supply caused by a depreciation in the real exchange rate is now much larger because of the implications for supply of the resulting decumulation of capital.

Stability in the Long Run

There are three dynamic variables in the long run analysis: capital stock, real financial assets and expected inflation. Substituting for output as determined from the demand side as in equation (2.13) and inflation (2.7) in the equations for evolution of real assets (2.10), capital stock (2.11) and rate of change of inflation (2.7), we can write the following differential equation system.

$$\begin{bmatrix} \dot{a} \\ \dot{k} \\ \dot{\pi}^e \end{bmatrix} = \begin{bmatrix} -\omega_{11} & \omega_{12} & -\omega_{13} \\ \omega_{21} & -\omega_{22} & 0 \\ \omega_{31} & -\omega_{32} & 0 \end{bmatrix} \begin{bmatrix} a \\ k \\ \pi^e \end{bmatrix}$$

where

$\omega_{11} = (t + \mu_1 + a_0^*)\lambda\gamma_2$

$\omega_{12} = (t + \mu_1 + a_0^*)\lambda\xi_1$ $\qquad \omega_{13} = a_0^*$

$\omega_{21} = \xi_1\lambda\gamma_2$ $\qquad \omega_{22} = \xi_1(1 + \lambda\xi_1)$

$\omega_{31} = \rho\phi\lambda\gamma_2$ $\qquad \omega_{32} = \rho\phi(\lambda\xi_1 + \psi_1)$

The characteristic equation associated with the transition matrix can be written as

$$\delta_0 D^3 + \delta_1 D^2 + \delta_2 D + \delta_3 = 0$$

where,

$\delta_0 = 1$

$\delta_1 = (\omega_{11} + \omega_{22})$

$\delta_2 = [(\omega_{11}\omega_{22} - \omega_{12}\omega_{21}) + \omega_{13}\omega_{31}]$

$\delta_3 = [\omega_{13}(\omega_{31}\omega_{22} - \omega_{21}\omega_{32})]$

The necessary and sufficient conditions for stability of the above three equation differential system (Gondolfo, 1971, page 241) is:

$\delta_1 > 0$

$\delta_2 > 0$

$\delta_3 > 0$

and

$\delta_1\delta_2 - \delta_0\delta_3 > 0$

These can be shown to be fulfilled. However note two important assumptions implicit in this proof:

$\psi_1 < 1$

and

$\omega_{13} > 0$

The first assumption has been discussed already at the beginning of this section. The latter of the two assumptions is in fact the assumption we made for stability of intermediate run dynamic variables. We may reiterate that this assumption amounts to long run solvency of government: tax policy is such that inflationary financing should yield positive real revenues for the government.

Constant Real Exchange Rate Policy

We can proceed to illustrate the consequences of different policies as before. But note that between the intermediate and long runs only difference to model structure is the flatter supply curve. No more figures are presented as Figures 2.3 and 2.5 presented earlier can serve our purpose. Therefore we can reinterpret all our results for intermediate run by reading ψ_2^* in the place of ψ_2, recognizing that the former is greater than the latter.

The comparative static results are the same as in the intermediate run; no effect on output, inflation falls and the balance of payments gap increases.

$$\frac{dy}{ds} = 0$$

$$\frac{d\pi}{ds} = \chi_1 / a_0^* > 0$$

$$\frac{d\dot{z}}{ds} = -\chi_1 < 0$$

Effects of an Expenditure Switching Policy

Output falls, real exchange rate depreciates and inflation increases.

$$\frac{dy}{ds} = \frac{\chi_1 \psi_2^*}{(\sigma + \mu_1 \psi_2^*)} > 0$$

$$\frac{d\theta}{ds} = -\frac{\chi_1}{(\sigma + \mu_1 \psi_2^*)} < 0$$

$$\frac{d\pi}{ds} = -\frac{\psi_2^* t}{a_0^*(\sigma + \mu_1 \psi_2^*)} < 0$$

Comparison of Results with Intermediate Run Under Expenditure Switching

It can be shown that output supply falls more in the long run as a consequence of capital decumulation. As this by itself reduces drain of foreign reserves, the required depreciation in real exchange rate is less. Inflation is higher in the long run in order to counter-balance the tendency for budget deficit to open up in the face of the bigger slump in output.

Effects of an Expenditure Switching and Cutting Policy

As is the case with the intermediate run results under this policy, output and real exchange rate effects remain the same as under expenditure switching.

The required cut in government expenditure is given by

$$\frac{dg}{ds} = \frac{\chi_1 \psi_2^* t^*}{[1 + \alpha r(1-t)](\sigma + \mu_1 \psi_2^*)} > 0$$

We can also see that the required reduction in government expenditure is more than that under a similar policy in the intermediate run as output supply has fallen more, requiring a larger reduction in demand.

2.6 Conclusion

We may conclude that a developing economy seeking to preserve internal and external balances after a negative external shock by expenditure switching and cutting policies need not face a cumulative collapse. In our analysis this collapse was avoided by a set of three conditions: diminishing returns to scale in the short run, monetary channels of influence of balance of payments, and scope of financing budget deficit by inflation tax. This we were able to show in a framework that allowed for wealth effects on aggregate demand and capital accumulation.

The after effects of this success on inflation and balance of payments on productive capacity will be very great. It might be possible to use our framework to target productive capacity i.e., to program adjustment with growth. This will require active use of investment stimulation instrument such as real interest rate. It is expected that in such a case, the required real depreciation and government expenditure contraction will be even greater. Furthermore, it is also possible to use our framework to assign alternatively instruments to targets, for example relying on expenditure cutting for current account targeting and expenditure switching for internal balance, or have expenditure cutting only. But these extensions of our framework to programming also for growth and to using alternative assignment of instruments is left for further work.

CHAPTER 3

DATA ISSUES AND ACCOUNTING FRAMEWORK

3.1 Introduction

Data base for building an aggregative macroeconometric model for Latin America just did not exist. Therefore the first empirical task was to construct a data set for subsequent econometric and simulation work. In this chapter we address this problem and explain how a data base was assembled. The sections to follow discuss the sources of data, the considerations behind the choice of Latin American countries the data of which we aggregated to form the regional data, deficiencies in data and how these were remedied, principles of data aggregation and methods of data projection. Finally we present the accounting framework which underlies the model to be specified later in Chapter 5.

3.2 Sources of Data

Given the structure of our theoretical model as in Chapter 2, we are looking for data on components of GDP, wages and prices, current account variables, monetary sector variables and government accounts. Data series on these variables are readily available in World bank's World Tables published since 1984. However, data aggregated into regional totals is not available from this source. Of late though (since 1990, too late and too little for our purpose), regional totals are available from this source for components of GDP and merchandise exports and imports are available at current prices. There are other United Nations publications like International Finance Statistics and Balance of Payments Statistics which do report 'area totals' for selected items of interest to the publishing agencies. But we cannot gather from any source constant price national accounts on the regional basis. Even these paltry data is published with severe health warnings regarding comparability across countries and time. This is a serious lacuna for researchers engaged in modelling how groups of countries respond to global policies. At present time though there are attempts to assemble proper developing country data base in a uniform accounting framework, see McCarthy, *et al* (1990).

Therefore we ventured into constructing data base for developing country regions on the basis of country level data collected from World Bank sources. As one can imagine this is very much computing resource intensive. Up to 80 Fortran algorithms were written to scrutinize, clean, aggregate and prepare data for econometric analysis. Since this is the first ever time such an effort is made, the data set relevant for Latin America thus generated and used in our research is placed in appendix 3C to this chapter. Altogether 76 time series from 1961 to 1986 are provided. These are gathered into current price flow variables, constant price flow variables, deflators, current price stock variables and constant price stock variables. Variables are grouped as described above because as we shall see in Section 3.4, aggregation method is specific to each group.

3.3 Choice of Countries

As noted in Chapter 1 on introduction, we wanted to construct a regional model for Latin America such that it can be easily incorporated into a currently available global macroeconometric model. Therefore we strictly adhered to the definition of the Latin American region as in GEM. GEM was our natural choice because GEM is a British product and this research also is done in Britain. GEM defines this region as all developing countries in Western Hemisphere as shown in International Financial Statistics excluding Venezuela which is a member of OPEC. Of the 29 countries which constitute the region we found that only 14 countries could be included in the study, for reasons of data availability as explained below.

Our data base consisted of individual country annual data from 1960 to 1986 obtained from World Bank sources. Basically this data set is what the World Bank publishes in 'World Tables' except that it is extended backwards to 1960 at our special request. This however does not mean that all data on all economic variables of interest are in fact available from

1960 for all countries! Length of available time series varies for various categories of data: expenditure components of GDP are available from 1960 to 1985; balance of payments statistics are available only since 1970; government financial statistics are only available from 1974. By excluding countries on a sequential basis according to data non-availability on expenditure components of GDP, balance of payments, money stock and government financial statistics, we arrived at a list of only 14 countries as indicated in Table 3.1.

Table 3.1

List of Countries Covered by the Study

and Full List of Countries in Latin America

1.		Antigua and Barbuda
2.	*	Argentina
3.		Barbuda
4.		Belize
5.	*	Bolivia
6.	*	Brazil
7.	*	Chile
8.	*	Colombia
9.	*	Costa Rica
10.		Dominica
11.	*	Dominican Republic
12.	*	Ecuador
13.	*	El Salvador
14.	*	Guatemala
15.		Guyana
16.		Haiti
17.		Honduras
18.		Jamaica
19.	*	Mexico
20.		Nicaragua
21.		Panama
22.	*	Paraguay
23.	*	Peru
24.		St. Kitts and Nevis
25.		St. Lucia
26.		St. Vincent
27.		Surinam
28.		Trinidad and Tobago
29.	*	Uruguay

Note

A star before a country's name indicates its inclusion in the study.

However, coverage of the region is reckoned to be satisfactory because nearly 90 per cent of the economic activity of the region takes place in the 14 included countries. Table 3.2 presents the coverage of 14 countries in 'true' regional totals for selected variables.

Table 3.2

Extent of Economic Activity of the Region Covered by Countries Included in the Study: 1980

Variable (All in Current US $ except Population)	Proportion to True Regional Total in %
1. Population	94.28
2. GDP market prices	97.09
3. Export of goods and non factor services	88.72
4. Import of goods and non factor services	88.32
5. External Debt (public and publicly guarantied.)	93.29
6. International Reserves	88.91

3.4 Data Deficiencies and Remedies

Data deficiencies of four types were noted which were remedied by suitable methods. Firstly, there were missing observations on a very small scale in GDP components and money stock which otherwise had a long time series from 1960 to 1986, suitable for our econometric work. These missing observations were interpolated using semi-log time trends, as noted in Table 3.3. Secondly, GDP components were not adding up to total GDP for Brazil for some years and we overwrote GDP figures with the correct totals (see Table 3.4 for details). Thirdly, pervasive gaps in government accounts were found which were made up by calibrating parameters from the available data (see Appendix 3A). Fourthly, capital stock data was not available and it had to be constructed by perpetual inventory method assuming reasonable depreciation rates (see Appendix 3B).

Table 3.3

Details on Data Gaps Filled

Country	GDP Weight in 1980	Years	Variable
Argentina	20.88	1960-64	money stock
Chile	3.74	1960-63	money stock
Ecuador	1.59	1960-65	money stock prv. consn. deflator govt. consn. deflator investment deflator export deflator import deflator

Table 3.4

Errors in Reported GDP Totals

Pricing	Country	Year	Percentage Error
Current Prices	Brazil	1960	10.49
		1961	10.77
		1962	3.24
		1963	2.34
Constant Prices	Brazil	1961	1.30
		1962	1.60
		1964	1.22

3.5 Principles of Data Aggregation

All the variables modelled are expressed in US $ terms. The only exception arises in the case of inflation variable which has to be an aggregate of inflation in local currency terms. Alternatively, one can use purchasing power parities (PPP) in the place of official exchange rates as a true measure of relative purchasing power. But PPP series constructed by United Nations International Comparison Project do not cover all countries yet, see United Nations (1986) No attempt is made to derive the true area totals for the region. What is furnished is a summary measure of 14 countries which account for most of the activity in the region. This is sufficient for the objectives for this thesis and when the model is inserted into a global model which will require true area totals the estimated will have to be suitably scaled.

Current Price Variables

First at the country level the relevant variable is converted into US dollars using the average annual official exchange rates. These are then summed up to give the regional total.

$$_{\$}x_t^A = \sum_{i=1}^{k} \frac{_L x_{it}}{e_{it}}$$

where

e is the nominal exchange rate: local currency per US $

k is the number of countries in the region superscript A denotes the aggregate for the region

subscript \$ denotes that the variable is measured in dollar terms

subscript L denotes that the variable is measured in local currency terms

t is the time subscript

Price Indices in US \$ terms

These are the geometric means of corresponding country level \$ price indices using an appropriate variable's current dollar values as weights. For instance to get an aggregate measure of the private consumption deflator, the weights used are the nominal private consumption in US \$ of the individual countries. The only exception to this rule is the GDP deflator which is derived by dividing the current price regional GDP with the sum of regional GDP components at constant prices. Geometric means are preferred to arithmetic means for two reasons. First, these are not unduly influenced by extreme movements in individual series. Second, if all series have constant although different rates of increase, their average will have a constant rate of increase, see International Finance Statistics (1987). It may also be noted that the weights of different countries are updated every year. Note that in what follows superscript b denotes a variable in base period prices.

$$_{\$}P_t^A = \prod_{i=1}^{k} \left(\frac{_{L}P_{it}}{EI_{it}} \right)^{\theta_{it}}$$

where

$$_{L}P_{it} = \frac{_{L}x_{it}}{_{L}x_{it}^{b}}$$

$$\theta_{it} = \frac{(x_{it}/e_{it})}{\sum_{i=1}^{k}(x_{it}/e_{it})}$$

EI_{it} = index of nominal exchange rate

Price Indices in local currency terms

These are the geometric means of corresponding country level local currency price indices using an appropriate variable's current dollar values as weights.

$$_{L}P_t^A = \prod_{i=1}^{k} (\quad _{L}P_{it})^{\theta_{it}}$$

Constant Price Variables

This is derived by deflating the regional current price variable with the regional $ price deflator.

$$_{\$}x_t^A = \frac{_{\$}x_t^A}{_{\$}P_t^A}$$

3.6 Methods of Data Projection up to 2000

Because balance of payments statistics are available only since 1970, as such the full model could be simulated only between 1972 and 1985 after allowing for lag structure. As the long run properties of the model may require a longer track for simulation we decided to project the variables of the model from 1986 to 2000. In doing this projection we drew upon the forecast up to 1994 by the International Monetary Fund (IMF) provided in the 'World Economic Outlook', October 1989. IMF's forecasts cover the rest of world variables such as inflation, growth in GDP which are exogeneous to the model and some of the regional variables such as volumes of import and export, GDP growth rate, and debt service projections. Making our own assumptions about Latin American inflation and relative prices we could project all the variables relevant to our model. The projections were done on a simple basis. These assumptions could have been even simpler had we forecast the endogenous variables on the basis of the time path of exogeneous variables assumed. The consequence of what we have done is that residuals of estimated equations for the forecast period are not ideal. The variables were first classified into relative prices, domestic-real, domestic-nominal, external-real and external-nominal. Then for each of these groups except the relative prices, we postulated a constant annual compound growth rate between 1986 to 2000. Relative prices however are assumed to be frozen at their 1985 values. A summary of the assumptions made in projecting data is available in Table 3.5.

Table 3.5

Assumptions Used in Projecting Data Series 1986-2000

Data Series have been projected from 1986 to 2000 by applying a constant growth rate to 1985 base values. Only exception is real LIBOR which is kept at 4.2 percent over the projection period. The numbers appearing against the variables represent annual compound growth rates.

Rest of the World Variables

Prices	3.3 %
Nominal Variables	6.3 %
Import Volumes	6.0 %
Real LIBOR	0.0

Domestic Variables

Real Exch. Rate	0.
Terms of Trade	0.
Real Wage	0.
Export Volume	6 %
Import Volume	6.6 %
Other GDP components, real	5 %
Nominal Variables in $ terms	8.3 %
Prices in Local Currency	100.0 %
Prices in US $ terms	3.3 %
Amortization	8 %
Interest Payments	6.3 %
Debt Stock	6 %

Most of the assumptions draw upon projections up to 1994 for LDCs in Western Hemisphere and Industrialized Countries, reported by World Economic Outlook, October 1989.

Our own particular assumptions as follows are:

Inflation for Latin American region - based on the average rate for the last five years.

Absorption grows at the same rate as GDP.

Debt variables as a proportion of export of goods and services projected for 1994 by World Economic Outlook will hold good for 2000.

Real Government Consumption is a residual in GDP identity.

Disbursement of Loans is a residual in Debt evolution identity.

Reserves are residual in balance of payments identity.

3.7 The Accounting Framework

The accounting framework is rudimentary because of problems of data availability. Particularly, separation of household sector from the private sector , flows between the private and public sectors, and flows between private and rest of world sectors could not be isolated.

In what follows, we first describe the budget constraint of the private and public sectors. Then, we specify the balance of payments identity and the balance sheet identity of the banking sector. Valuation effects are ignored while presenting the flows for simplicity. All the flows are measured in nominal US dollars.

The private sector is the sole recipient of all incomes generated in the domestic economy (Y) and the non-interest factor service receipts from abroad (OFS). This is spent on tax payments (T), private consumption (C_p), private investment (I_p), repayment of debt to the domestic banking sector ($-\Delta D_p$) and acquisition of money balances (ΔM).

$$Y + OFS = T + C_p + I_p - \Delta D_p + \Delta M \qquad (1)$$

Public sector receipts consists of tax revenues (T) and transfer payments from abroad (TR_f). This is expended on consumption (C_g), investment (I_g), net interest payments abroad (IP_f), net acquisition of claims on foreigners (ΔF) and repayment of debt to domestic banks (ΔD_g).

$$T+TR_f=C_g+I_g+IP_f+\Delta F-\Delta D_g \tag{2}$$

The balance of payments identity states that the sum of payments from residents for imports of goods and non factor services (Z), purchase of financial claims abroad (ΔF), increase in foreign exchange reserves (ΔR), interest payments to foreigners (IP) and non interest factor service receipts (OFS) is equal to the sum of export of goods and non factor services (X) and current transfers from abroad (TR_f).

$$Z+\Delta F+\Delta R+IP_f+OFS=X+TR_f \tag{3}$$

Banking sector issues fresh liabilities (ΔM) against fresh acquisition of assets ($\Delta R, \Delta D_p, \Delta D_g$).

$$\Delta M=\Delta R+\Delta D_p+\Delta D_g \tag{4}$$

The accounting relationships above can be presented in Table 3.6 following the tradition of Global Accounting Framework as developed by the McCarthy *et al* (1990). In this table private and public sector budget constraints appear int the first two columns; the balance of payments identity is laid out in the third column. The balance sheet identity of the banking sector is to be read across the last two rows of the table.

Table 3.6

The Accounting Framework

Private Sector	Public Sector	Rest of the World
Y	T	Z
T C_p	 C_g	X
S_p I_p	S_g I_g	S_f
  OFS	IP_f TR_f	IP_t TR_t OFS
$CURB_p$	$CURB_g$	$CURB_t$
 $-\Delta D_p$ ΔM	ΔF $-\Delta D_g$	 ΔR

Appendix 3A

Government Accounts and Base Money Generation

This appendix describes how the government accounts were generated for the simulation period. Data on government's budget deficit was available only for 1974-81. Government accounts were laid out as follows.

Nominal government revenue is a constant proportion of nominal GDP:

$$GR = \tau \times YDCP \tag{1}$$

Nominal government expenditure is the sum of nominal government consumption, nominal public investment (which is a fixed proportion of total investment in the economy), amortization of on external loans, net interest payments abroad and interest payments on home debt.

$$GE = GCCP + \rho \times ITCP + AMT + INT + LIBOR \times HD(-1) \tag{2}$$

Government's budget deficit:

$$GBD = GE - GR \tag{3}$$

Central bank Lending to government(CLG) increases by a constant proportion of the current budget deficit:

$$CLG = CLG(-1) + \mu \times GBD \tag{4}$$

Definition of base money:

$$BM = RESCP + \theta * HD \tag{5}$$

The parameters appearing in the equations above were calibrated around some "best guess" values such that the government budget that is derived is close to the observed values over the period 1974-81. The calibrated values of the three parameters τ, ρ, μ and θ are .18, .44, .75, and .27 respectively.

It may be noted that series on base money and home debt are not available in our World Bank data base. However, if initial period values for these are assumed, their evolution can be derived by the formulae above. Assuming an arbitrary value of money multiplier of 3 for the initial year, initial stock of base money was derived. Then, subtracting the value of foreign reserves from base money, the value of monetized home debt was estimated.

Appendix 3B

Construction of Capital Stock Series

Two approaches to construction of capital stock series can be identified when we look at the work of researchers who have attempted to construct capital stock by indirect means. The first one is the perpetual inventory method and the second can be called the econometric method.

Perpetual Inventory Method

Under this approach, one can either assume or derive the value of capital stock for a bench mark year and then derive the series for other years (either preceding or succeeding years) following the perpetual inventory method.

If one can assume the bench mark year value then the length of the time series on derived capital stock series will be equal to that of the fixed investment series, and one simply uses the perpetual inventory formula shown below.

$$K_t = (1-\lambda)\times K_{t-1} + I_t \qquad (1)$$

On the other hand, if we can make do with a shorter capital stock series, then one can only estimate the stock of capital for years beyond the assumed life of the capital stock (Leamer (1984)); for the later years perpetual inventory method can be used. For the first year one uses

$$K_t = \sum_{j=t-\theta}^{t} (1-\lambda)^{(t-j)} I_j \tag{2}$$

where,

θ = life of assets, assumed as 15 years as Leamer does.

$\lambda = 2/\theta$, following 'double declining method of depreciation'

K = stock of net fixed capital

I = Real Gross Fixed Investment

For the later years one simply uses the perpetual inventory method of equation (1).

Econometric Method

In the second approach a simple one-factor linear production function is postulated and the underlying constant capital-output ratio is estimated regressing output on its lagged value and investment (Dadkah and Fatemah (1986). Having estimated the capital-output ratio, the capital stock series is derived by dividing the output series with it as explained below.

The production function is given by

$$Q_t = a K_t + \epsilon \tag{3}$$

Evolution of the capital stock is given by

$$K_t = (1-\lambda) K_{t-1} + I_t \tag{4}$$

Substituting equation (3) into (2) gives the equation to be estimated:

$$Q_t = (1-\lambda)Q_{t-1} + aI_t + \epsilon \qquad (5)$$

which then gives

$$K_t = Q_t / a \qquad (5)$$

An advantage of the second approach is that the regression also gives an estimate of the depreciation coefficient which has to be assumed under the first approach.

Our Results

We estimated capital stock series by both the perpetual inventory and econometric methods. Under perpetual inventory method we experimented with different depreciation rates as well. It may be noted that for the perpetual inventory method, we constructed the initial year capital stock by making the assumption that in the first few years of data incremental and average capital output ratios were the same. The initial year incremental capital output ratio was derived after smoothing the output series by a three year moving average.

Econometric method produced the following estimated equation on our data set (1961-85):

$$Q_t = \underset{(10.971)}{0.8712}\, Q_{t-1} + \underset{(2.089)}{0.8382}\, I_t$$

R^2 = .9645 $\qquad \rho = .3763$

Procedure: Cochrane-Orcutt iterative procedure for correcting first order positive serial correlation.

Some data deficiencies had to be remedied before we could generate a series of gross fixed investment for Latin America. For Brazil, Dominican Republic and Paraguay there were missing values for fixed investment deflators which were filled. Argentina had no data at all on real gross fixed investment. Therefore we had to make a further assumption that ratio of real fixed investment to total investment in Argentina is the same as in the rest of the region.

Alternative estimates of net fixed capital stock constructed are presented in Table 3B.1.

Choice of Method

We chose to use the estimates obtained by using a perpetual inventory method with an arbitrary depreciation coefficient of 13 per cent. This value of depreciation is used by Leamer and also supported by our production function approach, the results of which were earlier presented. Leamer's method itself could not be used because of the short time series for capital stock that it will generate with our data set. The production function approach was rejected because it makes restrictive assumptions about the form and factors in the production function.

Table 3B.1

Alternative Estimates of Net Fixed Capital Stock

(in billions of constant 1980 US $)

Year	Leamer's Method	With Capital stock	Assumed Initial		Prod. Function Method
	d = .1333	d = .1333	d = .1288	d = .1000	d = .1333
1961		196	200	236	
1962		212	217	256	355
1963		224	229	270	371
1964		241	246	290	392
1965		257	263	309	418
1966		274	280	329	431
1967		290	296	349	458
1968		309	316	371	474
1969		337	345	404	508
1970		367	375	438	549
1971		397	406	474	585
1972		432	441	514	626
1973		471	481	559	668
1974		513	524	608	735
1975		551	563	654	783
1976	581	600	612	711	789
1977	621	641	655	761	839
1978	659	681	696	810	866
1979	708	731	747	870	927
1980	764	789	806	938	1022
1981	808	834	853	995	1082
1982	824	852	872	1024	1053
1983	809	838	859	1022	968
1984	795	826	848	1019	965
1985	795	813	852	1030	1019

Note : d denotes the depreciation coefficient.

Table 3C.1

Latin America Current Price Flow Variables in Millions of US $

	Variable	1960	1961	1962	1963	1964	1965	1966	1967
1	CP.$.CON.PRV	38191.1914	41052.1562	50658.1484	55507.2461	65096.625	58829.8281	68470.4375	72511.0625
2	CP.$.CON.GOV	5311.0859	5787.7891	7315.625	7962.125	8160.1211	7689.1406	9774.7617	10044.9961
3	CP.$.INV.GDI	10596.0117	12306.5547	13134.9336	14192.0977	17180.6758	16823.9297	19527.7148	19666.1797
4	CP.$.EXP.GNFS	6030.8203	6256.6836	6267.1641	8582.1094	8715.0234	8702.2109	9974.1758	9972.3906
5	CP.$.IMP.GNFS	6548.1719	6799.9023	7955.1367	9135.9687	9176.875	8133.3711	9873.5195	10093.4844
6	CP.$.GDP.MP	53580.9453	58603.2969	69420.6875	77107.5	89975.4375	83911.625	97873.625	102100.9375
7	CR.EXP(FOB+NFS)	..	..	..	..	..	..	..	..
8	DR.IMP(FOB+NFS)	..	..	..	..	..	..	..	..
9	NET.FCTINC	..	..	..	..	..	..	..	..
10	BOP.IMP.LTINTRST	..	..	..	..	..	..	..	..
11	BOP.NET.CURTRANS	..	..	..	..	..	..	..	..
12	NET.CURBAL.IMFDEF	..	..	..	..	..	..	..	..
13	NET.TOTLTCAP.EXRESV.EX	..	..	..	..	..	..	..	..
14	LT.CAP.LLOAN	..	..	..	..	..	..	..	..
15	LT.CAP.DISBUR	..	..	..	..	..	..	..	..
16	LT.CAP.REPYMT	..	..	..	..	..	..	..	..
17	LT.CAP.INFL.OTH	..	..	..	..	..	..	..	..
18	OTH.CAP.INFL	..	..	..	..	..	..	..	..
19	DECLN.RESER	..	..	..	..	..	..	..	..
20	GOV.CUR.REV	..	..	..	..	..	..	..	..
21	GOV.CUR.EXP	..	..	..	..	..	..	..	..
22	GOV.CUR.BAL	..	..	..	..	..	..	..	..
23	GOV.CUR.RECT	..	..	..	..	..	..	..	..
24	GOV.CAP.PYMT	..	..	..	..	..	..	..	..
25	GOV.ALL.BAL	..	..	..	..	..	..	..	..
26	CP.$.IMP.FUEL	..	..	..	..	..	538.4763	591.7681	611.2603
27	CP.$.IMP.MACH	..	..	..	..	..	2397.0598	2742.3115	2995.332
28	CP.$.IMP.OMAN	..	..	..	..	..	2405.2034	2768.7832	2756.7983
29	CP.$.IMP.MAN	..	..	..	..	..	4802.2539	5511.0859	5752.1211
30	CP.$.IMP.TOTAL(MERCH.)	..	..	..	..	..	6873.5156	7847.2656	8032.7617
31	CP.$.INV.FIXD	8852.457	10457.0859	11835.0312	12355.2109	14843.7578	14325.6914	16552.1758	17036.457

Table 3C.1

Latin America Current Price Flow Variables in Millions of US $

	Variable	1968	1969	1970	1971	1972	1973	1974	1975
1	CP.$.CON.PRV	75613.125	82538.9375	93503.625	107580.75	122099.4375	152566.4375	198647.4375	213535.25
2	CP.$.CON.GOV	10327.6523	11472.7227	13298.9766	15589.4922	17696.543	23039.9453	30504.4883	33848.8633
3	CP.$.INV.GDI	20436.4375	24457.1953	27660.8008	30561.3984	33914.7031	45821.4414	67535	71958.5625
4	CP.$.EXP.GNFS	10312.6836	12012.082	13283.7344	13486.5195	16652.207	23115.6758	30969.8555	29777.5469
5	CP.$.IMP.GNFS	11008.3828	12372.5586	14380.1641	16001.293	18570.082	24095.8437	39962.1641	40080.8359
6	CP.$.GDP.MP	105681.4375	118108.25	133366.75	151216.875	171792.6875	220447.375	287694.625	309039.4375
7	CR.EXP(FOB+NFS)	..	..	13337.7812	13521.8789	16138.1523	22679.8945	30362.875	29971.1211
8	DR.IMP(FOB+NFS)	..	..	14193.0859	15724.0977	17709.6445	23419.5	38930.0312	40396.5703
9	NET.FCTINC	..	..	-2041.4004	-2152.6548	-2401.2097	-3284.979	-4279.543	-5695.4062
10	BOP.IMP.LTINTRST	..	..	1162.6992	1249.6995	1341.6995	1899.5002	3477.8005	4755.1953
11	BOP.NET.CURTRANS	..	..	301.2	253.6525	272.4619	362.9314	420.3508	478.8406
12	NET.CURBAL.IMFDEF	..	..	-2595.5	-4101.1367	-3701.3005	-3662.8018	-12429.2734	-15612.4883
13	NET.TOTLTCAP.EXRESV.EX	..	..	2684.1001	3353.99	5575.4297	6949.4141	11109.9883	12401.3359
14	LT.CAP.LLOAN	..	..	1900.5002	1917.5	3518.4011	4849.8008	11926.0781	10446.4844
15	LT.CAP.DISBUR	..	..	4834.793	5059.8906	6880.7891	8917.0859	17722.3828	17394.3906
16	LT.CAP.REPYMT	..	..	2934.3005	3142.4011	3362.4001	4067.301	5796.2852	6947.8828
17	LT.CAP.INFL.OTH	..	..	4.9998	373.449	971.3035	25.1308	-2598.1917	-642.5288
18	OTH.CAP.INFL	..	..	838.489	588.5779	856.3826	570.7336	861.6694	561.7026
19	DECLN.RESER	..	..	-927.0894	158.5689	-2730.5261	-3857.3608	457.6104	2649.4661
20	GOV.CUR.REV	..	..	..	..	..	..	45884.1719	48701.043
21	GOV.CUR.EXP	..	..	..	..	..	..	38548.4336	43544.3281
22	GOV.CUR.BAL	..	..	..	..	..	..	6880.1094	4661.0664
23	GOV.CUR.RECT	..	..	..	..	..	..	216.9017	162.0153
24	GOV.CAP.PYMT	..	..	..	..	..	..	13067.8437	14451.1797
25	GOV.ALL.BAL	..	..	..	..	..	..	-5970.9297	-9654.7305
26	CP.$.IMP.FUEL	635.197	664.1055	704.3196	1038.0859	1183.8767	1903.0608	5540.8828	5759.5742
27	CP.$.IMP.MACH	3387.6089	3680.1094	4350.3555	4826.9336	5678.6172	6920.2773	9083.7852	11703.832
28	CP.$.IMP.OMAN	3081.1809	3463.3823	4123.293	4602.9766	5128.3633	6910.8398	12342.7734	11816.8789
29	CP.$.IMP.MAN	6468.7773	7143.4727	8473.6328	9429.918	10806.9727	13831.1211	21426.5898	23520.7461
30	CP.$.IMP.TOTAL(MERCH.)	8916.0352	9734.6562	11313.0859	12763.2148	14588.082	19826.4492	33813.2969	34953.293
31	CP.$.INV.FIXD	18405.8711	22128.5273	24912.5039	27908.7891	32445.4492	42158.1523	58251.3008	65330.8203

Table 3C.1

Latin America Current Price Flow Variables in Millions of US $

	Variable	1976	1977	1978	1979	1980	1981	1982	1983
1	CP.$.CON.PRV	243588.75	262175.625	306555.375	388440.125	481589.9375	523426.8125	428070.5625	370952.25
2	CP.$.CON.GOV	38271.1797	38942.832	47770.625	60903.0742	77708.3125	86229.0625	74402.1875	56564.7227
3	CP.$.INV.GDI	83918.625	87721.625	103775.1875	131959.5625	169713.1875	186429.75	128075.375	91106.25
4	CP.$.EXP.GNFS	38611.4883	44432.5	49487.8008	64650.7187	83391.0625	90879.625	81570.25	82571.0625
5	CP.$.IMP.GNFS	42362.2344	45516.4648	52024.1445	71077.8125	97001.625	104976.25	77221.25	62474.0469
6	CP.$.GDP.MP	362027.75	387756.125	455564.9375	574875.5	715400.8125	781989.1875	634897.5	53872..
7	CR.EXP(FOB+NFS)	35576.8828	43288.1641	48929.207	64183.7266	82521.75	89795.4375	80557.875	82011.1875
8	DR.IMP(FOB+NFS)	40203.0586	43902.4062	51747.8047	70907.4375	96433	105200.625	79192.5	61096.1367
9	NET.FCTINC	-6918.207	-8109.9102	-10017.4336	-13531.0703	-18659.7656	-28760.2969	-37816.2148	-32817.5078
10	BOP.IMP.LTINTRST	4563.8945	5349.1914	7718.8789	11276.9805	15245.6836	19962.4961	24381.5977	22550.5977
11	BOP.NET.CURTRANS	759.4128	748.7788	971.4709	1119.4236	1377.9568	1428.7327	1316.4128	1593.3682
12	NET.CURBAL.IMFDEF	-10781.9844	-7975.6055	-11864.5898	-19135.4844	-31193.4258	-42733.3086	-35129.5664	-10306.3477
13	NET.TOTLTCAP.EXRESV.EX	13950.0859	14183.8594	20769.1406	19724.125	24371.9258	43050.2969	32611.4141	24472.8281
14	LT.CAP.LLOAN	13371.3906	13633.2891	18229.0898	18710.4883	19802.0977	35605.8047	27314.0078	13750.7812
15	LT.CAP.DISBUR	20963	24131.3984	33862.8984	38832.7031	37372.3984	54727.5117	45521.4102	26615.5977
16	LT.CAP.REPYMT	7591.5742	10498.0742	15633.793	20122.1953	17570.293	19121.6953	18207.3867	12864.7891
17	LT.CAP.INFL.OTH	-1719.2446	-2319.2351	-1135.7485	-3626.0249	-666.0488	665.7703	-58.1199	7742.6094
18	OTH.CAP.INFL	791.9912	-1490.9893	-82.4399	4895.6992	4122.1953	-3989.4519	-13287.5664	-16069.7266
19	DECLN.RESER	-3960.0789	-4717.2617	-8822.0859	-5484.3477	2699.2783	3672.4719	15805.707	1903.2505
20	GOV.CUR.REV	58020.8086	70425.5	84598.25	104793.125	132548.1875	148146.5625	..	..
21	GOV.CUR.EXP	48820.25	54947.6016	69263.875	84081.5	112541	130836.5625	..	..
22	GOV.CUR.BAL	8614.3906	14819.8984	14572.1914	19788.7305	20007.2109	17309.8242	..	..
23	GOV.CUR.RECT	490.9973	410.1255	398.3147	1215.8679	1281.176	1153.0562	..	..
24	GOV.CAP.PYMT	14645.6914	22485.7422	24075.4141	29751.6367	39055.0273	54141.4062	..	..
25	GOV.ALL.BAL	-8983.8477	-6441.8203	-9196.7187	-8807.8125	-17766.6133	-35905.6562	..	..
26	CP.$.IMP.FUEL	6301.1992	7116.3594	7470.3555	11360.4492	15871.918	18120.8242	15696.3125	13058.5781
27	CP.$.IMP.MACH	11665.9258	12003.8164	14326.7422	18877.3516	24590.7656	27135.5625	19276.5234	14171.3086
28	CP.$.IMP.OMAN	10240.5977	11077.3398	13599.3281	18277.6211	26298.1836	26454.4531	19757.4062	13458.75
29	CP.$.IMP.MAN	21906.5742	23081.1719	27926.1055	37155	50888.9766	53590.0586	39033.9414	27630.0859
30	CP.$.IMP.TOTAL(MERCH.)	33620.2461	35930.9609	42602.8711	58692.1016	80021	84364.625	63708.5664	48147.8086
31	CP.$.INV.FIXD	79991.375	81055.875	96597.9375	126085.1875	155229.3125	172168.0625	129170.9375	88826.8125

Table 3C.1

Latin America Current Price Flow Variables in Millions of US $

	Variable	1984	1985	1986
1	CP.$.CON.PRV	398656.0625	394819.0625	..
2	CP.$.CON.GOV	58954.9727	58855.3828	..
3	CP.$.INV.GDI	102048.6875	102743.875	..
4	CP.$.EXP.GNFS	92175.75	90208.125	..
5	CP.$.IMP.GNFS	63877.2852	64402.5977	..
6	CP.$.GDP.MP	587957.875	582223.5	597292.625
7	CR.EXP(FOB+NFS)	92719.4375	89077.0625	79959.3125
8	DR.IMP(FOB+NFS)	62798.5078	62831.8164	64236.8867
9	NET.FCTINC	-35348.3672	-33150.4492	-30581.3164
10	BOP.IMP.LTINTRST	25683.8945	25962.0977	23521.0977
11	BOP.NET.CURTRANS	1901.3718	2754.4878	2535.4207
12	NET.CURBAL.IMFDEF	-3525.6924	-4150.7422	-12340.4844
13	NET.TOTLTCAP.EXRESV.EX	16654.4844	9221.8555	5498.5547
14	LT.CAP.LLOAN	13682.5859	6000.7812	5542.3906
15	LT.CAP.DISBUR	25799.8906	17899.8867	18096.7852
16	LT.CAP.REPYMT	12117.2852	11899.0937	12554.3867
17	LT.CAP.INFL.OTH	-119.8032	-1007.9941	-2536.4412
18	OTH.CAP.INFL	-6136.8828	-5994.0664	3761.6663
19	DECLN.RESER	-6991.8945	922.9456	3080.2568
20	GOV.CUR.REV	..	..	..
21	GOV.CUR.EXP	..	..	..
22	GOV.CUR.BAL	..	..	..
23	GOV.CUR.RECT	..	..	..
24	GOV.CAP.PYMT	..	..	..
25	GOV.ALL.BAL	..	..	..
26	CP.$.IMP.FUEL	11730.9805	10405.9648	5997.1367
27	CP.$.IMP.MACH	15200.7969	15872.1836	17861.7461
28	CP.$.IMP.OMAN	14873.8047	15310.4375	17924.1641
29	CP.$.IMP.MAN	30074.625	31182.6484	35785.9492
30	CP.$.IMP.TOTAL(MERCH.)	50571.2148	49762.9062	51001.3008
31	CP.$.INV.FIXD	93109.8125	103029.375	..

Table 3C.2

Latin America Constant Price Flow Variables in Millions of 1980 US $

	Variable	1960	1961	1962	1963	1964	1965	1966	1967
1	KP.$.CON.PRV	..	167139.5	177982.6	187916.8	199861.2	203464.8	218567.5	225937.5
2	KP.$.CON.GOV	..	26397.27	29637.23	30875.55	31391.71	30422.51	32904.77	33778.08
3	KP.$.INV.GDI	..	47704.07	47462.74	45619.53	54243.90	56377.81	60309.44	60609.23
4	KP.$.EXP.GNFS	..	25277.28	27206.42	28524.59	28405.09	30292.78	32343.67	33010.88
5	KP.$.IMP.GNFS	..	26988.12	27559.98	27591.60	29659.74	28881.37	33034.18	33858.14
6	KP.$.GDP.MP	..	239530.0	254729	265344.8	284242.1	291676.5	311091.1	319477.6
7	KP.$.INV.FIXD	..	40534.98	42765.58	39714.99	46865.62	48006.09	51119.79	52504.69
8	KP.$.IMP.FUEL	..	..	..	..	..	12640.28	13891.26	14348.82
9	KP.$.IMP.MACH	..	..	..	..	..	7990.25	8817.804	9539.359
10	KP.$.IMP.OMAN	..	..	..	..	..	8017.421	8902.921	8779.691
11	KP.$.IMP.MAN	..	..	..	..	..	16007.61	17720.70	18319.02
12	KP.$.IMP.TOTAL(MERCH.)	..	..	..	..	..	32072.46	35494.62	36845.31

Table 3C.2

Latin America Constant Price Flow Variables in Millions of 1980 US $

	Variable	1968	1969	1970	1971	1972	1973	1974	1975
1	KP.$.CON.PRV	238631.8	251682.1	271005.3	291173.5	309552.8	337350.5	362007.1	351186.1
2	KP.$.CON.GOV	35771.59	37892.90	40721.20	44511.90	44581.74	50513.12	53761.96	58774.96
3	KP.$.INV.GDI	64037.36	76704.37	82728.81	87206.12	91389.87	104756.2	122299.2	117354.9
4	KP.$.EXP.GNFS	35220.54	38868.26	39545.04	41248.85	46571.26	50078.80	52648.69	52319.69
5	KP.$.IMP.GNFS	37084.23	40717.68	45637.98	50233.22	53505.59	59000.44	71543.56	67540.68
6	KP.$.GDP.MP	336577.0	364429.9	388362.3	413907.1	438590.1	483698.1	519173.4	512095
7	KP.$.INV.FIXD	57674.59	69401	74509.12	79637	87430.62	96381.25	105487.3	106546
8	KP.$.IMP.FUEL	14910.72	15589.32	16533.32	18637.08	19002.83	21503.75	15089.71	16115.28
9	KP.$.IMP.MACH	10892.73	11219.94	12501.12	13152.47	14196.64	14914.48	16077.60	18636.85
10	KP.$.IMP.OMAN	9907.425	10559.18	11848.64	12542.23	12820.96	14894.14	21845.76	18816.74
11	KP.$.IMP.MAN	20800.06	21779.00	24349.72	25694.79	27017.62	29808.61	37923.36	37453.58
12	KP.$.IMP.TOTAL(MERCH.)	40284.78	42104.90	45816.23	50114.91	51940.55	57305.66	61752.90	61641.55

Table 3C.2

Latin America Constant Price Flow Variables in Millions of 1980 US $

	Variable	1976	1977	1978	1979	1980	1981	1982	1983
1	KP.$.CON.PRV	370246.8	381839.5	407103.9	451773.8	481591.3	480048.1	447682.1	450434.5
2	KP.$.CON.GOV	62136.41	61725.73	63324.60	71946.31	77708.25	77252.62	82585.68	75856.75
3	KP.$.INV.GDI	128063.6	131285.7	134018.7	147490.7	169712.5	163319.9	127545.2	102662.5
4	KP.$.EXP.GNFS	57526.39	62465.64	71056.68	77916.5	83391	88253.43	89022.75	96577
5	KP.$.IMP.GNFS	66568.93	68027.5	72021.68	83276.43	97001.56	99326.25	80598.43	61130.16
6	KP.$.GDP.MP	551404.3	569289.1	603482.2	665851	715401.5	709547.9	666237.4	664400.6
7	KP.$.INV.FIXD	122070.5	121309.6	124749.8	140925.0	155228.6	150826.1	128636.1	100094.0
8	KP.$.IMP.FUEL	16426.69	16955.94	17660.57	18629.91	15872.02	16113.03	15443.24	14123.48
9	KP.$.IMP.MACH	18313.93	17148.37	17797.28	20698.93	24590.91	27000.63	19451.76	14670.17
10	KP.$.IMP.OMAN	16076.39	15824.88	16893.73	20041.31	26298.31	26322.89	19936.93	13932.52
11	KP.$.IMP.MAN	34390.37	32973.24	34690.96	40740.42	50889.25	53323.80	39388.69	28602.70
12	KP.$.IMP.TOTAL(MERCH.)	58487.47	58028.75	61599.46	70189.37	80021.43	82707.06	65562.31	51040.98

Table 3C.2

Latin America Constant Price Flow Variables in Millions of 1980 US $

	Variable	1984	1985	1986
1	KP.$.CON.PRV	464221.2	478231.6	..
2	KP.$.CON.GOV	77563.62	76256.5	..
3	KP.$.INV.GDI	108993.5	112819.0	..
4	KP.$.EXP.GNFS	107678.6	112127	..
5	KP.$.IMP.GNFS	62906.75	62299.24	..
6	KP.$.GDP.MP	695550.1	717135	..
7	KP.$.INV.FIXD	99446.31	113132.5	..
8	KP.$.IMP.FUEL	13011.20	11887.44	12778.62
9	KP.$.IMP.MACH	16017.83	16554.69	15751.22
10	KP.$.IMP.OMAN	15673.16	15969.49	15806.26
11	KP.$.IMP.MAN	31691.01	32524.26	31557.54
12	KP.$.IMP.TOTAL(MERCH.)	54612.59	54604.98	55709.59

Table 3C.3

Latin America : Deflators ,1980 =100.

	Variable	1960	1961	1962	1963	1964	1965	1966	1967
1	DEFL.$.CON.PRV	..	24.5616	28.4624	29.5382	32.5709	28.914	31.3269	32.0934
2	DEFL.$.CON.GOV	..	21.9257	24.6839	25.7878	25.9945	25.2745	29.7062	29.7382
3	DEFL.$.INV.GD I	..	25.7977	27.6742	31.1097	31.673	29.8414	32.3792	32.4475
4	DEFL.$.EXP.GNFS	..	24.7522	23.0356	30.0867	30.6812	28.727	30.8381	30.2094
5	DEFL.$.IMP.GNFS	..	25.1959	28.8648	33.1114	30.9405	28.1613	29.8888	29.8111
6	IDX.PR.EXRATE(TR DWTS)	1.8112	1.8437	1.6854	1.8382	2.1996	4.2691	3.8709	4.8492
7	IDX.PR.EXRATE(EXP WTS)	..	1.9033	2.2504	1.7596	2.011	3.4535	3.166	3.8577
8	IDX.PR.EXRATE(IMP WTS)	..	1.7905	1.342	1.9151	2.3951	5.3562	4.7426	6.0788
9	DEFL.$.GDP.MP	..	24.4659	27.2527	29.0593	31.6545	28.7687	31.4614	31.9587
10	IDX.$.TOT.GNFS	..	98.239	79.8051	90.8651	99.1619	102.0088	103.1761	101.3361
11	DEFL.$.DOM.PRN	..	24.4322	27.757	28.9357	31.7626	28.7736	31.5337	32.1604
12	IDX.REAL.PR.EXRATE	..	158.275	156.5275	145.4369	154.7799	138.4584	121.8371	105.9979
13	DEFL.L.DOM.PRN	..	0.2935	0.3108	0.4185	0.4397	0.8683	0.9496	1.3638
14	DEFL.L.PRV.CON	..	0.3366	0.3341	0.4333	0.4645	0.915	0.9949	1.4147
15	DEFL.L.IMP.GNFS	0.4732	0.4511	0.3874	0.6341	0.7411	1.5084	1.4175	1.8122
16	DEFL.IMP.FUEL.$	..	..	..	..	..	4.26	4.26	4.26
17	DEFL.IMP.MACH.$	..	..	..	..	..	29.9998	31.0997	31.3997
18	DEFL.IMP.OMAN.$	..	..	..	..	..	29.9997	31.0997	31.3997
19	DEFL.IMP.MAN.$	..	..	..	..	..	29.9998	31.0997	31.3997
20	DEFL.IMP.TOTAL(MERCH).$	..	..	..	..	..	21.4312	22.1083	21.8013

Table 3C.3

Latin America : Deflators ,1980 =100.

	Variable	1968	1969	1970	1971	1972	1973	1974	1975
1	DEFL.$.CON.PRV	31.6861	32.7949	34.5025	36.9473	39.4438	45.2249	54.8739	60.804
2	DEFL.$.CON.GOV	28.8711	30.2767	32.6586	35.0232	39.6946	45.6118	56.7399	57.5906
3	DEFL.$.INV.GD I	31.9133	31.885	33.4355	35.045	37.1099	43.741	55.2211	61.317
4	DEFL.$.EXP.GNFS	29.2803	30.9046	33.5914	32.6955	35.7564	46.1586	58.8236	56.9146
5	DEFL.$.IMP.GNFS	29.6848	30.3862	31.5092	31.854	34.7068	40.8401	55.8571	59.3432
6	IDX.PR.EXRATE(TR DWTS)	7.0357	6.5756	7.25	8.0996	9.5218	11.4651	14.1973	24.1004
7	IDX.PR.EXRATE(EXP WTS)	6.0819	5.9473	6.6111	7.6661	9.656	10.6271	13.2571	24.2316
8	IDX.PR.EXRATE(IMP WTS)	8.0645	7.2491	7.8948	8.484	9.403	12.3311	14.9716	24.0034
9	DEFL.$.GDP.MP	31.3989	32.409	34.3408	36.534	39.1693	45.5754	55.414	60.3481
10	IDX.$.TOT.GNFS	98.6374	101.706	106.6082	102.6417	103.0242	113.0227	105.3109	95.9075
11	DEFL.$.DOM.PRN	31.6465	32.5887	34.4258	36.9589	39.5748	45.5081	55.0292	60.7388
12	IDX.REAL.PR.EXRATE	112.7535	99.5404	95.7265	99.1944	96.6347	104.622	131.6959	118.0243
13	DEFL.L.DOM.PRN	1.8523	2.0073	2.3864	2.601	3.4198	4.4755	6.0216	12.1178
14	DEFL.L.PRV.CON	1.9308	2.071	2.4709	2.7063	3.4323	4.4577	6.3742	12.1042
15	DEFL.L.IMP.GNFS	2.3939	2.2027	2.4876	2.7025	3.2635	5.036	8.3627	14.2444
16	DEFL.IMP.FUEL.$	4.26	4.26	4.26	5.57	6.23	8.8499	36.7196	35.7398
17	DEFL.IMP.MACH.$	31.0997	32.7997	34.7997	36.6998	39.9997	46.3997	56.4996	62.7994
18	DEFL.IMP.OMAN.$	31.0997	32.7997	34.7997	36.6998	39.9998	46.3997	56.4996	62.7998
19	DEFL.IMP.MAN.$	31.0998	32.7998	34.7997	36.6997	39.9997	46.3997	56.4997	62.7997
20	DEFL.IMP.TOTAL(MERCH).$	22.1325	23.12	24.6923	25.4679	28.0861	34.5977	54.7558	56.7041

Table 3C.3

Latin America : Deflators ,1980 =100.

	Variable	1976	1977	1978	1979	1980	1981	1982	1983
1	DEFL.$.CON.PRV	65.7909	68.6612	75.3015	85.9811	99.9997	109.0363	95.6193	82.3543
2	DEFL.$.CON.GOV	61.5922	63.0901	75.4377	84.6507	100	111.6195	90.0909	74.5678
3	DEFL.$.INV.GD I	65.5288	66.8173	77.4333	89.4697	100.0004	114.15	100.4156	88.7434
4	DEFL.$.EXP.GNFS	67.1196	71.1311	69.6455	82.9743	100	102.9757	91.6285	85.4976
5	DEFL.$.IMP.GNFS	63.6366	66.9089	72.234	85.3516	100	105.6883	95.8098	102.1984
6	IDX.PR.EXRATE(TR DWTS)	32.2797	47.7552	61.5934	77.2168	99.9991	137.4045	268.1748	655.8513
7	IDX.PR.EXRATE(EXP WTS)	31.2396	47.5516	61.1211	77.8441	99.9993	139.0243	277.2612	692.5112
8	IDX.PR.EXRATE(IMP WTS)	33.2579	47.9544	62.0457	76.6502	99.9993	136.0176	258.8999	610.3562
9	DEFL.$.GDP.MP	65.6556	68.1123	75.4894	86.3369	99.9999	110.2095	95.296	81.0836
10	IDX.$.TOT.GNFS	105.4733	106.3104	96.4165	97.2147	100	97.4334	95.6358	83.6584
11	DEFL.$.DOM.PRN	65.485	67.7402	76.2692	86.7826	99.9999	111.237	95.8615	80.3329
12	IDX.REAL.PR.EXRATE	113.7698	115.7879	111.234	107.9719	100.0002	88.8944	89.4262	106.9411
13	DEFL.L.DOM.PRN	18.0555	27.5957	39.998	61.0397	99.9989	163.3629	287.3181	626.7651
14	DEFL.L.PRV.CON	18.8854	28.426	40.0156	60.666	99.999	160.3628	278.8496	627.335
15	DEFL.L.IMP.GNFS	21.1642	32.0858	44.8181	65.4223	99.9993	143.7563	248.0523	623.7776
16	DEFL.IMP.FUEL.$	38.3595	41.9697	42.2996	60.9796	99.9993	112.4606	101.6387	92.46
17	DEFL.IMP.MACH.$	63.6997	69.9997	80.4996	91.1996	99.9994	100.4997	99.0991	96.5994
18	DEFL.IMP.OMAN.$	63.6996	69.9995	80.4992	91.1997	99.9995	100.4997	99.0995	96.5995
19	DEFL.IMP.MAN.$	63.6997	69.9997	80.4996	91.1993	99.9994	100.4993	99.0993	96.5995
20	DEFL.IMP.TOTAL(MERCH).$	57.4828	61.9192	69.1611	83.6196	99.9994	102.0041	97.1725	94.3316

Table 3C.3

Latin America : Deflators ,1980 =100.

	Variable	1984	1985	1986
1	DEFL.$.CON.PRV	85.8763	82.5581	..
2	DEFL.$.CON.GOV	76.0085	77.1808	..
3	DEFL.$.INV.GD I	93.6282	91.0696	..
4	DEFL.$.EXP.GNFS	85.6026	80.4517	..
5	DEFL.$.IMP.GNFS	101.5428	103.3762	..
6	IDX.PR.EXRATE(TR DWTS)	1403.9792	3295.6931	..
7	IDX.PR.EXRATE(EXP WTS)	1536.9219	3787.8252	..
8	IDX.PR.EXRATE(IMP WTS)	1232.1506	2711.9409	..
9	DEFL.$.GDP.MP	84.5313	81.1874	..
10	IDX.$.TOT.GNFS	84.302	77.8242	..
11	DEFL.$.DOM.PRN	84.3352	81.3238	..
12	IDX.REAL.PR.EXRATE	85.999	80.5237	..
13	DEFL.L.DOM.PRN	1657.74	4231.0039	..
14	DEFL.L.PRV.CON	1669.7429	4292.4414	..
15	DEFL.L.IMP.GNFS	1251.168	2803.5112	..
16	DEFL.IMP.FUEL.$	90.1606	87.5374	46.931
17	DEFL.IMP.MACH.$	94.8992	95.8772	113.3991
18	DEFL.IMP.OMAN.$	94.8998	95.873	113.3991
19	DEFL.IMP.MAN.$	94.8995	95.875	113.399
20	DEFL.IMP.TOTAL(MERCH).$	92.5999	91.1325	91.5485

Table 3C.4

Latin America : Current Price Stock Variables in Millions of US $

Variable	1960	1961	1962	1963	1964	1965	1966	1967
1 MONEY.BDEF	14083.188	14015.934	18032.195	20140.629	22401.766	21139.934	21981.539	23142.133
2 PUB.LLOAN	..	..	..	..	..	..	..	..
3 PRV.LLOAN	..	..	..	..	..	..	..	..
4 USE.FUND	..	..	..	..	..	..	..	..
5 SHORT.DEBT	..	..	..	..	..	..	..	..
6 INTL.RES.EXGOLD	1074.200	910.400	688.500	978.099	1043.600	1481.100	1496.900	1699.000
7 GOLD.HOLD	974.834	1020.544	827.090	904.502	735.623	652.810	584.154	603.680

Variable	1968	1969	1970	1971	1972	1973	1974	1975
1 MONEY.BDEF	26451.359	30560.641	35300.203	36934.984	44899.500	60334.434	75532.188	80679.625
2 PUB.LLOAN	..	..	14313.883	16122.086	19607.883	24573.398	33480.598	41050.805
3 PRV.LLOAN	..	..	..	..	..	..	19336.285	21474.988
4 USE.FUND	..	..	117.400	158.700	379.099	382.300	425.700	869.100
5 SHORT.DEBT	..	..	..	..	..	..	..	..
6 INTL.RES.EXGOLD	1996.200	2407.801	3338.402	3698.401	6811.977	10620.992	10045.688	7726.383
7 GOLD.HOLD	753.613	692.278	744.820	798.472	1204.414	2044.522	3228.502	2506.128

Table 3C.4

Latin America : Current Price Stock Variables in Millions of US $

Variable	1976	1977	1978	1979	1980	1981	1982	1983
1 MONEY.BDEF	102712.938	100060.563	126121.063	166768.500	195915.875	235120.125	191615.688	165980.500
2 PUB.LLOAN	51945.500	64615.121	82715.563	96659.188	110575.125	128405.125	151825.063	194707.813
3 PRV.LLOAN	23663.992	25921.801	29958.203	33695.699	39651.809	55519.512	57062.625	59825.016
4 USE.FUND	1774.301	1697.001	1078.301	1008.200	789.400	787.900	1985.700	7617.781
5 SHORT.DEBT	..	21314.996	23478.000	32067.004	51027.406	66098.875	74229.563	42608.207
6 INTL.RES.EXGOLD	12773.586	17200.387	25444.793	30757.289	28517.102	25645.699	16185.383	17287.188
7 GOLD.HOLD	2175.673	2857.100	4076.590	9590.273	11840.094	8417.840	8632.645	7436.180

Variable	1984	1985	1986
1 MONEY.BDEF	184364.375	171898.500	..
2 PUB.LLOAN	218335.938	238675.438	259325.938
3 PRV.LLOAN	57917.211	47394.512	42440.410
4 USE.FUND	10254.074	13141.590	14977.691
5 SHORT.DEBT	35577.813	31592.793	26560.996
6 INTL.RES.EXGOLD	28081.793	27608.902	..
7 GOLD.HOLD	5416.523	6601.141	7846.906

Table 3C.5

Latin America : Constant Price Stock Variables in Millions of 1980 US $

	Variable	1960	1961	1962	1963	1964	1965	1966	1967
1	KSTOCK.NET.$.LEAMER	..	..	..	..	..	..	..	..
2	KSTOCK.NET.$.PIM D=.1333	..	195516.00	212219.31	223645.44	240699.13	256620.00	273532.31	289575.13
3	KSTOCK.NET.$.PIM D=.1288	..	200204.00	217183.31	228925.06	246305.13	262587.06	279885.63	296341.00
4	KSTOCK.NET.$.PIM D=.1	..	236498.00	255613.75	269767.38	289656.25	308696.69	328946.81	348556.81
5	KSTOCK.NET.$.PFM	..	..	354678.63	371419.88	392394.38	418142.69	430937.25	457603.69

	Variable	1968	1969	1970	1971	1972	1973	1974	1975
1	KSTOCK.NET.$.LEAMER	..	..	..	..	..	..	..	..
2	KSTOCK.NET.$.PIM D=.1333	308649.31	336907.38	366506.75	397288.38	431760.44	470588.00	513345.94	551462.94
3	KSTOCK.NET.$.PIM D=.1288	315846.88	344566.75	374695.63	406071.81	441200.38	480755.00	524321.06	563334.50
4	KSTOCK.NET.$.PIM D=.1	371375.69	403639.13	437784.31	473642.88	513709.19	558719.50	608334.88	654047.38
5	KSTOCK.NET.$.PFM	473694.31	507687.44	549065.19	585357.63	626415.25	667507.81	735353.00	782607.13

Table 3C.5

Latin America : Constant Price Stock Variables in Millions of 1980 US $

	Variable	1976	1977	1978	1979	1980	1981	1982	1983
1	KSTOCK.NET.$.LEAMER	581818.31	621445.81	659003.56	708038.13	764113.88	808194.94	823892.88	808815.56
2	KSTOCK.NET.$.PIM D=.1333	600023.50	641350.06	680607.94	730807.94	788619.94	834323.13	851744.06	838300.63
3	KSTOCK.NET.$.PIM D=.1288	612847.56	655222.44	695579.56	746913.94	805940.13	852961.19	871735.94	859550.38
4	KSTOCK.NET.$.PIM D=.1	710713.19	760951.56	809606.19	869570.63	937842.25	994884.19	1024031.94	1021722.81
5	KSTOCK.NET.$.PFM	788914.25	839341.56	866071.06	926772.06	1022291.50	1082413.00	1052600.00	967660.06

	Variable	1984	1985	1986
1	KSTOCK.NET.$.LEAMER	794577.00	794735.13	..
2	KSTOCK.NET.$.PIM D=.1333	826001.50	829028.06	..
3	KSTOCK.NET.$.PIM D=.1288	848286.56	852159.81	..
4	KSTOCK.NET.$.PIM D=.1	1018996.88	1030229.75	..
5	KSTOCK.NET.$.PFM	964620.56	1018869.31	..

CHAPTER 4

MODELLING EXPORT VOLUMES AND PRICES FOR LATIN AMERICA

4.1 Introduction

In this chapter we deal with the modelling of export volume and price equations for Latin America. First we review the literature on the subject and then go on to explain the theoretical basis of our work. The scope for this review is restricted to multi- country studies as we are modelling the Latin American countries as a single region. For a recent review of empirical issues in modelling exports one can refer to Muscatelli, Srinivasan and Vines (1990). Full details of our empirical investigations follows our description of our theoretical specification.

4.2 Review of Theoretical Approach to Multi-country Studies

Multi-country studies can be grouped into two as those forming part of a world model and those which do not. Examples of the former are Taplin (1967,1973), Amano *et al* (1980), OECD (1988), IMF (1988), etc. For the latter, examples are: Khan (1974), Goldstein and Khan (1982), Grossman (1982), Riedel (1984), Bond (1985), Dornbusch (1985), Marquez (1988), Marquez and McNeilly (1988), Khan and Knight (1988).

World models approach the specification of export volume and price equations differently from the single country models[1]. This is because world models tend to specify import demand functions for each country or region as a tradition and then model export volume equations as driven by imports, constrained in such a way as to minimize discrepancy in global current accounts.[2]

The first empirical multi-country trade study in time series context was by Neisser and Modigliani (1953). Taplin (1967) reviews the world trade models, sets up an agenda and sketches models for research work. Armington (1969) lays the utility theoretic foundation for the modelling of bilateral or export volume equations for a good. Subsequent theoretical work by Taplin (1973), Hickman (1973), Hickman and Lau (1973) build on this framework with further simplifying assumptions to bring the model closer to empirical need for specifying aggregate export volume functions, while "preserving the spirit of Armington's approach".

Armington first introduces the distinction between a good and its products. The same "good" originating from different sources of supply(countries) is treated as different products which are imperfect substitutes for one another. The following four assumptions are made in the framework of utility maximizing behaviour of consumers subject to a linear budget constraint:

- assumption of independence, meaning that marginal rate of substitution between any two products of the same kind of good must be independent of the quantities of the products of all other kinds.

- homotheticity, each country's market share is unaffected by changes in the size of the market, as long as relative prices in that market remain unchanged.

- elasticities of substitution between products competing in any market are constant.

- the elasticity of substitution between any two products competing in a market is the same as that between any other pair of products competing in the same market, for all kinds of goods.

Armington's product demand function, X_{ij}, which follows from the above assumptions is separable from the demand function, X_i, for the good in question.

$$X_{ij} = b_{ij} X_i \left(\frac{P_{ij}}{P_i} \right)^{\sigma_i} \tag{1}$$

where,

X_{ij} is demand for ith good supplied by jth country, the demand for the ij th product.

P_{ij} is the price charged by the jth supplier for the ith good.

X_i And P_i are CES aggregation over the relevant product volumes and prices.

σ_i is the elasticity of substitution in the ith market.

There are several alternative theoretical rationalization for a product demand function of Armington as Branson (1972) notes, such as monopolistic competition model of tradeable goods or differential risk in purchasing goods from competing suppliers.

Utility tree approach pioneered by Armington has been extended in some ways. The relative price variable in Armington's approach has been extended to the concept of "effective price" by using a time trend or relative capacity utilization. In order to preserve global trade balance, these extensions call for restrictions at the estimation stage. Expectations on the price variable have been introduced by Hickman (1973). Armington's framework has been also in the context of export supply functions by Geraci and Prewo (1980) and intermediate goods by Clements and Theil (1978). Modelling of invisible components of exports have been attempted on roughly similar lines as in Bond (1979), OECD (1988).

Several simplifications are normally made to apply the logic of Armington in specifying aggregate export functions for a country. CES aggregation is given up in favour of weighted arithmetic or geometric mean in constructing market demand and average market price and therefore the elasticity estimated becomes market share elasticity rather than elasticity of substitution. Export unit values are used instead of bilateral prices of exports, ignoring price discrimination. Aggregations are made over markets and goods. Linear approximations to the product demand function are made and then aggregated.

4.3 Review of Empirical Work: World Models

Export Volume Equations

We have consulted three world models of 1988 vintage for their specification of the export sector of LDCs. These are MULTIMOD of IMF, INTERLINK of OECD, and GEM of NIESR, Britain. A comparative statement of their features with respect to the specification of export volume equations for LDCs is presented in Table 4.1.

TABLE

Specification of Export Volume Equations for Developing Countries in Selected World Models

Commodity Group	Elaticity wrt Mkt. Demand	Elasticity wrt Relative Price	Dynamics	Trend Coefft.	Sample Period	Data Frequency	Estimation Method
Primary Com.	See Note 1		absent				
Manuf.	1.0	.4960	absent	.011	1970-85	annual	Pooled Estimates for all regions.
Food	1.0	-	absent	absent	See Note 2		
Energy	1.0	-	absent	absent			
Raw Materials	1.0	-	absent	absent			
Manuf.	1.0	1.0	4 quarter distr. lag for the price var.	absent			
Services	0.92	0.9	absent	absent			
All Goods	1.0	1.073(LAM) 0.000(AF) 1.558(AS) 0.000(MS) See Note 3	ECM for all regions	.000(LAM) -0.006(AF) 0.002(AS) 0.005(MS)	7401-8502 6501-8502 7201 8504 6501-8502	quarterly	OLS

ultimod assumes that primary commodities are produced exclusively in LDC's. Therefore share of LDC exports in import markets is unity.

conometric details of trade equations in INTERLINK remain unpublished.

elative Price Variable in GEM is merchandise terms of trade, whereas in MULTIMOD and INTERLINK it denotes export price of exporting region relative to its competitors; Latin America (LAM), Africa (AF), Asia (AS) and miscellaneous developing countries (MS)

Three major conclusions regarding the specification can be drawn from Table 4.1. Firstly, all the three models impose unit elasticity of export volumes with respect to market potential, thus in effect specifying export market share equations. Secondly, relative price terms serve as explanatory variables only for manufactured goods, implying law of one price for other goods. Thirdly, dynamics are notably absent except in GEM which alone has a quarterly model.

A few additional observations about the estimated equations may also be made. There is considerable difference in the value of export volume elasticity with respect to relative export prices. INTERLINK and MULTIMOD are comparable in having a response only for manufactures; but the former reports a value of unity, double that of the latter. A unit elasticity with respect to relative export prices, as in INTERLINK, implies that export market shares for the commodity group in question, is constant in current price terms. Time trends are also present in the specifications, making the long run market shares steadily move in one direction, which is unsatisfactory.

Export Prices

Export price in aggregate is modelled as simply a weighted average of prices of commodity groups in the export basket. The determination of export prices of commodity groups, however, is vary different in the three models. We cannot go into full details of the differences in the determination of commodity prices here. Nevertheless, two important limitations of the existing approaches may be mentioned. Non-oil primary commodities are assumed to be produced entirely in LDCs in MULTIMOD which is contrary to the fact that in the world exports of food, the OECD countries dominate. Except in MULTIMOD, allowance for price setting behaviour by LDCs (even newly industrializing countries, when recognized as a group) in the export of manufactures is not made.

4.4 Review of Empirical Work: Multi-country Studies of LDC's

Multi-country studies of LDC exports have focussed on export volumes rather than prices, in keeping with the prevailing dominant thinking that primary commodities are homogeneous for which world prices prevail. It is fairly recently that LDCs have diversified into export of manufactures in a significant way. The main motivations for these studies have been the controversy regarding whether trade serves as an engine or handmaiden of growth, and more recently, the resolution of the debt crisis. Important studies published in the 80s are now compared in Table 4.2.

Table 4.2

COMPARISON OF MULTI COUNTRY STUDIES OF EXPORT VOLUMES FOR LDCs

...thor (year)	Exporter	Importer	Data	Commodities	Scale Variable	Price Variable	Dynamics	Est. Method	Short-run Elasticity wrt Scale Var.	Short-run Elasticity wrt Price Var.	Long-run Elasticity wrt Scale Var.	Long-r... Elastic... wrt Pric... Var.
...stein and Khan (1982)	Non-oil LDCs	Industrial countries	1963-80 annual	Non-Oil	GNP	-	-	OLS	1.3	0.	1.3	0.0
Reidel (1984)	Non-OPEC LDCs	Industrial countries	1960-78 annual	1 digit SITC	GNP	-	-	OLS dummies for 70s	-	-	0.9 to 1.3	0.0
Bond (1985)	Non-OPEC LDCs	Industrial countries	1967-81 annual	All goods	GNP	export price of LDCs to wt. exp. price of ROW	-	OLS	-	-	2.4	-0.8 to -0.1
...rnbusch (1985)	Non-OPEC LDCs, major mnf. exporters	World	1960-83 annual	Non-oil	OECD GNP	uvi LDCs to uvi DCs	absent	OLS	-	-	1.7 to 3.2	-0.5
Moran (1988)	15 LDCs	Trading partners	1965-83 annual	Maunuf.	GDP	relative export price	present	2SLS	0.34	-0.6	1.8 to 3.3	-6.0 to -1.0
Marquez (1988)	LDCs	major 5 OECD	1974-84 quarterly	1 digit SITC and NON-oil	GNP	Ratio of uvi to dom. price	yes	Spectral Regression	2.11	-0.96	1.8	-0.6

These studies have attempted to explain the export volumes of Non-oil LDCs to the industrial countries or rest of the world. Some studies have disaggregated exports by major commodity groups also, but we present results for aggregate exports only. Several interesting observations can be made from Table 4.2.

The income elasticity of LDC exports is higher in the period since the oil shock, as revealed in Reidel (1984). It may be noted that Dornbusch (1985) and Reidel (1984,1988) draw attention to the instability of the income elasticity estimate.

Relative price elasticity has been reported to be less than unity in most studies.

Dynamics have been either ignored or thought to be unimportant in most studies. In Marquez (1988) which features very elaborate dynamics by way of a variety of lags short-run price elasticity is higher than the long run, contrary to what one might expect and what is found in the survey of Goldstein and Khan (1985).

4.5 Theoretical Basis of our Work

We will work in demand-supply framework for Latin America. Export demand function is

$$xgi = f(\overset{+}{s}, \overset{-}{rpx})$$

where

xgi = index of export volumes

s = index of market potential, a base year market share weighted average of import volumes of all regions.

rpx = index of relative export price, ratio of export price of the region to a double weighted average of competitors export prices.[3]

This formulation of export demand function is in keeping with the current world modelling tradition, except that we do not impose *a priori* unit elasticity of export volumes with respect to market potential. We are not alone in doing this as some other studies viz., Klein and Van Pettersen (1973) and Samuelson and Kurihara (1980), also take a similar view . This unrestricted form will violate the homotheticity assumption of Armington, but given that we lump together all goods together which differ in their income elasticities in our export function, this may be justified. But our empirical results discussed below in section 4.6 show that for Latin America, the scale elasticity may in fact be imposed as unity. In contrast to other studies we do not allow for any variable to capture effective price such as capacity utilization or time trend which may be justifiable as allowing for non-price competitive factors. Capacity utilization will find place in our export supply function. Introduction of time trend is avoided to recover secular relationship from the variables.

Our export supply function will be inverted as a price function[4]. It is formulated as

$$pxg = g(\overset{+}{pd}, \overset{+}{cu})$$

where

pd = index of domestic cost

cu = index of capacity utilization

It is expected that export prices move in line with domestic costs in the long run. In the short run, however, capacity utilization can also influence the price setting behaviour. This formulation of supply function is again in keeping with the current world model tradition for imperfectly substitutable goods. This can be rationalized in the context of theory of firm as in Artus (1977), Deppler and Rippley (1978) or Cuthbertson and Corker (1985). It is a debatable point, however, whether this framework can be applied to those LDCs which produce a large proportion of primary commodities. The law of one price for primary commodities is frequently invoked but there have been criticism too as in Tinbergen (1950), Lord (1989).[5]

Volume and prices indices for other definitions of exports, goods and non factor services will be derived as functions (

link equations) of the corresponding ones for goods. The link equations estimated are presented in Chapter 5 where we assemble the full model for Latin America.

4.6 Econometric Analysis

Empirical Strategy

We now discuss how we propose to deal with empirical issues regarding choice of variables, functional form, specification of dynamics, simulataneity and structural stability. The questions of simultaneity and dynamic specification cannot be separated as we have a demand-supply framework.

Our empirical strategy is conditioned by data that is available to us. We have annual observations for all the time series that are relevant to us for the period 1965-85. Basic data at country level has been aggregated to give regional time series as explained in the appendix 4A on data sources and definitions.

The choice of variables has been governed by what is available to us from the data base. The appropriate functional form is assumed to be logarithmic partly for ease of interpretation, and because there was evidence that log specifications reduced remarkably heteroscedasticity (by visual examination of plot of residuals from a linear and log-linear specification) in our sample.

The questions of modelling dynamics in single equations carry over to a simulataneous equation framework and therefore these are discussed first. There are two approaches to dynamic specification at present: general-to-specific dynamic specification of Hendry (see Spanos, 1986), which we may call as an Autoregressive Distributed Lags (ADL) , and the Engle-Granger Cointegration approach (see Engle and Granger, 1987). In the first ADL approach, one seeks to find a parsimonious representation of data which will have desired long run properties. In the Engle-Granger procedure estimation of the long run and short run properties are done in two separate stages. In the first stage, simple static equation is estimated using OLS to is used to find the long run relationship. Then, in the second stage the dynamic model is estimated utilising the residuals of the first stage in an error correction framework. These two methods are expected to give similar results if one had sufficiently long time series. In the context of our small sample, it was decided to try both the approaches, as both the methods have some advantages in the context of small samples. The first stage cointegration approach will pose the three problems of small sample bias (we cannot appeal to super-consistency property of OLS estimator, see Stock, 1987), the fact that OLS is not designed to construct stationary residuals and in principle there can be more than one co-integrating vector. However, it has the advantages of more degrees of freedom in searching for dynamic specification and as all the variables in the second stage or stationary, standard t-tests are valid, unlike ADL which will have level terms alongside stationary terms. The ADL approach on the other hand reduces degrees of freedom and presence of level and difference terms may make t statistics on level terms unreliable introducing the risk of dynamic mis-specification (Banerjee *et al* ,1986).

ADL and E-G approaches become complicated in the context of a simulataneous equation framework. Degrees of freedom problem does become acute when one has to estimate a general ADL framework over a small sample. Extending E-G approach to simultaneous equations framework is a fairly recent focus of research and there does not appear to be a standardized body of knowledge yet. Our own applied econometric contributions can be found in Muscatelli, *et al.*, 1990. A compromise approach, often attempted by researchers is to impose a simple partial adjustment and apply 2SLS methods (see Reidel, 1988), which carries the risk of dynamic mis-specification.

First we studied the time series properties of the variables of our model in a systematic fashion as explained in Appendix 4B. These make use of corrections for small samples suggested by using Phillips and Perron (1988). Plots of explanatory variables against the dependent variable were also drawn to understand the nature of series and watch out for outliers.

OLS estimates of ADL regressions are attempted first without any restrictions. Next, *a priori* linear restrictions on coefficients are imposed if they are data acceptable. Wickens-Breusch reparameterization is done to obtain long run standard errors as in Gurney (1989). If necessary insignificant level terms are dropped and the equation is re-estimated. Then Engle-Granger regressions were estimated. Choice between ADL and E-G approaches is made on the basis of overall performance statistics and acceptability of error pattern.

The issue of simultaneity between export volumes and prices remains incompletely addressed. In a world model with a large system of simultaneous system of equations, the current practice eschews as impractical any system methods like 2SLS or 3SLS. Instead, OLS or IV methods are used. Given that the estimated equations were to form a macroeconometric model, it is tenuous that some variables domestic variables like costs and capacity utilization can be treated as exogenous. When we introduced volume terms in the price equation, they turned out to be insignificant. This encouraged us to believe in a recursive structural equation system, which had the attraction of being capable of a thorough econometric investigation with OLS in the context of our small sample size. A reduced form estimation could have been attempted to circumvent the problem of simultaneity, but was overruled as not being informative on the structural features.

Structural stability of the estimated relations assumes importance in the light of doubts raised by Dornbusch (1985) and Reidel (1984), particularly for the scale variable in the export volume equation. Though we cannot directly answer the issue as our scale variable is market potential rather than income of importers, we hope to throw some light on the debate. We apply the method of recursive least squares to detect the instability of parameters.

Export Volume Equations

The time series properties of the variables in the export volume equation can be seen from the appendix tables 4C. All the three variables, export volume, market potential and relative export price are found to be integrated of order 1 and above, and do not require a deterministic trend, at a conventional 5 % level of significance. Of these, the relative price variable is I(1) and the other two appear to be of a higher order, as can be inferred from Appendix 4C. The original work of Engle and Granger dealt with the cointegration among variables integrated individually to the same order. Subsequent work (See Hall (1986)),has shown that as long as at least a pair of I(2) variables are present, a linear combination of these may result in an I(1) variable and therefore, we again have essentially a set of I(1) variables. Therefore in principle these three variables could be cointegrated.

Regression results with diagnostics for the ADL and E-G approaches are presented in Table 4.3.

Table 4.3
Regression Results for Export Volume
(Sample 1965-85, Annual Observations)

	ADL	WB	ADL Restr.	WB Restr.	EG Stage I	EG Stage II
Dep. Var.	Δxgi	xgi *6	Δxgi	share *	xgi_{-1}	Δxgi
Constant	3.0206 (2.26)	12.909 (4.86)	3.986 (3.58)	11.903 (6.89)	9.309	0.037 (2.13)
Δs	0.8089 (3.23)	3.240 (3.62)	0.804 (3.35)	3.329 (3.73)		0.440 (1.88)
Δrpx	-0.748 (-3.3)	-2.996 (4.08)	-0.733 (-3.9)	-3.035 (4.26)		-0.492 (2.55)
xgi_{-1}	-0.250 (2.46)					
s_{-1}	0.244 (2.88)	0.978 (7.77)			0.847	
$(xgi-s)_{-1}$			-0.242 (-3.0)			
rpx_{-1}	-0.634 (2.46)	-2.540 (-5.6)	-0.608 (-3.6)	-2.518 (6.82)	-1.847	
res_{-1}	-	-				-0.211 (1.91)
R^2	0.546	0.942	0.546	0.745	0.957	0.311
D.W.	2.107	2.110	2.087	2.087	1.120	1.510
RSS	0.017	0.267	0.017	0.286		0.025
LM(1)	.31	.29	.31	.29		1.37
LM(2)	1.78	1.92	1.38	1.27		.82
ARCH	0.580	0.630	.69	0.750		1.530
DF					-2.677	
ADF					-2.872	
Memo Items	Δxgi	xgi *	Δxgi	share *	xgi_{-1}	Δxgi
Long Run Effects						
s	0.978	0.978	1.000	1.000	0.847	
rpx	-2.539	-2.540	-2.517	-2.517	-1.847	
Mean Lags years						
s			0.8			2.2
rpx			2.9			3.5

<u>Notes</u>

1.t values are given in brackets.
2.All variables are in natural logs.
3. LM and ARCH statistic is reported in F form.
4.Column heading WB indicates Wickens-Breusch reparameterization.

All the explanatory variables have the correct sign and the econometric relationships are reasonably well determined. The estimated coefficients are significantly different from zero at 5 per cent level of significance(critical value from t-table is around 2.1, for a degrees of freedom of 14 or 15). D.W. statistic as test for autocorrelation has many limitations as a test for autocorrelation as noted for instance in Maddala (1988). Therefore, autocorrelation up to second order is tested by means of an Lagrange Multiplier (LM) test, see Godfrey (1978), and the null hypothesis of zero autocorrelation could not be rejected at 5 per cent level of significance(critical values for LM (1/2) are around 4.75. LM test statistic for autocorrelation in squared residuals (ARCH) ,see Engle (1982), called ARCH, cannot reject the null that no such autocorrelation exists in the sample (critical value of F (2,14) statistic .at 5 per cent level of significance is 3.74). The first stage residuals from E-G procedure, as judged by Augmented Dickey and Fuller statistic, computed with small sample correction as in Phillips and Ouilaris(1987), does not indicate stationarity at 10 per cent level (critical value is - 3.45, in small samples). Cointegrating regression DW statistic, on the other hand suggests stationarity with the computed value of 1.12 against a critical value of .699 for a sample of 31 observations and 4 variables, see Sargan and Bhargava, (1983).

Two important observations about the estimated elasticities can be made. Firstly, the long-run price elasticity at 2.5 is higher than the short-run one at .7, as expected. Secondly, the market potential elasticity which can be restricted to unity in the long run, does not differ very much from the short run value. As a corollary, the mean adjustment lags for market potential is less than a year, but for the relative price variable it is 3 years[7]. These two features lead us to two important conclusions: that in the short run activity variable will be a major factor in the export performance of Latin America, and, that exports will follow the "J curve" in response to devaluations. These results are in conformity with similar findings for developed countries reported in Goldstein and Khan (1985). The consequences of these for balance of payments adjustment of LDCs can be better perceived after comparing with the corresponding scale and price elasticities for LDC imports, and this is pursued in Chapter 5, where we discuss partial model properties. The Wickens-Breusch normalized estimates indicate that the long run elasticities are in fact highly significant. The scale elasticities under alternative dynamic specification is around unity. But the long run price elasticity is lower under E-G approach. Our other export studies for newly industrializing countries in Asia ,see Muscatelli , *et al*,(1990), also indicated that across different dynamic specification estimate of scale elasticity is robust (around 2), unlike the relative price elasticity.

The relative price elasticities estimated are within the range of estimates by others. Data accepts the restriction of modelling export volumes as a as a market share equation. For this one compares column 1 and column 3 of Table 4.3. This conclusion is drawn by performing an F-test:

$$F_{r,n}=\frac{(RSS_r-RSS_u)/r}{RSS_u/n}$$

where RSS refers to residual sum of squares, r and u subscripts refer to restricted and unrestricted models, r refers to the number of restrictions and n is the degrees of freedom of the unrestricted model. The computed F was at 0.02 is far less than the critical value at 4.6, and therefore the null hypothesis that the restriction is true cannot be rejected.

The long run relative price elasticity is close to the value of "elasticity of substitution" at 3, assumed by Armington (1969).

The restriction that the export demand equation is homogeneous of degree zero in prices (both static and dynamic) also is accepted[8].

Note that in the E-G estimation only the dynamic homogeneity is testable, as to perform tests of this nature in the cointegration equation one will have to use the Johansen procedure, see Johansen (1988, 1989), not used in the present study. However, in the first stage of E-G procedure, we have imposed static homogeneity on *a priori* grounds with a view to improve estimates obtained (for support of this *a priori* restriction, see Hallman (1987)).

Estimated coefficients are stable over sample, more so in the case of ADL approach, as seen from plots of coefficient values from recursive least square regressions done on the restricted version of ADL and the second stage equation of E-G approach placed in Appendix 4E.

In order to choose between the ADL and E-G approaches to dynamic specification, the tracking performance and error pattern for the two approaches are presented in figures 4.1 to 4.4. Tracking performance and error pattern of ADL approach are decidedly better than that of E-G . Therefore in our full model we are well advised to use the ADL specification.

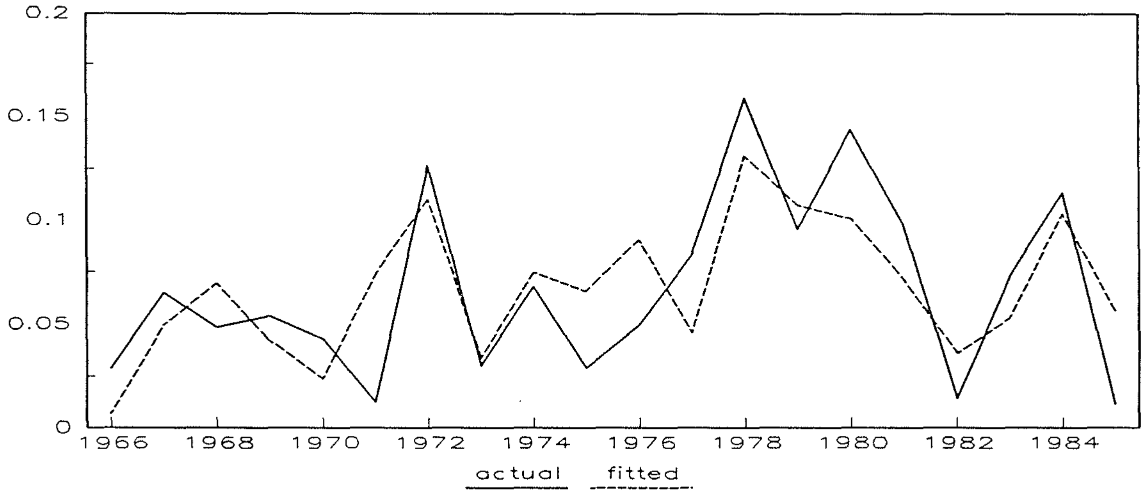


Figure 4.1
Tracking Performance of Restricted ADL Specification for Export Volume Equation

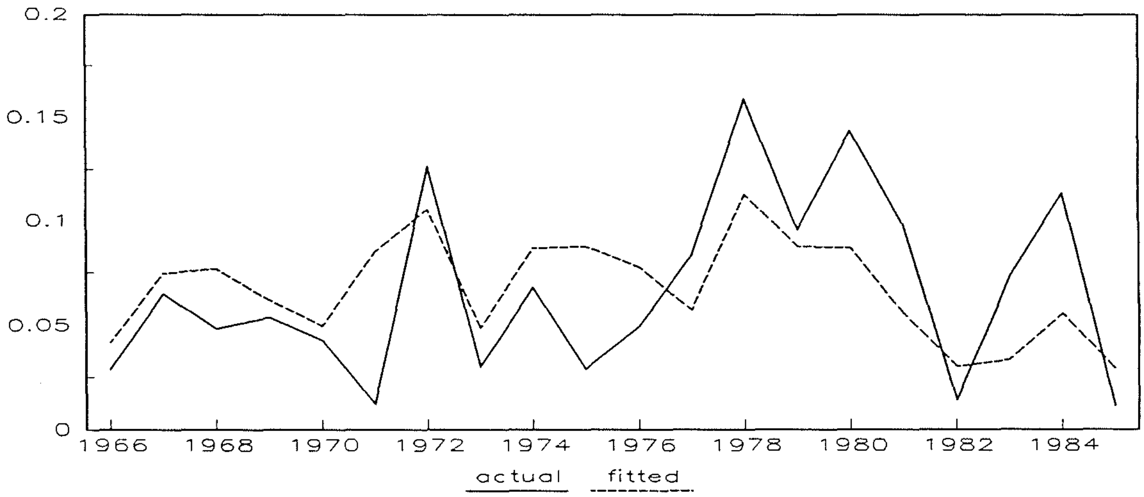


Figure 4.2
Tracking Performance of Engle-Granger Specification for Export Volume Equation

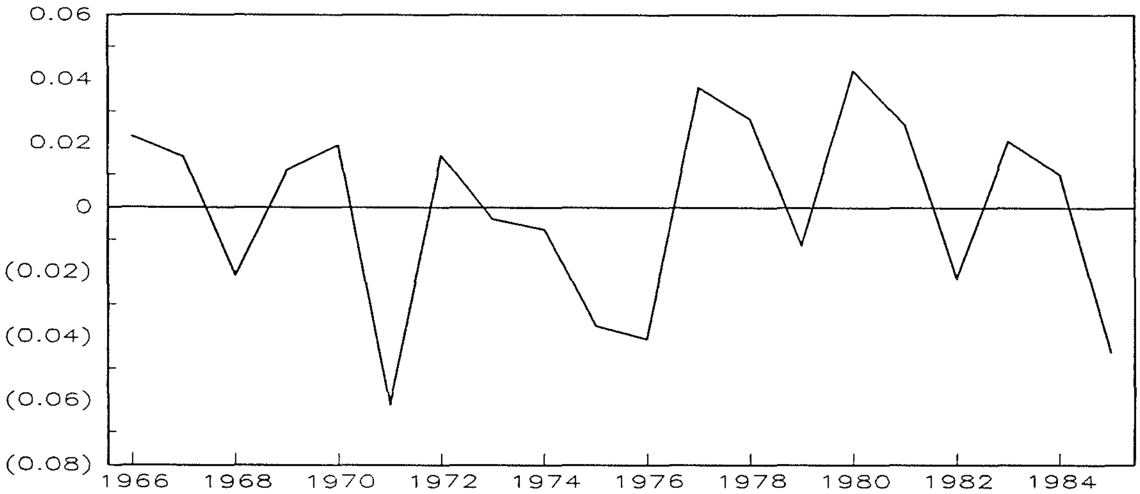


Figure 4.3
Residuals from Restricted ADL Specification for Export Volume Equation

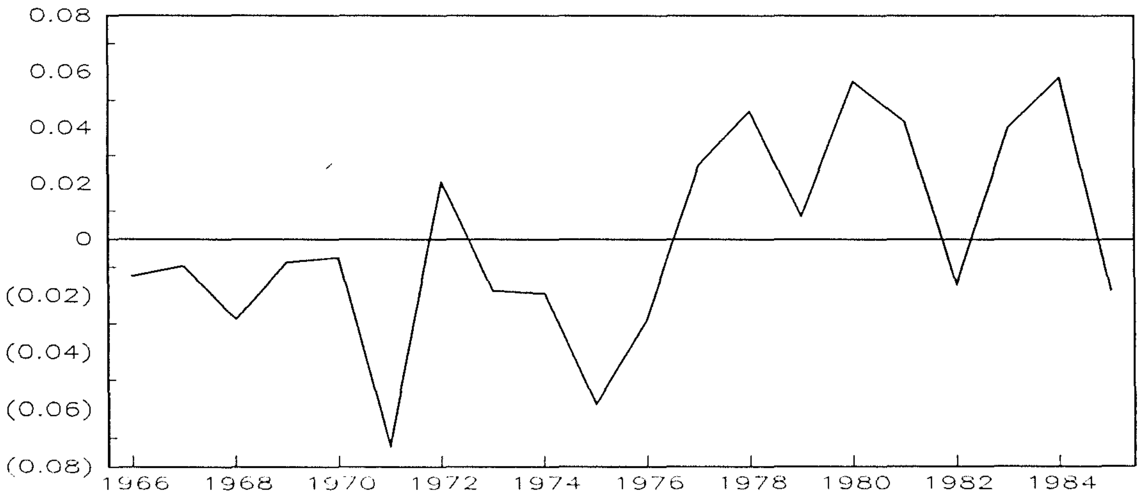


Figure 4.4
Residuals from Engle-Granger Specification for Export Volume Equation

Export Price Equations

Global models do not estimate export prices of countries of developing countries. Usually it is determined as a weighted average of the prices of constituent items determined in the world commodity markets separately modelled and the export price of manufactures in OECD countries. Multi-country models of export of manufactures from developing countries indicate price elasticity of supply anywhere between 0 and 3, as Moran (1988) summarizes.

Time series properties of the variables relevant for the specification of export prices are presented in appendix table 4D . We can infer from this table that the export price and domestic cost series are integrated of order 1 and above. Even at a 10 per cent level of significance, the computed ADF values (2.08 and 1.84, respectively) fall short of the critical value of 2.63, to suggest that the series are probably I(2). Capacity utilization is the only series which appears to be I(0), as one might expect. Deterministic time trends are generally absent. Therefore, in the cointegrating vector one should not have capacity utilization term. The scope for cointegrating relationship between two I(2) variables is a new area of research and our excercises here are only indicative.

The regression results with diagnostic statistics are presented in Table 4.4[9]. The variables have the correct signs and the relationships are reasonably well determined. The coefficients are significantly different from zero at 5 per cent level of significance except for the capacity utilization term and the constant. Capacity utilization term is significant at 10 per cent level and therefore retained. The restriction that prices are unit elastic with respect to costs in the long run is accepted, by performing an F-test as explained above (the computed F was .08 against the critical value of F (1,15) at 4.54. The residuals from the first stage of E-G procedure are judged by Dickey-Fuller and Augmented Dickey-Fuller statistics to indicate stationarity, at the margin, as the ADF statistic just falls short of the critical value.

Both the estimation approaches indicate dynamic homegeneity of prices with respect to costs[10]. Static homogeneity is supported in the ADL formulation, but not testable in E-G approach, as already noted above, when we discussed homogeneity issue in the export volume equation.

Export prices adjust to costs quickly with a mean lag of 1.5 years by either specification. The tracking performance of both ADL and EG specifications is equally good as can be seen from Figures 5 to 8.

Table 4.4

Regression Results for Export Prices

(Sample 1965-85, Annual Observations)

	ADL	ADL Restricted	EG Stage I	EG Stage II
Dep. Var.	Δpxg	Δpxg	pxg_{-1}	Δpxg
Constant	-0.0457 (-0.2745)	0.0057 (0.2862)	0.0119	-0.0113 (-0.5459)
Δc	1.1855 (4.6724)	1.1585 (5.0042)		1.1645 (5.0126)
Δcu	0.7475 (1.728)	0.7392 (1.763)		0.7402 (1.7671)
pxg_{-1}	-0.7345 (-2.6871)			
c_{-1}	0.7471 (2.6264)		1.0029	
$(pxg - c)_{-1}$		- 0.7170 (-2.7596)		
res_{-1}	-	-		-0.7219 (-2.7678)
R^2	0.6359	0.6336	0.9725	0.6343
D.W.	1.955	1.938	1.396	1.941
RSS	0.0889	0.0894		0.0893
LM(1)	.02	.04		.04
LM(2)	.55	.58		.58
ARCH	.53	.55		.56
DF			-3.157	
ADF			-3.406	
Long Run Effects				
c	1.0172	1.0	1.0029	1.0029

Notes

1. t values are given in brackets.
2. All variables are in natural logs.
3. LM and ARCH statistic is reported in F form.

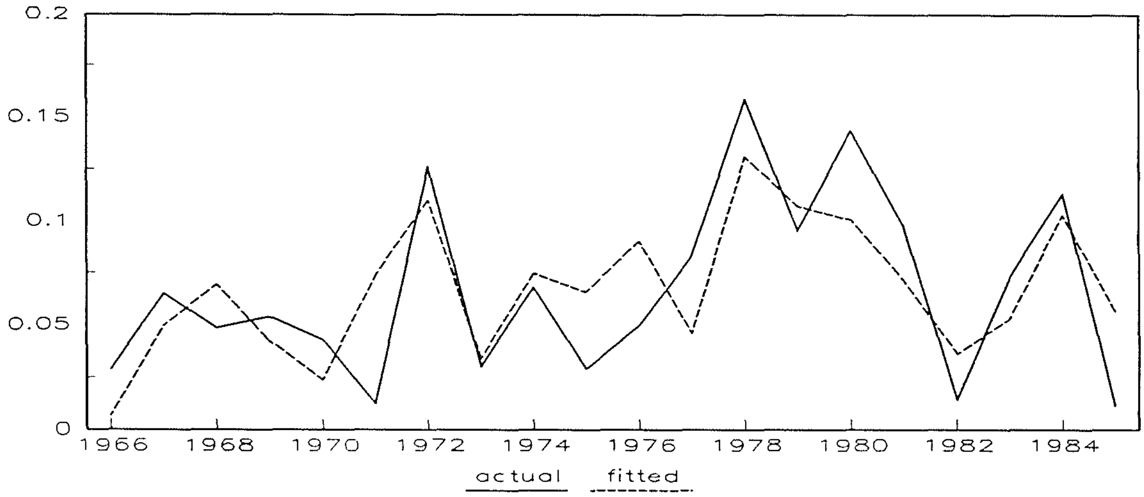


Figure 4.5

Tracking Performance of ADL Specification for Export Prices

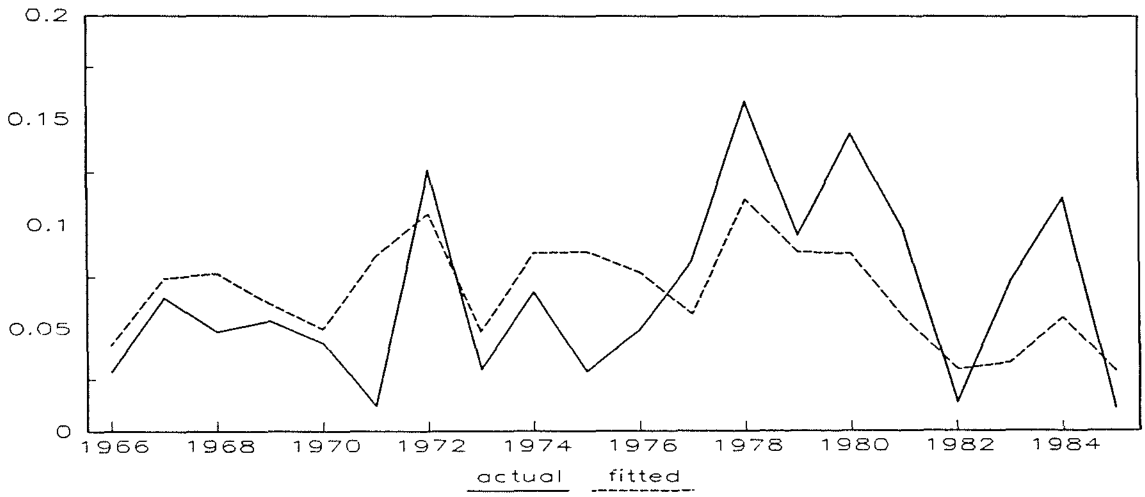


Figure 4.6

Tracking Performance of Engle-Granger Specification for Export Prices

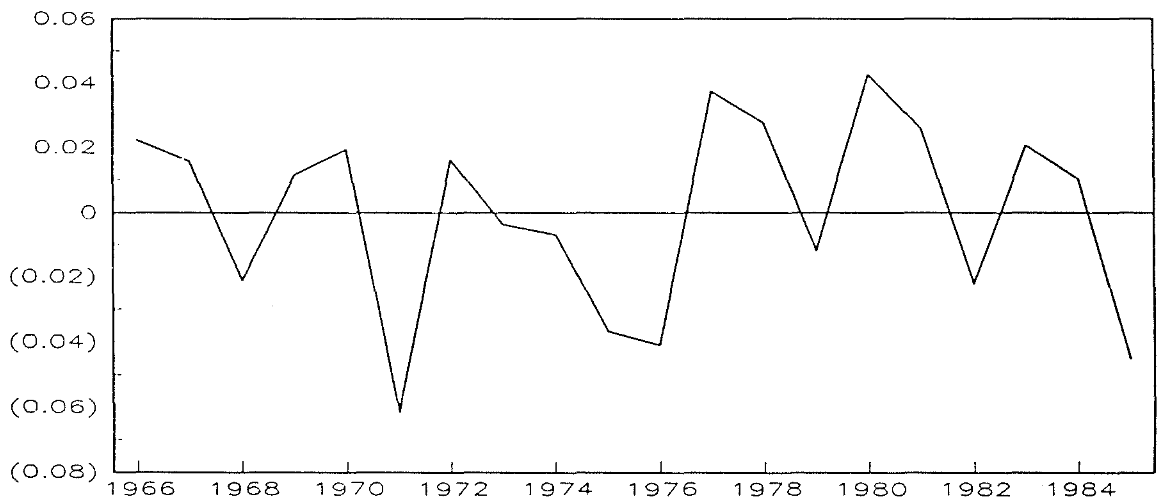


Figure 4.7

Residuals from ADL Specification for Export Prices

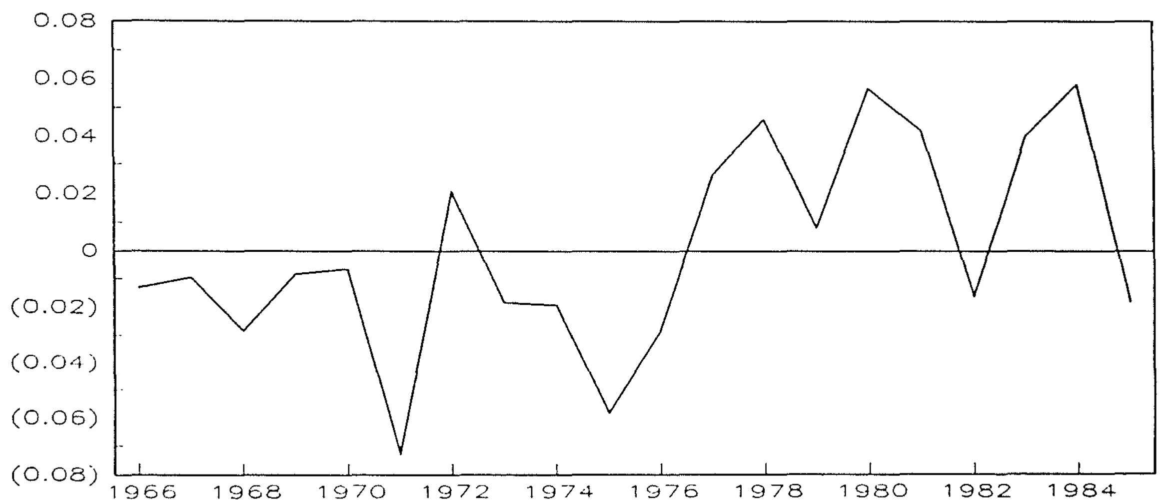


Figure 4.8

Residuals from Engle-Granger Specification for Export Prices

The estimated values coefficients are stable only over the last few years of the sample as indicated by plots of a recursive least squares estimation for the restricted ADL and the second stage E-G equation. Plots are placed in Appendix 4E.

4.7 Conclusions

We estimated export volume and price equations for four LDC regions following the usual practice in global models. In general, the estimated elasticities conform to available evidence. Notably, three popular results, two on volume and one on price equations, are accepted. These are: export volume is unit elastic with respect to export market; export volumes are homogeneous of degree zero in prices; and export price is homogeneous of degree zero with respect to costs. The dynamics underlying our estimated relations is in keeping with that of others, judging by the mean lags. A broad conclusion that arises in this regard is that, in the short-run market potential and capacity utilization will determine the export revenues, whereas in the medium term of up to 3 years, relative prices come into full play. An important feature on the supply-side of Latin American exports to come from this study is that capacity utilization effects are significant. We also note from our coefficient stability analysis using recursive least squares that export volume bears a stable relation to export market potential, definitely in the short run.

A serious limitation in our research is the use of a relative price measure in the export volume equation which is not very appropriate (see appendix 4A on data guide). This can be overcome by modelling separately manufactures and non-manufactures, a route which we did not take as building a more disaggregated model would have been more resource intensive.

Appendix 4A

Data Guide

Index of Cost (c)

Domestic absorption deflators in local currency units are deflated by indices of US $ exchange rates and then aggregated over countries using current weights of US $ value of domestic absorption, 19809=100.

Source: World bank's data base, cutoff date July 1988.

Index of Capacity Utilization (cu)

Constructed from an estimated production function for the region as a whole, regressing GDP at constant 1980 market prices (Y) upon Gross Domestic Fixed Investment (I), see appendix 3B to Chapter 3 on data issues.

Regression is specified as:

$$Y_t = \alpha + \beta Y_{t-1} + \sigma I_t$$

Capacity Utilization is constructed as:

$$cu_t = \frac{\hat{Y}_t}{Y_t}$$

Source: World bank's data base, cut off date July 1988

Index of Export Prices (pxg)

This is a Paasche unit value index of export of goods at fob prices aggregated over countries with current US$ weights of shares in regional exports.

Source: World bank's data base, cut off date July 1988

Index of Competitors' Export Prices (pxgc)

$$pxgc_i = \Sigma_j \lambda_{ij} \Sigma_{k \neq i} \phi_{kj} pxg_k / (1 - \phi_{ij})$$

where

$pxgc_i$ = Competitors' export price for region i

λ_{ij} = importance of region j in export of region i

ϕ_{ij} = element of export share matrix , 1980, placed in Table A1.

Source: pxg for the four LDC regions, World Bank's data base, for other regions' pxg and market share matrix: GEM's data base

Constructing a relative price measure using World Bank sources is problematic. International prices are used for non-manufactures and only for manufactures bilateral prices are constructed, using import unit value indices of partner countries. Therefore, our relative price measure constructed using World bank sources is not correct for *primary commodities*; it merely captures movements in average prices of different base year commodity baskets. We may hasten to add that even with regard to manufactures, commodity composition will matter, and some allowance is made to correct for this while constructing the index. See Moran and Park, 1986.

Index of Relative Export Price (rpx)

Defined as

$$rpx_i = \frac{pxg_i}{pxgc_i}$$

Index of Market Potential (s)

A market share weighted volume index of import volumes of trading partners.

Source: GEM's data base.

Index of Export Volume (xgi)

This is obtained by dividing current US $ value of Export of goods at fob prices at the regional level with pxg, derived above, and expressing as an index with base year 1980 = 100.

Source: World bank's data base, cut off date July 1988

Table 4A.1

Matrix of Weights to Derive Relative Export Price

1980

	Canada	USA	Japan	Germany
Canada	0.0000	0.0218	0.1223	0.0793
USA	0.0214	0.0000	0.0945	0.1047
Japan	0.0718	0.0566	0.0000	0.0963
Germany	0.0323	0.0435	0.0669	0.0000
France	0.0268	0.0414	0.0657	0.1355
Italy	0.0269	0.0397	0.0712	0.1276
Netherlands	0.0208	0.0359	0.0536	0.1256
Belgium	0.0223	0.0347	0.0510	0.1422
UK	0.0348	0.0439	0.0787	0.1446
Other OECD	0.0279	0.0381	0.0598	0.1150
OPEC	0.0516	0.0460	0.0657	0.0899
Far East	0.0540	0.0453	0.1098	0.0703
Latin America	0.0810	0.0437	0.0842	0.0847
Africa	0.0357	0.0340	0.0591	0.1222
Misc. LDC	0.0478	0.0428	0.0551	0.0902
Centr. Planned	0.0224	0.0257	0.0532	0.1098

Table 4A.1 Contd.
Matrix of Weights to Derive Relative Export Price
1980

	France	Italy	Nethl.	Belgium
Canada	0.0422	0.0296	0.0212	0.0202
USA	0.0641	0.0429	0.0359	0.0308
Japan	0.0608	0.0460	0.0321	0.0271
Germany	0.0872	0.0573	0.0522	0.0526
France	0.0000	0.0539	0.0670	0.0437
Italy	0.0772	0.0000	0.0623	0.0538
Netherlands	0.1038	0.0673	0.0000	0.0533
Belgium	0.0760	0.0654	0.0599	0.0000
UK	0.0808	0.0567	0.0508	0.0454
Other OECD	0.0752	0.0509	0.0503	0.0427
OPEC	0.0489	0.0333	0.0312	0.0309
Far East	0.0460	0.0320	0.0253	0.0231
Lat. America	0.0512	0.0336	0.0277	0.0253
Africa	0.0808	0.0452	0.0478	0.0408
Misc. LDCs	0.0593	0.0376	0.0381	0.0331
Centr. Planned	0.0624	0.0385	0.0302	0.0266

Table 4A.1 Contd.
Matrix of Weights to Derive Relative Export Price
1980

	UK	Oth. OECD	OPEC	Far East
Canada	0.0534	0.0834	0.2372	0.0852
USA	0.0660	0.1116	0.2074	0.0702
Japan	0.0708	0.1047	0.1772	0.1017
Germany	0.0904	0.1400	0.1683	0.0452
France	0.0785	0.1423	0.1424	0.0460
Italy	0.0789	0.1378	0.1387	0.0458
Netherlands	0.0764	0.1473	0.1406	0.0392
Belgium	0.0767	0.1405	0.1564	0.0403
UK	0.0000	0.1237	0.1526	0.0505
Other OECD	0.0635	0.1357	0.1402	0.0477
OPEC	0.0510	0.0911	0.2400	0.0712
Far East	0.0491	0.0903	0.2071	0.1011
Lat. America	0.0527	0.0887	0.1971	0.0566
Africa	0.0609	0.1156	0.1627	0.0498
Misc. LDCs	0.0486	0.1052	0.2233	0.0643
Centr. Planned	0.0485	0.1388	0.0765	0.0492

Table 4A.1 Contd.
Matrix of Weights to Derive Relative Export Price
1980

	Lat. Am.	Africa	Misc. LDC	Cen. Pld.
Canada	0.1038	0.0157	0.0580	0.0266
USA	0.0549	0.0146	0.0510	0.0300
Japan	0.0633	0.0152	0.0392	0.0371
Germany	0.0442	0.0219	0.0447	0.0532
France	0.0415	0.0225	0.0456	0.0470
Italy	0.0391	0.0180	0.0415	0.0416
Netherlands	0.0348	0.0206	0.0455	0.0353
Belgium	0.0358	0.0198	0.0443	0.0348
UK	0.0440	0.0174	0.0385	0.0376
Other OECD	0.0381	0.0170	0.0428	0.0553
OPEC	0.0550	0.0155	0.0590	0.0198
Far East	0.0460	0.0138	0.0495	0.0371
Lat. America	0.0793	0.0144	0.0472	0.0326
Africa	0.0419	0.0224	0.0500	0.0311
Misc. LDCs	0.0498	0.0181	0.0630	0.0236
Centr. Planned	0.0352	0.0115	0.0241	0.2474

Appendix 4B

Time Series Properties of Data Series

Formulation of Hypotheses for Testing

Test Statistic (comp. val. = c)	Null Hypothesis	Reject H_0 if: (ref. val.= r)
$Z\{t_\beta\}$	$\beta = 0$	$c > r$
$Z\{\phi_2\}$	$\beta = 0, \bar{\mu} = 0,$ and $\hat{\alpha} = 1$	c < r
$Z\{\phi_3\}$	$\beta = 0, \bar{\mu} = \hat{\mu},$ and $\hat{\alpha} = 1$	c < r
$Z\{\hat{\alpha}\}$	$\hat{\alpha} = 1$	c < r
$Z\{t_{\hat{\alpha}}\}$	$\hat{\alpha} = 1$	c < r
$Z\{\phi_1\}$	$\hat{\mu} = 0, \hat{\alpha} = 1$	c < r

Note:

The tests are based on the following alternative models of any variable x:

$$x_t = \hat{\mu} + \hat{\alpha} x_{t-1} + \hat{\epsilon} \qquad (1)$$

$$x_t = \hat{\mu} + \tilde{\beta} t + \hat{\alpha} x_{t-1} + \hat{\epsilon} \qquad (2)$$

For more detailed description of these tests, see Phillips and Perron (1988).

Appendix 4C

Time Series Properties of Data Series

Export Volume Equation

Series	$Z\{t_{(\beta)}\}$	$Z\{\phi_2\}$	$Z\{\phi_3\}$	$Z\{\hat{\alpha}\}$	$Z\{t_{(\hat{\alpha})}\}$	$Z\{\phi_1\}$	ADF
xg	1.90	18.35	1.98	0.28	0.60	23.37	0.56
s	1.10	8.52	2.78	-1.61	-2.12	12.61	-2.33
rpx	-1.94	2.60	3.82	-4.25	-1.39	1.21	-1.04
share	0.76	1.16	2.00	-8.66	-2.05	2.18	-1.92
Δxg	0.88	4.75	7.12	-17.47	-3.69	6.84	-2.38
Δs	-1.58	4.98	7.74	-15.51	-3.44	5.92	-2.79
Δrpx	-0.59	7.87	10.98	-20.10	-4.75	11.29	-5.36
$\Delta share$	1.62	3.90	6.13	-12.54	-2.92	4.29	-2.01

Notes

1. Sample Period and Data Frequency: 1965-85, annual.
2. Definition of Series (variables are in natural logs):
   - xg Export of goods, volume index.
   - s Index of market growth.
   - rpx Index of relative export price.
   - share Index of export market share (xg -s)

Appendix 4D

Time Series Properties of Data Series

Export Price Equation

Series	$Z\{t_{(\beta)}\}$	$Z\{\phi_2\}$	$Z\{\phi_3\}$	$Z\{\hat{\alpha}\}$	$Z\{t_{(\hat{\alpha})}\}$	$Z\{\phi_1\}$	ADF
pxg	0.287	3.176	1.472	-1.702	-1.751	5.051	-2.307
c	.417	4.469	1.029	-1.118	-1.455	6.889	-1.538
cu	-1.861	4.772	6.909	-13.029	-3.091	4.969	-2.297
Δpxg	-1.955	3.452	5.262	-9.960	-2.424	2.940	-2.083
Δc	-1.358	2.126	3.295	-8.636	-2.138	2.137	-1.841
Δcu	-.133	10.009	13.348	-19.830	-5.400	14.591	-3.959

Notes

1. Sample Period and Data Frequency: 1965-85, annual.
2. Definition of Series (variables are in natural logs):
   - pxg   Index of export price of goods.
   - c   Index of domestic cost.
   - cu   Index of capacity utilization

Appendix 4E

Recursive Least Square Plots of Structural Coefficients

Coefficients of Restricted ADL Equation for Export Volume

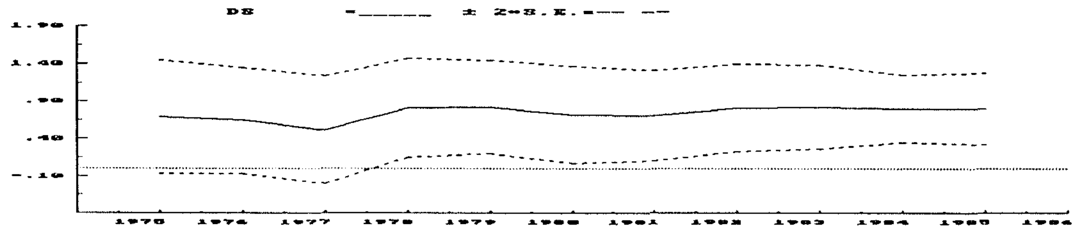


Figure 4E.1
Plot of coefficient of Δs

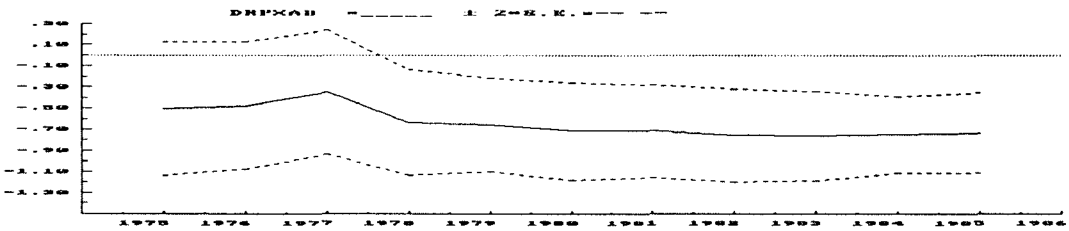


Figure 4E.2
Plot of coefficient of Δrpx

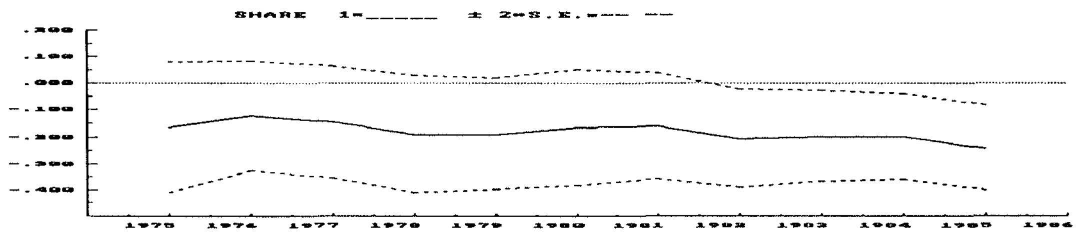


Figure 4E.3
Plot of coefficient of $\Delta(xgi-s)_{-1}$

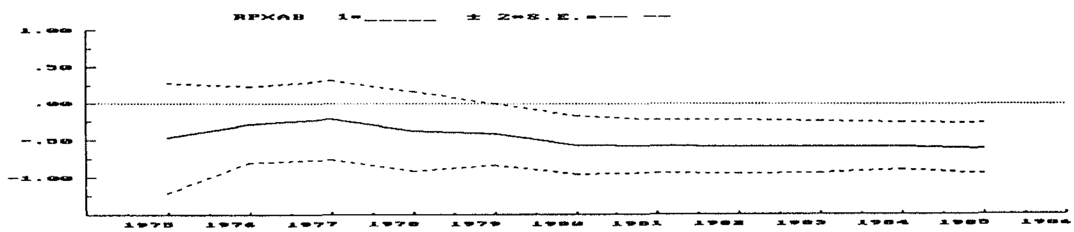


Figure 4E.4

Plot of coefficient of rpx_{-1}

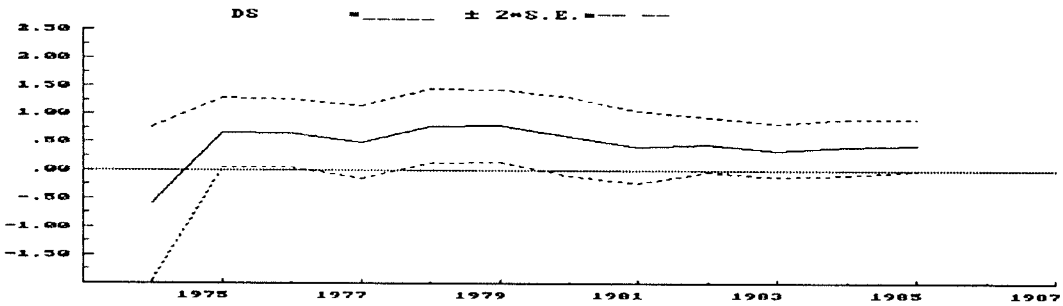


Figure 4E.4
Plot of coefficient of Δs

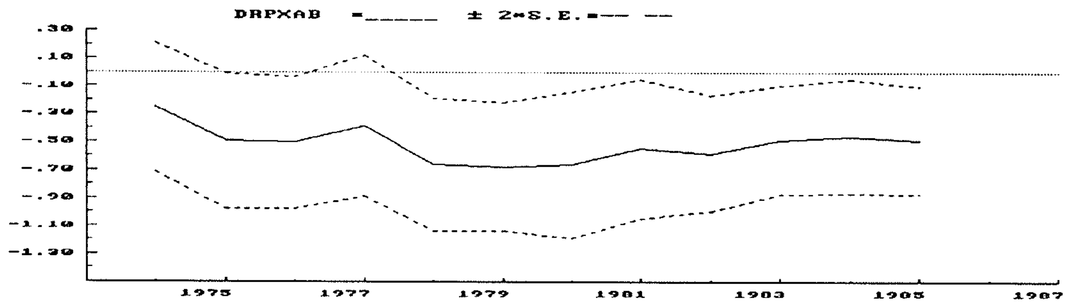


Figure 4E.5
Plot of coefficient of Δrpx

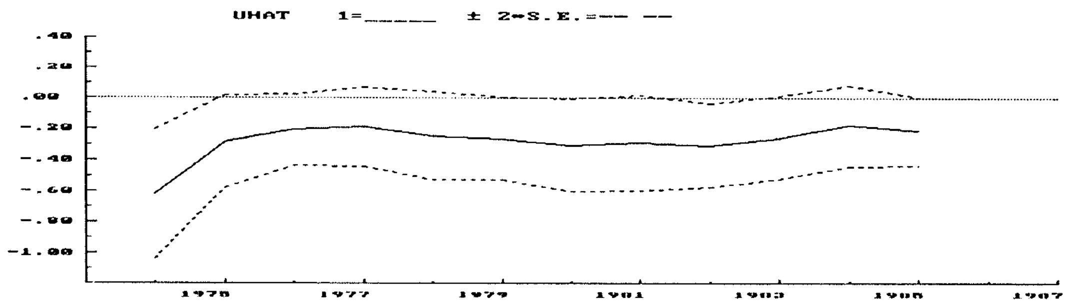


Figure 4E.6
Plot of coefficient of ECM term

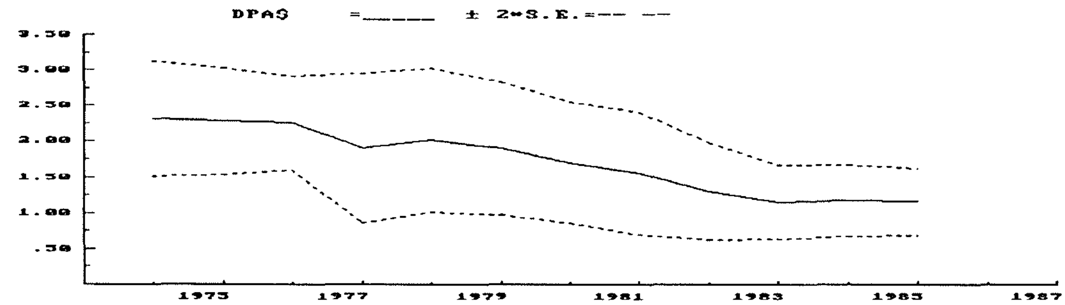


Figure 4E.7
Plot of coefficient of Δc

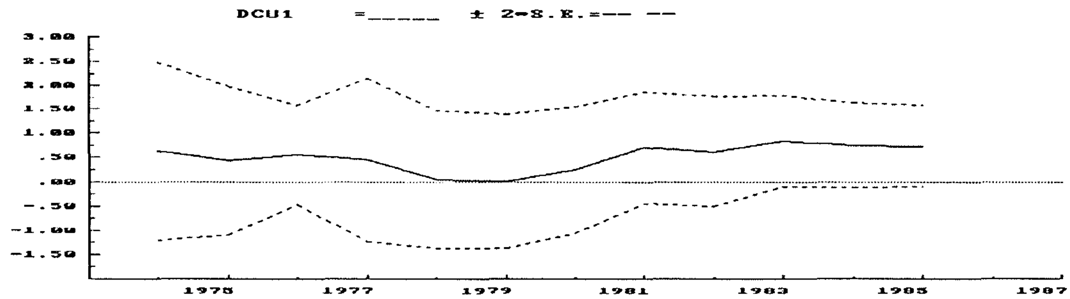


Figure 4E.8
Plot of coefficient of Δcu

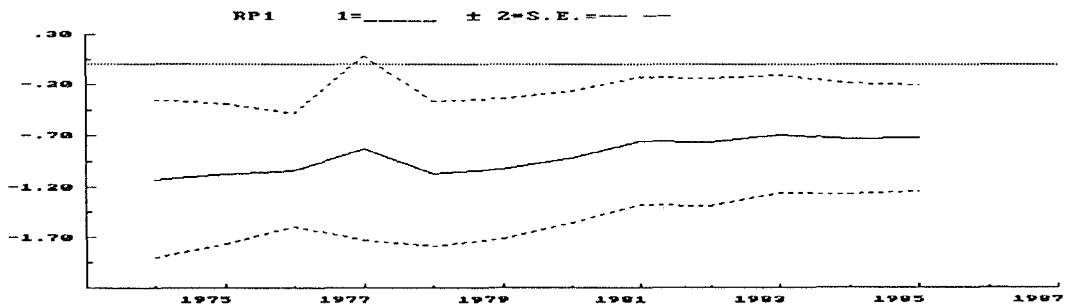


Figure 4E.9
Plot of coefficient of $(pxg-c)_{-1}$

Coefficients of E-G Equation for Export Prices

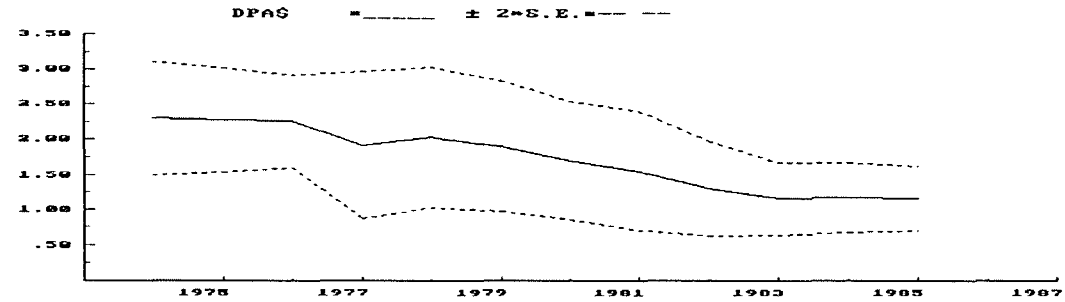


Figure 4E.10
Plot of coefficient of Δc

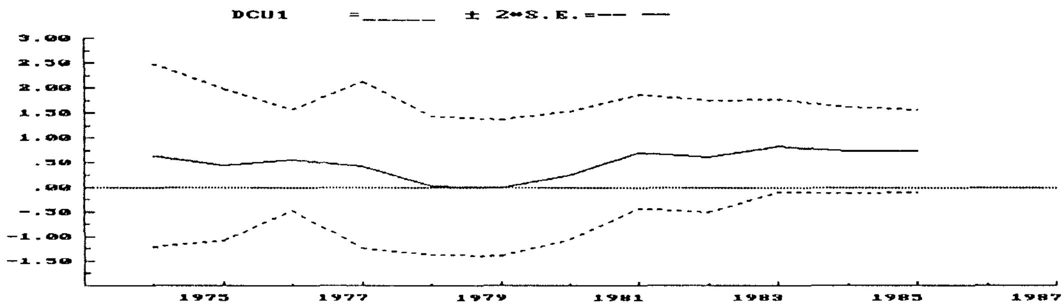


Figure 4E.11
Plot of coefficient of Δcu

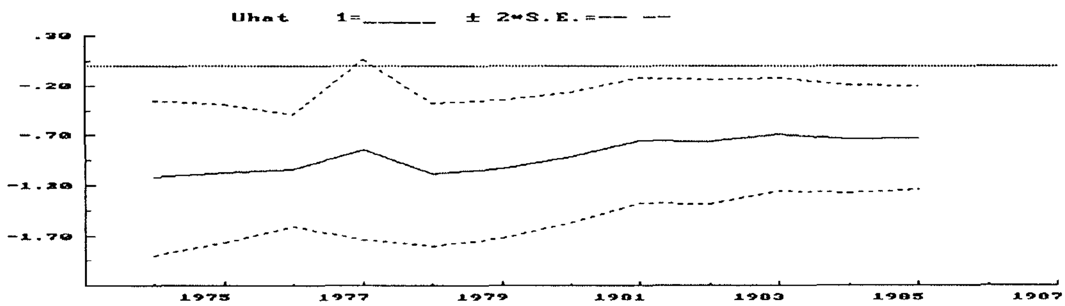


Figure 4E.12
Plot of coefficient of ECM term: $(pxg-c)_{-1}$

Endnotes

1. This tradition can be seen in the following context. For each country or region one can estimate four variables: volumes of export and import, prices of export and import. Global consistency in volumes and prices poses a choice in selecting which two of the four variables need to be constrained. The current tradition is to model import volumes and export prices without restrictions but impose restrictions while specifying export and import prices. It may be mentioned that this turns out to be an economical way of projecting bilateral trade flows, with further assumptions.

2. It has not been possible to eliminate this discrepancy completely for a variety of reasons as noted in OECD (1982). Important reasons for the trade account are: recording time asymmetry, data gaps, non-uniform definitions for cif and fob components, valuation differences and alternative sources of data. Therefore, some adjustment factors become necessary to balance global trade accounts.

3. $rpx_i = pxg_i/(\Sigma_j \lambda_{ij} \Sigma_{k \neq i} \phi_{kj} pxg_k/(1-\phi_{ij}))$

where

rpx_i = relative export price for region i
pxg_i = export price of region i
λ_{ij} = importance of region j in export of region i
ϕ_{ij} = element of export share matrix , 1980, placed in appendix table 4A.1.

4. The issue of normalization of demand and supply equation is an important one at the estimation stage. If sample size is large enough, full information methods can be used which do not require prior normalization of the structural relationships. With a sample size of 21 as we have, we had to take a prior view of the way we normalized the equations. If one is testing for a small country assumption, for example, like Reidel (1988), the demand equation may be normalized for price. We were not interested in this type of hypothesis testing because we were modelling exports of a group developing countries. Therefore we chose the conventional normalization of demand equation as a volume equation. More discussion of the normalization issue can be found in Muscatelli, *et al* (1990).

5. Ideally, one must measure capacity utilization in the export sector, data on which is not available. Instead, one can enter export volume and capacity to export (capital stock in export production) as separate variables. There is a formidable data problem in such an approach. Even the economy-wide measure of capital stock was done by indirect means as indicated in appendix 3B to Chapter 3. No information could be gathered on capital stock deployed in export pro-

duction. Attempts to proxy this with aggregate capital stock and also allowing for export volumes in estimation produced insignificant results.

6. xgi is normalized using the coefficient of lagged level term obtained in the estimated equation shown in the first column as follows:
xgi * = (xgi - .75 xgi $_{-1}$)/.25 xgi

7. The mean lags are derived by rewriting the estimated equation and equating coefficients to, a general ADL form (one explanatory variable case used for illustration):

$$Y_t = \mu + \frac{B(L)}{A(L)} X_t + u_t$$

which under first order autoregressive and distributed lag:

$$A(L) = 1 - \alpha_1 L$$

$$B(L) = \beta_0 + \beta_1 L$$

yields

$$Mean\ Lag = \frac{\alpha_1 \beta_0 + \beta_1}{(a - \alpha_1)(\beta_0 + \beta_1)}$$

For more details, see Johnston (1984).

8. Estimated equation by ADL approach without imposing homogeneity is:

Modelling DXG ADL Approach by OLS
The Sample is 1966 to 1985 less 0 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
CONSTANT	.90494	.57574	.82935	1.57178	.1597
DS	.79595	.25021	.29751	3.18116	.4377
DPXG	-.67958	.23503	.32111	-2.89149	.3914
DPXGC	.76031	.26731	.39526	2.84434	.3836
SHARE 1	-.19076	.10354	.15306	-1.84243	.2071
PXG 1	-.52315	.31899	.47067	-1.64000	.1714
PXGC 1	.53309	.28771	.41974	1.85284	.2089

R^2 = .5720143 σ = .0347580 F(6, 13) = 2.90 [.0510] DW = 2.085
RSS = .0157055787 for 7 Variables and 20 Observations
Information Criteria: SC = -6.100965; HQ = -6.381439; FPE = .001631
R^2 Relative to DIFFERENCE+SEASONALS = .76362

By comparing with the RSS of restricted equation displayed in column 3 of Table 4.3 we may perform an F-test, as already indicated in the text, to conclude that static and dynamic homogeneity cannot be rejected (computed value is around .4, whereas the critical value is 3.81 at 5 per cent level).

Estimated equation at the second stage E-G approach without imposing dynamic homogeneity is:

Modelling DXG, second stage of E-G approach by OLS
The Sample is 1966 to 1985 less 0 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
CONSTANT	.03659	.01785	.02052	2.05026	.2189
DS	.43160	.25191	.31858	1.71334	.1637
DPXG	-.48126	.21872	.27425	-2.20034	.2440
DPXGC	.49292	.19906	.24356	2.47626	.2902
UHAT 1	-.20540	.12258	.14718	-1.67563	.1577

R^2 = .3117542 σ = .0410335 F(4, 15) = 1.70 [.2026] DW = 1.503
RSS = .0252562117 for 5 Variables and 20 Observations
Information Criteria: SC = -5.925482; HQ = -6.125821; FPE = .002105
R^2 Relative to DIFFERENCE+SEASONALS = .61987

Again, by comparing with RSS here and that of restricted equation in the last column of Table 4.3 we cannot reject the dynamic homogeneity (computed F statistic is close to zero and the critical value is 4.54 at 5 per cent level).

9. Export price equation in the full model presented in Chapter 6 uses a capital output ratio term instead of capacity utilization. See equation 14 under Section 6.3. The parameters estimated by replacing capacity utilization as defined in this chapter with capital output ratio, are very not different from the parameters reported in this chapter except for the constant.

10. Static homogeneity is easily accepted by testing the coefficient of change in costs in both ADL and E-G forms (columns 1 and 4 of Table 4.4). The test is a t-test with the null that the coefficient tested is equal to unity. The computed t-values are around .5 and the cririal value above 2.

CHAPTER 5

MACROECONOMETRIC MODEL FOR LATIN AMERICA: SPECIFICATION AND VALIDATION

5.1 Introduction

In this chapter we explain the main features and the structure of the macroeconometric model we have put together for Latin America. After describing the individual equations, we perform validation tests on parts of the model. Results of an in-sample dynamic simulation are provided at the end. Full model simulations with external and internal shocks are discussed in the next chapter.

5.2 Main Features

The model has a fully specified income-expenditure process, supply side and foreign trade sector, a full set of balance of payments accounts and essential elements of government accounts. The economy underlying the model produces two goods: home good which is produced and consumed domestically and an exported good. In addition there is an imported good which competes with domestic production. Therefore there are three prices in the system: the endogenous home good and export prices and the exogeneous import price. All the individual economies in the region are assumed to behave in identical ways. In other words, country specific features are not allowed for. The model consists of 39 equations of which eight equations are behavioural and are estimated. The key notable features or innovations are:-

i) Consumption is driven by financial wealth accumulation which is modelled as the accumulation of money (M2) which in turn is fed by government budget deficit and reserve accumulation. This is in the same spirit as the theoretical specification we outlined in Chapter 2 equation 2.2.

ii) The supply side produces a natural rate of output which can be increased by real exchange rate appreciation (a standard open economy feature). Output can only be kept above its natural level by accelerating inflation.

iii) Capital accumulation is designed to feed into the supply side, making the trade off between output and real exchange rate appreciation more favourable (and capital decumulation does the reverse).

iv) There is no detailed treatment of the financial and government sectors. The real rate of interest equals the world real rate, money supply is endogenously determined by the size of fiscal deficit; and the government sector accounts are rudimentary. Here we have been constrained by available data for LDCs.

As LDC financial markets are repressed the official interest rates do not reflect the true marginal cost of borrowing. Faced with this difficulty, like Edwards and Khan (1985) or Haque, *et al*, (1990), impute a rate of interest which is a weighted average of world interest rate and a rate that will prevail in a closed economy money market equilibrium. Our choice of world real interest rate would imply perfect capital mobility; surprising though this may be, the empirical study of Haque, *et al* (1990) lends support to this.

5.3 Structure of the Model

For a description of the names of variables please see appendix 5A to this chapter.

Notation and Abbreviations

Notation

Everywhere below,

lower case = natural log

Γ = lag operator

$\Delta = (1 - \Gamma)$

exp = exponential to base e

Abbreviations and Econometric Statistics

DP = Data period

PR = Estimation programme

SSR = Sum of Squared Residuals

SE = Standard Error

DF = Dickey-Fuller test

ADF = Augmented Dickey-Fuller test

LM = LM serial correlation tests for orders given in brackets

DW = Durbin-Watson statistic

't ' values are given in brackets below the relevant coefficients.

Aggregate Demand (Constant 1980 prices)

Private Consumption

This equation is adopted form Hurn and Muscatelli (1989). Their final specification is replicated on our data base. Discrepancies were found in the dynamic equation results: short run income elasticity was 0.971 instead of .744; size of ECM term -.272 instead of -.724. However, both the terms are very significant and correctly signed. Our results are reported here and adopted for the model.

Consumer expenditure of the private sector is modelled as a function of real GDP, stock of money wealth and terms of trade. Due to data deficiencies we could not use private sector real disposable income and a better measure of wealth, which should include equities and physical form of wealth. The measure of wealth used is backward looking. Terms of trade is counted as a separate variable because our measure of real GDP does not take this into loss or gain in purchasing power that arises due to relative movement in trade of export and import prices. In addition a separate effect of real exchange rate on consumption is possible because, even with constant terms of trade a real depreciation will redistribute income against people engaged in non-traded goods sector. Empirically however, no such effect has been found once terms of trade effects are allowed for. Engle-Granger two stage procedure is used to estimate the consumption function. It may be noted that there was difficulty in finding long-run effect of wealth on consumption for Latin America and consequently the relevant elasticity was imposed at .2, based on our results for other LDC regions. This imposition of wealth effect did not distort econometric properties of the specification too much. There is limited short run dynamics. The short run income elasticity is higher than the long run.

$$\Delta c = \underset{(27.92)}{.971} \, \Delta yd + \underset{(-1.95)}{-.272} \, \Gamma\{c - .576 - .714 yd - .2 \, (m2 - ced + ex) - .095 \, tot\} \qquad (1)$$

DP = 1962-85 PR = TSP 4.1, OLS

R^2 = .935 DW = 2.102

SE = .039

First Stage:

DF = -3.08 ADF = -2.55

Exports

This is computed in three steps. First, the demand for export of goods is derived using a behavioural equation, relating it to the export market potential and relative export prices. This equation is the same as the one reported earlier in column 3 of Table 4.3 of Chapter 4, where we discussed at length the relevant specification and econometric issues. Notable features here are that export volumes are unit elastic with respect to export market potential and the long run relative price elasticity is higher than the short run, as one would expect. Secondly, the demand for exports of goods and non-factor services is determined using a link equation. Link equations have been estimated such that they bear a unit elastic relation between the two linked variables. The restriction of unit elasticity is commonly accepted by data, unless noted otherwise. Thirdly and finally, as the dependent variable is measured as a volume index, it is converted to absolute numbers.

$$\Delta\ xgi = \underset{(4.700)}{.0746} + \underset{(3.350)}{.804}\ \Delta s - \underset{(-3.9)}{.733}\ \Delta(pxa - pxac)$$

$$- \underset{(-3.0)}{.242}\ \Gamma(xgi - s) - \underset{(-3.6)}{.608}\,\Gamma(pxa - pxac) \qquad (2)$$

DP = 1965-85	PR = PC-GIVE 6.0.
R^2 = .546	OLS
SE = .033	DW = 2.087
	SSR = .017

$$xgni = xgi + .04192 \qquad (3)$$

$$XGN = const. \times \exp(xgni) \qquad (4)$$

Imports

This equation is adopted from Hurn and Muscatelli (1989). Both ADL and Engle Granger two stage estimates are reported in the source and we have chosen the two stage estimate arbitrarily as no preference for either is indicated by Hurn and Muscatelli. The equation was replicated on our data base and a negligible discrepancy was noted in the constant term at the first stage. Our replication results are reported and retained for the model.

Imports of goods and non-factor services is determined by GDP, real exchange rate, stock of foreign exchange reserves at the end of the previous year and a time trend. It must be mentioned that a time trend has been added to the first stage estimation to increase the long run income elasticity from .4 to above unity. A justification for this is that the time trend is interpreted as representing the import substitution policies, actively promoted by Latin American countries as a development strategy. Rationing effect is captured through a lagged real reserves term. The empirical specification differs from the theoretical one in Chapter 2 (equation 2.5), by its inclusion of the reserves term. This extra term of reserves is exogenized in simulations.

As in the consumption function, there is limited short run dynamics. Imports respond to income greater in the long run. The highly significant ECM term is negative but above unity, unlike commonly reported size of under unity. This in itself is of no special significance, except that error correction will display cycles. No autocorrelation problems are detected but Hurn and Muscatelli draw attention to 'less pleasing' RAMSEY mis-specification tests for omitted variables.

$$\Delta mgn = \underset{(7.892)}{1.164\ \Delta yd} \ \underset{(-7.778)}{-1.328}\ \Gamma\{\ mgn + .084\ T - 2.571\ yd$$

$$+ .139\ rex - .051\ \Gamma(2)\ (rescp - pmgn) + 21.41\} \qquad (5)$$

DP = 1961-85   PR = TSP 4.1, OLS

R^2 = .865   DW = 1.19   LM(1) = 1.504

SE = .040   LM(2) = 2.695

First Stage:

DF = -3.08   ADF = -2.55

Investment

Gross Investment is derived in four steps. First , a behavioural equation for the index of net fixed capital stock as a function of real interest rate and real GDP is used. In the second step this index is converted to a series of absolute numbers of net fixed capital stock. In the third step, gross fixed investment is derived by adding depreciation. Finally, a link equation is used to derive total gross investment which includes inventories.

The specification of the investment function is neoclassical in spirit as already noted in Chapter 2. Desired capital stock may be expressed as a function of expected output, price of output and user cost of capital, assuming a Cobb-Douglas production function and profit maximizing behaviour of firms. The user cost of capital is the sum of nominal interest rate and depreciation, less expected appreciation in price of capital. If we assume that price of output and capital move together, we can express desired capital stock as a function of expected real output and user cost of capital. The actual capital stock is assumed to adjust slowly to the desired stock. This dynamic adjustment is modelled as an error-correction process.

As already mentioned in the last section data on user cost of capital - real interest rate (ignoring fiscal incentives) in developing countries is very problematic. Therefore, foreign real interest rate, as represented by real LIBOR (LIBOR less inflation in US), is used as a proxy. Interest rate effect was negative as expected, implying a semi-elasticity of about .5, but not highly significant, statistically. This term is retained for sensible simulation properties. Empirically, availability of foreign capital , as measured by real disbursement of foreign loans in any year, also was a significant factor, though in theory one does not expect to have such factors. This term is statistically significant, but exogenized in simulations to achieve coherence with theory. The ECM term is negative and significant.

$$\Delta ki = \underset{(-3.95)}{-.091} + \underset{(2.12)}{.039}\,\Gamma(disbi-pk)$$

$$\underset{(-1.32)}{-.002}\,\{LIBOR + 12.88 - \Delta\ uspy(+1)\}$$

$$\underset{(-5.373)}{-.397}\,\Gamma\,(ki-ydi) \tag{6}$$

DP = 1972-84	PR = PC-GIVE 6.0.
R^2 = .856	OLS
SE = .016	DW = 1.97
	SSR = .002

$$k = const. \times ki \tag{7}$$

$$IF = K - \Gamma K + .1288\ \Gamma K \tag{8}$$

$$it = if + .0925 \tag{9}$$

GDP at market prices

This is a definitional identity:

$$YD = C + GC + XGN + IT - MGN \tag{10}$$

In index form this is expressed as:

$$YDI = \frac{YD}{const.} \times 100. \tag{11}$$

where constant is the 1980 value of GDP market prices.

Aggregate Supply

The equations for consumer prices and wages, constituting the supply side of the model, are adopted from Allen (1989). The econometric results using OLS methods are replicated on our data base and very slight differences are noted to the source and our estimates are coded into the model, as reported here[1]. The reduced form derivable from these two equations relating output to real exchange rate and capital stock corresponds to our theoretical specification in equation 2.6 of Chapter 2. Further elaboration on the derivation of this reduced form and its features are taken up in the next section.

Consumer Expenditure Deflator

The behavioural equation for prices assumes monopolistic competition under which prices are marked up over marginal costs. Costs consist of imported materials and wages. In addition there are two more factors which affect costs:

(i) diminishing returns in supply or possibly demand pressure, as measured by the ratio of output to capital stock. Over the longer term this ratio declines at a stable rate and therefore a time-trend was also included to compensate for this decline.

(ii) rationing costs as measured by output to import ratio, accounting for the shadow price of material inputs. The relevant category of imports here is intermediate and capital goods. As data by end-use classification of imports is not available for a long time period, total imports have been used. however, this is an empirical *ad hoc* factor which is exogenized in simulations.

Both dynamic and static homogeneity restriction are accepted and therefore imposed. The short run weight on import prices rises from 22 per cent to 33 per cent in the long run. The capacity utilization term is slightly weaker in significance than other terms, but retained.

$$\begin{aligned}\Delta ced = \Delta w \quad & - \underset{(-2.94)}{1.413} + \underset{(4.64)}{.221}(\Delta pmgnl - \Delta w) \\ & + \underset{(2.54)}{.114}\,\Gamma(pmgnl - ced) + \underset{(2.18)}{.236}\Gamma(w - ced) \\ & + \underset{(1.65)}{.326}(yd - k) + \underset{(3.72)}{.161}(yd - mgn) \qquad (12)\end{aligned}$$

DP = 1961-85 PR = TSP 4.1, OLS

DW = 1.676

SE = .040 SSR = .008

Wages

Real wage bargaining is assumed to take place on the basis of expected inflation. Long-run wages depend upon the rate of productivity as proxied by GDP. In the short-run, real wages may be affected by inflationary surprises. As wage data on LDCs is not available, Brazilian industrial real wage data is taken to be representative of the real wage levels in the region[2].

$$w = ced + \underset{(4.67)}{.443} - \underset{(-1.42)}{.046}\ \Delta\Delta ced + \underset{(2.93)}{.014}\ T - \underset{(-1.27)}{1.482} \qquad (13)$$

DP = 1965-85 PR = TSP 4.1, OLS

DW = 2.293

SE = .215 SSR = .011

Price Indices

Export Prices

The theoretical and econometric issues regarding this equation is discussed in detail in section 4.6 of chapter 4. In our theoretical outline of the full model, discussed in Chapter 2 an equation for export prices was not specified for simplicity. As indicated in Chapter 2, the treatment there is to be understood as a reduced form specification for export volumes. The specification has been re-estimated with a revised definition of capacity utilization as an output capital ratio for consistency with the supply side discussed above. By comparing this equation with the one in column 2 of Table 4.4 in Chapter 4, one can see that the elasticities and the size of ECM term correspond rather closely.

Export prices of goods depends on costs as proxied by the absorption deflator and capacity utilization. The variables are correctly signed. The capacity utilization term is weak in significance, but retained for desirable model properties. Export price of goods and non-factor services is derived using a link equation.

$$\Delta pxa = \underset{(-.85)}{-.0189} \underset{(4.51)}{+1.100} \Delta pab \underset{(1.22)}{+.620} \Delta(yd - k) \underset{(-2.86)}{-.768} \Gamma(pxa - pab) \tag{14}$$

DP = 1965-85 PR = TSP 4.1, OLS

R^2 = .600 DW = 1.66

SE = .113 SSR = .098

$$pxagn = pxa - .04734 \tag{15}$$

Import Prices

Import price of goods is exogeneous in US \$ terms. Import price of goods and non-factor services in US \$ terms is derived by a link equation. Import prices in local currency terms requires exogenously specified nominal exchange rate.

$$pmgn = pma + .3261 - .0148\ T \tag{16}$$

$$pmgnl = pmgn + ex \tag{17}$$

Other Prices

Deflators for government consumption, investment, absorption , home goods and GDP are assumed to be proxied by the consumer expenditure deflator in dollar terms, for simplicity. Real exchange rate is defined as the relative price of imports to home goods in home prices.

$$pgc = ced - ex \tag{18}$$

$$pk = ced - ex \tag{19}$$

$$pab = ced - ex \tag{20}$$

$$phl = ced \tag{21}$$

$$PY = CED / EX \tag{22}$$

Balance of Payments (Current Prices)

Exports and Imports

Current price values of exports and imports of goods and non-factor services are derived by multiplying the volumes with the appropriate price indices.

$$XGNV = XGN \times PXGN \tag{24}$$

$$MGNV = MGN \times PMGN \tag{25}$$

Net Interest Obligation

Net interest payments are derived by subtracting interest receipts on reserve holdings from interest dues on outstanding loans. The latter is generated by applying a five year distributed lag of LIBOR to outstanding stock of debt at the end of last period[3].

$$INT = \Gamma DOD \times .01 \times \left(.73 \times LIBOR + .27 \times \sum_{t=2}^{5} LIBOR_i\right)$$
$$- .01 \times LIBOR \times \Gamma RESCP \qquad (26)$$

Current Account Balance

This is a definitional identity along IMF conventions.

$$CBV = XGNV - MGNV - INT + OFS + CT \qquad (27)$$

Amortization

A fixed proportion (best guess from available time-series) of outstanding debt is amortized every year.

$$AMT = .095 \times \Gamma DOD \qquad (28)$$

Debt Service Payments

Debt service payments is defined to be the sum of amortization and interest payments:

$$DS = AMT + INT \qquad (29)$$

New Borrowing , Changes in Reserves and Evolution of Debt Stock

New borrowing is treated exogenous. Changes in foreign reserves are derived from the balance of payment identity. Given the amortization payments (equation 28) and the new borrowing, end of current period debt stock is computed as the sum of outstanding debt stock at the beginning of the period and any net capital inflows during the period.

New Borrowing

$$DISB = \overline{DISB} \tag{30}$$

Changes in Reserves

$$\Delta RESCP = CBV + DISB - AMT + OLTF + OCF \tag{32}$$

Debt Stock

$$DOD = \Gamma DOD + DISB - AMT \tag{33}$$

Government Accounts and Money Creation (Current Prices)

Data issues and calibration of parameters used to generate government accounts are discussed in Appendix 3A of Chapter 3.

Government Receipts

Government receipts are a constant fraction of GDP at market prices. It would have been preferable to model the dynamic structure in this relationship so that lags in collection of revenues can be modelled, but data available was only for 7 years and that too for some countries.

$$GR = .18 \times YD \times PY \tag{34}$$

Government Expenditures

Nominal government expenditures consist of nominal government consumption, nominal public investment (which is assumed to be a fraction of total investment) and debt service obligations on external and internal debt. Real government consumption is exogenous. Real investment follows form equation 9 above. Note that internal debt is rolled over and only interest obligations arise.

$$\begin{aligned} GE = {} & GC \times PGC + .44 \times (IT \times PK) + DS \\ & + LIBOR \times \Gamma HD \end{aligned} \tag{35}$$

Budget Deficit

$$GBD = GE - GR \tag{36}$$

Evolution of Internal Debt and its Monetization

It is assumed that in the normal circumstances, 75 percent of the government's budget deficit is financed by issuing internal debt. The monetized portion of internal debt by way of central bank lending is assumed to be 27 percent.

$$HD = \Gamma HD + .75 \times GBD \tag{37A}$$

$$\Delta CLG = .27 * \Delta HD \tag{37B}$$

Base Money

$$\Delta BM = \Delta CLG + \Delta RESCP \tag{38}$$

Money Creation

Money creation is governed by a simple money multiplier process. It has not been possible to model banking sector in detail, by separately identifying its lending to government and private sectors, because of data limitations. Our approach assumes that banking sector provides residual financing to the government sector. An implication of this simple treatment of the banking sector is that bank lending to private sector adjusts to secure the balance sheet identity of deposit money banks. However, it may be further noted in this context that bank lending to private sector does not affect any endogeneous variable in the model.

$$M2 = \underset{(4.230)}{.729\,\Gamma M2} + \underset{(2.591)}{1.300\,BM} - \underset{(-2.822)}{.629\,DMYDBT} \times BM \qquad (39)$$

DP = 1972-85 PR = TSP 4.1, OLS

R^2 = .9861 DW = 2.441

5.4 Partial Simulations of the Model

Having described the individual equations and their properties, we now turn to evaluate the properties of groups of equations which analytically belong together. We look at the keynesian multipliers on the demand side, the nature of underlying aggregate supply and the satisfaction of Marshall-Lerner conditions. For this purpose we need to use simulation methods because the complex dynamics of groups of equations make analytical derivations intractable. It may be noted that all the figures referred to in this section are placed at the end of this chapter.

Keynesian Multipliers

(a) First we obtain the Keynesian multiplier in response to an increase in government spending. (See Figure 5.1) A "full Keynesian multiplier" is displayed in MDL4 in which only consumption, investment imports and GDP are endogenous. This produces long cycles of multiplier-accelerator interaction with a periodicity of eleven years[4]. This cyclical process converges to give a full multiplier of about 1.6. We may break down the multiplier outcome as follows.

(b) The consumption function on its own with imports and investment fixed is smooth (MDL1). It overshoots its long-run effect. The reason is the large term with coefficient (0.971) on Δ yd.

(c) Simulating with the import equation and the GDP identity on their own (MDL2) gives plausible results: the long-run import elasticity is 2.6 (see Appendix 1, Section 1); but the import output ratio in the data is only about 10 per cent. Hence the rise in imports converges to about 1/4 of the rise in GDP (Imports are not shown in the figure).

(d) Consumption and imports interacting alone with the GDP identity (a multiplier without investment) in MDL3 produce savage saw-tooth dynamics because of the interaction of the large short term dynamics in consumption, and the large (lagged) ECM term in the imports equation. This may seem somewhat implausible. But its effects are sufficiently damped by the endogeneity of investment in MDL4 for us not to worry about it.

(e) Finally, if we include all of consumption, imports and investment, but fix out the capital stock effect on investment, then the outcome (not shown) is broadly as in MDL4 but without the long cycle.

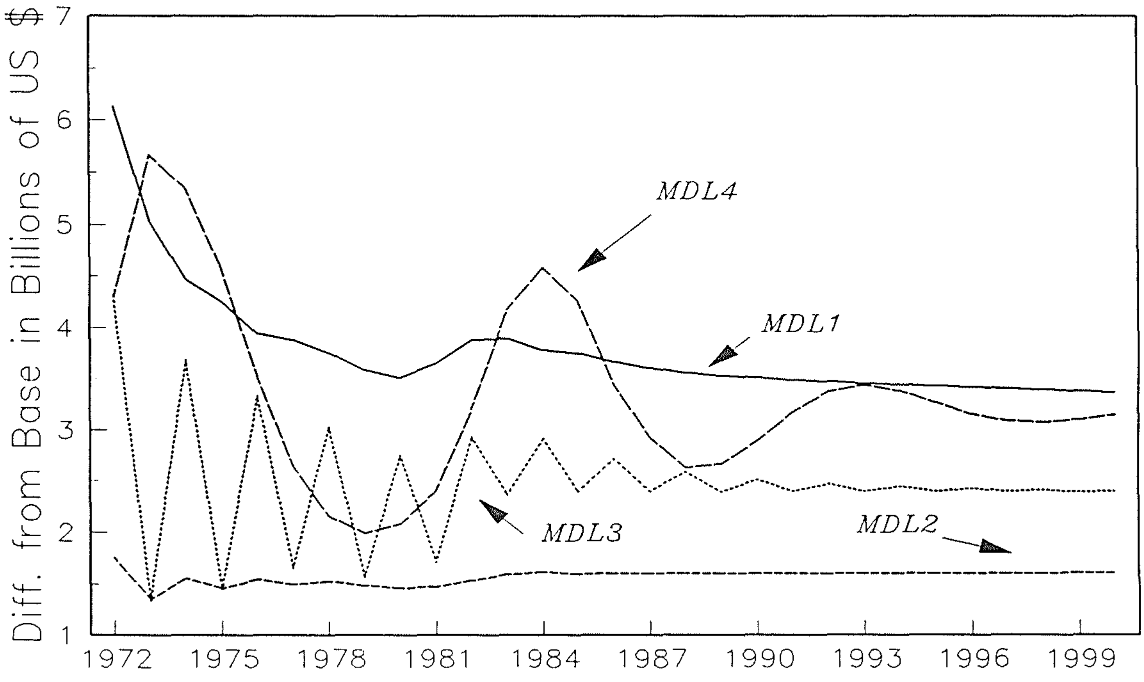


Figure 5.1

Keynesian Multipliers

(Effects of a Permanent US $ 2 Billion Increase in Govt. Consumption)

Notes

MDL1	Equation for Private Consumption and GDP identity.
MDL2	Equation for Imports and GDP identity.
MDL3	Equations for Private Consumption, Imports and GDP identity.
MDL4	Equations for Private Consumption, Imports, Investment and GDP identity.

Aggregate Supply

Before we examine the numerical results, we may explore analytically the implied reduced form of the supply side. We represent the long run wage and price equations of Section 4 (after all short run dynamics have washed out) as

$$ced = \beta_1 + \alpha w + (1-\alpha)epm + \phi_1(y-k) + \phi_2(y-m) \qquad (i)$$

$$w = \beta_2 + \delta_1 y - \delta_2(\Delta^2 ced) + ced \qquad (ii)$$

where ced, w, pm and e stand, respectively, for consumers' expenditure deflator, wages, import prices and (nominal) exchange rate; y, k, and m stand, respectively for output, capital, and imports. $\alpha, \phi_1, \phi_2, \delta_1 \text{and} \delta_2$ are estimated parameters and $\beta_1 \text{and} \beta_2$ are constants.

We can thus write aggregate supply by substituting equation (ii) in to (i) as:-

$$\begin{aligned} y = \beta_3 &+ \frac{\phi_1}{(\alpha\delta_1 + \phi_1 + \phi_2)}k + \frac{\phi_2}{(\alpha\delta_1 + \phi_1 + \phi_2)}m \\ &- \frac{(1-\alpha)}{(\alpha\delta_1 + \phi_1 + \phi_2)}(epm - ced) \\ &+ \frac{\alpha\delta_2}{(\alpha\delta_1 + \phi_1 + \phi_2)}\Delta^2 ced \qquad (iii) \end{aligned}$$

where β_3 is a constant. Estimated values of the parameters are:

$\alpha = .6745$ $\delta_1 = .4435$ $\delta_2 = .0456$

$\phi_1 = .9330$ $\phi_2 = .4589$

Hence aggregate supply is

$$y = \beta_3 + .5517k + .2714m - .1924rex + .0182\Delta^2 ced \quad (3)$$

where

rex = epm - ced

is the real exchange rate

Now consider the effect on prices of an increase in output with both capital and imports fixed, thus we are examining the properties of the short run aggregate supply curve.

With the nominal exchange rate fixed $\Delta^2 ced$ must converge to zero in the long run. Therefore a one per cent increase in output will require a 5.2 per cent (= 1/.1924) appreciation in the real exchange rate to satisfy both the desire for higher real wages implied by the wage equation and the diminishing returns implicit in the price equation. With consumer prices rising by 5.2 per cent, nominal wages then need to increase by roughly half a per cent more to deliver the higher real wages as required. This is exactly confirmed in the simulation exercises. See Figure 5.2 ; note how quickly the short run dynamic adjustment disappears. This is an indication of how "unkeynesian" the model is: higher output very quickly requires a higher real exchange rate - the reliance can be placed on unanticipated inflation is both small and short lived.

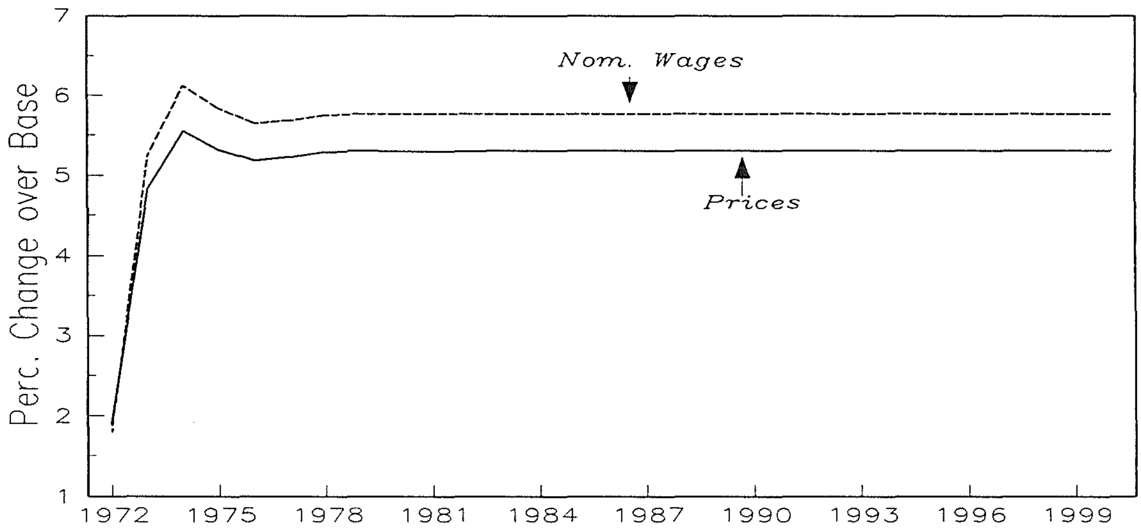


Figure 5.2

Effects of a Permanent 1 % Increase in Output (With Fixed Nominal Exchange Rate)

We may illustrate this another way by performing the same simulation but with the real exchange rate fixed. Now a one per cent increase in output will require a continuing acceleration of inflation of 55 per cent per annum (= 1/.0182 per cent). This is again exactly confirmed in the simulation exercises. See Figure 5.3. Although prices explode, the acceleration of inflation stabilises. Note again how quickly this outcome is reached.

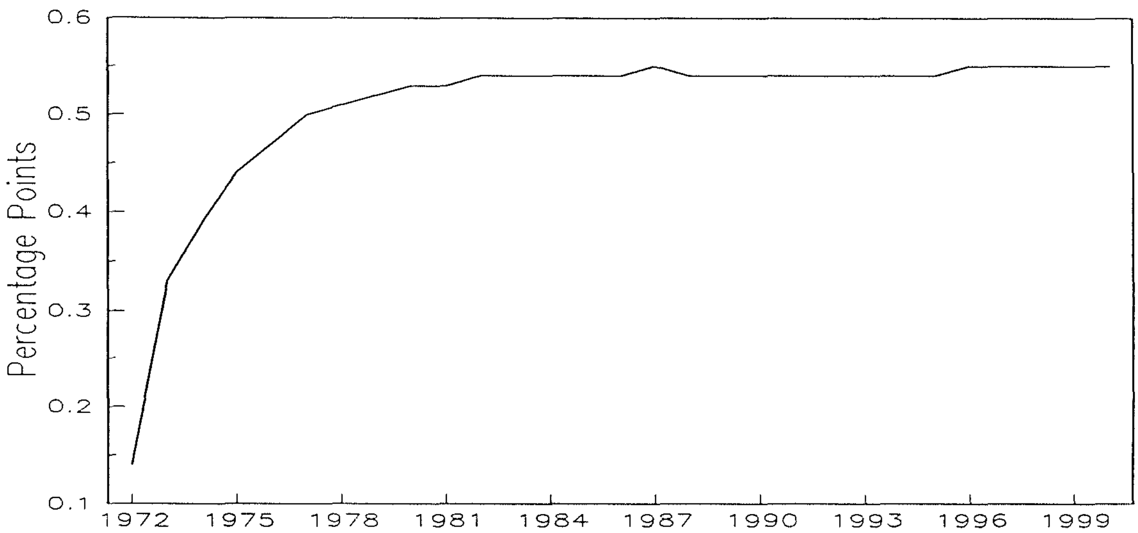


Figure 5.3

Effects of a Permanent 1 % Increase in Output (With Fixed Real Exchange Rate)

Finally, consider the effects of an increase in supply when both capital and imports rise in the same proportion as output. In that case the terms multiplied by ϕ_1 and ϕ_2 disappear and aggregate supply becomes

$$y = \beta_4 - \frac{(1-\alpha)}{\alpha\delta_1}(epm - ced) + (\delta_2/\delta_1)\Delta^2 ced$$

That gives

$$y = -1.088rex + 0.1028\Delta^2 ced \qquad (iv)$$

As a result with a fixed nominal exchange rate a one per cent increase in output would require only a 0.9 per cent appreciation in the real exchange; with a fixed real exchange rate permanent acceleration of inflation of only 9.7 per cent would be required. Thus the long run supply curve (equation (iv)) is flatter and more elastic than the short run supply curve (equation (iii)). These outcomes are not plotted in Figures 2 and 3 as the associated transition dynamics depend upon demand side details of the model (which determine how investment and imports evolve) and these are not our concern here.

Trade Sector

Figure 5.4 explores the effects of a (real) devaluation with output and prices exogenous. The Marshall Lerner conditions hold, and the full "reduced form" elasticity of the trade balance with respect to competitiveness appears to be about 2[5]. Figure 4.5 shows the effects of endogenizing prices, but still keeping output constant. The saw-tooth response of the current account is due to the dynamics of the wage price sector; the essential point is that wage and price adjustment works very rapidly to neutralize the effects of nominal exchange rate devaluation. Further results on exchange rate effects in the context of the full model are reported in the following chapter.

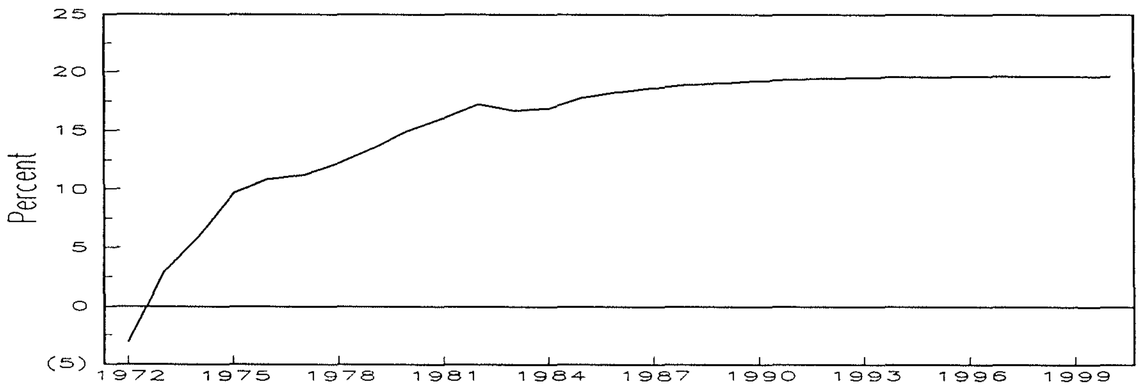


Figure 5.4

Effect of a Permanent 10 % Depreciation on Current Account Balance
(With Fixed Domestic Output and Prices)

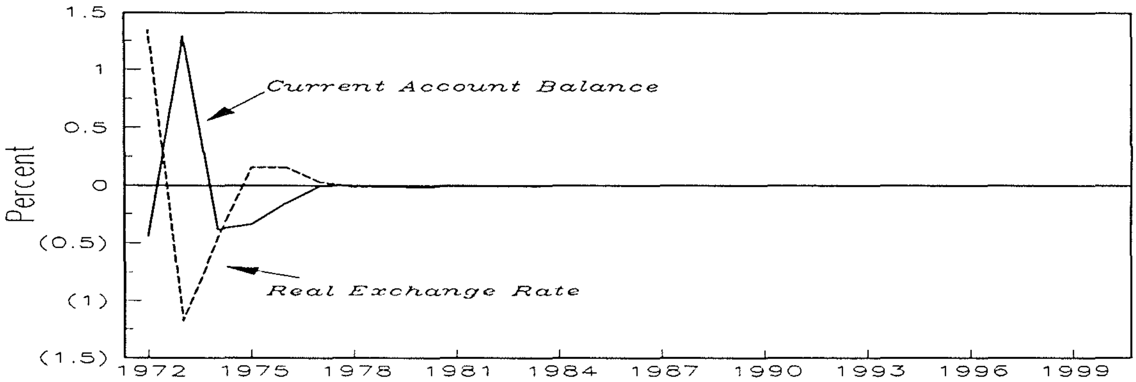


Figure 5.5

Effect of a Permanent 10 % Depreciation on Current Account Balance
(With Fixed Domestic Output and Endogenous Prices)

5.5 Tracking Performance of the Model

The model has not been tuned with a view to forecasting. But before we simulate it in full in the next chapter, it is worthwhile to look at the tracking performance of the full model. For this purpose a dynamic simulation has been performed over the historical period 1972-85. It is controversial whether such an exercise can be used to form judgement as to how well a model fits data. The dynamic simulation residuals become a complicated function of current and past equation results which is difficult to interpret , see Pagan (1989), Smith (1990). Furthermore, in doing this we will exaggerate the errors if we close the balance of payments in ways other than what has actually been done in history. Another source of error is the government accounts bloc in which the revenue and expenditure functions have been calibrated on very few observations over 1974-81. Therefore, we need to exogenize foreign lending , government accounts and consequently money stock.

Plots of the actual and the estimated values of the important behavioural variables of the model are presented in Figure 5.6. Root mean square percentage errors are presented in Table 5.1 below. The results suggest errors below 20 per cent on the average. This appears to be not bad considering that each of the equations have been estimated on its own and not as a part of a maximum likelihood procedure for the whole system.

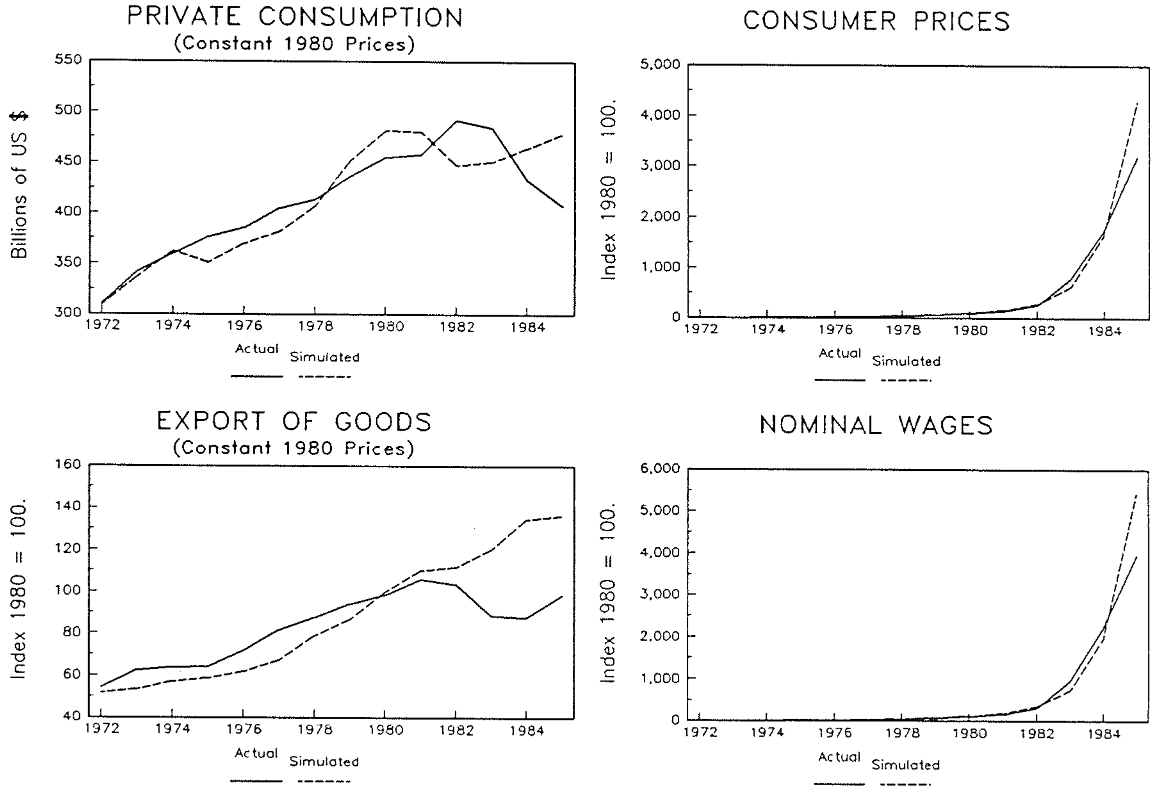
There is also a hint in the plots that tracking is poorer towards the end of the simulation period, which is a period of severe debt crisis and non-modlelled factors dominating outcomes. Some explanation can be offered on the pattern of errors across variables. We have used consumer prices for domestic cost and price of home goods. This could be responsible for a poor tracking of export prices and volumes. It is reckoned that exogenizing the link equations for price equations will further improve the results.

Table 5.1

Root Mean Square Percentage Errors for Selected Variables 1972-85

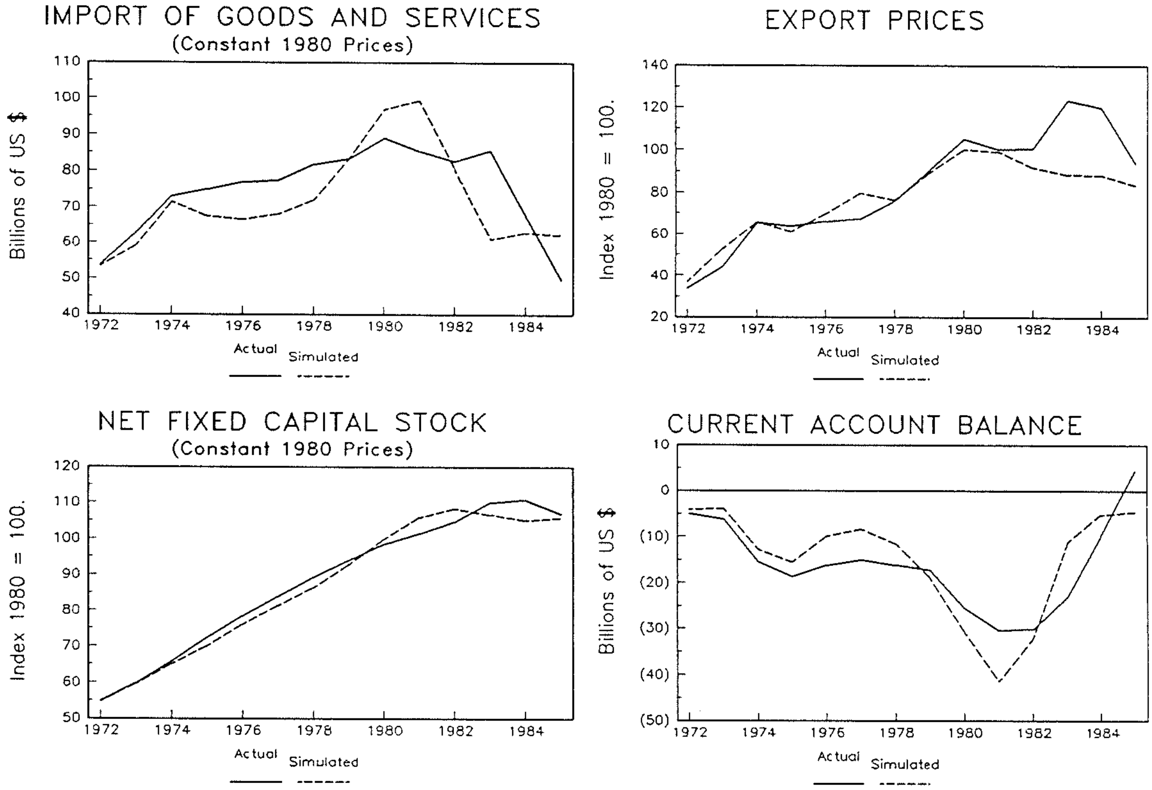
Variable	RMSE
Private Consump-	6.83
tion	22.06
Export of Goods	13.31
Import of Goods	2.84
Net Fixed Capital	16.64
Stock	18.53
Consumer Prices	13.53
Nominal Wages	
Export Prices	

Note $$RMSE=\sqrt{\frac{1}{n}\sum_{t=1}^{t=n}[((X-\hat{X})/X)*100.]^2}$$



Tracking Performance of the Model over 1972-85

Figure 5.6



Tracking Performance of the Model over 1972-85

Figure 5.6

Appendix - 5A

Definitions of Variables

Endogenous Variables (in million, where relevant)

1.	AMT	Amortization on debt, current US $
2.	BM	Base Money, current US $
3.	C	Private final consumption, constant US $
4.	CBV	Current account balance, current US $
5.	CED	Consumer expenditure deflator, local currency units
6.	CLG	Central bank lending to government, current US $
7.	DISB	New borrowing, current US $
8.	DISBI	New borrowing, index, current US $
9.	DOD	Public and publicly guarantied debt, outstanding and disbursed, current US $
10.	DS	Debt service payments, current US $
11.	GBD	Government budget deficit, current US $
12.	GE	Government expenditure, current US $
13.	GR	Government receipts, current US $

14. HD Government's Internal Debt, current US $

15. IF Investment (gross fixed), constant US $

16. INT Interest obligation, current US $

17. IT Investment (gross, total), constant US $

18. K Net fixed capital stock, constant US $

19. KI Net fixed capital stock index, constant US $

20. M2 Money broadly defined, current US $

21. MGN Import of goods and non-factor services, constant US $

22. MGNV Import of goods and non-factor services, current US $

23. PAB Absorption deflator, US $ terms

24. PGC Government consumption deflator

25. PHL Price index for home goods, in local currency

26. PK Investment deflator

27. PMGN UVI, import of goods and nfs, US $ terms

28. PMGNL UVI, import of goods and nfs, local currency terms

29. PXA UVI, export of goods, US $ terms

30. PXGN UVI, export of goods and nfs, US $ terms

31. PY GDP deflator, US $ terms

32. RESCP Foreign exchange reserves, current US $

33. REX Real exchange rate index

34. W Index of nominal wages, local currency terms

35. XGI Volume index, export of goods

36. XGN Export of goods and nfs, constant US $

37. XGNI Volume index, export of goods and nfs

38. XGNV Export of goods and nfs, current US $

39. YD GDP at market prices, constant US $

40. YDI GDP at market prices, index, constant US $

Exogeneous Variables (in millions, where relevant)

1. CT Net current transfers from ROW, current US $

2. DMYDBT Dummy set to unity for 80's.

3.	EX	Index of nominal exchange rate, local currency per US $
4.	GC	Government consumption, constant US $
5.	LIBOR	LIBOR, in percent
6.	OCF	Other capital flows, in current US $
7.	OFS	Net other factor services, in current US $
8.	OLTF	Other long-term capital flows, net, in current US $
9.	PMA	UVI, import of goods, in US $ terms
10.	PXAC	UVI, export of goods, a weighted average of competitors'
11.	S	Index of export market potential
12.	T	Time trend
13.	USPY	GDP deflator for the US economy.

Endnotes

1. Allen (1989) also reports IV estimates, which differ very little from the OLS estimates, except for the coefficient of inflation acceleration term in the wage equation (OLS: -.04560 and IV: - .03720). It would be preferable to use IV estimated equations in the model, but it is expected that this would make very little difference to our results.
2. Source is UN Economic Commission for Latin America, various volumes.
3. Anton Muscatelli has provided the lag length and lag weights on the LIBOR term.
4. Such cycles are not normally seen in the simulation properties of modern econometric models. But those models have a fully specified supply side rather than fixed prices, as here. The cycle just described disappears when we endogenize the supply side in our model below.
5. This statement follows simply from the fact that a 10 % depreciation causes, *ceteris paribus*, a 20 % improvement in trade balance.

CHAPTER 6

OPEN LOOP SIMULATIONS OF THE LATIN AMERICAN MODEL

6.1 Introduction

In this chapter we present the results of open loop simulations of the full model. In other words, in these simulations there are no fiscal, monetary or exchange rate policy responses in the face of shocks to the system. After describing general issues of simulation specification, we discuss the effects on the Latin American region of seven different shocks. Three of these originate abroad: export market slump, import price increase and interest rate increase. The four domestic shocks are: fiscal expansion, supply set back, exchange rate increase and addition to money stock.

6.2 Simulation Specifications

In the open-loop simulations to be presented the following policy instruments are exogeneous: government consumption, tax rates and the real interest rate. But government investment follows private investment (see Chapter 5, Section 5.2) and tax revenues are endogenous, as is the money supply. The nominal exchange rate is exogenized, except where otherwise noted. The simulations are conducted over a period of 29 years from 1972 to 2000, the later half of which is a forecast track computed on assumptions as explained in Chapter 3.

Some of the open loop simulations produce prolonged and sometimes accelerating inflation, and in many cases there is an exploding or imploding foreign debt. They should thus be regarded as diagnostic rather than descriptive. In reality policy would respond to such outcomes. In contrast, models of developing countries built at IMF such as MULTIMOD by Masson et al (1988) or 'Scenario and Forecast Model(SFM)' by Adams and Adams (1989) perform closed loop simulations. MULTIMOD is a multi-region global econometric model which distinguishes two developing country regions: oil and non-oil. SFM is a developing country model system that can be run in tandem with MULTIMOD. In both these models, all non-oil developing countries are treated as external finance constrained. Imports and investment accommodate to available external finance. Whereas in MULTIMOD developing countries can influence available external finance by shifting resources in to export sectors and thus improving their credit worthiness, in SFM external finance is exogenous. But, in the our model, there are deliberately no automatic reductions in domestic investment, or imports, in the model in response to growing foreign debt, as in MUTIMOD or SFM. Monetary or fiscal policy responses of developing countries can be studied in our model , but these are not possible either in MULTIMOD or SFM. The study of effectiveness of different possible policy responses in producing the required import reductions in such circumstances is taken up in the next chapter.

In some of the simulations we deliberately exogenize ("fix") parts of the model, as explained below. This again is not meant to describe reality, but to enable us to build up a picture of the model's internal dynamics and check whether its properties are sensible. The two cases of this are:

(a) The disbursement term in the investment equation remains exogeneous as in Section 3 chapter 6, where we discussed partial model properties. The reason for this is that the "open loop simulations" of the model are ones in which the region is able to borrow or run down reserves to the extent required to finance any emerging current account deficit. Such financial accommodativeness should not actually stimulate investment, as it would if the disbursement term in the investment equation were endogenized.

(b) The terms RESCP (reserves) in the import volume equation and (y - m) (output-import ratio) in the price equation are exogenized. These terms, which are highly significant econometrically, represents the effects of external constraints rationing imports, and thus driving up domestic prices. But as just explained those constraints do not bind in these simulations.[1]

We now briefly describe the method of simulation employed. First the model is solved in single equation mode, i.e., equation by equation, to 'fix' the residuals, over the simulation period 1972-2000. The difference between the 'actuals' and forecast constitute 'constant adjustments'.. Examination of the constant adjustments over the estimation period 1972-85 helps us to see how well we have replicated the residuals of the equations. This can only be a rough guide for two reasons: first, in the model we express the endogeneous variables in levels and not logs as is the usual case at the estimation stage and secondly with dynamic specification the starting period for simulation can affect the simulated constant adjustments for the initial periods, depending on the length of the lags. The constant adjustments are then included in the equations, multiplicatively for all price equations and additively for others[2]. Appendix 6A presents the codes used for generating the Fortran routines for solving the model. Having 'unfixed' the model thus, we forecast a base scenario over the sample period using Gauss-Seidel iteration procedure with a tolerance level of .01 per cent relative error. Then a shock of the desired type either to the exogeneous variables or constant adjustments is administered and a forecast is prepared. The difference between the 'base' values and the forecast values after a shock is examined to reveal the response of the system to the shock.

Altogether seven different types of shocks are administered in a structured way which progressively endogenize prices and money. The size and nature of shocks and the structure of simulations are described in Table 6.1 . When we desire to shock endogenous variables such as consumer prices (CED), or money stock (M2R), we perturb the residuals of the relevant equation. The dynamic structure of these equation will magnify these shocks. Though it is possible to compute and introduce adjusted residuals such that in partial equilibrium sense the endogeneous variable being shocked will shift by a known factor each time period, it is not done.

Table 6.1

Full Model Simulations

Names of Simulation Runs

Type of Shock	Exogeneous Money and Prices	Exogeneous Money	Endogeneous Money and Prices
Fiscal	MDL5C	MDL6C	MDL7C
Supply	MDL5E	MDL6E	MDL7E
Foreign Trade	MDL5F	MDL6F	MDL7F
Import Price	MDL5G	MDL6G	MDL7G
Money Supply	MDL5H	MDL6H	MDL7H
LIBOR	MDL5J	MDL6J	MDL7J
Nom. Exch. Rate	MDL5K	MDL6K	MDL7K

Nature of Shocks

Fiscal Shock : A permanent increase in Government's real Consumption expenditure (GC) by $ 2 Billion.

Supply Shock : A permanent 5 % point increase in the multiplicative constant adjustment to the inflation (CED) equation.

Foreign Trade Shock : A permanent 3.5 % point decrease in export market potential (S).

Monetary Shock : A temporary $ 1 Billion increase to the additive constant adjustment in the money supply (M2R) equation, in the year 1972.

Import Price Shock : A permanent 10 % increase in import prices (PMA).

LIBOR Shock : A permanent 1 % point increase in LIBOR.

Exchange Rate Shock : A permanent 10 % increase in the index of nominal exchange rate (EX).

The size and direction of shock is arbitrary chosen. It is conceivable that in non-linear models of the kind used in our simulations, outcomes could be sensitive to the size of shocks; asymmetries may be present which will produce different outcomes when the direction of shocks are reversed. It is suggested that one delivers proportional shocks because more often than not estimated macroeconometric models have a log-linear specification. It is also suggested that one computes measures of non-linearity and asymmetry to explore the sensitivity of models to the size and direction of shocks. See Zellner and Peck, (1973). Such investigations were done for the present model for aggregate demand shocks, but not reported here. But it may be mentioned that the model did not display serious sensitivity to the size and direction of shocks as regards the principal outcomes of output, prices and current account balance: when shocks are scaled up, so were the outcomes; when shocks were reversed outcomes turned out to be mirror images.

A related issue is the time profile of shocks. Should the shocks be temporary or permanent? For instance, if one is interested in fiscal multipliers, should one shock fiscal expenditure for one period only or sustain it over the entire simulation period? It is more convenient to deliver sustained shocks to exogeneous variables because, in that case one can simply read off the output effects, instead of having to cumulate the output effects over time, if one had done a temporary shocks.

For each shock, the time-paths of response in output, prices and current account balance is plotted and presented in figures. Also presented are a series of tables of short and long run effects of each shock on output, prices and current account balance, which may be useful as 'ready-reckoners'.

6.3 Fiscal Expansion

Figures 6.1,6.2 and 6.3, and, table 6.2 elaborate on the effects of fiscal expansion discussed in Section 5.2 of the last chapter, but now more nearly in the context of the full model.

Figure 6.1
Output (GDP)

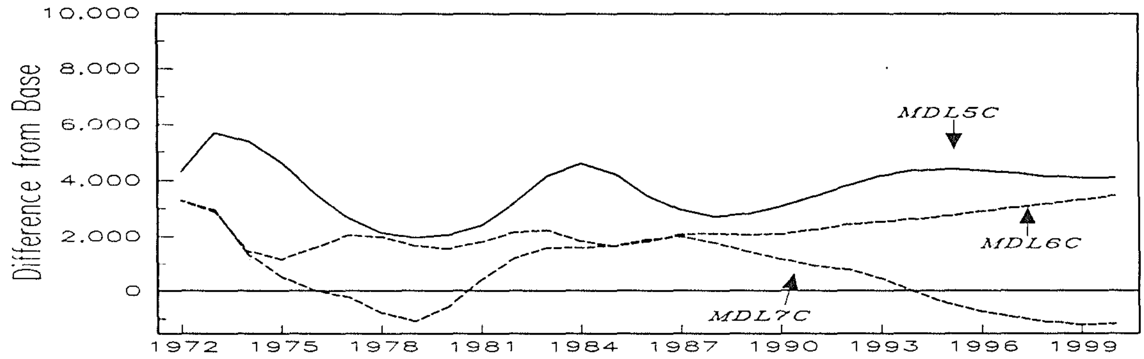


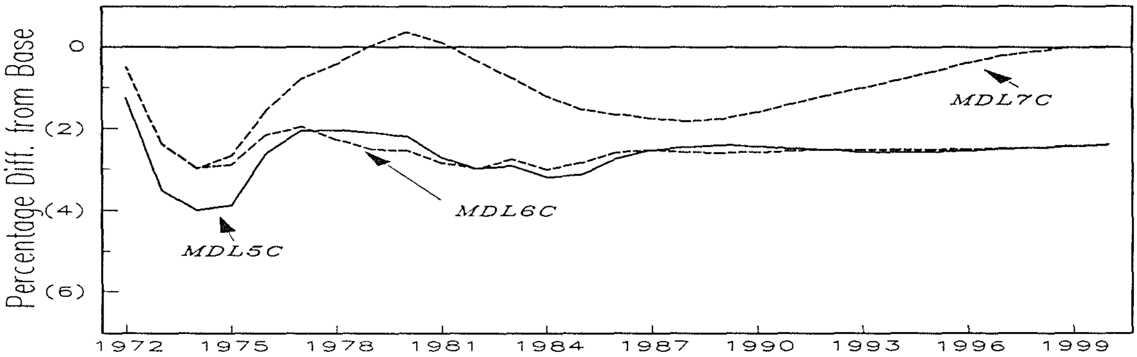
Figure 6.2
Prices

MDL5C
Money and Prices Exogeneous

MDL6C
Money Exogeneous

MDL7C
Money and Prices Endogeneous

Figure 6.3
Current Account Balance
(As Perc. of Base Exports)



MDL5C

Money and Prices Exogeneous

MDL6C

Money Exogeneous

MDL7C

Money and Prices Endogeneous

Table 6.2
Effects of a Fiscal Shock
(Permanent US $ 2 Billion Increase in Government Consumption)

Model Name	Additional Exog. Vars.	Effects on		
		Output Bn. US $	Prices %	Cur. Ac. % Points
MDL5C	Money & Prices	4.3 **4.1**	0.0 **0.0**	-1.3 **-2.4**
MDL6C	Money	3.3 **3.5**	1.0 **0.0**	-.5 **-2.4**
MDL7C	none	3.3 **-1.1**	1.0 **0.0**	-.5 **0.0**

Notes

1. Output is measured as absolute differences from base. Prices are measured as percentage differences from base. Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.
2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

(a) Both Prices and Money Exogeneous

First for comparison we present in the run marked MDL5C a fiscal expansion using the full model, but with prices (CED and PXA) and money (M2) exogenized. This reproduces the partial simulation of the Keynesian multiplier (MDL4) as expected (See Figure 6.1). An output multiplier of the order of 2 is indicated in both the short and long runs. In proportionate terms, the initial increase in output is one per cent; but the final increase is only 0.21 per cent, because base run output trends strongly upwards.[3] The current account deficit which emerges is exactly what one would expect from a Keynesian expansion. In the long run current account balance worsens by 2.4 percentage points which is nearly double the short run effect. This long run worsening of current account balance is observed in spite of the fact that output effects are similar in the short and long run because, drain of foreign reserves implies loss of interest receipts relative to base.

(b) *Prices Endogenous*

Next prices are endogenized (MDL6C) . The expansion raises prices as shown in Figure 6.2: CED increases by 2.5 per cent relative to base run by the second year of the simulation. Higher prices depress consumption (real balances fall with exogeneous nominal money) and depress net exports (the real exchange rate appreciates with an exogeneous nominal rate): in the first year output rises by only about 0.75 per cent instead of 0.98 per cent (and by year two the multiplier is less than half as large as in MDL5C). Clearly output and prices are jointly endogenous: over the first couple of years we can think of the model as having a downward sloping aggregate demand curve and an upward aggregate supply curve. In the first year the elasticity of the aggregate supply curve appears to about 1.3, which is roughly in accord with Figure 5.2, of the previous chapter[4] . In other words, the output multiplier is slightly less than 2 because the price rise, though temporary, erodes real value of wealth. Though price rises due to demand pressure in the short run, it returns to base in the long run because capital stock is built up in response to higher demand and this brings down prices. The effect on current account balance is negative and we observe that the long run deterioration of 2.4 percentage points now represents a four-fold increase over the short run one. Short run worsening of current account balance is less than MDL5C because lower short run output brings down imports much more than the fall in exports.

(c) Both Prices and Money Endogeneous

Mow money is endogenised (MDL7C). Fiscal expansion leads to balance of payments deficit and therefore causes the money supply, and therefore consumption, to contract. Output multiplier becomes much lower because a leakage to imports and loss of exports caused by the rise in activity and the currency appreciation causes a current account deficit (see Figure 6.3), a reserve loss, and a monetary contraction which counterbalances the injection caused by the budget deficit. Initially, one might think that output *must* rise enough for reserve loss to counteract the budget deficit so that money creation ceases (given that the long run equilibrium with a fixed nominal exchange rate must be one without on-going inflation and so without continuing extra nominal money creation). The effects on prices and current account balance are transitory. In fact it is a very interesting feature of the model which recurs in many of our exercises that it embeds a powerful self-correcting mechanism in the form of monetary feed backs from balance of payments.

This run, MDL7C, is put forward as an approximation to a sensible full model run and full details on results are given as Appendix 6B. Here we may draw broad conclusions that emerge from this run. Fiscal expansion seems to crowd out mainly private consumption; private investment is not affected very much because the model specification keeps interest rates fixed in the face of fiscal expansion. This crowding out effect on private consumption is attributable to the lower wealth stock in long-run equilibrium. Prices rise in the short run and as a consequence real exchange rate appreciates. Eventually, however, as capital stock is built up, this price rise is largely reversed. In current account balance, depleted foreign reserves imply a permanent loss of interest earnings; with a view to recoup this loss through increase in merchandise earnings a small depreciation and output deflation seem to occur towards the end of simulation period.

6.4 Adverse Supply Shock

Figures 6.4,6.5 and 6.6, and table 6.3 show the effects of a permanent upward shift in the residual of consumer price equation by 10 per cent.

Figure 6.4 shows that output falls steadily in all cases except in MDL5E which is a worrying feature of the model[5] ; in the case of MDL5E, this leads to a fall in output of 4 per cent. The price shock multiplies up three-fold through the wage-price spiral, as shown in Figure 6.5; more so when money is endogenous, because output is higher. The current account consequences are shown in Figure 6.6. The apparent improvement in current account balance point to the fact that in the model the effects of shrinking output dominate the adverse relative price effects on the trade sector. The long lasting hole in case MDL7E reflects the lagged effects on trade of the severe price spikes in Figure 6.5.

Table 6.3

Effects of a Supply Shock

(Effects of a 10 % Fall in Productivity)

Model Name	Additional Exog. Vars.	Effects on		
		Output Bn. US $	Prices %	Cur. Ac. % Points
MDL5E	Money & Prices	0.0	10.0	0.0
		- 4.0	**10.0**	**13.9**
MDL6E	Money	-2.5	17.5	8.2
		< 34.7	**25.3**	**14.0**
MDL7E	none	- 2.5	17.5	8.2
		< - 31.2	**35.2**	**- 0.8**

Notes

1. Output is measured as percentage differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.

2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

Figure 6.4
Output (GDP)

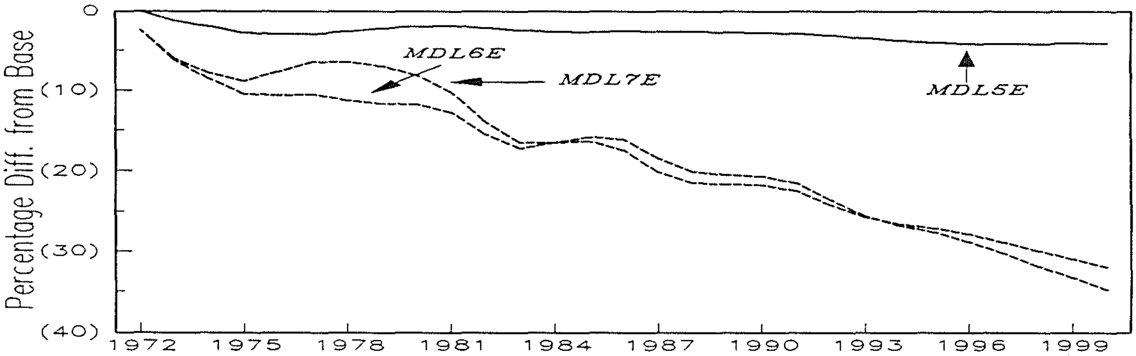
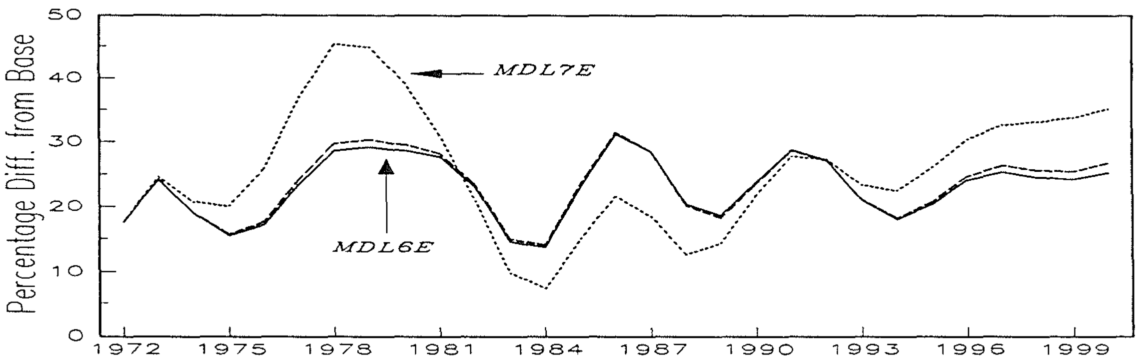


Figure 6.5
Prices



MDL5E

Money and Prices Exogeneous

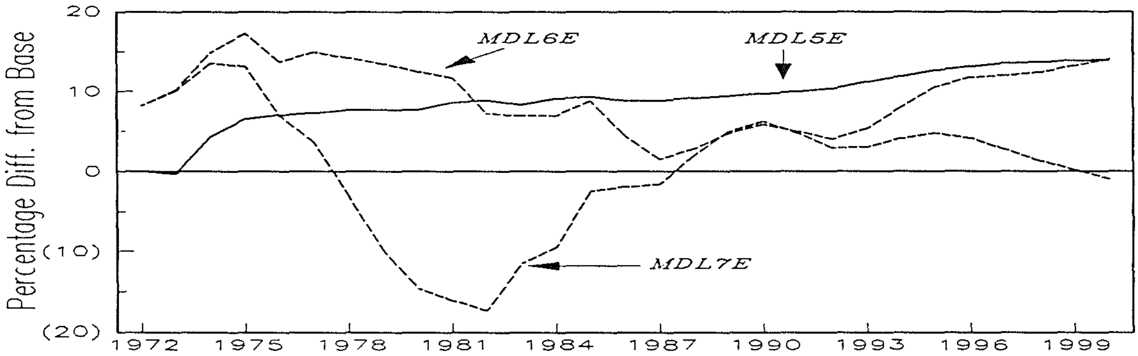
MDL6E

Money Exogeneous

MDL7E

Money and Prices Endogeneous

Figure 6.6
Current Account Balance
(As Perc. of Base Exports)



MDL5E
Money and Prices Exogeneous

MDL6E
Money Exogeneous

MDL7E
Money and Prices Endogeneous

6.5 Slump in Foreign Demand

Figures 6.7,6.8 and 6.9, and table 6.4 show the effects of a 3.5 per cent point decrease in the level of foreign demand for the country's exports. This shock is equivalent to US $ 3 Billion reduction in external demand.

As one might expect, in several respects the results echo the effects discussed earlier in Section 6.2 of a fiscal shock. The Keynesian multiplier model, with exogeneous money and prices (MDL5F), displays the multiplier accelerator cycles already familiar. Even although output falls strongly, the deterioration in the current account balance persists in the long term. When money alone is exogeneous (MDL6F) we observe that endogeneous variation in prices smooth out cycles in output and balance of payments; output is less contractionary because a fall in prices means that the real value of wealth will be higher than the case when prices were exogeneous. When the reserve loss caused by the export slump is allowed to affect the domestic money supply, as in MDL7F, we have the interesting result that balance of payments deficit is self-correcting in the long run. Note however that the output remains diminished and prices return to base. Possible policy reactions to this negative external shock are discussed further in the next chapter.

Table 6.4

Effects of a Negative External Shock

(Effects of a Permanent Fall of US $ 2.9 Billion in Export Market)

Model Name	Additional Exog. Vars.	Effects on		
		Output Bn. US $	Prices %	Cur. Ac. % Points
MDL5F	Money & Prices	-3.9 **- 8.5**	0.0 **0.0**	-2.7 **-2.6**
MDL6F	Money	-3.0 **-6.7**	-.9 **-.1**	-3.4 **-2.6**
MDL7F	none	- 3.0 **-11.0**	-.9 **0.0**	-3.4 **0.1**

Notes

1. Output is measured as percentage differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in
2. percentages. Therefore, in this case we measure absolute differences to base.

   First year impact is given as the short run effect.
   Long run effects are printed in bold type face.

Figure 6.7
Output (GDP)

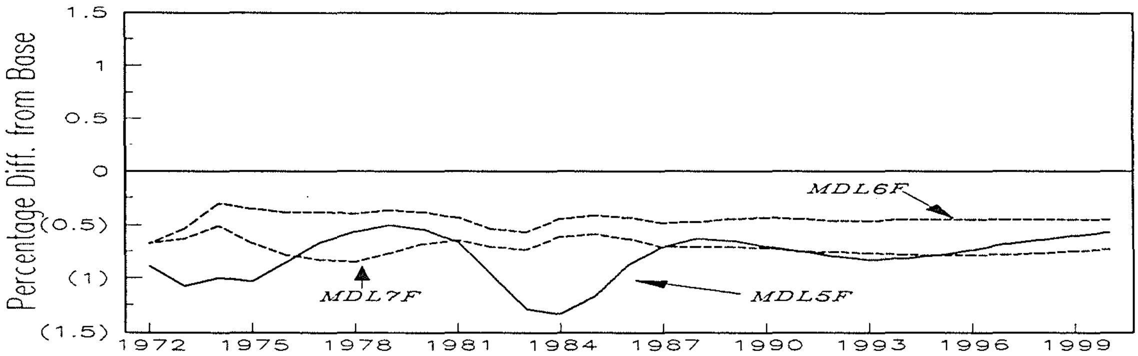
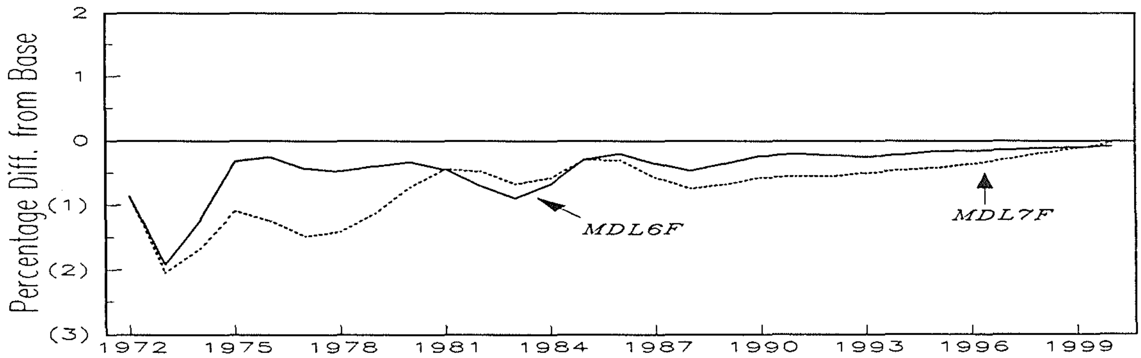


Figure 6.8
Prices



MDL5F

Money and Prices Exogeneous

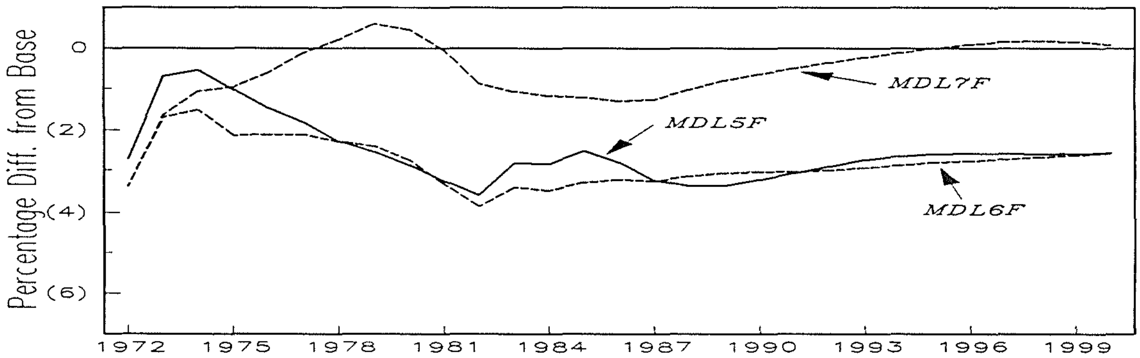
MDL6F

Money Exogeneous

MDL7F

Money and Prices Endogeneous

Figure 6.9
Current Account Balance
(As Perc. of Base Exports)



MDL5F

Money and Prices Exogeneous

MDL6F

Money Exogeneous

MDL7F

Money and Prices Endogeneous

6.6 Import Price Increase

Figures 6.10,6.11 and 6.12, and, table 6.5 show the effects of a 10 per cent increase in import prices. When money and prices are both exogeneous (MDL5G) output falls by 1.4 percent because of the terms of trade loss and reduction in real income, the effect of which is included in our consumption function. The effect on the trade balance remains negative at 13.0 percentage points, however, even although domestic spending and imports fall: this is what one would expect.

With endogenous prices(MDL6G and MDL7G), we expect domestic product price rises to follow the import price increase. But, crucially, they do this less than one for one. This is because of the contractionary effect on output of deterioration in terms of trade. The long run effect on prices which rise by 5.0 per cent is less than the short run spike of 7 per cent because output falls more in the long run. Note that with endogeneous money (MDL6G) current account balance remains deteriorated by 6 percentage points. This is less than the extent of the deterioration seen with exogeneous money because now real wealth is lower. Interestingly, with endogeneous money (MDL7G) and prices we witness automatic correction for the same monetary reasons as we saw with the fiscal shock earlier under Section 6.3. The very slow convergence of effect on output in MDL6G and MDL7G is also worth noting.

Table 6.5

Effects of an Import Price Increase

(Effects of a Permanent 10 % Increase in Import Prices)

Model Name	Additional Exog. Vars.	Effects on		
		Output %	Prices %	Cur. Ac. % Points
MDL5G	Money & Prices	0.0	0.0	-11.5
		- 1.4	**0.0**	**-13.0**
MDL6G	Money	-1.1	7.1	-7.6
		< - 8.4	**4.8**	**-6.0**
MDL7G	none	- 1.1	7.1	-7.6
		< - 8.9	**5.5**	**0.4**

Notes

1. Output is measured as percentage differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.

2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

Figure 6.10
Output (GDP)

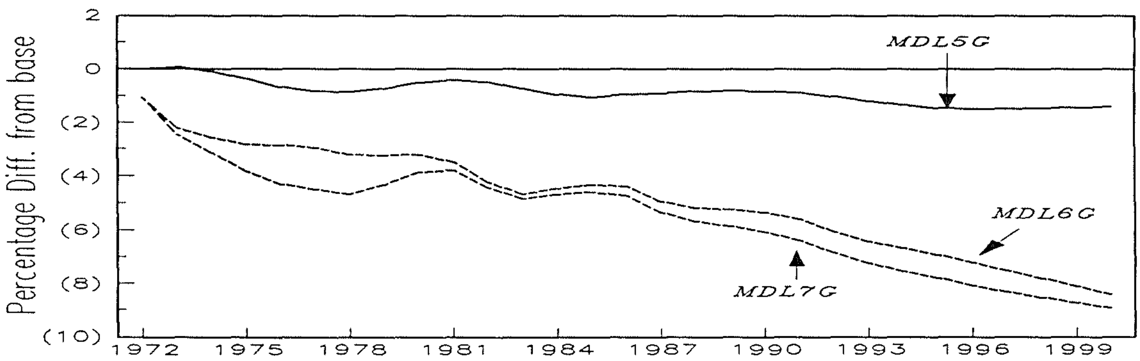
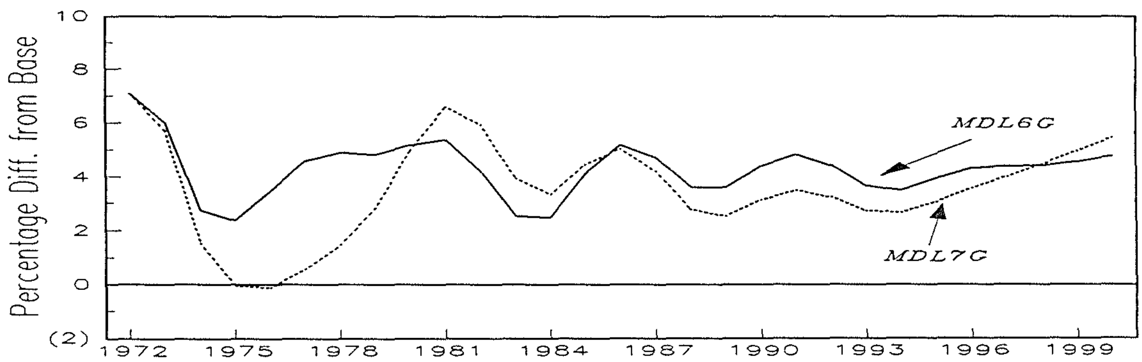


Figure 6.11
Prices



MDL5G

Money and Prices Exogeneous

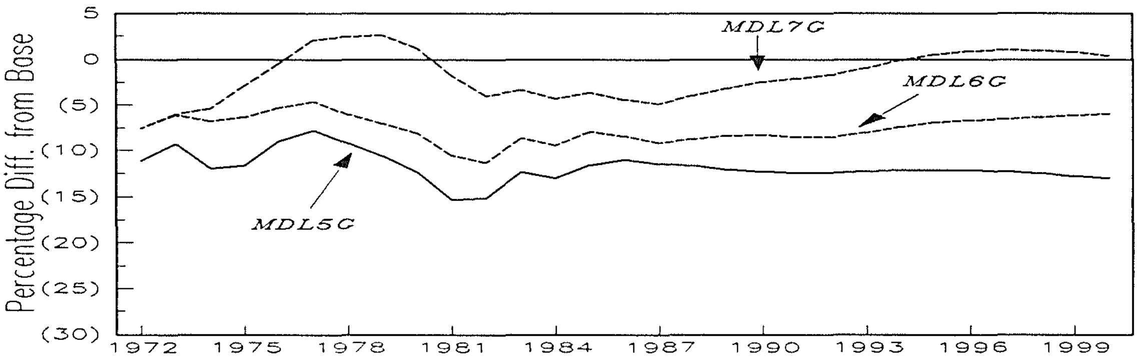
MDL6G

Money Exogeneous

MDL7G

Money and Prices Endogeneous

Figure 6.12
Current Account Balance
(As Perc. of Base Exports)



MDL5G

Money and Prices Exogeneous

MDL6G

Money Exogeneous

MDL7G

Money and Prices Endogeneous

6.7 Increase in Money Supply

Figures 6.13,6.14 and 6.15, and, table 6.6 show the effect of an increase of $1 billion in M2, nominal money stock. With exogenous prices, this would still mean a declining shock to real money because in the base prices rise over time. Therefore there is no long lasting effect on output. But the current account remains in deficit because extra money is drained through reserves and this permanently reduces the interest earnings from abroad.

Endogenizing prices (MDL6H) makes the only difference to the above result that the it smooths the fluctuations in output and current account balance. It appears that in the long run in run MDL7H, in which reserves are endogenous, the money injection disappears back to the Government and abroad through a reserve loss.

Table 6.6

Effects of a Money Supply shock

(Effects of a US $ 1 Bn. Increase in Nominal Money Stock)

Model Name	Additional Exog. Vars.	Effects on		
		Output US $ Bn.	Prices %	Cur. Ac. % Points
MDL5H	Money & Prices	0.0 .3	0.0 **0.0**	0.0 **- 0.6**
MDL6H	Money	0.0 .6	0.0 0.0	0.0 **- 0.6**
MDL7H	none	0.0 - .7	0.0 **- 0.1**	0.0 **0.3**

Notes

1. Output is measured as absolute differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.
2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

Figure 6.13
Output (GDP)

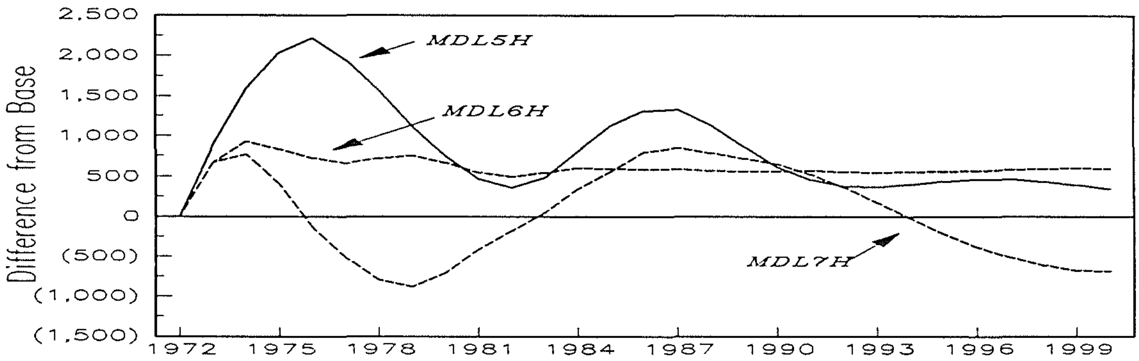
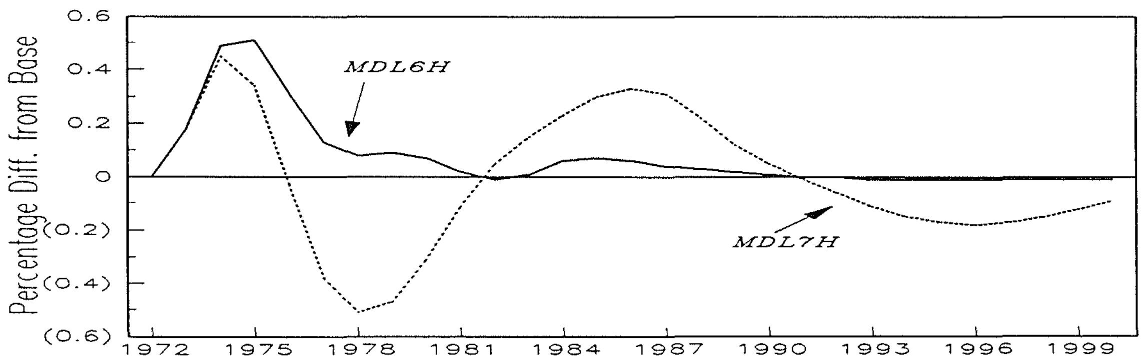


Figure 6.14
Prices

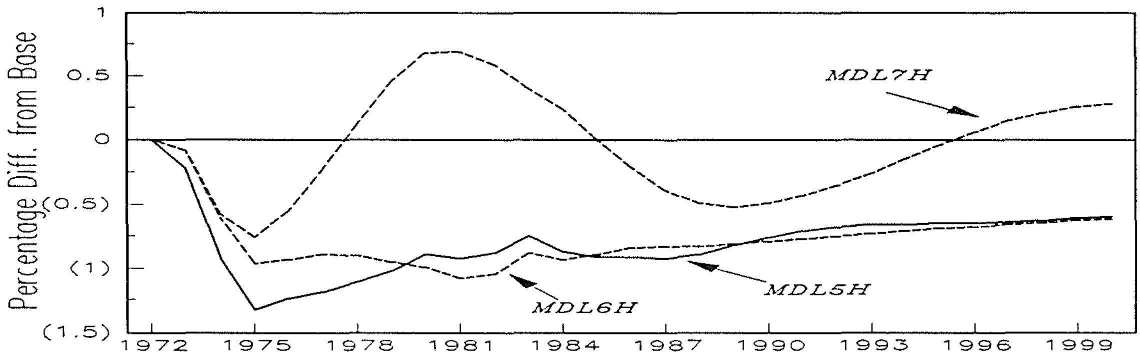


MDL5H
Money and Prices Exogeneous

MDL6H
Money Exogeneous

MDL7H
Money and Prices Endogeneous

Figure 6.15
Current Account Balance
(As Perc. of Base Exports)



MDL5H

Money and Prices Exogeneous

MDL6H

Money Exogeneous

MDL7H

Money and Prices Endogeneous

6.8 Increase in Interest Rate

The effects of a permanent 1 per cent point increase in LIBOR are shown in figures 6.16, 6.17 and 6.18, and, table 6.7. Output falls by 1/2 per cent on impact but recovers somewhat in the long run when prices and money are exogeneous (MDL5J). The effects on current account in contrast take time to take effect and in the long run it falls by 3 percentage points.

With exogeneous money (MDL6J) the loss in output continues and prices rise as dis-investment follows the rise in interest rate. The adjustment process is very slow. Output falls by 1.5 per cent and prices rise by 1 per cent in the long run. Current account worsens by 3 percentage points. When the effects of changes in reserves on the money supply are included, (MDL7J) reserve loss depresses domestic consumption, dragging down domestic output and prices, consequently adjustment is quicker. As a result the current account deficit gradually improves, and is almost back to zero by the end of this simulation.

Table 6.7

Effects of an Interest Rate shock

(Effects of a Permanent 1 % Point Increase in LIBOR)

Model Name	Additional Exog. Vars.	Effects on		
		Output %	Prices %	Cur. Ac. % Points
MDL5J	Money & Prices	- 0.5 **- 0.3**	0.0 **0.0**	- 0.4 **- 3.0**
MDL6J	Money	- 0.4 **< - 1.5**	- 0.3 **> 0.8**	- 0.6 **- 1.9**
MDL7J	none	- 0.4 **- 1.5**	- 0.3 **> 1.2**	- 0.6 **- 0.7**

Notes

1. Output is measured as Percentage differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.

2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

Figure 6.16
Output (GDP)

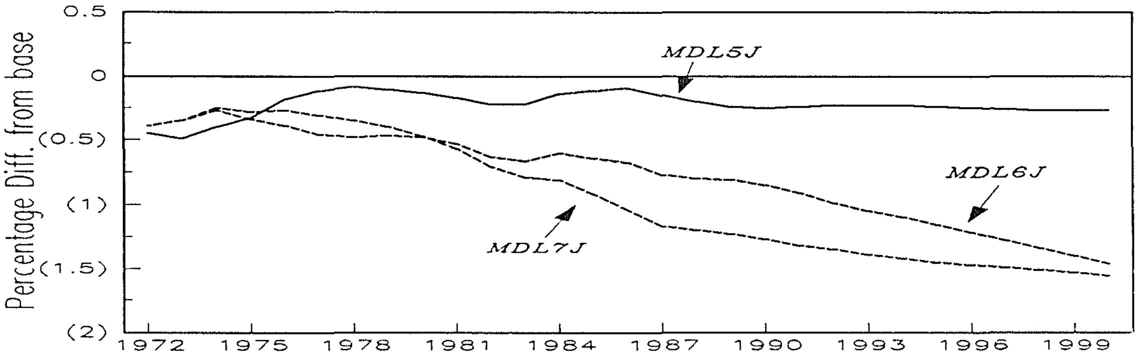
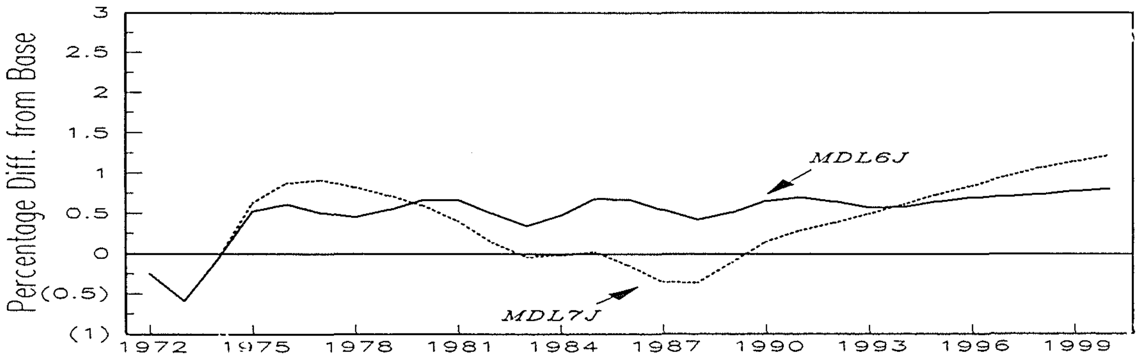


Figure 6.17
Prices



MDL5J

Money and Prices Exogeneous

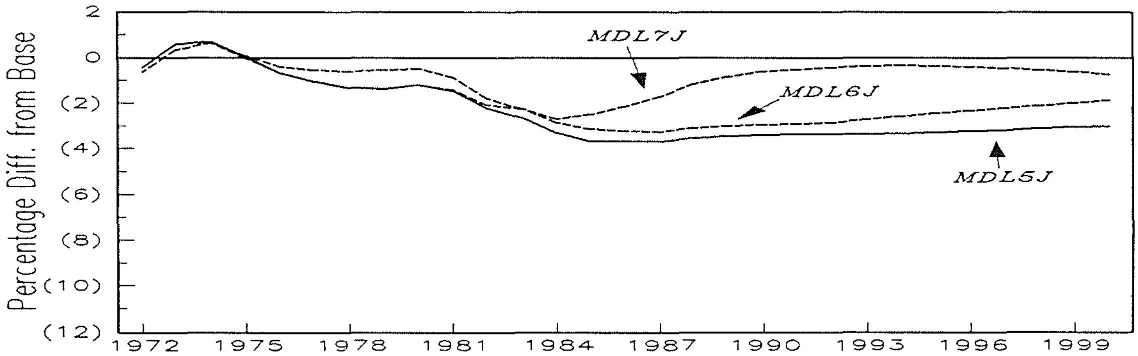
MDL6J

Money Exogeneous

MDL7J

Money and Prices Endoge-neous

Figure 6.18
Current Account Balance
(As Perc. of Base Exports)



MDL5J
Money and Prices Exogeneous

MDL6J
Money Exogeneous

MDL7J
Money and Prices Endogeneous

6.9 Devaluation

Figures 6.19, 6.20 and 6.21, and table 6.8 show the effects of a 10 % exchange rate depreciation.

Run MDL5K shows what happens when both prices and money are exogeneous: this corresponds to a real devaluation in a Keynesian multiplier world. Output rises by 11 per cent in the long run as shown in Figure 6.19. As a result there is almost no improvement in the current account in the long run. In run MDL6K prices are endogeneous but money is exogeneous. The wage price spiral works very rapidly. But prices settle only 8 per cent higher rather than 10 per cent. The reason is that with exogenous nominal money balances, real balances fall depressing consumption. The resulting fall in output is about 2 per cent. The consequence of this is that prices fall below what they otherwise would have been. With a real depreciation and fall in output, both of which are long lasting, the improvement shown in current account balance shown in Figure 6.21 is around 15 per cent. Run MDL7K is a classic "monetary approach to balance of payments" simulation. In the long run prices rise by 10 per cent and output is unchanged. A transient current account surplus rebuilds the real balances lost as a result of the price rise.

Table 6.8

Effects of an Exchange Rate shock

(Effects of a Permanent 10 % Point Increase in Nom. Exch. Rate)

Model Name	Additional Exog. Vars.	Effects on		
		Output %	Prices %	Cur. Ac. % Points
MDL5K	Money & Prices	1.7 **11.2**	0.0 **0.0**	- 5.3 **0.5**
MDL6K	Money	0.2 **- 2.0**	8.8 **8.8**	- 0.6 **> 13.9**
MDL7K	none	0.2 **- 0.4**	8.8 **> 10.6**	- 0.6 **3.4**

Notes

1. Output is measured as Percentage differences from base.
   Prices are measured as percentage differences from base.
   Current account balance measure is normalized with base nominal export revenues expressed in percentages. Therefore, in this case we measure absolute differences to base.

2. First year impact is given as the short run effect. Long run effects are printed in bold type face.

Figure 6.19
Output (GDP)

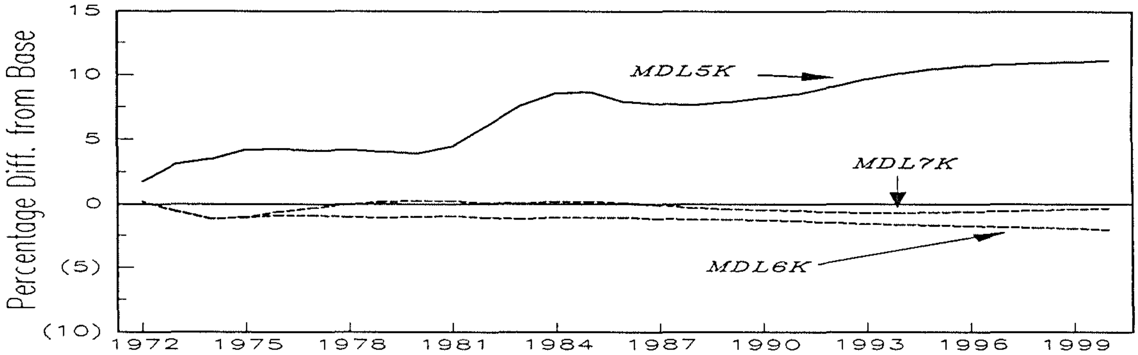
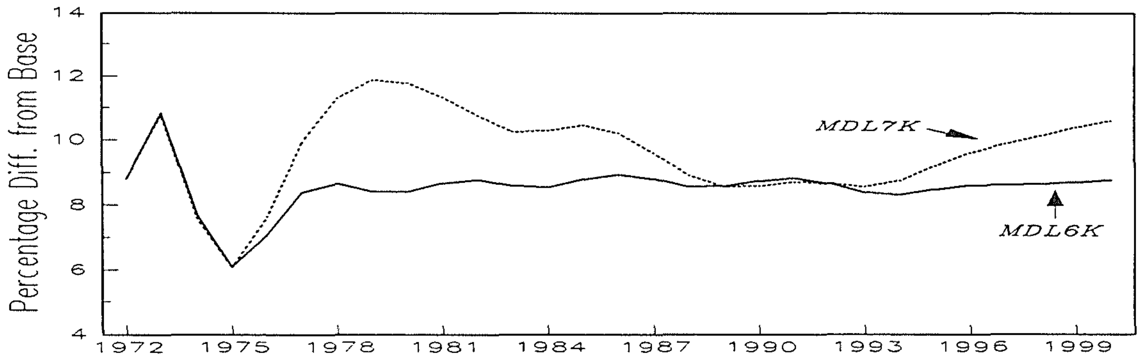


Figure 6.20
Prices



MDL5K

Money and Prices Exogeneous

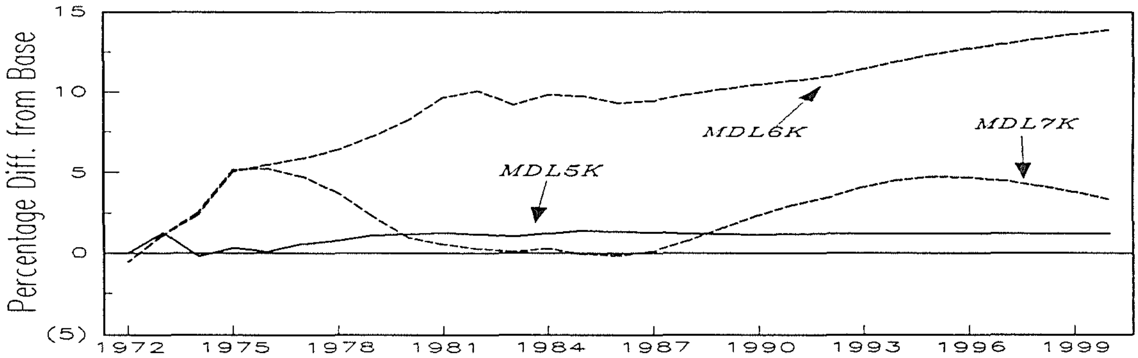
MDL6K

Money Exogeneous

MDL7K

Money and Prices Endogeneous

Figure 6.21
Current Account Balance
(As Perc. of Base Exports)



MDL5K
Money and Prices Exogeneous

MDL6K
Money Exogeneous

MDL7K
Money and Prices Endogeneous

Appendix 6A

Model Codes

```
& ALL
   MACRO ECONOMETRIC MODEL FOR LATIN AMERICA
   THE BASIC MODEL   STORED AS LAMBASIC.MOD
        K SWITCHED ON IN CED EQN.
        RESERVES EXOGENIZED IN IMPORT FUNCTION
        IMPORT RATIO EXOGENIZED IN PRICE EQUATION
     PRIVATE CONSUMPTION
*W   ECMC = ALOG(C(-1)) - .57624 -.71420 * ALOG(YD(-1))
*     +-.2 * (ALOG(M2R(-1)) - ALOG(PC(-1)) + ALOG(100))
*    +-.094783 * (ALOG(PXGN(-1)) - ALOG(PMGN(-1)) + ALOG(100))


*     C = EXP( ALOG(C(-1))
*     ++ .97117 * (ALOG(YD) - ALOG(YD(-1)))
*     +      -.27241 * ECMC)



     EXPORT VOLUME INDEX FOR GOODS


*     XGI = EXP( ALOG(XGI(-1))
*     ++ .074598
*     +             + .80379 * (ALOG(S) - ALOG(S(-1)))
*     +             - .73266 * (((ALOG(PXA)) - ALOG(PXA(-1)))
*     +                     -  (ALOG(PXAC) - ALOG(PXAC(-1))))
*     +             - .24152 * (ALOG(XGI(-1)) - ALOG(S(-1)))
*     +           - .60793 * (ALOG(PXA(-1)) - ALOG(PXAC(-1))))

     EXPORT VOLUME INDEX FOR GOODS AND N.F. SERVICES
*    XGNI = EXP( ALOG(XGI) + .04192)
     EXPORT OF GOOD AND NON FACTOR SERVICES IN 1980 US $
*    XGN = 83391.0 * XGNI*.01



     IMPORT OF GOODS AND NON FACTOR SERVICES
```

```
*W      ECMM = ALOG(MGN(-1)) + 21.412
*      +                  + .084747*T(-1)
*      +                  - 2.5766*ALOG(YD(-1))
*      +                  + .1386*ALOG(REX(-1))
*     +            - .050405*(ALOG(RESCPX(-2)) - ALOG(PMGN(-2))
*      +                                        + ALOG(100))
*       MGN = EXP( ALOG(MGN(-1))
*      +             + 1.1641*(ALOG(YD) - ALOG(YD(-1)))
*      +                         -1.3277*ECMM)
```

INVESTMENT

```
*W      IRPKUS = LIBOR + 12.88 - USFINF


*       KI =  EXP ( ALOG(KI(-1)) + 0.090303
*      ++.039237 * (ALOG(DISBI(-1)) - ALOG(PKX(-1)))
*      +         -.0018957 * IRPKUS
*      +     -.39382 * (ALOG(KI(-1)) - ALOG(YDI(-1))))
```

NET FIXED CAPITAL STOCK

```
*       K = 805940.1 * KI*.01
```

GROSS FIXED INVESTMENT

```
*I      IFN = K - K(-1)
*I      IF = IFN + .1288 * K(-1)
        IF = K - K(-1) + .1288 * K(-1)
```

GROSS TOTAL INVESTEMNT

```
*       IT = EXP( ALOG(IF) + .0925)
```

GDP AT MARKET PRICES

```
*I      YD = C + GC + XGN + IT - MGN

*       YDI = YD/715401.6 * 100.
```

CONSUMER EXPENDITURE DEFLATOR

```
*M      CED = EXP( ALOG(CED(-1)) - 1.4135
*      ++ ALOG(NW) - ALOG(NW(-1))
*      ++.22061 * ( (ALOG(PMGNL) - ALOG(PMGNL(-1)))
*      +                        - (ALOG(NW) - ALOG(NW(-1))))
*      ++.11387 * (ALOG(PMGNL(-1)) - ALOG(CED(-1)))
*      ++.2360 * (ALOG(NW(-1)) -ALOG(CED(-1)) + ALOG(100))
*      ++.32643 * (ALOG(YD) - ALOG(K))
*      ++.16057 * (ALOG(YDX) - ALOG(MGNX)))

        NOMINAL WAGES

*M     NW = EXP( ALOG(CED) - ALOG(100) + .44346 * ALOG(YD(-1))
*    +-.045614 * (ALOG(CED) - 2 * ALOG(CED(-1)) + ALOG(CED(-2)))
*      ++.014147 * T
*      +-1.4820)


*W      CU = YD/K*100.
*W      LCU = YD(-1)/K(-1)*100.
        WHEN PRICE IS EXOGENEOUS
        CU = YDX/KX*100.
        LCU = YDX(-1)/KX(-1)*100.

*M      PXA = EXP( ALOG(PXA(-1)) + .018916
*      +         + 1.1000 * (ALOG(PAB) - ALOG(PAB(-1)))
*      +         +  .62015 * (ALOG(CU) - ALOG(LCU))
*      +         -  .76838 * (ALOG(PXA(-1)) - ALOG(PAB(-1))))

        UVI FOR EXPORT OF GOODS AND NFS
*M      PXGN = EXP ( ALOG(PXA) - .04734)
        UVI FOR IMPORT OF GOODS AND NFS
*M      PMGN = EXP( ALOG(PMA) + .36206 - .01484 * T)


        UNIVERSAL DEFLATOR IN US $ TERMS
*W      UD = EXP(ALOG(CED) - ALOG(EXX)+ ALOG(100))

        PRIVATE CONSUMPTION DEFLATOR
*M      PC = UD
        GOVERNMENT CONSUMPTION DEFLATOR
*M      PGC = UD
```

```
        INVESTEMENT DEFLATOR
*M      PK = UD

        GDP DEFLATOR
*M      PY = UD




        EXPORT OF GOODS AND NFS CUURENT US $
*       XGNV = XGN * PXGN * .01

        IMPORT OF GOODS AND NFS CURRENT US $
*       MGNV = MGN * PMGN * .01
        INTEREST OBLIGATIONS
*       INT = DOD(-1) * (( .73 * LIBOR * .01)
*      ++      .27 * .01 * ( .25 * LIBOR(-1) + .25 * LIBOR(-2)
*      ++              .25 * LIBOR(-3) + .25 * LIBOR(-4)))
*      +-      LIBOR * RESCP(-1) * .01

        CURRENT ACCOUNT BALANCE
*I      CBV = XGNV - MGNV - INT + OFS + CT
        SUM OF CBV
*       SCBV = SCBV(-1) + CBV



        DEFINIG CBV SCALED BY BASE XGNV
*       CBVS = CBV / XGNVX
        DEFINING SUM OF SCALED CBV UP TO A GIVEN YEAR FOR INT.
CTRL
*       SCBVS = SCBVS(-1) + CBVS

        HOME GOODS PRICE DEFLATOR
*M      PHL = CED
```

```
*M      REX = EXP( ALOG(EX) + ALOG(PMGN) - ALOG(PHL))


        ABSORPTION DEFLATOR
*M      PAB = EXP( ALOG(CED) - ALOG(EX) + ALOG(100))


        IMPORT PRICE DEFLATOR IN LOCAL CURRENCY TERMS
*M      PMGNL = EXP(ALOG(PMGN) + ALOG(EX)- ALOG(100))

        AMORTIZATION


*       AMT = .095 * DOD(-1)

        NEW BORROWINGS
        CASE WHEN THERE IS NO EXTERNAL BORROWING
*       DISB = 0.0 * (AMT - CBV - OLTF - OCF)
      CASE WHEN ALL BOP DEFICIT IS FINANCED BY ETERNAL BORROWING
        DISB = 1.0 * (AMT - CBV - OLTF - OCF)

        DISBI = DISB/37372.40 *100.
        CHANGE IN RESERVES

*       RESCP = RESCP(-1) + CBV + DISB - AMT  + OLTF + OCF
        DEBT STOCK
*       DOD = DOD(-1) + DISB - AMT


        GOVERNMENT RECEIPTS
*       GR = .18 * YDCP
```

```
        GOVERNMENT EXPENDITURE
*       GE = GCCP + .25 * ITCP + AMT + INT
*      +                      + LIBOR * HD(-1) * .01
        GOVERNMENT'S BUDGET DEFICIT
*       GBD = GE - GR
          GOVERNMENT'S ACCUMULATION OF INTERNAL DEBT AND ITS
MONETIZATION
*       HD = HD(-1) + .75 * GBD
*       CLG = CLG(-1) + .27 * (HD - HD(-1))
        MONEY CREATION
        BASE MONEY
*I      BM = RESCP + HD
        MONEY SUPPLY
*       M2R = .729 * M2R(-1) + 1.300 * BM - .629 * BM * DMYDBT


        NET FLOWS
*I      NF = DISB - AMT
        MEMO ITEMS
*I      RR = RESCP/MGNV*100.
        DEBT SERVICE
*I      DS = AMT +INT
*I      DSR = DS/XGNV * 100.
*I      RW = NW/CED *100.
*I      GCCP = GC * PGC *.01

*I      YDCP = YD * PY /100.
*I      ITCP = IT * PK /100.
*W      GDSCP = ITCP + CBV
*I      SR = GDSCP/YDCP*100.
*I      FSR = -CBV/YDCP*100.
*I      CBVKP = CBV/PY*100.
*I      M2RKP = M2R/PC*100.


&&
```

APPENDIX 6B

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Components of Aggregate Demand

(Abs. Change over Base Run Values)

YEAR	C	GC	IT	XGN	MGN	YD
1972	2215.38	2000	0	-485.46	458.14	3271.78
1973	1787.66	2000	1540.34	-1013.55	1372.87	2941.56
1974	277.94	2000	1059.61	-1033.82	943.76	1359.97
1975	-703.03	2000	175.7	-606.45	350.64	515.59
1976	-1552.88	2000	-245.11	-166.68	21.66	13.69
1977	-2080.97	2000	-379.08	121.08	-133.12	-205.81
1978	-2995.25	2000	-368.19	375.5	-225.37	-762.56
1979	-3562.59	2000	-543.56	627.91	-416.07	-1062.19
1980	-3146.16	2000	-545.89	705.65	-417.66	-568.75
1981	-1935.81	2000	-159.11	442.4	-66	413.5
1982	-774.38	2000	378.76	-88.47	294.88	1221.06
1983	-85.97	2000	739.34	-600.26	446.02	1607.13
1984	312.31	2000	728.53	-960.78	467.24	1612.88
1985	694.03	2000	540.86	-1091.54	471.57	1671.75
1986	1124.97	2000	450.92	-1181.67	490.3	1903.94
1987	1240.5	2000	544.53	-1251.29	529.48	2004.31
1988	971.44	2000	524.97	-1196.63	515.34	1784.44
1989	498.88	2000	362.64	-968.02	424.89	1468.63
1990	-45.13	2000	201.05	-636.14	327.66	1192.13
1991	-656.38	2000	97.5	-282.92	241.23	916.94
1992	-1054.25	2000	12.97	15.72	177.67	796.75
1993	-1735.75	2000	13.78	301.17	126.61	452.63
1994	-2567.56	2000	-101.17	647.02	10.37	-32
1995	-3332	2000	-267.2	1030.64	-117.05	-451.63
1996	-3926.44	2000	-379.73	1355.06	-214.58	-736.5
1997	-4366.19	2000	-420.77	1563.5	-274.22	-949.13
1998	-4662.19	2000	-433.81	1659.23	-314.28	-1122.5
1999	-4758.44	2000	-439.42	1660.16	-335.66	-1202
2000	-4636.5	2000	-411.44	1553.53	-329.44	-1165

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Components of Aggregate Demand

(Percentage Change over Base Run Values)

YEAR	C	GC	IT	XGN	MGN	YD
1972	0.72	4.49	0	-1.04	0.86	0.75
1973	0.53	3.96	1.47	-2.02	2.33	0.61
1974	0.08	3.72	0.87	-1.96	1.32	0.26
1975	-0.2	3.4	0.15	-1.16	0.52	0.1
1976	-0.42	3.22	-0.19	-0.29	0.03	0
1977	-0.54	3.24	-0.29	0.19	-0.2	-0.04
1978	-0.74	3.16	-0.27	0.53	-0.31	-0.13
1979	-0.79	2.78	-0.37	0.81	-0.5	-0.16
1980	-0.65	2.57	-0.32	0.85	-0.43	-0.08
1981	-0.4	2.59	-0.1	0.5	-0.07	0.06
1982	-0.17	2.42	0.3	-0.1	0.37	0.18
1983	-0.02	2.64	0.72	-0.62	0.73	0.24
1984	0.07	2.58	0.67	-0.89	0.74	0.23
1985	0.15	2.62	0.48	-0.97	0.76	0.23
1986	0.22	2.5	0.38	-0.99	0.74	0.25
1987	0.24	2.39	0.44	-0.99	0.75	0.25
1988	0.18	2.28	0.4	-0.9	0.68	0.21
1989	0.09	2.17	0.26	-0.68	0.53	0.17
1990	-0.01	2.07	0.14	-0.42	0.38	0.13
1991	-0.1	1.97	0.06	-0.18	0.26	0.1
1992	-0.16	1.88	0.01	0.01	0.18	0.08
1993	-0.25	1.79	0.01	0.17	0.12	0.04
1994	-0.35	1.71	-0.06	0.34	0.01	0
1995	-0.43	1.63	-0.15	0.51	-0.1	-0.04
1996	-0.48	1.55	-0.2	0.64	-0.17	-0.06
1997	-0.51	1.48	-0.21	0.69	-0.2	-0.07
1998	-0.52	1.41	-0.2	0.69	-0.22	-0.08
1999	-0.5	1.35	-0.2	0.65	-0.22	-0.08
2000	-0.47	1.28	-0.18	0.58	-0.2	-0.08

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

BOP Current Account

(Abs. Change over Base Run Values)

YEAR	XGNV	MGNV	INT	CBV	RESCP	RR
1972	75.9	159.01	0	-83.11	-83.11	-0.76
1973	21.11	560.68	7.83	-547.4	-630.51	-3.56
1974	-324.77	527.16	68.73	-920.65	-1551.15	-4.16
1975	-476.91	208.08	107.81	-792.8	-2343.95	-5.92
1976	-458.23	13.78	130.56	-602.57	-2946.52	-6.96
1977	-254.68	-89.07	178.26	-343.87	-3290.39	-7.17
1978	-77.48	-162.79	291.2	-205.89	-3496.28	-6.59
1979	85.98	-355.13	422.7	18.4	-3477.88	-4.7
1980	365.3	-417.66	493.51	289.46	-3188.43	-3.17
1981	567.91	-69.76	537.89	99.77	-3088.66	-2.93
1982	425.22	282.52	410.48	-267.78	-3356.44	-4.41
1983	156.67	455.82	326.25	-625.4	-3981.84	-6.53
1984	-200.96	474.45	435.61	-1111.02	-5092.85	-8.24
1985	-456.91	487.5	427.8	-1372.2	-6465.05	-10.29
1986	-599.25	523.59	484.88	-1607.72	-8072.78	-11.69
1987	-693	584.09	605.46	-1882.55	-9955.33	-13.11
1988	-795.76	587.26	746.65	-2129.67	-12085	-14.43
1989	-850.38	500.17	906.38	-2256.93	-14341.9	-15.47
1990	-782.53	398.45	1075.64	-2256.62	-16598.5	-16.18
1991	-604.77	303.02	1244.89	-2152.68	-18751.2	-16.52
1992	-361.75	230.55	1406.34	-1998.64	-20749.9	-16.55
1993	-137.7	169.7	1556.24	-1863.64	-22613.5	-16.34
1994	64.27	14.36	1696.01	-1646.11	-24259.6	-15.83
1995	319.58	-167.41	1819.47	-1332.49	-25592.1	-15.06
1996	654.52	-317.05	1919.41	-947.85	-26540	-14.11
1997	999.81	-418.55	1990.5	-572.14	-27112.1	-13.03
1998	1278.94	-495.52	2033.41	-258.95	-27371	-11.91
1999	1472.28	-546.67	2052.83	-33.88	-27404.9	-10.8
2000	1587.94	-554.25	2055.37	86.82	-27318.1	-9.77

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

BOP Current Account

(Percentage Change over Base Run Values)

YEAR	XGNV	MGNV	INT	CBV	RESCP	RR
1972	0.46	0.86	0	2.05	-1.22	-2.06
1973	0.09	2.33	0.41	14.03	-5.94	-8.08
1974	-1.05	1.32	1.98	7.16	-15.44	-16.54
1975	-1.6	0.52	2.27	5.11	-30.34	-30.7
1976	-1.19	0.03	2.86	6.08	-23.07	-23.09
1977	-0.57	-0.2	3.33	4.07	-19.13	-18.97
1978	-0.16	-0.31	3.77	1.78	-13.74	-13.47
1979	0.13	-0.5	3.75	-0.1	-11.31	-10.86
1980	0.44	-0.43	3.24	-0.94	-11.19	-10.8
1981	0.62	-0.07	2.69	-0.24	-12.05	-11.99
1982	0.52	0.37	1.68	0.83	-20.76	-21.05
1983	0.19	0.73	1.45	5.62	-23.06	-23.61
1984	-0.22	0.74	1.7	21.62	-18.14	-18.74
1985	-0.51	0.76	1.65	29.97	-23.41	-23.99
1986	-0.61	0.74	1.76	36.15	-21.56	-22.14
1987	-0.64	0.75	2.06	43.97	-20.62	-21.21
1988	-0.67	0.68	2.39	52.27	-20.07	-20.61
1989	-0.66	0.53	2.73	59	-19.55	-19.97
1990	-0.55	0.38	3.05	63.82	-18.91	-19.21
1991	-0.39	0.26	3.32	67.22	-18.09	-18.31
1992	-0.21	0.18	3.53	70.91	-17.15	-17.3
1993	-0.07	0.12	3.68	78.3	-16.15	-16.26
1994	0.03	0.01	3.77	87.32	-15.09	-15.1
1995	0.14	-0.1	3.8	100.1	-13.96	-13.87
1996	0.27	-0.17	3.78	132.71	-12.75	-12.61
1997	0.37	-0.2	3.68	1941.93	-11.54	-11.36
1998	0.44	-0.22	3.54	-35.76	-10.36	-10.16
1999	0.46	-0.22	3.36	-2.19	-9.26	-9.06
2000	0.45	-0.2	3.17	3.55	-8.27	-8.08

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

BOP Capital Account

(Abs. Change over Base Run Values)

YEAR	DISB	AMT	NF	DOD	DSR
1972	0	0	0	0	-0.13
1973	0	0	0	0	0.01
1974	0	0	0	0	0.54
1975	0	0	0	0	1.01
1976	0	0	0	0	0.72
1977	0	0	0	0	0.61
1978	0	0	0	0	0.66
1979	0	0	0	0	0.59
1980	0	0	0	0	0.42
1981	0	0	0	0	0.32
1982	0	0	0	0	0.23
1983	0	0	0	0	0.31
1984	0	0	0	0	0.56
1985	0	0	0	0	0.69
1986	0	0	0	0	0.74
1987	0	0	0	0	0.82
1988	0	0	0	0	0.9
1989	0	0	0	0	0.95
1990	0	0	0	0	0.97
1991	0	0	0	0	0.95
1992	0	0	0	0	0.9
1993	0	0	0	0	0.86
1994	0	0	0	0	0.82
1995	0	0	0	0	0.77
1996	0	0	0	0	0.7
1997	0	0	0	0	0.62
1998	0	0	0	0	0.56
1999	0	0	0	0	0.5
2000	0	0	0	0	0.45

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

BOP Capital Account

(Percemtage Change over Base Run Values)

YEAR	DISB	AMT	NF	DOD	DSR
1972	0	0	0	0	-0.45
1973	0	0	0	0	0.04
1974	0	0	0	0	1.81
1975	0	0	0	0	2.56
1976	0	0	0	0	2.29
1977	0	0	0	0	1.71
1978	0	0	0	0	1.41
1979	0	0	0	0	1.21
1980	0	0	0	0	1.06
1981	0	0	0	0	0.75
1982	0	0	0	0	0.44
1983	0	0	0	0	0.73
1984	0	0	0	0	1.37
1985	0	0	0	0	1.64
1986	0	0	0	0	1.82
1987	0	0	0	0	2.05
1988	0	0	0	0	2.3
1989	0	0	0	0	2.51
1990	0	0	0	0	2.61
1991	0	0	0	0	2.61
1992	0	0	0	0	2.55
1993	0	0	0	0	2.49
1994	0	0	0	0	2.43
1995	0	0	0	0	2.33
1996	0	0	0	0	2.17
1997	0	0	0	0	1.99
1998	0	0	0	0	1.82
1999	0	0	0	0	1.67
2000	0	0	0	0	1.54

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Govt. Account, Money and Home Debt

(Abs. Change over Base Run Values)

YEAR	GE	GE	GBD	BM	M2R	HD
1972	527.15	1050.51	523.36	56.46	73.39	139.56
1973	1110	1875.77	765.77	-286.74	-319.26	343.77
1974	819.59	2028.35	1208.77	-885.05	-1383.3	666.11
1975	-25.67	1255.29	1280.95	-1336.26	-2745.56	1007.69
1976	-502.98	910.37	1413.35	-1561.93	-4032.02	1384.59
1977	-565.51	979.84	1545.35	-1493.71	-4881.17	1796.68
1978	-663.73	1373.73	2037.46	-1156.28	-5061.54	2340
1979	-884.77	1612.09	2496.85	-472.05	-4303.53	3005.83
1980	-768.23	2152.97	2921.2	596.39	-2361.97	3784.82
1981	25.58	3309.23	3283.66	1571.8	-667.2	4660.46
1982	763.84	3451.25	2687.41	2020.67	869.48	5377.11
1983	982.55	3127.36	2144.81	1967.22	1953.86	5949.05
1984	1013.69	3400.85	2387.16	1492.78	2426.02	6585.63
1985	796.73	3101.13	2304.39	735.09	2261.8	7200.14
1986	763.28	3115.31	2352.03	-245.43	1484.17	7827.34
1987	785.64	3358.98	2573.34	-1441.75	114.56	8513.57
1988	661.53	3523.97	2862.44	-2808.11	-1800.72	9276.89
1989	372.09	3557.92	3185.83	-4215.48	-4141.31	10126.45
1990	72.23	3596.78	3524.55	-5532.22	-6731.13	11066.33
1991	-154.91	3719.55	3874.45	-6651.7	-13554.2	12099.52
1992	-263.55	3922.89	4186.44	-7533.97	-19675.1	13215.9
1993	-384.67	4171.89	4556.56	-8182.53	-24980.4	14430.98
1994	-643.75	4299.02	4942.77	-8510.59	-29274.4	15749.05
1995	-942.22	4364.28	5306.5	-8428	-32297.4	17164.13
1996	-1115.95	4512.34	5628.3	-7874.97	-33782.3	18665
1997	-1142.19	4771.56	5913.75	-6870.13	-33558.4	20242.01
1998	-1092.28	5076.97	6169.25	-5483.88	-31593.1	21887.16
1999	-997.31	5388.38	6385.69	-3814.88	-27990.8	23590.02
2000	-819.56	5747.81	6567.38	-1976.78	-22975.3	25341.33

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Govt. Account, Money and Home Debt

(Percentage Change over Base Run Values)

YEAR	GE	GE	GBD	BM	M2R	HD
1972	1.7	3.35	124.61	0.36	0.16	1.6
1973	2.8	4.54	47.85	-1.46	-0.53	3.81
1974	1.58	3.52	20.62	-4.37	-1.83	6.54
1975	-0.05	1.95	14.86	-6.8	-3.4	8.46
1976	-0.77	1.26	20.47	-5.99	-3.93	10.41
1977	-0.81	1.26	20	-4.66	-4.88	12.11
1978	-0.81	1.4	12.44	-2.65	-4.01	12.92
1979	-0.85	1.26	10.4	-0.88	-2.58	13.12
1980	-0.6	1.38	10.65	1.05	-1.21	13.32
1981	0.02	1.87	9.13	2.57	-0.28	13.09
1982	0.67	2.24	6.81	3.39	0.45	12.36
1983	1.01	2.63	9.74	3.02	1.18	12.42
1984	0.96	2.67	11.01	1.86	1.32	12.61
1985	0.76	2.45	10.48	0.87	1.32	12.71
1986	0.67	2.29	10.4	-0.25	0.61	12.8
1987	0.64	2.28	10.83	-1.26	0.04	12.92
1988	0.49	2.22	11.48	-2.14	-0.55	13.09
1989	0.26	2.08	12.19	-2.82	-1.12	13.3
1990	0.05	1.95	12.87	-3.27	-1.6	13.56
1991	-0.09	1.87	13.52	-3.48	-1.48	13.85
1992	-0.14	1.82	13.96	-3.52	-1.91	14.16
1993	-0.19	1.8	14.54	-3.42	-2.17	14.49
1994	-0.3	1.72	15.11	-3.19	-2.29	14.84
1995	-0.4	1.61	15.54	-2.84	-2.27	15.19
1996	-0.44	1.55	15.83	-2.4	-2.15	15.54
1997	-0.41	1.52	15.97	-1.9	-1.93	15.88
1998	-0.36	1.49	16.02	-1.37	-1.65	16.19
1999	-0.31	1.47	15.96	-0.87	-1.33	16.47
2000	-0.23	1.45	15.81	-0.41	-0.99	16.73

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Prices and Wages

(Abs. Change over Base Run Values)

YEAR	CED	NW	RW	PXA	REX
1972	0.03	0.03	-0.04	0.56	-0.91
1973	0.1	0.1	0.28	1.14	-2.23
1974	0.08	0.09	0.32	0.61	-1.71
1975	-0.02	0	0.14	-0.27	0.17
1976	-0.15	-0.14	0.01	-0.63	0.89
1977	-0.22	-0.23	-0.03	-0.61	0.9
1978	-0.27	-0.3	-0.02	-0.52	0.77
1979	-0.42	-0.49	-0.06	-0.6	0.76
1980	-0.52	-0.66	-0.09	-0.4	0.52
1981	-0.06	-0.17	-0.06	0.12	0.04
1982	1.35	1.82	0.03	0.57	-0.43
1983	4.83	6.36	0.11	0.72	-0.82
1984	12.09	16.82	0.15	0.6	-0.62
1985	22.57	34.57	0.14	0.39	-0.42
1986	35.84	56.21	0.13	0.34	-0.33
1987	65.75	106.96	0.14	0.32	-0.31
1988	95.93	171.8	0.15	0.21	-0.22
1989	60.39	162.85	0.13	0.03	-0.07
1990	-115.72	-18.25	0.09	-0.13	0.07
1991	-510.56	-457.09	0.07	-0.22	0.15
1992	-1213.63	-1263.94	0.05	-0.23	0.18
1993	-2571	-2783	0.04	-0.26	0.19
1994	-6434	-7562	0.03	-0.35	0.24
1995	-15842	-20104	0	-0.43	0.29
1996	-33037	-43991	-0.02	-0.44	0.3
1997	-59360	-81602	-0.04	-0.39	0.27
1998	-98372	-139451	-0.04	-0.33	0.23
1999	-155143	-229167	-0.05	-0.26	0.18
2000	-215375	-340095	-0.05	-0.17	0.12

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Prices and Wages

(Percentage Change over Base Run Values)

YEAR	CED	NW	RW	PXA	REX
1972	0.95	0.91	-0.04	1.51	-0.94
1973	2.18	2.5	0.32	2.16	-2.13
1974	1.32	1.69	0.36	0.93	-1.3
1975	-0.15	0	0.14	-0.45	0.15
1976	-0.77	-0.77	0.01	-0.9	0.78
1977	-0.77	-0.8	-0.03	-0.77	0.78
1978	-0.68	-0.7	-0.02	-0.68	0.69
1979	-0.7	-0.75	-0.05	-0.67	0.7
1980	-0.52	-0.6	-0.08	-0.4	0.52
1981	-0.04	-0.09	-0.05	0.12	0.04
1982	0.48	0.51	0.02	0.62	-0.48
1983	0.77	0.86	0.09	0.82	-0.76
1984	0.72	0.85	0.12	0.68	-0.72
1985	0.53	0.64	0.11	0.47	-0.52
1986	0.42	0.52	0.1	0.39	-0.42
1987	0.38	0.49	0.11	0.36	-0.38
1988	0.28	0.4	0.12	0.23	-0.28
1989	0.09	0.19	0.1	0.03	-0.09
1990	-0.08	-0.01	0.07	-0.13	0.08
1991	-0.19	-0.13	0.05	-0.21	0.19
1992	-0.22	-0.18	0.04	-0.22	0.22
1993	-0.23	-0.2	0.03	-0.24	0.23
1994	-0.29	-0.27	0.02	-0.31	0.29
1995	-0.36	-0.36	0	-0.37	0.36
1996	-0.38	-0.4	-0.02	-0.37	0.38
1997	-0.34	-0.37	-0.03	-0.32	0.34
1998	-0.28	-0.31	-0.03	-0.26	0.28
1999	-0.22	-0.26	-0.04	-0.2	0.22
2000	-0.15	-0.19	-0.04	-0.13	0.15

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

BOP Indicator

YEAR	DCBV	XGNVB	IND
1972	-83.11	16652.21	-0.50
1973	-547.4	23115.67	-2.37
1974	-920.65	30969.63	-2.97
1975	-792.8	29777.03	-2.66
1976	-602.57	38609.75	-1.56
1977	-343.87	44429.93	-0.77
1978	-205.89	49485.57	-0.42
1979	18.4	64647.8	0.03
1980	289.46	83385.62	0.35
1981	99.77	90872.42	0.11
1982	-267.78	81560.13	-0.33
1983	-625.4	82557.25	-0.76
1984	-1111.02	92170.8	-1.21
1985	-1372.2	90214.21	-1.52
1986	-1607.72	98784.15	-1.63
1987	-1882.55	108157.6	-1.74
1988	-2129.67	118427.5	-1.80
1989	-2256.93	129679.8	-1.74
1990	-2256.62	141999.4	-1.59
1991	-2152.68	155484.5	-1.38
1992	-1998.64	170249.7	-1.17
1993	-1863.64	186420.5	-1.00
1994	-1646.11	204128.7	-0.81
1995	-1332.49	223517.6	-0.60
1996	-947.85	244747.6	-0.39
1997	-572.14	267993.9	-0.21
1998	-258.95	293449.4	-0.09
1999	-33.88	321326.5	-0.01
2000	86.82	351850.5	0.02

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Saving Ratios , Inflation Tax, Real BOP Deficit and Capital Stock

(Abs. Change over Base Run Values)

YEAR	SR	FSR	M2RKP	CBVKP	K
1972	-0.15	0.01	-888.64	-112.8	0
1973	-0.02	0.19	-3531.97	-993.17	1404.25
1974	-0.1	0.25	-4277.77	-1338.23	2189.38
1975	-0.25	0.26	-4328.03	-1353.14	2067.56
1976	-0.23	0.19	-4958.11	-1042.68	1577.81
1977	-0.16	0.11	-6027.41	-605.57	1029
1978	-0.1	0.07	-5614.91	-380.26	560.81
1979	-0.07	0.03	-3679.97	-131.59	-6.94
1980	-0.04	-0.01	-1356.36	130.41	-503.69
1981	-0.02	-0.01	-525.8	75.51	-583.88
1982	0.01	0.01	-60.53	-117.07	-163.38
1983	-0.01	0.09	815.41	-660.72	531.69
1984	-0.1	0.18	1260.98	-1261.39	1127.38
1985	-0.18	0.23	1636.06	-1651.82	1475.25
1986	-0.23	0.25	543.09	-1886.76	1696.31
1987	-0.24	0.27	-1094.44	-2145.7	1974.25
1988	-0.25	0.28	-2966.97	-2360.42	2198.56
1989	-0.26	0.28	-4747.34	-2435.58	2246
1990	-0.26	0.26	-6572.91	-2368.06	2140
1991	-0.23	0.23	-11836.1	-2192.18	1953.25
1992	-0.21	0.2	-16832.2	-1971.72	1713.5
1993	-0.17	0.17	-20873.1	-1779.84	1505.38
1994	-0.15	0.14	-23152.1	-1523.3	1219.25
1995	-0.12	0.1	-23874.9	-1194.8	818.63
1996	-0.09	0.07	-23705.1	-822.25	367
1997	-0.06	0.04	-22792.6	-479.02	-63.88
1998	-0.04	0.02	-20893.4	-208.09	-451.13
1999	-0.02	0	-17987.3	-23.86	-793.63
2000	-0.01	0	-14487.6	68.65	-1066.5

Full Simulation Results of RUN MDL7C

FISCAL SHOCK

Effects of a Perm. US $ 2 Bn. Inc. in Govt. consn.

THE BASIC MODEL WITH ENDOGENEOUS MONEY AND PRICES

Saving Ratios, Inflation Tax, Real BOP Deficit and Capital Stock

(Percentage Change over Base Run Values)

YEAR	SR	FSR	M2RKP	CBVKP	K
1972	-0.89	0.34	-0.78	1.09	0
1973	-0.08	10.93	-2.65	11.6	0.29
1974	-0.55	5.49	-3.11	5.77	0.42
1975	-1.36	5.16	-3.26	5.26	0.37
1976	-1.14	6.91	-3.18	6.91	0.26
1977	-0.8	4.92	-4.14	4.88	0.16
1978	-0.49	2.61	-3.35	2.48	0.08
1979	-0.37	0.76	-1.9	0.6	0
1980	-0.22	-0.34	-0.69	-0.42	-0.06
1981	-0.13	-0.26	-0.24	-0.2	-0.07
1982	0.1	0.16	-0.03	0.35	-0.02
1983	-0.09	4.56	0.4	4.82	0.06
1984	-0.63	20.47	0.59	20.74	0.13
1985	-1.09	28.99	0.79	29.29	0.17
1986	-1.33	35.24	0.19	35.58	0.2
1987	-1.39	43.05	-0.34	43.42	0.23
1988	-1.46	51.52	-0.83	51.85	0.25
1989	-1.52	58.59	-1.21	58.86	0.25
1990	-1.49	63.75	-1.52	63.96	0.23
1991	-1.35	67.37	-1.3	67.53	0.2
1992	-1.19	71.15	-1.7	71.29	0.17
1993	-1	78.64	-1.94	78.72	0.14
1994	-0.84	87.88	-2	87.87	0.11
1995	-0.69	100.9	-1.92	100.82	0.07
1996	-0.52	133.73	-1.78	133.59	0.03
1997	-0.35	1950.36	-1.6	1948.85	-0.01
1998	-0.21	-35.52	-1.37	-35.58	-0.04
1999	-0.12	-1.89	-1.11	-1.97	-0.06
2000	-0.07	3.79	-0.84	3.71	-0.08

Endnotes

1. There are two reasons for not allowing for import volume effect in the price equation. Firstly, in the theoretical framework outlined in Appendix 2, there is no scope for such effects. Secondly, even as a ad hoc variable to capture import rationing, using aggregate imports instead of raw material imports may be inappropriate.

2. It can be shown that adding the constant adjustments back enables the model to track history exactly. Note however, that the model's convergence is affected by the treatment of constant adjustments for a given iteration procedure.

3. In 1972 base run output is \$438 billion at 1980 prices, but there is a strong trend so that its projected value in 2000 is \$1491 billion. This is why the long-run multiplier (about one-third the size of the short run multiplier in absolute terms) is so much smaller in proportional terms.

4. In Figure 2 the elasticity was about 2.0. But there we had not fixed out the term in (y - m), as discussed in Section 6.2 which led to a term in ϕ_2 in the denominator of equation 3, meaning that there a 1 per cent rise in output would be associated with a larger rise in prices than here.

5. This problematic feature has to do with the way constant adjustment has been imposed on the price equation. Instead of increasing the residuals by 10 per cent as we have done we could have computed the residuals that will shift prices up by 10 per cent every year in the partial equilibrium sense. As already noted in section 6.2, in dynamic equations adding a constant residual would imply shocks that would be magnified, till the very end of simulation.

CHAPTER 7

ADJUSTMENT TO A NEGATIVE EXTERNAL SHOCK

7.1 Introduction

In this chapter we explore the policy choices available in the face of a negative external shock. The negative external shock we consider is a slump in foreign demand for exports the effects of which we described in the last chapter. After a brief recapitulation of these effects we outline the formulation of our control rules. The efficacy of expenditure cutting and switching policies in correcting the imbalance in current account balance is then presented. In contrast to our theoretical discussion in Chapter 2 where the policy objectives were both internal and external balance, here we concentrate only on external balance. In addition we could have investigated targeting of output as suggested in the conclusions of Chapter 2. However, we confine the objective in this chapter to target only external balance which is sought to be controlled by one instrument at a time. These results must be regarded as tentative and illustrative rather than exhaustive because of the software problems we ran into.

7.2 Effects of a Negative External Shock

In section 6.5 of chapter 6 we described the consequences of a negative external shock in terms of output, prices and current account balance in the absence of any policy response.

We witnessed the operation of an automatic correction mechanism through the channel of wealth effects: though recession is unavoidable deficit in current account balance was eliminated. Reserve financing may be sustainable and it may not lead to an attack on the exchange rate because eventually reserves are re-built by contraction of imports. But the process may be too slow, and the possibility of attack remains. This is why we need to consider the design of control rules.

7.3 Closed Loop Control Rules

We now turn to the design of control rules. As we first investigate expenditure cutting policy in the form of a fiscal contraction, we describe how we calibrated the parameters of the feed back rule in this context. Similar considerations were made while designing an expenditure switching policy in the form of exchange rate changes. The fiscal contraction rule says that government expenditure is cut when the current account is in deficit. After some experiment, the feed back rule was specified to be :

$$GC_t = GC_t^b + .8(CBV_t - CBV_t^b) + .4(\Sigma_{(t-1)}^t CBV_t - \Sigma_{(t-1)}^t CBV_t^b) \qquad (7.1)$$

This is a "proportional" plus "integral" controller in the following sense. When the current account balance is different from base, government expenditure is different from base (the coefficient is 0.8). This is the proportional element. But also when the sum of the current account balance is different from base the *level* of government expenditure is different from base (the coefficient is 0.4). This is the integral element.

These coefficients were chosen according to principles described in Chapter 11 of Weale, *et al* (1989). In essence one sets the proportional control rule equal to some largeish fraction of the multiplier effect of the instrument upon the target. Here in this model a one hundred billion increase in government expenditure causes a (real) effect on the current account balance of a similar magnitude, which explains the coefficient 0.8. One then choses an integral control parameter which is a small fraction of the size of the proportional control parameter (and that proportion is set at a half). This rule was "designed" by starting with much weaker proportional and integral elements and increasing their strength. The behaviour was somewhat insensitive to this (suggesting that we have not over-tuned the controller). Over the simulation period the price index changes by a factor of 4, which means that the present rule displayed here has, in effect, a strength which increases as time continues by about a factor of 4. In subsequent work we have scaled the current balance by the import price to remedy this. These subsequent exercises show that using 'real' current account balance as the target does not alter the character of results in a significant way.

Notice that this control rule does not have lags. This means that the policy responds to events on the balance of payments instantaneously. That is admittedly over optimistic and we leave out for further work the investigation of the effects of lags in response.

7.4 Effects of an Expenditure Cutting Policy

The implementation of control makes relatively little difference to the long run properties of the 'uncontrolled' model. As expected, output falls by a significantly greater amount in the short run (compare Figure 7.1 with 6.7), because of the fiscal contraction, and so do prices (compare Figure 7.2 with 6.8). Though in the short run current account worsens more due to "J curve effect" (compare Figure 7.3 with 6.8) balance of payments correction is more rapid (due to expenditure contracting reinforcing money contraction effects), than that resulting from the "self-correcting mechanisms" in the open-loop model discussed in section 6.5 of Chapter 6. Again in the intermediate run, when the current account wanders off course in the uncontrolled model, the control rule keeps it on course by means of lower output and lower prices. In the long run very little difference can be observed from the pictures. However, the details of the model results show that much of the burden of balance of payments correction now falls on reduced fiscal expenditures rather than on reductions in consumption being imposed by the monetary approach to the balance of payments mechanism.

Expenditure Cutting Policy

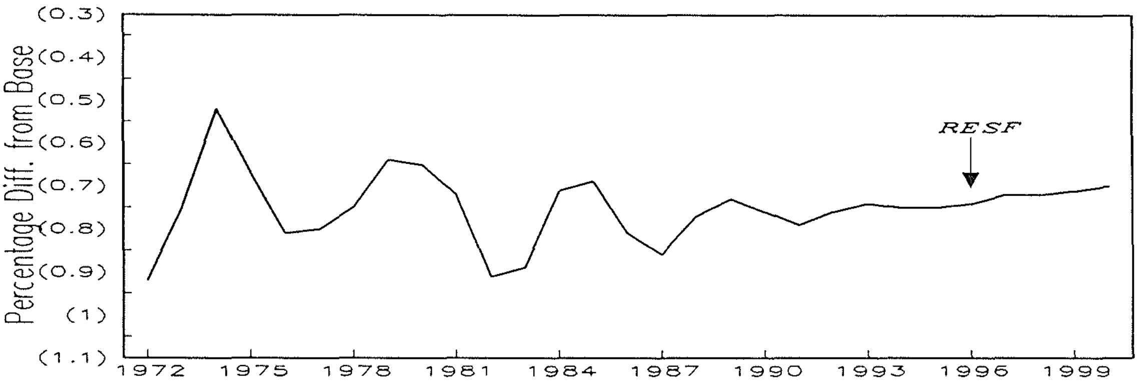


Figure 7.1
Output (GDP)

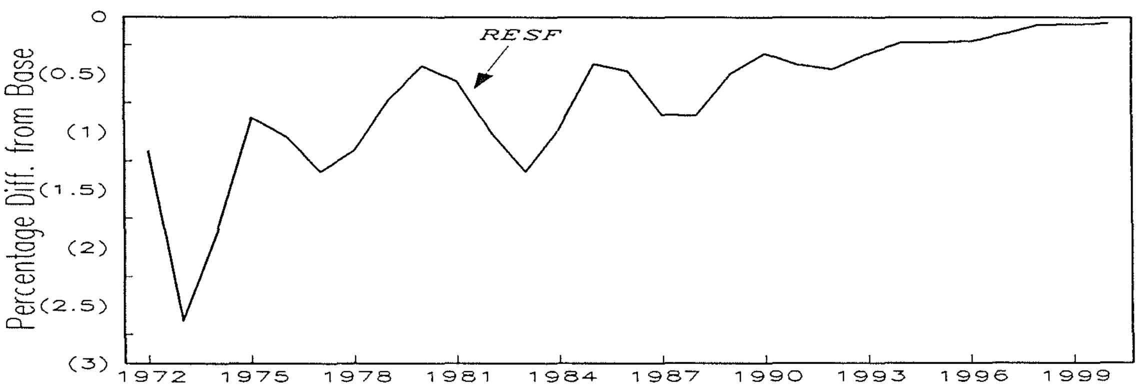


Figure 7.2
Prices

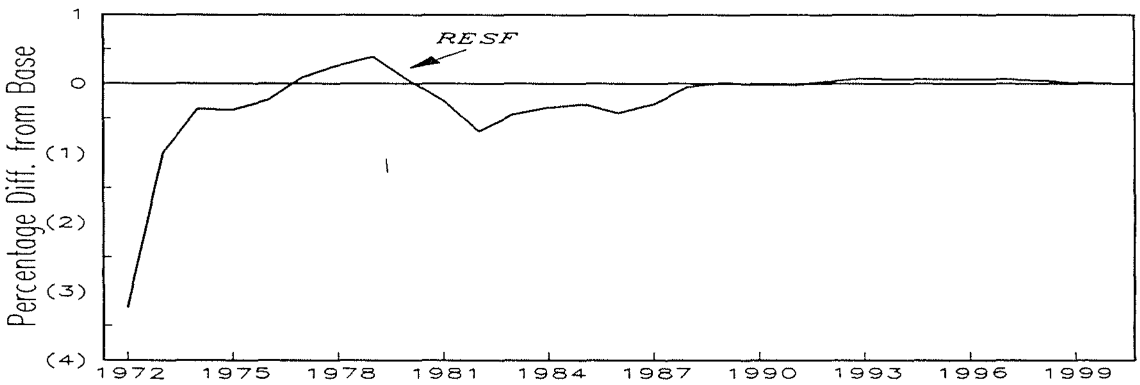


Figure 7.3
Current Account Balance
(As Perc. of Base Exports)

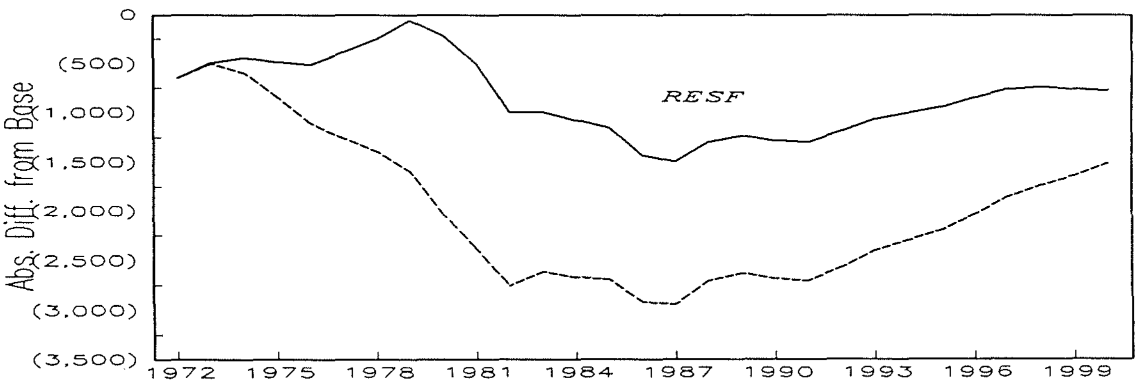


Figure 7.4
Government Consumption

7.5 Effects of an Expenditure Switching Policy

An expenditure switching policy consists in depreciating the real exchange rate in the face of a current account deficit. It is expected that though this policy could achieve external balance it will trigger inflation when output is near capacity.

We came up against a serious problem in attempting to implement an expenditure switching policy in our model. The model could not be solved even for a base scenario when a real exchange rate was programmed as exogeneous. There appears to be no definite reason why this should not be possible. While exploring the supply side properties in section 5.3 of Chapter 5, this was possible, which rules out the case that we introduce indeterminacy in the supply side specification of the model by forcing constant real exchange rates. However, there we solved the supply side model equations in their log forms, with a data base of variables also in log form. Coding the full model in log form and setting up a data base with variables in log forms would perhaps helped us to pursue this exercise as we intended. But our model has identities which are in levels[1], which fact discouraged us from resolving our problem by log transformations. It could be also be true that either the matrix of structural co-efficients do not possess an inverse or there is an intractable numerical mathematic problem. It remains that in the context of a full model we are unable to pin down the cause of our inability to fix or exogenize real exchange rates.

Given our inability to program fixed real exchange rate, we experimented with exchange rate rules which do not neutralize 100 per cent for current price changes:

$$\begin{aligned}
EX_t = EX_t^b \quad & + .25(PHL - PHL^b)_{-1} \\
& + .75(PHL - PHL^b) \\
& - .3(CBVS - CBVS^b)_{-1} \\
& - .2\left(\sum_i^{t-1} CBVS_i - \sum_i^{t-1} CBVS_i^b\right) \\
& - .4(\Delta CBVS_{-1} - \Delta CBVS_{-1}^b) \qquad (7.2)
\end{aligned}$$

Initially , we set the strength of proportional control term (the third term in equation 7.2) at .5, taking clue from our partial trade sector results reported in section 5.3 of Chapter 5. Accordingly the strength of integral control term (the fourth term in equation 7.2) was set at half the size of proportional term at .25. Later on we added the derivative term (the last term in equation 7.2) to damp the cycles. The coefficients that appear in equation 7.2 have the values last tried. The weights on current and lagged price levels were chosen by trial and error, slowly increasing the weight on current price, so that the model does not break down (if the weight on current price was 100 per cent it did break down). Thus we settled for a weight of 75 per cent on current price level.

It turns out that the control rule introduces sever cyclical oscillations in the target of base line current account balance. These cycles could not be eliminated by changing the feed back rule parameters.

7.6 CONCLUSIONS

It can be seen that only the fiscal control rule is capable of controlling the balance of payments as desired. The fiscal contraction required with reserve financing is quite modest suggesting that it would be more politically feasible. It is to be seen whether this s result survives the imposition of lags in control.

Of course control imposes costs in output and price fluctuations. An optimizing approach, would be required to formally tradeoff at the margin benefits of target control with these costs.

We are unable to argue the case for expenditure switching policies in the face of a negative external shock on the basis of our empirical model. Given the structure of our model the combination of strong real wage resistance and asset effects seems to produce unacceptable cycles in the current account balance.

Endnotes

1. It is possible to log-linearize identities using sample means or 'estimate' coefficients. Such attempts have not been made, but these can be explored further.

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