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# **Modelling Macroeconomic Adjustment with Growth in Developing Economies: The Case of India**

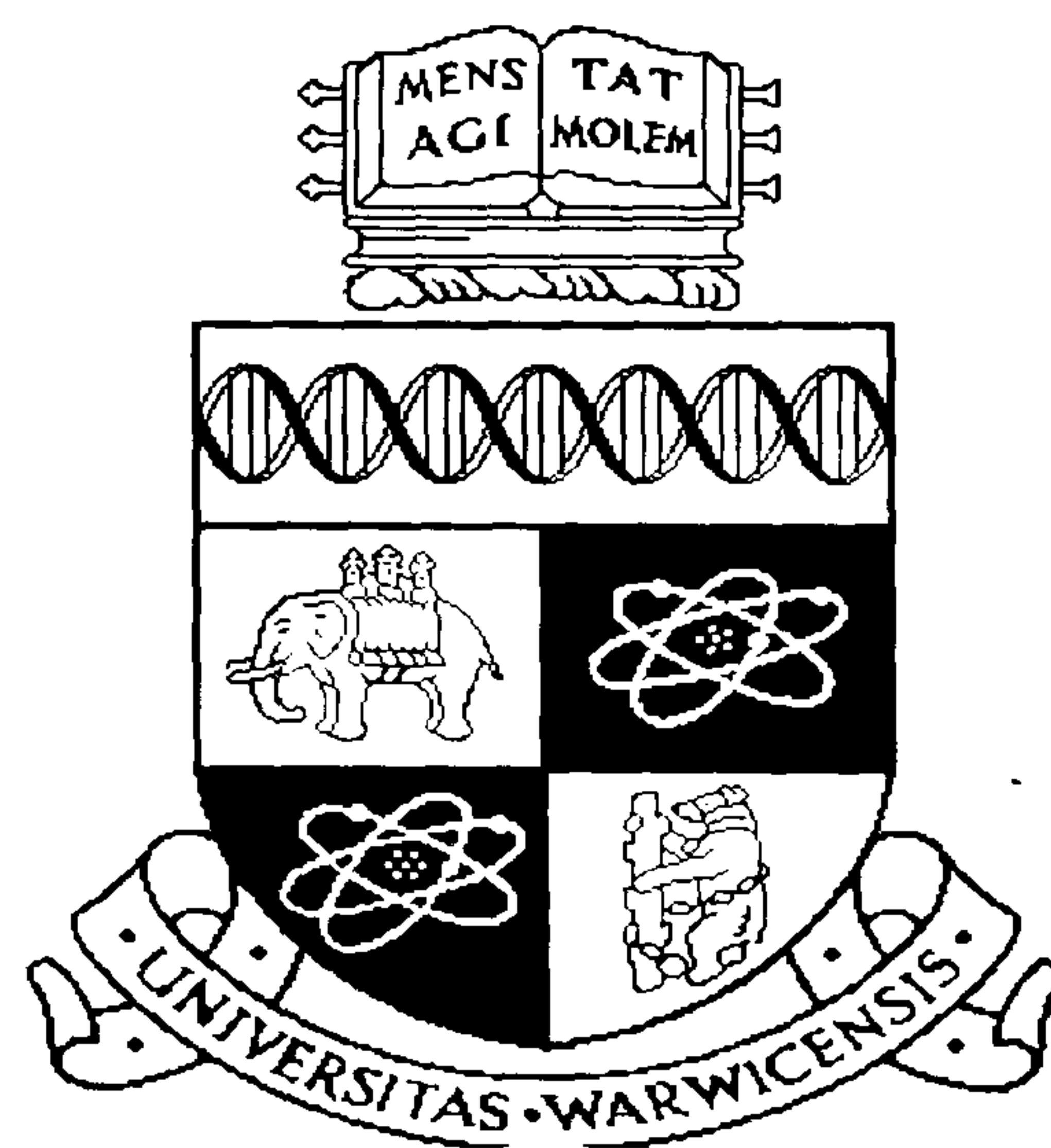
**By**

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**PhD THESIS [Academic Year 1997-98]**

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**This thesis is submitted in partial fulfilment of the requirements for  
the degree of Doctor of Philosophy (Ph.D.)**



**UNIVERSITY OF WARWICK  
Department of Economics**

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My involvement with macroeconomic modelling dates back to the summer of 1991 when I first started to work with T Krishna Kumar at the Institute for Social and Economic Change (ISEC), India. That was the time when the Indian economy was changing its policy paradigm from a state-dominated system to a market-oriented framework. So the economic policy reform in 1991 motivated me to work on macroeconomic policy modelling. I wish to express a deep sense of gratitude to T Krishna Kumar for his encouragement on initiating me to work on the area of macroeconomic modelling during my stay at ISEC and Indian Statistical Institute, Bangalore from 1991 to 1995. However, this doctoral dissertation could not have been possible without the guidance of Ken Wallis. I owe the greatest debt of gratitude to him, for without his indispensable encouragement and tutoring this study would never have seen the light of day. I also wish to express a debt to the Commonwealth Scholarship Commission in the UK without whose financial support I may not have been able to study at the University of Warwick, UK.

## SUMMARY

The aim of this research is to understand the current economic scene and the stabilisation policies in historical perspective, and to survey and develop models for analysing issues of macroeconomic adjustment with growth. The topics have been chosen for their continued relevance in the current policy debates. The standard open economy model on which the Bretton Woods macroeconomics is based takes into account neither the endogeneity and decomposition of aggregate government expenditure or investment nor the price formation process in a developing economy. Further, with the opening up of the Indian economy since 1991, macroeconomic policy analysis needs to be examined in a different analytical framework from the essentially closed economy framework that has hitherto characterised policy discussions in India. The present study investigates the appropriateness of the Fund-Bank approach to macroeconomic adjustment; modifies and analyses the respective effects of the model in light of the structural constraints in the form of low capital formation in the Indian economy after having disaggregated government expenditure into government consumption and investment expenditures. This thesis models trade, inflation and the determinants of long-run growth considering the role of endogenous growth and the demand factors in growth. The modelling procedure follows the VAR-based time series literature as against the traditional Cowles Commission approach to structural macroeconometric modelling. It estimates a macroeconomic model that incorporates the paradigm underlying the IMF's policy recommendations to developing countries, using Indian time series data from 1950-51 to 1995-96. It discusses structural sensitivities, dynamics and deterministic optimal control. This study investigates the effectiveness of three sets of key macroeconomic policy instruments which are typical in financial liberalisation process - namely, a tight credit policy, a depreciation of domestic currency and, a hike in regulated interest rates. Finally this study solves a multi-target and multi-instrument optimal control problem and finds that the two-target two-instrument problem of a standard policy package is not growth inducive and must target output growth in order to make the adjustment program as growth-oriented. This research has focused on explicitly recognising and analysing the operation of a credit or lending channel in the transmission of monetary policy.



# Chapter 1

## PROLOGUE

### 1.1 INTRODUCTION

The inspiration for this dissertation on modelling macroeconomic adjustment in developing economies (DEs) was originally prompted by the introduction of the stabilisation and structural adjustment policies in India in 1991. In this context the policy package applied to India as to many other DEs by the International Monetary Fund (henceforth the Fund) and the World Bank (henceforth the Bank) has received considerable attention in recent years. The onset of the continuing external and internal imbalances has contributed to a slowdown in growth, high inflation and balance of payments (BoP) difficulties, which has forced the Fund into a leading role in resolving the crisis. This adjustment involves both some finance and a set of conditionalities or policies. Though there has been much debate about the appropriate role of the Fund, there has been little analysis of the underlying analytical model which the Fund purports to use. So in this study we start off with the analytical framework for macroeconomic adjustment policy currently underway in many DEs and attempt at a comprehensive critical analysis of the Fund-Bank approach on development.

The nature of the this study is basically to build a dynamic macroeconometric model to explain stabilisation and structural adjustment problems in the case of India. As a country's macroeconomic policies can play a crucial role in contributing to economic development, it is indispensable to see how the macroeconomic adjustment policies have undergone changes in India's macro system to enhance growth. We need to first

understand the initial conditions or the base line position and the structure of dynamic forces that generate the macroeconomic imbalances in the Indian context. The question that one should examine then is the compatibility of the kind of policy framework that is being pursued by policy makers in India with the framework that is best suited for India given its initial conditions and structural characteristics. It may be noted that the policy framework being adopted by India is more or less the same as the one advocated by the Fund and the Bank for all those countries that approach them for assistance.<sup>1</sup> We therefore need to see the analytical approaches of the Fund and the Bank in designing such adjustment programs in support of their lending activities. The financial programming model of the Fund and the two-gap model of the Bank have been the most influential models of economic analysis for the developing world. Many DEs including India have undertaken adjustment programs sponsored by the Fund and the Bank, whose announced objectives have been the reducing of external imbalances and lowering inflation while avoiding recession and enhancing medium-term growth. Handling this type of problem would naturally require a dynamic model with expectations and supply side considerations that could simultaneously capture the major intertemporal relations between prices, BoP, and output. Hence what we need is a framework which is essentially eclectic in nature, drawing the received doctrines from the Fund and the Bank for growth-oriented macroeconomic adjustment that may be suitable for the Indian economy. So first we intend to do an assessment of the analytical foundations of this approach using a simulation model and, second, we construct and estimate a small

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<sup>1</sup> Similar view has been expressed by several people, eg. Mookherjee (1992), Sau (1993), Kumar (1993), Mundle and Mukhopadhyay (1993), and Chandrasekhar (1995). The liberalization policies of the early 1980s were also those suggested by the Fund and the Bank. For further details on the 1981 IMF loan and the early phase of liberalisation please see chapter 2.

macroeconomic model of the Indian economy over the period 1950-95, and analyse the consequences of different economic policies under various potential disequilibria in the economy, third, we develop a model to ascertain the factors determining growth in India, and finally, we combine adjustment with growth and carry out optimal control experiments.

Like much of the recent applied work on open economy macroeconomics for DEs, this thesis has been motivated by the recent macroeconomic developments dealing with the issues of stabilisation and growth in India. Over the recent years, the criticism that IMF-supported adjustment programs have not been successful in dealing with the problems of its member countries, has been strongly voiced. A number of studies have empirically examined the effects of Fund programs on key objective variables. Previous studies have very rarely relied on rigorous econometric models to assess the effects of the programs. Those that have done so, have ignored some aspects that are not inconsequential to the assessment of the impact of the programs. We show how a simple time-series approach, that avoids many of the flaws of the cross-country evaluations, can be used to assess the effect of the adjustment policies, supported by the IMF, on inflation and the BoP. The objective of this dissertation is to provide new estimates and adopt alternative econometric estimation methods in the assessment of the effects of IMF policies. We present evidence on the macroeconomic effects of IMF programs based on comprehensive analysis. Our analysis departs from previous work in the sense that we are modelling trade, inflation and growth in an unified framework. Unlike the conventional IMF model, real output is not taken to be predetermined in this study. There are several important differences between our study

and previous ones. The first difference is in the empirical methodology. Our estimated model is based on the cointegration framework of Phillips and Hansen (1990), and Johansen (1988) which estimates jointly the long-run characteristics and short-run dynamics of the system as part of a vector error correction model (VECM). The second difference between our study with others for DEs is that our study models stabilisation with growth in an integrated framework. The process of modelling the DEs is examined with reference to, (i) the lack of agreement between traditional structural econometric modelling and pure statistical time series modelling on the suitability of each other's approach; (ii) the lack of consensus as to the nature of the macroeconomic foundation of models of DEs; and (iii) the lack of attention given to the time series properties of individual series used in models of DEs. So in order to take (i), (ii), and (iii) into consideration, modelling of the DEs should appropriately follow the error correction approach which, among its other features, requires that variables are tested for their statistical time series properties prior to their use, thus taking account of (ii). By its nature the error correction modelling approach also indirectly takes account of (i).

### **SOME STYLIZED FACTS**

- Most DEs at one time or another have faced the need for macroeconomic adjustment. Almost throughout the developing world the introduction of market oriented reform agenda have been put in place under the auspices of the Fund and the Bank. While the Fund's focus is essentially short-term stabilisation, the Bank has focused on realising longer term structural adjustment in all DEs.
- Deficiencies in national policy-making and weaknesses in the economic structure of the economy contributes to macroeconomic problems.
- More often than not, a DE with BoP problems ends up requesting a line of credit or a "stand-by" loan from the Fund and a structural adjustment loan from the Bank.

- The Fund and the Bank provide financial help on the condition that the recipient country agrees on a given set of macroeconomic policy actions to meet the requirements of the institutions.
- The framework of most macroeconomic adjustment programs is an amalgam of two most influential models of economic analysis for the developing world, i.e., financial programming model of the Fund and the revised minimum standard model of the Bank.
- Persistence of disequilibrium is a common phenomenon in the DEs. Restrictive domestic regulations, inefficient public enterprises, investor skepticism regarding reforms and inadequate institutional, infrastructural, managerial and entrepreneurial capacity in the reforming country are some of the factors which can hurt the reform process. Thus policy formulation regarding the economic tools to be used will ultimately depend on country specific conditions necessitating country specific studies.
- Macroeconometric model building is no longer a matter of esoteric exercise for the Indian economy. But continuous changes in the structural characteristics necessitates the construction of a new dynamic model for the economy to reflect the theoretical underpinnings to a greater degree.

The Indian economy has undergone many structural changes since 1950. For example, the Green Revolution has made India self-sufficient in foodgrains. The nationalization of commercial banks in 1969, structural retrogression of the industrial sector since mid-1960s due to transport bottlenecks and increase in many-days-lost are some other examples. Recently India faced a severe economic crisis in 1991. Foreign exchange reserves were depleted. Fiscal deficit and federal debt levels were at record high. Most macroeconomic indicators pointed to an economy on the brink of collapse. Like many DEs, India turned to the Fund and the Bank in the early 1990s in order to secure latter's financial assistance in the form of several short and medium-term loans to alleviate the crisis. As a condition to IMF's loans, the government of India had to adopt policy

reforms based on demand management, complemented by supply-side strategies to stabilise and restructure the economy. These included reforms in the trade sector, efforts to contain the fiscal deficit, and tight credit policies to reduce inflation, which were expected to help the economy restore its macroeconomic equilibrium. In this study we analyse the impacts of these policies to determine their effectiveness in improving macroeconomic performance. The success of the reforms and the support for them will depend on the supply response these changes generate which in turn depend on a number of other factors that check growth.

The basic objectives of macroeconometric modelling are: (a) to understand macroeconomic structure and dynamic behaviour of an economy (explanation), e.g., linkages among sectors or lag structures; (b) to make short-run economic forecasts (prediction); (c) to estimate the effects of changes in policy instruments on target variables or to study the time pattern of responses (policy simulation); (d) to help arrive at better quantitative economic policies by evaluating policy alternatives (control). The review of existing macroeconomic models reveals that India is yet to have a comprehensive model taking note of the recent policy changes in the economy, and methodological developments in macroeconomic modelling. So far most of the econometric models for the Indian economy, covering the economy as a whole or of its major sectors, constructed during the last decades, have highlighted the structure and behaviour of the economy, but they have hardly concentrated on the policy simulation and control aspects taking note of the time-series nature of the data. Success in this type of modelling and policy making depends on (a) specification of model structure to capture essential features of an economy (e.g., theoretical framework, institutions etc.)

(b) good data base (c) good estimation procedures. Now structural models are not truly dynamic in the sense that they do not incorporate interlinkages among all the variables included in the system and do not take the optimum lags into account, which is embodied in the VAR framework. This study aims at a clear understanding of the impacts of major macroeconomic policy mechanisms in a dynamic econometric framework.

## **RESEARCH QUESTIONS**

- Whether the model or framework that the Fund or the Bank use to generate or design its adjustment programs is a growth-oriented model of development, if not, in what ways can it be modified to suit the country in question, and how to incorporate the new most important developments in the theory of long-run growth?
- Can we simulate an estimated econometric model to show whether the adjustment program leads to an improvement in the BoP through reduced demand rather than increased output?
- Can we solve an optimal control problem for an estimated macroeconomic model with growth and adjustment to demonstrate that demand contraction leads to reduction in output?

To start with, the thesis examines the IMF approach to macroeconomic adjustment in India using a model of stabilisation developed at the International Monetary Fund (IMF). There is considerable controversy among Indian economists regarding the impact of these policy changes on long term economic performance. This study analyzes the impact of public expenditure policies on output, prices and BoP in India. It has been pointed out that there has been a gap in the theoretical and empirical literature with

regard to the treatment of public expenditure policies in the context of stabilisation and structural adjustment programs. Empirical investigation of specific public expenditure policies, i.e., public consumption expenditures and expenditures for infrastructural investment with reference to the Indian economy has therefore been undertaken in this study. Within such a standard macroeconomic simulation model, we have analysed the effects of public consumption expenditure, and investment in public infrastructure.

India which was classified as strongly inward oriented, became aware that productivity, output and employment performance over the past thirty years has not been commensurate with the resources invested. The trade sector has not played a key role in the policy formulation. To correct this deficiency in its economic policy there have been significant changes in the domestic and trade policy of India since 1977 and more specifically since 1985. Though these changes are regarded as mild by international standards, they are considered major milestones in Indian economic policy. A model linking exports, imports and price behaviour has been developed. In small open economies nominal devaluation is generally the government's policy instrument for dealing with BoP problems. There is general agreement that at least among DEs devaluation is an effective means of improving a country's external balance. There are also conflicting theories on the effects of devaluation on the rest of the economy, a subject of some controversy. Most open economy models and the so-called 'orthodox' approach to stabilisation policy claim that devaluation ultimately has an expansionary effect on domestic production and incomes as demand shifts from non-tradables to tradables. Both the increase in exports and the substitution of domestic for imported goods stimulate domestic output.



In recent years this 'orthodox' view has been increasingly challenged by the so-called contractionary devaluation hypothesis which holds that for various reasons devaluation may not play a substantial role towards improving the trade account, if so, it restores external balance mainly via a reduction of domestic demand for imports rather than an expansion of tradables. Devaluing the currency would have an adverse impact on trade balance and output and be inflationary. The argument that devaluation has contractionary effects is of course not new. Many have stressed the potentially contractionary effects of devaluation on aggregate demand due to the inevitable redistributive effect and the difference in the savings rate of wage and profit earners. In addition, the monetary approach to the BoP has always stressed the initial contractionary effect of the decline in real balances as nominal devaluation increases the domestic price level. Consumption expenditure declines as individuals seek to restore the real value of holdings of financial assets.

The major argument advanced in this dissertation is that the adjustment programs are in general contractionary, investigating the effects of policy reform on the Indian trade and real sectors over the period 1950 to 1995. Like many other small DEs, India has implemented a number of IMF supervised adjustment programs as well as tried a number of its own 'unorthodox' stabilization policies. Following an overall appraisal of Indian macroeconomic performance and the Fund financial-supported adjustment programs (conditionality), the main part of the thesis provides empirical evidence on the determinants of aggregate foreign trade, monetary, and output sectors of the Indian economy. Most studies of export functions deal exclusively with the demand-side determinants of exports with little attention paid to the supply side of exports. So this

study models both the supply and demand functions of Indian domestic exports. The thesis also explores the dynamics of inflation investigating the role of demand and supply factors in the determination of inflation in India. The IMF view of inflation in LDCs is that it is essentially a monetary phenomenon, i.e. caused by an excess supply of money. Evidence is provided to derive a simple reduced form equation within the frameworks of both monetarist and structuralist models, which are influential in the inflation process in India, and hence the basic IMF view of inflation should be modified accordingly. In Chapter 6 we construct and estimate the macroeconometric model for India, designed to isolate the effects of exchange-rate devaluation and monetary contraction.

Thus the study examines the effects of policy reform on the Indian trade sector, its repercussions on the domestic economy, and the welfare costs associated with such policies in restoring stability and future economic growth. In a similar vein the study shows that the Fund policies dampen growth due to their restrictive effects on domestic credit expansion. Based on the theoretical foundations of endogenous growth, endogenous financial structure models and export-led model of growth, we argue that Vector Autoregression (VAR) is an appropriate framework for the econometric analysis of long-run growth. In a 'structuralist' economy, firms are dependent upon short-term credit to finance their working capital needs, whereas orthodox stabilization programs are designed in such a way that unambiguously improve the current account and stimulate output in the short run. Adopting a supply-side approach, a production model is specified which consists of the basic factor inputs of physical capital (public and

private) and the stock of human capital and augmented by exports, domestic credit to the private sector and the real interest rate.

The model estimation uses the recent econometric methodology comprising cointegration and general-to-specific strategy. Simulation and optimal control are used for policy analysis, which are now well established in the economics profession. Policy implications and different scenarios are analysed through model simulations. Simulation is used to examine the effects of exchange rate, monetary, and fiscal policy changes on various sectors of the economy. One of the continual problems of economics has been to choose between various alternative strategies that are available, so as to regulate or control the economy. It is in this context that optimal control method has an important contribution to make for the evaluation of policy alternatives. These models are more appropriate in order to indicate the optimum control paths for attaining certain pre-set targets. Thus it has been proposed to design a control experiment assuming the economy as a dynamic system and superimposing on it a policy objective function subject to the dynamic econometric model as constraints. Those constraints are provided by the estimated model. The objective function contains the target variables as well as the instrument variables to obtain optimal policies given economic targets, quantifies the tradeoffs between alternative policy choices, and evaluate the welfare costs. So this study establishes the use of control theory in providing guidelines for policy formulation using the concept of welfare maximization. Specifically, the relations between inflation, change in BoP, and growth will be explored along with the policy instruments such as exchange rate, domestic credit and public investment. Moreover, given the initiation of stabilisation and structural adjustment programs in the Indian economy, the present

study aims at a new structural model for policy purposes which will be evaluated in terms of its overall performance in policy simulation implications and optimal control.

## **1.2 OBJECTIVES OF THE STUDY**

### *A. GENERAL:*

1. To critically evaluate the analytics of macroeconomic adjustment policies while attempting to build a policy-based dynamic model, in order to analyse the effects of main policies of adjustment programs to guide development policy strategies to be followed in India.
2. To study the macroeconomic adjustment problems of the Indian economy with long-term growth.
3. To develop a time-series based control model in order to indicate the optimum control paths for attaining certain pre-set targets.

### *B. SPECIFIC:*

1. To find the likely dynamic response of recently implemented devaluation and tight credit policy on the trade balance and price.
2. To investigate the effect of public investment and real interest rate on growth.

## **1.3 METHODOLOGY AND DATA BASE**

This thesis is primarily an applied exercise, and the basic method combines long-run statics with short-run dynamics. The methodology adopted in this model includes the following:

1. The estimation of the model requires the techniques that account for data that is inherently nonstationary. Since the traditional approach to modelling ignores the temporal properties of the data by assuming stationarity, the reexamination of the model in the context of cointegrated vectors presents naturally as an interesting extension. Basically, specification and estimation of a structural model will be considered in addition to an unrestricted VAR model and cointegration, which has

emerged in recent years as a means of modelling equilibrium relationships between non-stationary series.

2. The method often followed for analysing the dynamic properties of macro models is in the spirit of a simulation approach, particularly deterministic dynamic simulation of the model. In order to have a choice of the appropriate policy, this model adopts method of optimal control where there is a plan objective function subject to the dynamic econometric model as the constraint.
3. Time-series data are compiled from secondary sources, such as, National Accounts Statistics (CSO, GOI), Economic Survey(GOI), International Financial Statistics (IMF, Report on currency and finance (RBI) and RBI Bulletin, and others.
4. The period covered is from 1950 to 1995 which has five phases: (1) from 1950 to 1965, a period of more or less steady growth; (2) from 1965 to 1973, a period of structural retrogression Phase I (industrial recession); (3) from 1973 to 1980, a period of structural retrogression Phase II (oil price shock, and breaking away from fixed exchange rate regime); (4) from 1980-81 to 1990-91, a decade of liberalisation period; (5) the last phase since 1991 is the period of stabilisation and structural adjustment under the framework developed by the Fund and the Bank.

#### **1.4 ORGANISATION OF THE DISSERTATION**

The chapter scheme is organised in accordance with the following order:

The prelude chapter deals with the blue print of this study. The subjects of research, viz., macroeconomic adjustment, time series econometric modelling, dynamic simulations and optimal control are introduced. And also their importance (theoretical and policy oriented needs), their place and role are highlighted within the overall perspective of decision-making in the context of development process of India along with objectives and methodology of the present study.

The growth profile of the Indian economy, different phases of its development and the macroeconomic adjustment during the post independence period is described in the second chapter. This chapter looks at the theoretical and empirical basis on which India has undergone the process of liberalisation i.e. the transition from an inward oriented to an outward oriented growth strategy.

The third chapter covers a fairly comprehensive review of plan models and computable general equilibrium models, macroeconometric models and control models constructed so far for the Indian economy with an examination of criticisms of the current state of macroeconometric modelling by providing (a) the criticisms of traditional econometric modelling, (b) the current thoughts on the role of economic theory in modelling, (c) current model evaluation techniques, and (d) current alternatives to traditional modelling, one of which is the error correction approach.

In the light of the above investigation of earlier studies, the focus of the fourth chapter is to provide a critical appraisal of the policy models for macroeconomic adjustment in order to maintain growth with stability. The structural adjustment models for DEs and their relevance in building a new econometric policy model for India is then highlighted. The orthodox stabilization theory, the structuralist critique, and the recent emphasis on structural adjustment with respect to DEs have been discussed in this chapter.

In chapter five some new simulation results are obtained within a macroeconomic simulation model that underlies adjustment policies in DEs. This chapter is an

exhaustive analysis of a model developed at the IMF to support its policies. The essay concludes that the model is deficient as a theoretical model of stabilisation and is strongly deficient from an empirical point of view.

Chapter six models trade and inflation, estimates it for short-run stabilisation and simulates the model with respect to some policy shocks usually incorporated in a Fund model. In this chapter the single-equation error correction approach is adapted to economy wide modeling following Phillips-Hansen's method of cointegration.

Chapter seven determines the long-run growth factors within a multivariate cointegration framework. Meaningful long-run economic relationships have been estimated and incorporated in the short-run dynamics by taking into account the apriori information provided by the theoretical framework.

The optimal control experiments for economic policy combining a model of growth (chapter 7) and adjustment (chapter 6) are offered in chapter eight in order to choose between policy options for the sake of prescribing policies for structural adjustment.

Concluding chapter brings together the major findings of the present study and brings out policy options for the development strategies to be followed in India. A set of conclusions concerning the model properties and the optimal policies are drawn. And also limitation of the study is indicated along with suggestions regarding areas of further fruitful research.

## Chapter 2

# MACROECONOMIC ADJUSTMENT IN INDIA: Nature of the Policy Setting

### ABSTRACT

*In this chapter, an attempt is made to describe the macroeconomic scenario and the policy developments of the Indian economy at a time when the policy framework has changed in the direction of market-oriented reforms. This chapter tries to highlight the analytical framework underlying the current economic changes and provides a critical assessment of the reform process. An analysis of the performance of macroeconomic policies is made by looking at various macroeconomic indicators such as inflation, growth and a critical balance-of-payments position. This is done by providing evidence through macroeconomic statistics. This chapter also identifies the heuristic explanations based on comparing the trend in one macroeconomic variable with trend in another.*

### 2.1 INTRODUCTION

This chapter aims at providing a description of the evolution of recent macroeconomic scene in the Indian economy. Particular attention is given to the 80s and the early 90's which cover the period of significant macroeconomic adjustment. Macroeconomic adjustment policies can be broadly categorised into two groups - stabilisation policies and structural reforms. While stabilisation policies basically aim at reducing macroeconomic imbalances by reducing the level of aggregate demand in the economy, structural adjustment policies aim at raising the rate of growth of output through policies that bring about major changes in the microeconomic structure by promoting competitiveness, efficiency and dynamism among the production units within the system.



This chapter aims at discerning how the adjustment policies are being used in India's macro system. The second section highlights some of these issues and also presents the policy response to the type of shocks India has faced in the recent years. The third section will discuss the trends in several macroeconomic indicators and offers some comments on how macroeconomic policies have been pursued in the recent years. The last section sums up.

## **2.2 INDIA'S EMERGING MACROECONOMIC ENVIRONMENT - 1950-1990**

Before evaluating the macroeconomic policy framework, it is useful to review the salient features of the macroeconomic environment by looking at the major trends which have brought increasing understanding of the nature of the macro economy of India. The evolution of Indian macro economy since 1950 can be broken down into five phases. In phase I (1950-65), India pursued a policy of self-reliance and growth with equity employing a framework developed by Nehru and Mahalanobis (Kumar, 1994). In phase II (1965-73), India went through a phase of internal recovery from wars and famines with a focus on green revolution and poverty alleviation. The policy makers' focus shifted to poverty alleviation partly because they did not wish to see a recurrence of a situation such as the Bihar famine of 1965-66 and 1966-67. The third phase covers the period 1973-80. This period may be referred to as period of adjustment to the external shocks, i.e., the two oil-price hikes, the Gulf war, which affected India's trade with the Middle East. The fourth phase (1980-91) is the liberalisation phase heralded by Indira Gandhi and Rajiv Gandhi. Finally the last phase since 1991 is the period of stabilisation and structural adjustment under the framework developed by the Fund and the Bank. Such economic reforms in India were launched in June 1991.

### **2.2.1 THE ANTECEDENTS OF THE INDIAN MACROECONOMIC CRISIS**

Looking back at the performance of the Indian economy from 1950 onwards, what is most obvious is poor growth performance. Performance of India's economy during the last four decades has been neither spectacular nor dismal. By most indicators it appears to be modest but in many ways steady. While there have been no spectacular advances, the economy has displayed a remarkable resilience which has enabled it to cope with difficult problems and to survive major shocks. Throughout the planning era since 1950, the growth rate of GDP is less than 6 per cent (Table 2.1, col.2). When we see the picture of the economy from a disaggregated angle, there has been some improvement in the post-independence period.

The post-independence period marks a turning point in the history of Indian agriculture, which is the most predominant sector in India both in terms of its contribution (in terms of output nearly 33.3 per cent, and in terms of employment about 66.7 per cent) as well as source of demand and supply of wage goods to other sectors in the economy. In the second five-year plan, large investments were made on major irrigation projects. Agricultural transformation which was initiated in the mid-sixties through the adoption of a new strategy for agricultural development seems to have made a visible impact on production by the late sixties. Production of foodgrains, particularly in water-assured regions, benefitted largely from this strategy. As a result the index of agricultural production more than doubled during the three decades between 1950-1980 (Table 2.5, Col. 1).

The industrial sector in India is consciously planned and developed by the government.

At the time of independence India had a slender industrial base. It goes without saying that during the course of about four decades following 1951, India's industrial economy had undergone structural changes. Whereas the agricultural sector has shown a wide variation in its rate of growth, sometimes turning negative, the manufacturing sector has maintained a more stable positive growth. From mid-sixties, however, the industrial growth has been sluggish, which has declined from 9.5 per cent during 1960-65 to 4.3 per cent during 1965-70 and further declined upto 3.5 per cent during 1970-75 (see Table 2.5, col.5). This slowing down of the rate of industrial growth has caused much concern and led to a variety of explanations for such a development in the Indian economy. It has been argued by many that the Indian economy did undergo a structural change during the mid sixties (see Srinivasan and Narayana, 1977; Shetty, 1978). Chakravarty (1979a) attributes the industrial retrogression to a decline in growth of demand for home goods. Kumar (1993) attributes this decline in growth of demand for home goods to an uneven spatial growth. The constraints on the public investment which began during mid-sixties (especially due to and in terms of foreign exchange shortage) seem to have triggered off such an industrial recession in India. The seventies witnessed sluggish industrial growth accompanied by a substantial improvement in the growth of agriculture. Now, under the liberalisation era of 1980s, Indian industry seems to have responded positively to liberalisation, some times reaching a level of 9 percent rate of growth per annum (Table 2.5). However, the BoP crisis of 1991 resulted in import compression of essential capital goods and industrial raw material. This has resulted in reduced industrial growth in the post reform period to the most dismal figures ever experienced in India's post independence period.

India was more or less insulated from external shocks for decades, owing to limited volume of exports, import restrictions it imposed, and due to its trade being only a small fraction of its gross domestic product (see Table 2.1). We notice that imports as percentage of GDP ranged between 4.6 and 7.1 per cent between 1950-1980 (Table 2.2, col.8) while exports as percentage of GDP during the same period ranged between 3.5 and 6.1 per cent (Table 2.2, col.7). Over the last four decades, India has registered a change in the pattern of its exports from an exporter of traditional items like jute, tea, tobacco, and cotton textiles, to a large supplier of manufactured products to overseas markets. Even though the aggregate exports as per cent of GDP has increased from 3.5 per cent during 1965-70 to 6.1 per cent in 1990-91, India's share in world exports has a secular decline from 0.6 per cent in 1970 to 0.5 and 0.4 per cent in 1975 and 1980 respectively, and then it increased marginally to 0.5 per cent in 1985 which has remained the same in 1990 and 1991 (Government of India, 1994, pp.S-95-97). Moreover, the growth rate of imports has always remained much higher than the export growth which has led to severe BoP current account deficits. From 1981 to 1987, the persistence of current account deficits was the result of the almost complete stagnation of exports (fixed at about 4.5 per cent of GDP). India's exports do not cover even two-thirds of its imports and are less than 5 per cent of the GDP during eighties.

Given this scenario of stagnation of total exports and imports being much higher in value terms than exports, it is very clear that India had an adverse balance of trade for most of the years and its performance has been far from impressive. The trade balance is met through external debt. With the export earnings more or less stagnant, such external borrowings resulted in huge debt service obligation (14.3 per cent of export in 1986-87,

which put severe pressure on the BoP (Table 2.7, col.11)). India's balance of trade increased upto a maximum of 4.3 per cent of GDP in 1980-81 (Table 2.2, col.9). This may be attributed to three factors, namely: (i) decline in the world demand for India's exports; (ii) expansion of domestic markets not accompanied by a corresponding increase in capacity expansion, and (iii) absence of a vigorous export oriented policy during the fifties and the sixties and even in the eighties when India liberalised its trade.

However, it is interesting to note that during the seventies, exports have shown a rapid increase. This, together with a sharp rise in remittances from abroad, led to a comfortable BOPs and forex reserves position during the latter half of seventies. The rise in remittances can be shown in the flow of Non-Resident Indians (NRI) deposits on the Foreign Currency Non-Resident (FCNR) accounts as proportion of BOP deficit in the current account, which was 17.3 per cent during 1975-80 (see Table 2.7, col.14). However, the trade gap is characterised by deficit, except for surpluses in 1972-73 and 1976-77. The trade deficit took turn for the worse since 1980-81 and more so from 1985-86 onwards, which coincides with the liberalisation phase introduced by Congress(I) governments under the leadership of Indira Gandhi and Rajiv Gandhi<sup>1</sup> (Table 2.2,col. 4).

India's worst trade gap position is attributed to poor policy and performance, wars, natural calamities during 1956 to 1972 and oil price hikes of OPEC, industrial recession, draining of foreign aid, raising interest on foreign loans, foreign exchange crisis during 1973 to 1983. Nevertheless, in the earlier decades of development experience, India was

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<sup>1</sup> It must be noted that such a policy without adequate steps being taken for export growth might have led the country into the kind of BOP crisis that the country faced in 1990-91.

able to secure international assistance through grants and soft loans at low interest rates. The country was also able to withstand major external shocks such as wars with China in 1962 and Pakistan in 1965 and 1971 respectively, successive droughts (including the disastrous droughts of 1965-66 and 1966-67), oil price hikes of 1973 and 1979 etc.. This was the period from the time of independence to the end of the 70s or about three decades of development experience. India had tried twice to stabilise external shocks through devaluation of its currency. The first program involved a devaluation-cum-liberalization in 1966 aimed to please external aid donors after breaking into war with China in 1962 and Pakistan in 1965 and 1971; the second was an orthodox package<sup>2</sup> following the first oil shock in 1973 with a focus on trade liberalisation in a comfortable BOPs situation in order to shift the emphasis from import substitution to export promotion. The net result was a substantial improvement in India's export performance (Table 2.2) and dramatic improvement in net invisibles, primarily on account of remittances by NRIs from the Gulf countries in the seventies, which gave rise to a small current account BOPs surplus (0.2 per cent of GDP on an average during 1975-80) [Nayyar, 1994].

On the domestic front inflation was contained within reasonable limits through fiscal discipline and monetary restraints during the earlier decades (monetised deficit as per cent of GDP was around 1 per cent during most of the 1950-1980 period, see Table 2.8, col.7). The annual inflation rate was 13.3 per cent during 1970-75, which came down to 4.7 per cent during 1975-80. This decline in inflation rate could also be due to the

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<sup>2</sup> Deficit reduction is the *sine qua non* of orthodox stabilisation packages of the type usually proposed by the Fund and the Bank.

increase in GDP growth rate from 2.1 per cent during 1970-75 to 3.7 per cent during 1975-80. The macroeconomic scene was markedly different during the eighties. Throughout the 1980s the total gross fiscal deficits of the centre and states increased secularly and by 1990-91 the total gross fiscal deficit of the centre and states became 10.0 per cent of GDP, of which the centre accounted for 8.4 per cent (see Table 2.8) [Bhattacharya, Barman and Nag, 1994; p.7].

The savings in the economy improved from 9.6 per cent during 1950-55 to 21.3 per cent during 1975-80 (Table 2.4, col.4). These savings could not be channelled entirely into productive private sector investments, which might be due to the prevailing system of government control on capital issues, MRTP legislation, the industrial policy of reserving certain items for small industries and for the public sector, and industrial licensing etc. These enormous private savings might have been channelled into public sector investment,<sup>3</sup> thereby creating a domestic public debt, which forms the major part of the government borrowing in India. This public debt increased from 23.1 per cent of GDP during 1960-65 to 36.0 per cent during 1975-80 (Table 2.7, col.6). The rate of investment in the economy as a whole has been steadily increasing since the 1950s, i.e. 9.8 per cent during 1950-55 to 20.9 and 24.2 per cent during 1975-80 and 1985-90 respectively (Table 2.1, col.10).

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<sup>3</sup>A much larger proportion of the total investment was in the public sector than in the private sector. The share of public sector investment in over-all investment was 68.9 per cent during 1951-56 and declined to 66.7, 64.7 and 63.9 per cent during 1956-61, 1961-66 and 1969-74 respectively, and then increased upto 66 per cent during 1974-79, after which it has shown a declining trend (calculated from the Table 1 of Dandekar (1992)).

There has been a secular decline in the share of capital expenditure in total central government expenditure since 1984-85 (Table 2.6, Col.15). The relative movement between the rates of growth in public and private investments do not give a clear picture of evidence of either complementarity (crowding-in) or substitutability (crowding-out) between the two (Table 2.10, Col.6 and 7). However, from the mid-eighties until the reform period there has been a decline in the share of public sector investment in total investment (Table 2.10, Col.8). This was accompanied by, with one year lag, a reduction in the growth rate of private investment. This evidence suggests that the growth of the economy is possibly constrained by, what we might call a fourth-gap, a gap in public investment in infrastructure. In order to get a clearer picture one needs to disaggregate the public investment and examine the relation between investment in infrastructure and private investment.

An examination of trade balance as percent of GDP (Table 2.1, col.5) and the savings-investment gap as percent of GDP (Table 2.4, col.7) shows that these are quite close until 1975. The divergence between these two after 1975 demonstrates the disequilibrium in BoP which led to the first IMF loan in 1981 and the second one a decade later in 1991. It is well documented in the literature that India had no pressing need to go for an IMF loan in 1981 with its conditionalities. This aspect is discussed in some detail a little later. It was the inability of the Indian Government to meet its revenue deficits and planned investments through domestic savings that forced the Government to go for an IMF loan in 1981. Several dissenting economists warned at that time of an impending debt trap. The experience is a clear evidence of the importance of that warning. There has been an almost five-fold increase in the trade-



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balance and current account deficit in 1980-81. Due to trade liberalization policies that accompanied the IMF loan as conditionalities during the 1980s, the imports steadily increased with no matching efforts at export promotion (Table 2.2, cols.2 to 5). Trade liberalisation without any structural adjustments in the economy during the 1980s was ultimately responsible for mounting debt and debt service obligations.

The Indian experience shows that during the two quinquennial periods 1950-55 and 1975-80, India recorded a low inflation rate, a low Saving-Investment gap, and a low current account deficit (Table 2.1, col.3; Table 2.4, col.7; and Table 2.2, col.11). This experience suggests that India can insulate itself from external shocks by lowering the savings-investment gap and current account deficits. It seems that the concept of self-reliance was quite mistakenly interpreted as import compression instead of export promotion to meet the increasing demand for essential imports such as capital goods and Petrol, Oil and Lubricants (POL). In a large economy with growing domestic demand exports can grow only with greater investment and modernisation of technology.

Government budget operations and money financing have tremendous influence on the economic activity and price level in the economy. The weakening of the political stronghold of the congress party and the desire of the non-congress governments in later part of the seventies to lure the voters had resulted in the adoption of populist welfare schemes,<sup>4</sup> whose cost outstripped the government's ability to mobilise tax revenues. The

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<sup>4</sup> The per capita government (both states and centre) social sector expenditure i.e., expenditure on education, health, housing, other social services and, transfers under agriculture and allied activities which comprise of direct spending on anti-poverty programs and food subsidy, has increased from 18.2 per cent of total per capita government expenditure in 1971-72 to 25.4 per cent in 1980-81 and remained at 25 to 26 per cent throughout the 80s (calculated from the Table 8 of Mundle and Mukhopadhyay (1993)).

total tax revenue of the government as a proportion of GDP has remained stagnant around 6 to 7 per cent during 1970 to 1985 (Table 2.6, col.12). The political vulnerability had also forced the government to do little to improve tax collection through enforcement of tax laws in face of widespread tax evasion. The net result was a huge public debt to finance the populist welfare schemes especially through the government borrowing from the RBI or monetised deficit, which went on rising upto 3 per cent of GDP in 1989-90. By the year 1990-91 the fiscal deficit reached a level of 8.4 per cent of GDP while it was only 6.1 per cent of GDP in 1980-81. In contrast it may be noted that the fiscal deficit was only 3.4 and 4.6 per cent of GDP during 1970-75 and 1975-80 respectively (Table 2.8, col.6). This resulted in an alarming situation during 1989-90 where public debt is resorted upon, not to finance the deficit in the government's capital account but to finance the deficit in the government's current or revenue account (Table 2.8, cols. 6 and 9). The government started living beyond its means. It became necessary for the government even to borrow from abroad to finance partly the current account deficit.

At a time when the fiscal deficit is already so high<sup>5</sup> (6.1 per cent in 1980-81), creating alarming inflationary pressure (9.8 per cent in 1980-81), instead of reducing pressure on BoP (current account deficit of 1.2 per cent of GDP in 1980-81) the country launched a massive import liberalisation policy in the beginning of the eighties which resulted in large trade deficits to be financed through external borrowings at highest commercial

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<sup>5</sup> The gross fiscal deficit as a ratio of GDP in India is large compared to other developing countries, which has widened significantly during the 80s (Rangarajan, Basu and Jadhav. 1989).

rates of interest. The idea behind import liberalisation is that export-led growth should be preceded by import-led exports. The crucial question now is, how far have the inflows of imports facilitated the growth of exports. Imports as per cent of GDP has always been higher than the exports as per cent of GDP (see Table 2.2). However, the fast deteriorating BoP position has become a consequence of imports growing at a faster rate than exports. Several factors have contributed to an increase in imports. First, the expenditure on defence and imports of defence equipments have increased in the 80s. Second, the import intensity of Indian industry, i.e., capital goods (engineering), iron and steel, and especially of consumer durable industries such as washing machines, has been increasing in the recent years. And third, increasing POL imports have also contributed to the trade deficit (Vyasulu et. al., 1991).

As exports were growing rapidly in the late 80's, the trade deficit as per cent of GDP, which was 1.2 and 3.1 per cent during 1975-80 and 1980-85 respectively, declined to 2.2 per cent during 1985-90 and further to 1.3 per cent during 1990-93 (Table 2.1, col.5). The current account deficit averaged 36 per cent of exports during 1982-84; it averaged 47 per cent during 1985-90, and was never less than 40 per cent of exports after the liberalisation phase (Table 2.2, col.11). At the beginning of 1980-81, the government of India entered into an arrangement for a large loan (SDR 5 billion, which was then equivalent to Rs.54000 millions) from the IMF under the Extended Fund Facility (EFF), which was supposed to be disbursed over a period of four fiscal years 1980-81 to 1984-85. For the IMF loan, India had to accept a number of restrictive conditions. The liberalisation policy followed in the early eighties, which was continued in the latter part of the eighties, is the result of the traditional conditionality clause of

IMF's EFF.<sup>6</sup> India, however, drew only SDR 3.9 billion and the arrangement was terminated in early 1984 at India's request. This was done apparently with a political purpose prior to the approaching general elections in which Rajiv Gandhi got elected as prime minister with Congress(I) winning the election with a huge majority. But the large BOP deficits in the current account, particularly after 1984-85, had to be met instead through heavy borrowing from commercial sources at high commercial rates leading to serious debt service problem (Joshi and Little, 1993). More precisely, according to the Fund's 'conditionalities', the adjustment requirements include liberalisation of external trade (now called 'outward orientation'), restraints on government expenditure, reduction of personal income and corporate profit taxes, limits on the growth of wages and salaries and on different types of transfers and subsidies, exchange rate adjustments (always downward) etc. (Datta, 1992; p.151).

Import liberalisation and external borrowings came at a time when the official exchange rate was set at a level lower than a free market rate thereby creating a dual exchange rate regime with a dual black market or "havala" rate. As imports and budget deficit created inflation, the gap between the official exchange rate and the havala rate widened (Nandi, 1994; and Kiguel and O'Connell, 1994). The spread between the black market and official exchange rate as percent of the official exchange rate was about 30 per cent during the seventies while it went as high as 42 per cent in 1990-91 (calculated from

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<sup>6</sup> The fact that India had accepted the typical IMF conditionalities such as import liberalisation (which also resulted in importing wheat and sugar from U.S.A. in years of bumper crops), tariff reduction, relaxation of restrictive conditions for industrial expansion (MRTP Act), facilitating technology imports and foreign direct investment etc. can be ascertained from various issues of *Economic and Political Weekly (EPW)*, Vol.16, 1981 [eg. "IMF's Eager Client", EPW, Vol.16, Oct. 17-24, 1981, p.1684, I.S. Gulati "In Deep Waters", EPW, Vol.16, December 19, 1981, pp.2077-78, Ashok Rudra, "Who is Afraid of Economists", EPW, Vol.16, December 19, 1981, pp.2083-85].

Table 8 of Nandi, 1994). The lenders and NRIs became sceptical of the value of rupee in the international currency market. This resulted in a dwindling of remittances from NRIs and unprecedented downgrading of India's credit rating in the international capital market (Basu, 1991; and Bhagwati, 1993). NRI deposits as a percentage of debt service payments increased from 22 per cent in 1980-81 to 133 per cent in 1985-86 and then it dwindled to 69 per cent in 1990-91 before NRI's started withdrawing heavily from their FCNR accounts in 1991-92 (see Table 2.7, cols.12 and 13). The Gulf war of 1990-91 and the political instability around that time aggravated the situation further. The foreign exchange reserves dwindled to such alarmingly low levels, at 1.4 and 2.2 per cent of GDP in 1989-90 and 1990-91 respectively (see Table 2.7, col.9), as to be just enough to pay for only two weeks of import bills. The country was thus led to a BoP crisis never experienced before requiring that the newly elected government should seek IMF's assistance and IMF-type policies to resolve the crisis and to avoid default in debt-service payments.

### **2.2.2 THE 1991 POLICY RESPONSE**

In response to the immediate crisis, which is not caused by any major supply shock unlike all major crises in the past, the initial policy response was really an effort to formulate and implement a strategy of macroeconomic adjustment in order to bring the economy back to positive growth. The initial macroeconomic policy response focused on the issues of fiscal stabilisation, monetary restraint and currency convertibility. The macroeconomic stabilisation policies include: (a) fiscal policy; (b) monetary and credit policy; and (c) exchange rate adjustment. Structural adjustment policies were also

contemplated to be introduced in a phased manner. These contain: (a) trade policy reforms; (b) Industrial policy reforms; (c) public sector reforms; (d) factor market reforms - land reform, labour policy, financial sector reforms etc.; (e) tariff policy; and (f) administered price policy.<sup>7</sup>

Foreign exchange shortages are the most common cause of macroeconomic instability in the DEs, especially in the recent period. When the economy is in such a situation, it undertakes stabilisation programs. How do these policies fit into an IMF-type austerity program? Such stabilisation programs based upon austerity always concentrate on reducing the fiscal deficit (Taylor, 1993a). Most stabilisation programs in DEs are carried out as per the advice of international agencies. The two most commonly involved such agencies are the Bretton Woods institutions - the Bank and (especially) the Fund. Both agencies often have a hand in stabilisation exercises. Hence they are usually described as Fund-Bank affairs (Taylor, 1988). Interestingly, the macroeconomic theoretical framework used by the Indian policy makers seems to be monetarist, which is the approach of the Bretton Woods agencies. In other words, macroeconomic policy in India has been more Friedmanite than Keynesian (Joshi and Little, 1987). When most of the DEs, including India, are using the basic macroeconomic models of the Fund and the Bank as key components of their analytical framework, it is necessary to know the analytical approaches employed most frequently

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<sup>7</sup> For details, see Government of India (1993), Das (1993).

by the Fund and the Bank in designing DE policies that deal with adjustment and growth.<sup>8</sup> This will be discussed in Chapter 4.

## **2.3 AN ANALYSIS OF PERFORMANCE OF RECENT MACROECONOMIC POLICIES SINCE 1980**

In this section we discuss the results of the macroeconomic crisis management measures highlighting the contrasting experiences of growth, inflation, and BoP deficits in the recent years. The two important problems are: (a) achieving macroeconomic balance internally, (b) achieving an equilibrium in the balance of India's external payments.

### **2.3.1 EFFECT OF LIBERALISATION ON GROWTH**

The impact of liberalisation on the growth scene can be measured broadly by looking into aggregate and sectoral growth rates. The aggregate growth rate has been calculated in terms of GDP which is highly aggregative and the sectoral growth rates have been calculated by using index of agricultural and industrial production for agriculture and industry respectively. The GDP growth rate has declined to 1.3 per cent in 1991-92 from 6.6 per cent in 1980-81. The GDP growth rate was 7.4 and 10.2 per cent in 1983-84 and 1988-89 respectively (Table 2.3, col.9).

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<sup>8</sup> There is debate in the literature whether the macroeconomic policies are forced on India through IMF's conditionality clauses or they are considered as most desirable by the Indian policy advisers who advise the government. As such policies result from an agreement between IMF and the Indian Government this debate is meaningless. What is important is to examine the process through which Indian Government takes such policy decisions and whether it consults its parliament or not, and whether it consults the economists before taking policy decisions or after such decisions are made. Ultimately what should be of real concern and interest is who will benefit from such policies and by how much and who will bear the cost and to what extent. Some of these issues are widely discussed in the Indian literature (eg. Kumar, 1993).

The GDP growth rate has gone up to 4.4 per cent in 1992-93, principally due to a strong performance in agriculture (Table 2.5). A sustained progress in agricultural production has been witnessed for 1992-93 and 1993-94, which is mainly attributable to the improved performance of the foodgrains production. In 1991-92, there was a reduction of about 1.7 per cent in growth of index of agricultural production, which has grown at the rate of about 3.9 per cent in 1992-93 (Table 2.5). The high growth of agricultural production in 1992-93 is attributable partly to good weather<sup>9</sup> and partly to a shift in cropping pattern towards high value cash crops - such as oil seeds, pulses, and sugarcane.

One reason for the low growth of GDP in 1991-92 was the near stagnation of industrial production. Actually, industrial production was in the doldrums in 1991-92 as the growth of index of industrial production was negative, -0.05 per cent, which went up to 1.8 per cent in 1992-93 (Table 2.5, col.5). This increase does not mean much given that it reflects a partial recovery from the dismal performance in 1991-92. Though the overall rate of industrial growth has picked up in 1992-93 as compared to the preceding year of stagnation, this is well below the average rate of growth of 7.2 per cent for the period 1980-81 to 1989-90. One telling and concrete instance is that of government

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<sup>9</sup> Looking at the actual rainfall as percentage of normal rainfall for the country as a whole, we find that the agricultural growth rate fluctuates exactly in relation to fluctuation of actual rainfall as a proportion of normal rainfall. The most bountiful rain years over the period we are looking at are 1983-84 and 1988-89, when the actual rainfall as percentage of normal rainfall was 113 per cent, 119 per cent respectively. Corresponding to these years the agricultural growth rate was highest (see Table 2.5, col.4). Since in the year 1991-92, we had a bad agricultural season, the agricultural growth was negative, which has improved in the later years. In 1992-93, the rainfall index is 93 per cent, and for the year 1993-94 as a result of favourable monsoon, it is 101 per cent (Government of India, 1994). This is reflected by an increase in growth rate of index of agricultural production.



spending to which the system has got tuned during the last four decades. The reduction in government spending has not at all been compensated by a matching increase in private spending. This is a clear instance of stabilisation through reduction in government expenditure being not accompanied by a structural adjustment of privatisation and collaboration between the private sector and the state. The result has been a recession in several important industries.<sup>10</sup> It appears that the current scenario remains one of uncertainty and diffidence. The longer it persists, the slower is likely to be the pace and widening of the coverage of reforms which in turn, is bound to be harmful (Pandit, Krishnamurty, Krishna, and Saibaba, 1993).

During the initial years of the recent stabilisation and structural adjustment experience, the focus was on stabilisation of price level and controlling the BoP deficit through a reduction in the gross fiscal deficit and devaluation of the rupee. The manner in which the gross fiscal deficit is reduced must be noted. In a soft democratic State, such as India, the government finds it extremely difficult, politically, to bring about a significant reduction in its expenditure on the subsidies, poverty alleviation and grants to the States and the Union Territories. The Economic Survey 1993-94 (Government of India, 1994, p.20) shows clearly that as a proportion GDP, government expenditure on defence, subsidies and grants to the States and the Union Territories did decrease but only marginally. On the other hand the government expenditure on interest payments (as a proportion of GDP) had registered an increase. This meant that the IMF stipulated

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<sup>10</sup> In the short-run, both the inflation rate and the budget deficit are affected by the growth rate. A supply shock will both reduce the growth rate and raise the inflation rate, and given government spending a reduction in growth will increase the deficit (Fischer, 1993).

reduction in the gross fiscal deficit could be achieved only through a reduction in public investment. Through tax reforms the government could raise its revenues during these initial years and thus able to recognise the adverse impact of reduction in public investment. It is currently correcting the situation through promotion of privatization of power and transport sectors (Government of India, 1994, pp.129-145).

The mobilisation of domestic savings has been one of the most impressive achievements of the Indian economy in the last few decades. The gross domestic saving as a percentage of GDP at current market prices has increased upto the maximum of 24.1 per cent in 1989-90 with fluctuations in the earlier years. The gross savings rate declined from 21.2 to 18.8 per cent between 1980-81 and 1983-84, and remained more or less stagnant upto 1985-86, and then it peaked up to 24.1 per cent in 1989-90 (Table 2.4, col.4). Since 1989-90, the increase in savings rate has not been that remarkable. It has declined from 23.4 per cent of GDP in 1991-92 to 22.3 per cent in 1992-93 due to a decrease in household financial saving rate (RBI, 1994). While it is true that India's savings rate has risen all the way through the 50s, 60s and 70s, it is clear that the sharp rise took place in the late 60s and the 70s. It seems that a part of the better growth performance in the 80s was a lagged impact of the increase in savings (Basu, 1993). The rate of investment has increased from 22.7 per cent in 1980-81 to 27.5 per cent in 1990-91 (Table 2.4, col.5). But there is a marginal decline in the investment rate (from 27.5 per cent in 1990-91 to 24.5 per cent in 1992-93) in the post-reform period due to a squeeze on public expenditure mainly on capital account (Table 2.6, Col.15). The investment-saving gap (or the rate of net capital inflow from abroad) accelerated from 1.0 per cent of GDP during 1991-92 to 2.2 per cent during 1992-93. This situation

regarding savings and investment seems to suggest that the real investment in India is being hindered by such a thing as a "poor investment climate". This poor investment climate may be due to poor physical infrastructure such as power, transport and communications, or due to lack of credibility for the policies in view of delays and failures in implementing the major policy reforms. In this regard the country may repeat the follies of the first IMF loan and its after effects unless the State develops a credible policy environment to promote private investment.

### **2.3.2 EFFECT OF POLICIES ON CONTROLLING INFLATION**

Controlling inflation is a major issue in macroeconomic adjustment process, which is generally given a high weight in the overall social welfare function of the policy makers. The rate of inflation has been very high during 1990-92. It is, in fact, true that inflation rate has been brought down to a very low level of 7 per cent by the end of 1992-93 from a high level of 13.6 per cent in 1991-92 as per official calculation. This calculation of inflation by finance ministry has been done on a point-to-point basis in terms of the wholesale price index (WPI). But, as per annual average data on WPI of all commodities, the calculated inflation rate for 1992-93 is 10 per cent and the GDP deflator for the same period registered a growth rate of 9.5 per cent. GDP deflator is generally a little below the wholesale price indicator. During the second half of the 1980s, the average rate of inflation was 6.7 per cent per annum in terms of WPI, which climbed to 10.3 per cent in 1990-91.

The slowdown in the rate of inflation on an average-of-period basis is much less than what point-to-point rates suggest (see cols.5 and 6 of Table 2.3). Thus, the weekly rate of inflation has decelerated steadily but the annual rate based on the 52-week average of the WPI is a little higher than 10 per cent - the critical double digit mark. Thus the official claims regarding controlling inflation are quite deceptive as the following arguments will demonstrate: (i) the stabilisation policies introduced in July 1991 pushed up the rate of inflation in the second half of 1991 and the first half of 1992 so that point-to-point rates now show a decline in comparison with those high price levels; (ii) the measurement of inflation on a point-to-point basis is somewhat deceptive because it tends to overstate both the acceleration and the deceleration in inflation (Nayyar, 1993). Thus, it is more appropriate to calculate the trends in inflation on the average-of-period basis. Table 2.3 provides the information on annual rates of income growth and of inflation in India. Moreover, the important point is not just the stabilisation of the economy by bringing down the inflation rate but it is rather at what cost we were able to do so. It is obvious from the Table 2.3 that we have been able to reduce the rate of inflation at the cost of accepting negligible growth. This trade-off will be shown in Chapter 8 optimal control experiment. Despite this, the recovery in the rate of growth has been from just 1.3 per cent in 1991-92 to 4.4 per cent in 1992-93, still much below the average growth rate 6 per cent for the period 1980-81 to 1989-90. High inflation of 1991-92 was created by the Fund-Bank policy (because of devaluation and increase in money supply) and it was reduced to a level prevailing during the pre-IMF policy period through the IMF policies. Thus the policy only annulled its own impact on inflation but in the process also created a serious recession. The net impact of the policy is recessionary.

Table 2.3 also gives the annual rates of change in money supply (narrow and broad) along with the wholesale price index of all commodities. The trends in money supply since 1980-81 show that the growth of money supply has no steady acceleration. In fact, with the exception of the year 1989-90, which records the highest rate of (broad) money supply growth i.e. 20.4 per cent, and the year 1983-84, acceleration has all along been followed by deceleration. M1 has increased by only 7.3 per cent in 1992-93 compared to 1991-92, while the expansion of M3 has been kept down to no more than 14.2 per cent. Changes in reserve (or high powered) money which are largely determined by government's borrowing from the Reserve Bank to cover budgetary deficit, (i.e., the monetised deficit) has increased by over 11.5 per cent in 1992-93 (Table 2.4, Col.10). Thus, increase in fiscal deficit gives rise to increase in money creation thereby leading to inflation. This is because the non-plan expenditure is a major part of government expenditure, and wages and salaries which are (through DA) indexed to rate of inflation form a major part of this non-plan expenditure. But it is also quite possible that the fiscal deficit itself may also depend on the rate of inflation. In this connection, another point to be noted is that the demand for money itself also depends on inflation. So Inflation will not occur if the supply of money keeps up with the growth in the demand for money, which depends, along with some other factors, on the expected rate of inflation.

On the other hand, the wholesale price index (point-to-point) for all commodities shows a steady acceleration since 1985-86, with the exception of 1988-89. This shows that the finance ministry's perception that the problem of inflation can be controlled by placing excessive emphasis on controlling the monetary expansion through a reduction in RBI's

credit to the government seems to have been exaggerated. In view of the above, in a recent paper Pandit (1993) indicates that in the Indian economy in recent years cost-push phenomena play a vital role in determining the course of price movements than the demand-pull factors. Balakrishnan (1991) also pointed out that the continuous slowing down of money (M3) growth has not been able to dampen the inflationary pressure, which implies that in India inflation is not a purely monetary phenomenon. More importantly, in the Indian private corporate sector, the ratio of value added to output has declined both in the engineering goods sector and manufacturing sector in the eighties, which suggests a rise in input costs and inefficient material management (Swaminathan, 1993). This rise in costs may be treated as one of the factors in generating inflationary pressures in the economy.

The general price level did not fall or even stabilise in any year throughout the 80s. Even in 1983-84 and 1988-89, when agricultural production increased by as much as 14 and 21 per cent respectively, the inflation rate continued to be as high as 8 per cent (Bhattacharya, 1992). If it is claimed that inflation is only due to structural factors, then one may ask why the inflation rate was as high as 8 per cent during 1983-84 and 1988-89, when the agricultural growth rate was 14 and 21 per cent respectively. One may offer two possible explanations for this. First, the agricultural price policy does not in general accommodate a downward shift in the procurement prices when the agricultural production is good. Second, in the non-agricultural sector the adjustment for excess supply might be in terms of quantity adjustment, through holding of inventories instead of a downward adjustment in prices. Brahmananda et.al.(1992) also find that money plays an important role in the short-period in causing upward drift in prices, which gives

support to the policies to restrict growth rates of money supply with a view to reducing the inflation rate. In fact, it is evident from Table 2.3 that from 1990-91 to 1992-93, any change in money (M3) growth has been reflected in corresponding change in inflation rate.

From these observations it appears that the studies incorporating structural factors in causing inflation might not have taken due note of the demand pull factors. Studies which emphasise monetary factors may not have given adequate attention to the cost-push factors. Hence there is a difference of opinion and evidence regarding the rate of inflation in the country. A real model to explain inflation should incorporate both demand and supply sides of the problem. To the extent that these two types of studies do not incorporate adequately both these factors, each one of them may be overstating the influence of either the demand-pull or the cost-push factors. It is quite possible that certain prices are affected more by one type of factors than the other. There is therefore a need for modelling inflation which is taken up in Chapter 6.

### **2.3.3 THE NEXUS BETWEEN FISCAL DEFICIT, BOP, AND MONEY SUPPLY**

The imbalances in the fiscal system started developing since 1983-84 as revenue deficit exceeded the budget deficit with 1986-87 as an exception (Table 2.8). Large revenue deficit in the central budget indicates that a significant part of revenue expenditure is financed by borrowed resources on which there are interest and repayment liabilities. Table 2.6 shows that there is a shift away from investment (capital) expenditure to current (revenue) expenditure during the 80s. The fiscal discipline or lack of it is

reflected in the size of the fiscal deficit. The gross fiscal deficit in the central government's budget measures the difference between revenue receipts plus grants and total expenditure plus net domestic lending. This gross fiscal deficit had been running high for quite some years in the past, and it became 8.4 per cent of GDP in the second half of the 1980s, as compared with 6.3 per cent during the first half of the 1980s. It rose from 6.1 per cent of GDP in 1980-81 to 9 per cent in 1986-87 and hovered around the 8 per cent level till 1990-91 and has declined to 5.7 per cent in 1992-93 in view of the fiscal adjustment currently underway (Table 2.8, col.6).

This gross fiscal deficit was met by borrowings, both domestic and foreign, which led to sharp rise in public debt. Particularly, it resulted in monetary deficit which remained more or less the same at 3.0 per cent of the GDP in 1989-90. Such high levels of fiscal and monetary deficits (monetised deficit as a percentage of fiscal deficit became 38.8 per cent in 1989-90) have been largely responsible for the high rate of inflation and the high BoP deficit on current account that have afflicted the Indian economy during recent years. Additionally, a portion of the external borrowings was utilised to finance revenue deficit (the difference between government's revenue receipts and expenditure on current account), which gave rise to the critical BoP position. The deficit in the current account of the BoP in 1992-93 amounts to 2.1 per cent of GDP as compared with 2.6 per cent in 1988-89, 2.2 per cent in 1989-90, 3.3 per cent in 1990-91, and 0.9 per cent in 1991-92 (when import compression measures were adopted in the face of a BoP crisis). It doubled from first half of the 1980s to the second half of the 1980s.



Table 2.2 gives the evidence of this sequence. Hence it is the revenue deficit which is the source of rising current account deficit. Looking at the figures of revenue deficits as per cent of GDP (Table 2.8, col.9) and current account deficits as per cent of GDP (Table 2.2, col.10), it is obvious that any change in revenue deficit is reflected in a change in current account deficit, particularly they are so during 1987-90. Moreover, large amount of revenue deficits seem to have gone for unproductive government expenditure, which eventually gives rise to payment problems. The current account of the BOPs can only be improved through a reduction in domestic expenditure (absorption) - combined with policies that "switch" demand away from tradables to nontradables, and supply from nontradables to tradables, if an unnecessary fall in the total output is to be avoided.

The persistent current account deficits which were most possibly have been financed by borrowing from abroad, led to a continuous increase in external debt of the nation which rose from 10 per cent of GDP at the end of 1980-81 to 15.1 per cent at the end of 1990-91 and 24.3 per cent in 1992-93 (Table 2.7, col.7). Exports as percentage of GDP has virtually remained the same in the 80s, which have improved only in the early 90s in view of the policy reforms. Since there exists an inverse relationship between inflation and exports growth, any increase in inflation rate will result in corresponding decline in exports growth. Hence, controlling inflation is of prime importance internally along with the external stabilisation. At the macro level, the ratio of imports to GDP is generally regarded as an indicator of import-intensity, which has however, fallen from 9.2 in 1980-81 to 6.7 in 1987-88 and then increased upto 8.1 per cent in 1990-91. It has become 9 per cent in 1992-93. The uptrend in rupee value of imports could be explained

in terms of three factors, i.e., the steady depreciation in the value of rupee, the increase in the unit prices of imports and the persistent uptrend in the volume of imports (Singh, 1994).

The debt service burden for India in terms of exports is also too high. The debt service burden rose from 12 per cent of export earnings in 1980-81 to 14.4 per cent of export earnings in 1990-91. The debt indicators in Table 2.7 suggest that India's total foreign debt as percentage of GDP has been increasing at a very rapid rate. Internal debt of the government also accumulated rapidly, rising from 22.7 per cent of GDP at the end of 1980-81 to 29.0 per cent of GDP at the end of 1990-91 (Table 2.7, col.6). As a result, interest payments increased from 2.2 per cent of GDP and 13.3 per cent of total central government expenditure in 1980-81 to 5.6 per cent of GDP and 28.4 per cent of total central government expenditure in 1990-91 (Table 2.9, cols. 7 and 8). The reduction in the gross fiscal deficit of the central government during the post-reform period has arrested the rapid increase in internal debt which has remained in the range of 28 per cent as a proportion of GDP (Table 2.7, col.6).

India's foreign currency reserves have increased from 1.4 per cent of GDP in 1989-90 to 4.4 per cent of GDP in 1992-93, mainly due to the IMF loan, NRI remittances and inflows of financial capital from Foreign Institutional Investors (FIIs). After the shift to 'full convertibility' on the trade account, the foreign exchange value of the rupee has been stabilised. There has been a deliberate attempt by RBI to maintain a stable exchange rate by buying dollars in the foreign exchange market. One newspaper estimate states that the Indian rupee would have appreciated by about 12 percent if the

RBI did not intervene. It is an interesting question whether RBI's act of purchasing dollars is guided by IMF's pressure to keep the dollar value intact or by Indian Government concern to stabilise the exchange rate to avoid speculation on the forex market. A recent statement by the RBI that it is going to liberalise consumer goods imports even further lends some credibility to the view that such intervention by RBI has been to help the dollar and to help increase consumer goods imports from the U.S. than to arrest fluctuations in the exchange rate. But it is an equally convincing argument to say that if the dollar-rupee exchange rate is not maintained at the current levels there could be a decline in exports. That can be a great setback to export promotion drive. Which one of these two is more significant can be ascertained only through a detailed policy simulation model. However, the movement in the fiscal deficit and trade deficit as a per cent of GDP indicates that the period of fiscal expansion has coincided with the growing trade gap.<sup>11</sup> In other words, this implies that a part of the borrowing to finance the fiscal deficit is occurring abroad and not domestically.

Of course, it remains true that the Indian economy has shown remarkable resilience in the recent years. Most important among the positive outcomes has been the performance of agriculture whose output in 1992-93 was 4 per cent above that in 1990-91, itself a record year, and there are indications that it may grow further. Linked closely to this is the downturn in the rate of inflation, which is attributable to a sharp reduction in the inflation rate for agricultural goods and agro-based manufactures. To the extent that

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<sup>11</sup> The presumed link running from fiscal deficit to trade deficit has been examined by Mohanty and Joshi (1992) through a formal test of causality and they found that trade deficit is significantly correlated with the past values of public sector deficit and this relationship was found to be statistically significant.

these good harvests were a consequence of good monsoons rather than the fruits of good government policy, the lower inflation rate is also largely, it seems to be, a result of benign divine intervention of the weather God rather than an outcome of successful stabilisation policy.

One may say from Table 2.3 that India had reduced inflation rate from 9.8 per cent in 1980-81 to 4.9 in 1982-83 without any reduction in gross fiscal deficit, while it reduced inflation from 13.7 in 1991-92 to only 10 per cent in 1992-93 by a significant reduction in gross fiscal deficit. Of course, one must be cautious in making such statements as we are really not sure what would have been the inflation in 1992-93 if policies suggested by IMF were not used. A comparison of real GDP growth and growth in M3 prior to 1980s and after clearly shows that there was more M3 growth prior to 1980s than after for more or less the same real GDP growth rate of about 4 to 5 per cent. Gross fiscal deficit (GFD) as percentage of GDP was as high as 9.0 in 1986-87. When it was reduced marginally to 8.1 by 1987-88, the inflation rate was brought down almost by 50 per cent - from 10.7 to 5.6 per cent. This would be clear from policy simulations of Chapter 8.

The analysis presented here has one serious drawback. It is based either on the time trend of a single macroeconomic variable or on the comparisons of time trends of two variables taken at a time. In the real world the time trend of any single macroeconomic variable depends on, not just one other, but on several other macroeconomic variables. To fully comprehend what is happening and what is likely to happen under alternate policy regimes one needs a "dependable" dynamic econometric model of the Indian economy.

## 2.4 CONCLUSION

India's reform program has a long way to go because it has yet to accelerate growth, diversify the economy, stimulate investment and domestic savings and create the basis for a sustained growth process which can lead to greater self-reliance in terms of reduced borrowing and substantial reduction in mass poverty. There has been a sizeable fiscal adjustment since 1991, but the success of reforms depends crucially on the State's role in creating *realistic* optimistic expectations through the credibility of the policy makers and through State's role in promoting investment in infrastructure such as power, transport, communications, etc. A sizable portion of the adjustment has come from a reduction in domestic investment, which has to be stepped up in order to attain long-term growth. It is also worth noting that the decline in the average-of-period rate of inflation is largely attributable to the good monsoon and its impact on the prices of agricultural commodities. The two crucial parameters of the economic situation, namely, the inflation and the adverse BoP strains, have remained still serious, although there is an improvement in BoP position due to external borrowing, which may be equivalent to reducing current BoP deficit by postponing the BoP crisis to the future.

In this connection the real problem in designing, implementing, and evaluating the stabilisation and structural adjustment policies seems to be the straight jacket approach that is being used by the IMF - almost the same general approach being used for all countries irrespective of country-specific features. This is the reason why people who criticize the Fund and the Bank try to attribute what the country is doing to what the Fund and the Bank want the country to do. It could very well be the intention of the

Fund and the Bank that the country's government reduce wasteful government expenditure and not to cut public investment in infrastructure, but there seems to be no strategic plan, especially suited to Indian conditions, on state intervention with regard to a partnership between the public sector and the private sector in creating the necessary infrastructure investment in the key sectors of the economy such as power, transport, and communications. If action had been taken in time, during the 1980s, to reduce wasteful government expenditure to contain the budget deficits, to restrain imports, and to create better climate for private investment and export growth, the macroeconomic imbalances would not have reached the distressing magnitudes that were experienced in 1991. Therefore, a push towards sensible public investment policy and directed intervention as in East Asia would make a wager on an Indian Growth miracle a much more appealing choice (Taylor, 1994a). Before we formulate a model to link public investment with private investment and rest of the economy, in the next chapter we provide a critical review of the existing macroeconomic models and emphasise the need for developing a dynamic econometric policy model using time-series analysis for estimation, prediction, and policy evaluation.

TABLE 2.1  
MAJOR TRENDS IN BASIC MACROECONOMIC INDICATORS, 1950-1993  
(% increases and ratios)

PERIOD	GDP growth rate	Avg inflation rate	Exch rate change	Trade Balance as % of GDP	Budget Deficit as % of GDP	Agricul- tural growth rate	Industrial growth rate	Saving rate	Invest- ment rate	Pub. debt as % of GDP	External debt as % of GDP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1950-55	4.2	-2.2	0.0	-1.0	0.5	5.5	6.1	9.6	9.8	4.1	0.1
1955-60	3.8	3.9	0.0	-2.4	1.9	2.4	7.1	11.9	14.2	3.8	0.2
1960-65	5.2	5.5	0.0	-2.4	0.4	4.0	9.5	12.9	15.2	31.3	8.1
1965-70	3.0	7.2	10.8	-1.8	0.6	2.2	4.3	14.1	15.9	35.8	16.5
1970-75	2.1	13.3	1.2	-0.7	1.0	1.1	3.5	16.8	17.6	37.3	12.6
1975-80	3.7	4.7	0.4	-1.2	1.0	2.2	5.3	21.3	20.9	45.3	9.3
1980-85	5.6	9.3	8.2	-3.1	1.2	6.0	6.3	19.4	20.9	55.6	11.7
1985-90	6.1	6.7	7.1	-2.2	2.0	4.2	8.5	21.7	24.2	56.7	14.4
1990-93	2.3	6.8	10.0	-1.3	1.6	0.9	2.0	23.3	25.4	47.6	19.1

Notes: (a) Ratios and percentages in the period refer to the arithmetic averages.

(b) Inflation rate is for the annual average WPI (Base 1981-82=100).

(c) GDP growth rate is based on the GDP at constant market prices (Base 1980-81=100).

(d) All other variables are expressed at current prices. Hence the growth rates and ratios are based on values at current prices.

(e) Figures given for the quinquennial period in this and all subsequent tables are annual averages. The quinquennial periods are defined as follows: the period 1950-55 represents five fiscal years 1950-51 to 1954-55 and so on.

Sources: CSO, National Accounts Statistics, several issues.

RBI, Report on Currency and Finance, various issues.

Government of India, Economic Survey, relevant issues.

TABLE 2.2  
EXTERNAL TRADE INDICATORS

YEAR	Nominal Exports	Nominal Imports	Trade Balance	Current Account Deficit	GDP	Col.2 as % Col.6	Col.3 as % Col.6	Col.4 as % Col.6	Col.5 as % Col.6	Col.5 as % Col.2	Exchange Rate (ER)	% $\Delta$ in ER
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	(Rupees Crores)				(Percentages)							
1950-55	605	702	-97	-2	9963	6.1	7.0	-1.0	0.0	-0.3	4.76	0.0
1955-60	599	903	-304	-250	12780	4.7	7.1	-2.4	-2.0	-41.7	4.76	0.0
1960-65	719	1183	-464	-374	19571	3.7	6.0	-2.4	-1.9	-52.0	4.76	0.0
1965-70	1187	1797	-610	-561	33478	3.5	5.4	-1.8	-1.7	-47.3	6.85	10.8
1970-75	2193	2560	-367	-553	55133	4.0	4.6	-0.7	-1.0	-25.2	7.70	1.2
1975-80	5346	6463	-1117	210	95653	5.6	6.8	-1.2	0.2	3.9	8.49	0.4
1980-81	6711	12549	-5838	-2214	136013	4.9	9.2	-4.3	-1.6	-33.0	7.91	-2.1
1981-82	7806	13608	-5802	-2839	159760	4.9	8.5	-3.6	-1.8	-36.4	8.97	13.4
1982-83	8803	14293	-5490	-3280	178132	4.9	8.0	-3.1	-1.8	-37.3	9.67	7.8
1983-84	9771	15831	-6060	-3316	207589	4.7	7.6	-2.9	-1.6	-33.9	10.34	7.0
1984-85	11744	17134	-5390	-2873	231343	5.1	7.4	-2.3	-1.2	-24.5	11.89	15.0
1985-86	10895	19658	-8763	-5956	262243	4.2	7.5	-3.3	-2.3	-54.7	12.24	2.9
1986-87	12452	20096	-7644	-5830	292949	4.3	6.9	-2.6	-2.0	-46.8	12.78	4.4
1987-88	15674	22244	-6570	-6293	333201	4.7	6.7	-2.0	-1.9	-40.1	12.97	1.5
1988-89	20232	28235	-8003	-10410	396593	5.1	7.1	-2.0	-2.6	-51.5	14.48	11.7
1989-90	27681	35416	-7735	-9830	453986	6.1	7.8	-1.7	-2.2	-35.5	16.65	15.0
1990-91	32553	43193	-10640	-17366	530865	6.1	8.1	-2.0	-3.3	-53.3	17.94	7.8
1991-92	44042	47851	-3809	-5186	609500	7.2	7.9	-0.6	-0.9	-11.8	24.47	36.4
1992-93	53351	62923	-9572	-14631	705566	7.6	8.9	-1.4	-2.1	-27.4	25.89	5.8

Notes: The figures for current account deficit are taken from the RBI, whose data differ considerably from, but superior to the DGCIS data that are often quoted.

Source: Economic Survey, Government of India, several issues.  
Report on Currency and Finance, RBI, several issues.



TABLE 2.3  
INFLATION RATE AND GROWTH RATES OF GDP AND MONEY SUPPLY

YEAR	Wholesale Price Index (PTP)	Wholesale Price Index (ANA)	GDP Deflator	Infl. Rate of Col.(2)	Infl. Rate of Col.(3)	Infl. Rate of Col.(4)	GDP at 1980-81 Market Prices (Rs. Cr)	GDP Growth Rate (9)	Narrow Money Supply (M1) (Rupees Crores)	Broad Money Supply (M3)	Growth Rate of M1 (12)	Growth Rate of M3 (13)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1950-55	-	16.5	18.4	-	-2.2	-2.1	49312	4.2	1844	2235	1.3	0.6
1955-60	-	16.9	19.2	-	3.9	4.2	60241	3.8	2444	3208	6.9	10.1
1960-65	-	21.1	23.7	-	5.5	5.5	74501	5.2	3411	4659	8.5	7.5
1965-70	-	30.9	34.6	-	7.2	7.2	87280	3.0	5429	7671	9.9	11.9
1970-75	-	45.3	48.0	-	13.3	10.5	103916	2.1	9681	15143	12.8	15.1
1975-80	-	66.8	69.2	-	4.7	5.7	124926	3.7	16063	33830	11.4	19.2
1980-81	-	91.5	90.7	-	18.2	11.6	136013	6.6	23424	55774	17.4	19.2
1981-82	100.0	100.0	100.0	-	9.3	10.3	144900	6.5	23919	62426	2.1	11.9
1982-83	107.2	104.9	107.4	7.2	4.9	7.4	150379	3.8	26563	72868	11.1	16.7
1983-84	114.8	112.8	116.5	7.1	7.5	8.5	161547	7.4	30449	85899	14.6	17.9
1984-85	121.2	120.1	125.3	5.6	6.5	7.5	167489	3.7	36034	101957	18.3	18.7
1985-86	127.4	125.4	134.6	5.1	4.4	7.5	176648	5.5	44095	119394	22.4	17.1
1986-87	134.2	132.7	143.4	5.3	5.8	6.5	185250	4.9	47102	140633	6.8	17.8
1987-88	148.5	143.6	155.7	10.7	8.2	8.6	194085	4.8	53988	162660	14.6	15.7
1988-89	156.9	154.3	168.2	5.7	7.5	8.0	213827	10.2	62123	192076	15.1	18.1
1989-90	171.1	165.7	182.7	9.1	7.4	8.6	225417	5.4	74485	231343	19.9	20.4
1990-91	191.8	182.7	202.2	12.1	10.3	10.7	238144	5.6	92892	265828	24.7	14.9
1991-92	217.8	207.8	229.1	13.6	13.7	13.3	241261	1.3	114838	317481	23.6	19.4
1992-93	233.1	228.6	254.0	7.0	10.0	10.8	251962	4.4	123278	362665	7.3	14.2

Notes : (a) '-' not available

(b) wholesale price index inflation rates

(c) Growth rate refers to average annual growth rate in per cent.

Source: CSO, National Accounts Statistics, Various Issues.

RBI, Report on Currency and Finance, Several Issues.

TABLE 2.4  
SAVING, INVESTMENT, AND MONEY SUPPLY INDICATORS

YEAR	Gross Domestic Saving Investment		Rate	Rate	Investment Col.6	Money-M3	Reserve	Rate of	
	-----Rate				Saving	as % of	as % of	Money	Increase in
	Saving	Investment			Gap	GDP	GDP	Reserve	Money
	(in Rupees Crores)				(Rs. Cr.)			Money	Reserve Money
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1950-55	952	979	9.6	9.8	26	0.3	22.4	1398	1.1
1955-60	1515	1810	11.9	14.2	296	2.3	25.1	1844	7.3
1960-65	2519	2980	12.9	15.2	461	2.4	23.8	2576	7.2
1965-70	4709	5312	14.1	15.9	603	1.8	22.9	3771	8.4
1970-75	9256	9699	16.8	17.6	443	0.8	27.5	6173	10.9
1975-80	20405	19968	21.3	20.9	-437	-0.5	35.4	11837	17.8
1980-81	28786	30880	21.2	22.7	2094	1.5	41.0	19452	17.4
1981-82	33478	36089	21.0	22.6	2611	1.6	39.1	20463	5.2
1982-83	34068	36634	19.1	20.6	2566	1.4	40.9	23110	12.9
1983-84	38971	41488	18.8	20.0	2517	1.2	41.4	28824	24.7
1984-85	42114	45406	18.2	19.6	3292	1.4	44.1	31477	9.2
1985-86	49655	55889	18.9	21.3	6234	2.4	45.5	38165	21.2
1986-87	57072	63427	19.5	21.7	6355	2.2	48.0	44758	17.3
1987-88	71747	78572	21.5	23.6	6825	2.0	48.8	53352	19.2
1988-89	87152	99456	22.0	25.1	12304	3.1	48.4	62310	16.8
1989-90	109559	121838	24.1	26.8	12279	2.7	51.0	77591	24.5
1990-91	127535	145731	24.0	27.5	18196	3.4	50.1	87779	13.1
1991-92	142479	148715	23.4	24.4	6236	1.0	52.1	99505	13.4
1992-93	157186	172908	22.3	24.5	15722	2.2	51.4	110943	11.5

Notes: Savings and investment are at current prices. The savings rate and investment rate are percentages of gross domestic product (GDP) at current market prices.

Source: RBI, Report on Currency and Finance, Various Issues.  
Government of India, Economic Survey, Relevant Issues.

TABLE 2.5  
AGRICULTURAL AND INDUSTRIAL PRODUCTION INDICATORS

YEAR	Index of Agricultural Production	Index of Industrial Production	Growth Rate of Col.(2)	Growth Rate of Col.(3)	Actual Rainfall as per cent of Normal Rainfall
(1)	(2)	(3)	(4)	(5)	(6)
1950-55	47.9	20.9	5.5	6.1	-
1955-60	56.3	28.9	2.4	7.1	-
1960-65	65.5	43.2	4.0	9.5	-
1965-70	68.2	56.8	2.2	4.3	-
1970-75	80.7	70.7	1.1	3.5	-
1975-80	93.0	90.2	2.2	5.3	-
1980-81	100.0	100.0	15.6	4.0	104
1981-82	105.6	109.3	5.6	9.3	100
1982-83	101.6	112.8	-3.8	3.2	85
1983-84	115.6	120.4	13.7	6.7	113
1984-85	114.3	130.7	-1.2	8.6	96
1985-86	117.1	142.1	2.5	8.7	93
1986-87	112.7	155.1	-3.7	9.1	87
1987-88	111.8	166.4	-0.8	7.3	81
1988-89	135.4	180.9	21.1	8.7	119
1989-90	138.2	196.4	2.1	8.6	101
1990-91	141.8	212.6	2.6	8.2	106
1991-92	139.3	212.5	-1.7	0.0	91
1992-93	144.7	216.3	3.9	1.8	93

Notes: (a) Indices have been converted from the old series by simple arithmetic conversion method.

(b) Index numbers of industrial production are groupwise for financial years.

(c) Growth rates are average over the quinquennial period of annual growth rates from 1950 to 1980.

Source: (i) All India index numbers of Area, Production & yield of principal crops, Directorate of Economics & Statistics, Ministry of Agriculture, GOI.

(ii) Monthly statistics of Production of selected industries, CSO, GOI.

(iii) Actual rainfall as percentage of normal rainfall has been taken from Economic Survey (various issues), Ministry of Finance, New Delhi.

TABLE 2.6  
REVENUES AND EXPENDITURES BY CENTRAL GOVERNMENT

YEAR	Total Revenue Receipts	Tax Revenue	Non-Capital Receipts	Capital Receipts	Total Expenditure	Revenue Expenditure	Capital Expenditure	Col.2 as % GDP	Col.7 as % GDP	Col.4 as % GDP	Col.5 as % Col.3	Col.8 as % GDP	Col.9 as % Col.7	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1950-51	101	88	71	16	13	102	77	25	1.0	1.0	0.7	18.7	0.8	24.4
1955-56	143	107	82	23	36	175	99	76	1.1	1.4	0.6	21.1	0.8	43.5
1960-65	2424	1523	1121	318	900	2523	1373	1150	12.4	12.9	5.7	20.8	7.0	45.6
1965-70	3887	2650	1975	652	1237	4084	2478	1606	11.6	12.2	5.9	24.6	7.4	39.3
1970-75	6044	4716	3564	1106	1328	6546	4457	2089	11.0	11.9	6.5	23.4	8.1	31.9
1975-80	13283	9837	7357	2231	3446	14054	9404	4650	13.9	14.7	7.7	22.7	9.8	33.1
1980-81	19139	12829	9388	3094	6310	22495	14385	8110	14.1	16.5	6.9	24.1	10.6	36.1
1981-82	22849	15574	11573	3564	7275	25401	17027	8374	14.3	15.9	7.2	22.9	10.7	33.0
1982-83	27202	18091	13056	4448	9111	30494	20982	9512	15.3	17.1	7.3	24.6	11.8	31.2
1983-84	32609	20493	15476	4239	12116	35988	24852	11136	15.7	17.3	7.5	20.7	12.0	30.9
1984-85	38425	24384	17694	5853	14041	43879	27938	15941	16.6	19.0	7.6	24.0	12.1	36.3
1985-86	48522	29207	21140	6895	19315	52666	33924	18742	18.5	20.1	8.1	23.6	12.9	35.6
1986-87	55826	34254	24319	8764	21572	62916	40860	22056	19.1	21.5	8.3	25.6	13.9	35.1
1987-88	63811	38403	28015	9022	25408	68261	46174	22087	19.2	20.5	8.4	23.5	13.9	32.4
1988-89	74931	45052	33751	9840	29879	79111	54106	25005	18.9	19.9	8.5	21.8	13.6	31.6
1989-90	83986	53966	38349	13947	30020	92908	64210	28698	18.5	20.5	8.4	25.8	14.1	30.9
1990-91	93931	54954	42978	11976	38977	105298	73516	31782	17.7	19.8	8.1	21.8	13.8	30.2
1991-92	104559	66031	50069	15962	38528	111412	82291	29121	17.2	18.3	8.2	24.2	13.5	26.1
1992-93	110306	74128	54044	20084	36178	122618	92702	29916	15.6	17.4	7.7	27.1	13.1	24.4

Notes: Since comparable data is not available for all the individual years during the fifties, we could not calculate the annual average of the five years period. Hence we have presented the annual figures for the first year of two quinquennial periods.

Source: Economic Survey, Government of India, (various issues).

TABLE 2.7  
IMPORTANT DEBT INDICATORS

YEAR	Total Public Debt	Internal Debt	External Debt	Col.2 as % GDP	Col.3 as % GDP	Col.4 as % GDP	Foreign Exchange Reserves	Col.8 as % GDP	Debt Servicing	Col.10 as % of Exports	NRI Debits	Col.12 as % Col.10	Col.12 as % Col.10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(14)	TPD	IntD	ExtD	2/GDP	3/GDP	4/GDP	FXR <sub>0</sub>	Exch. Sv.	Debt	Debt/GDP	NRI	?	?
1950-55	411	404	6	4.1	4.1	0.1	915	9.2	-J	-	-	-	-
1955-60	489	466	23	3.8	3.6	0.2	549	4.3	-	-	-	-	-
1960-65	6117	4530	1587	31.3	23.1	8.1	290	1.5	-	-	-	-	-
1965-70	11987	6447	5540	35.8	19.3	16.5	543	1.6	-	-	-	-	-
1970-75	20591	13652	6939	37.3	24.8	12.6	898	1.6	532	24.2	-	-	-
1975-80	43308	34424	8884	45.3	36.0	9.3	4349	4.5	716	13.4	36	5.1	17.3
1980-81	44294	30864	13430	32.6	22.7	9.9	5544	4.1	804	12.0	178	22.1	-8.0
1981-82	53086	35653	17433	33.2	22.3	10.9	4024	2.5	849	10.9	206	24.2	-7.3
1982-83	67237	46939	20298	37.7	26.4	11.4	4782	2.7	948	10.8	383	40.5	-11.7
1983-84	75557	50263	25294	36.4	24.2	12.2	5972	2.9	1033	10.6	709	68.7	-21.4
1984-85	88993	58537	30456	38.5	25.3	13.2	7243	3.1	1176	10.0	879	74.7	-30.6
1985-86	106839	71039	35800	40.7	27.1	13.7	7820	3.0	1367	12.5	1767	129.3	-29.7
1986-87	126815	86313	40502	43.3	29.5	13.8	8151	2.8	1782	14.3	1650	92.6	-28.3
1987-88	147848	98646	49202	44.4	29.6	14.8	7687	2.3	2153	13.7	1840	85.5	-29.2
1988-89	169377	114498	54879	42.7	28.9	13.8	7040	1.8	2798	13.8	2465	88.1	-23.7
1989-90	202726	133193	69533	44.7	29.3	15.3	6251	1.4	3342	12.1	2442	73.1	-24.8
1990-91	234350	154004	80346	44.1	29.0	15.1	11416	2.2	3993	12.3	2756	69.0	-15.9
1991-92	273175	172750	100425	44.8	28.3	16.5	23850	3.9	5562	12.6	-1111	-20.0	21.4
1992-93	370405	199100	171305	52.5	28.2	24.3	30745	4.4	7659	14.4	5419	70.8	-37.0

Notes: External debt figures represent borrowings by central government from external sources and are based upon historical rates of exchange.  
'-' indicates not available; CAD - current account deficit

Source: (a) Economic Survey, Government of India (various issues).  
(b) RBI, India's Balance of Payments, 1948-49 to 1988-89, July 1993.  
(c) EPW Research Foundation, 1993, India's External Debt, Special Statistics: 1, Economic and Political Weekly, 28 (23): 1151-58, June 5.

TABLE 2.8  
GOVERNMENT DEFICIT INDICATORS

YEAR	Gross Fiscal Deficit	Monetised Deficit	Budget Deficit	Revenue Deficit	Col.(2) as % of GDP	Col.(3) as % of GDP	Col.(4) as % of GDP	Col.(5) as % of GDP	Col.(3) as % of Col.(2)
(1)	(Rupees Crores)				(Percentages)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1950-55	-2	-	46	52	0.0	-	0.5	0.5	-
1955-60	337	49	248	43	2.6	0.4	1.9	0.3	14.7
1960-65	1000	376	87	150	5.1	1.9	0.4	0.8	37.6
1965-70	1435	186	196	172	4.3	0.6	0.6	0.5	13.0
1970-75	1870	628	544	216	3.4	1.1	1.0	0.4	33.6
1975-80	4384	1030	962	243	4.6	1.1	1.0	0.3	23.5
1980-81	8299	3551	2576	2037	6.1	2.6	1.9	1.5	42.8
1981-82	8666	3207	1392	392	5.4	2.0	0.9	0.2	37.0
1982-83	10627	3368	1655	1308	6.0	1.9	0.9	0.7	31.7
1983-84	13030	3949	1417	2540	6.3	1.9	0.7	1.2	30.3
1984-85	17416	6055	3745	4225	7.5	2.6	1.6	1.8	34.8
1985-86	21857	6190	4937	5889	8.3	2.4	1.9	2.2	28.3
1986-87	26342	7091	8261	7777	9.0	2.4	2.8	2.7	26.9
1987-88	27044	6559	5816	9137	8.1	2.0	1.7	2.7	24.3
1988-89	30923	6503	5642	10515	7.8	1.6	1.4	2.7	21.0
1989-90	35632	13813	10592	11914	7.8	3.0	2.3	2.6	38.8
1990-91	44632	14746	11347	18562	8.4	2.8	2.1	3.5	33.0
1991-92	36325	5508	6855	16261	6.0	0.9	1.1	2.7	15.2
1992-93	40173	5389	12132	18574	5.7	0.8	1.7	2.6	13.4

Notes: Fiscal deficit data from 1980-81 onwards are taken from RBI Bulletin, but prior to 1980-81, fiscal deficit is computed by deducting revenue receipts from total central expenditure.

Source: Economic Survey (various issues); Indian Economic Statistics, 1990-91. Report on Currency and Finance (various issues).

TABLE 2.9  
INTEREST PAID AND INTEREST, DIVIDENDS, AND PROFITS RECEIVED BY GOI

YEAR	Interest	Interest	Dividends	Total	Col.(5)	Col.(2)	Col.(2)
	Payments	Receipts	& Profits	(3+4)	as % of	as % of	as % of
	(Rupees Crores)				(Percentages)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1950-51	-	2	23	25	-	-	-
1955-56	62	3	29	32	51.6	0.6	6.4
1960-61	162	15	53	68	42.0	1.0	9.0
1965-66	639	307	82	389	60.9	2.4	16.2
1970-71	1004	575	121	696	69.3	2.3	18.0
1975-76	2059	934	195	1129	54.8	2.6	17.1
1980-81	3002	1794	292	2086	69.5	2.2	13.3
1981-82	3601	2215	321	2536	70.4	2.3	14.2
1982-83	4422	2852	419	3271	74.0	2.5	14.5
1983-84	5352	2668	451	3119	58.3	2.6	14.9
1984-85	6624	3963	407	4370	66.0	2.9	15.1
1985-86	10444	4586	415	5001	47.9	4.0	19.8
1986-87	13338	5339	507	5846	43.8	4.6	21.2
1987-88	16115	5745	604	6349	39.4	4.8	23.6
1988-89	20189	6973	475	7448	36.9	5.1	25.5
1989-90	25074	8466	715	9181	36.6	5.5	27.0
1990-91	29955	9573	779	10352	34.6	5.6	28.4
1991-92	26563	9061	967	10028	37.8	4.3	23.8
1992-93	32500	12436	2549	14985	46.1	4.6	26.5

Notes: Data from 1950-51 to 1975-76 is for the corresponding year only, not annual average for quinquennial period due to unavailability of comparable data.

Source: RBI, Report on Currency and Finance, Vol.II, Various Issues.

TABLE 2.10  
GROSS DOMESTIC CAPITAL FORMATION: PUBLIC AND PRIVATE

YEAR	Gross Domestic Capital Formation:			Growth Rate of Col.(2)	Growth Rate of Col.(3)	Growth Rate of Col.(4)	Col.(3) as % of Col.(2)
	Total	Public Sector	Private Sector				
(1)	(Rupees Crores)			(Percentages)			(8)
	(2)	(3)	(4)	(5)	(6)	(7)	
1950-55	979	309	669	6.24	16.21	1.99	31.74
1955-60	1810	743	1068	14.68	16.25	14.69	40.78
1960-65	2980	1473	1507	13.85	17.10	10.89	49.02
1965-70	5312	2222	3090	11.65	3.30	19.85	42.35
1970-75	9699	4029	5670	17.17	19.83	16.24	41.61
1975-80	19968	9143	10825	13.86	17.32	12.90	46.37
1980-81	30880	11767	19113	22.16	-0.43	42.00	38.11
1981-82	36089	16781	19308	16.87	42.61	1.02	46.50
1982-83	36634	20100	16534	1.51	19.78	-14.37	54.87
1983-84	41488	20381	21107	13.25	1.40	27.66	49.13
1984-85	45406	24915	20491	9.44	22.25	-2.92	54.87
1985-86	55889	30874	25015	23.09	23.92	22.08	55.24
1986-87	63427	35415	28012	13.49	14.71	11.98	55.84
1987-88	78572	35087	43485	23.88	-0.93	55.24	44.66
1988-89	99456	42183	57273	26.58	20.22	31.71	42.41
1989-90	121838	48611	73227	22.50	15.24	27.86	39.90
1990-91	145731	55662	90069	19.61	14.50	23.00	38.20
1991-92	148715	61764	86951	2.05	10.96	-3.46	41.53
1992-93	172908	72986	99922	16.27	18.17	14.92	42.21

Notes: Nominal gross domestic capital formation (GDCF) in the private sector has been derived by deducting public sector GDCF from aggregate GDCF. Aggregate GDCF is adjusted total series for errors and omissions.

Source: Economic Survey 1993-94, Government of India, p.S-7.



## CHAPTER 3

# ANNALS OF INDIAN MACROECONOMIC MODELLING EFFORTS

### ABSTRACT

*This chapter provides a review of the existing macroeconomic modelling literature for the Indian economy. This review is undertaken mainly to identify the gaps so as to build a macroeconomic model that takes due note of the current economic changes. In so doing two broad aspects are explored. First, an analysis of the theoretical framework of the current state of the art of macroeconomic modelling in India. Second, the nature of the empirical work on macroeconomic modelling that has been done so far since its inception. From this it is revealed that most of the existing models are essentially explanatory in nature comprising static equilibrium models, and to some extent some of them are dynamic only through lagged disequilibrium adjustment. Moreover, the static and comparative static structural models fitted to macroeconomic data, which are presumably generated by a non-stationary stochastic process, are known to give rise to spurious correlation and also lead to incorrect inferences. Cointegration and error correction models are better suited to build models that explain long-run equilibrium relations with short-run fluctuations. Hence this chapter offers some critical remarks on macroeconomic modelling and the relevance of an optimal control policy model for macroeconomic adjustment based on a VAR model with error correction mechanism.*

### 3.1 INTRODUCTION

In the previous chapter, we explored the overall picture of the Indian macro economy which suggests that the new policy initiatives have not yet succeeded fully in reviving the economy. The important question to ask is whether these adjustment problems have been modelled appropriately in the Indian context. In fact, macroeconomic model building in India is no longer a matter of simple experimentation. Over the years, a number of quantitative investigations have appeared from time to time describing the short-term fluctuations in the Indian economy. So we intend to provide a survey of the development of macroeconomic models in India, which is more than four decades old. Macroeconomic modelling was initially developed in the DCs in Tinbergen-Klein

traditions,<sup>1</sup> which was made possible with the steady evolution of economic theory, statistical techniques, and macroeconomic statistics. Subsequently, due to the efforts made by the UN in building a system of national accounts statistics, such modelling exercises were carried out for the DEs as well.

There are a number of reviews which document the major features of the models and their applications. In total, there have been five major surveys on macroeconomic modelling in India. The surveys by Desai (1973), Krishnamurty and Pandit (1984), Jadhav (1990), and Krishna, Krishnamurty, Pandit and Sharma (1991) are prominent among these.<sup>2</sup> But no survey is quite exhaustive in its coverage from the beginning of modelling efforts to the present. All earlier reviews on macroeconomic modelling efforts for the Indian economy have largely dealt with traditional structural econometric models. The purpose of the present review is to shed some new light on the nature of all types of macroeconomic models for India since its inception. A question may be raised as to what is the need for doing yet another review when there are already some reviews on this topic. Four justifying reasons can be advanced for yet another review: (i) this review updates the stock of literature by adding some of the more recent modelling efforts, (ii) this survey emphasises theoretical issues in addition to the econometric aspects, (iii) this survey includes some models which earlier reviews did not - models such as control-theoretic models, multisectoral plan models and computable general equilibrium (CGE) models, and (iv) the present review also

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<sup>1</sup> Macroeconometric models of the Tinbergen-Klein type aim at describing the structure and the functioning of a given economy by specifying a Keynesian type of model and estimating it using multiple regression methods.

<sup>2</sup> Bhagawati and Chakravarty (1969), Rudra (1985) give excellent reviews on India's contribution to macroeconomic planning models.

suggests the limitations of traditional macroeconomic modelling and suggests directions in which the modelling efforts need modifications in view of the changing macroeconomic environment, and the evolution of the econometric methodology. In keeping the above points in view, the remainder of the chapter is structured as follows.

A review on the classification and characterisation of different types of macro models of the Indian economy is presented in section 3.2. Section 3.3 presents a critical appraisal of the existing modelling efforts. Section 3.4 sums up.

### **3.2 MACROECONOMIC MODELS OF THE INDIAN ECONOMY**

India is the first among the DEs for which economy-wide econometric models have been constructed as early as 1950s. For formalising the macroeconomic policy strategies about the working of the Indian economy, four different types of alternative models have always been pervasive in the Indian economy.<sup>3</sup> They are: (1) Plan models and CGE models; (2) Macroeconometric models; (3) Control-theoretic models. This taxonomy is important as it is based on certain major common features shared by a group of macroeconomic models. While CGE models take explicit account of income distribution and its impact on demand and thus price behaviour through a Walrasian general equilibrium framework, the structural macroeconometric models are generally based on a Keynesian general equilibrium framework of IS-LM version. The three kinds of models described here simply reflect different motivations towards macroeconomic modelling.

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<sup>3</sup> The classification given below is not a water-tight classification of strictly mutually exclusive compartments. In fact one can find macro models that fall into more than one category. However, based on the major emphasis each model has, one may be able to place the model in any one of these four types (see, for example, Capros, Karadeloglou and Mentzas (1990), who follow a similar type of nomenclature and use the terms macroeconometric and CGE model classes).

Plan models deal with the setting of the targets for the economy at the end of the plan period and specifying the instruments or policies to achieve such targets. In other words, Indian plan models had mostly been worked out on the basis of consistency considerations for a terminal year. Many of Indian plan models are truly multisectoral linear dynamic equilibrium models, i.e., Chakravarty-Eckaus-Lefebvre-Parikh (CELP) model is a linear dynamic equilibrium model. One may note that input-output framework has been extensively used in the plan models. The econometric models developed for India, on the other hand, are more aggregative in character and they generally incorporate a Keynesian type of a static model with disequilibrium dynamics introduced through lagged adjustment. They are not truly dynamic with features that incorporate long-run statics with short-run dynamics. In the changed scenario of the Indian economy, what is required is essentially a dynamic model of the above type for stabilisation with growth. CGE models are mostly disaggregated static equilibrium models. If they are dynamic they are so only to the extent of incorporating capital accumulation and growth.

### **3.2.1 PLAN MODELS AND CGE MODELS**

Macroeconomic planning models can come under the following sub-groups: (a) Aggregate growth models; (b) Static multi-sectoral input-output consistency models; (c) Dynamic input-output consistency models; (d) Dynamic input-output programming models; (e) Hybrid models that use aggregate final demands for the demand side and dynamic input-output model for the supply side.

The first two five-year plans of the Indian economy are based on growth models, i.e., Harrod-Domar model (First Five Year plan) and Mahalanobis' two-sector and four-sector models (Second Five Year plan). The First Five Year plan model was a savings constrained model, whereas the Second Five Year plan model was a multi-sectoral growth model with a plan for expanding the role of the state to bring about growth with equity. These two models ignored the foreign exchange constraint, i.e., they are one-gap (savings-investment gap) models. In the latter five-year plans, planning models of input-output type have been used. One can interpret the subsequent five year plan models as disaggregate multi-sectoral growth models which are descendants of the Harrod-Domar growth model.

A striking feature of the Third Plan was that the achievement of inter-industrial consistency was attempted in some detail. There was a marked shift away from the simple decision-models to the multi-sectoral models. An analytical improvement incorporated in the Third Plan was the explicit attention given to foreign trade as a bottleneck. As a result the plan model made a case for increasing the rate of foreign aid in breaking the bottleneck and on the possible desirability of "using aid to end aid" so as to reach the stage of self-sustained growth at some foreseeable future date. The Third Five Year Plan model thus belongs to the two-gap variety, savings-investment gap and trade or balance of payments gap.

For the Fourth Plan Allan Manne and Ashok Rudra built a static multi-sectoral consistency model while S. Chakravarty, R. Eckaus, L. Lefebvre and Kirit Parikh developed an explicitly dynamic, multi-sectoral model. The Chakravarty-Eckaus-

Lefebber-Parikh (CELP) model is a finite horizon, linear optimization model with explicit intersectoral and intertemporal relationships and boundary conditions relating to the initial year as well as to the terminal year of the plan (Bhagwati and Chakravarty, 1969; P.14). From a methodological perspective, the theoretical elegance and the empirical detail of the CELP model should lead us to believe that it is completely adequate for the purpose of generating development plans for the Indian economy, empirically it still ignores many fundamental features peculiar to the Indian economy, such as price formation. Similarly, the framework of the Fifth Five-Year Plan Model (Planning Commission, 1973) consists in applying an open static Leontief model for ensuring terminal year consistency amongst the output levels of different sectors. This model consists of three parts: a macro-economic model; an input-output model; and a consumption model. The macroeconomic model gives the relationships between the fiscal, monetary, and employment variables, the input-output tables provide further inter-industrial break-down of macro aggregate variables and finally the consumption model shows how poverty and welfare measures can be altered through public policy. Even though the consumption sub-model was the most novel feature of the Fifth Plan, it was severely criticised on the ground of economic feasibility in practice due to the difficulty in operationalising the objective of poverty alleviation through income generation for the targeted segment of the population to afford the minimum consumption levels specified for them (for detailed evaluation, see Rao and Karnik, 1994).

The Sixth Five Year plan model (Planning Commission, 1981) is comprised of a core model, a macro model and five major sub-models, which were primarily designed to

process the inputs (as exogenous variables) for the core model. The sub-models are: agriculture, exports, demography, autonomous investment and public consumption, and long-term objectives. While endogenising the final demands the plan models used the knowledge of the already existing econometric models. An important analytical gap that existed in earlier plans which has been highlighted in the Sixth Plan Technical Note (Planning Commission, 1981, p.17) is that income distribution and the production structure of the economy are explicitly functionally related. For the first time, an investment planning model was developed and incorporated into the existing input-output (IO) system implying that the static IO model was converted into a dynamic Leontief model.

The basic structure of the Seventh Plan Model (Planning Commission, 1986) and its working are the same as in the Sixth Plan Model. The model comprises of a 'core' and seven major 'sub-models'. The core model consists of (i) a macro-economic model; (ii) an input-output model; and (iii) investment model. The sub-models are agriculture, industry, consumption, poverty, export and import, financial resources, and demography and employment. The macroeconomic model consists of a number of national income and expenditure identities, and this in combination with input-output model endogenously determines investment in the terminal year. Given a target rate of growth and base year GDP, saving and consumption decisions of public and private sector, and certain other exogenous variables, macroeconomic model determines resources available for investment.

From the Fifth Plan onwards, an equilibrium framework has been adopted for the purpose of analysis. In this approach, given the time-path of the macroeconomic targets in the planning period, along with the targeted sectoral private consumption estimates, the sectoral output levels are determined employing the input-output relations for making decisions on the level and structure of investments across the sectors. The targets are seldom realised, for the most striking explanation seems to be either misspecification of the model itself, or the unrealistic targets, or the unrealistic assumptions that are made regarding the exogenous variables while generating the forecasts. Hence the specification of the models and the targets must have an intimate relationship with the complexities of the economy. Nevertheless, doubts have been raised, quite justifiably, about the usefulness of the kind of plan models that have been in use, in view of the fact that prices are ignored in the analytic framework in these models (Rudra, 1985). In fact, given the price fluctuations in the Indian economy, a true macroeconomic policy model needs to take note of explaining these movements to make it best suited for India. This is done subsequently in the CGE models.

In India, the macroeconomic modelling has also been analysed within the framework of CGE model. This model combines the features of the input-output framework and the static econometric models to provide an analytical frame for economy-wide analysis. In CGE models one does not necessarily estimate all the parameters, unlike in econometric models, but one only numerically calculates some of the parameters of the model. That is, at a given point in time the researcher can assume a set of parameter values for the model and describe an equilibrium, and then he can keep altering these parameter values until the model can track adequately the observed values of the variables. As the data



points are assumed to be in an equilibrium configuration, CGE models have tended to be very Walrasian or Neoclassical in nature (McMahon, 1989).

CGE models were developed for India at a time when the policy maker's focus shifted to poverty alleviation and income distributional aspects. Initial attempts to develop CGE models for India were made in the late 1970s at the International Institute for Applied Systems Analysis (IIASA) and in the early 1980s at the National Council of Applied Economic Research (NCAER). The first model developed at IIASA has been by Parikh and Narayana (1981). The model is a static sequential applied GEM to carry out food policy analysis. It permits adequate accounting of the macroeconomic feedback of various government policies and permits assessment of impact on growth and distribution of income in the context of open economy of India. These models were intended to provide results for 'counterfactual' analysis and 'forecasts' for the major macro variables. They have relied heavily on balance equation specifications in the economy and exogeneity of many variables. One of the major uses of this type of model can be in tracing the macro sensitivities of different short term policy instruments in explaining short term inflation and growth. These models follow the SAM-based approach and are static one-period models with mark-up pricing for many non-agricultural variables and usually a fixed supply assumption for agriculture. There are several CGE models that have been built for India. These models involve simultaneous clearance of several markets and estimation of equilibrium output and price levels. Equilibrium in several markets is obtained by adjusting the corresponding prices in each market till total demand equals total supply. The model of Narayana, Parikh, and Srinivasan (1991) is the first published walrasian general equilibrium model of the

Indian economy designed to evaluate government policies. The model is with no money in the system and only relative prices matter. The allocation of aggregate investment between agriculture and non-agriculture is not explicitly dynamic in this model. The model is then used to examine the following policies respectively: public distribution, foreign trade and aid, rural works programs, agriculture-industry terms of trade, fertiliser subsidy, and irrigation development. All these models emphasise growth with equity, but no focus on short-run dynamics which is important for an economy undergoing macroeconomic adjustment.

### **3.2.2 MACROECONOMETRIC MODELS**

Econometric models should play an important role in analyzing the interlinkages in the economy in a dynamic setup. Despite an early start, macroeconomic model building in India, on the whole, did not record much success compared to the successes achieved in the case of DCs. Of course, there was no clear-cut theoretical paradigm to describe the development process. Nonetheless, the empirical investigations were carried out mainly by individual researchers with limited resources. Teamwork involving model-builders from different institutions was not emphasised in India. Such team work was confined to single institutions such as Reserve Bank of India (RBI), Perspective Planning Division (PPD) of Planning Commission, and Delhi School of Economics (DSE). This may be contrasted with the research programs in USA supported by National Science Foundation (NSF) and Brookings Institution, and in UK by Economic and Social Research Council (ESRC), where econometricians from different institutions are brought together to compare and build econometric models (Wallis, 1993).

### 3.2.2.1 Theoretical Difficulties in Building Macroeconometric Models for India

The reason for the poor progress in econometric modelling in India may be due to a lack of clear theoretical framework suitable to model the development process. Most of the macroeconometric models of the earlier vintage for the Indian economy have tended to profess allegiance to one theoretical stream, largely Keynesian, which assumes that in the short-run it is only demand that constrains the economy. The starting point of Keynesian theory is the 'principle of effective demand' and any policy that can stimulate the aggregate spending or the effective demand would prove effective. The Keynesian theory relies more on using fiscal and monetary policy for bringing about desirable changes in the effective demand. The introduction of partial adjustment, or adaptive expectation into a Keynesian type of model through lagged endogenous variables makes it a short-run disequilibrium adjustment model.

There was a strong current of arguments questioning the appropriateness of Keynesian theory for the DEs. This criticism of relevance of wholesale application of Keynesian theory to India was initiated by Rao (1952). The main point in Rao's argument is that in the supply constrained economies of developing countries the multiplier effect of increasing effective demand through an increase in government expenditure would tend to work itself out more through raising prices than by increasing employment and output. Rao does not find evidence of the existence of excess capacity and is of the opinion that as demand increases and producers do not respond by increasing the supply, particularly in the agricultural sector. Many suppliers are not materialistically oriented and the multiplier works more on the income than on the output, i.e., income

rises more in the nominal sense than in the real sense. A lot of income increase is dissipated in increase in imports and building cash balances.

However, it should be kept in mind that now-a-days many developing countries are also having excess capacity in some manufacturing industries. Producers in these developing countries have started complaining about "recession". They have become materialistically oriented and do have positive responses to price stimuli, though in many cases the oligopolies and monopolies try to make more money by raising prices than by increasing production. However, the cause for this excess capacity may not necessarily be insufficient demand. It could be due to suppliers creating an artificial scarcity utilising the industrial licensing system and due to constraints on credit and infrastructure both of them being controlled by the state. Such excess capacity is also allowed to persist along with high prices as a result of import restrictions and administered prices which are sometimes set higher than the world prices.

The debate on relevance of Keynesian perspective in a DE was carried out by many scholars later. Chakravarty (1979b), for instance, argued that in the process of development the DEs are likely to have diminishing returns in agriculture while one can assume at least constant returns to scale in industrial sector. Such a situation is likely to turn the terms of trade between agriculture and industry against industry. As a result agricultural prices would go up, money wages remaining constant, the proportion of wage income spent on food rises, leading to erosion in the residual purchasing power. Such a development is likely to cause under-utilization of capacity in industry because of shortage of demand for its products. If there are increasing returns to scale in the

industrial sector as a result of R & D and technological progress then money wages will not remain constant. Money wages will then grow offsetting the increase in food bill. Demand for non-wage goods can then grow through increasing returns to scale in industry. This is however prevented by legislations such as MRTP. This is one explanation given for structural retrogression in the Indian economy in late sixties (for detailed explanations on structural retrogression see Shetty, 1978).

According to Dasgupta (1987), it is resources constraint rather than demand deficiency to which one would have to turn for an explanation of mass unemployment and under-employment in an under-developed country. In India too, there is hardly any evidence for a general deficiency in aggregate demand. It is often argued in support of the demand deficiency hypothesis that many of Indian industries have been running at less than full capacity. But excess capacity in the industrial sector has to be explained not in terms of demand deficiency, but in terms of market imperfection - monopolistic competition or simply oligopoly, often reinforced by shortage of raw materials. The remedy here lies not in the creation of additional demand through money financing but through removal of unhealthy market imperfections in the economy.

The debate leads to a consensus that there is no single approach (Keynesian or otherwise) that fits LDCs, but there are situations in which Keynesian type is appropriate in DEs as well. The prudent way of dealing with such problems would be to apply Keynesian solutions only at right points and times as Raj (1952) pointed out in his comment over Rao's contention. Klein (1965) also favoured application of Keynesian tools to the industrial sector of some moderately industrialised countries like

India. Industrial sector of such economies is likely to respond positively to an autonomous rise in investment and is thus likely to be supply elastic. This suggests that an eclectic approach for modelling the Indian economy would be more appropriate.

Since there are alternative economic theories and theoretical systems, the primary goal of modelling is that of knowing which hypothesis or which sets of hypotheses help us to understand the reality best. Classical approach assumed a given level of income, output and employment and by virtue of Say's law focused myopically on the determination of the level and rate of change of prices. According to the Classical dichotomy, relative prices are determined by the real forces of demand and supply, and the absolute price level is determined by the quantity and velocity of money. A major controversy in monetary economics is about the role of real and monetary variables with prime importance to monetary factors. The monetarist hypothesis is based on two assumptions: first, the demand for money is a stable function of disposable income alone; and second, the supply of money is exogenous. The variations in the money supply affect the rate of inflation and the consequential change in relative prices affects the allocation of resources. The Neo-classical economists assert that real income is determined by real factors like productivity, technical change, population growth and thrift.

The structuralist perspective, one of the major developments in theoretical research during the sixties, revitalized macroeconomic modelling effort in the DEs. Structuralists have maintained that, the economic models based on monetarist and fiscalist version of macroeconomics were appropriate to study the short-run fluctuations under demand constraint, and that they are not applicable to DEs. It is argued that DEs

are quite complex and their functioning is severely limited by specific and durable structural features of their economies such as scarce capital and abundant labour. As such they are supply constrained in many markets and demand constrained only in very few markets. The demand constraints operate in these DEs through adverse income distribution. Yet, only recently have serious attempts been made to formalize and test structuralist hypotheses about development in DEs. In fact, recent articulation of the structuralist position (Taylor, 1983) seems to be more reasonable and even capable of generating several alternative scenarios for DEs.

It may be noted that most of the discussion was based more on one's impression of how the Indian economy functioned than on a detailed empirical statistical analysis of the Indian economy. One must, however, mention here some studies such as attempts by Ahluwalia (1979), Krishnamurty (1984), Pandit (1984), and Bhattacharya (1984) who introduced planned government investment expenditure as a determinant of investment and output in the private manufacturing. However, these studies introduce public investment as a component of total investment within a static Keynesian framework whereas it was the intention of the planning process to use such investment to stimulate long-term growth. The impression one gets is that there is a lot more scope to integrate institutional and planning considerations into macroeconomic models to make them much more specific to suit the Indian economic environment.

### **3.2.2.2 Specific Components of Macroeconomic Models:**

Here we present a brief blueprint of the existing macroeconomic models of the Indian economy looking at some components which we would be dealing with in subsequent

chapters. Most models are basically the Tinbergen-Klein type of models which are explicitly Keynesian in their basic framework.<sup>4</sup> The models prior to 1970 have been extensively surveyed by Desai (1973). They are typically Keynesian except Agarwala's (1970) model, which is based on Lewis' (1954) two-sector growth model with feedback from agriculture to industry. The earliest econometric work, which dates back to the fifties, was a short-term economic policy model for India by Narasimham (1956). From early seventies onwards more serious efforts were made with focus on macro economic policy. Out of the models of the seventies, only the models of Gupta and Ahluwalia are policy-oriented whereas others are explanatory and to some extent forecast-oriented in nature. The models upto the late seventies have been reviewed by Krishnamurty and Pandit (1984).

One specific feature that runs through most of the models developed in late seventies and early eighties is that they incorporated certain structural characteristics of the Indian economy by specifying the relation between public and private investment, and by treating public investment as an exogenous variable determined by the planning process. Most of these models are structural models of the Cowles Commission variety that employed time-series ignoring the fact that these time-series are non-stationary. For most of the models in the seventies and eighties, the sample was very small and the time period overlapped in these models. The data generating mechanism is dynamic and structural while the paradigm chosen was mostly static and Keynesian. Even when the

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<sup>4</sup> For a review of how the supply constraints have been ignored in macroeconomic models of the Indian economy, see Desai (1973).



models tried to incorporate the supply side through production functions such attempts did not adequately reflect the supply response to institutional policy interventions.

### **Production Function**

Most of the models showed remarkable structural similarities with minor differences in the treatment of the production function. Aggregate supply can be looked at through a production function. Most of the models that are constructed in the later period (particularly after 1979) realised the need to incorporate supply constraints, which can be specified either in terms of a Neoclassical production function or in the form of a classical production structure with a fixed ICOR, or in the form of a price equation which is often specified in such a way that the price of output equals the cost of the inputs plus a mark-up. In Agarwala's (1970) model, output in the agricultural sector depends upon the lagged capital stock in agriculture and the rainfall. The food-grain production in agriculture determines the employment in the manufacturing sector, which in turn along with lagged capital stock determine the output of the manufacturing sector. Mammen (1973) is exclusively Keynesian, in the sense that he specified no production function.

Ahluwalia's (1979) model takes into account both aggregate expenditure and the supply constraints in the form of availability of food-grains. The main supply constraints are taken as those arising from agriculture and foreign sectors, which are incorporated into the performance of manufacturing sector. In Krishnamurty (1984), production in agriculture is mainly weather determined, the other factors being land and capital. The output of industry is determined by capital, labour, infrastructure, imported raw

materials and intermediate goods, and agricultural raw materials. The production function is of a neo-classical type admitting substitution possibilities. The assumption that agricultural production is mainly weather determined, has to be modified, as it also depends on public investment in irrigation. In Pandit (1984), agriculture sector provides the crucial supply constraint. Given certain output from agricultural sector the main adjustment mechanism studied is outside the agricultural sector in terms of savings investment equilibrium and the demand in the non-agricultural sector.

In Pani (1984) the agricultural production functions are specified separately for food grains and non-food grains. Production in manufacturing is specified separately for registered and unregistered (small scale) manufacturing. Production in registered manufacturing sector is specified as a function of capital stock and capacity utilization. The capacity utilization again depends on government investment expenditure and real domestic expenditure. The output in the unregistered manufacturing sector is taken as function of capital stock in that sector and the output in the registered manufacturing industry, the later standing as a proxy for both supply and demand factors. The output in other services is obtained as residual, equated to aggregated demand in the economy less the income generated in rest of the sectors. In Bhattacharya (1984), the production function in manufacturing sector is of standard Neoclassical variety depending on capital stock and employment with only a minor modification, i.e., output is dynamically related to capital stock instead of a single one period relationship. However, the most important investigation that is required under the newly emerging policy environment is how does the production sector respond to the new policy

environment in terms of working capital constraint and human capital as a factor of production following the Neoclassical model with endogenous growth.

### **Investment Function**

Many existing models have explicit investment equations with lags, but there is rarely any theoretical discussion on the underlying growth mechanism. In Agarwala's (1970) model, investment function is specified separately for government and private sector with private investment function for agriculture and non-agriculture. Private investment depends upon profit level which is made to depend upon non-agricultural output. The government investment depends upon the targeted and realised income. The investment functions in Agarwala's model are not dynamic because they do not involve lagged variables, leave alone the accelerator relationship. Marwah (1972) included investment as a function of income with a Koyck distributed lag and interest rate, and found a positive interest elasticity of investment expenditure. In Ahluwalia's (1979) model, government's gross investment was made to determine the capacity utilisation of the manufacturing sector.

Krishnamurty (1984) has taken the government investment for development purpose as the main growth-inducing factor. He identifies the links between public sector and private sector investment to trace complementarity and crowding out effects of public investment. Private investment in agriculture is influenced by the relative price of agriculture vis-a-vis the rest of the economy (reflecting profitability), resource availability represented by real income originating in agriculture, and by public investment. The private investment in industry is influenced by non-wage income of the

industry, aggregate public expenditure (representing the complementarity or crowding-in), and total savings in the economy less public and private investment in agriculture (representing crowding out effect). The private investment in the tertiary sector is determined as a residual. Pandit (1984) studies the behaviour of savings and investment of the economy by constructing equations for savings and investment at a disaggregated level of (1) household sector, (2) corporate sector and (3) government sector. The investment is a driving force in the model of Pandit (1984). The households' investment is related to household savings. But the investments in the corporate sector and agriculture are determined by investment demand equations.

In Pani's (1984) model, three investment functions are specified. One is for the private investment in agriculture, depending on net domestic output in agriculture. The second one is for total investment in other services sector (private plus government) which depends on the total output in agriculture, output in manufacturing and output in transport and communication sectors. And the third is for private investment in manufacturing sector, which is a function of total investment in government sector, lagged capital stock in manufacturing sector and the net domestic product at factor cost. Bhattacharya (1984) treats the allocation of public investment to each sector as well as total public investment as exogenously determined by the Five Year Plans. The private investment is influenced by income, interest rate and credit.

In most of these models the investment function specifications appear somewhat ad-hoc as models seemed to have ignored constraints on growth of investment due to certain gaps such as inadequate domestic saving, scarcity of imported capital goods and

imported intermediate goods, scarcity of foreign exchange reserves, inability of the government to increase public investment, industrial licensing and other governmental regulations etc. These specifications of the investment function considered public sector as a stimulant to the overall economic growth and recognised the fact that the government can mop up private savings for public investment through financial intermediation and monetary policy (interest policy, credit policy, SLR, and CRR etc.).<sup>5</sup> The impact of these interventions by the government on efficient functioning of the capital market had escaped the attention of the macroeconomic modellers. There is now therefore a need to relate the investment function to other related variables of the financial sector.

### **Price Function**

The supply constraints can also be specified in the form of price equations. Narasimham's (1956) price behaviour equations were on the lines of Tinbergen's model for UK and USA. General price level, which is weighted average of agricultural and non-agricultural prices, is determined by the money supply. The mechanism of price adjustment is as follows: the agricultural prices affect the cost of living, which in turn affect wage rate in the manufacturing sector. The wage rate, in turn, changes the employment in manufacturing sector which gives rise to changes in manufacturing prices. The manufacturing prices in turn affect the non-agricultural prices. This

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<sup>5</sup> Reserve requirements are the most important instruments of monetary policy. They consist of two different ratios which the banks have to observe - the cash reserve ratio (CRR) and the statutory liquidity ratio (SLR), (see Joshi and Little (1994) for details on the regulation of the financial system, financial deepening and the flow of funds).

mechanism on the whole depicts how the agricultural and non-agricultural prices adjust to each other, given the general price level.

Marwah (1972) models price behaviour in terms of excess demand and a quantity theoretic explanation. In other words, one is a disequilibrium adjustment model and the other is an equilibrium model of quantity theory type. In Mammen's (1973) model, price level is explained alternatively by the exogenous price level in the agricultural sector via wages and by a wage-cost mark-up equation. In Ahluwalia (1979), the relative price of food-grains are made to depend on the marketed surplus of food-grains in terms of manufactures. The absolute level of prices is determined in the money market through equilibrating the demand for money with the supply of money. In Pani (1984), commodity prices are determined by money stock in circulation apart from their demand and supply conditions.

In Krishnamurty (1984), the supply constraint arising from the agriculture sector, and money supply created mainly through money financing of the government, are taken as inflation inducing factors. Industrial prices are cost-determined through mark-up mechanism. He assumes that the price level of the tertiary sector is determined as a residual between the overall (quantity theory) price level and the sectoral price equations. The adjustment mechanism of Pandit (1984) allows working capital costs to affect the price formation in manufacturing. Pandit (1985) also emphasised the role of costs in price movements. Krishnamurty, Pandit and Sharma (1989) find a significant effect of import prices on prices of capital goods.<sup>6</sup> Balakrishnan (1991) provides an

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<sup>6</sup> An adjustment of exchange rate has an immediate impact on domestic price level, which is normally captured through the import prices in a price equation.

anatomy of the inflationary process within the Structuralist framework for India over the period 1950 to 1980. He departs from the earlier tradition of using the Cowles Commission's approach by using the cointegration and error correction (CEC) model that is eminently suited to model business cycles with long-run trends and short-run cycles. He shows that Indian inflation is crucially dependent upon the pattern of wage and price determination with agricultural (industrial) prices responding to changes in demand (costs). He establishes the existence of a long-run equilibrium relationship between prices and costs indicating that prices are cost-determined through the existence of an error-correcting response to any short-run dynamic inconsistency between prices and costs. The major concern of Balakrishnan (1991) is to explain the inflationary approach and the institutional environment affecting food prices, particularly the public distribution system and the price support program. It concludes that, during the 1950-65 period, the relative higher growth rate of the manufacturing sector was responsible for the terms of trade between agriculture and industry moving in favour of agriculture, while during 1965-80 terms of trade went in favour of industries. The government's policy of fixing the procurement prices of foodgrains was largely responsible for the inflationary pressure. But, procurement being only about ten percent, inflation could not have been caused entirely due to this, instead the excess demand for industrial products would have contributed substantially to inflationary pressures. He compares the explanatory power of the model based on the structuralist framework with that of a simple version of a model based on the monetarist framework and finds that the statistical evidence is in favour of the former. This is so because of excess demand which causes inflation. It also considers the determination of prices and wage rates in the manufacturing sector. The estimates show that a "cost-plus" price equation for

industry<sup>7</sup> is statistically well determined and that the mark up is seen to be counter cyclical.

### **Fiscal Sector**

The specification of the functioning of the fiscal system, i.e., the role of Government, is very important in any model for a DE. Most of the models in the sixties treated government expenditure and investment as exogenous (see Desai, 1973), whereas Gupta (1973) had a government budget constraint as an integral part of the model. The main features of Krishnamurty's (1984) model include (i) the role of public expenditure particularly on infrastructure (ii) endogenising public revenue and expenditure by linking them to inflation. Pandit's (1984) model is intended to study the growth and inflation trade-off in terms of interrelationships between public sector investment, budgetary constraints and money finance. In addition to this, Madhur, Nayak, and Roy (1982) tries to find out overall budgetary deficit by taking the receipts and expenditure of the government sector as a whole. Bhattacharya (1984) focuses on the macro economic implications of public expenditure, particularly the relation between (i) inflation and growth, (ii) public expenditure and money financing, (iii) money supply and inflation, (iv) government budget constraints and resource mobilisation, (v) savings and investment, (vi) sectoral resource allocation and sectoral growth, (vii) foreign trade and capital flows. The special feature of the model is that it shows how various government budgetary instruments and policies are interdependent and how they

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<sup>7</sup> Cost-plus pricing in industrial markets implies that increased labour costs are passed on in full, because the mark-up is assumed to remain constant. producer prices are generally fixed on a cost-plus basis. A cost-plus pricing rule may be represented by the expression  $P_i = (1+g)C$ , where  $P_i$  is a measure of final product price in manufacturing,  $C$ , a measure of industrial costs and  $g$ , the proportional mark-up over costs.



constrain each other. On the whole, in models by Krishnamurty (1984), Pandit (1984) and Bhattacharya (1984) there is an explicit recognition of government operations on both growth and inflation in the economy. For developing a model to examine structural adjustment policies (SAP) one must have a detailed fiscal structure. Further, there is a need to separate the current account and capital account. While examining government expenditure we need to see how much of it is for investment and how much on current expenditure. This type of focus on capital and revenue expenditures of the government are important to examine rigorously the intergenerational transfers of benefits and costs of government operations. There is thus a need to respecify the fiscal sector of the macro economy, which is attempted in Chapter 5.

### **Monetary Sector**

So far as money market in India is concerned, there are lot of variations in different models. In India monetary and fiscal policies are interlinked. The analysis of monetary policy in India ultimately boils down to the analysis of budget deficits and money supply and their effect on the price levels and growth. In Madhur, Nayak, and Roy (1982) study, the monetary sector is modelled within the overall framework of the money-multiplier theory of money stock determination. More specifically, the multiplier values of the stock of broad money and aggregate deposits depend on three asset ratios: the currency to deposit ratio of the public, the reserve to deposit ratio of banks, and the borrowings (from the RBI) to deposit ratio of banks. In Pani (1984), money supply is endogenously determined by the link to the government deficit, which in turn is determined endogenously. In Krishnamurty (1984) and Pandit (1984), feedback mechanisms have been introduced between the real and monetary sectors. The money

supply is endogenous and is related to the budget-deficit through the monetary base. Krishnamurty (1984) has a discussion of the two-way relationship between budget deficit and inflation via money supply. The money supply variable represents the overall excess demand situation in the price equations of both Krishnamurty (1984) and Pandit (1984). Chakrabarty (1987) shows that the non-monetised method of financing the public investment provides the double benefits of real output growth and lower prices. This supports the recommendations of the Chakravarty Committee on the monetary reforms in India. It also advocates liberalisation of the interest rate as well as the exchange rate policies for the Indian economy. Budget deficit certainly increases money supply and thereby price level, however, reductions in the budget may lead to reductions in planned investment expenditures (as it is difficult if not impossible to reduce public consumption expenditures without reducing subsidies which can be politically unrealistic) and future growth of GDP thus creating pressure on price levels. We have made an effort to bring about this distinction explicit in chapter 5.

Balakrishnan (1991) discusses the relevance of the interest elasticity of the demand for money to issues in monetary policy and the nature of the money supply process in India.

He finds that the demand for money is interest elastic and that the money supply is endogenous. He reports very little contemporaneous correlation between change in money supply and change in price level, which is in contrast with the entire gamut of literature on money-price causal nexus in India. Such radically different results that Balakrishnan (1991) obtains, are precisely due to the dynamic nature of the model he chose within a structuralist framework and due to the differences in the two statistical methodologies. Balakrishnan uses the CEC modelling methodology while the earlier

models employ structural modelling with non-stationary time series that could generate spurious correlation and misleading inferences.

The monetary sector is weak in most of the models. The demand for money is influenced by the saving behaviour and the alternative forms of saving. The financial sector as a whole is not modelled by any of the existing models. The relative effectiveness of different monetary policy instruments such as CRR, SLR, the bank rate, exchange rate control, controlling money supply etc. depend on the so-called transmission mechanism that depicts the complex interdependence between these instruments and the demand and supply of alternate financial assets. In the newly emerging policy environment it is necessary to understand clearly this transmission mechanism, which is attempted in chapter 8.

### **External Sector**

The treatment of foreign trade sector has also varied in different models. In Agarwala's (1970) model, the expenditure equation for imports, specified in real terms, determine the real value of income. In Ahluwalia (1979), the import constraint is included in both capacity utilization function and investment function of the manufacturing sector. However, the foreign trade sector has got a weak link in almost all the models. In Anjaneyulu (1993), the external block has been dealt in a more detailed fashion by covering relationships in respect of exports (including invisibles), imports (including invisibles), external debt, amortisation and interest payment expenditure in respect of external debt liabilities. Assuming that there are no supply constraints, exports are expected to be determined by the demand factors such as world gross domestic output

and real exchange rate (in a partial adjustment framework). The imports equation has also been postulated in a demand framework with gross domestic output and real exchange parity (in a partial adjustment framework). To analyse the impact of current account deficit on external debt, change in external debt has been related to current account deficit. To have some idea about debt servicing, amortisation payments and interest payment on external debt have been related to the level of external debt.

Indian exports are more or less stagnant in real terms and imports are subject to a constraint which equals a constant export earning plus foreign debt. Engineering goods exports have received a set back in the eighties (see Swaminathan, 1993). In a structural adjustment model with emphasis on globalisation of the economy through export-led growth it is essential to model this sector by incorporating export and import functions in greater detail with what should be the appropriate level of devaluation, which is executed in chapter 6.

### **3.2.3 CONTROL-THEORETIC MODELS**

One of the basic problems of economics has been to choose between various alternative strategies that are available, so as to regulate or control the economy. Hence, a major emphasis of recent quantitative economic research has been to develop methodologies to determine the policy instruments for attaining the desired performance of economic systems. It is in this context that we can bring in the control theoretic approach, which has an important contribution to make in the macroeconomic policy determination. A beginning in this direction was made in the fifties by Tinbergen (1952), who developed

only a static theory of quantitative economic policy. Theil (1958) generalised Tinbergen's approach to dynamic economic policy models by applying the mathematical theory of optimal control. Chow (1975) deals with statistical and empirical applications of control theory to dynamic economic policy models. The use of modern control theoretic approach along with various dynamic economic models provides an operational procedure for solving for values of policy instrument variables to achieve desired objectives.

The policy aspects are invariably dichotomised and divorced from macroeconomic model specification and estimation in many of the macro models reviewed in the previous section. In these models, econometric relations are first specified and estimated, and then a policy objective function is grafted on to it to generate optimal economic policies. Employing control theoretic approach one can estimate the parameters of the model by taking into account the relative importance of the parameters for the policy objectives and by giving greater weightage to recent observations on which the future course depends. Like the control engineers economists can also combine model specification, sample selection, estimation and control as a single cybernetic problem.

Among the control models for macroeconomic policy making, the works of Rao (1984, 1987), Pethe (1987), and Singh (1993) are important, which are aimed at identification and estimation of control models for the Indian economy. Rao (1984) was the first one to apply control theory to derive optimal strategies for the Indian economy by critically evaluating the consistency approach of the Indian planning framework. It was mainly

intended to exhibit the novelty and usefulness of control theory in an economic policy environment. Rao (1987) established feedbacks between real, monetary and banking sectors, examined the links between taxes, deficits, money and prices, and analysed imports by relative prices. Moreover, two-gap model was used to relate real and external sectors. He has also constructed an econometric control system incorporating the Kalman filter technique into the plan framework for the Indian economy. Rao (1989) used feedback theory to determine an optimal savings rate as well as the trade-off between current and future consumption. Rao (1990) showed that even a moderate time-lag in the processing of information can convert a stable control system into an unstable one.

Pethe (1987) applies the concept of robust modeling to the Indian economy for identifying robust model and robust policy on the basis of welfare losses through constructing alternative model variants, in the light of the evidence that large macro-econometric models for DCs have not always produced accurate forecasts. The concept of robust modeling formalises the idea that given the complexity of the real world, policy makers/governments would go for safe bets, (minimizing the losses consequent upon a wrong choice of a model) rather than look for policy of fine tuning. In order to identify a robust model, one must have at least two reasonable and comparable macro-models, as candidates from which unambiguous choice of optimal policies can be extracted. After the identification of the robust model, the more convenient policy tool for a given model must be identified with the help of the impact multipliers in devising a more robust policy design. Singh (1992) evaluated the performance of alternative feedback (Tinbergen's, Theil's and Optimal Control theory) rules in order to determine

the most suitable one for controlling money supply as target variable through budget deficit and bank credit as policy instrument variables. Singh (1993) has examined the feedback between budget deficits, money supply and prices to determine the critical size of the deficit beyond which an inflationary spiral could be triggered off. This has been developed within a small (non-linear) macroeconomic model linking money supply, prices and output. The results of the control runs provide optimal level of real output, money supply and prices under different economic scenarios. Government development expenditure and tax rate have been selected as two control variables. Both these variables exert contractionary and expansionary impact on the target variables viz. output, prices and money supply. Thus, the model demonstrates the presence of a strong inflation-government expenditure trade-off, given the existing structural linkages in the economy. For evaluation of stabilisation and structural adjustment policies, optimal control approach is the most appropriate approach to obtain optimal policies within a dynamic economic environment given agreement on objective function, but the available control models for India are only of use when linearized econometric models are used.

### **3.3 A CRITICAL APPRAISAL**

This section gives a critical appraisal of plan and CGE models, macroeconomic models, optimal control models in our effort to understand the data generating process and to devise optimal policies that can change the future course of economic events. Plan models have econometric components to determine the final demands. Econometric models have plan outlays as exogenous variables. CGE models also use

estimated econometric equation and also use input-output tables such as those used in plan models. Control models use econometric models.

In recent macroeconomic modelling literature another major issue has attracted attention. Should we take the data as it comes ignoring economic theory and developing system theoretic control models, since the study of economics is a system-theoretic endeavour, or shall we take economic theory to set up the model (Moore, 1985). What seems to be needed is a framework that tries to understand the data generating mechanism of economics as a dynamic mechanism with trend (growth), cycles, seasonality and error. Most of the macroeconomic models reviewed here, with the exception of Balakrishnan (1991), take the data generated by a truly dynamic, self-regulating error-correcting system but postulate a model that is not truly dynamic and does not explain how the randomness or error enter into the model. There is a need therefore to model the economy as cointegrated error-correction system. Both cointegrated error correction models can be represented as VAR models with certain constraints on the parameters. Initial interest in VARs arose because of the inability of economists to agree on the economy's true structure and the inability of existing strategies for large scale macroeconomic modelling to produce accurate forecasts. Because of the large models' poor forecasting performance and in the absence of any knowledge about true relations, the use of the VAR type time series model of Sims (1980) has become a popular tool in empirical model building as an alternative to structural econometric models. Thus VAR models are allowed to reveal the dynamic structure, and allow to capture empirical regularities in the data and thereby providing insight into channels through which the different policy variables can act on target



variables. In principle, one would like to include all series which are likely to have important interdependencies. In practice, the limited size of existing data sets requires the use of small scale models. Hence the process of marginalisation, i.e., the joint probability density of the VAR, must be defined in the choice of variables with respect to some potentially relevant variables (Clements and Mizon, 1991).

Lucas (1976) questioned the appropriateness of using econometric models for policy simulation experiments by arguing that the structure of a model can be altered by the impact of expectations concerning the policy. Thus the problem of structural invariance and its relevance for policy analysis is the essence of what is called the Lucas critique of policy evaluation. In other words, even if a model is perfectly estimated and remarkably stable within the sample period, its structure may change once expectations concerning the policy become formulated. In fact, this point was recognised much earlier by Marschak (1953). What is even more important, the Lucas critique states that in such a case, when a policy experiment is performed, the parameters of the marginal process must change, and often in a way unexpected by the policy maker.

Macroeconomic models are formulated in recent years employing the concept of rational expectations. The rational expectations approach to macroeconomics attempts to build macroeconomics entirely on the microeconomic foundations of market clearing and optimization by economic agents who face an uncertain economic environment.

Expectations of variables are widely used in applied econometrics, since the optimizing behaviour of economic agents depends in part on their views of the future. Rational expectations is an equilibrium concept. They are those expectations, based on

information which is a common knowledge, such that if economic agents make their decisions based on them the future unfolds itself so as to fulfil those expectations. Expectations are called rational if they are based on the past history and all people with same information form the same expectations. But the assumption that expectations are rational which is often made in macroeconomic model building is seldom tested. It is often the case that lagged dependent variables are used as explanatory variables and as proxies for rational expectations. But the modeling effort in India has so far not examined the sensitivity of the properties of a macroeconomic model to the rational expectations hypothesis except Ghani (1991) which evaluates the role of rational expectations in price setting behaviour in India, and Rastogi (1994) in which expectations are invariably restricted to the prices. Ghani (1991) evaluates the role of rational expectations in price setting behaviour in India and that prices respond fully to anticipated changes in aggregate demand. Ghani has claimed that anticipated reductions in money growth in India result in contemporaneous reductions in price level, while unanticipated changes affect output. Balakrishnan (1993) provides evidence that is contrary to this claim, having employed rational expectations in price formation. The results suggest that the monetary authority in India cannot be certain of containing inflation solely by implementing a pre-announced reduction in the money growth rate. This result of Balakrishnan differs from the monetarist's view. Balakrishnan claims that his approach and his conclusions on the issue need to be taken seriously as he uses a different specification.

The Granger representation of a Vector Autoregressive Integrated Moving Average (VARIMA) process as a CEC model (Engle and Granger, 1987) provides a kind of

synthesis between structural models and atheoretic time series models. Most economic time series have a VARIMA representation. One must represent the data generating process (DGP) as a reduced form VAR model for cointegrating equations and error corrections for endogenous economic variables. These cointegrated equations are what Engle and Granger call as long run economic relations or attractors (Engle and Granger, 1991). The cointegrating equations are (there can be several of them) the structural equations. It then becomes necessary for estimation to place restrictions on the parameters. It is here that one can depend on the theory to set up exclusion restrictions. Co-integration and error correction models can serve both as confirmatory as well as exploratory multivariate time series models in economics. There is some discussion in recent years on the forecasting performance and on the reliability of policy simulations when one uses different types of models such as unrestricted VAR models, restricted VAR models (including Bayesian VAR models), and models of error correction mechanism (ECM) (Runkle, 1987).

Le Sage (1993) demonstrates that an ECM model with VAR has a better forecasting ability than a simple VAR model. One may also refer to Litterman (1986) for the usefulness of Bayesian VAR models for forecasting. Good Bayesian priors must come from a greater understanding of the underlying macroeconomic phenomena through a combination of macroeconomic theory of business cycles and a careful observation and analysis of patterns of temporal and intertemporal linkages between variables. It has also been observed recently that economic time series exhibit stochastic trends (Nelson and Plosser, 1982; and Stock and Watson, 1988). One should exercise caution in interpreting economic time-series as random walks with stochastic trends. Such a conclusion is

normally drawn on the basis of questionable unit-root tests which have poor power characteristics. Some of this recent literature also cautions that trends and cycles can not be separated (empirically) and that misspecification of trend can lead to misguided conclusions (Stock and Watson, 1989). Most of this literature is not backed by macroeconomic theory. One needs to explain, falling back on macroeconomic reasoning, why economic time-series exhibit stochastic trends.

The cointegration and error-correction models depend on two crucial foundations - a unit root test methodology and a linear relation between cointegrating economic series. It is well known that the unit root tests suffer from two shortcomings - the presence of nuisance parameters in the sampling distribution of the test-statistic and the low power for the tests. This latter aspect was also emphasised from a Bayesian perspective by Sims (1988). The usual practice in the cointegration and error-correction modeling has been to consider the economic variables either in their levels or in their logarithms or as some other simple transformations, specify a vector autoregressive model with error-correction, and with cointegrating restrictions which are linear. Dynamic economic theory and vector-autoregression with error correction provide the necessary synthesis for an appropriate modelling of the time series.

### **3.4 CONCLUSION**

This chapter has evaluated the analytical aspects of various macroeconomic models that are built so far in the Indian context, rather than falling in the usual practice of giving more emphasis to the statistical and computational aspects of the same. It has been noted

that the traditional macroeconomic models based on time-series data assume that the underlying time-series is stationary. In recent years, macroeconomic model building has come under severe criticism from knowledgeable observers. Hendry (1980) raises the question of whether applied econometrics is closer to 'alchemy' than to 'science', while Leamer (1983) suggests, 'Let's take the "con" out of econometrics'. Sims (1980) suggested that current macroeconomic models are badly under-identified and that the VAR methodology be used as an alternative to the large scale macroeconomic models. One of the major advantages of policy analyses conducted with VAR is the endogeneity of many policy instruments (for a comparison of these three econometric methodologies, see Pagan, 1987). Nevertheless, a number of critiques have been raised to the VAR methodology. Existing criticisms of VAR models have placed much emphasis on the transformations undertaken to yield causal chains (Cooley and LeRoy, 1985). However, other objections have also been levelled at different stages of the analysis (for details see Canova, 1995). The debate over appropriate research methods continues.

Even though the prime objective of this review is to focus on economic aspects of macro models, to overcome some of the theoretical problems raised in this chapter one has to go in for a better choice of econometric technique. Since most of the existing macroeconomic models of India include the possibility of obtaining spurious or dubious results, the important issue which needs to be highlighted here is the question of policy formulation and evaluation when structural and institutional changes take place, as is currently happening in India. This is rather difficult to deal with in terms of

the traditional modelling procedure. These structural econometric models that are built so far for India, seem to have failed in explaining and predicting short-term fluctuations even under an unchanging structure. Thus, in order to avoid the pitfalls of traditional econometric modelling, following Sims (1980) we can have a time series model of VAR type that is superior to other specifications, which can be used to meet policy makers' needs adequately.

One thing that comes out clearly from this review is that there are significant differences in approaches among the models, even with similar kind of objectives. Hence, an alternative approach to evaluate adjustment with growth, which of course has been ignored in all the earlier studies, should be the prime objective of the present study on econometric policy modelling. In view of the importance of modelling adjustment with growth, we intend to take a closer look at the current approach to macroeconomic adjustment in India in the next chapter using a model of stabilisation and growth developed at the International Monetary Fund.

## Chapter 4

# POLICY MODELS FOR GROWTH-ORIENTED ADJUSTMENT: AN ANALYTICAL CRITIQUE

### ABSTRACT

*In this chapter the theoretical framework of the IMF and the WB underlying the currently underway adjustment policies is described and the limitations of the analytic framework has been brought out.*

#### 4.1 Introduction

Macroeconomic stability and growth are the pressing problem for any policy framework. In the existing macroeconometric models of India as reviewed in the previous chapter, the aim has not been to follow a policy framework to examine the impact of stabilisation policies to bring inflation and BP deficit down on a sustainable basis. In this context, the Fund has played an important role in assisting developing countries in dealing with external disequilibria through its short-run stabilisation programs based primarily on monetary approach to BOP problem with flexible and controllable exchange rate. The Bank focuses on higher real growth and standard of living in the medium and long-term based on a variant of the two-gap growth model (Revised Minimum Standard Model) which deals with the interactions between 'savings constraint' and the 'foreign exchange constraint' in the determination of the growth rate of a developing country.

Many countries have undertaken adjustment programs which are invariably of a type in which short-run imbalances in savings and investments, or imports and exports, or government expenditure and revenue are corrected without paying any attention to the

long-term growth aspects. Hence this chapter aims at describing the analytics of inflation, BOP and growth within the Fund-Bank framework. The questions addressed therefore are:

- What body of economic theory forms the basis for designing adjustment programs by the Fund and the Bank in support of their lending activities directed principally at strengthening the BOP?
- What is the empirical and other apriori support for the underlying analytic framework?
- What are the limitations of the analytic approach and in what ways should it be modified?

In formulating a growth-oriented adjustment program which has three objectives such as treatment of economic growth, BOP improvement and price stability, the idea is to determine a set of demand management policies (domestic credit ceilings and reductions in the fiscal deficit), exchange rate policies, structural policies (policies to increase savings and the level and efficiency of investment), and external financing policies that would achieve these targets. The model presented in this chapter draws on Khan and Montiel (1989) and Khan, Montiel and Haque (1990) which contains a price-output sector, a monetary sector, and an external sector that together determine growth, inflation and the BOP. In section 4.2 we critically examine the model properties and in section 4.3 we show the way it could be modified to formulate a behavioural model with more economic structure. The last section sums up.



## 4.2 THE MODEL

The Fund's approach to economic stabilisation is based on an analytical framework known as "Financial Programming" (FP) that links the monetary sector with the balance of payments (IMF, 1987). The analytical foundation underpinning financial programming has come to be known in the literature as 'the monetary approach to BoP'.<sup>1</sup> Domestic credit ceilings and changes in the exchange rates are the key policy instruments which the financial program uses to achieve the desired targets. Polak's (1957) model forms the cornerstone of most Fund programs, and highlights the functioning of the central bank by way of credit expansion in the economy. In the ultimate analysis Polak concludes that credit expansion is the cause of balance of payments disequilibria. Broadly defined, a financial (or stabilisation) program is a package of policies designed to eliminate disequilibrium between aggregate demand and supply in the economy, which typically manifests itself in BOP deficits which are met through borrowing from abroad and through excessive money supply, the latter resulting in inflation. In other words, the analytical framework of the Fund essentially focuses on correcting short term imbalances by aiming at a desired BP outcome, and a desired rate of inflation.<sup>2</sup> The theoretical core of the model can be outlined as follows:

### **Assumptions of the Model:**

1. A small open economy has been assumed that maintains a fixed exchange rate.
2. The model assumes continuous equilibrium because all adjustments take place in one period, but it is specified in discrete time.
3. Private sector is assumed to own all factors of production

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<sup>1</sup> See especially IMF (1987) for a comprehensive description and assessment of the financial programming framework that underlies Fund adjustment programs.

<sup>2</sup> Many original articles using the monetary approach are collected in IMF (1977).

## The Macroeconomic Framework:

The private sector's budget constraint is:  $Y - T - C - S_p \equiv 0$  [4.1]

The private sector savings are devoted to:  $S_p \equiv P_D dk + dM^d - dDC_p$ <sup>3</sup> [4.2]

The budget constraint for the government is:  $edF + dDC_g \equiv G + ieF - T - T_B$  [4.3]

The supply of money, on the other hand, comes from the banking system's balance

sheet as  $dM^s \equiv e_0 dR + dDC$  [4.4] and,  $dDC = dDC_g + dDC_p$  [4.5]

The portion of the central bank's profits that is transferred to the government is given by

$$T_B = ieR \quad [4.6]$$

The gross national product (GNP) is given by

$$\tilde{Y} = Y - ie(F - R) \quad [4.7]$$

Given these budget constraints, balance-sheet relationships, and definitions, we can proceed to describe the analytical model. The following notations are used in the model.

### *Endogenous variables:*

$dy$ : change in real output (GDP),  $d\tilde{y}$ : change in real output (GNP),  $dP_D$ : change in the price of domestic output,  $dR$ : balance of payments in foreign currency.

### *Exogenous variables:*

$M^d$ : nominal demand for money;  $M^s$ : nominal supply of money,  $R$ : stock of international reserves of the monetary system expressed in foreign currency,  $dDC$ : change in domestic credit,  $dDC_p$ : change in domestic credit to the private sector,  $T$ : taxes;  $C$ : consumption;  $S_p$ : savings,  $dDC_g$ : change in domestic credit to the government sector,  $T_B$ : profits of the central bank;  $Y$ : nominal income,  $i$ : interest rate.  $e$ : nominal exchange rate expressed as units of domestic currency per unit of foreign currency,  $P_z$ : world price of imports expressed in foreign currency,  $X$ : exports in foreign currency,  $Z$ : imports in foreign currency,  $ieF$ : interest on foreign borrowing,

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<sup>3</sup> Here the symbol  $d$  is used to denote the change in a variable from the last period ( $y_0$ ) to the present ( $y$ ); that is,  $dy = \Delta y = y - y_0$  and so on.

$dF_g$  : change in net foreign assets of the private sector,  $dF_p$ : change in net foreign assets of the public sector,  $dk$ : change in private capital stock.

#### 4.2.1 THE MONETARY COMPONENT

The structure of all Fund programs is built on a framework that links the monetary sector with the balance of payments, which is generally referred to as 'financial programming' (IMF, 1987). The analytical foundation underpinning financial programming has come to be known in the literature as 'the monetary approach to BOPs'. This approach is particularly used to explain balance of payments disequilibria. Broadly defined, a financial (or stabilisation) program is a package of policies designed to eliminate disequilibrium between aggregate demand and supply in the economy, which typically manifests itself in BOPs deficits and inflation.

The first relationship is the flow supply of money that comes from the banking system's balance sheet as given by equation [4.4]:  $dM^s \equiv e_0 dR + dDC$

The second relationship defines the flow demand for money in which the Fund's assumption of exogenous income velocity has been retained:

$$dM^D = vPdy + vy_0 dP \quad [4.8]$$

The third key relationship in this model is the assumption of money market flow equilibrium, which holds continuously in the money market, so  $dM^d = dM^s$  [4.9]

The aggregate price level can be expressed as a weighted average of the price of importables ( $P_Z$ ) and the price of domestic output ( $P_D$ ), which is given by

$$dP = \theta dP_Z + (1 - \theta)dP_D \quad [4.10]$$

It's assumed here that  $\theta$  is constant and that  $e_0 = P_{Z0} = P_{D0} = 1$ , and that  $P_Z^* = 1$ , where  $P_Z$  is the price of foreign goods measured in foreign currency. Thus  $dP_Z = P_Z^* de = de$  [4.11]

#### 4.2.2 THE GROWTH COMPONENT

The Bank's approach is a variant of the two-gap growth model or a modified Harrod-Domar model of an open economy, defined as the Revised Minimum Standards Model (RMSM) by World Bank (Khan, Montiel, and Haque, 1990). The concern of RMSM is with medium-term growth and its financing through savings and foreign assistance. Assuming a historically or technologically given incremental capital-output ratio (ICOR), output can be a function of the level of investment. This relationship allows one to obtain either the growth of real GDP based on the available level of investment, or the required level of investment consistent with a desired rate of growth. Taking the neoclassical production function as the starting point, the growth of capacity has been assumed to be a linear function of real investment, treating the increases in the factor productivity and the size of the labour force as exogenous.

$$dy = \alpha_0 + \alpha_1 dk \quad [4.12]$$

The counterpart to equation [4.12] for GNP is given by

$$d\tilde{y} = dy - \frac{P_{D0} [ie(dF - dR) + i(F_0 - R_0)de] - ie_0(F_0 - R_0)dP_D}{P_{D0}P_D} \quad [4.13]$$

The second element in the simple growth model is the identity that relates aggregate investment to aggregate savings. Since real GDP growth is a target variable, the budget

constraint for the private sector can be used to derive an expression for investment, which could be written as

$$dk = s_p + \left[ t - g - ie \left( \frac{F - R}{P_D} \right) \right] + e \left[ \frac{dF - dR}{P_D} \right] \quad [4.14]$$

The third relationship in the model is that for private savings behaviour. The simplest way of representing this relationship is to make real private saving proportional to real private disposable income:  $s_p = s(y - t)$  [4.15]

### 4.2.3 THE MERGED MODEL

Despite the increased attention that macroeconomic adjustments in DEs has received during the past decade, no consensus has emerged on the appropriate analytical framework for the study of DE macroeconomic issues. The Fund and the Bank were using their respective models as one input into policy analysis. The 1980s witnessed increased collaboration between the Fund and the Bank in their conditional lending to DEs. It soon became clear that for stabilisation and adjustment purposes, the demand side and the supply side needed to be integrated into a consistent framework linking government policies and availability of foreign resources to targets, such as growth, inflation. In the simple Fund model, real output is essentially determined outside the system, whereas in the Bank model, Inflation is not determined because price is assumed as exogenously given, and monetary variables do not play any direct role. In sum, the Fund model is a short-run monetary stabilisation model involving short-run disequilibrium adjustment through price changes while the Bank model is a medium-

term neoclassical equilibrium growth model. But what we need is growth-oriented adjustment as growth cannot be sacrificed at the altar of adjustment. Khan and Montiel (1989) and Khan, Montiel and Haque (1990) attempted to integrate these two models in order to provide an eclectic policy model for developing economies. This is known as “growth-oriented adjustment” programs, which involves merging the Fund’s monetary model of BOPs with the Bank’s two-gap approach and analysing it by identifying the three gaps and establishing linkages between them and between the real and monetary sectors.

The additional relationship, i.e., external sector’s budget constraint, defines the balance

$$\text{of payments: } dR = X - Z - i(F - R) + dF \quad [4.16]$$

Defining the balance of trade deficit as  $B=Z-X$ , it has been assumed that the change in trade balance ( $dB=B-B_0$ ) is a function of changes in the real exchange rate and

$$\text{income: } B = B_0 - a \left( \frac{de - dP_D}{P_D} \right) + bdy \quad [4.17]$$

The framework outlined above can be summarized in the table below:

**Table 4.1: Structure of the Merged Framework**

Endogenous Variables	Exogenous and Predetermined Variables	Policy Instruments	Parameters
dy	$y_0$	t	$\alpha_0$
$d\tilde{y}$	F	e or de	$\alpha_1$
$P_D$ or $dP_D$	$R_0$	g	s
R or dR	$P_{D0}=P_{Z0}=e_0=1$	DC or dDC	v
	$B_0$	$DC_p$ or $dDC_p$	$\theta$
	dF		a
	i		b

Given the values of the seven behavioural parameters, the 13 equations of the model determine values for the 10 endogenous variables and 3 target variables conditional on the exogenous variables and policy instruments. Conversely, given chosen values for the target variables, two of the policy instruments can be chosen arbitrarily and the model will then determine values for the endogenous variables and the three remaining policy instruments.

The model can be solved by condensing it into three relationships between  $dy$ ,  $dP_D$  and  $dR$ . Substituting equation [4.15] in [4.14] and then the resultant in [4.12] yields an equation for the growth of output:

$$dy = (1 - s\alpha_1)^{-1} \cdot \left\{ \alpha_0 + \alpha_1 \left[ s(y_0 - t) + (t - g) + \frac{e[dF - dR - i(F - R)]}{P_{D0} + dP_D} \right] \right\} \quad [4.18]$$

Since  $\alpha_1 < 1$  and  $0 < s < 1$ , the  $(1 - s\alpha_1)^{-1}$  will be positive. This implies that if the trade balance is assumed to be in deficit, i.e.,  $[dF - dR - i(F - R)] > 0$ , an increase in  $dP_D$  will reduce  $dy$ , given  $dR$ . Next, substituting for the flow demand for money from [4.8] and the flow supply of money [4.4] into the equilibrium condition [4.9] and solving the resulting expression for the change in reserves using [4.10] and [4.11] yields

$$dR = vdy + vy_0\theta de + vy_0(1 - \theta)dP_D + v\theta dedy + v(1 - \theta)dP_D dy - dDC \quad [4.19]$$

Using equations [4.16] and [4.17], we can write the equation for  $dR$  as

$$dR = (dF - B_0) + a(e / P_D - 1) - bdy - i(F - R) \quad [4.20]$$

Now we can use [4.20] to eliminate  $dR$  from the growth equation [4.18]. The result is

$$dy = (1 - s\alpha_1 - \alpha_1 be / P_D)^{-1} \cdot \left( \alpha_0 + \alpha_1 \left\{ s(y_0 - t) + (t - g) + \frac{e}{P_D} [B_0 - a(e / P_D - 1)] \right\} \right)$$

[4.21].

Because  $F=F_0+dF$  and  $R=R_0+dR$ , equation [4.21] can be rewritten as

$$dR = (dF - B'_0) + a'(e / P_D - 1) - b'dy - i'(F_0 - R_0) \quad [4.21a]$$

Setting the balance of payments equation [4.21a] with reserve change equation [4.19], and assuming that the change in real output is exogenous, the monetary model can be solved for  $dR$  and  $dP_D$ . The model's solution for the change in the price of domestic output can be determined from

$$dP_D = \frac{[dF - B'_0 - i'(F_0 - R_0) + dDC] - (b' + v)dy - vy_0\theta de - v\theta dedy + a'(e / P_D - 1)}{v(1 - \theta)(y_0 + dy)}$$

[4.22]

These two expressions [4.21] and [4.22] can be solved simultaneously for  $dy$  and  $dP_D$  as functions of the exogenous and policy variables. This is the solution of the model in the 'positive' mode. Similarly, the solution of the model in the 'programming' mode would give the values for  $dDC$  and  $de$  conditional on targets  $dy^*$ ,  $dP_D^*$ , and  $dR^*$ .

To obtain an overall perspective on the properties of the merged model, the results obtained from the comparative-static experiments are summarized in Table 4.2. This table shows the signs of the impact effects that changes in the various policy instruments, behavioural parameters, and exogenous variables have on prices, real output, and the balance of payments.



**Table 4.2: Impact Effects of Changes in Instruments, Parameters, and Exogenous Variables**

Change (Increase) in:	Impact Effects on:		
	Domestic Prices ( $dP_D$ )	Real Output( $dy$ )	Balance of Payments ( $dR$ )
Domestic credit ( $dDC$ )	$> 0$	$> 0$	$< 0$
Exchange Rate ( $de$ )	$> 0$	$< 0$	$> 0$
Government spending( $dg$ )	$> 0$	$< 0$	?
Private Saving rate ( $ds$ )	$< 0$	$> 0$	?
Factor productivity ( $d\alpha_0$ )	$< 0$	$> 0$	?
Velocity of Money ( $dv$ )	$> 0$	$> 0$	$> 0$
Capital Inflows ( $dF$ )	$< 0$	$> 0$	?

The desired balance of payment level can be achieved through a curious mix of Keynesian and monetarist prescriptions. While in a closed economy, controlling government expenditure through reduction of fiscal deficit via reduction in central bank's credit to the government is a Keynesian-cum-monetarist prescription for containing (domestic) inflation, the exchange rate policy is the only monetarist prescription in an open economy to alter the balance of trade position which is a component of BOP. Fiscal deficit reduction is a demand management policy that reduces the level of inflation under a short-term constant supply situation.

### 4.3 A CRITICAL LOOK AT THE MODEL

The theoretical core of the Fund model can be summarised as follows:

$$y = \bar{y} \quad [4.3.1]$$

$$Y = P\bar{y} \quad [4.3.2]$$

$$P = (1 - \Theta)\bar{P}_d + \Theta \cdot E \cdot \bar{P}_z \quad [4.3.3]$$

$$M_d = \frac{1}{v} P\bar{y} \quad [4.3.4]$$

$$M_s = R + DC \quad [4.3.5]$$

$$DC = DC_g + DC_p \quad [4.3.6]$$

$$M_d = M_s = M \quad [4.3.7]$$

$$E.dF = E.dF_g + E.dF_p \quad [4.3.8]$$

$$S_g - I_g = dF_g - dDC_g \quad [4.3.9]$$

$$Z = m\bar{y} \quad [4.3.10]$$

$$E.dR = E\bar{X} - EP_z Z + E.dF \quad [4.3.11]$$

The analytical framework of the Bank model can be set out as follows:

$$y = C + I + X - Z \quad [4.3.12]$$

$$dy = dy^* \quad [4.3.13]$$

$$I = k dy^* \quad [4.3.14]$$

$$X = \bar{X} \quad [4.3.15]$$

$$Z = my \quad [4.3.16]$$

The Khan *et al* model does not take into consideration the fact that policy behaviour evolves over time. Hence one might extend this model by building more economic structure. The Khan *et. al.* merged model can be written in the following simple endogenised framework to understand the driving force behind the model.

$$y = f(k); \dot{k} = I = g(R); m = h(y, p); B = b(e, y).$$

From this it appears that exchange rate is the key variable affecting the trade balance thereby influencing the BoP, which has impact on investment and thereby growth. Domestic credit also influences balance of payments inversely in this model. Demand contraction based on credit restriction forms the core of the adjustment program for reducing or eliminating external deficits. But external deficits and an excess supply of goods may both result from a sudden reduction in export demand or increase in the import bill. Adding further demand contraction to this will improve the balance of payments, but at the cost of additional unemployment and reduction in output. The key result of this model could be interpreted in terms of monetary policy (domestic

credit) having positive impact on output and fiscal policy (government expenditure) having negative impact on output.

The combined Fund-Bank approach does not incorporate major macro features such as interest rate effects, price-wage determination. In this model inflation is a derived relationship and the model is silent about the plausible factors generating the inflationary pressures in the economy. While inflation control is a leading objective of the adjustment programs, yet the model lacks a proper theory of inflation. The behavioural equations in this model are primarily based on very ad-hoc rules of thumb, which do not have wide appeal for a number of reasons. Money is the only financial asset in the model. By excluding the interest rate the model leaves out a potentially important channel through which monetary policy could affect the economy, as well as an important policy instrument to change savings and thus output. The model assumes away any role for the public sector in the generation of national output and investment. So in effect structural adjustment means abolition of public sector and to introduce a complete capitalistic economy. There is no guarantee that this experiment can bring any sustainable stability and growth for the DEs, in fact the performances of countries in Africa who are going through the adjustment program for more than a decade are far from success (Basu, 1995). What is therefore needed is a policy model that emphasizes the importance of public sector in generating basic infrastructure. The assumption that the private sector owns all factors of production is an unrealistic assumption for most DEs when government leads the way.

The major deficiency of the IMF model lies in its failure to link together fiscal and monetary policies. Such a linkage is essential particularly in a country in which the largest component of the monetary base or 'reserve money' is the government's borrowing from the Central Bank, including both treasury bills and dated securities held by the Bank. All things taken together, fiscal policy is only one of the many complex factors that determine increases in outputs and exports. Hence, in India, the question of monetary policy is largely subsumed in the fiscal policy, because the government's monetised deficit is the largest contributor to the growth of liquidity in the system (Datta, 1992; p.190). In other words, the fiscal policy as a very important adjustment instrument that has implications for monetary policy. Moreover, the institutional arrangements in India make it easier to coordinate fiscal and monetary policy. With such a strong linkage between the fiscal and monetary measures in an economy where the State plays a key role, adoption of monetary approach to stabilisation can create major adverse supply shocks.

The analytical approach of the merged model is still a simple highly aggregated and primitive theoretical paradigm. It is a fixed-target Tinbergen type model with a highly aggregative general growth model. More importantly, the original Fund view, by and large, ignored the existence of domestic structural problems and adverse external environments. Khan and Knight (1981) formulated a structural version of the monetary model, which makes inflation and output endogenous along with the balance of payments. While the Bank approach is captured through a highly aggregated growth model its detailed policy guidelines for structural adjustment are based on the

neoclassical theory of market mechanism. In particular, liberalisation of external trade has been accepted as a well-advertised Fund-Bank remedy.<sup>4</sup>

While it has been noted that (Khan and Knight, 1981) fluctuations in money play a relatively important role in accounting for inflation fluctuations, but an unimportant one for real output variations which holds for both actual and unanticipated changes in money, in the present model the monetary policy has a positive impact on output and it shows the superiority of monetary policy over fiscal and exchange rate policy which have negative impact on output growth. Hence in chapter 5 we would show how fiscal policy can have a positive impact on output growth in India.

Recently, Bacha (1990) and Taylor (1993b) have pointed out that the fiscal constraint as a possible third gap limiting the <sup>growth</sup> prospects of the DEs. An important feature of the three gap model is its treatment of capital formation. A burgeoning literature in the late 1980s emphasised that public and private investment are often complementary. One practical implication is that the government's infrastructure, public utility, and even manufacturing projects are likely to 'crowd in' investment by the private sector by making it more profitable, instead of crowding it out through the mechanism of higher government borrowing putting pressure on financial markets (Taylor, 1993b). However, in these models the money market is assumed to be in

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<sup>4</sup> It is interesting to observe that the Fund-Bank policies are based on the old neo-classical wisdom rather than the new wisdom which replaces the assumption of constant returns to scale. The "new international economics" literature [Krugman, 1990] suggests that "strategic trade policy" can provide more benefits to the home country than a free-trade policy.

equilibrium while its constituents, viz. savings-investment, current account, and government expenditure and revenue can be in disequilibrium, and whereas this is an improvement over the standard monetary models, it still does not contain a short run disequilibrium around a long run growth equilibrium in an open economy framework. Hence there is a need to integrate these type of models with the monetary models that we are talking about and point out what would be the optimal level of tight credit policy that would give rise to output growth in Chapter 8.

In most DEs, fiscal imbalances are partially or wholly financed by money creation. Any difference between total government expenditures ( $G$ ) and total government revenues ( $T$ ) representing the fiscal deficit must be financed by increases either in money creation ( $\Delta M$ ), or net borrowing from abroad ( $\Delta B^*$ ), or in net indebtedness to the domestic private sector ( $\Delta B$ ). Each one of these variables are associated with an undesirable consequence. Any increase in  $\Delta B$  will crowd-out private investment. An increase in high-powered money will increase money supply and generate inflation. An increase in  $\Delta B^*$  will increase the debt service payments obligation. Hence, a limit has to be set on the borrowing requirements of the government. Further, how the fiscal deficit will be met must depend on the relative costs and benefits associated with the three possible sources of financing the fiscal deficit.

Moreover, the Fund-Bank approach to stabilisation and structural adjustment has prescribed almost always a standard menu for all DEs irrespective of their structural characteristics. This was based on the assumption that the problems faced by all of them

are traceable to market imperfections, which are assumed to exist in those economies either naturally or because they are deliberately created in order to bring about equity at the cost of some loss in efficiency. There are several critiques of this approach. The most prominent among them is Taylor (1988, 1993b). Thus different economies with different institutional relationships and varying lines of causality in their economic systems require different approaches to stabilisation and structural reforms. But when countries embark on structural reform in a situation of deep macroeconomic disequilibrium, stabilisation policies squeeze supply responses. This often leads to a situation where the economy achieves neither stabilisation nor adjustment, so that the outcome is stagflation and poverty rather than growth and prosperity (Nayyar, 1995). Furthermore, It is supposed and believed that the Fund and the Bank are choosing their policies based on their extensive and varied experience in lending to countries that faced severe BOPs crises (Kumar, 1993). This lending experience is again based on the monetary approach of the Fund and neoclassical development approaches of the Bank. In other words, they are framing such programs by augmenting the analytical framework described above by various country experiences. But such country experiences are quite varied and the Fund-Bank policy framework can not adequately explain this variety in country experiences (Taylor, 1988).

Sundararajan (1986) had addressed the problem of providing an analytical framework for India's stabilisation policies using the traditional monetary approach to balance of payments type of IMF model to evaluate. through policy simulation, alternate policies such as credit contraction and devaluation. He favoured the devaluation policy by providing empirical support for exchange rate adjustment against credit policy in India.

We would examine this model in detail in Chapter 6. Moreover, given the shortcomings of this merged model, there is a need to have a dynamic econometric policy model, particularly for the Indian economy, which will fulfil the above deficiencies of the merged model being followed by India for deciding on the macroeconomic policies that are specific to India. Hence, a scientific analysis basing on a well defined model which causally links the specific policy interventions indicated above has yet to be designed. Development of such a model is the basic purpose of the present study.

The stabilisation program has usually implied a reduction in investment rather than current expenditures since it might be difficult to cut back employment or expenditures on social services such as education and health, and on maintenance and operation of existing facilities. The nature of monetary shocks and its implications on output are particularly relevant for DEs. Often, import and financial liberalisation are included in a policy package for structural adjustment, but they are not part of the analytical model described above. Import liberalisation is also likely to reduce output, and financial liberalisation involves higher rates of interest to encourage savings. Further, growth is best served by a well functioning capital market and this is best obtained when governments do not try to interfere by controlling interest rates at below the equilibrium levels. Higher interest rates may be an appropriate measure where savings are a constraint and an inappropriate policy where investment is low. Investment incentives are likely to be adversely affected by raising interest rates, which might encourage financial holdings at the expense of capital formation. So the interlinkage between the financial and the real sector can come through the cost of capital.



#### 4.4 CONCLUSION

On the whole the consensus seems to be that there is excessive emphasis on demand deflation and not enough emphasis on measures which would increase the supply response in countries undertaking adjustment. So the question is how does one reconcile the conflict between macroeconomic stabilisation and growth. The following chapters deal with empirical investigations on (i) stabilization programs within a macroeconomic simulation model to show whether the present trend of a decline in the proportion of government investment spending is counter-productive to the objective of growth (ii) the impact of devaluation and credit restrictions within a fully-fledged macroeconometric model, (iii) the determinants of long-run growth of output and investment, and (iv) designing growth-led adjustment policies in the optimal control framework.

## Chapter 5

# DYNAMICS OF MACROECONOMIC ADJUSTMENT WITH GROWTH: SOME SIMULATION RESULTS

### ABSTRACT

*This chapter examines the impact of several macroeconomic policies, both demand and supply management policies, on economic activity within a small macroeconomic simulation model. The model is based on a standard analytical framework that underlies adjustment policies in developing countries. The standard approach has been to use aggregate government expenditure as an instrument of fiscal policy to shock economic activity in a developing economy, with a negative dynamic response typically observed. In the context of such a small macroeconomic simulation model we decompose government expenditure into consumption and investment expenditure. Simulation exercises with and without model-consistent expectations throw up some contrasting results in the sense that fiscal policy can influence output positively through the effects of public sector investment on private investment in a developing economy such as India.*

### 5.1 INTRODUCTION

In the last chapter we described the analytics of the standard policy model for stabilisation and growth. This chapter simulates a small macroeconomic model of DEs which explicitly covers the basic interrelationships between money and the real economy. With the help of the model some simulation experiments are carried out in order to analyse and compare the effects of different monetary, fiscal and exchange rate policy measures on certain macroeconomic variables and also on the economy as a whole. Macroeconomic management in DEs has typically been demand-oriented with little emphasis on supply-side policies in order to achieve short run stabilisation, which ignores medium term growth in view of the implicit assumption that productive capacity is exogenous. Such neglect of medium run growth in the adjustment process came under vehement criticism in recent years as persisting external and internal imbalances led to a slackening in growth, balance of payments (BP) difficulties, and

high inflation. The cause of the short run disequilibria has frequently been traced to a situation of government fiscal deficits that end in excessive monetary expansion and feed domestic demand. Stabilisation programs (whether sponsored by the IMF or otherwise) are typically put into effect to reduce these demand pressures. A financial (or stabilisation) program is a package of policies designed to eliminate disequilibrium between aggregate demand and supply in the economy, which typically focuses on correcting short term imbalances by aiming at a desired BoP outcome, and a desired rate of inflation.

It has frequently been argued that these adjustment programs fail to encourage economic growth. Attempts at integrating short run stabilisation and long run growth in the context of developing world have not been able to adequately address the complex dynamic interactions involved in the relationship between stabilisation and growth. However, Khan and Knight (1985) [henceforth KK] attempted to show that the adjustment programs of the IMF type can achieve a viable BoP within the context of improved long-term growth performance and price stability.<sup>1</sup> While KK's structural model can be understood to be based on standard financial programming model of the Fund<sup>2</sup> and gap model of the World Bank<sup>3</sup>, the Fund and the Bank models, on the

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<sup>1</sup> Examples of the burgeoning literature on the subject of growth-oriented adjustment can be found in Khan, Montiel and Haque (1990), Blejer and Chu (1989), Bacha and Edwards (1988), and Corbo, Goldstein, and Khan (1987).

<sup>2</sup> The Fund doctrine has been expounded at length in Polak (1957), which considers only one policy instrument, that is, domestic credit ceilings. After 1973 with the breakdown of the Brettonwoods convention of fixed exchange rates, the exchange rate has been the second major instrument for stabilisation through demand management (IMF, 1977; 1987).

<sup>3</sup> For an overview of the gap models, see Chenery and Strout (1966), Bacha (1990), and Taylor (1994b). The two-gap conception, including the resource gap and the trade gap, is a simple open economy extension of the Harrod-Domar model of long-term growth based on the simple Keynesian system.

contrary, rely heavily on accounting identities and thus leave out a substantial amount of economic structure and behaviour.

The model presented in this chapter is in essence a variant of the simulation model reported in KK. KK in their simulations show that adjustment programs often supported by the resources of the Fund do not impose significant economic costs. They indicate how alternative combinations of demand-side and supply-side measures can be expected to influence the rate of growth of output in the short run. Here we show that the composition of government expenditure is a neglected factor in explaining the long-term growth of the economy. Instead of considering aggregate government expenditure as in KK's simulations, a decomposition into consumption and investment expenditure allows public investment expenditure to become a major stimulant to long-term growth. This is important when government expenditure is treated either as a individual policy measure or as part of a complete policy package. A policy package is meaningful because most of the adjustment programs contain a set of policies to be implemented synchronously. Though KK's model is treated as a medium term model with the specification of the determinants of productive capacity, it is still deficient in terms of its treatment of investment as exogenous.<sup>4</sup> Hence, a behavioural private investment equation, influenced by public expenditure, can be introduced as an additional channel through which economic activity could be stimulated. The formation of expectations in KK was modelled in an adaptive fashion, and we consider the sensitivity of the results to this assumption by also implementing

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<sup>4</sup> The stylized Fund-Bank model treats investment as determined by the available saving, while the three-gap model derives it residually from saving, foreign exchange availability, or the government budget, depending on which is the binding constraint.

a forward-looking treatment. The second section of this chapter presents the model. The third section provides empirical estimates of an investment model. We analyse the effects of policy changes on economic growth in the fourth section. The fifth section sums up.

## **5.2 THE ANALYTICAL MODEL**

Although no single model can generally cover the whole range of policy measures contained in a typical adjustment program, one such model that does include the whole gamut of policies involving the control of aggregate demand and supply is the one by Khan and Knight (1985) which is a variant of the econometric model developed by Khan and Knight (1981, 1982). Khan (1990) provides a summary of studies evaluating the effects of Fund-supported adjustment programs on the leading macroeconomic objectives in the short-run. Overall, these studies yield three conclusions. First, there is frequently an improvement in the balance of payments and the current account, although a number of studies show no effects of such programs. Secondly, inflation is generally not affected by programs. Finally, the effects on the growth rate are uncertain, with the studies showing an improvement or no change being balanced by those indicating a deterioration in the first year of a program. The theoretical core of the KK model can be summarised in what follows.

### **Structure of the Model**

KK's model, a highly aggregated structural dynamic model, which has been found to provide a framework in the sense of being able to handle several policies synchronously, can be taken as a starting point for analysing the dynamic effects of macroeconomic

policies. This simulation model was preferred from numerous in the literature on development macroeconomic models for the following reasons:

1. It is an aggregated model with a simple open developing economy structure;
2. It integrates monetary and real sectors of the economy;
3. The model simultaneously determines output growth, inflation, balance of payments, and money supply;
4. It explicitly considers the composition of the balance of payments and more importantly allows capacity output growth to be endogenously determined.

The model consists of six behavioural equations and five identities, as follows:

The first equation is a standard demand for money equation relating the desired stock of real money balances ( $m^d$ ) to real income ( $y$ ), the rate of interest on deposits ( $r$ ), and the expected rate of inflation ( $\pi^e$ ), which is assumed to follow an adaptive process:

$$\log m_t^d = a_1 \log y_t - a_2 \log r_t - a_3 \pi_t^e. \quad [5.1]$$

The next two equations describe the behaviour of imports and exports. The desired demand for real imports depends on real income and relative prices:

$$\log \left( \frac{IM}{Pm.\varepsilon} \right)_t^d = a_4 \log y_t - a_5 \log \left( \frac{Pm.\varepsilon}{P} \right)_t \quad [5.2a]$$

The actual quantity of imports is assumed to adjust proportionally to the difference between the demand for imports and actual imports in the previous period. This partial adjustment model is specified as

$$\Delta \log \left( \frac{IM}{Pm.\varepsilon} \right)_t = \beta \left[ \log \left( \frac{IM}{Pm.\varepsilon} \right)_t^d - \log \left( \frac{IM}{Pm.\varepsilon} \right)_{t-1} \right] \quad [5.2b]$$

where  $\beta$  is the coefficient of adjustment,  $0 \leq \beta \leq 1$ . As is well known, this type of adjustment model introduces a distributed lag process (with geometrically declining

weights) into the behaviour of real imports. Substituting equation (5.2a) into (5.2b) and solving for the level of nominal imports yields

$$\begin{aligned} \log IM_t = & \log(Pm.\varepsilon)_t + \beta[a_4 \log y_t - a_5 \log(Pm.\varepsilon / P)_t] \\ & + (1 - \beta)[\log IM_{t-1} - \log(Pm.\varepsilon)_{t-1}]. \end{aligned} \quad [5.2]$$

The volume of exports will increase with the productive capacity of the economy (represented by  $y^*$ ) and with the profitability of producing and selling exports (captured by the ratio of export prices to domestic prices -  $Px.\varepsilon/P$ ):

$$\begin{aligned} \log X_t = & \log(Px.\varepsilon)_t + a_6 \log y_t^* + a_7 \log(Px.\varepsilon / P)_t + a_8 \log(Px.\varepsilon / P)_{t-1} \\ & + a_9 \log(Px.\varepsilon / P)_{t-2}. \end{aligned} \quad [5.3]$$

The domestic rate of inflation ( $\Delta \log P$ ) is assumed to be positively related to the excess supply of real money balances and the rate of foreign inflation, which is measured by the rate of growth of import prices ( $\Delta \log Pm$ ) adjusted by the percentage change in the exchange rate ( $\Delta \log \varepsilon$ ):

$$\begin{aligned} \Delta \log P_t = & a_{10}[\log(M / P)_{t-1} - \log m_t^d] + a_{11}(\Delta \log Pm_t + \Delta \log \varepsilon_t) \\ & + (1 - a_{11})(\Delta \log Pm_{t-1} + \Delta \log \varepsilon_{t-1}). \end{aligned} \quad [5.4]$$

This formulation ensures that domestic inflation is determined by foreign inflation in the long run and the dynamic coefficients associated with foreign inflation add up to one.

The rate of growth of output ( $\Delta \log y$ ) is specified to respond to both monetary and fiscal variables, the deviations of output from capacity output (the output gap), and the rate of growth of real exports:

$$\begin{aligned} \Delta \log y_t = & a_{12}(\Delta \log DCP_t - \Delta \log P_t) + a_{13}(\Delta \log DCP_{t-1} - \Delta \log P_{t-1}) \\ & - a_{14} \log(y_{t-1} / y_t^*) + a_{15}(\Delta \log G_t - \Delta \log P_t) \\ & + a_{16}[\Delta \log X_t - \Delta \log(Px.\varepsilon)_t]. \end{aligned} \quad [5.5]$$

The rate of growth of capacity output ( $\Delta \log y^*$ ) is central to analysing supply-side policies, and a simple growth model that starts with an aggregate production function ( $f$ ) relating output ( $y$ ) to the capital stock ( $K$ ) and the labour force ( $L$ ) has been used:

$$y = f(K, L). \quad [6a]$$

Converting this equation into rates of growth yields

$$\frac{dy}{y} = f_K \cdot \frac{dK}{y} + \left( f_L \cdot \frac{L}{y} \right) \cdot \frac{dL}{L} \quad [6b]$$

where the variable  $dK$  is defined as equal to the rate of gross real investment ( $IR$ ), treated as exogenous. A log-linear approximation to equation (6b) would render the capacity output growth equation, that is,

$$\Delta \log y_t^* = a_{17} (IR / y)_t + a_{18} \Delta \log L_t \quad [5.6]$$

where  $a_{17} = f_K$  and  $a_{18} = f_L \cdot L / y$ .

The remaining equations in the model are identities. The supply of money comes from the banking system's balance sheet in the form of domestic credit and international reserves as

$$\Delta M_t = \Delta DC_t + \Delta R_t. \quad [5.7]$$

The external sector's budget constraint defines the balance of payments, which is equal to the trade balance ( $X-IM$ ), the net services account ( $S$ ) and the change in foreign financing to the private sector ( $\Delta FIP$ ) and the public sector ( $\Delta FIG$ ):

$$\Delta R_t = X_t - IM_t + S_t + \Delta FIP_t + \Delta FIG_t. \quad [5.8]$$

Changes in domestic credit ( $\Delta DC$ ) can result from changes in commercial banks' claims on the private sector ( $\Delta DCP$ ) and central bank financing of the government budget deficit ( $\Delta DCG$ ):



$$\Delta DC_t = \Delta DCP_t + \Delta DCG_t. \quad [5.9]$$

Now the fiscal and monetary accounts are linked by assuming that any government deficit ( $G-T$ ) can be financed only by borrowing from the banking system ( $\Delta DCG$ ) or borrowing abroad ( $\Delta FIG$ ), that is,

$$G_t - T_t = \Delta DCG_t + \Delta FIG_t \quad [5.10a]$$

where  $G$  and  $T$  are government expenditures and revenues respectively. Rearranging yields:

$$\Delta DCG_t = G_t - T_t - \Delta FIG_t \quad [5.10]$$

Finally, the expectations of inflation were assumed to be generated by an adaptive process in which these expectations are revised proportionally to the difference between the actual rate of inflation in the previous period ( $\Delta \log P_{t-1}$ ) and the rate that was expected to prevail ( $\pi_{t-1}^e$ ):

$$\Delta \pi^e = \gamma (\Delta \log P_{t-1} - \pi_{t-1}^e) \quad [5.11]$$

where  $\gamma$  is the coefficient of expectations,  $0 \leq \gamma \leq 1$ . In this formulation a value of  $\gamma$  equal to unity would mean expected rate of inflation is equal to the actual rate of inflation in the previous period:  $\pi_t^e = \Delta \log P_{t-1}$ .

The framework outlined above contains 11 equations, the structure of which has been summarised in Table I (II). KK calibrate it by imposing the values of the parameters, the specific choice of which were broadly consistent with the estimates obtained by empirical studies on various aspects of stabilisation policies in developing countries. They have used it to compare alternative policy packages for the balance of payments, inflation and real output growth. These comprise a package of demand-management policies (that is, a once-for-all reduction in the rates of growth of nominal domestic

credit and nominal government expenditures, plus a devaluation) and a combined package of demand-management and structural policies (that is, the above-mentioned demand management policies, plus a set of structural policies that would gradually raise the rate of growth of capacity output). They find that the combined package of demand-management and supply-side policies succeeds in putting the economy on a higher secular growth path. However, the demand-oriented policy package includes a reduction in government expenditure, and the model makes no distinction between government consumption expenditure and government investment expenditure. In a country like India, a cut in govt expenditure in practice falls more on the reduction of capital expenditure, which contributes to long-term growth, relative to consumption expenditure. Hence the composition of the government expenditure is important in gauging their effect on long-term growth.

In itself, KK model is inadequate in achieving the objective of growth-oriented adjustment despite their claims of doing so in the absence of a growth-inducing mechanism in the model that primarily comes through investment which KK treat as exogenous. Hence an alternative way of examining the effect of fiscal policy on output growth should be made through public investment. Though the IMF literature holds the view that government fiscal deficits adversely affect real output due to the crowding-out effect, here we argue that it will be no longer valid if the deficit is created in generating physical infrastructure in the economy that would induce private investment and thereby growth. Further an increase in public investment can result through the receipt of foreign financing, since most governments in DEs are fiscally constrained and financing through domestic credit expedites inflation. Since the reduction in fiscal deficit through

cuts in government expenditures does not take the relationship between public and private investment as the public sector provides the necessary infrastructure, and thus reductions in public investments on basic infrastructure may have adverse effects on private investment and growth, we modify the basic KK model in two ways:

- The supply side is extended by incorporating a detailed investment mechanism;
- Agents' expectations are made forward-looking and specifically are formed rationally for the relevant future variable, namely expected inflation in the present model.

The following equations are the three new equations added to the KK model. Expectations of inflation ( $\pi^e$ ) are assumed to be generated in a forward-looking model-consistent manner, suppressing equation (5.11).

It has invariably been argued by Indian economists that the public investment on infrastructure must not be cut in the transition process of the economy, for it has adverse long-term consequences. In other words, the private sector relies on public investment in most of the infrastructure because this is either a natural or a legal public monopoly. Hence there are potential supplyside relations between public and private investment, and public infrastructure and private investment should be complementary, in that infrastructure deficiencies will hold back both private production and private investment (Joshi and Little, 1994). Thus the real private investment equation has been introduced to depend on real public investment and real interest rate:<sup>5</sup>

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<sup>5</sup> Similar type of specifications have been suggested both in the agricultural sector (Mallick, 1993) and in the industrial sector (see Nayyar, 1995) of the Indian economy. Investment functions described in Chapter 3 also motivate us for this type of specification.

$$\log IRP_t = a_{19} \log IRG_t + a_{20} RIR_t. \quad [5.12]$$

The real interest rate (RIR) is defined as nominal deposit rate ( $r$ ) minus the expected inflation rate:  $RIR_t = r_t - \pi_t^e$ . Total real investment is equal to real public investment and real private investment:

$$IR_t = IRG_t + IRP_t. \quad [5.13]$$

From the demand side, total government expenditure can be disaggregated into government consumption expenditure (GC) and government investment expenditure (IRG):

$$G_t = CG_t + IRG_t, \quad [5.14]$$

The above extension of the model has been summarized in Table 5.1 (I2).

**Table 5.1: Structure of the Model**

Endogenous variables	Purely Exogenous variables		Endogenous Variables	Policy Variables
<b><i>I1: Original Version (KK specification)</i></b>				
$\Delta \log y$	S	IR	M	$\varepsilon$
$\Delta \log P$	T	Px	DC	DCP
$\Delta \log y^*$	FIG	Pm	DCG	G
$m^d$	FIP		$\Delta R$	
IM	L		$\pi^e$	
X	r			
<b><i>I2: Revised Version (Extended specification)</i></b>				
IRP			G	IRG
IR			RIR	GC

The 14 equations of the model determine values for the 14 endogenous variables conditional on the exogenous variables and policy instruments.

M: nominal stock of money, DC: domestic credit, DCP: domestic credit to the private sector, DCG: domestic credit to the government sector, P: domestic price level, y: real income,  $\varepsilon$ : nominal exchange rate expressed as the index of units of domestic currency per unit of foreign currency,  $\Delta R$ : balance of payments in domestic currency, X: exports in domestic currency, IM: imports in domestic currency, FIP: change in net foreign assets of the private sector, FIG: change in net foreign assets of the public sector.

### 5.3 ECONOMETRIC EVIDENCE FOR THE INVESTMENT MODEL

The model contains 20 structural parameters and 2 adjustment parameters. Although the complete model could have been estimated as a system, we chose to follow KK and the same parameter values with a minor change in 4 parameters in the demand for money and exports equations in order to ensure the dynamic stability of the model. All the parameter values are listed in Table 5.2 in the Appendix. For the new behavioural equation (5.12), the coefficients are estimated using Indian data. The annual data from 1950-51 to 1994-95 have been compiled from various issues of Economic survey, Government of India (GOI), and Report on currency and finance, RBI respectively. Assuming inflation expectations as static, the real interest rate (RIR) is calculated as nominal deposit rate ( $r$ ) minus the current inflation rate. When we solve the model in the next section, inflation expectations ( $\pi^e$ ) will be assumed to be generated in the model in backward and forward-looking manners.

Here, first we examine each time series and see whether it is stationary employing the unit root tests. Table 5.3 presents the results of unit root tests using the annual time-series data from 1950-1994. In order to avoid difficulties with the logarithm of a negative number, RIR has been included without taking its logarithm. Based on the ADF test, it is evident from Table 5.3 that all the time series  $IRP_t$ ,  $IRG_t$  and  $RIR_t$  are integrated of order one or stationary in the first-differences. The ADF statistics are calculated without and with time trend for level data and first differences. The null hypothesis of a unit root in the univariate representation cannot be rejected for the variables in levels. So the results are compatible with the hypothesis that nonstationarity

characterises the variables. To see whether these nonstationary series move together, we need to estimate a linear relationship between them. Given the presence of unit root in each series, a precondition for the existence of a stable steady state relationship is cointegration between the variables. The variables are said to be cointegrated if each variable has a unit root in its univariate representation and some linear combination of these variables is stationary (Engle and Granger, 1987). Though there are several tests of cointegration, here we opted for the cointegration approach proposed by Phillips and Hansen (1990).<sup>6</sup> So parameters of the single cointegrating relation are estimated by the fully-modified OLS procedure.<sup>7</sup> The results are obtained using Microfit version 4.00 (see Pesaran and Pesaran, 1997). On the basis of the above mentioned specification, the empirical results are presented in Table 5.4.

The results, in general, conform to the earlier apriori expectations. Moreover, it is interesting to note that the long-run coefficient associated with public investment is highly significant at all levels of significance under this specification. The results exhibit strong cointegration among the variables and the relationship constitutes a stationary time-series with a constant mean (see Fig. 5.1). Cointegration implies that there exists an ECM of the above cointegrating equation. The ECM is estimated using OLS with lagged differences for all the variables. The ECM regresses the current value of the dependent variable, in stationary form, onto its own lagged values, current and lagged

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<sup>6</sup> In general, the asymptotic distribution of the OLS estimator involves the unit-root distribution and is non-standard and hence carrying out inferences using the usual t-tests in the OLS regression will be invalid. To overcome these problems appropriate corrections are required. Phillips-Hansen's fully-modified OLS (FM-OLS) estimator takes account of these in a semi-parametric manner.

<sup>7</sup> This procedure has the drawback that, in the case of more than two time series, more cointegrating vectors may exist. However, a preliminary investigation for the presence of other cointegrating vectors via the multivariate Johansen procedure did not yield different results.

values of the stationary forms of the independent variables, and the lagged error term from the cointegrating relation. The general to specific method is used to find a parsimonious representation of the relationship; that is, variables are deleted from the most general specification using the F-test of jointly zero coefficients. The diagnostic test statistics indicate that there is no evidence of serial correlation, of heteroscedasticity, of non-normality of the residuals, and of misspecification. So the short-run model passes all the diagnostic tests and the EC term is quite significant in  $\Delta \ln(\text{IRP})_t$  and  $\Delta \ln(\text{IRG})_t$  influences change in private investment to a large extent, since the estimate (0.62) is highly significant. The error correction term being significant implies that the private investment adjusts in the short run to a disequilibrium in the long run relationship by 30 per cent. The results of the estimated long-run and short-run model are presented in Table 5.4.

**Table 5.4: Estimation of the Investment Equation**

\*\*\*\*\*

Long-run model is based on Fully Modified Phillips-Hansen regression

**Long run equation:**  
 $\ln(\text{IRP}) = 0.43437 + 0.98148 * \ln(\text{IRG}) - 0.0019776 * \text{RIR}$   
(2.1416) (42.2646) (0.30257)

**Short-run equation:**  
 $\Delta \ln(\text{IRP}) = 0.62218 * \Delta \ln(\text{IRG}) - 0.011342 * \Delta(\text{RIR}) + 0.0477 * \Delta \ln(\text{IRP}(-1)) - 0.30098 * \text{EC}(-1)$   
(2.9752) (-2.7594) (0.2744) (-2.5733)

Diagnostic Tests:  
A: Serial Correlation  $F(1, 36) = 0.40109 [0.531]$   
B: Functional Form  $F(1, 36) = 0.67906 [0.415]$   
C: Normality  $\chi^2(2) = 0.63949 [0.726]$   
D: Heteroscedasticity  $F(1, 40) = 0.19678 [0.660]$   
S.E. of Regression ( $\sigma$ ) = 0.17703

\*\*\*\*\*

Notes: Figures in the parenthesis are t values; Numbers in the square brackets are the probability values; A: Lagrange multiplier test of residual serial correlation; B: Ramsey's RESET test using the square of the fitted values; C: Based on a test of skewness and kurtosis of residuals; D: Based on the regression of squared residuals on squared fitted values.

## 5.4 DYNAMIC RESPONSES TO POLICY SHOCKS

In this section we assess the effects of single policies and different combinations of policies on growth, inflation and trade by performing simulation experiments, particularly the deterministic dynamic simulation method. The exogenous data used in the simulations are for the Indian economy. First, for each period, actual values of all the exogenous data are imposed on the model yielding baseline series for the simulated variables. Second, the model is simulated by adding to the exogenous variables shocks as designed in the KK model. The magnitudes of the shocks in the basic model are same as the policy shocks (both domestic and foreign) in the KK model: a permanent reduction in total government expenditure, devaluation of the official exchange rate, and reduction in the stock of domestic credit to the private sector. In the extended model the separate roles of government consumption expenditure, investment expenditure, and interest rate shocks are examined. Model solutions for the forward-looking expectations were obtained using the Fair-Taylor algorithm (Fair and Taylor, 1983) in *WINSOLVE* (Pierse, 1996). The simulation analysis has been carried out for, first, the basic model (KK's model), second, the extended model, third, with rational expectations. The model is highly aggregative and thus focuses only on what are considered the most important macroeconomic relationships. The simulations conducted with different variants start with the assumption that the authorities wish to achieve an increase in economic growth.



### 5.4.1 The Basic Model

In the basic model, we perform the policy shocks for four endogenous variables such as output growth, inflation and balance of payments (exports and imports) in the model. The shocks are first accomplished independently and then combined as a policy package to discern its overall impact. The policy package consists of an unanticipated permanent reduction in government expenditure and domestic credit by 10 per cent, and devaluation by 10 per cent. Chart 5.1 (figs.1-4) shows percentage deviations from baseline values for the four endogenous variables. The reduction in government expenditure has a short-run expansionary effect on output growth and balance of payments of the economy; and a permanent contractionary effect on inflation and capacity output. Consider first the case of the output response when the nominal government expenditure is shocked by 10 percent. The dynamic negative response of output in case of G is due to the fact that the rate of growth of output would decline at the beginning of the program in view of the tighter fiscal policy restraining aggregate demand and then starts to rise as inflation declines raising real domestic credit and real government expenditure. The general improvement persists for about two years and eventually the growth rate approaches its original level.

This contradicts the Keynesian viewpoint in the short run that government spending is necessary to stimulate the economy and generate growth. This contradiction may be because of the problem of wasteful spending resulting in high fiscal deficits and national debt burdens. So in this simple model, reduction in government spending increases

output due to lower absorption. Nevertheless the importance of fiscal deficit reduction in long-term economic stability cannot be under-estimated. Now the question is whether the government really reduces the current wasteful spending or they resort to reduction in capital expenditures which has a positive impact on capacity output growth, in the process of fiscal adjustment. Since KK's model makes no distinction between these two types of expenditures, we cannot say anything about their impact effects. The existing evidence in the Indian economy shows that there has been a significant decline in the gross investment in the public sector (see chapter 2), which means that this decline must be contributing to the decline in the capacity output growth of the economy. Hence the short-term increase in output growth after one period due to government expenditure reduction in KK's model is deceptive.

A reduction in the rate of growth of domestic credit to the private sector results in decline in total domestic credit growth. This will directly reduce the growth of output, although the effect will be dampened by the fall in domestic inflation that keeps the rate of growth of real credit from declining as much as it would otherwise. Here output falls because of the restrictive monetary policy working towards lowering the rate of growth of output in the first period and then improves until it reaches the steady state.

A devaluation in the context of this model has two distinct effects. First, it creates a wealth effect through the increase in domestic prices. Both the growth rates of real credit and real government expenditures would decline as a result, and thus real output growth would fall. Second, as real exports begin to rise in response to the change in relative prices, output is stimulated. The way the model is set up, it would be expected that

devaluation would be contractionary in the short run as the wealth effect initially dominates the relative price effect. Later on, the process is reversed and devaluation becomes expansionary. As far as the foreign exchange bottleneck is concerned, in the long run many DEs experience difficulties with their BoP due to a low income elasticity of demand for their exports on the one hand and a high income elasticity of demand for imports on the other. KK have modelled exports supply instead of exports demand equation. In the imports equation, the income elasticity of demand coefficient appears to be very low, which might not increase imports and hence the gap gets narrowed with the increase in exports.

Chart 5.1 also shows the combined effects of 10 per cent reduction in the nominal government expenditures and domestic credit to the private sector, and a 10 per cent devaluation within the basic model. Since credit to the public sector is given by eqn (10), any reduction in the domestic credit takes the form of a reduction in the credit made available by the banking system to the private sector. Since price adjusts in the model, these policies translate into real changes in the short-run. The capacity output growth would decline as the combined policy package does not increase the capacity output growth, for the KK model does not contain any mechanism which could raise investment and thereby the economy's trend growth rate of capacity output. Unless capacity output growth increases, the targeted output growth cannot be met. This points to the fact that investment must be made endogenous by disaggregating it into public and private, and then the question is to examine whether cuts in public investment constrain the supply response of the economy in the medium-term.

#### 5.4.2 The Extended Model

The extended model contains the equations from (12) to (14). Now in the extended model we examine the impact of four types of shocks including policies that increase the level or rate of growth of capacity output in the economy. Instead of total government expenditure we have government consumption expenditure and government investment expenditure (as a supply-inducing policy) separately. Chart 5.2 (figures 1 to 6) presents those simulations of both independent and combined shocks. The effect of consumption expenditure shock on output is the same as the total govt expenditure in the KK model. The investment shock (Chart 5.2, fig.2) to output growth shows a continuous decline in output, which means that the extended model is basically an investment-led growth model. In case of the combined shock (consumption expenditure, credit and devaluation shocks) the output growth declines initially as KK model (although not by the same proportion). If the combined shock contains a reduction in the investment expenditure, then the output growth and capacity output growth would decline permanently as investment is the driving force for output growth in the model. This response is same as the output response to investment shock, for the responses are additive as the model is linear.

Whereas expenditure shocks show a decline in inflation in the basic as well as in the extended model, a devaluation shock in both the models results in gradual increase in inflation and then declines to the steady-state [see Chart 5.1 (fig.2) & Chart 5.2 (fig.3)],

which is quite evident from the initial effect of devaluation. Since in developing countries like India, the demand-management policies such as a cut in government expenditure falls on a reduction in government investment expenditure leading to a decline in capacity output growth, the adjustment programs are unlikely to be growth-oriented contrary to the claim made by KK. The model also brings out apparently the fact that the reduction in investment expenditure opens up the way for a decline in capacity output growth thereby a contraction in real output leading to an increase in inflation. Considering domestic credit as a major component of the money supply, a reduction in domestic credit to the private sector by 10 per cent brings down inflation marginally and remains stable after two years, which indicates the importance of tight credit policy in the standard stabilisation program (fig.2 in Chart 5.1 and fig.3 in Chart 5.2). The combined shock demonstrates an initial decline in output which improves after a period in the KK and extended model, in the absence of an investment expenditure shock.

Moreover, in this model, another question that we address here is whether financial liberalisation can stimulate investment and growth. We simulate an one percent increase in nominal interest rate, which leads to decline in output growth in the long-run because of the feedback that comes through the inclusion of the dependence of private investment on real interest rate (see Chart 5.4). In the early 1970s, McKinnon-Shaw hypothesis (McKinnon, 1989) in their analysis of financially repressed DEs, attributed the poor performance of investment and growth in DEs to financial repression. Interest rate ceilings, high reserve ratios and directed credit programs were

viewed as sources of financial repression, the main symptoms of which were low savings, credit rationing and low investment. During the 1980s and 1990s, liberalisation of financial markets have thus been suggested, so that with the real rate of interest adjusting to its equilibrium level saving and the consequent expansion of total real supply of credit would then induce a higher volume of investment. Economic growth would, therefore be stimulated not only through the increased investment but also due to an increase in the average productivity of capital. But the unsuccessful evidence of the financial liberalisation is because of the existence of macroeconomic instability and inadequate banking supervision. Currently in the Indian economy, the experience of high positive real interest rates, possibly triggered by fiscal instability, indicate a poorly functioning financial system. The McKinnon-Shaw school expects financial liberalisation (institutional interest rates rising towards their competitive free-market equilibrium levels) to exert a positive effect on the rate of economic growth in both the short and medium runs, whereas the Neostructuralists predict a stagflationary (accelerating inflation and lower growth) outcome from financial liberalisation in the short run and possibly a positive influence in the medium run through a dominant saving effect (Fry, 1997). In practice, it is virtually impossible to isolate the effects of financial components of the reform package, as most cases of financial liberalisation are usually accompanied by other economic reforms (such as fiscal, trade and foreign exchange reforms). However, we have examined the effect of one per cent increase in interest rate within our extended model, which suggests a Neostructuralist outcome of low growth and high inflation, and a deterioration in trade balance (Chart 5.4).

### 5.4.3 Modelling Expectations

Since expectations are treated in a simple fashion and adoption of an adjustment program may alter expectations, there is a need to introduce model-consistent expectations instead of adaptive expectations in inflation in the KK model. In Chart 5.3 we present the simulations assuming that the expectations of inflation are generated rationally within the extended model, so that expected inflation is equal to the actual rate of inflation in the future period. The shock analysis of various policies are carried out with rational expectations in the extended model. The results are different in the short run. It has a short-run effect in changing the magnitudes. Credit shock and devaluation shock behave in the same fashion as well (see Chart 5.3, fig.1). The assumption of model consistent expectations make things different for the simple reason that when inflation is expected to be higher after introduction of a reform program, there will be lower money demand and hence high inflation thereby lower actual output growth in the first period. Because of model-consistent expectations, output in the next period due to investment shock increases, and then declines permanently (Chart 5.3, fig.2). One interesting thing that we notice with the combined shock is that the output declines in the first two periods and slowly improves as in the independent shocks. But there has been a change in the magnitudes due to the forward-looking expectations. In case of an investment shock, output declines in the first period and because of the low price expectations, output improves for next period and then declines permanently as it was before without rational expectations.

In these simulations, we find rational expectations playing very little role in changing our results. The sensitivity of expectations is prominent in the short run. Moreover, the change in short run properties due to rational expectations is not a very uncommon result in the literature on macroeconomic modelling. For example, Fisher et al. (1992) and Bikker et al. (1993) show that the switch from adaptive to rational expectations dynamics affects only short-run properties of the model (for an elegant discussion, see Wallis (1995)).

In sum, a government expenditure reduction giving rise to increase in output growth after one period is illusory, since when we disaggregate  $G$  into  $CG$  and  $IRG$ , and shock public investment as an indicator of fiscal policy we find that it results in a constant decline in the output growth in the present model. Though the perfect foresight assumption does not change the results very much in the medium-term, it does change the short run properties of the model.

## **5.5 CONCLUSION**

The purpose of this chapter was to analyse a small, but well articulated and internally consistent, dynamic macroeconomic simulation model for a representative developing country that relies on familiar macroeconomic theory and in which expectations are formed rationally. The model has been intended to be suitable for the analysis of general equilibrium interactions among the key macroeconomic variables that typically concern policy makers in such countries. Hence public investment to maintain or expand infrastructure is complementary to private investment and any



increase in infrastructural investment would undoubtedly give rise to higher output growth in the economy. The assumption of rational expectations does affect the short-run adjustment process, leaving the long-run implications unchanged. The present exercise reveals that the contractionary fiscal policy taking the form of a cut in real public sector investment is by no means growth-inducive in the medium term.

Recent years have witnessed a phenomenal upsurge of interest in the methodology of econometric modelling and the analysis of time series exhibiting homogeneous non-stationarity due to autoregressive unit roots. The objective of the next chapter is to empirically analyse the stabilisation aspects of macroeconomic behaviour in the Indian economy, in the light of these important econometric developments since in this chapter we used parameter values of KK for the Basic model which were obtained from the traditional modelling procedure for a cross-country analysis.

**Table 5.2**  
**Parameters Employed in the Simulations**

The parameters imposed on the model to run the simulations are reported in below:

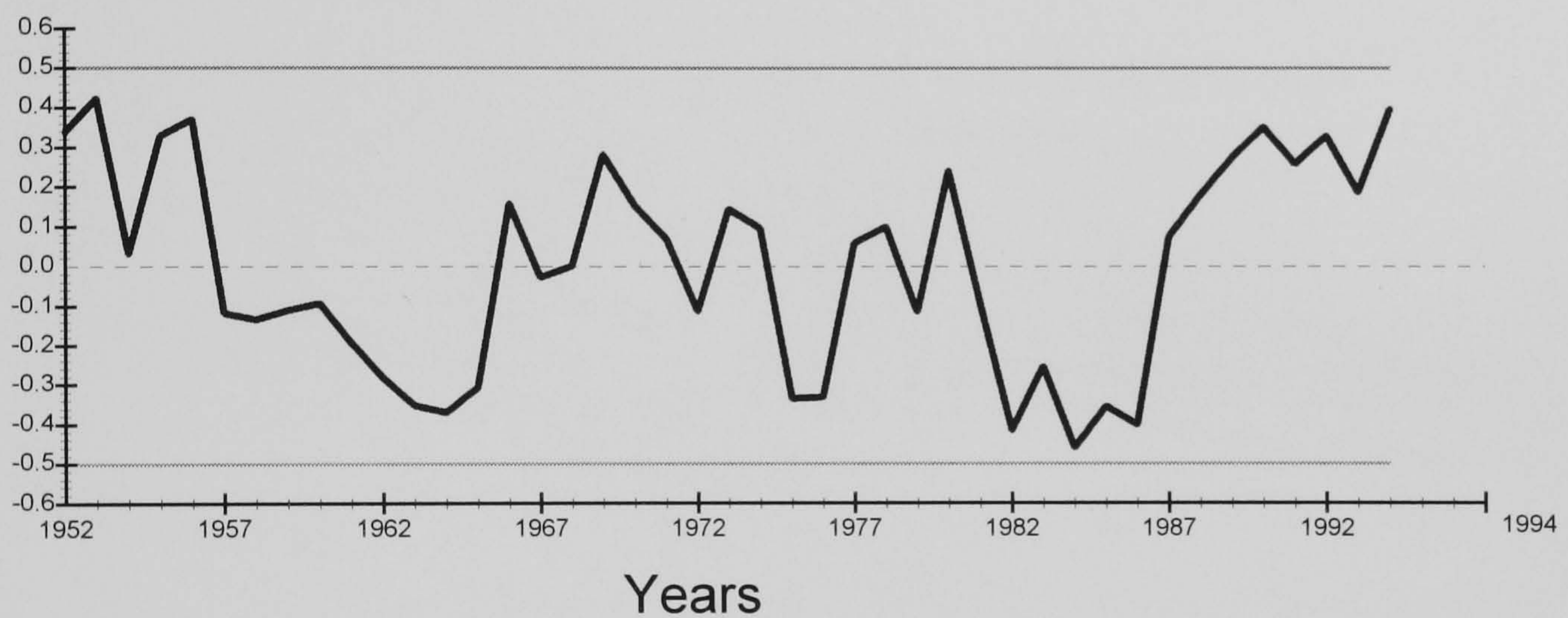
<i>Equation</i>	<i>Parameter</i>	<i>Value</i>
<b>1. Demand for money:</b>		
<i>Income</i>	$a_1$	0.55
<i>Interest rate</i>	$a_2$	0.20
<i>Expected inflation</i>	$a_3$	0.35
<b>2. Imports:</b>		
<i>Adjustment</i>	$\beta$	0.40
<i>Income</i>	$a_4$	0.41
<i>Relative price</i>	$a_5$	0.20
<b>3. Exports:</b>		
<i>Capacity output</i>	$a_6$	0.30
<i>Relative prices</i>	$a_7$	0.10
	$a_8$	0.30
	$a_9$	0.10
<b>4. Inflation:</b>		
<i>Excess Money demand</i>	$a_{10}$	0.33
<i>Foreign inflation</i>	$a_{11}$	0.27
<b>5. Real output:</b>		
<i>Real private credit (current)</i>	$a_{12}$	0.06
<i>(lagged)</i>	$a_{13}$	0.03
<i>Output gap</i>	$a_{14}$	0.90
<i>Government Expenditures</i>	$a_{15}$	0.04
<i>Exports</i>	$a_{16}$	0.05
<b>6. Capacity output:</b>		
<i>Capital</i>	$a_{17}$	0.18
<i>Labour</i>	$a_{18}$	0.59
<b>7. Expected Inflation (adjustment)</b>		
	$\gamma$	1.00

**Table 5.3:**  
**Unit-root tests**

VARIABLES	ADF in LEVELS		ADF in FIRST DIFFERENCES		~I( )
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	
Log(IRP)	1.0092	-1.9217	-5.7846	-5.9363	I(1)
Log(IRG)	-0.91615	-2.4860	-5.9162	-5.9529	I(1)
RIR	-4.9727	-4.9279	-7.3229	-7.2234	I(0)
ECM	ADF test statistic in levels -3.1436		Phillips-Perron test in levels -3.121123		I(0)

Notes: 95% critical value for the ADF statistic (with intercept and no trend) = -2.9320  
95% critical value for the ADF statistic (with intercept and trend) = -3.5189

**Graph 5.1: Plot of the Cointegrating Relation**



**Graph 5.2: Plot of Residuals of the Dynamic Equation**

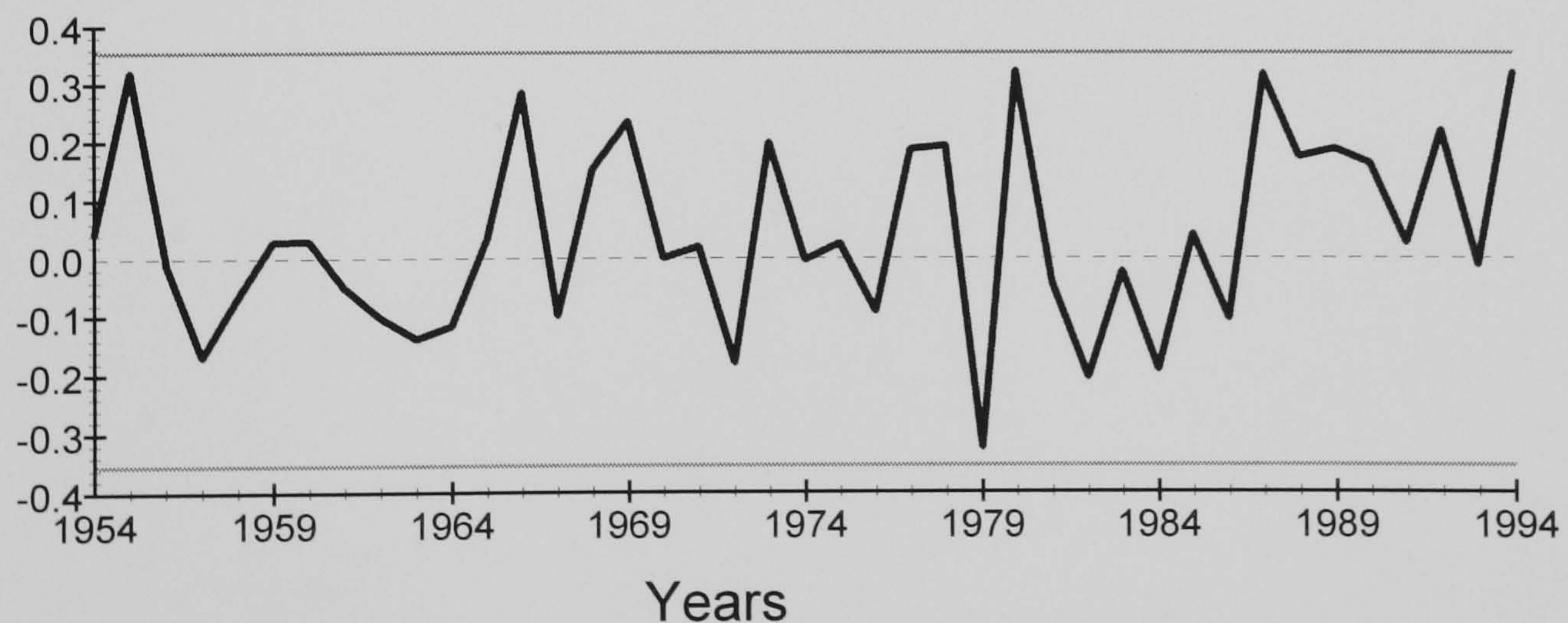


CHART 5.1 : SIMULATION OF THE BASIC MODEL

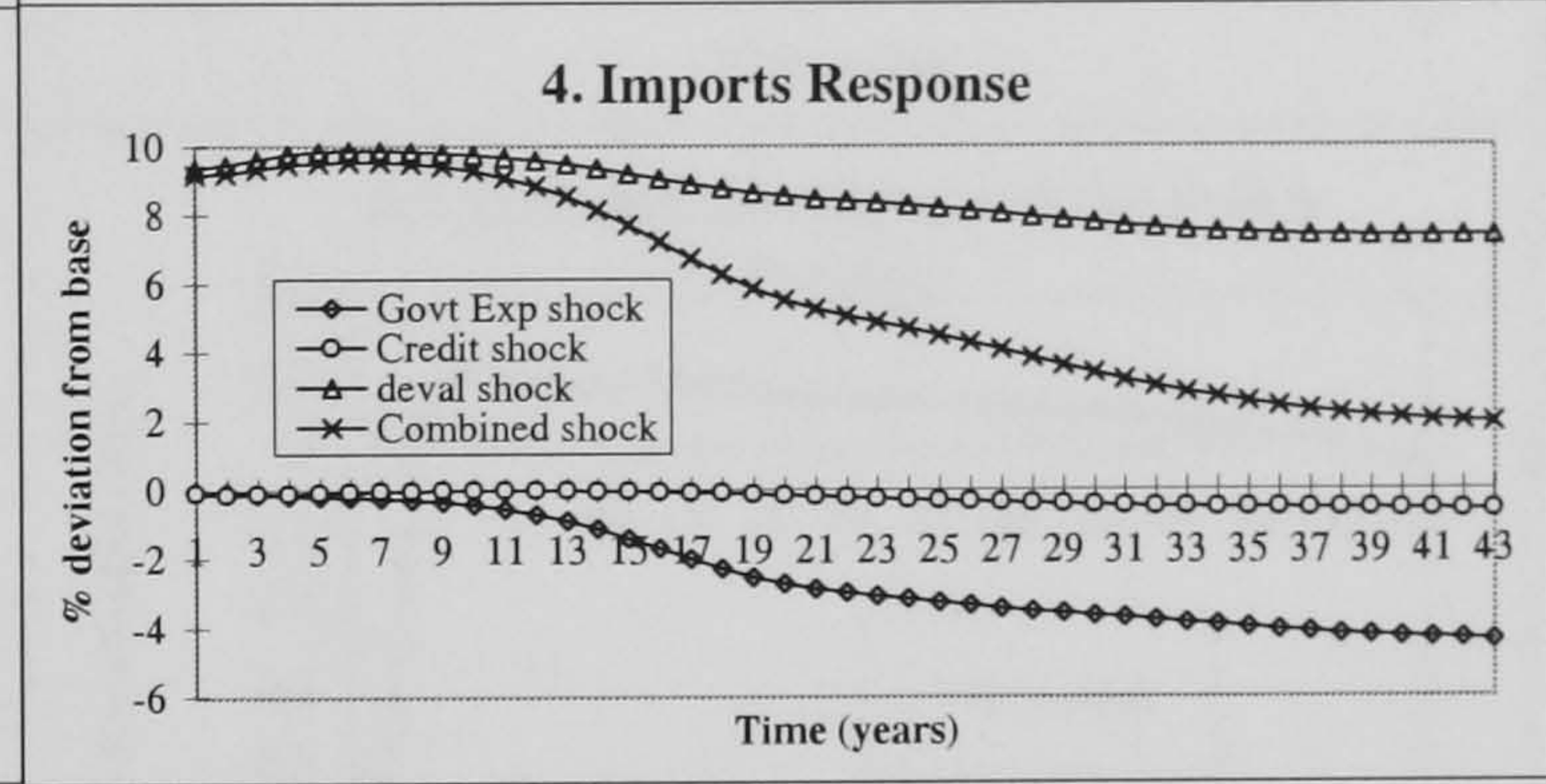
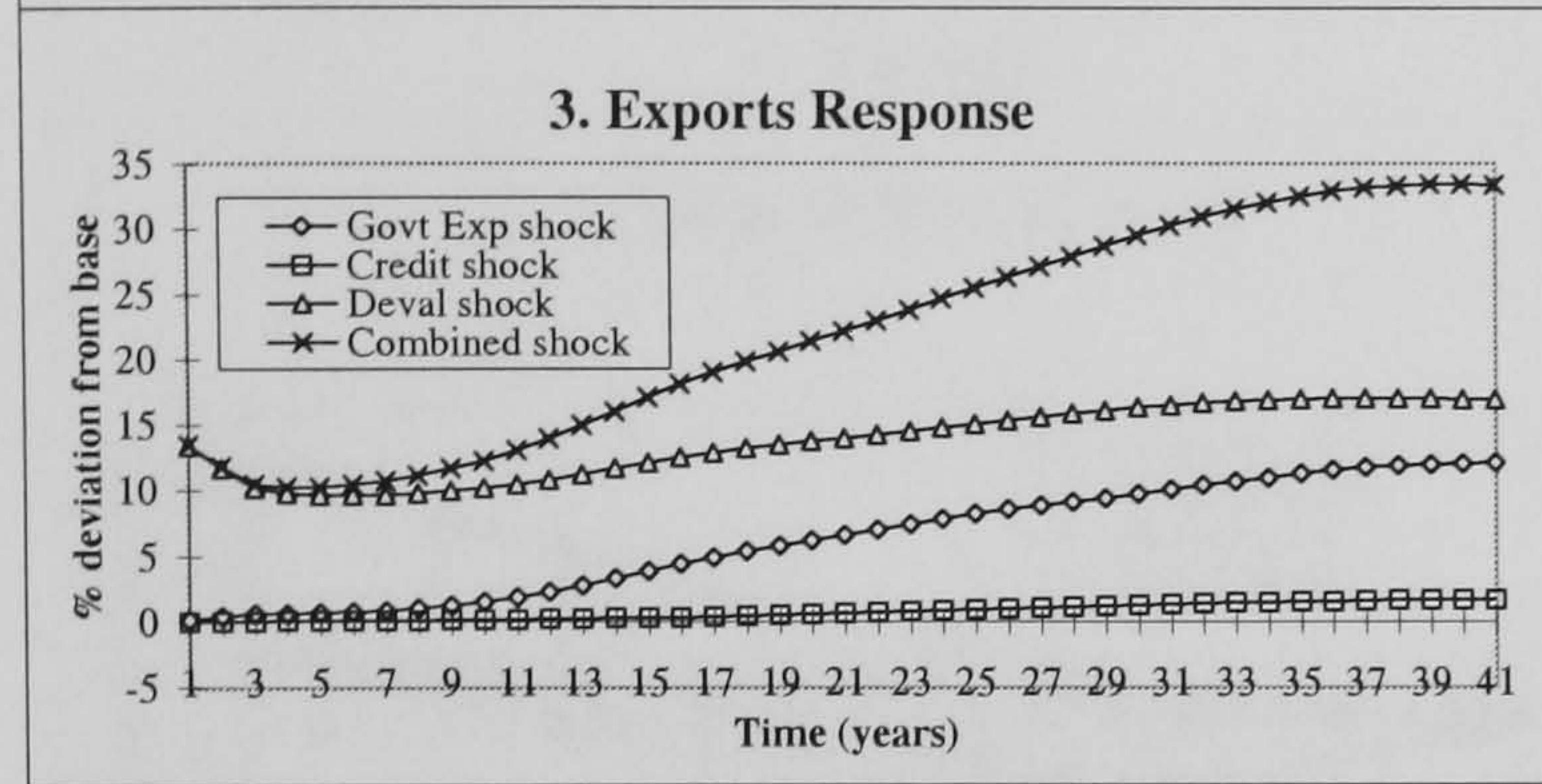
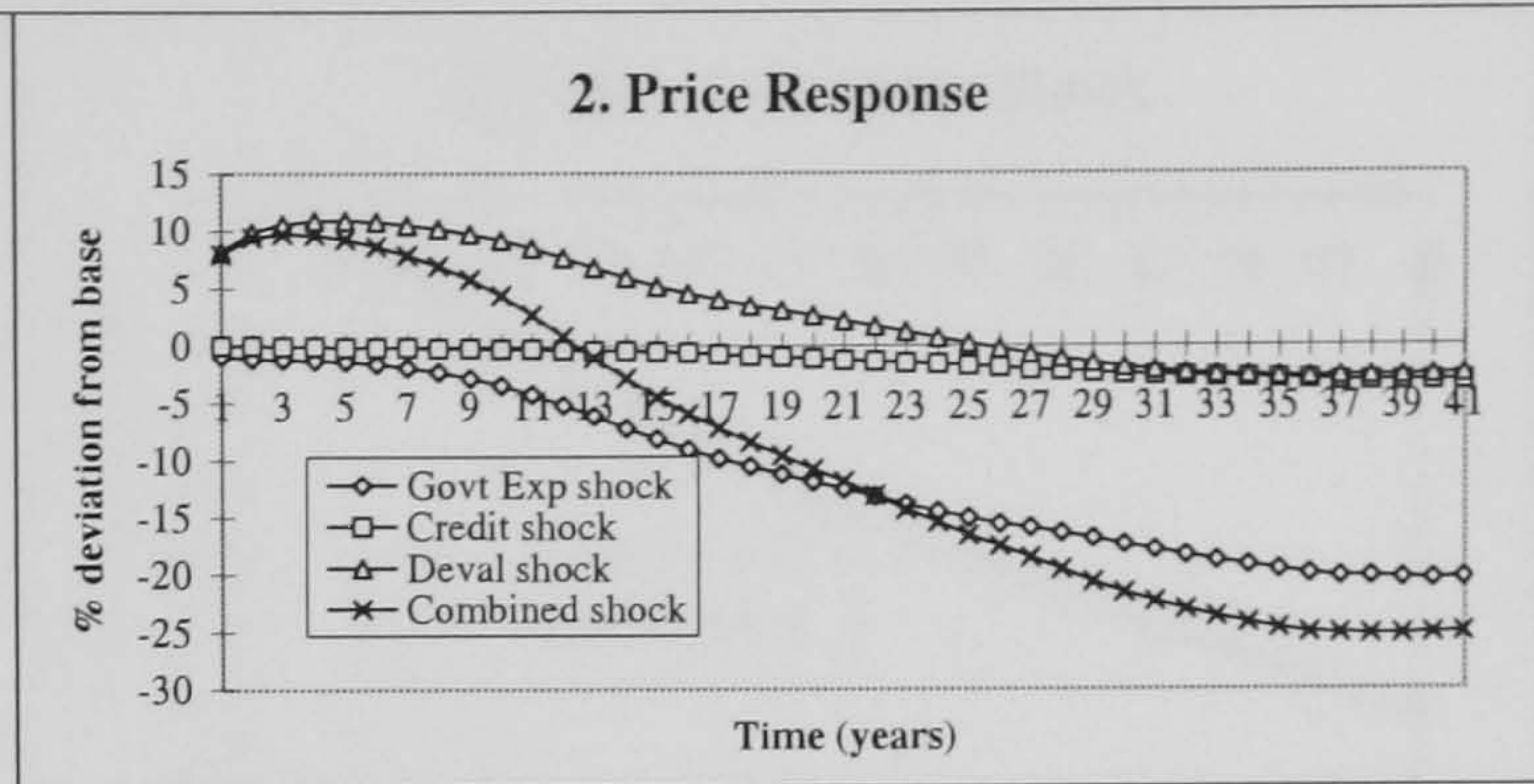
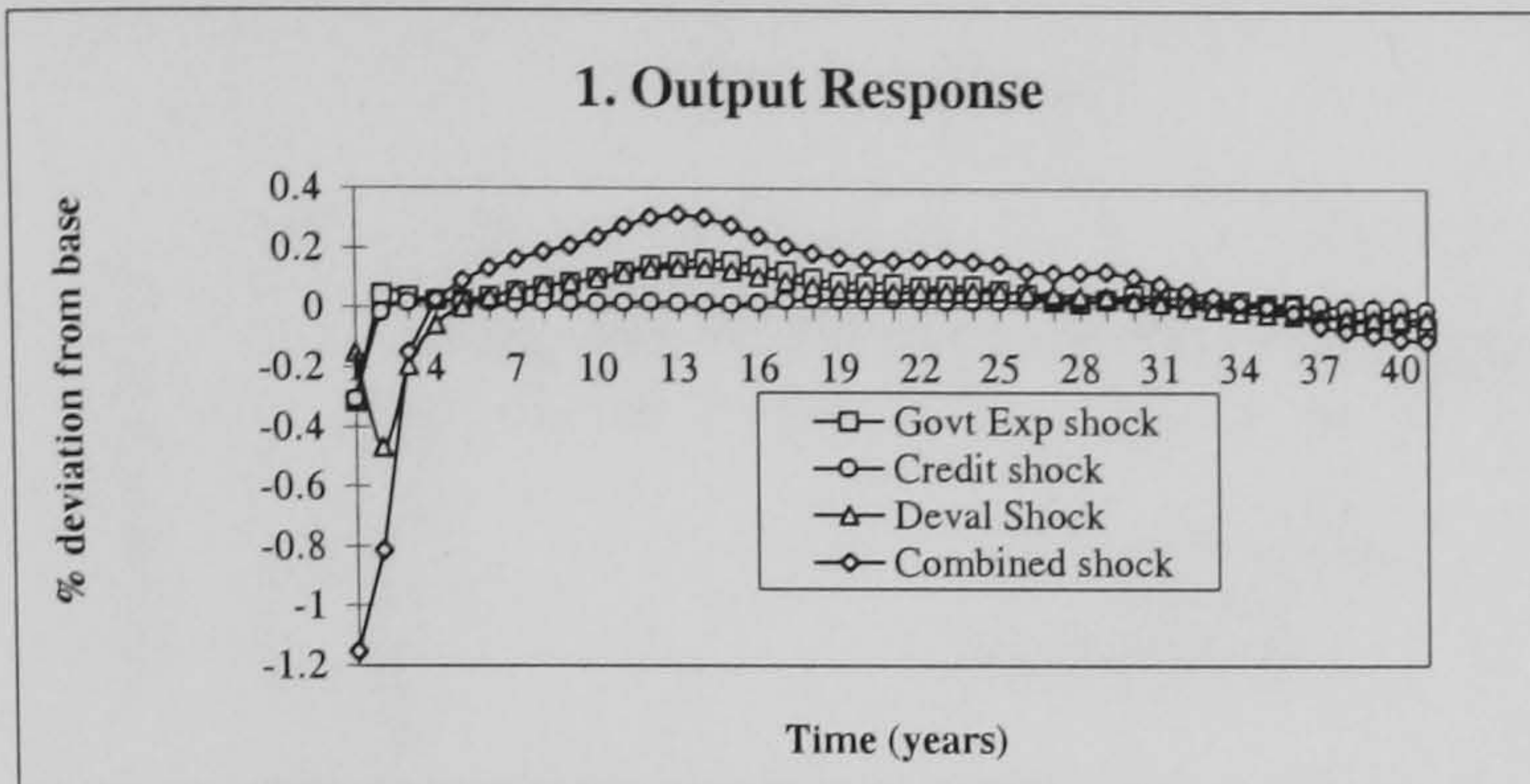


CHART 5.2 : SIMULATION OF THE EXTENDED MODEL

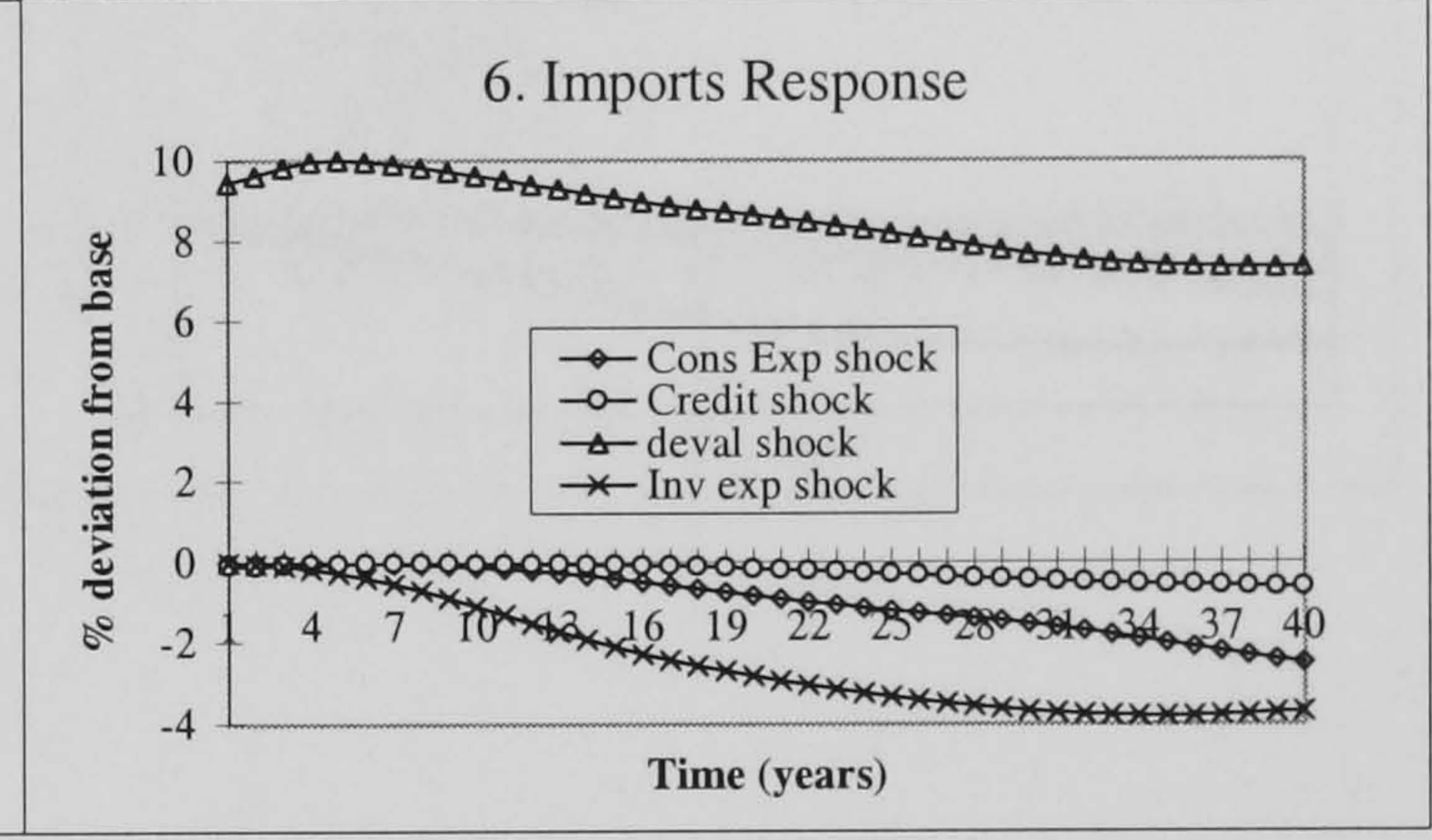
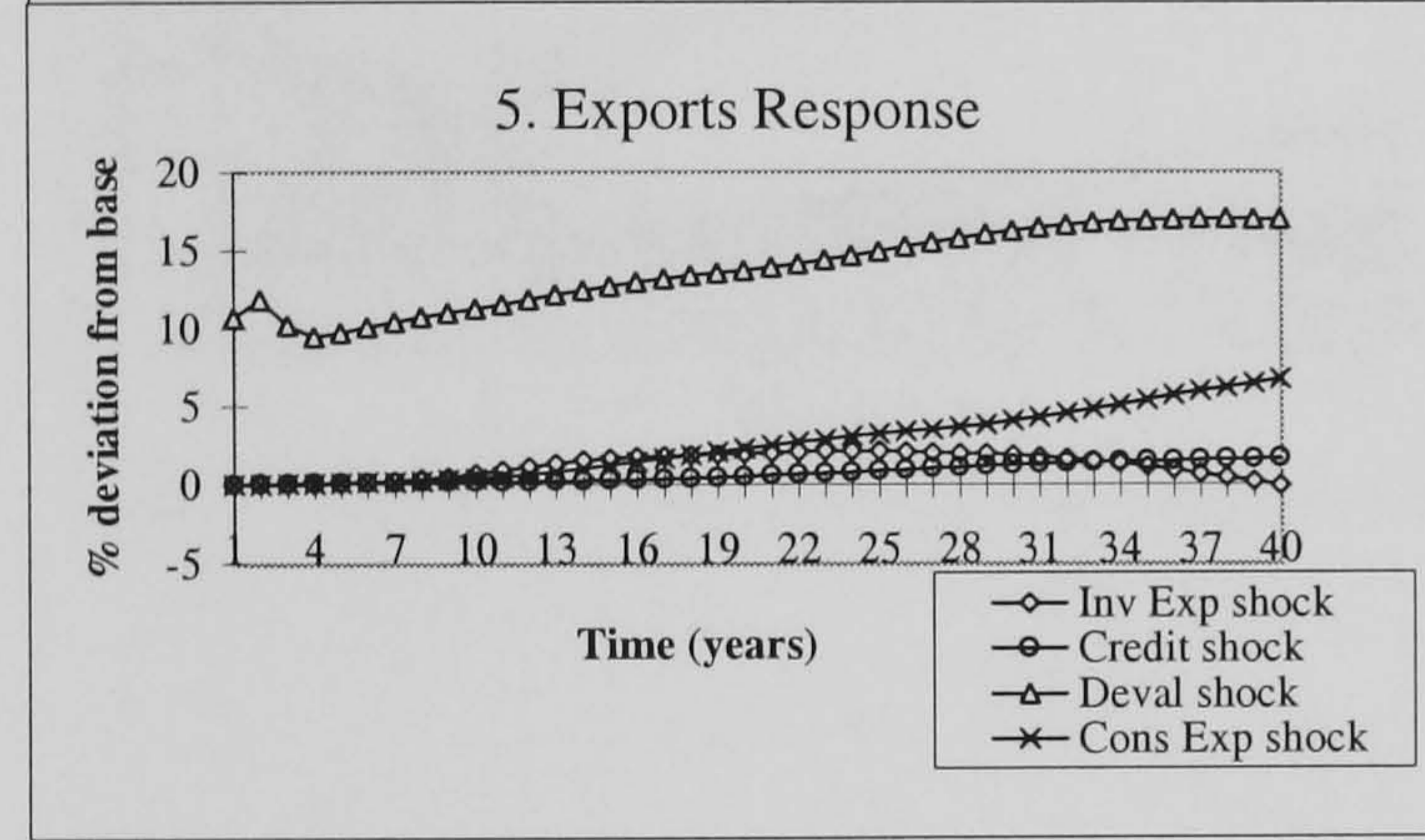
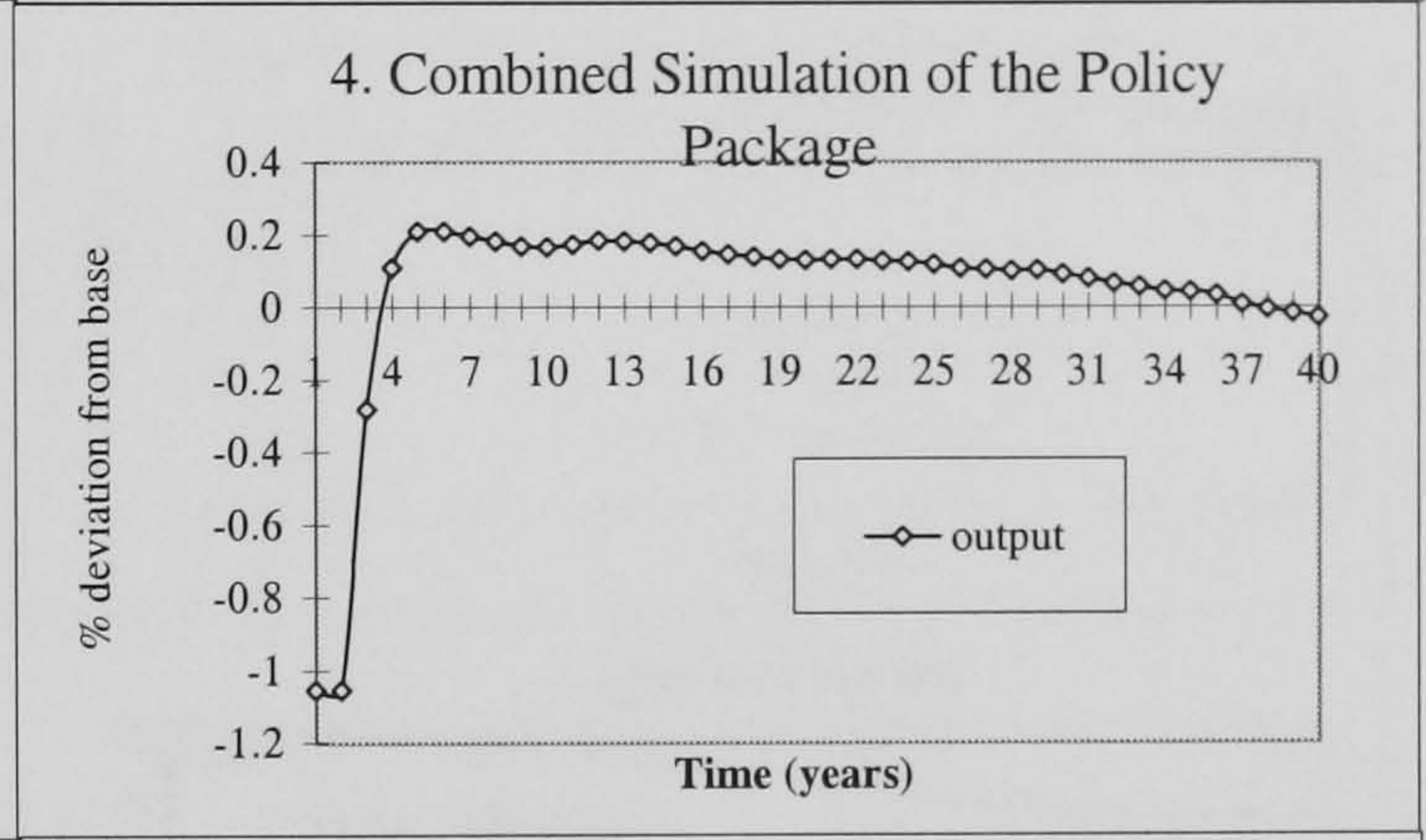
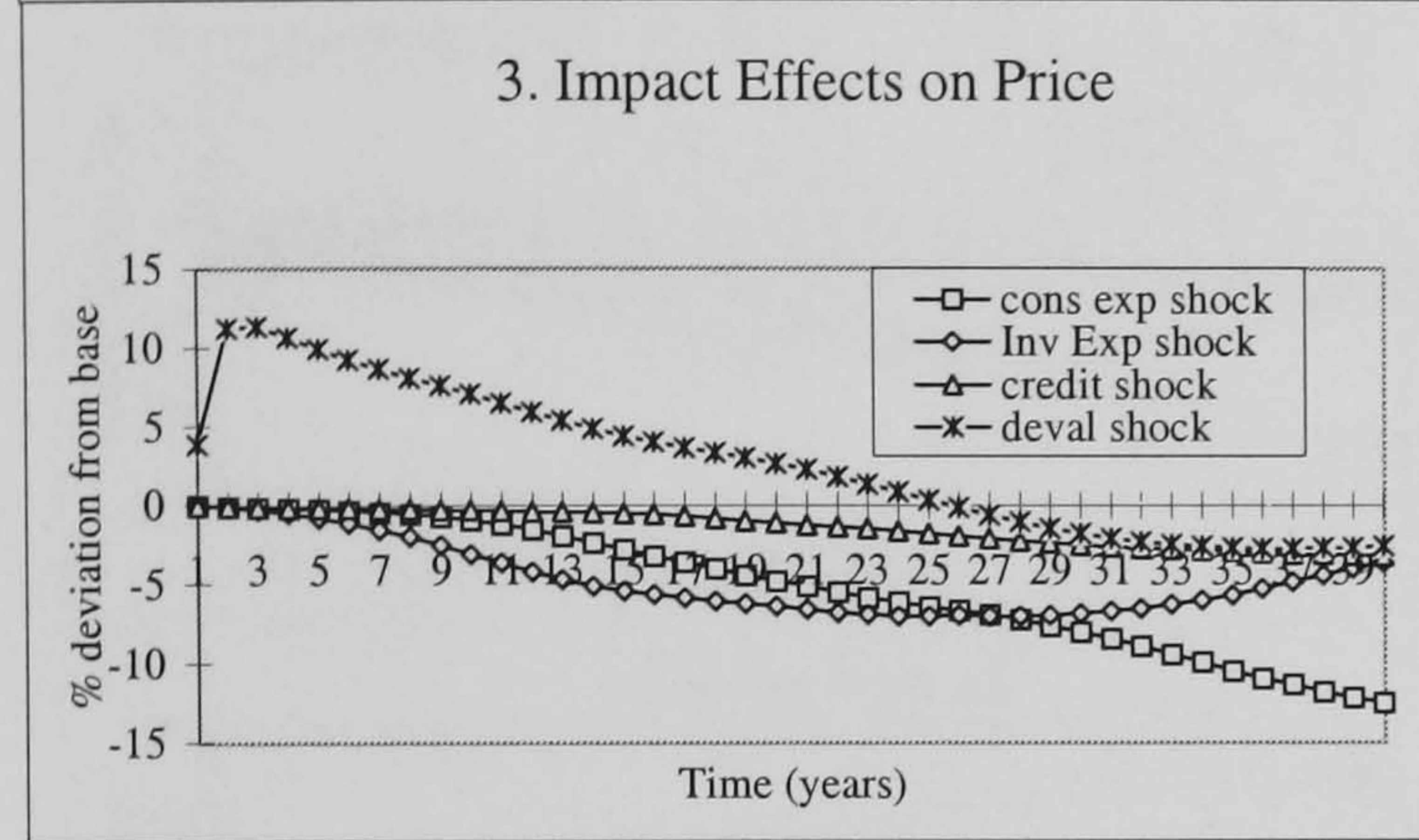
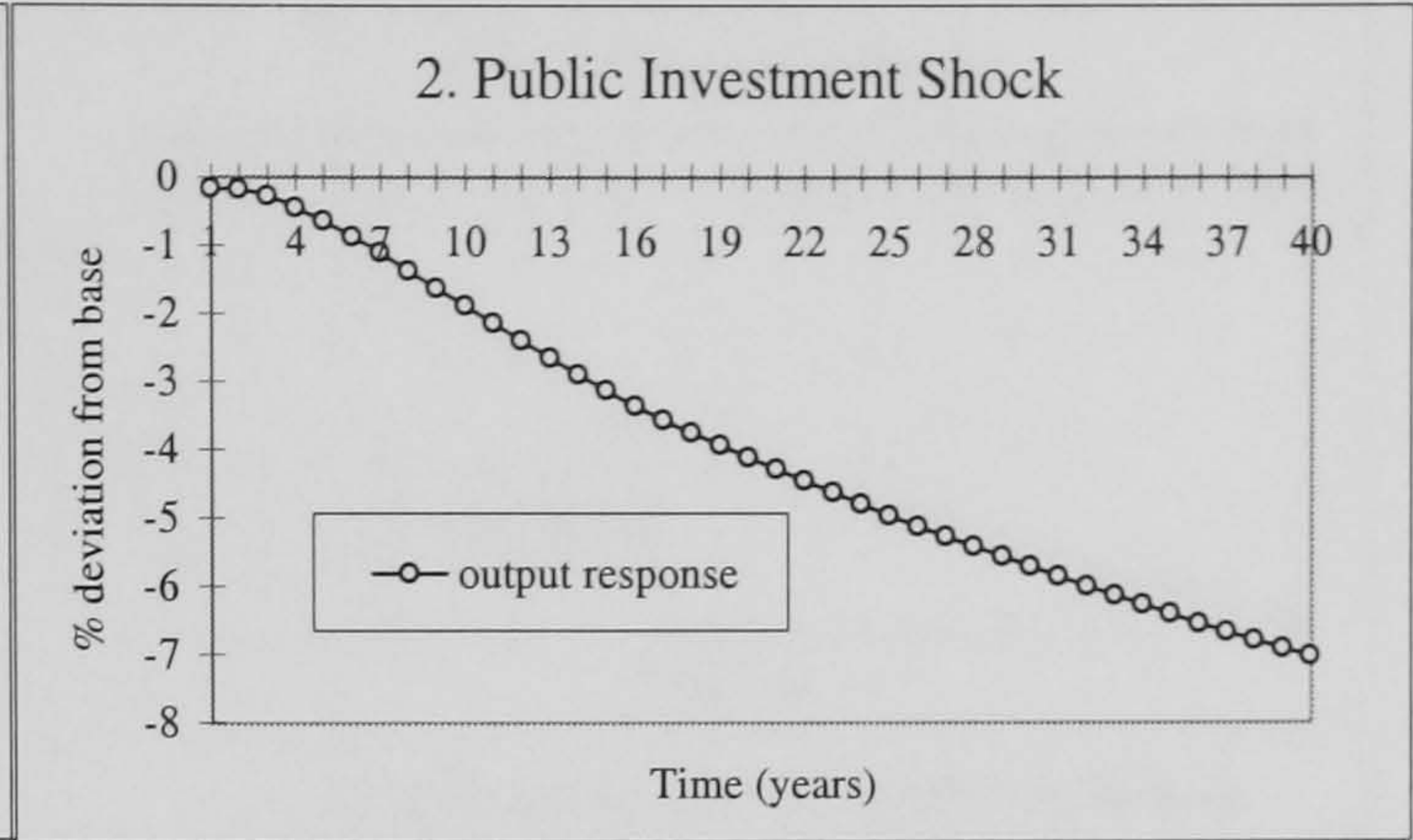
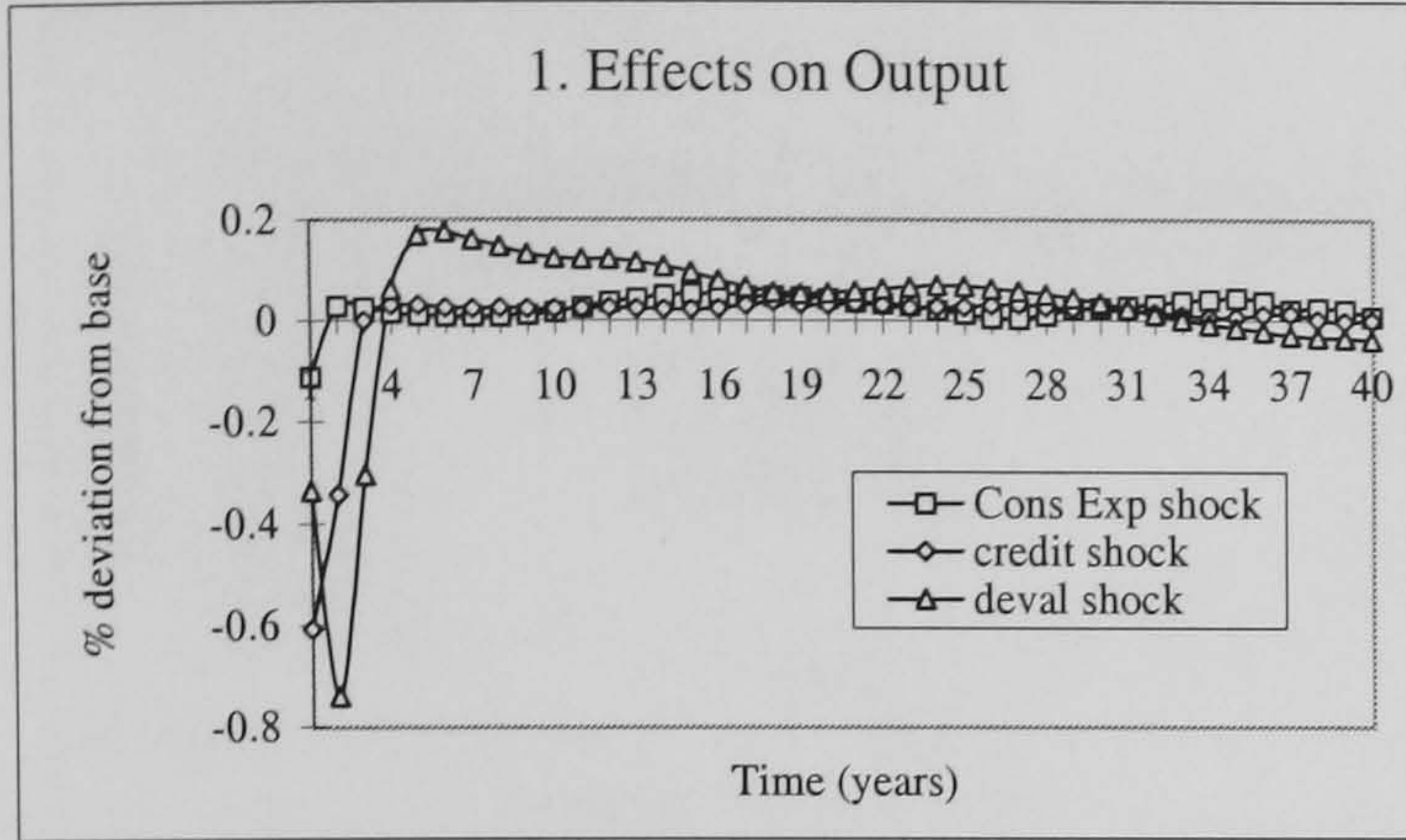


CHART 5.3 : SIMULATION OF THE EXTENDED MODEL WITH RATIONAL EXPECTATIONS

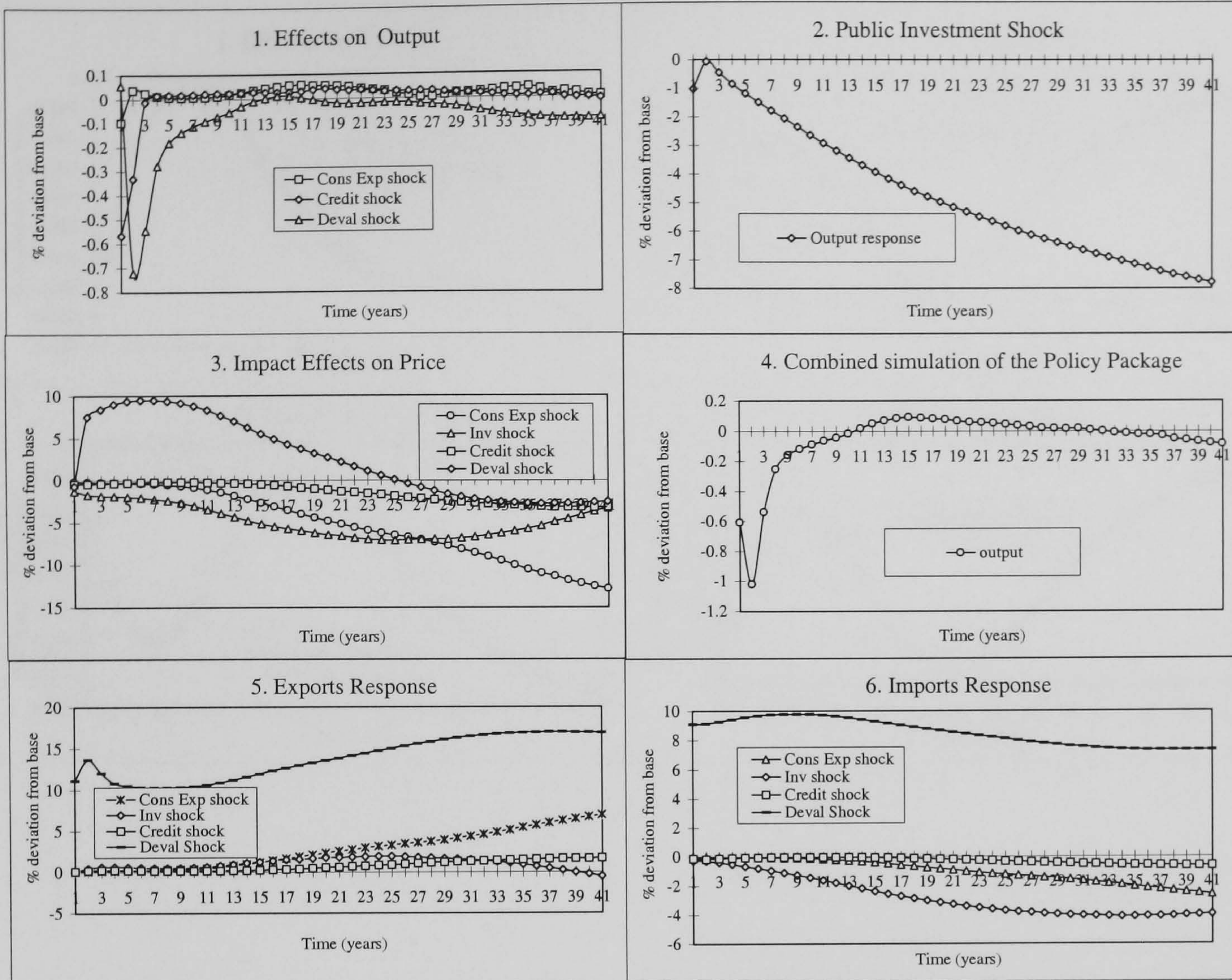
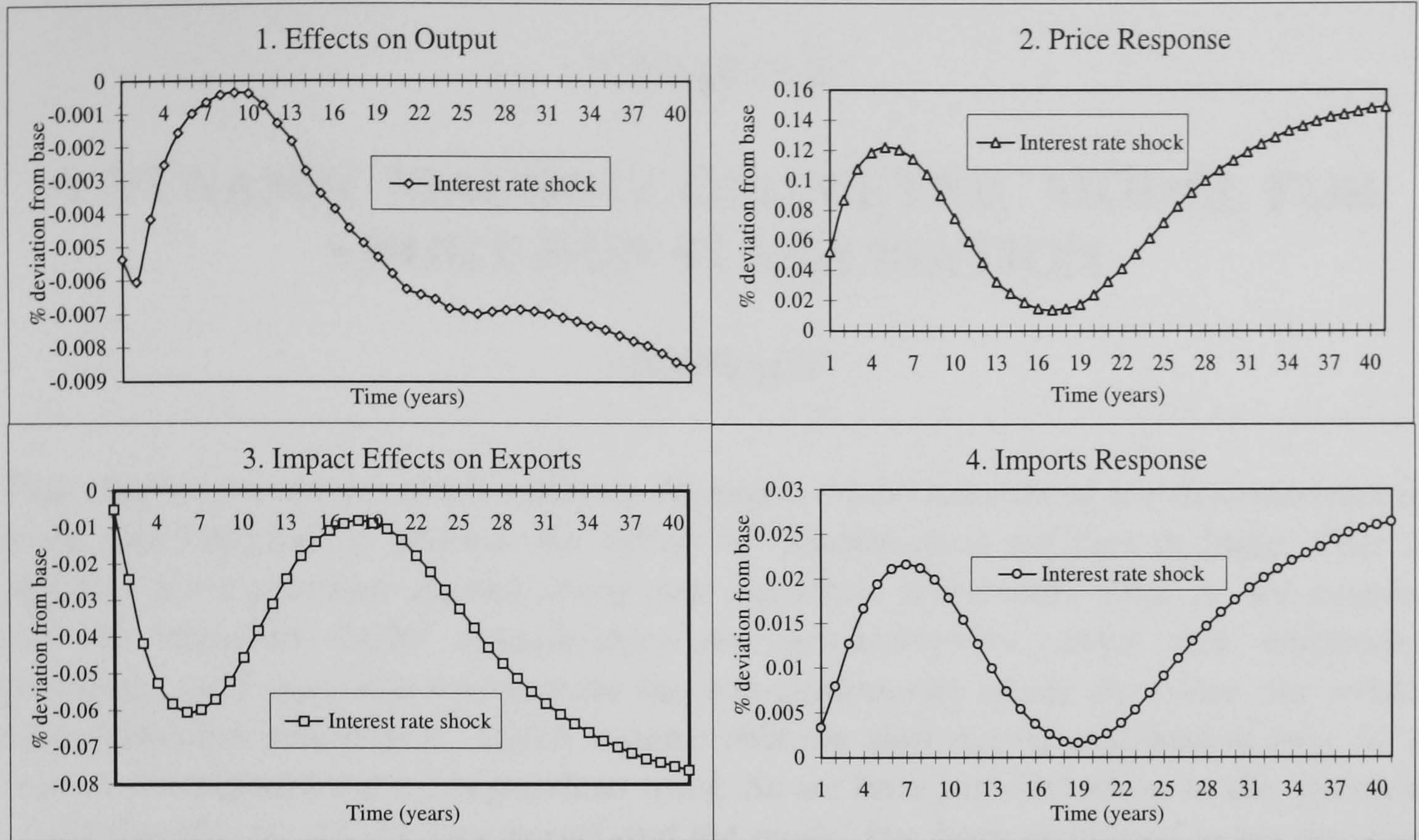


CHART 5.4 : SIMULATIONS OF THE FINANCIAL LIBERALISATION



## Chapter 6

# A DYNAMIC MACROECONOMETRIC MODEL FOR SHORT-RUN STABILISATION

### ABSTRACT

*This chapter presents a small macroeconomic model examining the determinants of trade and inflation to address the effects of stabilisation policies in India. This is different from previous studies along one important dimension. That is, we assume that the variables under consideration are non-stationary rather than stationary processes, and explicitly incorporate the non-stationarity of the data into our model and estimation procedures, which suggest that the stationarity assumption may be a source of misspecification in previous work. So we have paid attention to the question of stationarity for all the time series and the model has been estimated using the data from 1950 to 1995 employing fully-modified Phillips-Hansen Method of estimation. The cointegrating relations obtained justify the need for a short-run dynamic model which has then been estimated. This chapter examines the effects of a reform policy package which are similar to those implemented in 1991 on the Indian trade and inflation using dynamic simulations method. Policy simulations compare the dynamic responses to devaluation with the responses to tight credit policy. It is shown that the trade balance effects of tight credit policy are more enduring than those of devaluation. The simulations demonstrate that the devaluation has actually worsened the trade balance and hence devaluation is not an option in response to a negative trade shock, whereas the reduction in domestic credit produces a desirable improvement in the trade balance.*

### 6.1 INTRODUCTION

In the previous chapter we examined a standard model of stabilisation and growth to show how it is not growth-inducive. However the previous exercise being a simulation model for a cross-section of DEs, we intend to model the inter-relations between trade and inflation in this chapter for the Indian economy using a modelling strategy which develops structural econometric models via sequential reduction of a congruent vector autoregressive data representation. The Indian economy went



through severe fiscal and external imbalances in the summer of 1991. On July 4, 1991 the Government of India undertook the major task of fundamentally altering its development paradigm by announcing a massive dose of devaluation and other major policies aimed at reducing the fiscal deficit and the current account deficit. These two instruments, namely reducing the Central bank credit to the Government (which is the major source of financing the fiscal deficit) and devaluing the currency are the standard instruments currently employed in many countries that are undergoing BoP crises. The basic questions that arise in this context are: (i) whether devaluation or reduction in domestic credit is a solution to BoP crisis? (ii) by how much should the Government reduce its credit leading to reduction in fiscal deficit? and (iii) by how much should the Government devalue the Indian rupee? In other words, can we evaluate alternative devaluation strategies. Thus the major focus of this chapter is to answer these quantitative economic questions following the policy model of Sundararajan (1986) [henceforth VS]. But our study is different from VS in the sense that VS did not pay any attention to the question of stationarity while dealing with the time series. This comment also applies to the subsequent studies following VS (Murty and Prasuna, 1994; Paul, 1994; Verma, 1994). Krishnamurty and Pandit (1996) is a very recent model of India's trade flows, which is a part of the on-going project "Macroeconometric Modelling for India" supported by the National Science Foundation, USA, but suffers from the same criticism as the above studies (i) by not paying any attention to the new econometric literature, not even the equation diagnostics of a dynamic model (ii) model specifications are very conventional by adding a lagged dependent variable in the export and import equations to allow for slow adjustment. However, it is now well known that traditional ways of estimating

time series models may suffer from the spurious regression problem (Granger and Newbold, 1974) and attention should be paid to the potential non-stationarity of the time series.

This chapter analyses the determinants of India's trade balance and inflation during 1950-51 to 1995-96 using behavioural equations explaining the demand for real balances, the price level, export demand, export supply and imports, and definitional equations specifying the money supply formation and the BoP identity. We use the basic theoretical set-up of VS model and re-model it within a systematic econometric framework in order to evaluate the comparative performance of the dynamic responses to devaluation and tight credit policy. A distinguishing feature of this study is that it provides a supply side model of inflation in addition to the treatment of the demand factor. Contrary to VS's claim of the superiority of devaluation over tight credit policy, our policy simulations show that the trade balance effects of tight credit policy are more enduring than those of devaluation and the devaluation has actually worsened the trade balance, whereas the reduction in domestic credit produces a desirable improvement in the trade balance and is more effective in reducing inflation. The arrangement of this chapter is laid out as follows. In section 6.2, we present the analytics of the VS model and outline its critiques. Section 6.3 presents an alternative model of inflation. The model results are presented in section 6.4, and policy simulations of the model are in section 6.5. This chapter is concluded with a brief recapitulation of the key points in section 6.6.

## 6.2 ANALYTICS OF THE STABILISATION MODEL

The official quantitative modelling exercises to back-up the Government policies in India on determining the impact of fiscal deficit and exchange rate instruments are virtually non-existent. The policies being currently employed in India are known to be based on a CGE Model that is available with the IMF and the World Bank<sup>1</sup>, and they stand on global structural adjustment experiences gathered by the IMF and the World Bank Staff. Further we feel that while there exists extensive literature on the experience of structural adjustment policies in various DEs there is no econometric model following the new time series literature to analyse the current account deficit problems facing India. Hence we limit the scope of this chapter to build an aggregate macroeconomic model to explain the balance of payments and general price level.

Our model derives its starting point, both theoretical and analytical from VS, a quantitative economic policy model. VS employed the standard Monetary Approach to BoP which is the basis of the IMF's policy framework. VS model is based on a fairly standard economic paradigm with little or no role for supply-side factors. Hence we need to emphasise both money and supply-side factors in price formation along with the incorporation of some of the recent developments on structural adjustment experiences in India by updating the database. Since the role of prices is important in determining trade flows and thereby trade balance, we need to know exactly how best to model the price formation process. In our view, the best way to model inflation is

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<sup>1</sup> For a summary of the CGE model, see World Bank, 1996, pp.133-34.

by bringing together both the demand and supply factors as determinants of inflation. The basic econometric model we use here is an adaptation of the model proposed by VS to compare the dynamic responses to devaluation with the responses to tight credit policy, which does not model the price formation process in India. The VS model is described as follows:

### 6.2.1 The VS Model

#### 1. Price Equation

$$\ln P_t = -v\alpha_0 + \ln(M_t) - v\alpha_1 \ln(YM_t) + v\alpha_2 \sigma_0 \pi_t + v\alpha_2 \sum_1^n \sigma_i \pi_{t-i} - (1-v) \ln(M_{t-1}) \quad [6.1]$$

#### 2. Definition of inflation

$$\pi_t = \ln(P_t) - \ln(P_{t-1}) \quad [6.2]$$

#### 3. Definition of desired real balances

$$\ln\left(\frac{M}{P}\right)_t^d = \alpha_0 + \alpha_1 \ln(YM_t) - \alpha_2 \sigma_0 \pi_t - \alpha_2 \sum_1^n \sigma_i \pi_{ti} \quad [6.3]$$

#### 4. Unit value of exports

$$\ln(PX_t) = \beta_0 + \beta_1 [\ln(P_t) - \ln(E_t + S_t)] - \beta_2 \ln(PW_t) - \beta_3 \ln(Y_t) + \beta_4 \ln(YW_t) + \beta_5 \ln(X_{t-1}) - \beta_6 \left[ \left(\frac{M}{P}\right)_t^d - \left(\frac{M}{P}\right)_{t-1} - \Delta\left(\frac{D \cdot K}{P}\right)_t \right] \quad [6.4]$$

#### 5. Export demand

$$\ln(X_t) = \delta_0 - \delta_1 \ln\left(\frac{PX}{PW}\right)_t + \delta_2 \ln(YW_t) + \delta_3 \ln X_{t-1} \quad [6.5]$$

#### 6. Imports

$$I_t = \phi_0 + \phi_1 \frac{PM_t (E_t + T_t)}{P_t} + \phi_2 Y_t + \phi_3 EI_t + \phi_4 \left[ \left(\frac{M}{P}\right)_t^d - \left(\frac{M}{P}\right)_{t-1} - \Delta\left(\frac{D \cdot K}{P}\right)_t \right] + \phi_5 \left[ \frac{KI_t + X_t \cdot PX_t}{PM_t} \right] + \phi_6 R_{t-1} + \phi_7 I_{t-1} \quad [6.6]$$

$$7. \text{ Money supply identity: } M_t = K_t (R_t + D_t) \quad [6.7]$$

#### 8. Balance of payments identity

$$R_t = R_{t-1} + X_t \cdot PX_t \cdot E_t - I_t \cdot PM_t \cdot E_t + KI_t \cdot E_t \quad [6.8]$$

*Endogenous Variables:*

$P_t$  is the price level (represented by the wholesale price index),  $\pi_t$  is the rate of inflation,  $M_t$  is the nominal money supply ( $M_3$ ),  $(M/P)^d$  is the desired real balances,  $PX$  is the unit value of exports in US dollars,  $X_t$  is the export volume,  $I_t$  is the import volume,  $R_t$  represents the foreign exchange reserves in rupees.

*Exogenous Variables:*

$YM$  is the marketed output,  $Y_t$  is the national income at constant prices,  $YW$  is the real GNP of trading partners,  $E_t$  is the nominal exchange rate (Rs per US\$1),  $S_t$  is unit export subsidies (Rs per US\$1),  $T_t$  is unit import duties (Rs per US\$1),  $PW$  is world price level (in US\$),  $PM_t$  is the import unit value in US\$,  $KI_t$  refers to net foreign assets of the non-banking sector (in US\$),  $EI_t$  is the essential imports,  $D_t$  is net domestic assets of the Reserve Bank of India,  $K_t$  is the money multiplier.

### 6.2.2 Critiques of the VS Model

The VS model is a semi-dynamic model with traded and non-traded goods and one asset - money. There are no explicit equations for the non-traded goods market. The level of real output is exogenous. The model was used to compare the dynamic responses of devaluation and tight credit policy on inflation and trade balance. The following points are pertinent in this regard:

1. The model does not describe the price formation process. Instead it derives a model of price determination by simply inverting the real money balances equation, which is indeed ambiguous as to what explains inflation except money. Hence we need to provide a model of price determination by following the literature on Indian inflation.
2. VS considered only temporary shocks to evaluate the dynamics of devaluation and tight credit policy, what actually happens during an economic crisis is a permanent shock, hence there is a need to consider both temporary and permanent shocks.
3. The model is not truly dynamic in the sense of assuming all the variables to follow a dynamic process, and thus the approach to dynamics needs the respecifying equations:

- (a) The actual stock of real balances in VS model assumed to have a partial adjustment mechanism that adjusts proportionally the difference between the demand for real money balances and the actual stock in the previous period, but we abandon this assumption and instead we add an interest rate variable in the money demand relation that makes the excess money demand a stationary process and the error correction term resulting from this money demand relation would be the adjusting variable. Hence the specification of the lagged adjustment of real money stock is no longer important.
- (b) The role of lagged exports variable was used in VS to approximate the slow adjustment of consumers to changes in relative prices, which we have excluded as we do not intend to combine a long-run relation with short-run adjustment.
- (c) The actual level of imports was assumed in VS as a distributed lag function of the permitted level of imports with Koyck type geometrically declining lag coefficients, which we have abandoned assuming that the permitted level is equal to the actual level of imports. Moreover our assumption excludes the introduction of lagged imports variable in the long-run imports equation unlike the traditional specifications that combine a long run relation with short-run adjustment.
- (d) When all the equations in the VS model are log-linear except import equation which is linear, we have made the import function as log-linear because they are traditionally estimated in log-linear form (see Sedgley and Smith, 1994).
- (e) Other aspects of the model are left as in VS including the exogeneity of  $Y$ , barring a few other empirical issues that need investigation in section IV.

### **6.2.3 Monetary Disequilibrium**

The demand for money equation is fairly standard as in VS, but it includes interest rate as an additional argument. The desired stock of real money balances  $(M/P)^d$  is

related to marketed output<sup>2</sup> rather than real national income, interest rate (IR), and the expected rate of inflation ( $\pi^e$ ) that follows a general distributed lagged process:

$$\ln\left(\frac{M}{P}\right)_t^d = \alpha_0 + \alpha_1 \ln(YM_t) - \alpha_2 \ln(IR_t) - \alpha_3 \pi_t^e \quad [6.9]$$

where  $\pi_t^e = \sigma_0 \pi_t + \sum_{i=1}^n \sigma_i \pi_{t-i}$  with  $0 \leq \sigma \leq 1$ , implying that the weights sum upto

unity. This can also be written recursively as  $\pi_t^e = \sigma \pi_{t-1}^e + (1 - \sigma) \pi_{t-1}$  or

$\pi_t^e - \pi_{t-1}^e = (1 - \sigma)(\pi_{t-1} - \pi_{t-1}^e)$  which is a first-order adaptive expectations model. We

have generated the expected rate of inflation ( $\pi^e$ ) series numerically using the optimal

estimate of  $\sigma$  obtained by Rao (1997) which is defined as:  $\pi_t^e = 0.617 \pi_{t-1}^e + 0.383 \pi_{t-1}$ .

The expected and actual rates of inflation are shown in Graph 6.1. The expected inflation seems to follow the actual inflation with a lag.

The money supply equation is modelled within the framework of money multiplier theory of money stock. Supply of money is a definitional relation which links the reserve or high-powered money through the money multiplier as shown in equation 6.7 above. The excess flow demand for real money balances (ED) can now be defined as  $ED_t = (M/P)_t^d - (M/P)_{t-1} - \Delta(D^*K/P)_t$ . It is a measure of the excess flow demand for money in which  $(M/P)_t^d - (M/P)_{t-1}$  measures the gap between desired real balances and the existing stock of real balances, and  $(D^*K/P)_t$  measures the stock of real balances supplied domestically either through fiscal deficits or through the Central Bank's net lending to the commercial sectors.

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<sup>2</sup> The currently marketed output derives its source mainly from the current non-agricultural output and the lagged agricultural output.

#### 6.2.4 Export Function

The volume of exports depends on the relative price of exports which exhibits the profitability of producing and selling exports [captured by the ratio of export prices (inclusive of export subsidies) to domestic prices -  $(PX(E+S)/P)$ ], real output and excess flow demand for real balances:

$$\ln X_t^s = \varphi_0 + \varphi_1 \ln (PX(E+S)/P)_t + \varphi_2 \ln Y_t + \varphi_3 ED_t$$

The world demand for India's exports is specified as a function of a trade-weighted average of real output in other countries and the real exchange rate or the competitiveness, defined as the ratio of prices of Indian exports relative to foreign prices.

$$\ln(X_t^d) = \delta_0 - \delta_1 \ln\left(\frac{PX}{PW}\right)_t + \delta_2 \ln(YW)_t + \delta_3 \ln(E)_t \quad [6.10]$$

Equating export supply with export demand, the reduced form equation for the unit value of exports can be derived as shown below:

$$\ln PX_t = \beta_0 + \beta_1 [\ln P_t - \ln(E_t + S_t)] - \beta_2 \ln PW_t - \beta_3 \ln Y_t + \beta_4 \ln YW_t + \beta_5 ED_t \quad [6.11]$$

This export supply function incorporates both monetary factors and relative price factors including export subsidies. The hypothesis regarding the impact of monetary disequilibrium is that when there is excess flow demand for money, it is expected to reduce real expenditures on both tradables and non-tradables, which would then reduce domestic demand for exportables and hence the export supply will increase. Though Prasad (1992) has claimed to be respecifying export demand and export supply functions, the reduced form is no way different from the one mentioned here.



### 6.2.5 Import Function

The long-run desired import demand ( $I^d$ ) is influenced by competitiveness or the relative price of imports, real national income, and the excess flow demand for real balances:

$$\ln I_t^d = \gamma_0 - \gamma_1 \ln((PM(E+T)/P))_t + \gamma_2 \ln(Y)_t + \gamma_3 \ln(I_F)_t - \gamma_4 ED_t \quad [6.12]$$

Actual imports in India were subject to a considerable degree of control and the volume of imports permitted by the authorities were through the import licensing system. Hence it is assumed that the import policy had two competing objectives: to allow the level of imports to be as close as possible to the desired import level, and to maintain real reserves as close as possible to the desired reserve level.<sup>3</sup> The two objectives are necessarily in conflict and a compromise is reached through a linear decision rule.

$$\ln I_t^P = (1 - \eta) \ln I_t^d + \eta [\ln F_t - (\ln R_t^* - \ln R_t)] \quad [6.13]$$

where  $I^P$  is the permitted volume of imports,  $F$  is the foreign exchange receipts in the form of net capital inflows,  $R^*$  is the desired reserve level.

The desired level of reserves is specified as a function of long run exchange receipts as perceived by the authorities.

$$\ln R^* = \kappa_0 + \kappa_1 \ln F^* \quad [6.14]$$

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<sup>3</sup> Krishnamurty and Pandit (1996) claim that under the new policy environment in India the stock of foreign currency reserves deflated by import unit value index cannot be taken as a determinant of the volume of imports because during the erstwhile policy regime imports were rationed according to priorities and in doing so foreign currency reserves served as a resource constraint. Since the sample used in this study spans from 1950 onwards, we keep this variable as a determinant of import demand.

where  $F^*$  is the long-run exchange receipts. Thus the actual level of imports is equal to the permitted level of imports. We have made a few modifications to the VS model from an empirical point of view: (a) we have replaced  $R_{-1}$  with real foreign exchange assets such as  $(R/PM)$  in the imports equation, as it is a real import demand equation. (b) Since the data on  $R$  includes foreign exchange earnings through exports, we do not include this again while defining the real capital inflows variable, i.e.,  $(KI/PM)$  in the import demand equation. Assuming for simplicity the long-run exchange receipts can be approximated by the current exchange receipts (i.e.,  $F^*=F$ ), and substituting eqs. [6.13], [6.14] into [6.12], we get the following import function:

$$\ln I_t = \phi_0 - \phi_1 \ln\left(\frac{PM_t(E_t+T_t)}{P_t}\right) + \phi_2 \ln Y_t + \phi_3 \ln EI_t - \phi_4 ED_t + \phi_5 \ln\left[\frac{KI_t}{PM_t}\right] + \phi_6 \ln\left(\frac{R_t}{PM_t}\right)$$

[6.15]

where

$$\phi_0 = -\eta\kappa_0 + (1-\eta)\gamma_0; \phi_1 = (1-\eta)\gamma_1; \phi_2 = (1-\eta)\gamma_2; \phi_3 = (1-\eta)\gamma_3; \phi_4 = (1-\eta)\gamma_4; \\ \phi_5 = \eta(1-\kappa_1); \phi_6 = \eta;$$

### 6.3 DYNAMICS OF INDIAN INFLATION

Research on the nature and sources of Indian inflation has been guided by competing theoretical explanations. There is no clear view about which variables determine prices at the macroeconomic level. The Monetarist proposition on the acceleration of inflation stresses the quantum and cost of money, whereas the Structuralist explanation of inflation stresses wage cost, raw material cost, and capacity utilisation (see Agenor and Montiel, 1996). Further, it has been argued and well established that

cost-push phenomena play a more vital role in determining the course of price movements than the demand-pull factors. Nevertheless, it has been observed in chapter 2 that the studies incorporating structural factors in causing inflation have not taken due note of the demand pull factors and studies which emphasise monetary factors have not given adequate attention to the cost-push factors. Hence there is difference of opinion and evidence regarding price formation in the Indian economy. A more complete model explaining inflation should incorporate both demand and supply side factors. To the extent that these two types of studies do not incorporate adequately both these factors, each one of them may be overstating the influence of either the demand-pull or the cost-push factors. It is quite possible that certain prices are affected more by one type of factor than the other. There is therefore a need for a detailed analysis on price formation behaviour prior to considering its stabilisation through various possible policy responses.

In view of the recent opening up of the Indian economy, the external component has an important role to play in domestic price formation by incorporating the effect of exchange rate variations. Hence to analyse the dynamics of inflation in the Indian economy, we need a model that incorporates the tradable/nontradable distinction and allows for differentiated tradables. This decomposition into domestic (non-tradable) and external (tradable) components in price formation has not been dealt with in the existing models of inflation [for example, Ghatak and Deadman (1989), Balakrishnan (1991), Ghani (1991), Joshi and Little (1994), and Sen and Vaidya (1995), Rao

(1997)].<sup>4</sup> In VS model, the re-arranged price equation assumes a monetarist model where a reduction in money supply may control inflation. But a monetary squeeze may not reduce rates of inflation if price formation is determined by structural rigidities or real disproportionalities, and based on mark-ups, administered-pricing and cost-indexation (Nayyar, 1995). Among non-monetary factors, food supply and government buffer stock operation through public distribution system and import price are other determinants of the inflation rate. The relative disparity between agricultural and non-agricultural income is an important factor behind inflation. In recent years however, the importance of this factor has declined due to lower elasticity of employment with respect to non-agricultural income. There is also a possibility of an increasing inflation rate due to a wider discrepancy between service income and commodity output growth, especially in the eighties (Bhattacharya and Lodh, 1990). However, the existing models are not capable of forecasting the path of future inflation satisfactorily.

The model that has guided specification of the price equations in this chapter is discussed in Corbo (1985). Let the index of the general price level be decomposed into a weighted average of the price of tradables and nontradables. This distinction is important since a large chunk of goods in India are non-tradables. The price of tradables can be defined as the weighted average of the price of homogeneous tradables and differentiated tradables.

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<sup>4</sup> Moreover, foreign influence on domestic component of price level is not entirely due to the behaviour of import prices, the transmission could also be through interest rates, where domestic nominal interest rate is given by the constant world interest rate plus the devaluation rate. High interest rates do contribute to cost-push inflation as well. This gives us another reason why we need to include flow excess demand for money as it is influenced by the interest rates and causes inflation.

Defining the general price level,  $P$ , a weighted average of the prices of traded goods,  $P^T$ , and prices of nontraded goods,  $P^N$  with weights  $\theta$  and  $(1-\theta)$ , it can be written in logs as

$$\ln P_t = \theta \ln P_t^T + (1 - \theta) \ln P_t^N$$

We assume that the price of traded goods is a weighted average of the price of agricultural tradables,  $P^A$ , and industrial tradables,  $P^I$ :

$$\ln P_t^T = \mu \ln P_t^A + (1 - \mu) \ln P_t^I.$$

For homogeneous agricultural tradables, we assume that there is law of one price. The law of one price states that in the absence of transport costs and market imperfections, free trade delivers an unique market-clearing price for a homogeneous commodity, such that further arbitrage is uneconomic. Conventionally, agricultural price has been visualised to be a flex-price, though for some commodities such as rice, wheat, sugar and edible oils, prices are fixed by the government. We write the agricultural price equation as determined by the market:

$$\ln P_t^A = \ln IPA_t + \ln E_t$$

where  $IPA_t$  refers to international price of domestically consumed agricultural tradables expressed in foreign currency.

Price of industrial tradables is assumed to be a function of the unit labour costs, price of imported raw materials, and excess demand:

$$\ln P_t^I = \tau_0 + \tau_1 (\ln WM_t - \ln QM_t) + (1 - \tau_1) (\ln IPRM_t + \ln E_t) + \tau_2 ED_t$$

where QM is average labour productivity in the manufacturing sector. WM is the nominal wage in manufactured goods sector. The costs of intermediate inputs should be made explicit here as production in DEs is strongly dependent on imported inputs, such as fertilizer for agriculture, petroleum for energy and so on. The parameter value would reflect the extent to which the country depends on imported raw materials in the production of its output. We impose a unit restriction on the supply-side variables, where the coefficient  $\tau_1$  measures the importance of domestic costs. In order to avoid difficulties with the logarithm of a negative number, ED is included without taking its logarithm. ED is primarily a type of term reflecting cyclical variation in mark-up and hence the presence of this disequilibrium term in the long-run model.

The price of nontraded goods is formed from three sources. First, movements in prices are assumed to be determined as a mark-up over unit labour costs in the long-run; second, any rise in the price of imported intermediate goods leads to rise in the price of non-tradables; third, money market disequilibrium (ED). This disequilibrium concept has an important implication for the dynamic effects of monetary policy on the price level through change in domestic credit. Thus,

$$\ln P_t^N = \lambda_0 + \lambda_1(\ln WN_t - \ln QN_t) + (1 - \lambda_1)(\ln IPRM_t + \ln E_t) + \lambda_2 ED_t$$

where QN and WN are the average labour productivity and wage in the non-tradable sector respectively. For wage formation, we assume that the relative wage between the tradeable and nontradeable sector is constant, i.e.,  $WM = WN$ .<sup>5</sup> We also for

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<sup>5</sup> Though the rate of change of wages in the tradeable sector can take the form of an expectations-augmented Phillips curve, since wages are indexed to previous period inflation, we do not intend to include this in the present model because output is exogenous.

simplicity assume that  $QM=QN$  due to data problem. For the cost-push variables, the coefficients add up to unity.

The above relationships can now give us the following estimating price equation:

$$\ln P_t = \omega_0 + \omega_1(\ln IPA_t + \ln E_t) + \omega_2(\ln WM_t - \ln QM_t) + \omega_3(\ln IPRM_t + \ln E_t) + \omega_4 ED_t \quad [6.16]$$

where,

$$\omega_0 = \theta(1-\mu)\tau_0 + (1-\theta)\lambda_0, \omega_1 = \theta\mu, \omega_2 = \theta(1-\mu)\tau_1 + (1-\theta)\lambda_1, \omega_3 = \theta(1-\mu)(1-\tau_1) + (1-\theta)(1-\lambda_1), \omega_4 = \theta(1-\mu)\tau_3 + (1-\theta)\lambda_3, \text{ and } \omega_1 + \omega_2 + \omega_3 = 1.$$

In this model,  $\frac{\partial P}{\partial E} \approx 1$  which means that the model is homogeneous in prices, but the continuous depreciation of the currency would not give rise to an equal change in the permanent rate of inflation as wage is exogenous. However, the idea of long-run homogeneity in the price equations has been accepted as very important in many supply-side models of inflation (For example, see Church and Wallis, 1994). Thus the idea is, once the link between demand and supply factors in price formation process are properly taken into account, the effect of devaluation becomes crucial to understanding the transmission mechanism of policy shocks to the price level. We demonstrate empirically, in the next section, both static (long-run) and dynamic (short-run) homogeneity in prices.

## 6.4 MODEL ESTIMATION

Dynamic specifications based on the Error Correction Mechanism (ECM) have been widely applied in empirical analysis of single equation models. Recent developments

in cointegration theory (Banerjee et.al., 1993; Hendry, 1995) have provided formal justifications for the use of such formulations in economic modelling. ECM specifications are then interpreted as modelling the short-run dynamics of the data around a long-run equilibrium relation among the variables. The very stylized model for the long-run relations which contain our structural hypotheses on the working of the system consists of a price equation [6.16], a money demand equation [6.9], exports price equation [6.11], export and import demand equations [6.10 & 6.15]. To verify that whether the included variables yield valid long-run equilibrium relations, we would subject each of the five equations to univariate cointegration analysis<sup>6</sup> and test whether they yield economically plausible parameters. The parameters of these equations have been estimated by the fully-modified OLS (FM-OLS) procedure proposed by Phillips and Hansen (1990). Model estimation is carried out on the basis of a sample of 46 annual observations pertaining to the period 1950 to 1995. The basic data are compiled from various sources which are given in the Appendix along with the notes.

#### **6.4.1 Pretests for Integration and Cointegration**

An informal examination of the data may be useful to give a preliminary idea of the time series properties of the variables. Graph 6.2 plots the (logarithms of) levels of all the variables and Graph 6.3 plots the first differences of the logarithms of the variables. The Graphs confirm that Non-stationarity is apparent in all the series. Data

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<sup>6</sup> This procedure has the drawback that, in the case of more than two time series, more cointegrating vectors may exist. Hence, we have carried out a preliminary investigation for the presence of other cointegrating vectors equation-wise via Johansen's system based estimation procedure, which does yield the presence of a single cointegrating relation. We cannot do a complete VAR analysis to infer  $r=5$  as we have too many variables with too few observations. However the equation-wise results can be obtained from the author.



on ED has been generated using its definition in Section 6.2.3. The spike in ED in the year 1989 is due to the positive excess money demand, which is due to the decline in domestic credit.

The starting point is to test for integration properties of the individual series using the Augmented Dickey-Fuller (ADF) tests with/without trend. These tests allow us to test formally the null hypothesis that a series is  $I(1)$  against the alternative that it is  $I(0)$ . In order to determine the order of integration, we must apply the test to the levels of the variables and then to the first differences of the variables. These results, which are reported in Table 6.1, clearly show that the null hypothesis of a unit root cannot be rejected except ED even at the 10% level of significance. Critical values for tests were computed using the response surface estimates given by MacKinnon (1991). We therefore conclude that the variables under consideration are well characterised as non-stationary or integrated of order  $I(1)$ . Based on the unit root tests for all the variables, the existence of long-run cointegrating equilibria can be tested in the next step.

#### **6.4.2 Empirical Results**

The central features of macroeconomic modelling consists of specifying and estimating contemporaneous and intertemporal linkages between economic variables. It is well known that in order to avoid the flaws in econometric modelling, which ignore the non-stationary nature of the data, we need a modelling representation that could capture both the long- and short-run dynamics by taking into consideration the potential co-

movement of the series. The cointegration approach of Phillips-Hansen (1990) provides an ideal framework for this representation.<sup>7</sup> So the equations are estimated employing FM-OLS estimation method as this method enables us to obtain consistent estimates of the parameters of the regression model.

When the series are  $I(1)$  and some of the regressors are endogenous, the OLS estimator is asymptotically second order biased (estimation in finite samples is biased and hypothesis testing over-rejects the null). This is why IV methods can be used. However, IV approaches, although better than OLS in term of efficiency, do not provide asymptotically efficient estimators. The FM-OLS method of Phillips-Hansen has specially been developed to deal with the presence of endogeneity in the regressors. The Phillips-Hansen estimator is asymptotically efficient (i.e., the best for estimation and inference) and does not require the use of instruments. The semi-parametric corrections used in the FM estimator (these are transformations involving the long run variance and covariance of the residuals) deal with endogeneity of the regressors and potential serial correlation in the residuals. In other words, Phillips-Hansen method is the best method that should be used in estimating a single cointegrating relation. Estimation is carried out using Microfit version 4.00 (see Pesaran and Pesaran, 1997).

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<sup>7</sup> Phillips-Hansen procedure is similar to Engle and Granger (1987) in the case of testing for cointegration as both follow residual-based tests. But for estimation of the parameters, the asymptotic distribution of the OLS estimator involves the unit-root distribution and is non-standard and hence carrying out inferences using the usual t-tests in the OLS regression will be invalid. The Phillips-Hansen FM-OLS takes account of this as opposed to standard OLS estimation method.

Table 6.3 presents parameter estimates of the long run cointegrating regressions. The residuals from these regressions are interpreted as disequilibrium terms measuring the discrepancies between actual values of the variables and their long-run equilibrium values. Such residuals are tested for stationarity or cointegration by employing ADF and PP tests, which are reported in Table 6.2. These test statistics allow us to reject the null hypothesis of no cointegration at 1% and 5% levels. These results suggest that the variables under study form a valid cointegrating relationships. In other words, the FM-OLS cointegration estimates suggest that all the equations are an adequately well specified long-run model of inflation and trade balance and no other variables are required to capture its long-run stochastic trend.

Overall, the coefficient estimates are of correct sign and of plausible magnitude and the tests confirm strongly that the variables are cointegrated. The residuals are denoted as equilibrium correction (EC) terms, such as, EC1, EC2, EC3, EC4, EC5 for each equation respectively. These EC terms may be important in affecting the short run dynamics of the model and are included (lagged one period) in the formulation of an ECM consisting of five dynamic (first difference) equations corresponding to the five long run relations. The ECM regresses the current value of the dependent variable, in stationary form, onto its own lagged values, current and lagged values of the stationary forms of the independent variables, and the lagged error term from the CR. The general to specific method is used to find a parsimonious representation of the relationship; that is, variables are deleted from the most general specification using the F-test of jointly zero coefficients. The results of the dynamic system estimates

along with the equation diagnostics are also reported in Table 6.3. The test results are in favour of the congruency of the unrestricted system. Each EC term is assumed to enter its own equation with a negative sign supporting the EC interpretation.<sup>8</sup> The diagnostic test statistics indicate that there is no evidence of serial correlation, of heteroscedasticity, of non-normality of the residuals. These tests broadly confirm that the estimated equations do not show evident sign of misspecification.

Now we are going to discuss each equation in turn. Our empirical finding for the question as to whether prices are determined by excess demand for money or by cost-push in India indicates that the cost-push factors are more important in causing price level than the excess demand as the magnitude of its impact is very negligible. Price level, measured by the wholesale price index is positively and significantly affected by the domestic unit labour costs and the cost of imported inputs (measured in US dollars). The cost-push factors satisfy the unit long-run homogeneity restriction in the price equation and the parameter estimates are statistically significant with correct a priori expected signs. Homogeneity of degree one is easily accepted by the data. The changes in import prices being significant implies that inflation, indeed seems to have been imported which is consistent with the analysis of Dalal and Schachter (1988) that has adopted an input-output framework. The money market disequilibrium is not significant in the price equation in the short-run, though it is so in the static equation. In a monetarist framework Sundararajan (1992) has shown that in the case of India the coefficients of money supply are not statistically significant, whereas in a structuralist

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<sup>8</sup> This one-to-one assignment of EC terms indicates that the  $\alpha$  matrix in Johansen notation is diagonal (above a block of zero).

framework the import price coefficients are significant. So our model that combines both demand and supply factors suggests a weak role of money in its influence on prices in India in the short-run. Within VS's framework, the monetary disequilibrium concept is not stationary statistically [ $ED \neq I(0)$ ], whereas including interest rate in the money demand equation, we show  $ED = I(0)$  justifying it as a disequilibrium variable in statistical terms. The income elasticity of demand for real balances is 1.95 in the long run and 1.45 in the short-run. This finding is in line with some of the money demand functions for India that the income elasticity of demand has always been higher than unity. The speed of adjustment of actual real balances is 0.26 as seen from the significant EC2 term.

The evidence also shows that the current year wages positively affect current price level in the long run as well as in the dynamic equation. And domestic costs dominate import prices in the determination of the general price level in the long run, whereas the short-run elasticity of prices with respect to unit labour costs is approximately same as with respect to foreign raw material import prices. The role of rising agricultural prices is more important, which serve as a nominal standard for other prices in India (Goyal, 1995). In the past, the role of supply shocks (rise in agricultural and import prices) has been very significant leading to periods of lower non-agricultural growth and higher inflation (Goyal, 1997). The coefficient of the error correction term in the dynamic price equation is negative and significant. It implies relatively high adjustment since 32 per cent of the deviations from the long run equilibrium are reversed in the following year.

The model revealed that the price elasticity of export demand is negative and significant in the long run supporting the hypothesis that trade policy reforms have increased the responsiveness of export and import demand and export supply to price changes. This is obvious from the Chow forecast test from 1991 to 1995 which suggests that there is a structural break after the 1991 economic reform in export demand equation. The key significant variables in exports demand are relative prices of exports, world income and exchange rate in the long run. When world real income increases by one per cent, the export demand from India increases by 0.72 per cent in the short run and 0.68 per cent in the long-run. As relative price level decreases by one per cent, export demand volume increases by 0.12 per cent in the short run and by 0.58 per cent in the long-run. These results are different from those of VS in the magnitude of the relevant elasticities. The price at which we export our commodities (unit value index of exports) is positively influenced by the price level as measured by the wholesale price index deflated with exchange rate plus unit export subsidy in the long- and short-run. A 10% increase in this variable pushes up unit value of exports by 0.5% in the short-run. The removal of export subsidies may not result in a reduction in the exports prices in the short run leading to an increase in export demand all other things remaining the same. World prices are significant in determining export prices for India. The monetary disequilibrium variable is highly significant in the export supply equation unlike in VS which was statistically insignificant due to model mis-specification. This variable influences trade flows through its effects on relative prices. This seems to push up export prices rather than reducing them. The error

correction term is about 0.22 and significant. This low speed of adjustment may be due to the fact that India is a price taker in some export goods, being a price setter in others. Since our model is a highly aggregated specification for exports, price elasticities may not be the same with the nature of the export commodity. Manufactured exports in India may exhibit a demand function very different from traditional commodity exports (Lucas, 1988).

The major determinants of real import demand in the long run are net national income, real foreign exchange assets, real capital inflows and excess flow demand for money. The inelasticity of imports with respect to relative price of imports is that the imported goods were mostly essential goods and imports were largely determined by non-price factors such as import licenses in the long run, whereas the short run elasticity of imports is negatively significant with respect to relative price of imports. The effect of income is highly significant in the long run, though it is not so in the short-run. Import demand is significantly negatively related to the price of imports only in the short-run. Our result stands in contrast with that of Sinha (1996) who found no cointegrated relationship among import, import price, domestic price and real income, as we have additional variables in the long-run relation. The level of foreign exchange receipts was also highly significant in explaining the level of imports. An increase in monetary disequilibrium variable strongly depresses imports as it has the statistically significant negative coefficient, but of a low magnitude. The magnitude was very high in VS because he did not have a log-linear equation for imports. Moreover, excess demand for real balances is not always caused due to

unfavourable trade balance, it could also arise because of an increase in the fiscal deficit. This may provide another reason why the impact of monetary disequilibrium on trade is of a very low magnitude. Another difference is that in VS the coefficient of lagged reserve variable was not statistically significant, whereas in our model both the reserve and capital inflows variable are highly significant in the long-run. All these differences in our model with VS may be attributed to the model misspecification and updated database.

The evidence from this section suggests that the cointegrating regressions implied by the model are an adequate specification of long-run behaviour which integrates traditional system analysis with cointegration analysis and extracts information that has a more appealing economic interpretation. Overall, a reasonable speed of adjustment towards the long-run equilibrium is strongly indicated for all the endogenous variables. The short run dynamic model derived from the long run behaviour have been used to perform policy simulations in the next section.

## **6.5 MODEL SIMULATION**

This section attempts to answer the main question raised in this chapter. In order to evaluate the overall performance of the complete model, we use simulation techniques, particularly the deterministic dynamic simulation method. First, for each period, actual values of all the exogenous data from 1963 to 1995 are imposed on the



model estimated in section IV, yielding baseline series for the simulated variables. Second, the model is simulated by adding to the exogenous variables shocks as designed in the VS model. The magnitudes of these shocks are: a temporary depreciation of the exchange rate by 10 per cent in the first year, and a temporary reduction in domestic credit by 1 per cent. The model solutions have been obtained using *WINSOLVE* (Pierse, 1997). The percentage change resulting from the deviation of dynamically simulated values from the base for inflation and trade balance are exhibited in Chart 6.1. Dynamic simulations indicate that the model is stable.

In what follows, we consider the dynamics of devaluation and domestic credit policy in India. Policy simulations focus on the dynamic effects of devaluation and how they contrast with the effects of tight credit policy, which were mainly the point emphasised by VS model. Here we evaluate the effect of a temporary depreciation by 10 per cent. A devaluation in the context of this model has two distinct effects. First, there is a change in the relative prices; second, it creates a liquidity effect through the increase in domestic prices leading to changes in the excess demand for real balances. The way the model is set up, a 10 per cent devaluation influences price level by 9 per cent as it has a direct impact through traded goods prices and prices of imported raw materials. VS had modelled price level in terms of only demand variables such as money without exchange rate or cost factors. So in our model the price level does not behave in the same way as VS, because price will increase more due to devaluation in view of the direct effect of the exchange rate. In other words, price level in VS was not modelled in an open economy context. In the second period the excess demand for

money declines by 2.61 per cent due to money demand decline by 1.08 per cent because of rise in expected inflation. Such fall in ED gives rise to an increase in price by 0.05 per cent as the elasticity of the general price level with respect to excess flow demand for money is 0.00003. So in the first year of devaluation, price rises and declines in the second period due to the negative liquidity effect.

Trade balance has been calculated as  $X \cdot P_X - I \cdot P_M$ . As far as the impact on trade balance is concerned, a 10% devaluation gives rise to a phenomenon where the price increase gives rise to export price increase by 0.36 per cent leading to a decline in exports demand by 0.04 per cent. Moreover, a 10 per cent devaluation results in an imports decline by 0.61 per cent due to the relative price increase, so in the first year trade balance is negative. In the subsequent year due to the negative liquidity effect and price effect, export price increases leading to further deterioration in trade balance. Afterwards, the trade balance improves due to the positive relative price effect being stronger than the liquidity effect in going back to the steady state in the long-run. Alternatively, since devaluation leads to an increase in the relative price of tradables that usually follows a decline in aggregate expenditures (Dornbusch, 1980)<sup>9</sup>, which leads to a price decline and an increase in ED. Export price being positively related to ED with a coefficient of 0.002 in the short-run, an increase in ED leads to export price increase and hence export demand declines (see Table 6.3, Eqn.4) and price decline gives rise to import increase (see Table 6.3, Eqn.5), thus trade balance deteriorates until it goes to the steady state through the dominant relative price effect.

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<sup>9</sup> Nominal domestic absorption is given by  $A = C + I + G$ ; defining national income as  $Y = C + I + G + X - M$ , we have  $A = Y - (X - M) = Y - TB$ .

When the credit policy is being tightened by a 1 per cent reduction, price declines in the same period by 0.01 per cent due to decline in money supply by 0.89 per cent, and then such price decline leads to increases in real money balances giving rise to decline in excess demand for money that has a relative price effect in improving the trade balance which can be seen from the exports price equation. In the subsequent years the price level increases by such a small magnitude that trade balance will not deteriorate. Though in the case of credit shock, there is no direct relative price effect, there is an indirect effect which comes through the liquidity effect through price change that makes trade balance positive. Since devaluation is usually taken as an immediate solution to BoP crisis, it worsens trade balance, not tight credit policy (see Figs.2 & 4, Chart 6.1). Despite the short-run effects of these two policies being quite different, the improvement in trade balance due to tight credit policy is more enduring than the improvement resulting from devaluation.

Since the actual devaluation is a permanent one, we simulate the impact of permanent shocks such as 10 per cent devaluation and 1 per cent credit contraction on price level and trade balance, which is depicted in figs.5 to 8 in Chart 6.1. In case of temporary shock, once the shock is removed, the model starts to go back to the original steady state. Clearly, the temporary shock dies out rather quickly and the long-run cumulative effect is zero. But a 10 per cent permanent devaluation results in about the same percentage change initially which gradually converges to the steady state of 5 per cent, whereas a 1 per cent change in domestic credit declines the price level by 0.3

per cent in the long-run. A permanent devaluation and credit shocks show trade balance an oscillatory pattern (Figs.7 & 8), but a deterioration in trade balance which can be looked at through the price response because the adjustment mechanism is mainly the change in price. In case of permanent devaluation shock, price increases leading to export price increase and fall in export demand, whereas in case of credit shock the effect is negligible. Permanent devaluation gives rise to a huge deterioration in trade balance as compared to a permanent tight credit policy. The permanent effects dominate in the long-run whereas the temporary shocks prevail only in the short-run.

The idea here is also to examine whether the permanent heavy devaluation policy chosen by the Government under pressure from IMF is an ideal one relative to a 10% depreciation as simulated above or a do-nothing option would have seemed better. So if we evaluate alternative devaluation strategies such as 20 per cent, 30 per cent, or the actual scenario about 39 per cent devaluation in 1991, we would get a very high deterioration in trade balance. In addition to the devaluation shock with the credit policies of the central bank, we also simulate the effects of tariffs and export subsidies in bringing about a BoP equilibrium and inflation stabilisation in the context of the structural reform policy. Thus we simulate the effect of a policy package that comprises the following: (1) a 10 per cent permanent devaluation; (2) 1 per cent permanent reduction in domestic credit; (3) permanent reduction of tariffs by 10 per cent; (4) permanent reduction of export subsidies by 10 per cent. The results are presented in Figs. 9 & 10 in Chart 6.1. Reduction in import duties, or import liberalisation and reduction of subsidies do have a positive impact on foreign reserves.

In this joint simulation, the devaluation impact on price dominates (see fig.9) and there is a decline in foreign reserves (as defined in Eq.6 in Table 6.3) in the first year (see fig.10), which improves in the subsequent years until it goes to the steady state.

## **6.6 CONCLUSION**

This chapter focuses on the inflationary impacts of the devaluations and the tight credit policy associated with the 1991 crisis, and India's trade balance during 1950-95. A supply-side model of inflation determination in addition to the standard demand framework has been estimated on Indian data. The short-run dynamics have been obtained from error correction models. Price dynamics responds not only to the movement of international prices, but also to other cost components, and to internal demand. The model has then been simulated to evaluate the dynamic responses to devaluation and tight credit policy. We argue that devaluation is not the most efficient policy instrument, whereas short-run solutions like credit control would be the better solution for temporary and exogenously generated disequilibria. There is a clear distinction between temporary and permanent responses, as in the case of temporary shock, the overall effect of the policy shock is neutral in the long-run. In this model we abstract from output changes to highlight the complex dynamic interactions between inflation and trade balance. However the model's assumption of exogenous output is clearly restrictive, because of likely output effects of devaluation and the effects of credit conditions on investment. Thus an explicit link between monetary

sector, external sector, and output is essential if this model is to be useful in studying the effects of medium and long term trade policy choices on the economy. The next chapter looks at the determinants of long-term growth with adequate characterizations of the non-stationary features of the data and rigorously evaluating the model's congruence with all available information in a VAR system.

## **APPENDIX : NOTES ON DATA SOURCES AND DEFINITIONS**

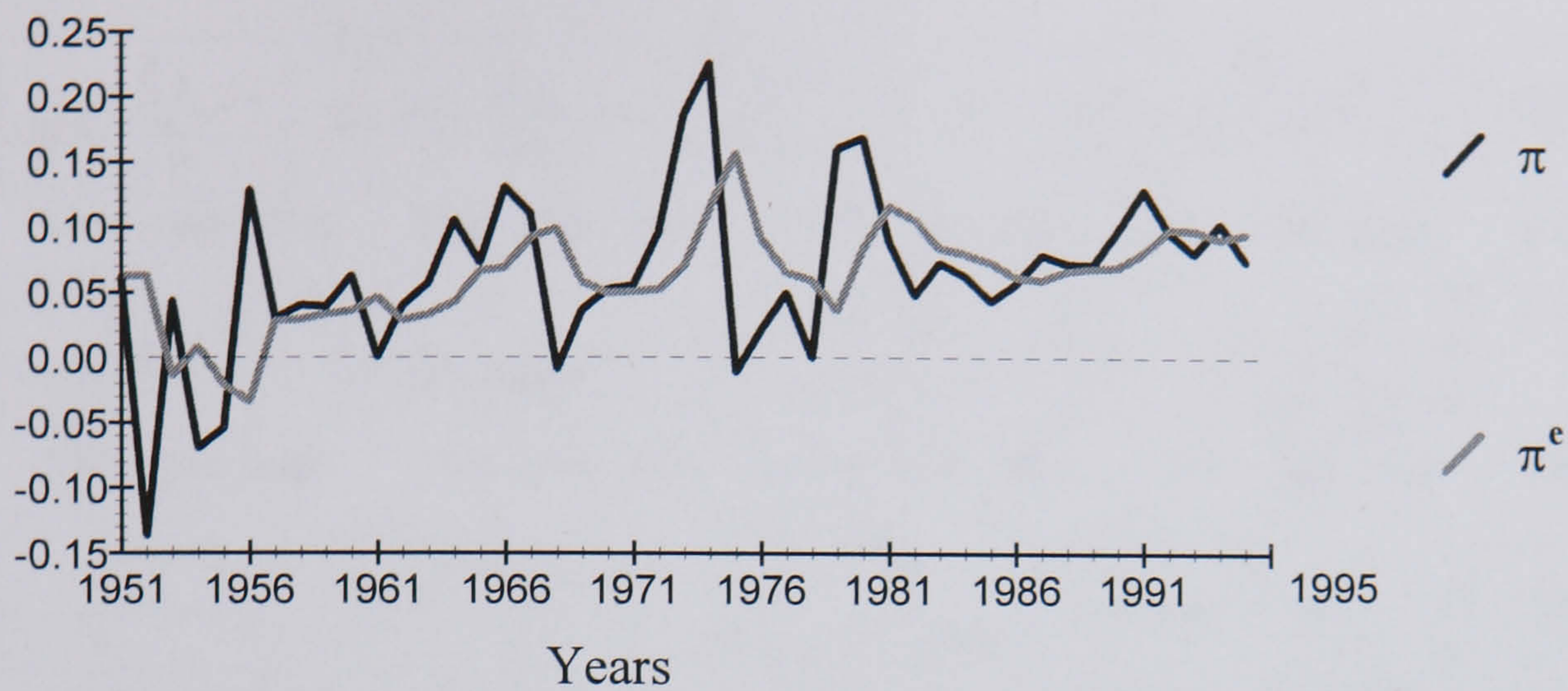
Most of the series have been presented in Rupees crores (1 crore = 10 million).

1. Data on Net National Product at market prices (constant prices with respect to base 1980-81 = 100) are taken from from NAS-New Series, 1989, CSO, Min. of Planning, GOI; From 1989-92, the source is National Accounts Statistics, 1992. Data on marketed output has been derived by following the procedure as in VS.
2. Data on Money Supply (M3), Foreign Exchange Reserves, domestic credit, money multiplier, and capital inflows of the non-banking sector have been compiled from (a) Report on Currency and Finance, Volume II: statistical statements (various issues), RBI; (b) RB Bulletin - Monthly, RBI. M3 consists of currency with the public, deposit money of the public, time deposits with banks. Due to several definitional changes in 1978, the RBI, which till then had carried out most of its analysis with respect to narrow money (M1), was compelled to conduct its accounting of money supply in terms of M3, because the data on M1 for the post-1978 period was no longer comparable with those in the earlier years. Hence, in this study we have carried out our empirical analysis in terms of M3. MD is defined as M/P. The measure of excess demand for real balances has been constructed from the estimated money demand function and data on domestic credit and money multiplier (M3/Reserve Money).
3. Wholesale Price Index (new series) - Index Numbers of Wholesale Prices in India, Office of the Economic Adviser, Min. of Industry, GOI. Wholesale Prices data are taken as a surrogate for General price level which are compiled for the base year 1980-81 = 100 from H.L. Chandhok and The Policy Group, India Database - The Economy, Volume I, 1990, pp.286-287. In fact, we have checked that wholesale price index data from this source is consistent with the original source. The index for the calender years 1953, 1962 and 1971 relate to averages of 9 months (April-December). Data on average per capita earnings in the manufacturing sector is taken from Statistical Abstract of India (Annual), CSO, Ministry of Planning, Government of India. Average labour productivity in the manufacturing sector is calculated by dividing industrial production (CSO, Monthly Statistics of Production of Selected Industries) by the labour force (World Bank Database, and Economic Survey).
4. Exports and Imports - (a) Foreign Trade Statistics, Directorate General of Commercial Intelligence and Statistics (DGCIS), Min. of Commerce, GOI; (b) Statistical Abstract of India (Annual), CSO, Min. of Planning, GOI. DGCIS data on Exports and Imports have been taken from Economic Survey, 1991-92, Part II, Sectoral Developments, Government of India, Ministry of Commerce, pp. S-80. Indices of Unit Value of Imports and Exports (in US \$) have been obtained from IMF CD-ROM database (Base 1990=100).
5. The source for unit value of raw material imports is DGCIS, Calcutta - the original source. From 1957-58 to 1968-69, the base is 1958-59=100 and 1968-69 is the overlapping year for conversion. From 1968-69 to 1978-79, the base is 1968-69=100 and 1978-79 is the overlapping point. From 1978-79 onwards, the base is 1978-79=100. Data was not available from 1950 onwards. So we

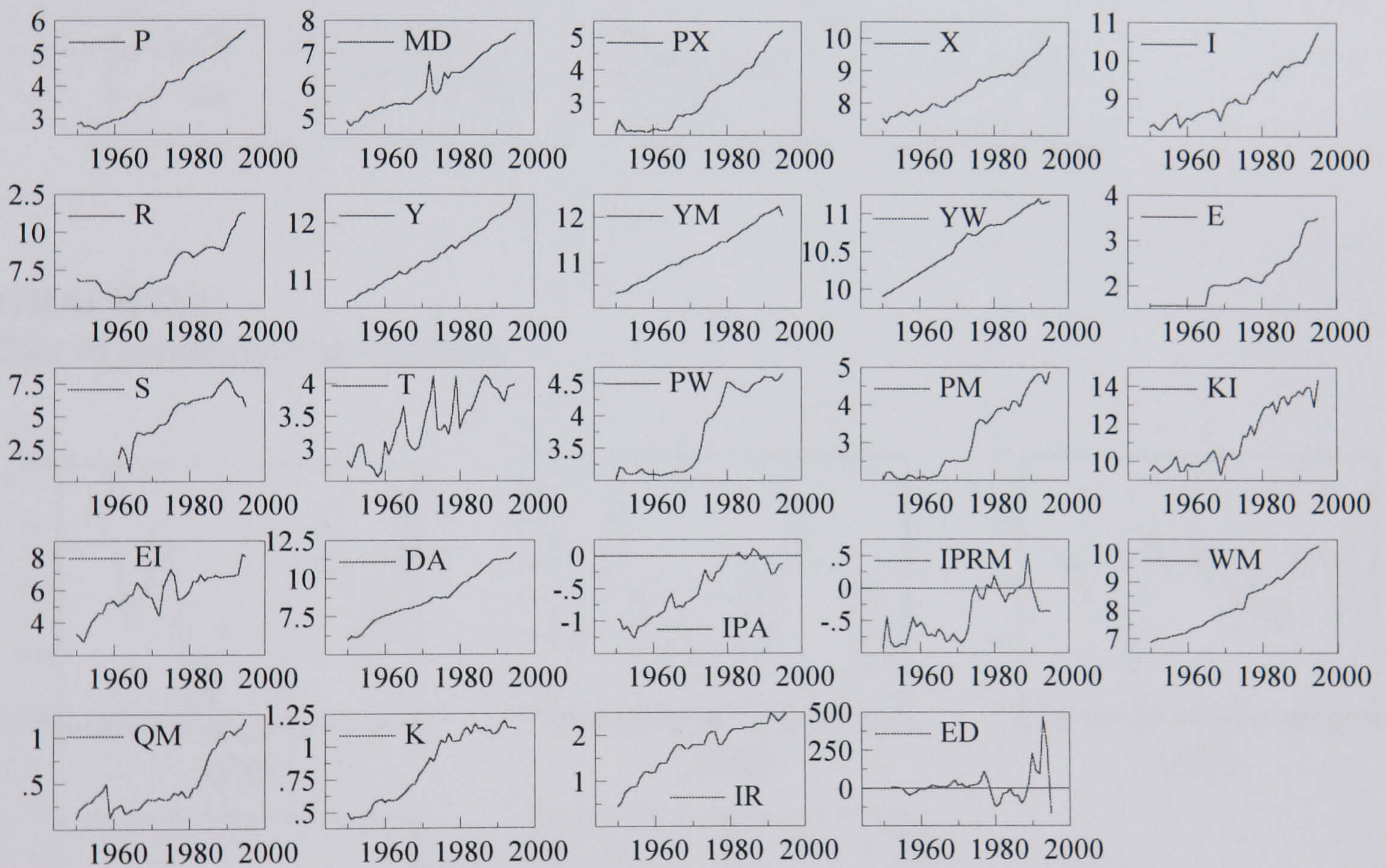
took the unit value of raw material imports data (1968-69=100) from Balakrishnan (1991) [Table A3.7, Col.5] for the years 1950-51 to 1956-57. After converting the two time series to a comparable base (1981-82=100), we have taken a weighted average of both the time series to get a series of unit value of raw material imports.

6. Data on Customs (Imports) duties have been compiled from Report on Currency and finance, Vol.II Statistical Statements (various issues). For 1975-76, there is no separate figure for Exports and Imports duties. There is only one figure which is the combination of Imports, Exports & other revenues less refunds & drawbacks, i.e., Rs.1498 Crores. So in order to get separate figures, we had to take the Customs duties (which is the combination of Imports (gross), Exports (gross), other revenue less Refunds & drawbacks for the preceding and succeeding years of 1975-76, out of which we got the percentage of Export and import duties for the two years. This proportion was multiplied with the total for the year 1975-76. As a result, we got two different figures for both Exports and imports duties respectively. Accordingly, the average of these two different values for exports and imports duties gave rise to a single figure for Exports and Imports duties respectively. Moreover, due to the non-availability of accounts data on imports and exports duties for the year 1977-78, we have taken Budget Estimates data.
7. Exchange Rate of Indian Rupee - (a) Report on Currency and Finance, RBI; (b) Economic Survey, Min. of Finance, GOI. World Income - World Tables, 1991, A World Bank Publication; and International Financial Statistics (various issues). Data on World price (Unit value Indices of imports of trading economies) has been obtained from IMF CD-ROM Database (in U.S. dollars; 1990=100).

**GRAPH 6.1**  
**Expected and Actual Rate of Inflation**



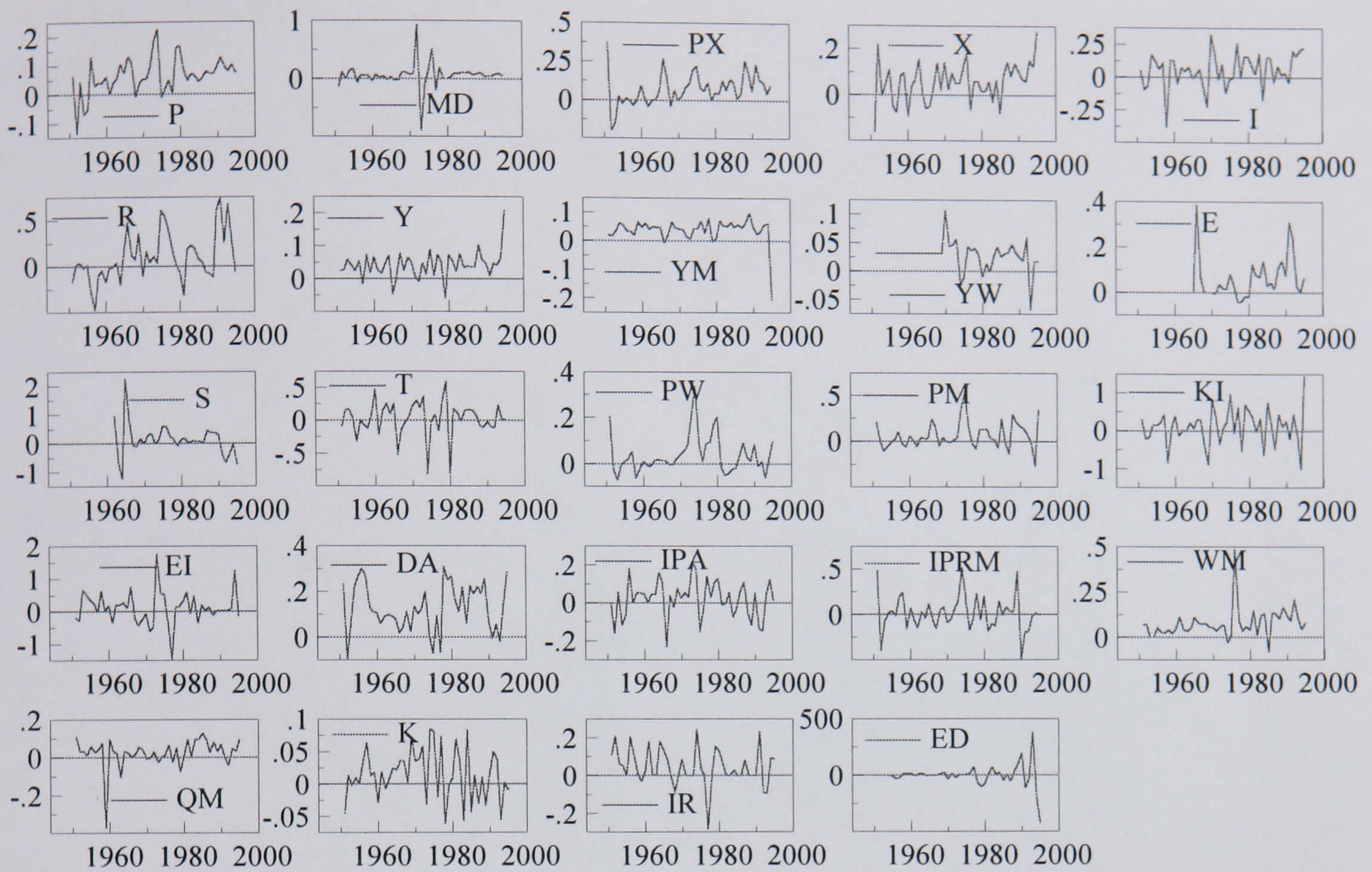
**GRAPH 6.2:**  
**Plot of (log) Levels of the Variables**





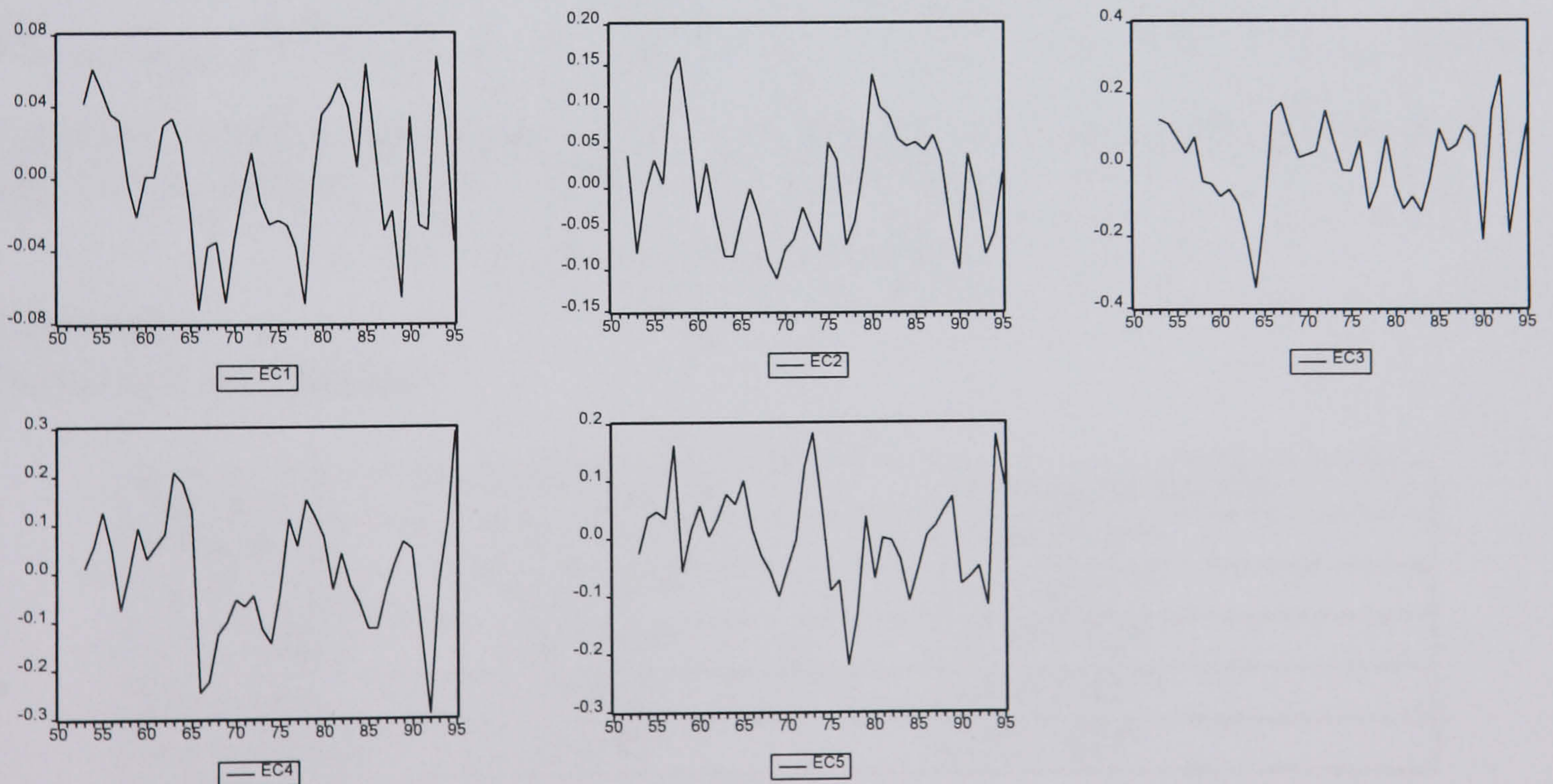
### GRAPH 6.3:

#### Plot of first differences of the (log) Variables



### GRAPH IV:

#### Plot of cointegrating relations



**Table 6.1:**  
**Unit-root tests**

VARIABLES	ADF in LEVELS		ADF in FIRST DIFFERENCES		~I( )
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	
P	-0.189	-3.0136*	-3.9721**	-4.4309**	I(1)
MD	-0.358	-2.7748	-7.0823**	-7.0378**	I(1)
PX	-2.197	-2.4308	-4.4411**	-5.3862**	I(1)
X	-1.019	-0.2995	-3.6419**	-4.3857**	I(1)
I	-0.817	-1.1720	-5.3147**	-5.7220**	I(1)
R	0.269	-2.3519	-6.6947**	-7.0277**	I(1)
Y	1.953	0.2209	-4.1533**	-4.7560**	I(1)
YM	-0.782	-2.2919	-3.2520*	-6.5455**	I(1)
YW	-1.726	-1.6504	-4.0768**	-4.3375**	I(1)
E	0.297	-1.2514	-3.8482**	-4.4267**	I(1)
S	-1.794	-1.4599	-5.6601**	-7.7836**	I(1)
T	-2.109	-3.6810*	-5.8928**	-5.8169**	I(1)
PW	-1.054	-1.9929	-3.8122**	-3.7905*	I(1)
PM	-2.352	-2.9638	-4.9628**	-5.2475**	I(1)
KI	-1.706	-2.4818	-6.9771**	-6.9921**	I(1)
EI	-2.105	-2.7770	-4.6261**	-4.5673**	I(1)
DA	0.778	-2.1332	-3.7216**	-3.6722*	I(1)
IPA	-1.296	-1.6324	-5.4289**	-5.4628**	I(1)
IPRM	-1.814	-2.2077	-4.9095**	-4.9158**	I(1)
WM	0.612	-2.3888	-5.3283**	-6.3237**	I(1)
QM	0.859	-1.1228	-3.9174**	-3.8813*	I(1)
K	-1.346	-0.5265	-4.4670**	-4.6925**	I(1)
IR	-0.498	-4.2229**	-7.0499**	-6.9531**	I(1)
ED	-4.503**	-4.5649**	-8.0586**	-7.9763**	I(0)

Notes: All variables are measured in natural logarithms; ADF unit root test is based on two lags; Critical values are: 5%=-2.956, 1%=-3.65 (without trend)

5%=-3.516, 1% = -4.184 (with trend)

**Table 6.2:**  
**Tests for Cointegration**

Regression	ADF t-statistic	Phillips-Perron test
P Residuals	-3.477769*	-3.624318**
PX Residuals	-4.564763**	-4.352857**
X Residuals	-3.804824**	-3.057466*
I Residuals	-3.570913*	-4.174702**
Md Residuals	-3.454182*	-3.315874*

\*\* Critical Values: 1% = -3.5889; 5% = -2.9271

**Table 6.3:**

**Estimation of the Model Equations**

\*\*\*\*\*

Long-run model is based on Fully Modified Phillips-Hansen regression

**1.Price equation:**

**Long-run:**

$$\begin{aligned} \text{Ln}(P) = & 0.828 + 0.73*(\text{Ln}(\text{IPA})+\text{Ln}(\text{E})) + 0.16*(\text{Ln}(\text{WM})- \text{Ln}(\text{QM})) \\ & (2.669) \quad (13.291) \quad (4.00) \\ & +0.11*(\text{Ln}(\text{IPRM})+\text{Ln}(\text{E})) - 0.0003*\text{ED} \\ & (4.48) \quad (-5.15) \end{aligned}$$

Wald test of long-run homogeneity restriction imposed on parameters  $\chi^2(1) = .1666\text{E-}3$  [.990]

**Short-run:**

$$\begin{aligned} \Delta\text{Ln}(P) = & -0.002 + 0.84*(\Delta\text{Ln}(\text{IPA})+\Delta\text{Ln}(\text{E})) +0.07*(\Delta\text{Ln}(\text{W})-\Delta\text{Ln}(\text{Q})) \\ & (1.12) \quad (21.05) \quad (2.84) \\ & +(1-0.84-0.07)*(\Delta\text{Ln}(\text{IPRM})+ \Delta\text{Ln}(\text{E}))-0.00003*\Delta\text{ED} + 0.06*\Delta\text{Ln}(P(-1)) - 0.35*\text{EC1}(-1) \\ \rightarrow & ( \quad ) \quad (-0.78) \quad (0.84) \quad (-3.05) \end{aligned}$$

Adj. R<sup>2</sup>=0.792;      BG = 1.66 [0.205];      BJ = 1.108 [0.575]  
ARCH = 0.048 [0.83];      Chow = 1.13 [0.367];      WHT = 31.25 [0.306]

**2.Desired real Balances:**

**Long-run:**

$$\begin{aligned} \text{ln}(\text{MD}) = & -14.95+1.96*\text{ln}(\text{YM})-1.03 \pi^e - 0.56*\text{ln}(\text{IR}) \\ & (-25.83) \quad (31.25) \quad (-2.25) \quad (-6.497) \end{aligned}$$

**Short-run:**

$$\begin{aligned} \Delta\text{Ln}(\text{MD}) = & 0.012+1.45*\Delta\text{Ln}(\text{YM})-0.32*\Delta\pi^e -0.34*\Delta\text{Ln}(\text{IR}) -0.26*\text{EC2}(-1) \\ & (0.71) \quad (4.23) \quad (-1.08) \quad (-3.93) \quad (-2.31) \end{aligned}$$

Adj.R<sup>2</sup>=0.49;      BG = 0.288 [0.59];      ARCH = 2.14 [0.13]  
JB=1.25 [0.54];      WHT = 21.29 [0.09];      CHOW = 0.667 [0.65]

**3.Unit value of exports:**

**Long-run:**

$$\begin{aligned} \text{Ln}(\text{PX}) = & -11.80 + 0.03*(\text{Ln}(P)-\text{Ln}(E+S)) + 0.657*\text{Ln}(\text{PW}) + 1.89*\text{Ln}(Y) \\ & (-5.405) \quad (0.504) \quad (5.896) \quad (6.28) \\ & -0.86*\text{Ln}(\text{YW}) + 0.0012*\text{ED} \\ & (-1.91) \quad (4.75) \end{aligned}$$

**Short-run:**

$$\begin{aligned} \Delta\text{Ln}(\text{PX}) = & -0.007 + 0.048*(\Delta\text{Ln}(P(-1))-\Delta\text{Ln}(E(-1)+S(-1))) + 0.367*\Delta\text{Ln}(\text{PW}(-1)) \\ & (-0.255) \quad (1.57) \quad (2.51) \\ & +0.55*\Delta\text{Ln}(Y) + 0.73*\Delta\text{Ln}(\text{YW}(-1)) + 0.0002*\text{ED} +0.28*\Delta\text{Ln}(\text{PX}(-1))-0.215*\text{EC3}(-1) \end{aligned}$$

(1.94)                      (1.399)                                      (1.469)                      (1.946)                                      (-2.025)

Adj. R<sup>2</sup>=0.26;                                      BG = 2.13 [0.135];                                      BJ = 1.24 [0.537]  
 ARCH = 1.14 [0.29];                                      Chow = 1.21 [0.329];                                      WHT = 36.45 [0.269]

**4.Export demand:**

**Long-run:**

$$\text{Ln}(X) = -1.66 - 0.58 \cdot \text{Ln}(PX/PW) + 0.68 \cdot \text{Ln}(YW) + 1.18 \cdot \text{Ln}(E)$$

(-1.19)    (-2.64)                      (3.96)                      (4.91)

**Short-run:**

$$\Delta \text{Ln}(X) = 0.07 - 0.12 \cdot \Delta \text{Ln}(PX/PW) + 0.72 \cdot \Delta \text{Ln}(YW) + 0.18 \cdot \Delta \text{Ln}(X(-1)) - 0.298 \cdot \text{EC4}(-1)$$

(3.54)    (-1.08)                                      (1.565)                      (1.14)                      (-2.88)

Adj. R<sup>2</sup>=0.14;                                      BG = 2.14 [0.13];                                      BJ = 3.48 [0.18]  
 ARCH = 1.26 [0.295];                                      Chow = 2.72 [0.037];                                      WHT = 28.38 [0.20]

**5.Imports:**

**Long-run:**

$$\text{Ln}(I) = -5.20 - 0.17 \cdot \text{Ln}((PM \cdot (E+T))/P) + 1.00 \cdot \text{Ln}(Y) + 0.002 \cdot \text{Ln}(EI)$$

(-7.34)    (-2.95)                                      (11.70)                      (0.102)

$$+ 0.32 \cdot \text{Ln}(KI/PM) + 0.16 \cdot \text{Ln}(R/PM) - 0.0003 \cdot \text{ED}$$

(10.65)                                      (7.11)                                      (-2.56)

**Short-run:**

$$\Delta \text{Ln}(I) = 0.02 - 0.12 \cdot \Delta \text{Ln}((PM \cdot (E+T))/P) + 0.22 \cdot \Delta \text{Ln}(Y(-1)) + 0.06 \cdot \Delta \text{Ln}(EI)$$

(1.48)    (-2.74)                                      (0.74)                                      (3.00)

$$+ 0.30 \cdot \Delta \text{Ln}(KI/PM) + 0.05 \cdot \Delta \text{Ln}(R(-1)/PM(-1)) + 0.07 \cdot \Delta \text{Ln}(I(-1)) - 0.0003 \cdot \text{ED} - 0.598 \cdot \text{EC5}(-1)$$

(12.39)                                      (1.32)                                      (0.96)                      (-2.92)                      (-4.53)

Adj. R<sup>2</sup>=0.83;                                      BG = 2.08 [0.14];                                      BJ = 0.45 [0.798]  
 ARCH = 0.259 [0.61];                                      Chow = 1.92 [0.12];                                      WHT = 39.33 [0.41]

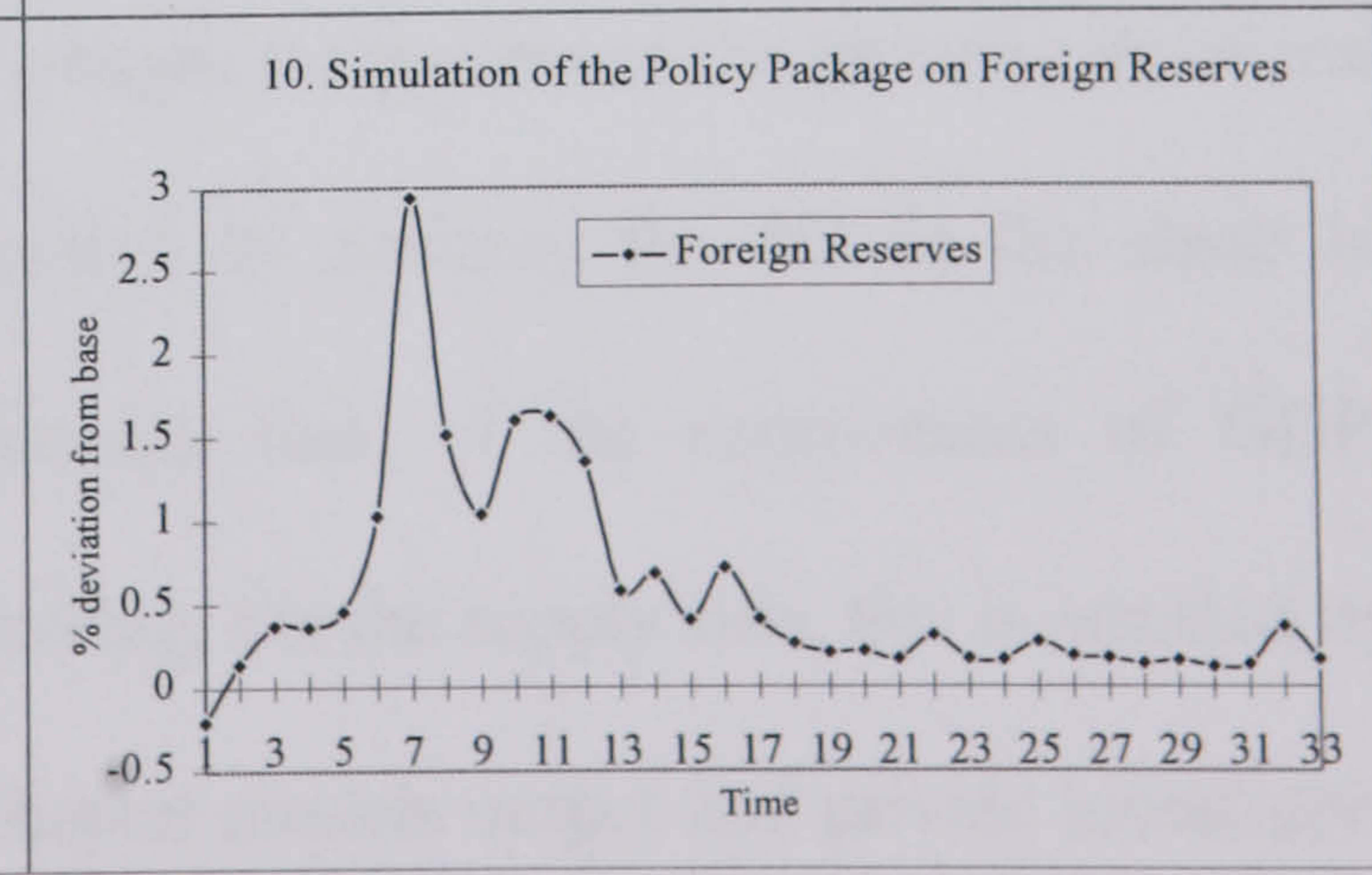
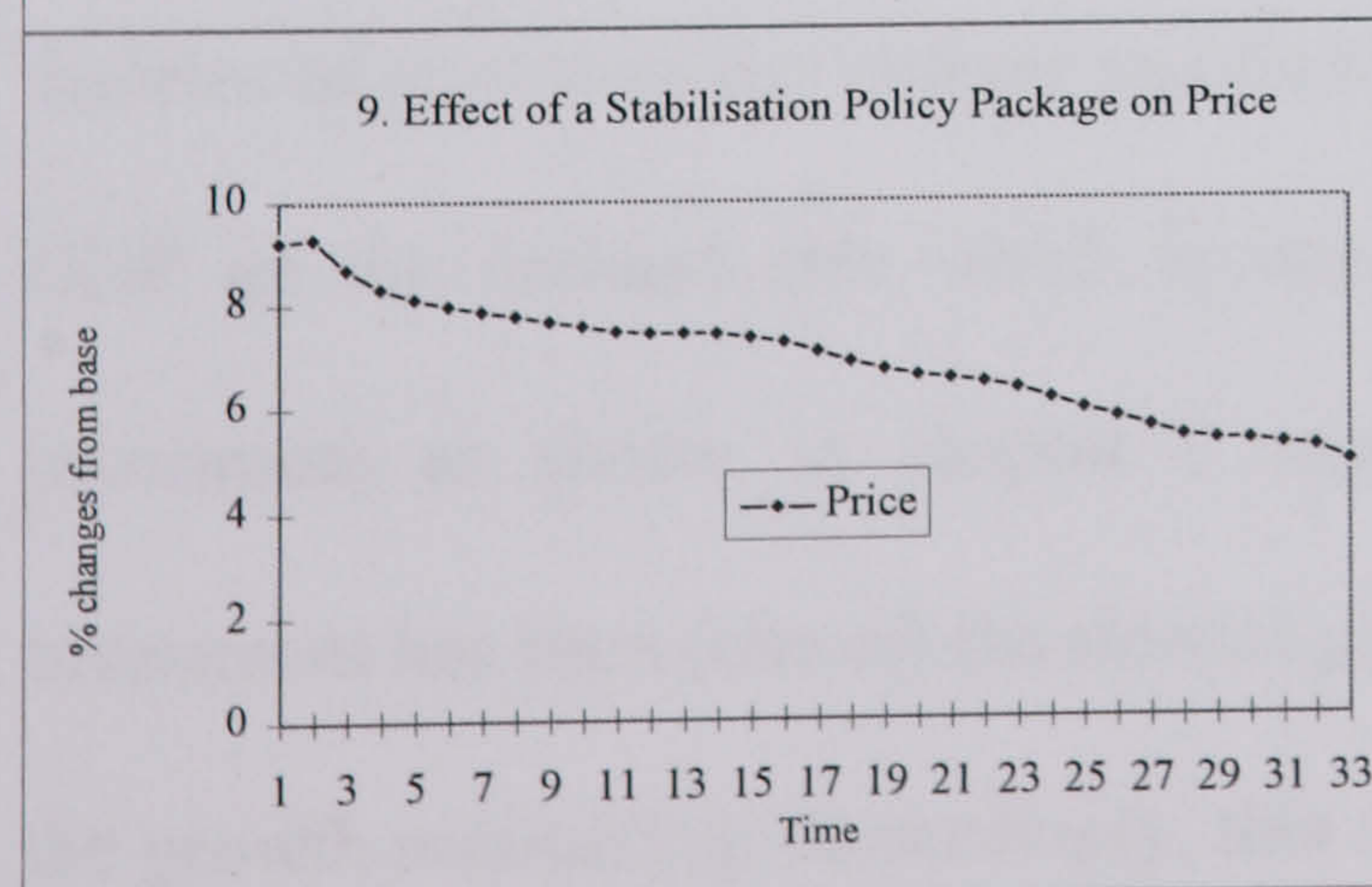
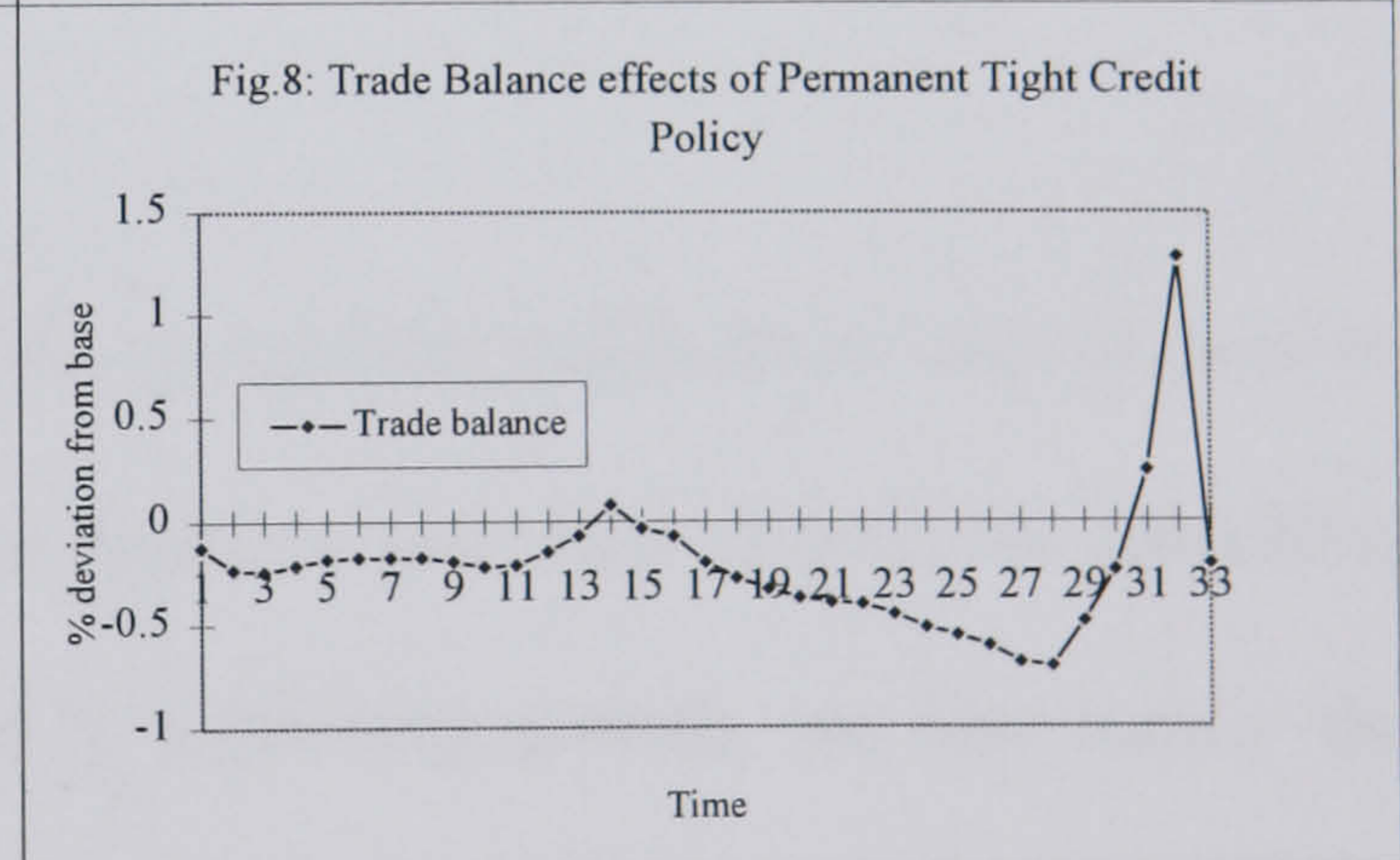
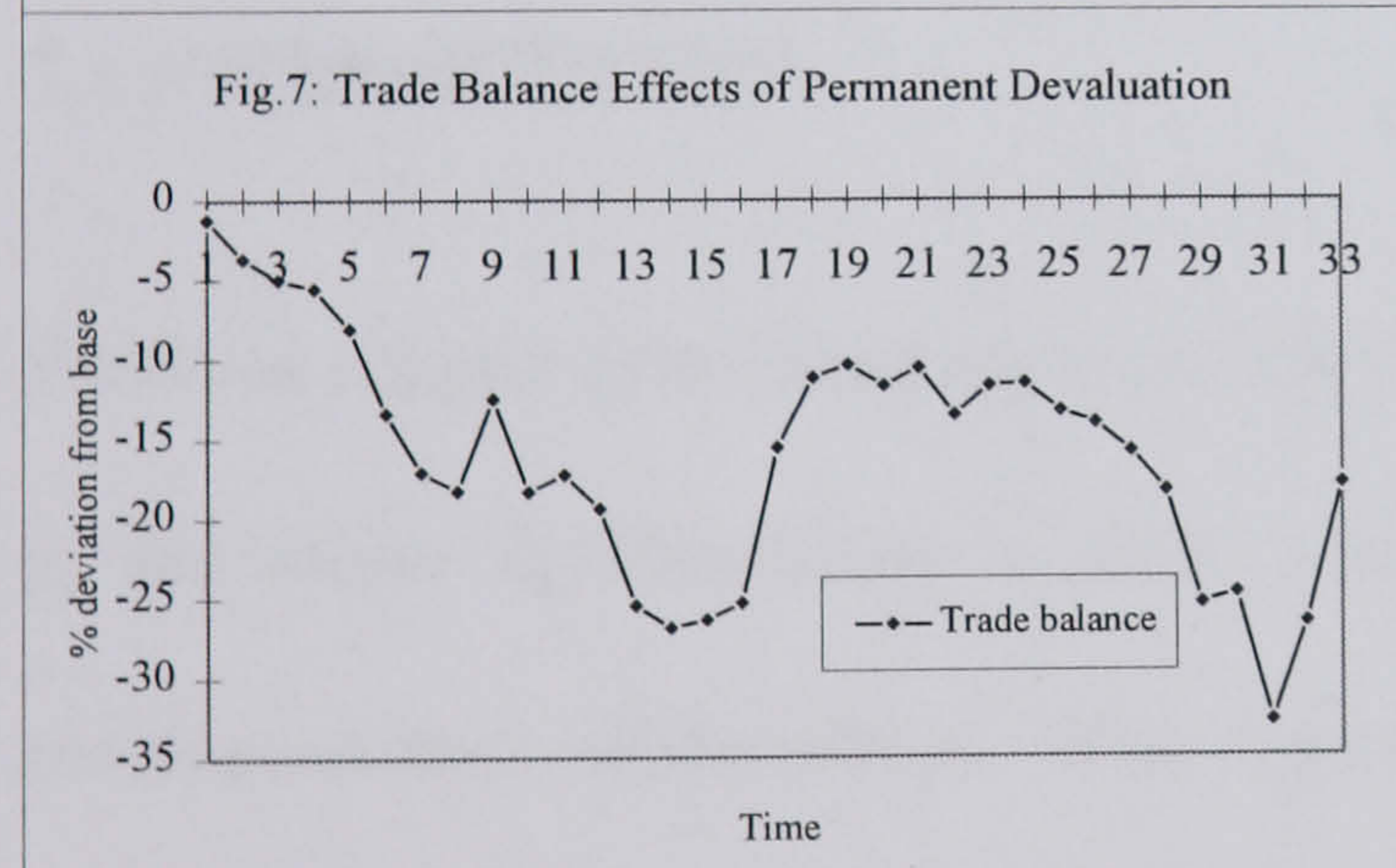
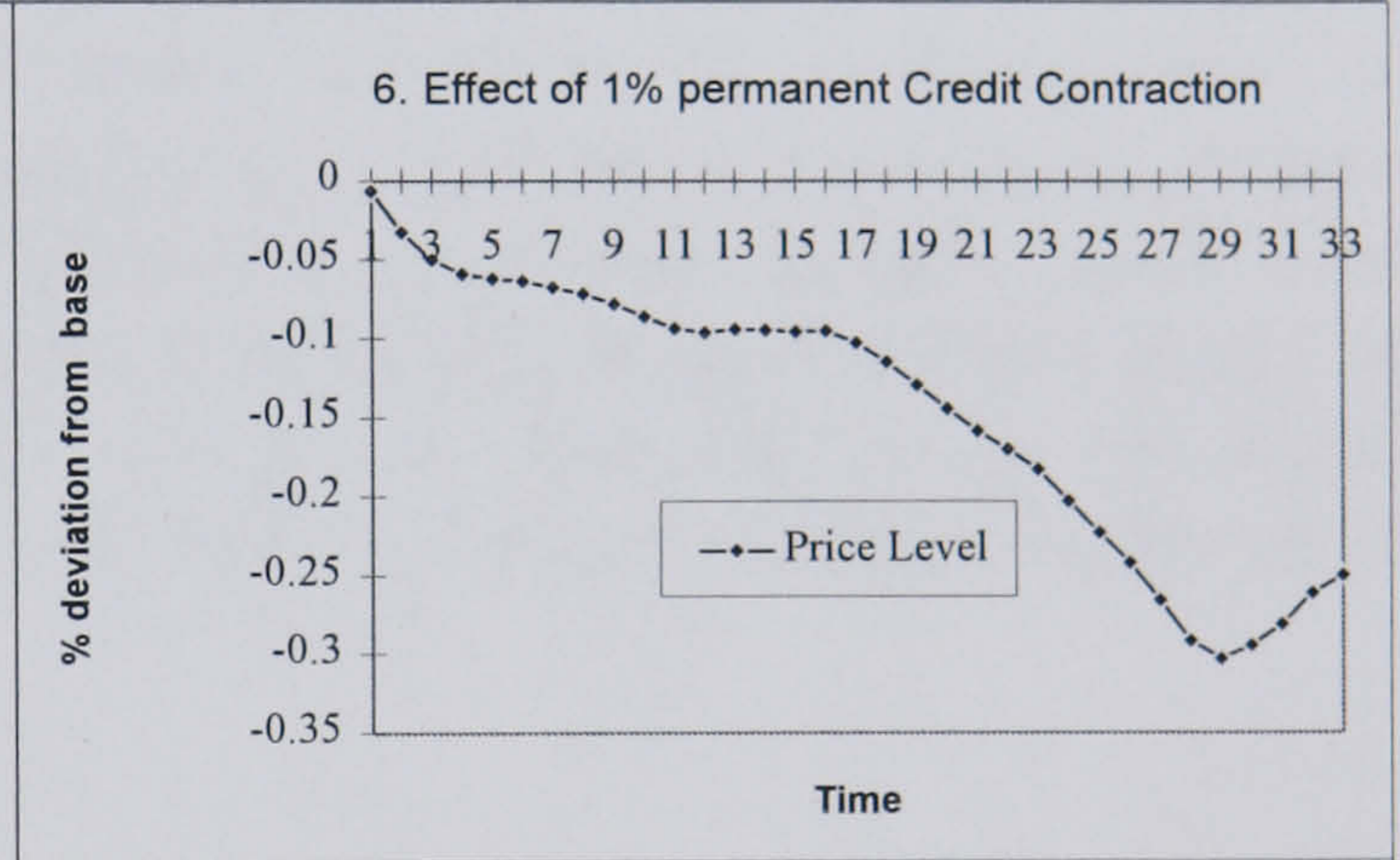
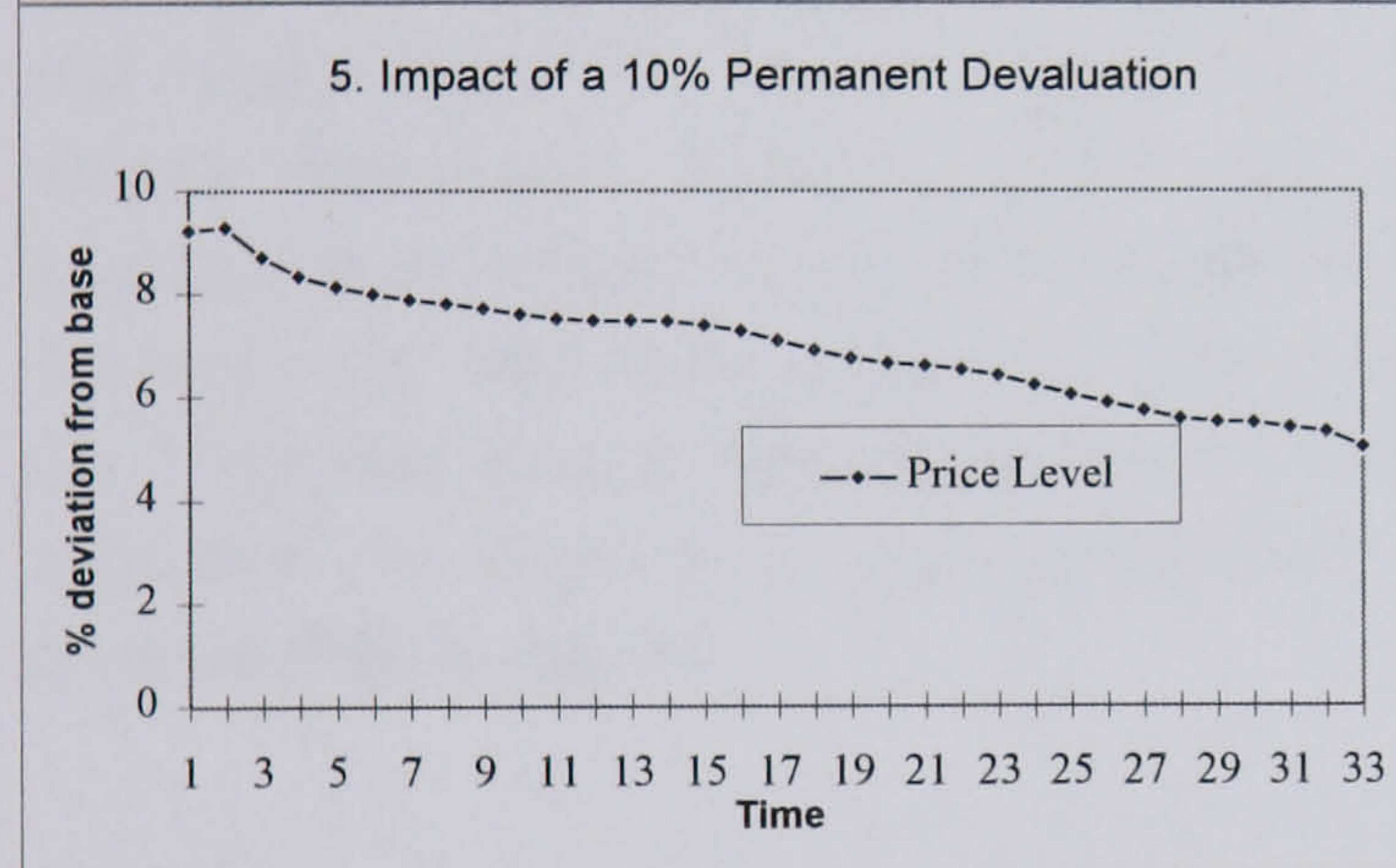
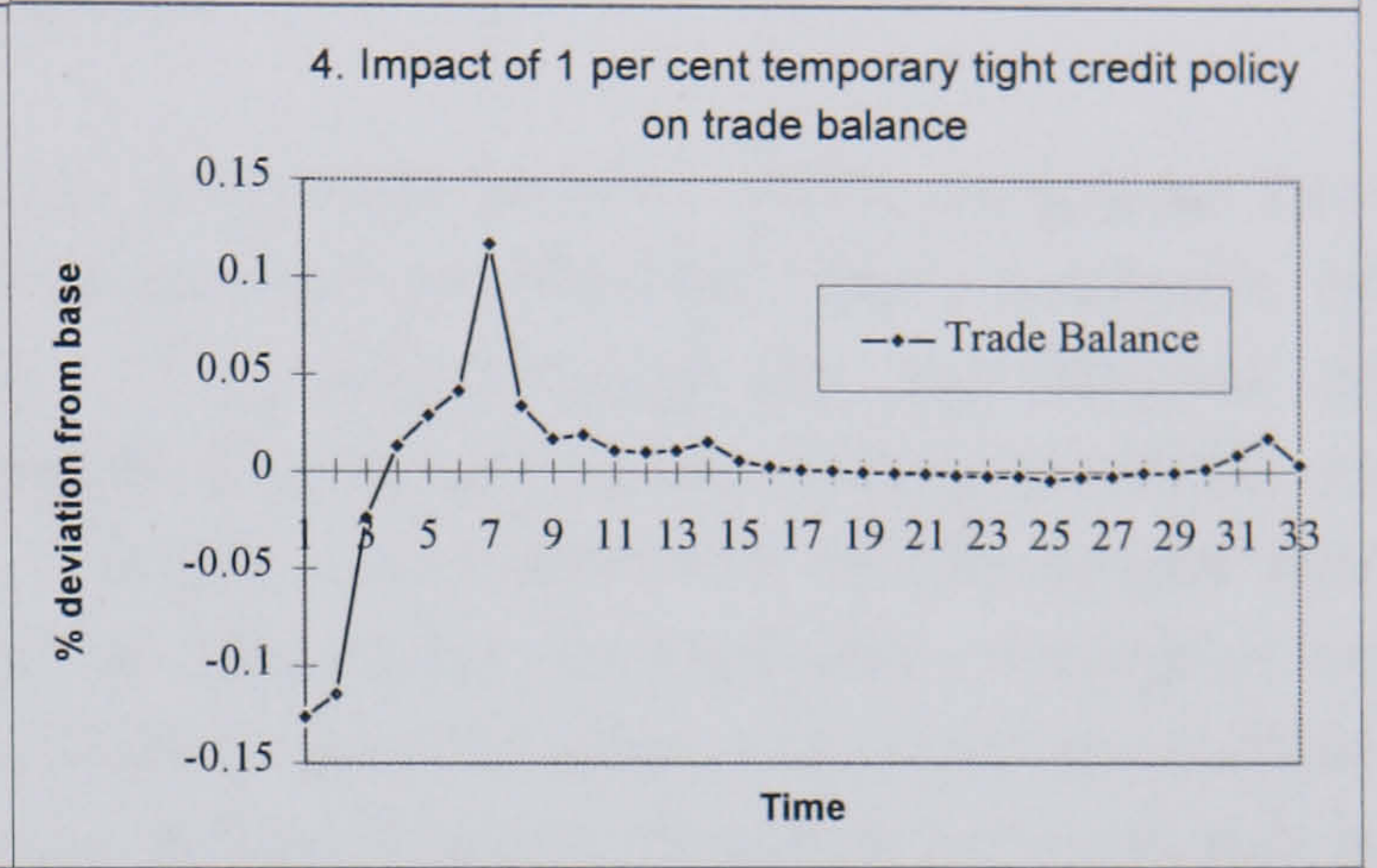
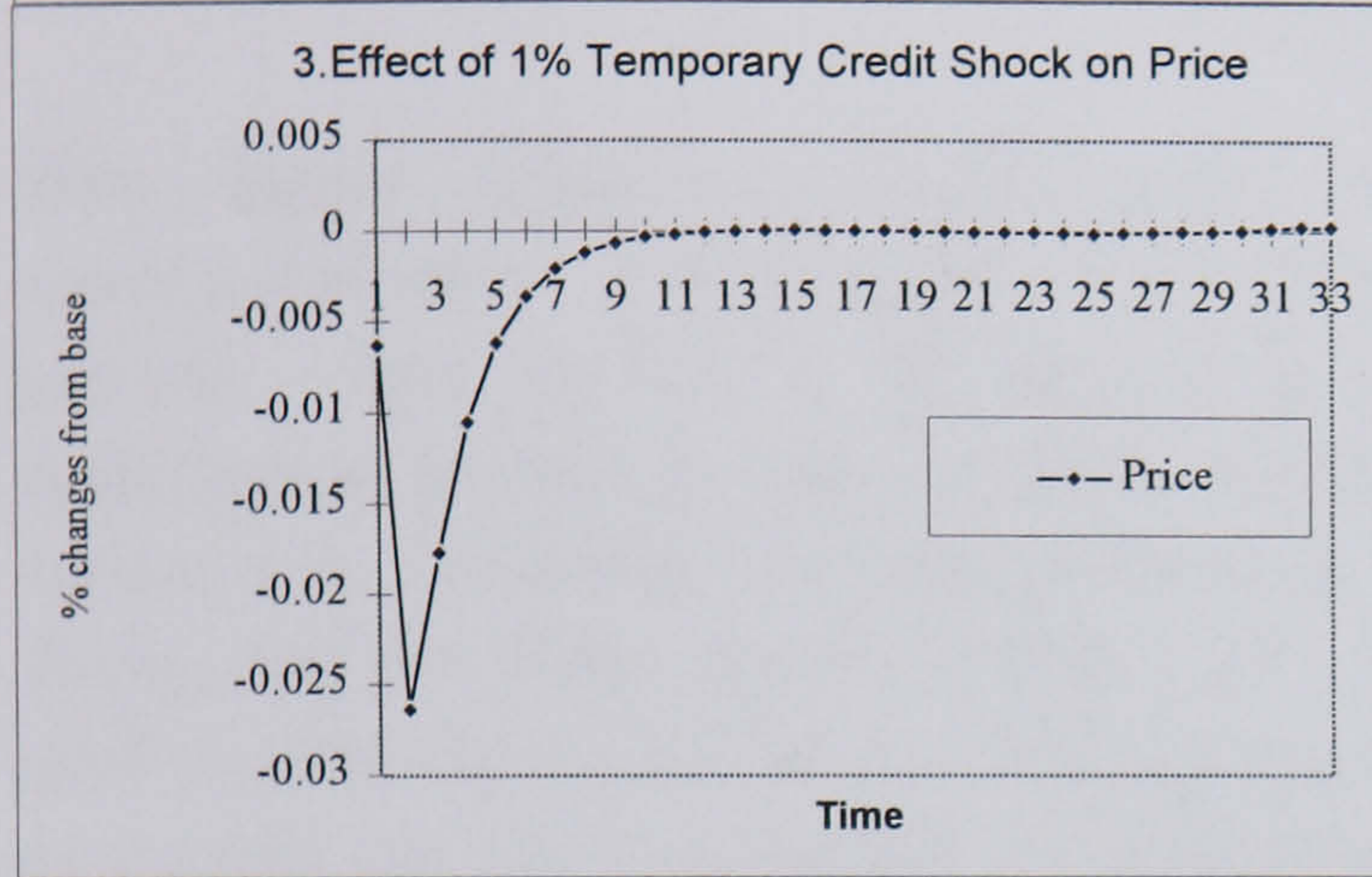
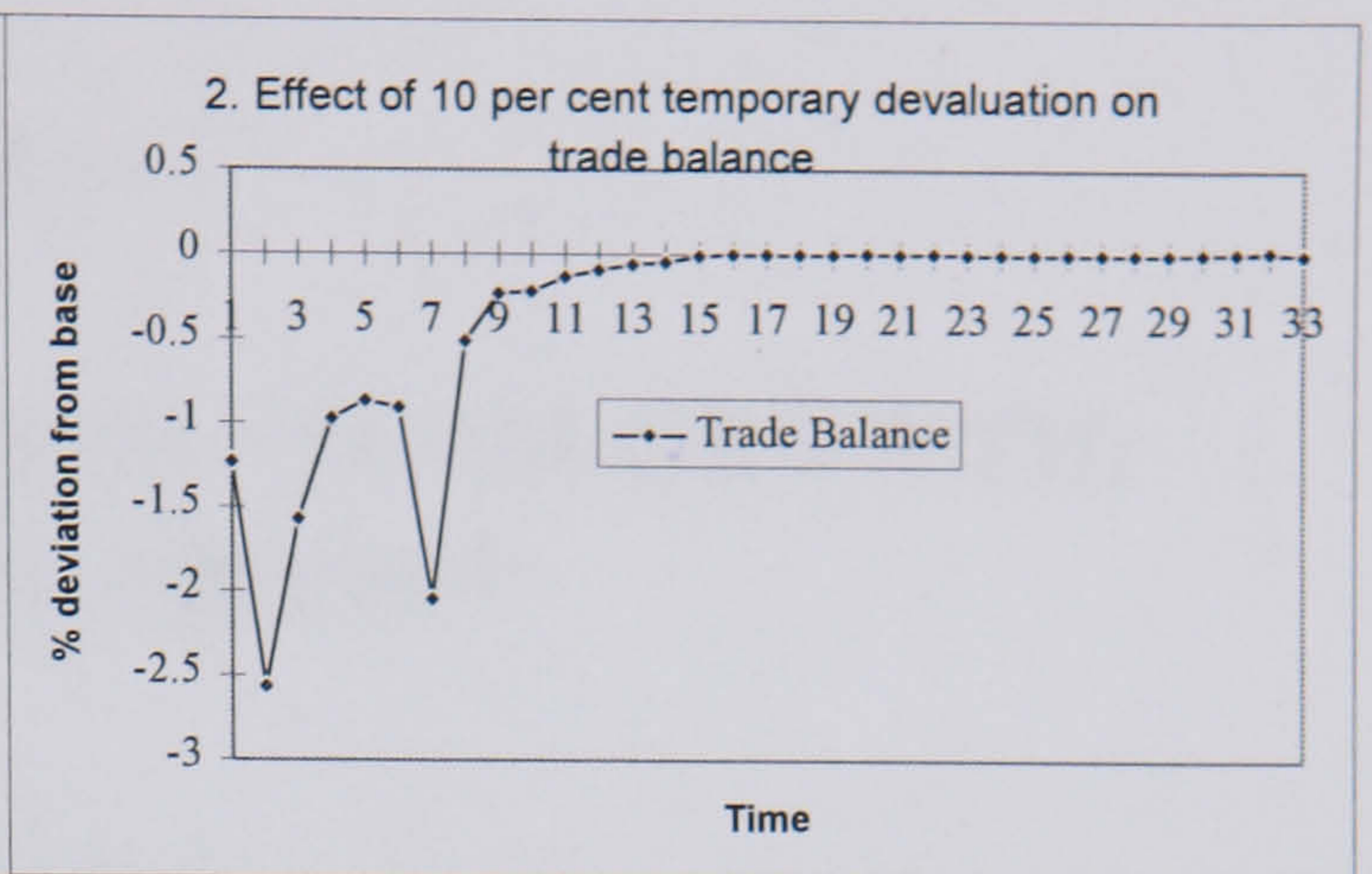
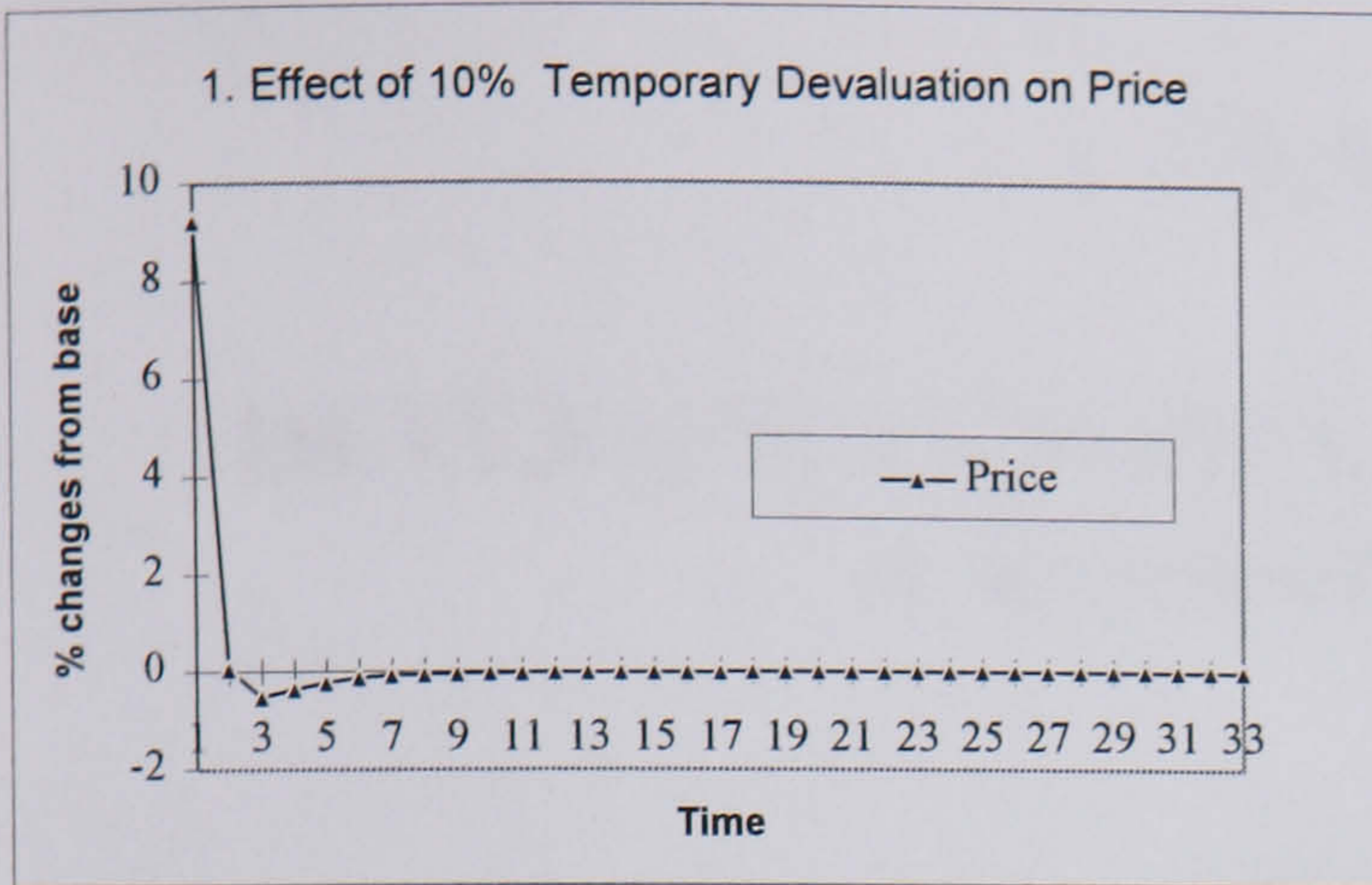
**6.Balance of payments: R = R(-1)+X-I+KI**

**7.Money supply: M = k\*(R+D)**

\*\*\*\*\*

- t-statistics for the individual parameters are in parenthesis. The abbreviations for the statistical tests following each equation are as follows: BG is the Breusch-Godfrey test for autocorrelation; BJ is the Bera-Jarque normality test; WHT is the white test for heteroscedasticity; ARCH is the Engle-test for autoregressive conditional heteroscedasticity; CHOW is the Chow stability test (Chow Forecast Test: Forecast from 1991 to 1995). Probability values are in square brackets.

CHART 6.1 : MODEL SIMULATIONS



## Chapter 7

# DETERMINANTS OF LONG-TERM GROWTH: A Keynesian Approach

### ABSTRACT

*This chapter attempts an eclectic synthesis on long-term growth which integrates two standard models - Neoclassical model with endogenous growth and export-led model of growth - and unfolds a Keynesian theory of growth through the mechanisms of endogenous growth in which capital accumulation is driven by investment spending as opposed to household savings behaviour. A vector autoregressive (VAR) model has been used for India from 1950 to 1995 using Johansen's multivariate cointegration approach to derive latent equilibrium relationships and the short-run error correction equations are then estimated. We found two cointegrating relationships for real output and real private investment respectively. Output is determined by the factors such as private investment, human capital, real interest rate and public investment. Private investment is driven by public investment, domestic credit to the private sector, real interest rate, and human capital, which seems to support a McKinnon-Shaw model in the long run and a Keynesian/Structuralist view in the short-run. Lastly, the model validates the hypothesis that growth has not been export-led in India, rather it is growth-driven exports.*

### 7.1 INTRODUCTION

Previous chapter provided a rigorous analysis on short-run stabilisation and discussions to the major developments in time series analysis and their impact on modelling macroeconomic relationships. With regard to modelling growth, we first survey the theories of growth in this chapter and then analyse the pattern of the growth rate of real GDP on the demand side which is warranted by noticing the fall in the share of investment as shown in chapter 2 suggesting that, of the components of GDP, investment has been (one of) the slowest growing. On the supply side, this is justified by the growth accounting. Accordingly, this chapter models output and private investment

on the assumption that declining levels of investment expenditure leads to a shortage of physical capital and thereby retards economic growth. In the recent years there has been a growing concern with the theoretical and econometric analysis of growth-oriented adjustment in DEs. The standard model of economic growth has been mostly supply-driven within the framework of Neoclassical theory in which the process of capital accumulation is driven by household savings behaviour and in which aggregate demand effects are absent. But the core part of the analytical framework of the gap models of the Bank for funding DE adjustment programs<sup>1</sup> advocates that higher investment is necessary for long-run growth. In other words, this implies that it is the rate of growth of demand that may constrain the rate of output growth. In a growth context, Keynesian economics emphasizes the primacy of investment spending by firms in determining capital accumulation and the rate of technical progress (Palley, 1996; 1997). The other strand of growth literature is based on export-led growth theories of international trade. The question as to whether exports influence economic growth, is of crucial importance. Economic theory tells us that expansion of productive capacity through income growth can raise exports, and increased profitability of exports can induce increased saving and thereby capital emplacement, which gives rise to high economic growth. The controversy over the relation between export performance and economic growth has been a subject of continuous discussion in the development economics literature. A number of studies have examined the theoretical and empirical aspects of relation between exports and economic growth using cross-country statistical comparisons.<sup>2</sup>

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<sup>1</sup> For an overview of the gap models, see Bacha (1990), and Taylor (1994).

<sup>2</sup> For a detailed survey, see Mallick (1995).

Most of these empirical studies demonstrate that exports contribute to income growth more than just the change in the volume of exports.

As the existing growth theories for model building are idiosyncratic and complex, it is important to examine the two different theories of growth within a unified framework. These conflicting views provide our motivation to reinvestigate India's economic growth to determine whether growth can be described by incorporating the mechanisms of endogenous growth with export-led growth or/and growth theory in a Keynesian mode (see Palley, 1996) that requires the mechanisms of endogenous growth with capital accumulation being governed by investment spending (rather than saving). Thus the question as to what factors determine the performance of economic growth and what is the long-term relation among these factors and its determinants which are devoid of any spurious correlations, is very stimulating. The objective of this chapter is to derive an empirical analysis of the relationship between output, private investment, exports, school enrollment rate as a proxy for human capital, real interest rate, government investment expenditure, real domestic credit to the private sector in India over the period 1950-51 to 1995-96 using multivariate cointegration modelling. The aim is to use Johansen's cointegration (1988) technique to find the long run linear relationships entering the growth equilibrium of the Indian economy. The plan of the chapter is as follows: The following section will be tracing the analytical framework and the methodological issues behind long-term growth. The third Section presents econometric evidence for the factors determining output growth. The last section will be devoted to concluding remarks.



## 7.2 ANALYTICS OF ECONOMIC GROWTH

It is now well known that the concept of economic growth is central to the policy strategies of most DEs. Even the early efforts to adapt the growing Keynesian macroeconomic thinking to the problem of economic development were stalled by the appearance of a consensus that planners must worry about long-term growth in the DEs, not short-run stabilization (Rao, 1952). Indeed both the Fund and the Bank aim at influencing the DE macroeconomic policies in order to have adjustment with growth. In this chapter we do not wish to go in to a detailed analysis of the Fund-Bank policies as there is a vast literature on the topic.<sup>3</sup> However, the concept of "growth-oriented adjustment" or the notion that economic growth is essential for the achievement of the twin goals of a sustained reduction in inflation and viable balance of payments, has recently received the attention of policymakers and academics alike (Khan *et al.*, 1991). Indeed, growth-oriented adjustment is a key characteristic of the policy packages that make up Fund-supported market-based reform programs which are part and parcel of the macroeconomic policies currently underway in many DEs.

### 7.2.1 Neoclassical Model with Endogenous Growth

Long before the Neoclassical theories, the most popular model of economic growth was the so called Harrod-Domar model which made the first important contribution to aggregate growth theory. These aggregate growth models were extended by many authors in the 50's and 60's with Solow's classic articles playing a leading role in the

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<sup>3</sup> For details on the analytical basis, see Mills and Nallari (1992), Taylor (1994).

way in which economists have seen the questions regarding growth. Solow (1956) showed that the rates of saving and population growth taken exogenously by assuming a standard neo-classical production function with decreasing returns to capital, determine the steady-state level of income per capita, which is exogenous. These exogenous Neoclassical growth models have been extended in the late 80's and early 90's giving rise to endogenous growth models (Romer, 1986; Lucas, 1988; Rebelo, 1991).

The endogenous growth models developed by Lucas-Romer challenged the old neoclassical model by emphasizing the role of endogenous factors (i.e., human capital stock and R&D activities) as the main engines of economic growth. While early Neoclassical models assumed that total factor productivity growth (or technical progress) was exogenously given, the newer endogenous growth models imply that this component of growth might be attributed to the 'learning by doing' effect occurring between physical and human capital, which results in increasing returns to scale in production technology (Lucas, 1988). The most distinctive difference between neoclassical exogenous and endogenous growth theories is that the former assumes constant returns to scale whereas the latter generally assumes increasing returns to scale. The assumption of increasing returns to scale provides a possible way to long-run sustained growth in endogenous growth theories. These theories of endogenous economic growth stresses the point that the opening up of the investment opportunities under a liberalised atmosphere in a 'market-friendly' economy brings about high economic growth. Besides, the gap model of the Bank which is offered as an alternative analytic framework for growth believes that growth of real output is related to the total

investment in the Harrodian sense, where investment can be considered as one of the demand factors in determining growth.

There are certain broader issues which are not assumed by these Neoclassical models. To judge whether these theoretical attempts have been fruitful, we need to know what is the best approximation of a true model of development. If the goal of the growth theory is to show the mechanism by which growth takes place taking note of the demand side, then the new growth theory (endogenous) falls well short. These models are all pre-Keynesian, where there is no problem of effective demand. In other words, there is no "demand" proper in these models. Two questions follow from this: (a) without effective demand, how does one talk of actual growth. What does "potential" or "warranted" mean in observable term? What sort of comparison with "actuality" can one do on this basis? (b) Is it sensible to talk of "endogenous" growth leaving demand side out of the picture. Hence there is room for more theoretical exploration in explaining the growth processes by considering both the demand and supply aspects.<sup>4</sup> In Neoclassical models, capital accumulation continued to be driven by household savings behaviour rather than firms' investment spending, and there was no role for aggregate demand factors. The inclusion of an investment function would then create a point of entry for aggregate demand factors, for investment being both a demand and a supply phenomenon.

A wide range of endogenous growth models have treated human capital as a critical factor in determining growth rate of output (see Lucas, 1988). Lucas-Romer endogenous growth model suggest that endogenously accumulated human capital has a direct impact

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<sup>4</sup> For a theoretical exploration in this direction, see for example, Palley, 1996.

on the productivity of labour and as a result, human capital becomes specific to the individual leaving innovation in the stock of knowledge as an exogenous factor. It is an important source of long-term growth, either because it is a direct input into research (Romer, 1990) or because of its positive externalities (Lucas, 1998; Becker, Murphy, and Tamura, 1990), and policies that enhance public and private investment in human capital promote long-run economic growth. The inclusion of human capital variables in endogenous growth models are intended to capture quality differences in the labour force, as non-physical capital investment increases the productivity of the existing labour force. They commonly relate to education and are measured by an index of educational attainment, by mean years of schooling, or by school enrollment. Secondary school enrollment is the variable most commonly used in endogenous growth studies, and it is also adopted here. Microeconomic studies for numerous DEs have found that individuals with greater education tend to have relatively higher earnings (for further details, see Levin and Raut, 1997). Educational investment may also contribute indirectly to economic growth by reducing fertility and improving health and life expectancy.

The endogenous growth literature on finance and development posits a symbiotic relationship between the evolution of the financial system and development of the real economy. Domestic credit can affect economic activity in many ways. It may contain at least two types of information about the process of financial intermediation. First, changes in credit may reflect an inability of financial intermediaries to make loans perhaps due to changes in monetary policy. In this case, firms unable to issue debt in the open market may become credit-constrained leading to lower levels of investment and

job creation. Second, changes in credit may reflect shocks to the intermediation system itself. Financial deregulation, financial innovations, or changes in the solvency of borrowers or lenders have implications for economic activity that may be transmitted through changes in the quantity of credit. Further, the *sine qua non* of financial liberalisation in practice has been a significant increase in interest rates, as we always observe an increase in practice. The resultant increase in interest rates in the official market decreases the quantity of finance available to firms because it draws resources out of the unorganised market, and it is less efficient in intermediation due to the prevalence of high reserve requirements. For example, King and Levine (1993) present a model in which financial sector taxes such as deposit rate ceilings or high reserve requirements have a negative effect on financial intermediation and, consequently, on innovative activity and economic growth. Moreover, the rise in real interest rate increases the cost of borrowing and decreases investment. Thus the effect on growth is expected to be negative as real interest rate captures the credit/capital cost of investments.

### **7.2.2 Export-led Model of Growth**

Another major economic policy strategy advocates export-led growth, and there is considerable empirical evidence suggesting that growth has indeed been export-led in the most rapidly developed DEs. Moreover, there is a recognition that India is a dependent economy in which the supply side of real output is constrained by the inadequate availability of foreign exchange. In international trade theory, a number of reasons have been advanced about why exports could serve as the engine of growth. It

has been argued by a number of economists that a highly satisfactory performance on the export front by a number of DEs has been the result of a high rate of economic growth achieved by them as an outcome of skillful management of their economic policies. The relationship between exports and economic growth seems to be one of interdependence such that one affects the other. There are substantial grounds for believing that there is a causal relationship between exports and economic growth, and that this relationship is one of interdependence rather than of unilateral causation. There are also grounds for believing that exports are a key factor in promoting economic growth and that it is generally a rise in exports that stimulates an increase in aggregate economic growth, rather than vice-versa.

Many of the earliest studies (Maizels, 1968; Michaely, 1977; Balassa, 1978; Heller and Porter, 1978) concentrated on correlations between exports and income; aggregate production functions that included exports as an explanatory variable then followed (Tyler, 1981; Feder, 1982; Ram, 1985). Next came studies employing causality tests (Jung and Marshall, 1985; Bahmani-Oskooee *et al.*, 1991) followed by the determination of causation using cointegration and error correction techniques (Bahmani-Oskooee and Alse, 1993; Ghatak and Price, 1997) and VAR methodology (Mallick, 1995; Henriques and Sadorsky, 1996). However, to postulate an uniform relationship between export growth and economic growth among countries is unrealistic, given the considerable differences in economic structure exhibited by DEs. This uniformity is susceptible to a wide range of criticisms including the non-existence of balanced growth paths (Quah, 1993), the sensitivity of the results to the set of conditioning variables (Levine and Renelt, 1992), the heterogeneity of slope coefficients

across countries, the likely differences in causality patterns and cross-sectional endogeneity of regressors, and the standard measurement and statistical problems (see Arestis and Demetriades, 1997).

It has been mentioned in the literature that export growth and income growth are positively related. In either case, import growth can act as an intervening variable because some of the Indian industries are import-intensive in nature, and macroeconomic policies are always aimed at keeping the balance of payments position within reasonable limits to maintain a stable exchange rate. Imports of raw material and intermediate inputs can be taken as one of the supply factors in the growth process. However Ghatak and Price (1997) find that imports do not appear to be important to Granger cause output in the case of India. Hence among other reasons, since price fluctuations and political intervention influence economic growth to some extent, to control for these factors the real interest rate surprises are included. The reason is that growth is highly sensitive to favourable or unfavourable real interest rate movements. Moreover, the real interest rate is especially an important variable because changes in real interest rate has an impact on investment in two opposite directions. On the one hand, it affects investment positively through the effect of increasing financial savings and the supply of credit to the investors (McKinnon/Shaw framework). On the other hand, the real interest rate affects investment negatively since it captures the price of credit/capital (Keynesian/Structuralist approach).

Technically, the ideas in such a complicated set-up can be presented in a simple setting as follows:

Following the standard endogenous growth approach (Rebelo, 1991), a given country's production can be characterised by the augmented aggregate production function as

$$Y_t = A_t K_p^\gamma K_g^\theta (HL)_t^\eta \quad \gamma + \theta + \eta > 1 \text{ for endogenous growth}$$

$$A_t = X_t^\phi (RIR)_t^\lambda (RDCP)_t^\omega \text{ and } HL = E^\delta$$

where  $Y$  is real output,  $K$  is the physical capital stock and  $K_p$  and  $K_g$  denote private and public sector capital stock,  $L$  is raw labour input,  $HL$  is the average level of human capital,  $A$  is technical progress,  $E$  is the measure of education level,  $\delta$  is the return to level of education,  $X$  is exports volume. The real interest rate ( $RIR$ ) is defined as nominal deposit rate minus the current inflation rate; thus inflation expectations are assumed to be static.  $X$ ,  $RIR$  and  $RDCP$  are not proper arguments of the standard production function approach, in that they are not production inputs. But they are intended to reflect those international and domestic factors that influence productivity but are not captured in  $L$  or  $K$ . So total factor productivity ( $A$ ) is determined by the volume of exports, real interest rate and real domestic credit to the private sector ( $RDCP$ ).

Assuming both types of capital stock depreciate at the same rate at  $\psi$ , the evolution of  $K_p$  and  $K_g$  is given by the following:

$$\dot{K}_p = I_p - \psi K_p \quad \text{and} \quad \dot{K}_g = I_g - \psi K_g .$$

In steady state  $\dot{K}_p = \dot{K}_g = 0$  and two types of capital stock converge to  $K_p^*$  and  $K_g^*$ .

$$\text{That is, } K_p = \frac{1}{\psi} I_p \quad \text{and} \quad K_g = \frac{1}{\psi} I_g .$$



Substituting this in the production function and taking logs gives the following long-run output model:

$$\ln Y_t = \frac{\gamma}{\psi} \ln \text{PVTCF}_t + \frac{\theta}{\psi} \ln \text{PUBCF}_t + \eta\delta \ln E_t + \phi \ln X_t + \lambda \ln \text{RIR}_t + \omega \ln \text{RDCP}_t$$

where PVTCF is private investment and PUBCF is public investment.

In equilibrium we assume that the process of capital accumulation is investment driven recognising saving as a residual that adjusts to accommodate the level of investment spending. Gross private capital formation describing the physical endowments is the most common variable in studies of endogenous growth. Investment as opposed to the accumulated stock of capital can be used because it is an important vehicle for technological diffusion due to the vintage effect of new capital. Further, during fiscal adjustments government capital spending is indeed reduced more than other categories of government spending and this decline in public capital spending has important growth retarding effects. Hence a structural feature that can be incorporated here is the 'crowding-in' hypothesis which assumes that there is complementarity between government and private investment. Thus it is necessary to decompose total investment into private and public investment, as public investment on infrastructure is treated as an engine of growth. The other structural variables are the real interest rate and real domestic credit to the private sector.

Given the linkage among the variables that make output growth possible, we would argue that it would be better to use the multivariate theory of cointegration as an appropriate technique, where all variables in the VAR system are supposed to be dynamically related. This is precisely because of the limitations of the econometric

evidence that is often put forth in support of the cross-country growth studies. For instance, in many studies all or most DEs are treated to be alike and country-wise cross-section data was used. Countries differ from one another with respect to their size, level of skills of their labour force, infrastructure, the role of the state, stability and type of their governance etc. As such the statistical evidence gathered can not be taken as representing any DE. In some other cases the econometric evidence is offered in terms of structural econometric models with time-series data. But such models ignore the non-stationary nature of the data, which are known to give spurious results and hence cannot be taken seriously (see Nelson and Plosser, 1982; Perron, 1988).

### **7.3 EMPIRICAL ANALYSIS**

In this section the empirical results are presented. Economic growth is measured in terms of real Gross Domestic Product (GDP). The annual data on real GDP at factor cost (GDPFC), real gross domestic private capital formation (PVTFCF), real exports at constant (1980-81) prices as a percentage of GDP (EXPG), real public investment expenditure (PUBCF), domestic credit to private sector and interest rate from 1950-51 to 1995-96 have been compiled from various issues of Economic survey, Government of India (GOI), and Report on currency and finance, RBI respectively. Higher secondary school enrollment (SERAT) has been obtained from the Handbook of Educational and Allied Statistics, GOI, 1987; Selected Educational Statistics (various volumes), GOI; and Education in India, Vol. I (various years), GOI. Graph 7.1 reports the plots of the logarithms of the seven time series and the change in the log of the variables. All series

exhibit strong upward trends except EXPG which is volatile reflecting possible effects of trade policy.

The econometric applications are necessarily driven by economic theories, which gives rise to econometric relations of a structural type. Since most of the macroeconomic time series are non-stationary, it is now quite well known that the traditional structural equations portray spurious correlations and erroneous conclusions (Granger and Newbold, 1974; Phillips, 1986). As a precondition for cointegration, the individual series are tested for a common order of integration and then Johansen maximum likelihood method is applied to find the cointegrating vectors (Johansen, 1988; 1991).

### 7.3.1 Testing for Stationarity:

Here we test for integrated properties of the data using graphical and correlogram evidence, and with ADF tests for existence of unit roots. The essence of these tests is the null hypothesis of non-stationarity whose rejection requires a negative and significant test statistic. The ADF statistics are calculated as the t-ratios of the coefficient on  $x_{t-1}$  (i.e.,  $\tau_1$ ) in the equation below:

$$\Delta x_t = \tau_0 + \tau_1 x_{t-1} + \tau_2 T + \sum_{i=1}^k \varphi_i \Delta x_{t-i} + \varepsilon_t$$

Here, we examine each time series and see whether it is stationary or non-stationary employing the unit root tests.<sup>5</sup> If a time series is found to be non-stationary, we next examine, whether its first difference is stationary. Using this procedure we determine the

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<sup>5</sup> For an overview of unit-root tests, see Hendry, 1986.

order of integration of a time series. Table 7.1 presents the results of ADF test statistics for the log levels and first differences of the logs of the annual time-series data of India for the period 1950-1995. From the Table it is evident that all the time series such as output, private investment, exports, real interest rate, human capital proxied by school enrollment rate, public investment, domestic credit to the private sector are integrated of order one in levels, i.e., stationary in first-differences based on the ADF test. In selecting the order of the ADF test, we follow Dickey, Bell and Miller (1986) who have argued that the choice of additional lags, i.e., value of  $k$ , could be determined by the level of significance of estimated lag coefficients using the standard t-test. The results are compatible with the hypothesis that non-stationarity characterises the variables in this study.

### **7.3.2 Cointegration and Short-Run Dynamics:**

Given the presence of unit root in each series, a precondition for the existence of a stable steady state relationship is cointegration between the variables. The variables are said to be cointegrated, if each variable has a unit root in its univariate representation and some linear combination of these variables is stationary. Problems concerning non-stationarity and cointegration of the data may be solved by employing the Johansen's maximum likelihood (ML) method [Johansen (1988, 1991)], because this approach has the advantage of making all the variables explicitly endogenous in which an error correction mechanism is also included.

The Johansen method is a multivariate method which starts with an unrestricted vector autoregressive (VAR) representation as:

$$y_t = \mu + \sum_{i=1}^k \Pi_i y_{t-i} + \varepsilon_t$$

where  $y_t$  contains all  $N$  variables of the model,  $\Pi$  is the  $N \times N$  matrix of parameters, and  $\varepsilon_t$  is a vector of random errors and is distributed as  $N(0, \sigma^2 V)$ .

The VAR model can be represented in terms of first differences as follows:

$$\Delta y_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Gamma_k y_{t-k} + \Psi x_t + \varepsilon_t$$

where  $\Gamma_i = -I + \Pi_1 + \dots + \Pi_i$  ( $I$  is a unit matrix),  $y = [\text{LGDPFC}, \text{LPVTFC}, \text{LSERAT}, \text{LXPG}, \text{LPUBCF}, \text{LRDCP}, \text{LRIR}]$ ,  $x = [\text{DUM74}, \text{DUM79}]$ .

The Johansen method uses a maximum likelihood (ML) estimate of the above multivariate system. The rank of  $\Gamma_k$  (which is a  $N \times N$  matrix) can at most be equal to  $N$ , in which case all variables in  $y_t$  are integrated of order zero (i.e., the variables constituting the vector process  $y_t$  are not cointegrated). If the rank of  $\Gamma_k$  is equal to  $R < N$ , then  $R$  indicates the number of cointegrating vectors and there exists a representation of  $\Gamma_k$  such that  $-\Gamma_k = \alpha \beta'$ , where  $\alpha$  and  $\beta$  are  $N \times R$  matrices. The maximum likelihood estimates of  $\alpha$  and  $\beta'$ , after normalization, can be interpreted as the adjustment matrix and the matrix of co-integrating vectors (long-run multipliers) respectively. Johansen has proposed two likelihood ratio test statistics to test the null hypothesis on the number of cointegrating vectors, both of which are based on the number of significant eigenvalues of  $\Pi$ : the maximal eigenvalue and the trace statistic. A test of zero restrictions on  $\alpha$  is the test of weak exogeneity when the parameters of interest are long-

run. Toda and Phillips (1994) interpret weak exogeneity in a cointegrated system as a notion of long-run causality. We employ weak exogeneity tests to examine the issue of long-run causality between the variables in the system.

The Johansen ML method is applied to the VAR formed by the seven variables. The lag length included in the VAR is two<sup>6</sup>. The system diagnostics are presented in Table 7.2. The results are obtained using PcFiml version 9.00 (see Doornik and Hendry, 1997), which are presented in Table 7.3. It reports the  $\lambda_i$  eigenvalues, the  $\lambda$ -max and the trace statistics (both adjusted and unadjusted for degrees of freedom), and the 5% critical values. The test statistics indicate that the hypothesis of two cointegrating vectors cannot be rejected. Hence, there are two long-run relationships, which can be thought of as long-run output and private investment equations. Both  $\lambda$ -max and the trace statistics support the existence of two vectors at 1% level of significance. A visual inspection of vector1 and vector2 in Graph 7.2 confirms the existence of two cointegrating relationships because they are stationary. Table 7.4 reports the normalised  $\beta$  eigenvectors and the corresponding  $\alpha$  coefficients. Having obtained the cointegrating relations, we need to test the variables which are exogenous by imposing zero-restrictions on the adjustment coefficients in the following adjustment vectors denoted as  $\alpha_1=[\alpha_{11}, \alpha_{12}, \alpha_{13}, \alpha_{14}, \alpha_{15}, \alpha_{16}, \alpha_{17}]$ , and  $\alpha_2=[\alpha_{21}, \alpha_{22}, \alpha_{23}, \alpha_{24}, \alpha_{25}, \alpha_{26}, \alpha_{27}]$ . The outcome of the tests of hypotheses about the adjustment coefficients reveals that LXPG, LRIR, LRDCP, LPUBCF are weakly exogenous.

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<sup>6</sup> We adopt the sequential reduction method of VAR lag length selection recommended by Doornik and Hendry (1997) starting from maximum 2 lags with annual data. The testing begins with a comparison of 2-lag model with 1-lag model. The null hypothesis that the second lag is equal to zero is rejected.

	$\alpha_1$	$\alpha_2$
LGDPFC	-0.036532	0.023852
LPVTCF	1.0713	-1.1968
RIR	9.2052	6.0543

The weak-exogeneity tests are reported as follows:

LR-test, $\alpha_{13}$ & $\alpha_{23}$ : $\chi^2(2) = 0.34031$ [0.8435]	LR-test, $\alpha_{14}$ & $\alpha_{24}$ : $\chi^2(2) = 2.3187$ [0.3137]
LR-test, $\alpha_{15}$ & $\alpha_{25}$ : $\chi^2(2) = 2.751$ [0.2527]	LR-test, $\alpha_{16}$ & $\alpha_{26}$ : $\chi^2(2) = 4.0106$ [0.1346]
LR-test, $\alpha_{17}$ & $\alpha_{27}$ : $\chi^2(2) = 16.952$ [0.0002] **	LR-test, $\alpha_{13}$ to $\alpha_{26}$ : $\chi^2(8) = 7.7845$ [0.4548].

Now, we need to test hypotheses about the cointegration vectors by identifying them.

Denoting the two long-run equilibrium relationships by  $\beta_1 = [\beta_{11}, \beta_{12}, \beta_{13}, \beta_{14}, \beta_{15}, \beta_{16}, \beta_{17}]'$  and  $\beta_2 = [\beta_{21}, \beta_{22}, \beta_{23}, \beta_{24}, \beta_{25}, \beta_{26}, \beta_{27}]'$  respectively, we impose the following restrictions for exact identification:

$$\beta_1 = [1, \beta_{12}, \beta_{13}, \beta_{14}, \beta_{15}, 0, \beta_{17}]' \text{ and } \beta_2 = [0, 1, \beta_{23}, \beta_{24}, \beta_{25}, \beta_{26}, \beta_{27}]'$$

The restrictions on  $\beta_1$  indicates an equation for output. In order to exactly identify it, we impose  $\beta_{11}=1$  and  $\beta_{16}=0$  because LRDCP affects output indirectly through private investment. Theoretically the second vector must be interpreted as an investment function in order to have a complete model in which aggregate demand factors would play an important role in generating growth. The restrictions we impose to identify the second vector are  $\beta_{22}=1$  and  $\beta_{21}=0$  to get an equation for private investment. The over-identifying restrictions are the coefficients associated with exports:  $\beta_{14}=0$  and  $\beta_{24}=0$ . Moreover it has been well documented in the literature that output has never been export-led in India. In the present context, we are mainly interested in whether exports can be excluded from the cointegrating relations. We want to impose this restriction just to test the hypothesis that export is weakly exogenous and has not influenced output growth in India. We test the theoretical restriction whether there is export-led

growth or growth-driven exports in the long-run output equation. The hypothesis that exports do not enter the cointegrating relations between the other variables cannot be rejected. The likelihood ratio (LR) test statistic for testing the two  $\beta$  with eight  $\alpha$  restrictions is distributed as  $\chi^2(10) = 14.172$  [0.1653], which is accepted. This implies that export is exogenous and has not influenced output in the long run. In other words, there has been no export-led growth in India. The following two restricted cointegrating relationships are obtained:

$$\text{LGDPFC} = 0.21773 * \text{LPVTFC} + 0.63966 * \text{LSERAT} + 0.16661 * \text{LPUBCF} + 0.083522 * \text{RIR}$$

and,  $\text{LPVTFC} = 0.4475 * \text{LSERAT} + 0.0132 * \text{LPUBCF} + 0.515 * \text{LRDCP} + 0.06138 * \text{RIR}$ .

These two long-run equations determining levels of real output and private investment constitute the real output sector. Since the coefficients associated with investment and human capital variables add up to greater than unity ( $\beta_{12} + \beta_{13} + \beta_{15} > 1$ ), there is basis for confirming the presence of endogenous growth, and the 'learning by doing' effect does appear to cause India's economic growth to have a rapid and sustained growth. Therefore India's economic growth can be described by an endogenous growth model and investment on human capital should be considered as a crucial factor for economic growth. Moreover, it substantiates the Keynesian belief that it is investment behaviour that determines the extent to which household savings are realized in the form of capital accumulation. The hypothesis that government investment crowds out private investment is not true as the crowding-in factor is strictly positive. There is also a complementarity relation between human capital and private capital formation. An explanation of the inability on the part of exports to increase economic growth may be that in the case of the Indian economy, the percentage change in imports owing to one



percent change in income is quite high. We plot the restricted cointegrating relations in Graph 7.2, which look very much same as the unrestricted one.

The results exhibit strong cointegration among the variables and the relationships constitutes a stationary time-series with a constant mean. But cointegration implies that there exists ECMs of the above cointegrating equations. The ECMs are estimated using FIML with one lag differences for all the variables. Given that all the variables are weakly exogenous except output, private investment and real interest rate, we need to model  $\Delta\text{GDPFC}$ ,  $\Delta\text{LPVTCF}$ ,  $\Delta\text{RIR}$  jointly. Since RIR is not truly endogenous theoretically in this model, we model only short run output and investment jointly. The results of the estimated ECMs are presented in Table 7.5. From the evidence it is quite clear that India's economic growth in the short-run is influenced to a large extent by private investment on physical capital, public investment on infrastructure, which are significant in the ECM of  $\Delta\text{GDPFC}$ .

The influence of  $\Delta\text{LRIR}$  on change in output is mixed in the short run, negative in the ECM of  $\Delta\text{LPVTCF}$  and positive in  $\Delta\text{LGDPFC}$ . The coefficient being negative in the private investment equation can be interpreted as a Keynesian investment function where investment is negatively related to the real interest rate. This also corroborates the structuralist approach to investment (see Taylor, 1991) that lowering the interest rate will stimulate investment and economic growth in an economy where organised financial market coexists with informal credit market. In the presence of informal loan markets a rise in official interest rates may lead to a reduction in financial intermediation and have an adverse effect on output in the short and medium run.

Essentially, this is because informal credit markets are more efficient at providing financial intermediation than the official commercial banking system, because operators in the informal markets are able to escape from government banking regulations (see, for example, van Wijnbergen, 1983). The estimate being positively significant implies that it supports a Neoclassical model of McKinnon-shaw type. The coefficient of exports in the output equation is significant indicating that exports is an important factor for growth in the short-run. The coefficient of private investment with respect to change in output is significant implying an accelerator process in the short-run, and with respect to real domestic credit is positive and significant. Public investment has a crowding out effect on private investment via output in the short-run.

It is evident that the ECM1 and ECM2 terms are highly significant implying that output and private investment adjust in the short run to a disequilibrium in the long run relationship. The parameter estimates indicate that investment adjusts the fastest to a disequilibrium in the long-run relationship while the estimated coefficient on the ECM1 term in the output equation suggests a slow output adjustment. It may be noted that the negative and significant effect of dummy variable (DUM79) in 1979 in the output ECM reveals an adverse effect of oil price shocks. It appears that the ECMs are well specified as none of the diagnostic tests is failed. The equations pass the LM test in their F-version, and Normality test for residuals distributed as  $\chi_2^2$ . LM is the Lagrange multiplier test for serial correlation, which is asymptotically distributed as a chi-square test. The constancy of the model is accepted with almost every forecast lying well inside the individual 95% confidence bars (see Graph 7.3). The 1-step (ex post) forecast analysis 1991 to 1995 test values are given below.

Parameter constancy forecast tests:

using  $\Omega$   $\chi^2(10) = 11.955$  [0.2881]  $F(10,28) = 1.1955$  [0.3353]

using  $V[e]$   $\chi^2(10) = 10.289$  [0.4155]  $F(10,28) = 1.0289$  [0.4455]

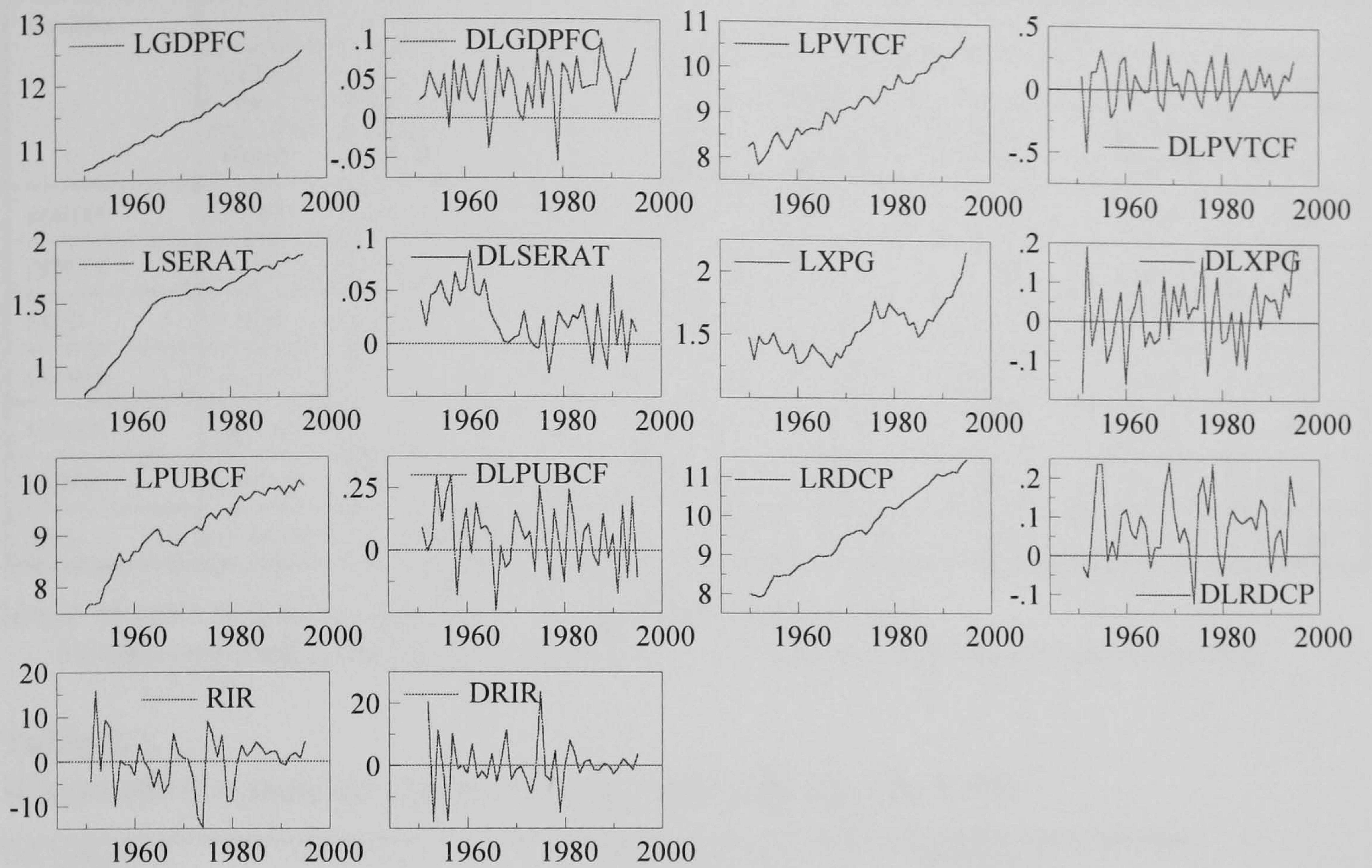
## 7.4 CONCLUSION

In this chapter, we made an empirical attempt to join the theory of aggregate demand with the theory of endogenous growth, which contrasts with Neoclassical growth theory in which the influences of aggregate demand are completely absent. We examine the behaviour of demand and supply factors in explaining the long-run growth in India within the multivariate cointegration framework using the annual data for the period 1950-51 to 1995-96. By performing the cointegration test for the existence of long-run relationships, we find that there are two cointegrating vectors explaining output and private investment in the Indian context. The key factors to long-term growth are public investment, human capital, real interest rate and domestic credit to private sector. Public investment appears to influence growth directly as well as indirectly via private investment, and cutting back public investment may seriously harm economic performance. The error correction models provide evidence to trace the short run dynamics of the cointegrating vectors. The adjustment mechanisms in the short run are supportive of investment-induced growth processes providing a demand-oriented explanation for long term growth.

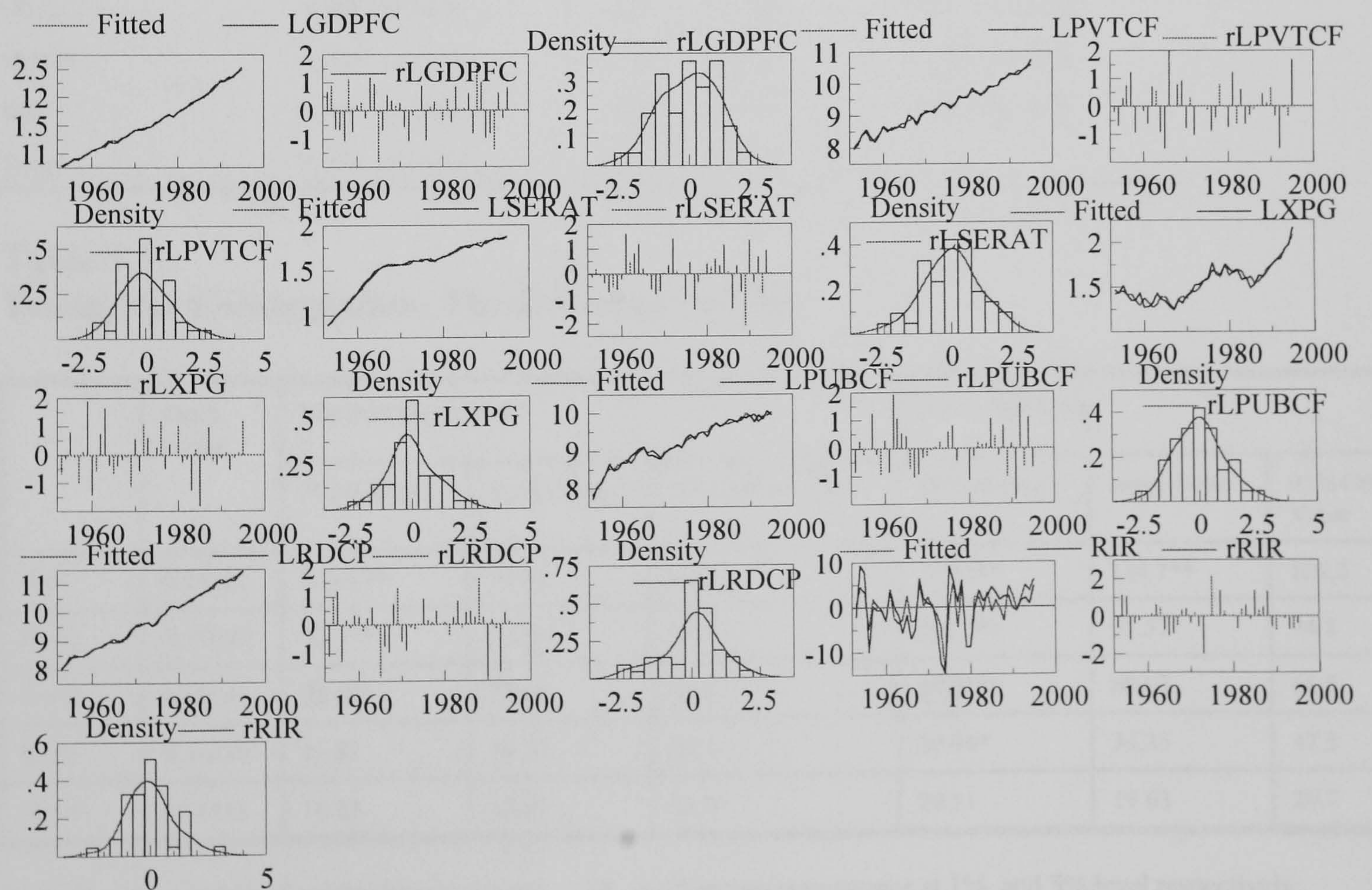
In a restricted model, we have shown that there has been no export-led growth in India by performing weak exogeneity tests and imposing zero restriction on the coefficients of real exports in both the cointegrating relations during the sample period. In contrast to

the export-push approach, the analysis here focuses on domestic demand as the engine of growth in the early stages of development. However, this finding is different from the earlier findings in the sense that the present framework includes not only export-led growth hypothesis but also endogenous growth proposition in which capital accumulation is driven by investment spending by firms, not by the savings behaviour of households. Thus the present exercise is a first empirical attempt of this kind in providing a demand-side explanation for the problem of long-run growth highlighting the point that economic growth is determined not only by supply factors but also by demand factors. In the next chapter we combine the present model with the model of the previous chapter. The model simulation technique is then used to check the properties of the combined model in the next chapter along with the optimal control solutions.

**Graph 7.1**  
**Levels and First Differences of the Variables**



**Graph 7.1a: Graphical Diagnostics-Fitted and Actual Values and Scaled Residuals of the Variables**



**Table 7.1**  
**Testing for Unit Root**

Variables	DF				ADF			
	LEVELS		FIRST DIFFERENCES		LEVELS		FIRST DIFFERENCES	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
LGDPFC	1.1980	-1.1924	-7.8081**	-8.2084**	1.5726	-0.55135	-5.4004**	-5.9361**
LPVTCF	-0.5625	-5.1832**	-7.3260**	-7.2263**	-0.3391	-6.2306**	-8.1855**	-8.1249**
LXPG	0.5834	-1.5115	-7.0380**	-7.5510**	1.0797	-0.97095	-4.4481**	-4.9690**
LPUBCF	-2.3821	-3.4433	-8.0540**	-8.5336**	-2.5916	-2.9774	-5.1742**	-5.7775**
LSERAT	-4.0745**	-2.6130	-4.4491**	-5.6196**	-3.2548*	-2.5779	-2.4619	-3.2676
LRDCP	-0.42227	-3.3777	-5.4111**	-5.3436**	-0.48216	-3.9984*	-5.8744*	-5.8047**
RIR	-5.0841**	-5.0922**	-8.0836**	-8.0104**	-4.4984**	-4.4953**	-7.5394**	-7.5745**

Notes: \*\* and \* indicate significance at 1% and 5% level respectively;  
Numbers reported in the Table are t-values of  $\tau_1$  and ADF unit root test is based on one lag.

**Table 7.2**  
**Diagnostic test statistics for individual equations and the VAR**

Variables	AR 1-2 F	Normality $\chi^2$	ARCH(1)
LGDPFC	1.135 [0.3381]	0.73375 [0.6929]	0.98564 [0.3307]
LPVTCF	2.1049 [0.1438]	1.13 [0.5684]	0.40095 [0.5326]
LSERAT	0.5483 [0.5850]	0.88742 [0.6417]	0.018699 [0.8924]
LXPG	2.6584 [0.0906]	0.98864 [0.6100]	0.19874 [0.6597]
LPUBCF	0.78731 [0.4665]	0.6855 [0.7098]	1.0953 [0.3057]
LRDCP	2.2743 [0.1246]	2.7207 [0.2566]	0.32399 [0.5745]
RIR	1.3117 [0.2880]	3.4221 [0.1807]	0.64448 [0.4300]
System	1.1441 [0.3101]	12.5 [0.5662]	-

**Table 7.3**  
**Testing for Cointegration: The Johansen Method**

	Eigen values	Maximal Eigenvalue			Eigenvalue Trace		
		-Tlog(1-\mu)	using T-nm	95% Critical value	-T\Sum log(.)	using T-nm	95% Critical Value
R=0	0.74066	58.03**	39.14	45.3	199.7**	134.7**	124.2
R<=1	0.70641	52.7**	35.54	39.4	141.7**	95.57*	94.2
R<=2	0.58747	38.07*	25.68	33.5	89.01**	60.03	68.5
R<=3	0.39810	21.83	14.72	27.1	50.94*	34.35	47.2
R<=4	0.31441	16.23	10.95	21.0	29.11	19.63	29.7

Note: R is the number of cointegrating vectors; \*\* and \* means significance at 1% and 5% level respectively.

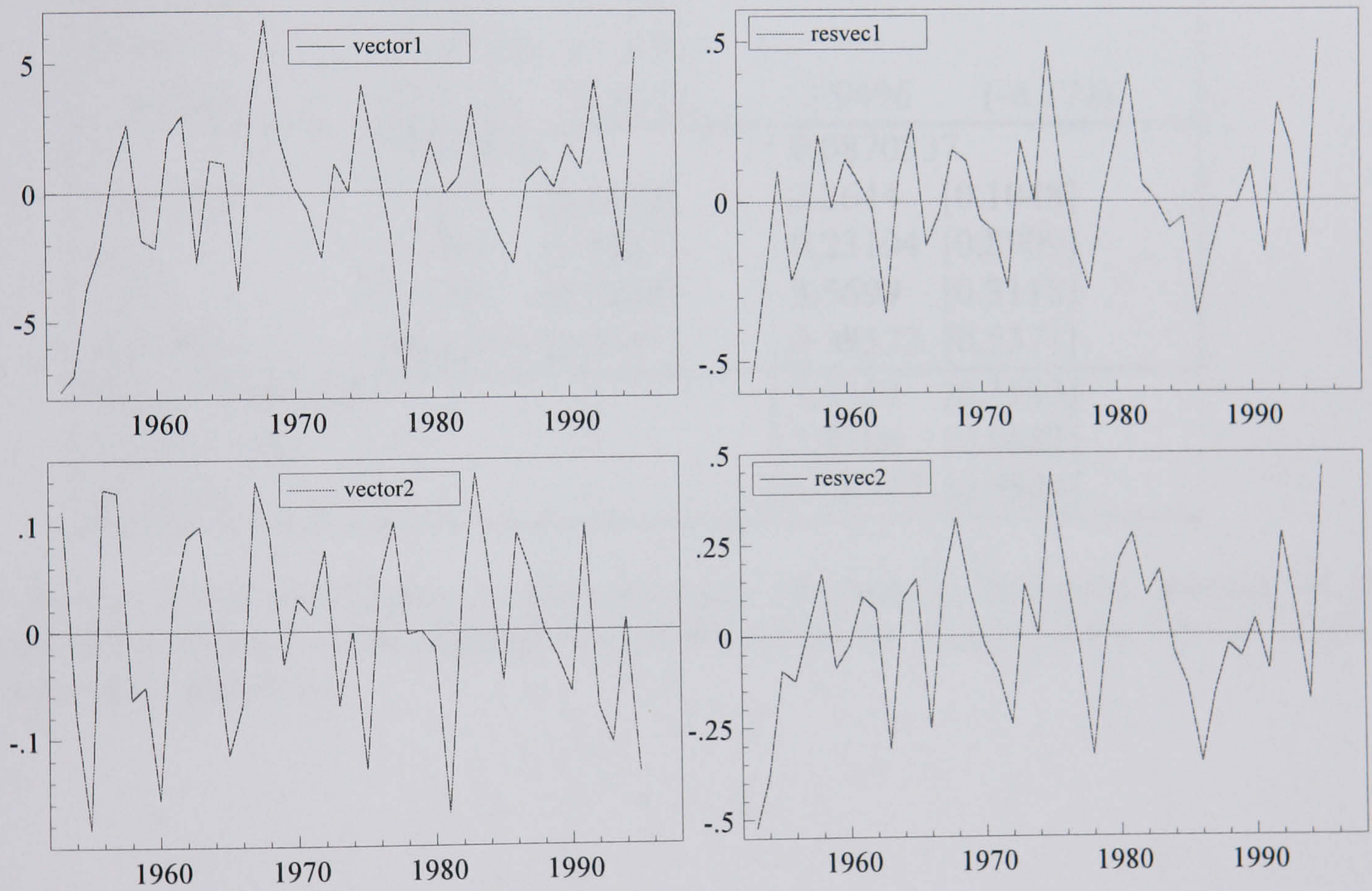
**Table 7.4**

**The Johansen Method: Normalised  $\beta$  Eigenvectors and  $\alpha$  Adjustment Coefficients**

	LGDPFC	LPVCF	LSERAT	LXPG	LPUBCF	LRDCP	RIR
Cointegration Coefficients	1.0000	23.775	-11.330	-13.488	2.1883	-12.452	-0.62317
	-1.0302	1.000	0.22928	-0.076394	0.16420	-0.35614	0.032558
Adjustment Parameters	0.0013319	-0.021185	-0.00073095	0.0051327	-0.0096560	-0.0062763	0.73815
	-0.031873	-0.85847	-0.020579	-0.064717	-0.15844	-0.091665	-23.974

**Graph 7.2**

**Cointegration Vectors: Unrestricted and Restricted**



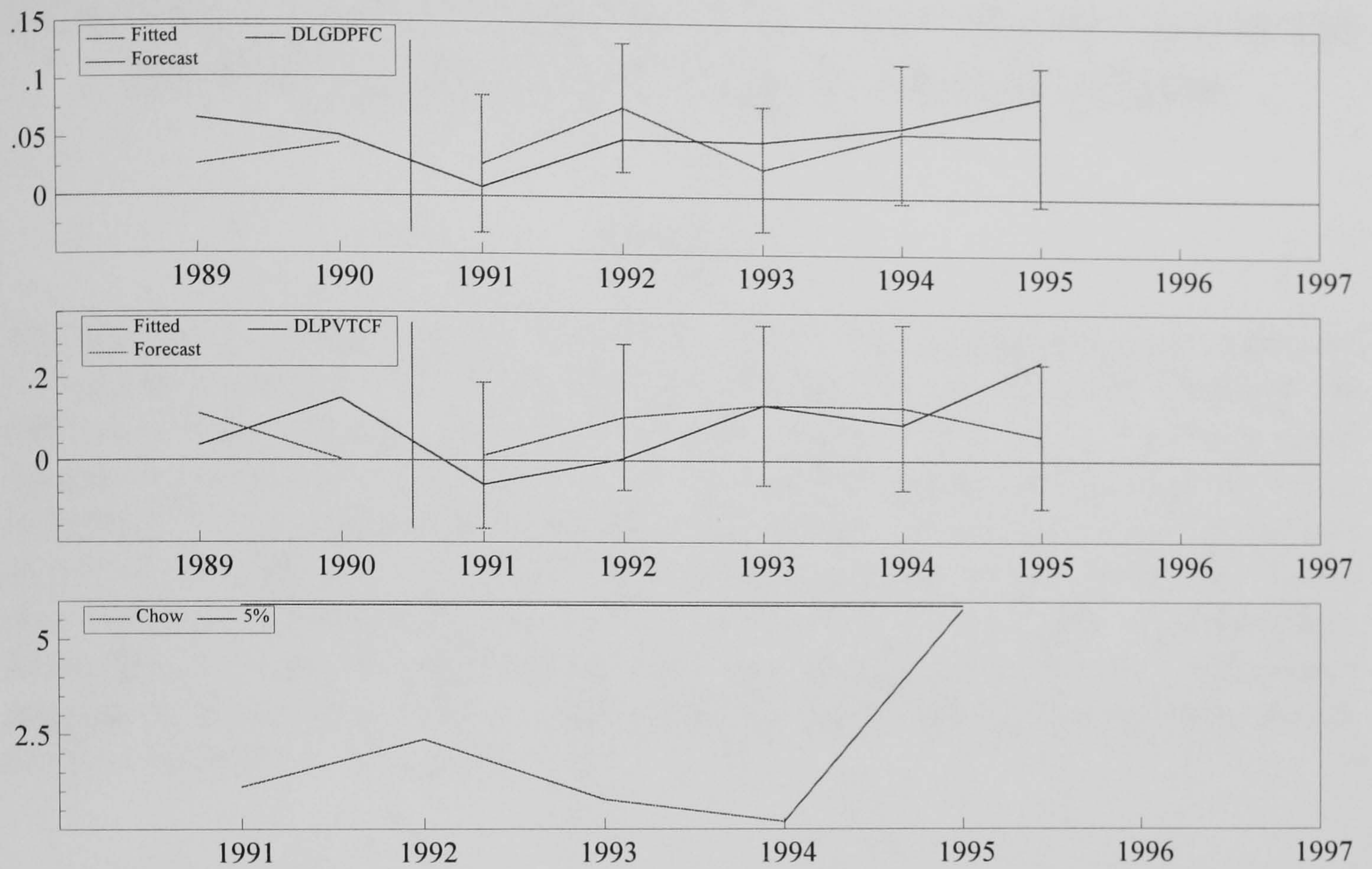
**Table 7.5**  
**FIML Estimates of the ECMs**

	$\Delta$ LGDPFC	$\Delta$ LPVTCF
ECM1 <sub>t-1</sub>	-0.067023 (-3.167)	1.1709 (8.025)
ECM2 <sub>t-1</sub>	0.081684 (1.533)	-1.2160 (-7.883)
$\Delta$ LGDPFC <sub>t-1</sub>	-0.27048 (-1.809)	1.1001 (2.233)
$\Delta$ LPVTCF <sub>t</sub>	0.055143 (1.049)	-
$\Delta$ LPVTCF <sub>t-1</sub>	-	0.47387 (3.639)
$\Delta$ LSERAT	-	1.3019 (2.481)
$\Delta$ LXPG <sub>t-1</sub>	0.11865 (1.980)	-
$\Delta$ LPUBCF <sub>t-1</sub>	-0.073100 (-2.197)	-
$\Delta$ RIR <sub>t</sub>	0.0019947 (2.126)	-0.0079216 (-1.867)
$\Delta$ RIR <sub>t-1</sub>	-	0.010022 (3.427)
$\Delta$ LRDCP <sub>t</sub>	-	0.52240 (2.057)
$\Delta$ LRDCP <sub>t-1</sub>	0.17892 (2.396)	-
DUM79	-0.087370 (-3.038)	-
Constant	0.22732 (1.435)	-3.9496 (-6.174)
$\sigma$	0.0250585	0.0870837
AR(1-2)F	2.1232 [0.1472]	2.2644 [0.1048]
N (2)	2.1094 [0.3483]	0.23104 [0.8909]
$\chi^2$	2.3113 [0.5104]	3.5699 [0.3118]
ARCH(1)	0.065295 [0.8011]	0.39522 [0.5371]
Vector AR(1-2)F		1.7353 [0.1103]
Vector N (6)		2.9386 [0.5682]
$\chi^2_{LR}(13)$		11.6757 [0.5544]

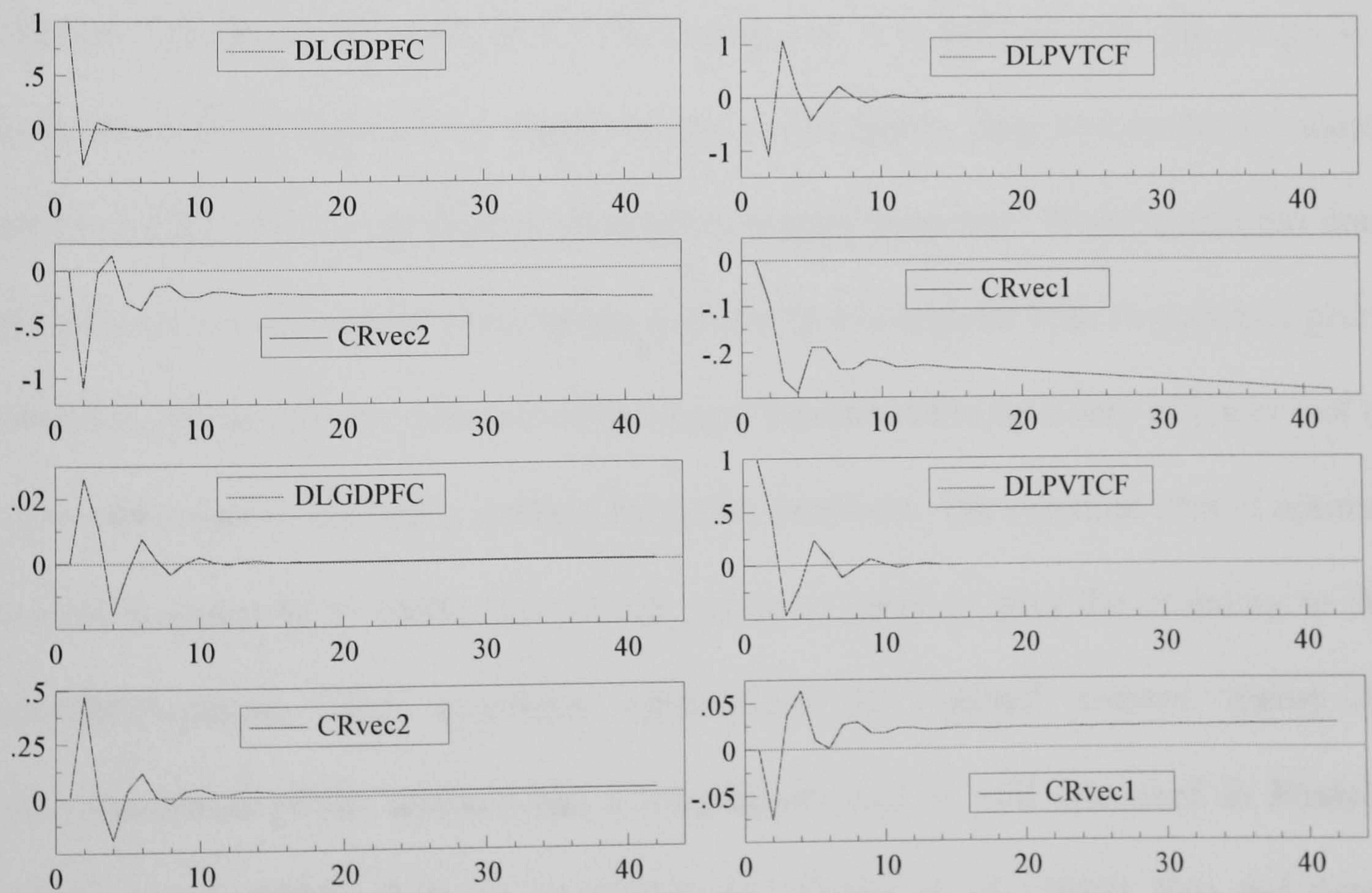
\* Figures in the parenthesis are standard errors; Numbers in the square brackets are the probability values;  $\sigma$  is the standard error of the regression;  $\chi^2_{LR}(18)$  is the LR test of over-identifying restrictions.



**Graph 7.3**  
**Dynamic model-based forecasts**



**Graph 7.4**  
**Dynamic simulation and Impulse Responses**



## Chapter 8

# DESIGNING ADJUSTMENT POLICIES WITH GROWTH IN THE OPTIMAL CONTROL FRAMEWORK

### ABSTRACT

*This chapter is concerned with studying the effects of typical instruments associated with a policy package such as changes in exchange rate and domestic credit on the short run targets especially BoP improvement and inflation reduction within a small macroeconomic model of India. The model used here differs from many in the sense of being a policy-oriented model. We carry out optimal control exercises in the context of such a model to obtain optimal policies given the targets. The analysis thus carried out indicates that demand contraction based on credit restriction leads to improvement in the BoP and reduction in price level rather than increased output. Hence this chapter suggests that there is a need to target output for making the adjustment programs as growth-oriented.*

### 8.1 INTRODUCTION

We obtained a growth model in the previous chapter which is combined in the present chapter with the model of chapter 6. So this chapter is concerned with the design and analysis of policy feedbacks by using optimal control theory. Macroeconomic models are invariably used for simulation, forecast or control purposes.<sup>1</sup> Since simulation does not provide a direct means of obtaining a policy that is *optimal* with respect to a given objective, in the last few decades control theory has proved to be a very efficient tool to study the dynamic economic systems for policy purposes. The essential idea of optimal control is precisely to derive the optimal policy in order to steer the economy to the specified targets. The economic applications of optimal control theory in macroeconomic policy research has a long history and is well discussed in Pindyck (1973), Chow (1975), Holly *et. al.* (1979), and Turner *et. al.* (1989). Rao and Singh

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<sup>1</sup> For an overview of different approaches to policy making, see Wallis (1995).

(1997) derive macroeconomic stabilisation policies for the Indian economy applying control methods within a financial programming approach of the IMF.

The classic modes of macroeconomic adjustment to achieve the goals of BoP viability, price stability, and a sustained satisfactory rate of economic growth are suggested by the Fund to help DEs to design a comprehensive package of economic policies (see IMF, 1987). The monetary restraint aiming at reducing the growth of absorption and the rate of inflation gives rise to the private sector being crowded out of the credit markets. This chapter aims to see how this macroeconomic policy problem can optimally be designed within the small macro system for India. So the control model can be represented by a two instrument, two target problem which is the basic macroeconomic problem of the Fund adjustment program. The second section presents the model, which is a combination of the model of stabilisation (as in ch.6) and the growth model (as in ch.7), and considers its properties. The third section discusses the method of optimal control and the results of optimal control experiments. The last section sums up.

## **8.2 THE MODEL**

Macroeconomic imbalances arising both from external shocks and from inappropriate domestic policies repeatedly confront DEs with the need to restore domestic and external balance. Adjustment programs, often supported by the resources of the Fund are designed to simultaneously achieve both the objectives. As discussed in Ch.4 above, the underlying rationale for the current approach to macroeconomic adjustment in India can be explained in terms of 'financial programming' which is the theoretical

mainstay of nearly all IMF-supported adjustment programs. Whether the external disequilibrium is caused by lack of supply or demand, the Fund emphasises credit restrictions in the sense that a credit crunch will necessarily improve the BoP and generate the resources to repay foreign creditors. Now the issue of whether these adjustment policies, especially credit policy, lead to reduction in output is of crucial importance. The effects of credit policy are less evident in the literature with respect to its impact on output, or on the channels of transmission of monetary impulses to the rest of the economy. The broad concerns of monetary policy in India have been, (1) to regulate monetary growth so as to maintain a reasonable degree of price stability, and (2) to ensure adequate expansion in credit to assist economic growth (Rangarajan, 1998). So we need to base our argument on the role of credit as a factor of production and its role in affecting the supply side of the economy. If these effects are important it seems clear that restrictive credit policy may have greater adverse effects on output growth and less effect on price inflation. Dornbusch (1990) has argued that there is a possibility of stabilisation resulting in stagnation because structural adjustment is only a necessary but not a sufficient condition for growth. To elucidate the major channel via which credit policy affects the supply side is an objective of the econometric model and optimal control experiments presented below.

### **8.2.1 Definition of Variables Used in the Model:**

This section lists out the variables used in the model. Variables in a control model are classified into three categories: (a) *State variables* which describe the state of the economy but can not be directly modified by policy makers, such as inflation rate, GDP, exports, imports etc. (b) *Control variables* which are variables that can be directly

controlled by policy makers, such as exchange rate, domestic credit to affect the money supply, government expenditures etc. (c) *Exogenous variables* which are determined outside the system over which neither the economic system being described nor the policy maker have any control.

#### *State Variables*

$P_t$  is the price level (represented by the wholesale price index),  $\pi_t^e$  is the expected rate of inflation,  $M_t$  is the nominal money supply ( $M_3$ ),  $(M/P)_t^d$  is the desired real balances,  $PX_t$  is the unit value of exports in US dollars,  $X_t$  is the real export,  $I_t$  is the real import,  $R_t$  represents the foreign exchange reserves in rupees,  $Y_t$  is the real Gross Domestic Product (GDP) at constant prices,  $PVTCF_t$  is real gross domestic private capital formation,  $EXPG_t$  is real exports at constant (1980-81) prices as a percentage of GDP,  $RIR_t$  is real interest rate.

#### *Control Variables*

$E_t$  is the nominal exchange rate (Rs per US\$1),  $DC_t$  is net domestic assets of the Reserve Bank of India,  $PUBCF_t$  is real public investment expenditure.

#### *Exogenous Variables*

$YM$  is the marketed output,  $YW$  is the real GNP of trading partners,  $S_t$  is unit export subsidies (Rs per US\$1),  $T_t$  is unit import duties (Rs per US\$1),  $PW$  is world price level (in US\$),  $PM_t$  is the import unit value in US\$,  $KI_t$  refers to net foreign assets of the non-banking sector,  $EI_t$  is the essential imports,  $K_t$  is the money multiplier,  $RDCP_t$  is real domestic credit to private sector,  $ED_t$  is monetary disequilibrium,  $IR_t$  is nominal interest rate,  $SERAT$  is school enrollment rate, and  $DUM79$  is oil price dummy of 1979.

### **8.2.2 Structure of the Model:**

For the application of optimal control, the following model is developed which combines the preceding two chapters by integrating adjustment with growth relating to the Indian economy. The model has 10 endogenous and 11 exogenous variables. Of the 10 endogenous variables, 7 structural stochastic equations are estimated using annual data pertaining to the period 1950-51 to 1995-96. Equations 6 & 7 are identities and Equation 10 is a definition. Equations 1 to 7 are obtained from ch.6 and Equations 8 & 9

are taken from ch.7. Expected inflation is defined as in ch.6. The EC variables are as in chapters 6 & 7.

### 1.Price equation:

$$\begin{aligned} \Delta \ln(P) = & -0.002 + 0.84 * (\Delta \ln(IPA) + \Delta \ln(E)) + 0.07 * (\Delta \ln(W) - \Delta \ln(Q)) \\ & (1.12) \quad (21.05) \quad (2.84) \\ & + (1 - 0.84 - 0.07) * (\Delta \ln(IPRM) + \Delta \ln(E)) - 0.00003 * \Delta ED + 0.06 * \Delta \ln(P(-1)) - 0.35 * EC1(-1) \\ & \quad \quad \quad (-0.78) \quad (0.84) \quad (-3.05) \end{aligned}$$

### 2.Desired real Balances:

$$\begin{aligned} \Delta \ln(MD) = & 0.012 + 1.45 * \Delta \ln(YM) - 0.32 * \Delta \pi^e - 0.34 * \Delta \ln(IR) - 0.26 * EC2(-1) \\ & (0.71) \quad (4.23) \quad (-1.08) \quad (-3.93) \quad (-2.31) \end{aligned}$$

### 3.Unit value of exports:

$$\begin{aligned} \Delta \ln(PX) = & -0.007 + 0.048 * (\Delta \ln(P(-1)) - \Delta \ln(E(-1) + S(-1))) + 0.367 * \Delta \ln(PW(-1)) \\ & (-0.255) \quad (1.57) \quad (2.51) \\ & + 0.55 * \Delta \ln(Y) + 0.73 * \Delta \ln(YW(-1)) + 0.0002 * ED + 0.28 * \Delta \ln(PX(-1)) - 0.215 * EC3(-1) \\ & (1.94) \quad (1.399) \quad (1.469) \quad (1.946) \quad (-2.025) \end{aligned}$$

### 4.Export demand:

$$\begin{aligned} \Delta \ln(X) = & 0.07 - 0.12 * \Delta \ln(PX/PW) + 0.72 * \Delta \ln(YW) + 0.18 * \Delta \ln(X(-1)) - 0.298 * EC4(-1) \\ & (3.54) \quad (-1.08) \quad (1.565) \quad (1.14) \quad (-2.88) \end{aligned}$$

### 5.Imports:

$$\begin{aligned} \Delta \ln(I) = & 0.02 - 0.12 * \Delta \ln((PM * (E + T)) / P) + 0.22 * \Delta \ln(Y(-1)) + 0.06 * \Delta \ln(EI) \\ & (1.48) \quad (-2.74) \quad (0.74) \quad (3.00) \\ & + 0.30 * \Delta \ln(KI / PM) + 0.05 * \Delta \ln(R(-1) / PM(-1)) + 0.07 * \Delta \ln(I(-1)) + 0.0003 * ED - 0.598 * EC5(-1) \\ & (12.39) \quad (1.32) \quad (0.96) \quad (-2.92) \quad (-4.53) \end{aligned}$$

### 6.Balance of payments:

$$R = R(-1) + X - I + KI$$

### 7.Money supply:

$$M = k * (R + DC)$$

### 8. Real Output

$$\begin{aligned} \Delta L(Y)_t = & 0.227 - 0.27 \Delta L(Y)_{t-1} + 0.055 \Delta L(PVTFCF)_t + 0.119 \Delta L(XPG)_{t-1} - 0.073 \Delta L(PUBCF)_{t-1} \\ & (1.435) \quad (-1.809) \quad (1.049) \quad (1.98) \quad (2.197) \\ & + 0.002 \Delta L(RIR)_t + 0.1789 \Delta L(RDCP)_{t-1} - 0.087 DUM79 - 0.067 EC6_{t-1} + 0.82 EC7_{t-1} \\ & (2.126) \quad (2.396) \quad (-3.038) \quad (-3.167) \quad (1.533) \end{aligned}$$

### 9. Real private investment

$$\begin{aligned} \Delta L(PVTFCF)_t = & -3.95 + 1.1 \Delta L(GDPFC)_{t-1} + 0.47 \Delta L(PVTFCF)_{t-1} - 1.30 \Delta L(SERAT)_t - 0.0079 \Delta RIR_t \\ & (-6.174) \quad (2.233) \quad (3.639) \quad (-2.481) \quad (-1.867) \\ & + 0.01 \Delta RIR_{t-1} + 0.5224 \Delta L(RDCP)_t + 1.1709 EC6_{t-1} - 1.216 EC7_{t-1} \end{aligned}$$

(3.427)

(2.057)

(8.025)

(-7.883)

10. Real Interest Rate:  $RIR_t = IR_t - \pi_t^e$

The change in the general price level is a function of the prices of imports and the exchange rate, which is a policy (or instrument variable). The purpose of controlling credit is to accommodate balance of payments situation. Given  $R^*$  and  $P^*$ , the two instruments DC and E can be chosen to meet  $R^*$  and  $P^*$ . So the monetary transmission mechanism focuses on the intermediate variables such as the interest rate, credit, and exchange rate to influence prices and output. In India, the output effect of money supply, stems from three major sources, namely through the aggregate demand effect and through the impact on the quantum and cost of credit. Hence the control of domestic credit becomes an important policy instrument for adjustment with growth.

### **8.2.3 Dynamic Properties of the Model:**

Since simulation analysis provides some important guidelines for optimal control analysis, we first analyse the dynamic properties of the model by introducing single shocks to the system and solving the model for the sample period. The exogenous (policy) variables which are analysed here are: domestic credit, exchange rate, and public investment. A sustained 10 percent negative shock (an unanticipated shock) is introduced to DC and PUBCF, a permanent 10 percent positive shock to exchange rate. The time path of GDPFC and P is derived by means of dynamic multiplier analysis and the cumulative differences between the base and variant solutions are computed; these differences are presented in Chart 8.1. These simulations suggest that the stability properties of the model are satisfactory.

In what follows we discuss the overall properties of the model through three standard simulation experiments, which are depicted in Chart 8.1. The first simulation experiment elicits the response of the model to a permanent negative shock in credit. Output falls more sharply, and prices decline due to the shock in credit leading to demand contraction. Thus the very mode of adjustment in the Fund policy package creates serious supply-side constraints. It has been argued in the Indian context that curtailing growth in money supply might adversely affect output, because money, apart from being relevant as a means of influencing aggregate demand, also plays a crucial role as an input for the productive sectors in the economy in the form of credit (see Rangarajan, 1998). The balance of payments improve in general due to the reduction in the domestic credit. Exchange rate depreciation by 10 per cent reduces the level of output in the first period and as relative price effect dominates after the next period, output rises. The price response emerges more quickly in the devaluation shock and slowly settles down to a lower level in the long-run.

In explaining overall investment behaviour in the economy, a crucial role was generally assigned to public investment. The issue of crowding out is a well accepted proposition that in DEs there is a close relationship between private and public investment, although there is a considerable uncertainty as to whether the public sector investment raises or lowers private investment. Public sector investment can result in crowding out if it utilizes physical and financial resources that would otherwise go to the private sector. Furthermore, the financing of public sector, whether through taxes or issuance of debt will lower the resources available for the private sector and thus depress private



investment activity. On the other hand, public investment that is related to infrastructure and the provision of public goods can be complementary to private investment. Public investment can enhance private investment and raise the productivity of capital, increase the demand for private output through increased demand for inputs and additional services. The overall effect of public investment on private investment will, therefore, depend on the relative strength of these various effects. The question is to determine whether and to what extent the effect of the public investment crowds out or crowds in the private investment in India. The major conclusion is that the effect of public investment on the private sector investment appears to be crucial. It is obvious that by putting in place part of the foundations of a modern economy in the form of infrastructure, private sector participation has been increased. Thus, public investment stimulates private investment. So we analyse the output response under a cut in public investment by 10 per cent. Since the short-run response of output due to cut in public investment is negative, output increases. This result is different from our previous finding in ch.5 because in the growth model of ch.7 we obtained a negative short-run response of 0.07 which implies that there is a one-to-one crowding out of private investment by the public capital in the short-run, though complementarity or crowding-in prevails between public and private investment in the long-run. Therefore, the need becomes imminent to continue support the private sector and motivate it to participate actively in the economy. As shown in ch.5, for the case of financial liberalisation,<sup>2</sup> we investigate the effect of an one per cent increase in the interest rate, which leads to a

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<sup>2</sup> Real interest rates tend to be relatively high in DEs undertaking adjustment programs involving monetary stringency.

negative output effect and positive price effect. So high interest rates are a disincentive for productive investment, aggravating the recession associated with adjustment.

### **8.3 THE DESIGN OF OPTIMAL CONTROL EXERCISE**

Since the purpose of this chapter is to undertake an optimal policy formulation for India keeping in view the adjustment strategies, it is worthwhile to survey briefly the literature on the method of optimal control. Since a large number of economic problems are naturally described as dynamic systems which can be influenced by policies in an attempt to improve their performance, control theory has gained widespread application by economists. Tinbergen (1952) defined the concept of a 'Policy Model' which predicted the effect of 'instruments' on 'targets'. Tinbergen's approach to quantitative economic policymaking involves the following elements:

- a criterion or welfare function that depends on certain economic variables;
- a classification of endogenous variables into two categories, target and irrelevant variables, and classification of exogenous variables into instruments and data variables;
- an econometric model involving relationships between endogenous and exogenous variables;
- a set of boundary conditions and constraints on the target (i.e., state variables in control theory language) and instrument (i.e., control variables in control theory language) variables.

In Tinbergen's approach, the policy model may be a fixed target or a flexible target model; in the former, the welfare function contains fixed target values, but in the latter,

such target values are chosen as to optimize the welfare function. The policy model as delineated in the previous section aims at building Tinbergen type fixed target model.

### **8.3.1 A Digest on Optimal Control Applications:**

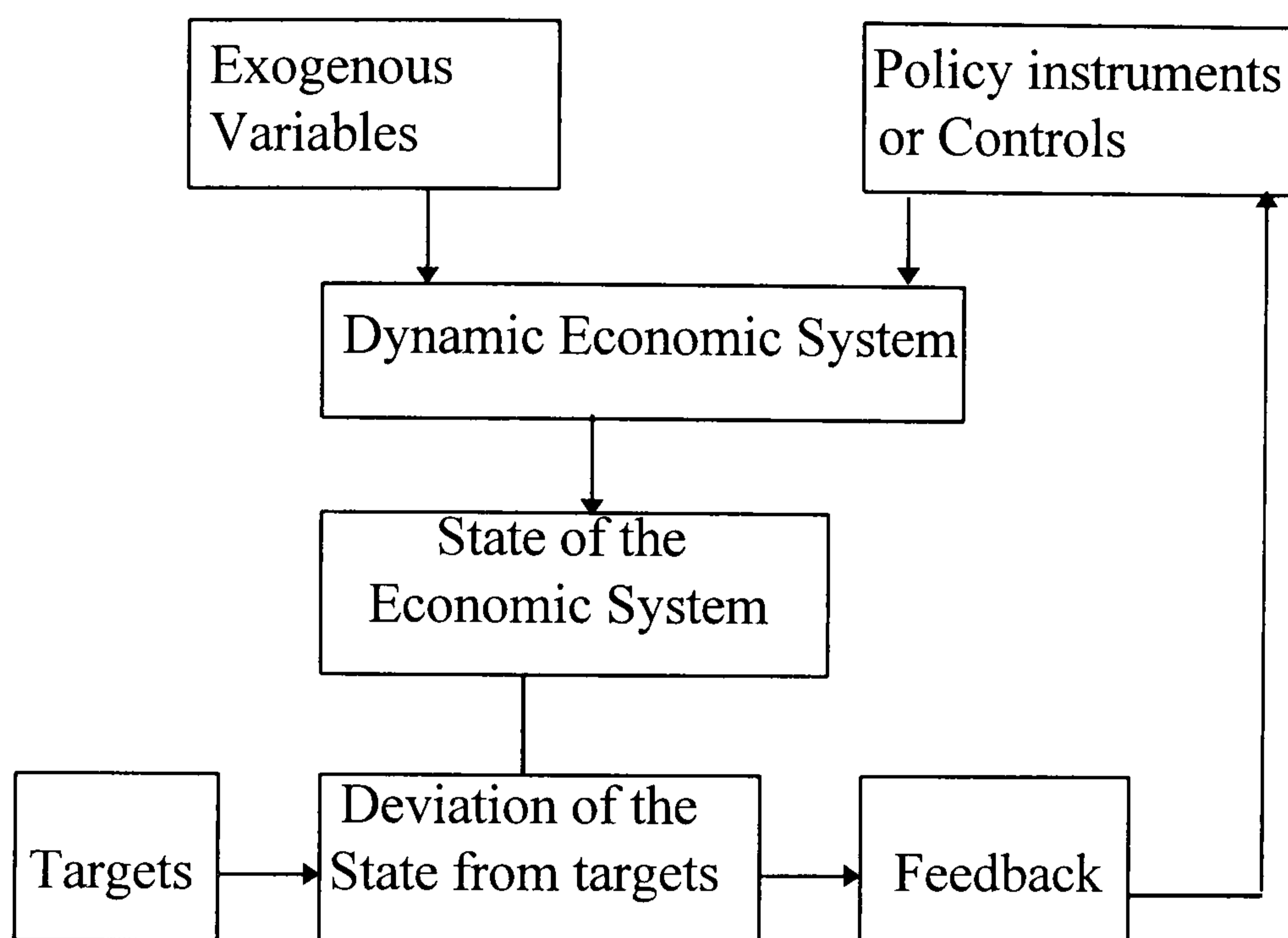
Recently there has been a revival of interest in the applications of optimal control in economics. The use of modern control theoretic approach along with various dynamic economic models provides an operational procedure for solving for values of policy instrument variables to achieve policy objectives. The basic concept in the field of optimal control is the concept of the welfare loss function or simply the loss function. One way in which these techniques are likely to be more widely used is for the purpose of finding the optimal set of policies over time for a deterministic or stochastic system.

Any dynamic system is designed to reach a target or to follow a desired path through time. A special case of a policy target problem is the *Type II fix* in British terminology, a form of control in which the instrument is adjusted period by period by exactly the amount needed to contemporaneously eliminate any deviation of the target variable from its desired value (Church *et.al.*, 1996). When feedback is used to determine macroeconomic policy, then condition of the economy ascertains policy. Papers in Britton (1989) attempt to derive explicit feedback rules that approximate the fully optimised solution in large non-linear models. Feedback control is an optimization technique for quantitative macroeconomic policy-making (Livesey, 1979) which involves:

- A dynamic system
- A set of controllable inputs
- A set of measurable outputs
- A policy objective function
- A formula or set of formulae that link the level of controllable inputs to the deviation of the outputs from the desired level.

The feedback control policy is an error-correction mechanism in which the error-correction, or feedback, leads to a simple method for determining optimal control actions based on the deviation of target variables from their desired values. The following figure represents the mechanism of feedback control policy.

**Figure 8.1: Mechanism of Feedback Control Policy**



Thus the condition of the economy, i.e., growth rate or inflation rate, is fed back to determine the policy setting, i.e., exchange rate or domestic credit respectively.

### 8.3.2 Policy Experiments using Optimal Control:

Traditionally, optimal control problems in economics are solved as quadratic linear programming problems where the objective function, which is a quadratic function, is minimized, subject to a set of linear equations, called the system equations. The objective function is specified as a scalar function of the values of the endogenous variables (targets) and policy instruments over the planning period. The optimal control problem is then to find the values of the policy instruments that, together with the

resulting predicted values of the endogenous variables, minimise the objective function, penalizing squared deviations of the state variables from its target values, and penalizing changes in the instruments. The loss function:

$$J = \sum_{t=1}^T k_{1t} [x_t - x_t^*]^2 + k_{2t} [u_t - u_{t-1}]^2$$

is minimized subject to the system equations:

$$x_{t+1} = A_t x_t + B_t u_t + C_t z_t + c_t$$

where  $x$ =state variables,  $u$ =control variables,  $x^*$ =desired paths for state variables,  $k_1$ =penalty weights for state variables,  $k_2$ =penalty weights for control variables,  $z$ =exogenous variables,  $c$ =constant terms.

In the cost function, relative penalties are attached to the deviations of actual values of endogenous variables from their desired values to reflect the policymaker's priorities. Relative weights applied to the presence of the path of the instrument variables in the objective function may reflect the extent to which certain policy instruments can be used, or the desirability of relatively smooth changes in policy instruments. In the case where the loss function is quadratic and the dynamic system is linear, the solution gives a control policy in the form of a linear feedback rule, i.e., the optimal policy is a linear function of lagged endogenous variables and the exogenous factors including the target values of the target variables. The estimated model is then used to trace the optimal control trajectories and the associated trajectories of the endogenous macroeconomic aggregates (state variables). The path that the adjustment programs take can be seen in the context of policy experiments that we undertake using the estimated macroeconomic model. In the cost functional expression  $J$ ,  $x_t^*$  is the desired path of the state variable.  $k_1$  and  $k_2$  are the penalty weights on the targets and instruments to be tracked. The  $k_1$  coefficients give the relative costs of deviating from the desired paths of

each state variable while the  $k_2$  coefficients give the relative costs of changing the control variables from one period to the next. The optimal control solutions have been obtained using Program SLIM for the solution of large macro-models developed at the Macroeconomic Modelling Bureau, Warwick.

The deterministic optimal control problem is to find  $u_t$  which minimises the welfare loss function (J), given the dynamic system. We compare the optimal solutions with the historical data over an experimental period of 5 years between 1991 to 1995. We chose the period 1991-95 to reflect the important change in policy regime. In the year 1991, the Indian economy had balance of payments deterioration and there was exchange rate devaluation which increased the foreign reserves position and led to a sudden jump in the price level in 1991. So for increasing the foreign reserve position, we had to go for both devaluation and tight domestic credit policy. Since the mix of these two policies (devaluation and tight credit policy) have been used to achieve both the targets from 1991 onwards, this period for our control exercise would enable us to examine the policy trade-off. The desired trajectories of the target variables are set at 1 percent fall in inflation rate, 2 per cent rise in output growth rate and 3 per cent increase in change in international reserves. One way of specifying the penalty weights to each of the elements of the cost function is to set what are known as 'equal priority values', which are typically inversely proportional to the scale of the terms involved. So we have calculated the value of the loss function by fixing the weights by choosing the equal priority values such that each term in the loss function leads to equal cost for all variables after optimisation.

### 8.3.2.1 Experiment 1

In the first run we are mainly concerned with examining how well the optimal paths of the state and control variables track their paths within a two targets - two instruments problem usually embodied in a Fund-sponsored stabilisation package for DEs. The key macroeconomic instruments that are often present in the discussion of stabilisation policies are the credit restrictions and the exchange rate policy to control BoP deficit and inflation. In other words, the stabilisation programs of the Fund are thus oriented by a policy framework with two targets and two instruments. Assume that two targets are set with respect to inflation and the change in net foreign reserves, in principle it requires at least two instruments in order to be able to attain both targets simultaneously. Given a desired change in BoP by 3 percent and desired reduction in inflation by 1 per cent, the two instruments viz., exchange rate and domestic credit can optimally be chosen to meet the targets. Weights assigned in the objective function are chosen according to the equal priority values, which are presented in Table 8.1.

**Table 8.1**  
**Specification and Value of the Objective Function**

	Desired Value	Weight	Value of the loss function (J)	% Change in J
Targets:			2.6247	2.25363
Inflation	1 %	1		
Change in Reserves	3 %	$3.81 \times 10^{-5}$		
Instruments:				
Exchange Rate	Base	$8.94 \times 10^{-6}$		
Domestic Credit	Base	$3.45 \times 10^{-14}$		

The time paths of the targets with the differences from the base solution that minimize the loss function are presented in Table 8.2, and the optimal controls are displayed in Table 8.3.

**Table 8.2**  
**Trajectories of Price and Balance of Payments: differences from base solution**

	Actual INF	% diff	Actual $\Delta R$	% diff
1991	12.87	-1.01	12433.72	0.02
1992	9.58	-0.99	6894.75	3.03
1993	8.02	-0.99	29675.75	2.99
1994	10.31	-0.98	19359.88	2.99
1995	7.40	-0.92	-5395.51	2.74

**Table 8.3**  
**Trajectories of Instruments: differences from base solution**

	Actual E	% diff	Actual DC	% diff
1991	24.47	-0.91	293199	-1.69
1992	30.65	-1.39	336080	-4.64
1993	31.37	-0.96	373987	-3.56
1994	31.39	-2.20	451646	-3.16
1995	33.45	-4.21	538562	-0.0002

From Tables 8.2 and 8.3, there seems to be a trade-off between the two instruments in order to achieve the targeted change in reserves and inflation. Among these two different policy objectives, the objective of low inflation can be achieved at the deterioration of the reserve position. Here we analyze the trade-off relations between inflation and change in reserve position. Given targeted rates of increase in foreign reserves, an improvement in the BoP in 1991 requires a choice of the instrument with a direct impact, i.e., devaluation, which helps the process of BoP improvement. Since exchange rate has a direct impact on price level and when we target inflation reduction, it gives rise to exchange rate appreciation in the year 1991. This exchange rate appreciation reduces export demand and hence we cannot achieve the BoP target,



which is precisely the reason why change in R is off-target in 1991. The other instrument which can influence reserve change is domestic credit that has declined by 2 per cent in order to increase R by 0.02 per cent. However it is off-target, and in the next year since DC is influencing P with a lag in the excess demand term, which are also entering exports price and import demand equations, the two instruments together bring down inflation and the foreign reserve target is achieved.

There has been about 2 percent credit contraction and about 1 percent appreciation in the exchange rate in 1991, and in the following year there has been about 1.4 percent appreciation and 5 per cent credit contraction to achieve 1 percent reduction in inflation and 3 percent rise in reserves relative to base-run values. A cut in domestic credit reduces money supply and lowers price level on the one hand, and increases foreign reserves on the other. In reality, what the monetary authorities usually do is to manipulate available monetary policy instruments to control the amount of net domestic credit in order to attain the desired amount of domestic liquidity, which is derived from the money demand function. If the foreign reserves exceed the required domestic liquidity, there has to be some degree of currency appreciation in order to achieve the 3 percent increase in reserve change.

**Table 8.4**  
**Trajectories of Output and Investment: differences from base solution**

	GDPFC (% diff)	PVTFC (% diff)
1991	-0.37	-2.71
1992	-1.07	-7.21
1993	-1.07	-7.77
1994	-1.09	-2.76
1995	-0.45	1.76

However, credit control and exchange rate changes are not sufficient to achieve multiple economic targets. The effect of credit restrictions often lead to drastic declines in private investment, which is detrimental to output growth. Essentially because credit restraints raise rates of interest to firms, leading to higher costs, which inhibit investment. Table 8.4 shows the responses of output and investment to the policy obtained above. Since output is not targeted in this kind of stabilisation exercises, output tends to decline during the adjustment process, which is obvious from Table 8.4. This, of course, is the real side of the picture, where the transmission mechanism is a fall in output consequent to a tighter credit policy. So we argue that the IMF's financial programming model is incomplete as a growth-led model and hence inadequate as a framework for policy formulation. That may be because of the fact that policy objective function is not sufficiently general.

#### **8.3.2.2 Experiment 2**

In this run we also include a growth objective and try to derive macroeconomic policies with the following targets: a 2 percentage point increase in growth trajectory, a 1 percentage point fall in inflation trajectory, and a 3 percent rise in foreign reserves. In a policy package, it is coordination rather than specialization of policies among the financial authorities that is important. When the number of targets exceeds the number of instruments, not all targets can be attained simultaneously by optimal control. So in addition to the change in domestic credit of the banking system and exchange rate changes, we also consider the public investment expenditure as an instrument of fiscal policy to target the level of output, in that PUBCF not only constitutes a component in the aggregate demand but also adds to the productive capacity of the economy to mitigate the demand pressure. These three policy instruments must be determined

jointly in order to achieve the targets set in a financial program of growth-led adjustment since various sectors are interacting with one another in the economy. The penalty weights associated with the objective function are given in Table 8.5.

**Table 8.5**  
**Specification and Value of the Objective Function**

	Desired Value	Weight	Value of the loss function (J)	% Change in J
<b>Targets:</b>			18.9085	0.561297
Inflation	1 %	1		
Output Growth	2 %	0.249999		
Change in Reserves	3 %	$3.81 \times 10^{-5}$		
<b>Instruments:</b>				
Exchange Rate	base	$8.94 \times 10^{-6}$		
Domestic Credit	base	$3.45 \times 10^{-14}$		
Public Investment	base	$2.30 \times 10^{-11}$		

**Table 8.6**  
**Trajectories of 3 Targets and 3 Instruments: differences from base solution**

	INF (%diff)	$\Delta R$ (% diff)	Growth (%)	E (% diff)	DC (% diff)	PUBCF (% diff)
1991	-0.38	0.002	0.015	-0.344	-0.81	-15.42
1992	-0.24	0.988	0.821	-0.316	-2.87	-34.89
1993	-0.45	1.125	0.823	0.427	-2.96	-50.81
1994	-0.21	0.679	1.874	0.793	-3.03	-47.27
1995	-0.15	10.349	0.813	0.972	2.76	0.04

We may possibly draw the conclusion from Table 8.6 that it is not possible to attain the objective of low inflation and high growth and balance of payments improvement simultaneously. The target growth path has 2 percentage point higher than base. Output along the optimal path are less than those along the target path except for the year 1994, when the growth target of 1.87 per cent is achieved. Optimal inflation is always less than what is indicated by the target path. Optimal output growth has increased by about 2 percentage point in 1994. The departures from the target path can be explained by a number of variables influencing output. The impact of monetary policy on output is seen

through credit availability, as credit forms an important input in the production system. The credit channel of monetary policy transmission on growth raises the issue of sustainability of such financing from the point of view of its implications for inflation.

Public investment has declined by about 51 per cent in 1993 to achieve the 2 percent rise in output growth in 1994. Since in our short-run model as demonstrated in the simulation there is a crowding out effect of public investment being fed back through the error correction mechanism, this essentially requires that the government should get rid of activities that are more efficiently undertaken in the private sector. Moreover, as upgrading of the infrastructure and human capital base cannot be financed by domestic credit to Government due to its monetisation effect, it would be preferable to adopt a non-inflationary means of financing such as privatisation of the inefficient public sector enterprises. Privatisation of public enterprises (PEs), widely known as divestiture, is now a global phenomenon. Due to the poor performance of the majority of the PEs and increasing financial burdens and constraints, almost all countries (both developed and developing) have implemented or planned to implement privatisation programs. Besides enterprises reforms, privatisation is seen as the best alternative or approach (if not panacea) in improving managerial practices and performance in this sector. The welfare loss from 3 targets and 3 instruments control is very high, essentially because it is difficult to achieve the targeted low inflation with high growth and hence there are no potential gains for control. So it may be desirable to control the economy with alternative instruments to stimulate growth.

Exchange rate policy affects prices quite significantly. When devaluation induces price increase in 1993, a tight credit policy brings it down. It is conceivable that a depreciation in the exchange rate first increases import prices relative to domestic prices and decreases export prices relative to the world price level. These in turn tend to increase foreign reserves via rise in export earnings. Since there is an exchange rate appreciation to reduce inflation in 1991, foreign reserve target cannot be achieved. Further, any attempt to raise rate of growth of output translates into an increase in imports, for imports being determined by income. Due to devaluation in later periods, the increase in foreign reserves becomes a source of monetary expansion unless domestic credit is further restricted. This is the general rule about the channel through which a change in the exchange rate affects the balance of payments and domestic prices. However, using all three instruments simultaneously and optimally, it has not been possible to attain our target values for each of the target variables due to their differential effects on the targets. Monetary policy instrument (DC) has a comparatively stronger effect on R, and the fiscal policy instrument (PUBCF) has a relatively stronger effect on GDPFC. The contractionary impact of monetary policy on output (as shown in Table 8.6) has to be offset by a reduction in government expenditure (PUBCF) leading to increase in private investment and thereby growth. Output growth achieves its target level in 1994. The reasons why output does not respond to the policy instruments more vigorously includes the increased cost resulting from exchange rate changes and credit constraints. The latter arising from the restrictions imposed on bank credit to control monetary aggregates for an increase in reserve change. Rao and Singh (1997) executed one period optimal control solutions involving (i) the growth rate, inflation rate, interest rate and foreign exchange reserves as the primary targets; and (ii) the exchange rate, tax

rates, domestic credit allocation and market borrowings as the primary instruments. But they neither took into account the importance of exchange rate as an argument in the price equation nor considered the implied trade-offs between targets. They predicted a 5.4 per cent real growth rate and a 10.9 per cent inflation rate for 1994-95, whereas we obtain 8.2 per cent real growth rate and 10.1 per cent inflation rate for the year 1994-95. Their objective function evaluated the loss incurred as a result of any deviations between the actual values of the instruments and targets from their desired values, associated with each policy.

The results from this exercise suggest that in the period 1991 to 1995, it would have been better in terms of improving growth, if there had been more emphasis on both demand and supply side policies for the goal of higher growth. So the results show that the most effective policy instrument in the Indian economy is the manipulation of the domestic credit and public investment, and any optimal policy required to accommodate stabilisation with growth needs to have a greater allocation of domestic credit to the private sector and by creating a space in the public sector budget through reduction in public investment in sick industrial units in order to increase public investment on infrastructure, which would raise private sector investment considerably thereby resulting in higher output growth. It has been demonstrated in the literature that public equipment investment crowds out private investment in machinery and equipment.

#### **8.4 CONCLUSION**

An attempt is made in this chapter to evolve a policy framework in the design of growth-oriented adjustment programs for stabilising the economy at a low inflation

and high growth rate within a macroeconomic system ignoring uncertainties in the parameters and regression equations to provide guidelines for policy formulation. Control experiments carried out in this chapter revealed that with equal priority penalties on the state and control variables using the concept of welfare maximization it was possible to attain about 2 percentage point rise in growth in the year 1994 only during a 5-year control horizon with a lower percentage point reduction in inflation. But the optimal trajectory of inflation turned out to be about its desired level, and reserves at its desired level, within the IMF's policy framework, though not in the extended framework where output is targeted. Though the essential purpose of any optimal control model is to plan for the future, we have carried out the experiments over a historical period in order to avoid the difficulties that arise in the choice of the future paths of the exogenous variables. In effect, this is a counterfactual exercise showing how things could have been done differently in the past, which has a long tradition in control exercises. However, in order to have adjustment with growth, we need to target output growth using other instruments in addition to the 2 targets - 2 instruments policy framework of IMF. Surely the point is that the 2-2 framework neglects other variables, and when these are taken into account the true costs of these policies are seen. So the question which remains to be answered is what is a more realistic objective function. Besides providing some ideas of the optimal paths for various policy strategies, the control technique is complementary to the traditional simulation procedures in macro model analysis. Thus macromodel simulation and optimal control techniques could be effectively used for policy making in an alternative manner.

CHART 8.1 : Dynamic Simulations of the Model

Fig.1: Effect of Tight Credit Policy on Output

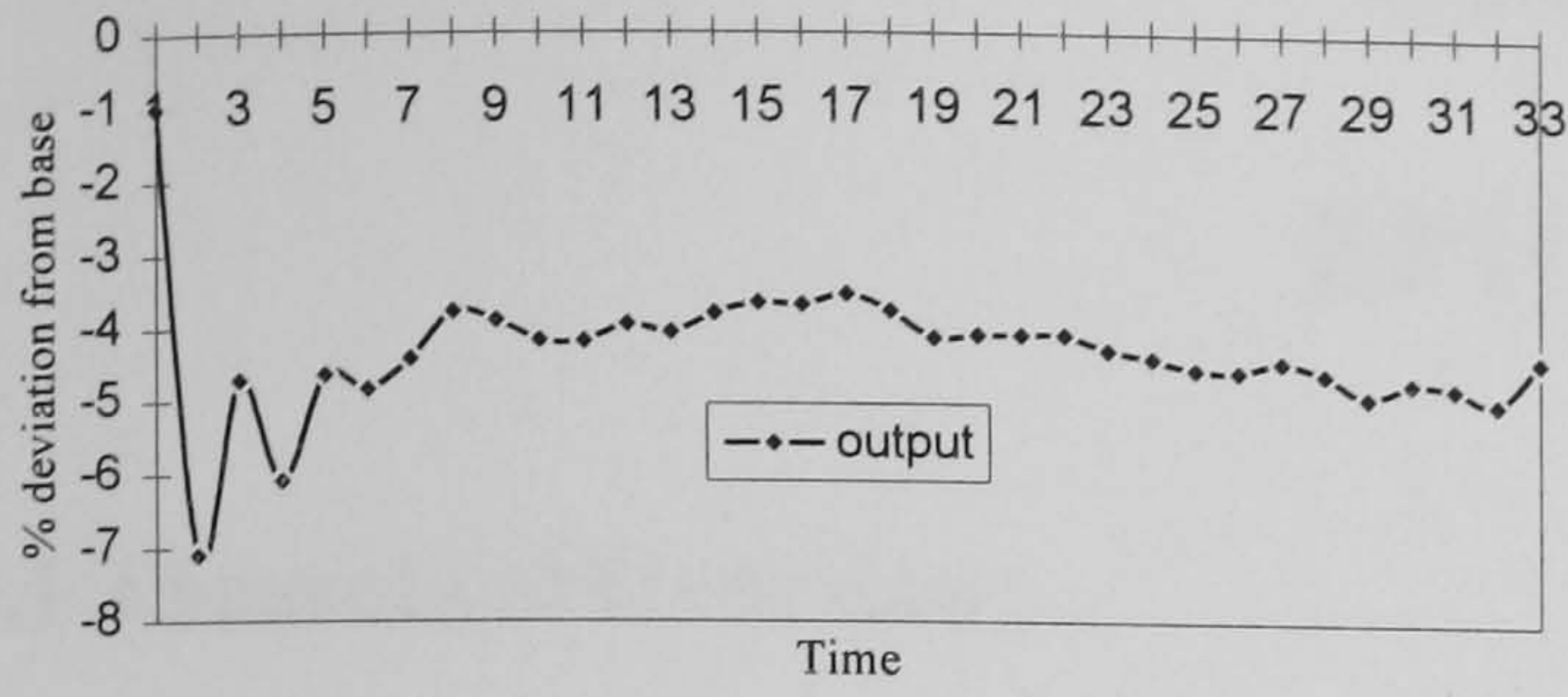


Fig.2: Price Response to Tight Credit Policy

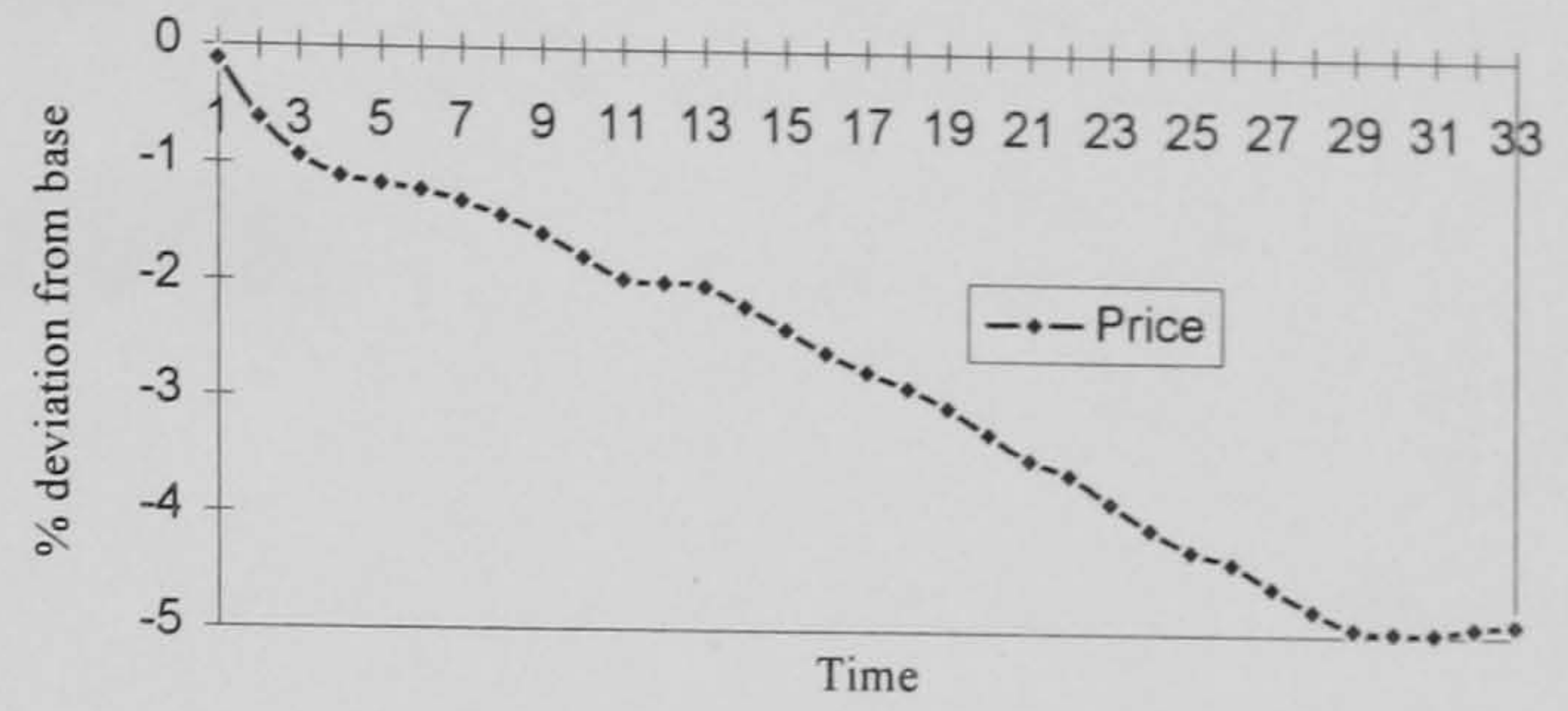


Fig.3: Impact of Credit Contraction on Balance of Payments

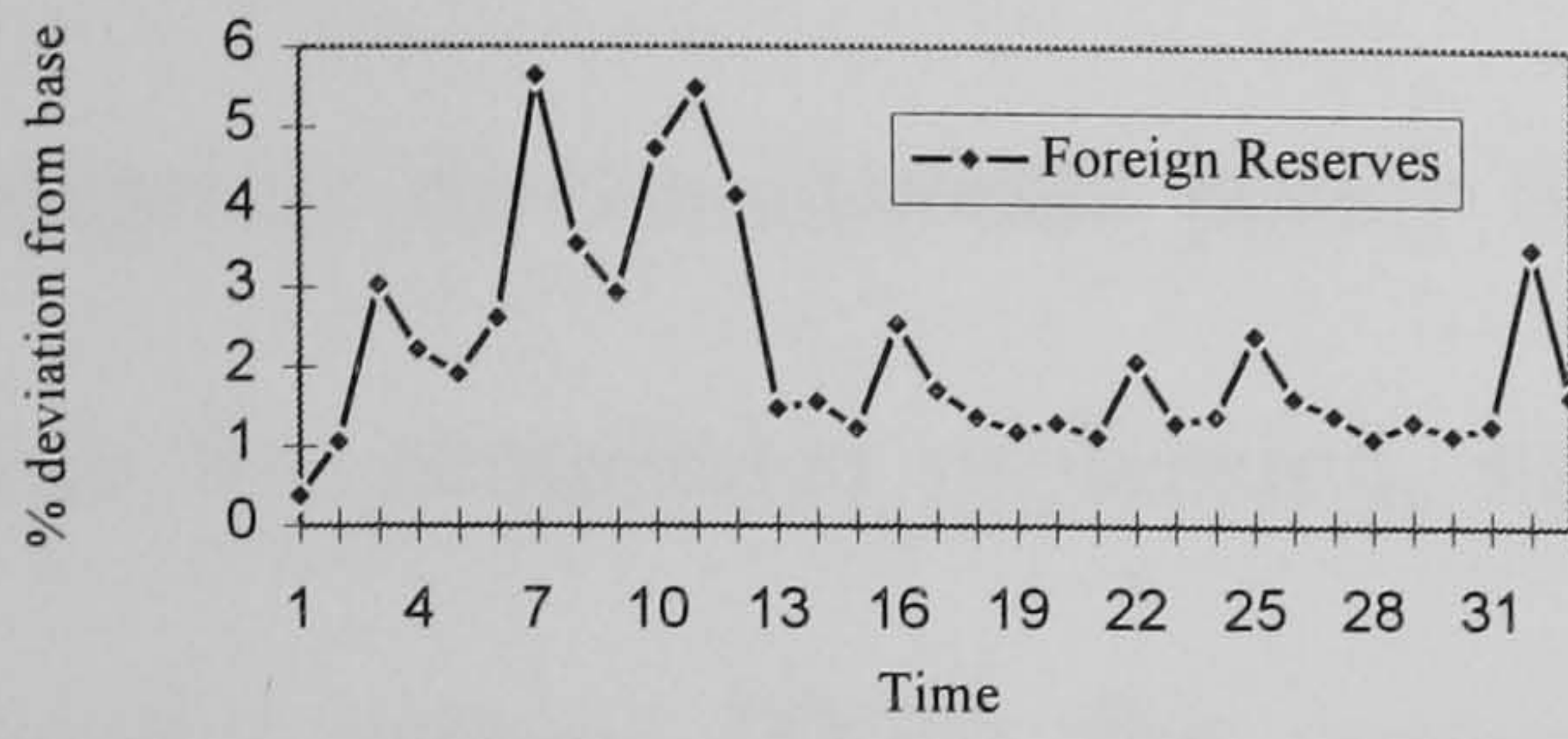


Fig.4: Impact of devaluation on output

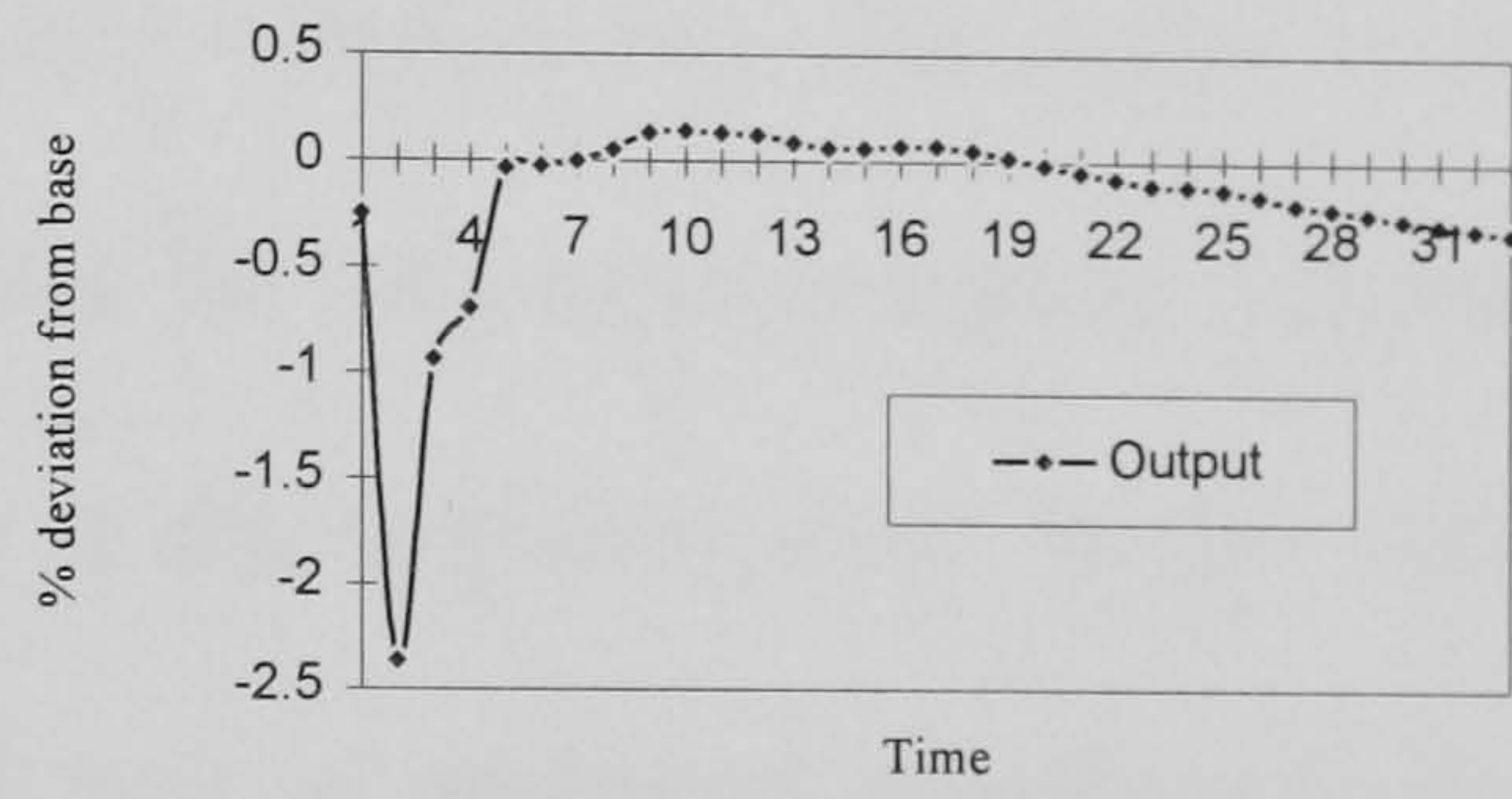


Fig.5: Devaluation shock on Price

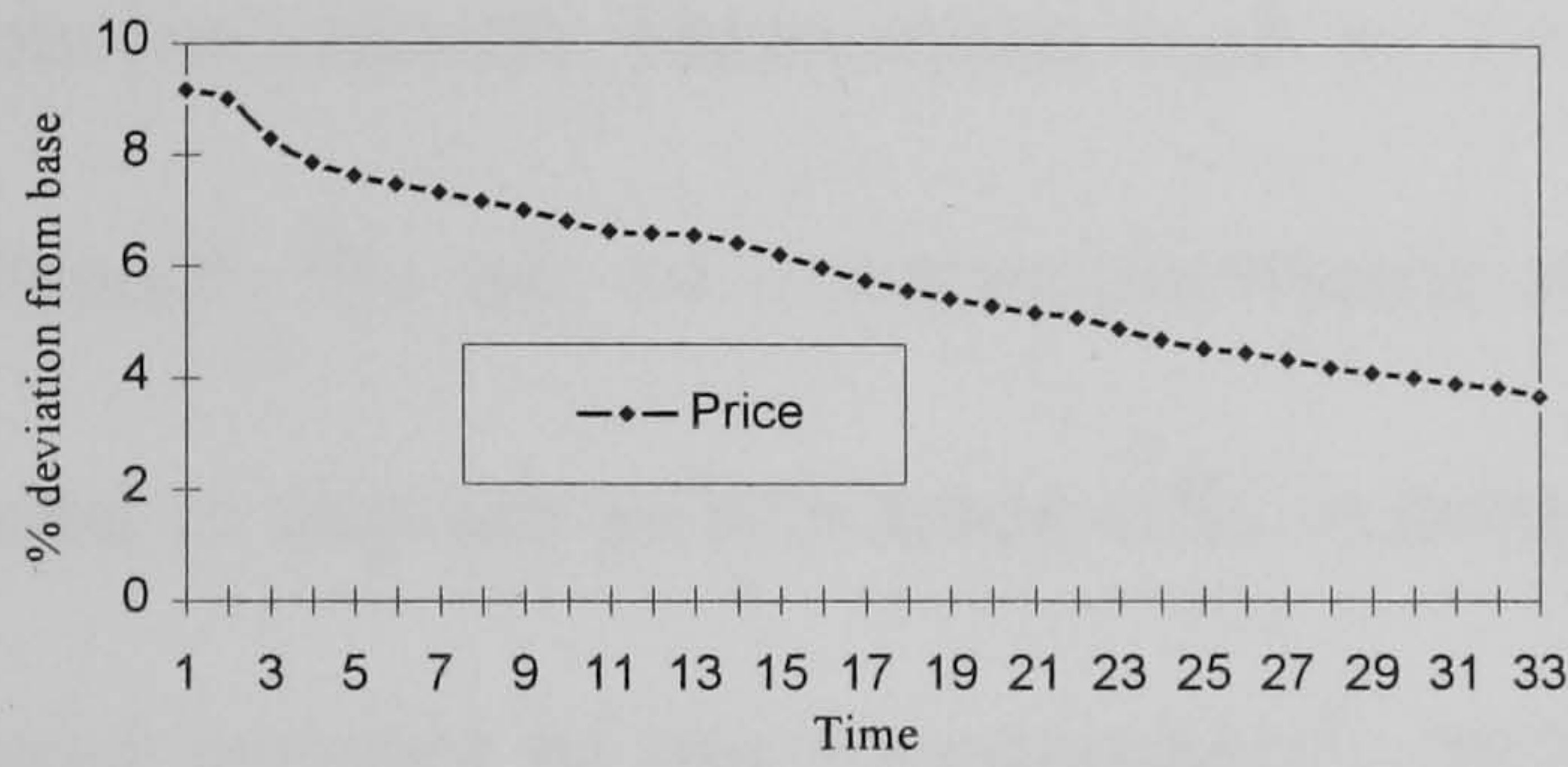


Fig.6: Impact of Devaluation on Balance of Payments

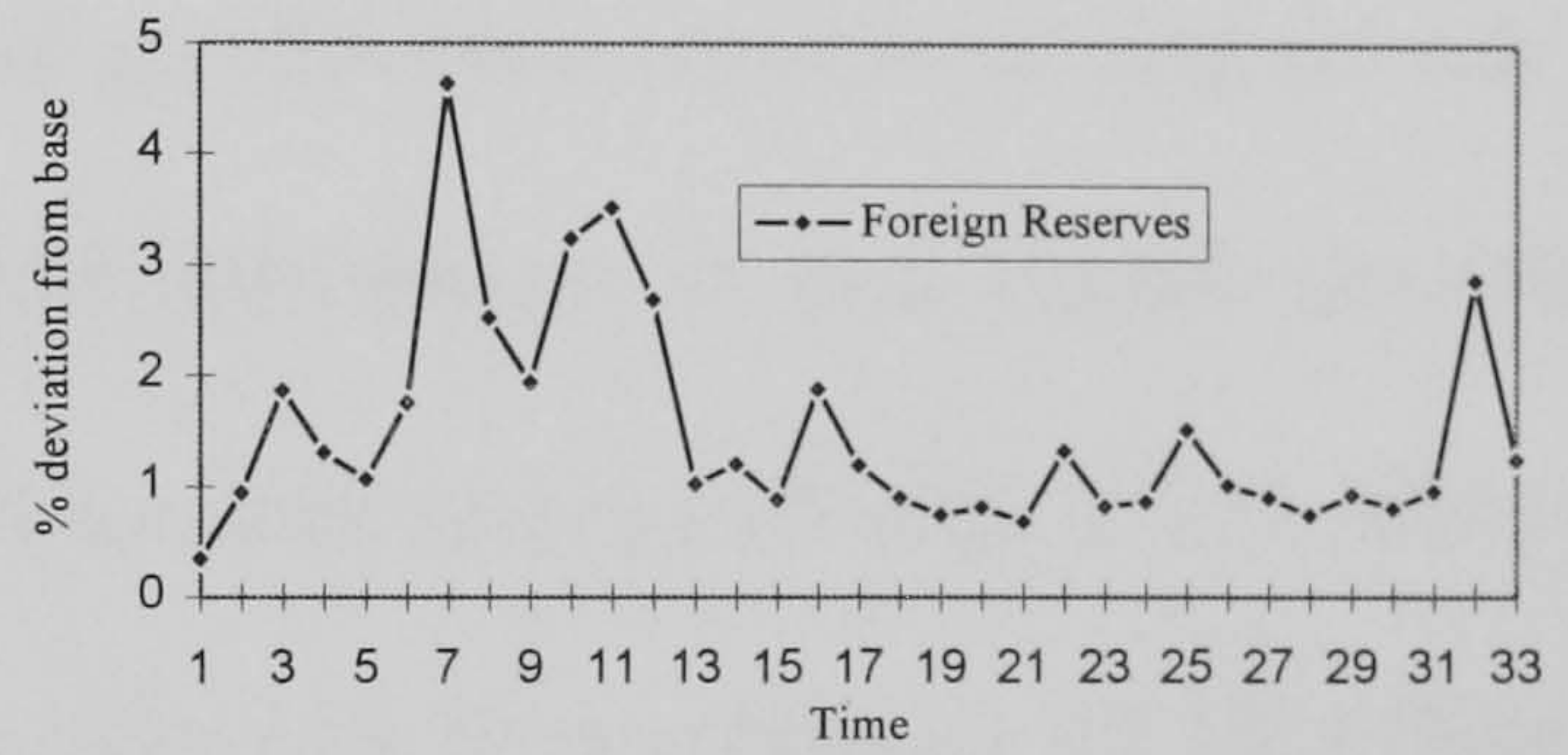


Fig.7: Effect of negative public investment shock on output

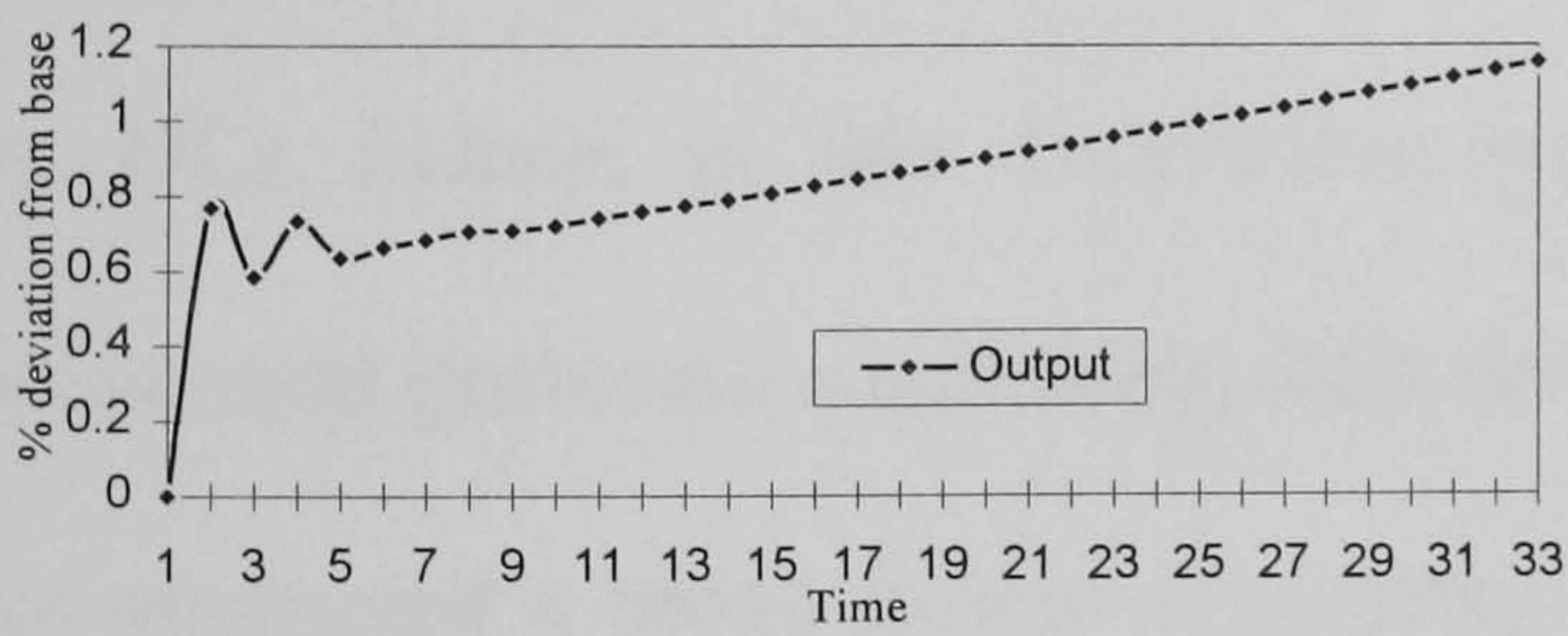


Fig.8: Investment Shock on Price

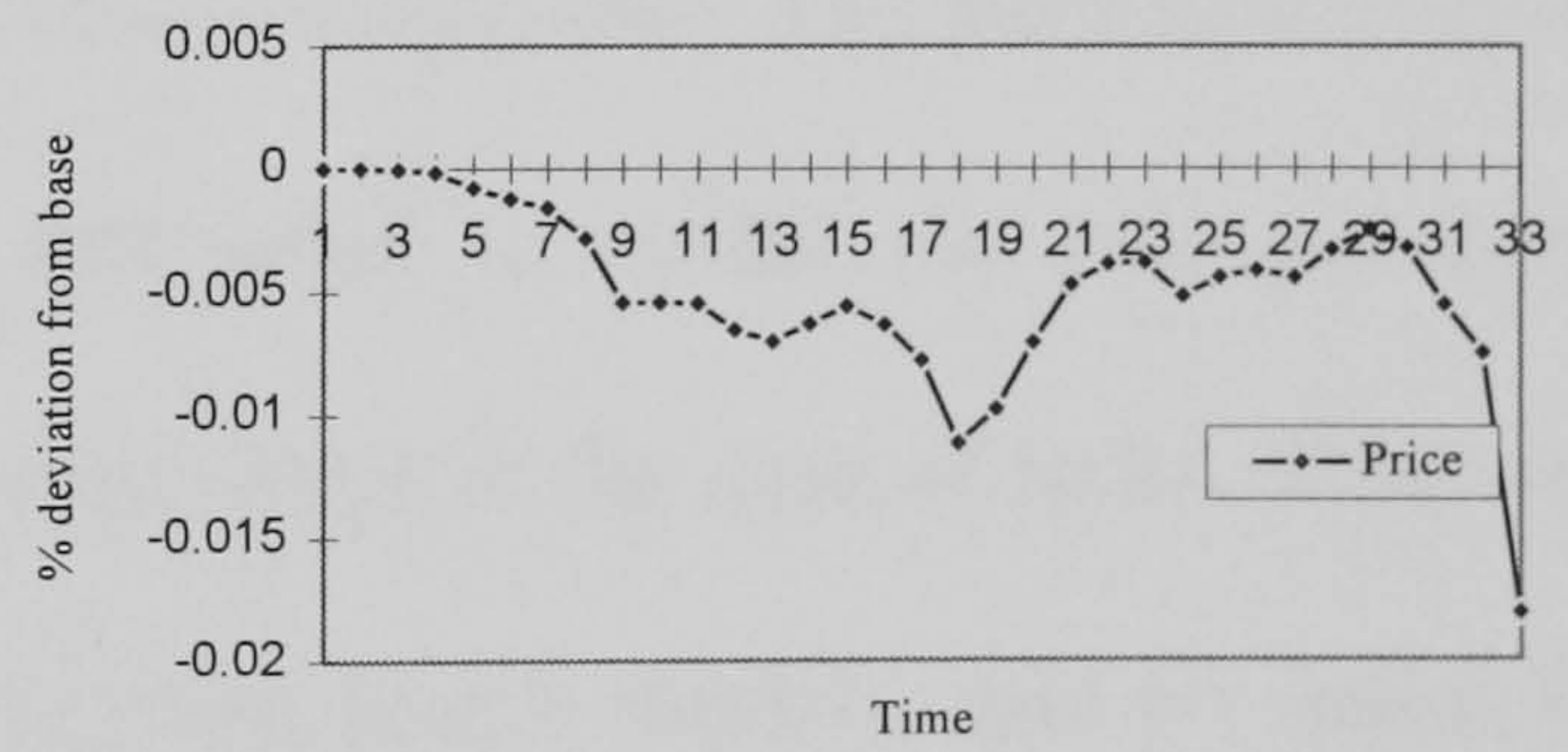


Fig.9: Public Investment Shock on Balance of Payments

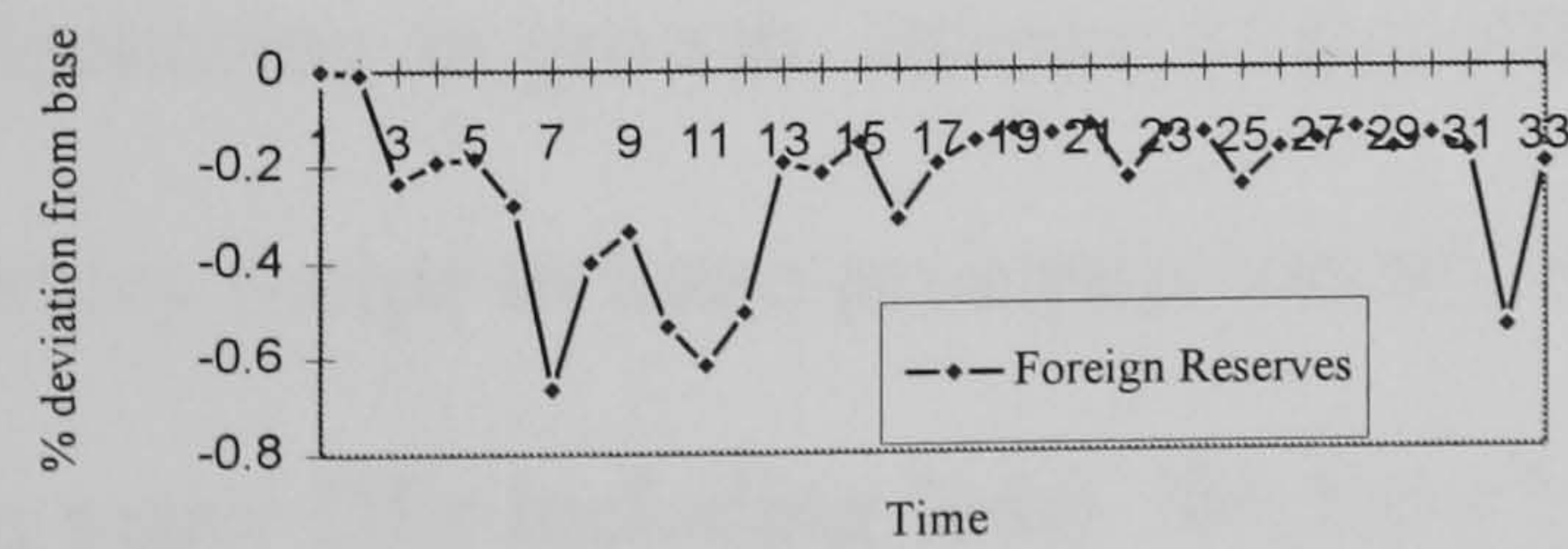
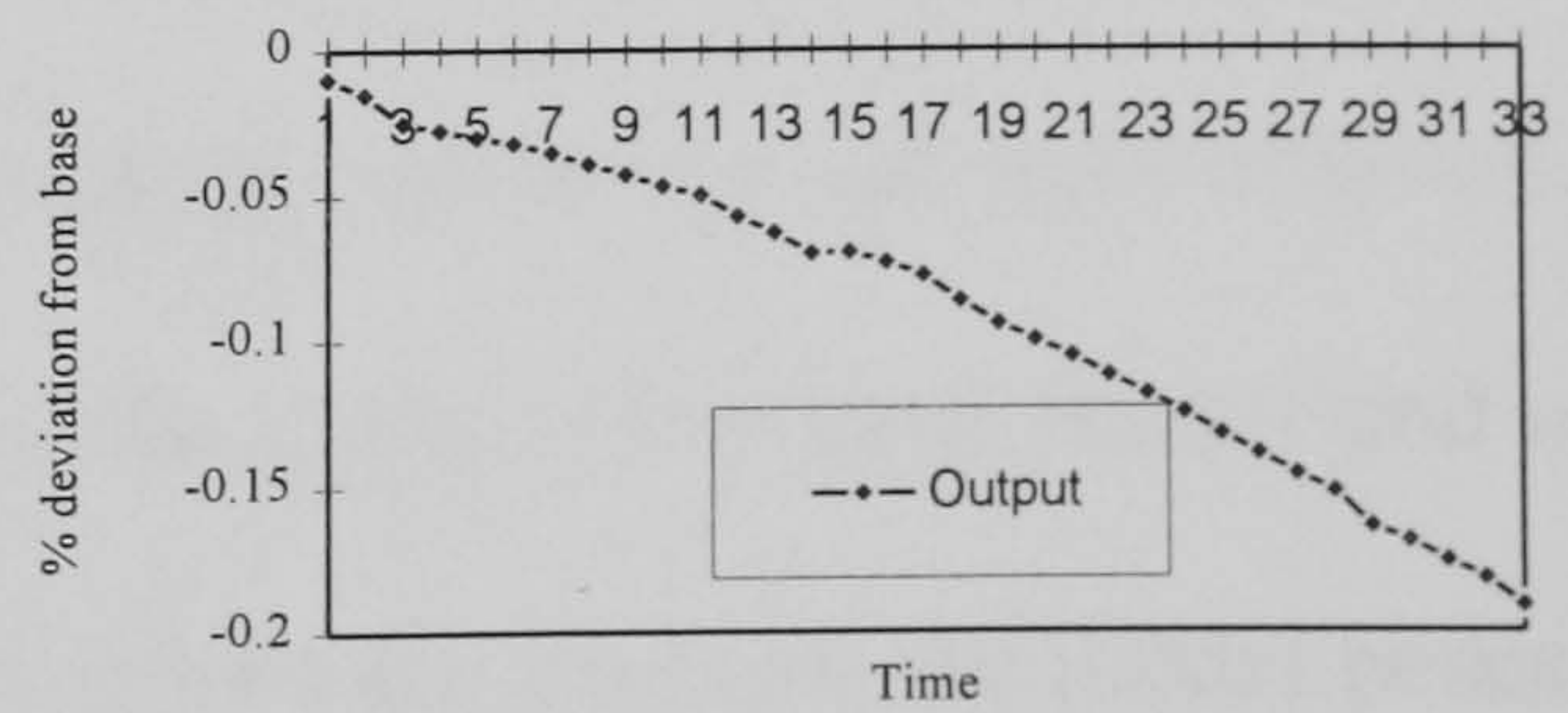


Fig.10: Impact of Financial Liberalisation on Output





## Chapter 9

### EPILOGUE

#### 9.1 Theoretical Overview:

The development process of an economy is a complex one. The reality is that the appropriate macroeconomic policy framework for DEs remains a hotly debated issue within the economics profession, more so at the empirical level. In the context of industrial nations (DCs), the conventional way of analyzing complicated dynamic macroeconomic phenomena such as those of stabilisation, adjustment, and growth is through the use of macroeconometric models. Simulations of such models are often used to explore policy trade-offs in complex dynamic settings (Wallis, 1993). While a large number of macroeconometric models have also been estimated for DEs (Khan, Montiel, and Haque, 1991), the state of the art is substantially less advanced than it is for DCs. Hence, in this dissertation we attempted to model the macroeconomic adjustment problems confronting DEs and implement in the case of India. This study has attempted a broad survey of existing macroeconomic models and we learnt that there is considerable disagreement among models. The emerging problems are slackening in growth, balance of payments (BoP) difficulties and high inflation. The policy recipe to these problems has been the application of stylized Bank-Fund model in many DEs including India. We have highlighted the dilemma the model poses with regard to credit and demand restraint that it is necessary to curb inflation and promote growth, whereas we argue that such restraint leads to shortages of working capital and, therefore stifles industrial growth. Similar discussion along these lines between

mainstream thinking and alternative model with regard to their analytical structures and policy prescriptions has been provided in Jha (1994).

The focus of Keynesian economics was more on fiscal policy in a closed economy than on monetary policy. Hence Polak (1957) attempted to streamline the monetary side of the analysis in an open economy context, which concludes that credit expansion is the cause of the BoP crises. The monetary disequilibrium model of IMF (IMF, 1977; 1987), which is an extension of Polak (1957), has two instruments such as domestic credit and exchange rate, in which the potential adjustment mechanism is change in price, and real output is essentially determined outside the system. The main weaknesses of the Fund Model are that it assumes a constant velocity of money, it is static, it is concerned only with short-term monetary explanation of BoP difficulties, and its failure to link together fiscal and monetary policies. The Bank Model assumes two gaps, and lacks prices, employment, public finance and monetary sectors. The potential adjustment mechanism is change in real output. Inflation is not determined within the model because price is assumed as exogenously given, and monetary variables do not play any direct role. In view of the respective strengths and weaknesses, efforts by many researchers have gone into the merger of the two models. Khan and Montiel (1989) and Khan, Montiel and Haque (1990) attempted to integrate these two (IMF-WB) models in order to provide an eclectic policy model for DEs. But these are static one-period model, where no allowance is made for lags and dynamics. These models rely heavily on accounting identities and thus leave out a substantial amount of economic structure and behaviour.

The major economic difficulties facing India are low economic growth, persistently high inflation, huge BoP deficits and heavy external indebtedness. In order to address these contemporary problems, an internally consistent macro framework is indispensable. The Fund and the Bank models are used for policy discussion, forecasting, and program lending negotiations in India.<sup>1</sup> A stand-by arrangement is the result of a process of negotiation between the Fund and the member country. Usually when a country goes to the Fund for help it is confronting a difficult problem in its BoP. The Fund uses a particular model to obtain the target and ceilings that appear in the stand-by arrangement. This model is applied in connection with a programming exercise (Financial Programming). After having reviewed the relevant economic modelling literature, and the major thread that runs through the various types of the merged Fund-Bank models, we model trade, inflation and growth: government finance to address fiscal gap, pattern of expenditure, BoP sector to cover trade gap, imports, and exports; monetary sector to address money supply and demand; the relationship between prices, wages and exchange rates; and production functions.

Since the early 1980s, the Bank and the Fund put pressure on DEs to adopt structural adjustment programs which emphasize free market economic principles and a reduced role of the state in the economy. So the purpose of this dissertation has been to contribute, both theoretically and empirically, to the resolution of some of the issues that lie at the center of the debate between the IMF and the 'New Structuralists' over the design of short-run macroeconomic stabilisation programs for DEs. Under structuralist

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<sup>1</sup> The IMF was basically a creation of the U.S. and U.K. in July 1944. The circumstance assured the preponderance of both but mainly that of the U.S. Shortly after its foundation the IMF started to develop a policy of providing its resources attached to a particular set of policies that the member country should follow (conditionality).

approach to Stabilisation policy, the central stabilisation policy issue is whether monetary and fiscal policies comprise reliably effective stabilisation instruments in DEs. Structuralists (Taylor, 1981; 1983) advocate for supply-side policies because stabilisation problems arise from bottlenecks in the structure of DEs. Liberalisation can help in certain aspects, but at the same time lack of finance due to credit contraction inhibits growth. The conclusions in this study are very much in line with structuralist thinking on development issues. Among many different issues, we have investigated the following specific questions.

First, we have shown how the standard simulation model does not generate growth oriented macroeconomic Adjustment. Second, we have estimated a macroeconomic Model examining the determinants of trade and inflation in order to simulate the short-run stabilisation issues such as devaluation and tight credit policy. Third, we survey the existing growth models laying out the controversies to provide an eclectic version for the determinants of long-term growth. Finally, we design adjustment policies with growth in the optimal control framework that credit restraint leads to a drop in output, though it helps to improve BoP situation in the short run.

## **9.2 Empirical Findings:**

It is an empirical fact that there is an increasing number of countries whose economic performance has not been encouraging. The poor results faced by many of the DEs not only point to the ineffectiveness of adopted policies but suggest the need for reformulations of existing approaches in order to provide insights and policies that are

consistent with reality. This study focuses on the need for relevance in theoretical frameworks and consequently emphasizes the need to pay greater attention to the behavior of the supply side of the economy. Along these lines recent efforts in connection with the DEs involve the design of economic models that can accommodate the twin issues of growth and adjustment. In a similar vein the model presented in this study is eclectic in orientation, combining elements of the Neoclassical, Keynesian and the Structuralist approaches. A strong emphasis is placed on the incorporation of supply and demand factors that influence economic growth.

The purpose of this dissertation is threefold. The first objective is to review the historical development of the Indian economy and to evaluate the effects on some relevant macroeconomic variables of the Fund policies under which India has been operating since 1991. The second is to study the links between monetary policy, the BoP, and prices in India between 1950 and 1995, and to construct a medium-sized macroeconometric model which could be helpful in conducting short-term economic policy in India. The third is the model determining the factors underlying growth. The model is estimated using data from 1950 to 1995, and undertakes to examine what impact India's economic changes have had on the economy in general and in particular on India's trade, inflation and growth. The results suggest that demand management policies would not be very effective in causing output changes, though significant price level reductions may be possible.

The model results show that there was a negative relationship between price and monetary flow disequilibrium. The relationship between the domestic and foreign

components of the monetary base is bi-directional. A whole battery of tests is performed for the model diagnostics, and the results obtained confirm the working of the monetary approach to the BoP in India, but not growth inducive. The IMF's policy prescriptions based on currency devaluation do not seem conducive to an improvement in trade balance, although it contributes to an improvement in the overall BOP position due to capital account flows. Devaluation has contractionary output effects with a small impact on the trade balance coming from the adjustment of real imports. The demand side adjustments to monetary restraint in the form of credit squeeze reduces output growth.

The objective of this dissertation has also been to examine the role played by stabilisation programs in shaping public expenditure in DEs, and how changes in the composition of expenditures can affect growth. Two questions are addressed. Which categories of expenditure appear to be the disproportionate victims in the process of stabilisation and how different categories of expenditure may affect the path of economic growth. The results indicate that stabilisation efforts significantly changed the composition of spending in a systematic fashion which affected growth to varying degrees. The study has concluded that public consumption expenditures can play a role in the stabilisation of prices. Reduction in these expenditures will increase output through reduction in overall prices in the short run. In view of the widespread concern about the detrimental effects of stabilisation programs, one emerging conclusion is that these programs appear to consistently shift public expenditure away from growth-augmenting areas. The study confirms the catalytic role of public investment expenditures in stimulating private investment in key sectors such as agriculture and

infrastructure. Even though public investment expenditures for the development of infrastructure increases aggregate prices and BoP deficits in the short run, these investment expenditures increase private investment and aggregate output in the medium term. The initial increase in aggregate price level as a result of higher public investment expenditure, is dampened in the medium term.

Private investment is found to be positively related to bank credit to the private sector, public investment, real interest rates, human capital in the long-run, and negatively related to the real interest rates in the short-run. We examine the endogenous growth models hypothesis that the level of output and investment growth are most likely to be the channels of transmission from financial intermediation to economic growth. Our findings give some support to endogenous growth models. The impact of real interest rates on private investment gives partial support to the McKinnon/Shaw approach since an increase in the real interest rate may stimulate private investment in the long run with a negative effect on investment in the short-run giving empirical credence to Keynesian/structuralist tradition. We also find evidence that economic growth of India is not export-led growth. Exports do not contribute to output in the long-run, whereas it does contribute in the short-run.

The same models are also used to address one of the most controversial aspects of IMF programs, namely, the potential contractionary effect of the devaluation of the exchange rate on output. More generally, the results do support that the orthodox policy measures, especially devaluation, are recessionary and incapable of improving the current account. The study concludes that trade policy reform does not have significant

and enduring effects on the monetary and output sectors. Examination of determinants of foreign trade shows that demand for exports is price-elastic, while demand for imports is income-elastic. However, it appears that India's export supply is constrained by capacity. Study of the monetary sector reveals that the error correction models of money demand behaviour reveal a well-fitting function. Estimates of the structural parameters as well as model simulations suggest that the model performs well in tracking the historical values of the dependent variables.

The Indian economy has undergone substantial changes. Next the effects on the Indian economy of IMF policies implemented in 1991 is investigated in order to consider economic policy options in terms of deterministic optimal control methods. In recent years, a number of studies have demonstrated the potential application of the mathematical techniques of optimal control theory to economic stabilisation policy analysis. The model we use is a small, linear macroeconomic model of the Indian economy. The macroeconomic policy analysis by means of the system simulations is made to explore the dynamic responses and performances of the model both in short-term and in long-term. The optimal control problem is defined as tracking target paths of endogenous variables and policy variables. It is subject to a quadratic objective function and the constraint of a linear system of the econometric model. Some optimization experiments are designed to demonstrate the use of the optimal control approach. The numerical solutions for optimal stabilisation policies are calculated and presented. The experiment results show that this approach is valuable both as a tool for policy planning and as a method of analyzing the dynamic properties of the



econometric model. The major conclusion is that the control results are shown to be consistent with the predictions of the simulation results.

### **9.3 Policy Implications**

Since its conception in 1950, the Planning Commission of India has relied on quantitative economic models to undertake economic policies needed to achieve the desired goals. The models may be classified as (1) consistency models, (2) optimization models, and (3) econometric models. Most of the econometric models dealt with the Indian economy upto early 1980s. The deterministic control experiments were conducted over the duration of 1991 to 1995, with a view to provide a hindsight opinion on the results achieved under the New economic policy regime.

The results suggest that deterministic control methods can be invaluablely used in policy making. They throw light not only on the various trade-offs between desired economic goals but also present some possible advantages in terms of magnitudes of policy considerations. It is concluded that larger control theoretic macroeconomic models need to be constructed by the Indian Policy makers, especially for conducting short term economic policy. This study solves a multi-target and multi-instrument optimal control problem as a way of conducting investigations to examine alternative policy packages within the estimated macroeconometric model of adjustment and growth. The loss function targets growth, inflation and changes in foreign reserves. It compares the control solution obtained with historical data over an experimental period between 1991 and 1995 under the alternative objectives of growth and price

stability. It is argued and found that the nature of the macroeconomic adjustment is such that it is likely to constrain economic growth. So the analysis suggests public investment expenditure as an instrument of government control and deficit reduction by not cutting domestic credit to the private sector must be the key element in any future policy package. In a policy recommendation, for annual real GDP growth target of 2 percentage point increase, public investment should decline by 50 percent in the short-run. Addressing the inflationary problems in India requires an effective monetary policy that will focus on effective management of exchange rates and the curbing of excessive money supply growth. In the present study, credit is one channel through which monetary policy can affect economic activity. The mechanics of monetary policy mechanism supports a demand type of shock in the long-run and a supply shock in the short-run. The sign being positive in the long-run suggests that interest rate has to be increased in the long-run in order to avoid financial repression, whereas the sign being negative in the short-run implies that interest rate has to be lowered to increase investment and growth in India.

A key to India's economic reforms in 1991 was the liberalisation of one of the most controlled regimes in the world. By following an outward oriented strategy, India has removed controls on industry and trade and opened the doors to foreign investment. Foreign direct and portfolio investment flows contributed to a large surplus in the capital account and to further accretion of reserve to \$20.8 billion by March 1995. The external account improvements are based on the stabilisation and reform efforts resulting in capital account flows rather than current account improvements as predicted by our model. As it emerges from our study, structural reforms have been

justified in the area of private investment in public sector dominated areas of production. So the private sector should be allowed to play a major role in newly expanding areas such as electronics and automobiles, power generation and distribution, railways and expressway construction. Other industries, including steel, oil refining and exploration, air transport, parts and mining can be opened to the private sector in the form of possible divestment of shares in some public sector enterprises. The government of India must have a transparent and consistent policy on investment and must simplify regulations. The study concludes with a call for much greater emphasis on the creation of a domestic capital goods sector rather than the unsuccessful demand management policies tried over the past decades. The application of the model to other countries that share similar structural, behavioral, and technological characteristics is also suggested. The findings suggest that IMF conditionality should not be taken as granted and the Fund should perhaps adopt a more flexible conditionality in its dealing with DEs.

#### **9.4 Concluding Remarks Towards a Research Strategy**

Model building is an evolutionary process that will continue to reflect new developments in economic theory, new econometric methods, and better understanding of the structure of DEs. Since the database for examining the impact of structural adjustment policies (SAP) since 1991 is too short a period, there is a need for a detailed empirical work in future. The analysis of the financial sector in this study is very weak to draw any strong conclusion about the impact of financial liberalisation. So for developing a model to examine the increasing role of the

financial sector, it is necessary to model the financial sector in detail to explain the equilibrium relations between financial aggregates such as money, equity capital, foreign direct investment etc.. One needs to develop a model describing the supply and demand for different types of financial assets. The demand for assets depends on the term structure of returns and on risk. The amount of savings and its structure depends on how the entire financial sector operates. Hence in a model for structural adjustment, there is a need for developing a model for the entire financial sector. One must also examine debt service obligations - how much of government expenditure is for debt repayment, both domestic and foreign. It is in this direction that the fiscal sector needs to be modified. Under the new policy the government reduced the number of sectors reserved for public investment. It also reduced the number of sectors in which private investment, domestic or foreign, required prior government approval. Our study shows this kind of state policies can help India, given its base-line position and institutional structures, move-on fast to a new institutional framework that is best suited for it in the prevailing global political and economic environment. Much disaggregated analysis needs to be done in the area of analysing costs and benefits of privatising public sector units.

It is well known that the consumption pattern and the demand and supply conditions are quite different in rural, semi-urban and urban areas. Thus the price indices are different for these three types of regions. Price formation and production, consumption and employment relations must therefore take note of these regional variations. Such a step may be taken up by any future macroeconomic model for India.

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