

ANALYTICAL FOUNDATIONS OF FINANCIAL PROGRAMMING AND GROWTH ORIENTED ADJUSTMENT

**M.J. Manohar Rao
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Issued for Discussion

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62301

**Department of Economic Analysis and Policy
Reserve Bank of India
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As far as the study is concerned, we have tried to avoid what has been aptly termed by economist Jean Waelbroeck as, 'John Wayne econometrics' in which "the valiant econometrician strides through his sample, his trusted OLS colt at his hip, ignoring dangerous outliers, avoiding residual traps, tracking elusive theories and riding off into the sunset with the beautiful regression at his side". In trying to guard against such a nemesis which surprises even the most wary econometrician, it is possible that we could have stumbled into fresh pitfalls and, in this context, we alone are responsible for any ensuing errors, be it forecasting, empirical or analytical (and we do hope that these are in descending order of magnitude) that may have cropped up in the study. In concluding, we hope that the final noise-to-signal ratio will be tolerably low.

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ANALYTICAL FOUNDATIONS OF FINANCIAL PROGRAMMING AND GROWTH ORIENTED ADJUSTMENT

M. J. Manohar Rao*
Balwant Singh*

1. INTRODUCTION

This study is a technical introduction to the analysis of monetary stabilization and fiscal adjustment programmes with special reference to the current status of the Indian economy. As the ongoing debate over structural adjustment programmes in India has often been very confused due to the inherent unfamiliarity with the basic macroeconomic logic underlying these reforms, the objective of this study would be to provide an analytical framework related to the understanding of certain key issues in the reform and transformation of open economies.

Considering that the framework of most structural adjustment programmes is a blend of two extremely influential models of economic analysis for the developing world, i.e., the Polak model of the International Monetary Fund (IMF) and the two-gap model of the World Bank, it is essential to consider our analysis on broadly similar lines if one is to realize the overall implications of the macroeconomic reforms currently under way. It is primarily with this view in mind that we have made every possible effort to present these fairly rigorous models in as simple a manner as possible without loss of generality or analytical precision in the process.

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Broadly speaking, a structural adjustment programme comprises a comprehensive set of economic measures designed to achieve broad inter-related short-run macroeconomic targets. The fundamental objective of all such programmes is to provide for an orderly adjustment of both macroeconomic and structural imbalances so as to increase economic growth and reduce inflation while maintaining a sustainable balance of payments position.

A broad understanding of the role of monetary and fiscal policy in influencing macroeconomic performance invariably plays a key aspect in the success of all adjustment programmes as the use of the primary instruments of demand management often has to be supplemented by a variety of other policy measures, most prominently exchange rate policy, but also structural policies, such as pricing policies, incomes policies, and specific aspects of taxation and public spending policies.

The underlying rationale for the current approach to macroeconomic stabilization in India can be explained in terms of, what is generally known as, "financial programming" which is the theoretical mainstay of nearly all IMF-supported adjustment programmes. A financial program usually comprises, in addition to certain key behavioural equations, a set of balance sheet accounting identities which imposes the necessary constraints, both in terms of coordination and sequencing, on the desired monetary and fiscal policy measures intended to achieve pre-specified economic targets. The actual iterative process by means of which these desired targets are achieved through the manipulation of the policy variables, subject to the balance sheet constraints, is referred to as financial programming.

1.1 Financial Programming

The basis for financial programming was articulated and formalized principally by Polak (1957) whose model is considered to be the most influential piece of work in macroeconomics after the General Theory of Keynes (1936) especially as it currently forms the cornerstone of most IMF supported programmes and policy prescriptions (see Taylor 1987, 1988).

Polak was dissatisfied with the Keynesian overemphasis on fiscal policy and the inadequate treatment meted out to monetary aspects and, consequently, he attempted to "streamline the monetary side of the analysis" (see Polak 1957, p. 32) by assuming that in an open economy, operating under a fixed exchange rate, the money supply is endogenous and is influenced by balance of payments (BOP) surpluses or deficits. The Polak approach can basically be interpreted as an attempt to integrate monetary and credit factors into BOP analysis and thus derive a formal relationship between the domestic component of the money stock (domestic credit), current account deficits and changes in reserves, which could then be employed for policy prescription.

While the approach outlined in this paper still forms the basis of most structural adjustment programmes recommended by the IMF, several events in the 1970s, notably the switch to a system of floating exchange rates amongst major currencies and the sharp increases in real interest rates in international credit markets, have implied that the design structures of financial programming models which have been adopted by many countries have evolved over time in an attempt to absorb many of the developments that have taken place in the study of open-economy macroeconomics.

Despite this fact, financial programming has not yet received the widespread recognition that it so richly deserves in the economic profession. Surprisingly enough, even until the late 1970s, there was very little material on its theoretical underpinnings, apart from Kragh (1970), Robichek (1971) and a compendium of earlier papers on the Fund's approach to financial programming (International Monetary Fund 1977). To be sure, the analytical basis for endogenizing money supply was formalized by Polak and Argy (1971), on the lines suggested by Christ (1969), although their model was incomplete in the sense that it only considered the accounting constraints on the banking and external sectors, and not those for the private and government sectors.

Crockett (1981) and Guitian (1981) did provide general descriptions of the policy content of adjustment programmes in terms of all the four sectors for developing economies, while Goldstein (1986) covered the global effects of such adjustment programmes. However, none of these discussed the theoretical details regarding the implicit inter-sectoral relationships. The theoretical aspects of the design of Fund-supported adjustment programmes were heuristically explained in International Monetary Fund (1987) which, by dealing exclusively with general stabilization issues, skirted the all-important fact that IMF-supported adjustment programs are necessarily country-specific.

Moreover, most of these works were devoted to analyzing imbalances in the monetary and external sectors and their impacts on inflation and the BOP, and very little effort was made by the IMF to determine the repercussions of these variables on the real growth rate of the economy which was assumed to be exogenous.

1.2 Growth-Oriented Financial Programming

The World Bank however, unlike the IMF, focused attention on higher real growth and, consequently, the framework of its model revolved around the real variables of the economy. Based upon the Harrod-Domar model and its extension via the two-gap models of Chenery and Bruno (1962), McKinnon (1964) and Chenery and Strout (1966), the Bank's concern was to estimate the levels of investment, imports and external finance consistent with a target real growth rate. In such an analysis, prices were assumed to be constant or if the rate of inflation was needed to arrive at the real GDP growth rate, then it was given exogenously.

Thus, this dichotomy between the approaches of the Fund (where an exogenously given real growth rate determined the inflation rate) and the Bank (where an exogenously given inflation rate determined the real growth rate) often led to conflicting policy prescriptions because of the weak linkages postulated between the real and monetary sectors of the economy.

While a few attempts were made to integrate the real and the monetary sectors together by Mohsin Khan and his associates at the IMF (see Khan and Knight 1985; Khan and Zahler 1985; Khan, Montiel and Haque 1986, 1988; Khan and Montiel 1989), as well as to work out the implications of a growth-oriented model of financial programming (see Chand 1987), these writings have been relatively inaccessible. In this context, with the probable exception of Bacha (1987, 1990) and Khan, Montiel and Haque (1990), there have hardly been any authoritative and readily accessible source on such a merged Bank-Fund framework thereby pre-empting any meaningful debate on its analytical content.

While most discussions on macroeconomic stabilization, based on such a growth-oriented financial programming methodology, have assumed that fiscal austerity, competitive real exchange rates, sound financial markets and deregulation provide the conditions for a resumption of growth, Dornbusch (1990) has argued that there is a possibility of stabilization resulting in stagnation because structural adjustment is only a necessary but not a sufficient condition for growth.

Needless to say, even if the current stabilization policy that has been initiated in India does result in the resumption of growth (as it currently seems to be doing), there is little assurance that such a resumption will not translate itself once more into rising current account deficits and the subsequent run on reserves. These past trends in the Indian economy have raised several interesting, albeit unanswered, questions regarding the optimal mix of stabilization policies that need to be pursued in order to avoid the possibility of such a recurrence.

As all these issues have not yet been fully recognized by orthodox economics, the study is primarily geared towards discussing the real and monetary aspects of short-run structural adjustment using growth-oriented financial programming analysis based on a conventional macroeconomic flow-of-funds methodology.

The policy issues, then, that will have to be studied within the Indian context will have to deal with the following related questions: (1) What are the essential steps to ensure monetary stabilization and fiscal adjustment? and (2) What policy coordination measures are necessary to ensure sustainable growth without rising inflation or increasing deficits?

1.3 Outline Of The Study

Thus, any design of monetary stabilization and fiscal adjustment policy for the Indian economy will have to evaluate the following four elements in order to decide which of these are most likely to play a central role in the long-run success of a stabilization effort measured in terms of a rapid smooth transition to growth. These are: (1) The desired levels of inflation and international reserves, (2) The optimal levels of domestic credit and the exchange rate, (3) The appropriate levels of capital flows and investment, and (4) The sustainable levels of fiscal and current account deficits.

Given such a framework, the initial aim of this paper would be to strengthen the logical rigour of growth-oriented financial programming techniques by describing an analytical framework capable of integrating, both, the financial programming model of the IMF and the two-gap model of the World Bank in a more meaningful manner than has been hitherto attempted so as to remove the existing dichotomies between the real and financial sectors of the economy.

While it does draw to a certain extent on previous studies that have attempted such a merger (see Mills and Nallari 1992), it probes further by attempting to identify the existence of optimal adjustment paths as well as transmission mechanisms inherent in such a framework. In this context, particular emphasis is placed on the response of the economy, both in terms of changes in the inflation rate as well as international reserves, to the combination of stabilization policies that have been employed in the Indian context.

By stressing on the theory underlying stabilization policies, it is hoped that the study will dispel the popular misconception that the approach to the design of structural adjustment is based on a particular view of the economy or, more importantly, on the convictions of any single school of thought.

That money and monetary policy play key roles in determining BOP outcomes, and therefore clearly also in the design of adjustment programmes, does not necessarily make such adjustment programmes "monetarist" in character, although this point has been raised by Dell (1982), amongst others. The concentration on monetary flows in such programmes can be justified on several grounds, ranging from the theoretical view that the BOP is essentially a monetary phenomenon to the more pragmatic reason that data on monetary variables contain important macroeconomic information and are relatively more accurate and timely than data on real variables (see Rhomberg and Heller 1977).

Based upon the nature of the approach adopted by the IMF and the World Bank, the study attempts to provide a unified theoretical approach to growth and inflation. Needless to say, there could be various possible interpretations of the theoretical mechanisms forming the adjustment process in such a unified theory, and consequently a variety of theoretical specifications could have been used as a reference framework while specifying an adjustment programme for the Indian economy.

To avoid such complications, a financial programming model is constructed with respect to the analytical framework specified in the study. In doing so, the paper deals exclusively with the specific characteristics of the Indian economy and not with

general issues underlying stabilization policies, thereby addressing itself to the fact that adjustment programmes need to be tailored to the circumstances of the countries where they are being applied. It needs to be noted that, although Fund-supported programmes in recent years have been applied solely to developing countries, the analysis of the paper, especially with regard to the inflation process, could easily be generalized to developed economies as well although there is no discussion on the inter-related effects of such global adjustment programmes.

The remainder of the study is organized as follows: Section 2 deals with the basic framework of financial programming and, using the flow-of-funds methodology, relates the monetary and fiscal accounts to the balance of payments. Section 3 describes the analytical approach to endogenizing inflation and reserves within the conceptual framework of financial programming analysis and highlights, using stabilization theory, the relationship amongst these two macroeconomic objectives and certain policy instruments that are central to such adjustment programmes. The possibility of extending such a framework to determine investment and growth, via the two-gap model, is examined in Section 4 which also discusses the implications of an endogenous interest rate. A short-run financial programming model for the Indian economy is constructed in Section 5 and the effects of various policy instruments - in particular, those operating through the monetary and external sectors - and the channels through which they influence growth, inflation, BOP and reserves are analyzed using optimal control theory. Section 6 summarizes the main theoretical, empirical and policy issues raised in the study.

2. ANALYTICAL FRAMEWORK FOR MACROECONOMIC MANAGEMENT

2.1 Three Basic Macroeconomic Relationships

Macroeconomic analysis is governed by three key accounting concepts: production, income and expenditure (or savings). From the viewpoint of an economy or an economic agent, these concepts are linked by three basic relationships: production and income, income and expenditure, and savings and asset acquisition.

For any producing unit, the value of production must equal the value of incomes that the unit generates. A similar argument holds for an economy: the value of domestic production must equal the value of incomes - excluding transfers - that are domestically generated.

For any economic agent, income earned (regardless of whether the source is domestic or foreign) plus transfers received must finance expenditure. Income plus transfers, however, need not equal expenditure. Savings, which may be positive or negative, is the balancing item. The basic relationship between income and expenditure is, therefore: for any economic agent, income plus transfers must equal expenditure plus savings.

The third basic relationship, on which we shall focus extensively in this study, links savings and asset acquisition: for any economic agent, savings plus borrowings must equal asset acquisition. There is no presumption about savings or borrowings being positive or negative. Specifically, either or both can be negative and the relationship will still hold.

The link between savings and investment (asset acquisition) of a sector and its associated financial transactions with other sectors can be explained using a flow-of-funds accounting format.

2.2 A Macroeconomic Consistency Framework

Such a framework, which explains the intersectoral transactions in an economy, can be represented in the form of a consistency matrix. The four sectors identified for this purpose are: the government sector, the private sector, the external sector and the monetary sector. As our purpose is to study only the intersectoral links between savings and investment, we have focused attention exclusively on the capital accounts, which highlights the sources and uses of funds, of each of the four sectors. The ensuing matrix is far more compact than the one suggested by Easterly (1989) as it excludes intersectoral current accounts transactions which are relevant only if one is analyzing all the three relationships specified in Section 2.1.

The government is defined as all levels of government (central and state) as well as public sector corporations funded through the government budget. The nongovernment (private) sector includes the household sector as well as the private corporate sector. The monetary system identified in the consistency matrix includes, both, the Reserve Bank of India (RBI) and all other scheduled commercial banks, as well as private savings banks and other public savings institutions. As we are interested only in the role of the monetary system as an intermediary for channelling savings from one sector to the other, such an aggregation is preferable. However, any study that attempted to analyze how the operations of the RBI would affect money supply through commercial bank regulations, such as cash reserve ratios, statutory liquidity ratios, bank rates, amongst others, would require further disaggregation.

Table 2.1 presents the capital accounts transactions of such a 4-sector economy and rows and columns 1 through 5 describe the financing of asset acquisition by the government sector, the private sector and the external sector through the intermediary of the monetary sector.

In row 1 and column 1, government savings (S_g), government borrowings from the monetary system (δDC_g), net direct government borrowings from the private sector (δNDB_g), and net foreign borrowings by the government (δNFB_g) are used to finance asset accumulation by the government sector (I_g). Asset acquisition is of three forms: gross investment, financial assets in the form of loans to the private sector, and the acquisition of foreign assets. The last two items have been netted out from government borrowings from the private sector and foreign borrowings of the government, respectively, and, therefore, these items do not appear explicitly as separate entities in the matrix.

Row 2 and column 2 deal with the private sector. Private savings (S_p), borrowings by households from the monetary system (δDC_p) and net private borrowings from foreign residents (δNFB_p) are used to finance private investment (I_p), net lending to the government (δNDB_g) and new issues of currency and the change in demand as well as time deposits held by the monetary system (δM).

Similarly, in row 3 and column 3, the savings of foreign residents or the current account deficit (CAD) plus the proceeds from the acquisition of new foreign exchange assets (accumulation of reserves) by the monetary system (δR) are used to finance the net foreign borrowings of the government sector (δNFB_g) as well as the private sector (δNFB_p).

Table 2.1
CONSISTENCY ACCOUNTING MATRIX

SOURCES (Across) USES (Down)	GOVERNMENT SECTOR [C1]	PRIVATE SECTOR [C2]	EXTERNAL SECTOR [C3]	MONETARY SECTOR [C4]	SECTORAL SAVINGS [C5]	TOTAL
GOVERNMENT SECTOR [R1]		Domestic borrowings by govt. (δNDB_g)	Foreign borrowings by govt. (δNFB_g)	Domestic credit to govt. (δDC_g)	Government Savings (S_g)	Govt.savings plus borr. $(=S_g + \delta NDB_g + \delta NFB_g + \delta DC_g)$
PRIVATE SECTOR [R2]			Foreign borrowings by private sect. (δNFB_p)	Domestic credit to private sect. (δDC_p)	Private sector savings (S_p)	Priv.savings plus borr. $(=S_p + \delta NFB_p + \delta DC_p)$
EXTERNAL SECTOR [R3]				Foreign exchange reserves (δR)	Current account deficit $(Z-X)$	External savings plus reserves $(=Z-X+\delta R)$
MONETARY SECTOR [R4]		Broad money $(M3)$ +other liabilities (δM)				Liabilities of monetary system $(=\delta M)$
SECTORAL INVESTMENT [R5]	Government investment (I_g)	Private sector investment (I_p)				Total investment $(=I_g + I_p)$
TOTAL	Government investment $(=I_g)$	Assets of private sector $(=I_p + \delta NDB_g + \delta M)$	Net capital inflows $(= \delta NFB_g + \delta NFB_p)$	Assets of monetary system $(=\delta DC_g + \delta DC_p + \delta R)$	Domestic plus foreign savings $(=S_g + S_p + Z-X)$	

NOTE: The “ δ ” preceding a variable indicates a one-period change, i.e., $\delta X = X - X(-1)$.

Row 4 and column 4 deal with the monetary system. As an intermediary, it acquires liabilities in the form of new domestic currency issues, demand deposits, time deposits, and other liabilities such as treasury bills, and so on (δM). It, in turn, acquires assets in the form of loans to the government sector (δDC_g) and the private sector (δDC_p), and net foreign assets or international reserves (δR).

Row 5 and column 5 deal with the savings-investment link at the macroeconomic level and indicate that domestic savings, i.e., the sum of government savings (S_g) and private savings (S_p), plus foreign savings (CAD) must finance total investment, i.e., the sum of government investment (I_g) and private investment (I_p).

2.3 The Derivation Of Sectoral Budget Constraints

Table 2.1 summarizes the capital transactions of the four transactors in the economy: the government sector, the household or the nongovernment (private) sector, the external sector and the monetary system as an intermediary. Based upon the basic relationship that links savings and borrowings with asset acquisition, Table 2.1 can be used to formally set out these sectoral budget constraints.

2.3.1 The government budget constraint

Equating the sum of the entries in row 1 and column 1 shows:

$$S_g + \delta DC_g + \delta NDB_g + \delta NFB_g = I_g \quad (2.1)$$

Eq. (2.1) basically expresses the savings, borrowings and asset acquisition relationship (or the savings constraint) for the government sector: government savings plus net borrowings is identical to the (physical) assets acquired by the government during the accounting period.

Eq. (2.1) can be rewritten as follows to reveal the sources of financing a government budget deficit:

$$I_g - S_g = \delta DC_g + \delta NDB_g + \delta NFB_g \quad (2.2)$$

where the expression on the left-hand-side is the overall fiscal deficit of the government. The sources of financing such a fiscal deficit are, therefore, foreign borrowings, direct borrowings from the private sector and borrowings from the monetary system. Eq. (2.2) reveals two possible sources through which high fiscal deficits can crowd out the private sector. Assuming that government borrowing from external sources is restricted, then crowding-out can occur either through direct government borrowing from the private sector, or through government borrowing from the monetary system. The latter presumes that there is a ceiling on overall credit of the monetary system, which is often the case in anti-inflationary stabilization programmes. This explains as to why, in addition to overall domestic credit ceilings, structural adjustment programmes often have sub-ceilings on central bank credit to the government in order to prevent crowding out.

2.3.2 The private sector budget constraint

Equating the sum of the entries in row 2 and column 2 shows:

$$S_p + \delta DC_p + \delta NFB_p = I_p + \delta NDB_g + \delta M \quad (2.3)$$

Eq. (2.3) states that the assets acquired by the private sector (with their savings and borrowings) comprise physical assets, currency and demand (including time) deposits, and loans made to the government, such as the purchase of government bonds. Adding up eqs. (2.1) and (2.3) yields:

$$S + \delta DC + \delta NFB = I + \delta M \quad (2.4)$$

where $S=S_g+S_p$; $\delta DC=\delta DC_g+\delta DC_p$; $\delta NFB=\delta NFB_g+\delta NFB_p$; $I=I_g+I_p$.

2.3.3 The external sector budget constraint

Equating the sum of the entries in row 3 and column 3 shows:

$$CAD + \delta R = \delta NFB_g + \delta NFB_p = \delta NFB \quad (2.5)$$

which yields:

$$CAD = \delta NFB - \delta R \quad (2.6)$$

Eq. (2.6) indicates that a current account deficit (or positive savings by the external sector) which is the excess of imports (Z) over exports (X), i.e., $CAD = Z - X$, must be financed either by an increase in net capital inflows (implying an increasing indebtedness of the domestic economy) or by a drawing down of international reserves.

Note that the elements in the left-hand-side of eq. (2.6) are in the form of goods and services, while those on the right-hand-side are in terms of foreign exchange (currencies). In particular, imports constitute a consumable or investable resource inflow, whereas exports constitute a resource outflow.

Under the circumstances, it can be seen that a capital flight, which is manifested by a fall in net external borrowings (δNFB), which is not accompanied by a drawdown of foreign exchange reserves by the banking system (δR) would imply financing either by increased exports or reduced imports. Thus, there is an opportunity cost to holding foreign exchange reserves which could either be in the form of foregone consumption and/or domestic investment. Depending on the level of per capita consumption or the rate of return on domestic investment, this cost may be considerable (see Krugman and Taylor 1978).

Substituting eq. (2.5) into eq. (2.4) yields:

$$S + \delta DC + CAD + \delta R = I + \delta M \quad (2.7)$$

2.3.4 Assets and liabilities of the monetary system

Equating the sum of the entries in row 4 and column 4 shows:

$$\delta DC_g + \delta DC_p + \delta R = \delta M \quad (2.8)$$

which states that the assets of the monetary system, in the form of foreign assets (reserves) as well as changes in credit to the government and private sectors are identical to changes in broad money and other liabilities of the monetary system.

Eq. (2.8) can be rewritten as:

$$\delta R = \delta M - \delta DC \quad (2.9)$$

Eq. (2.9) states that the change in foreign exchange reserves is equal to the demand for money less the change in total domestic credit. This equation suggests that if the demand for money is held constant, then increases in domestic credit are offset by decreases in reserves on a one-to-one basis. Alternatively, it implies that given a desired level of reserves, and with the demand for money exogenously determined, the required change in domestic credit can be estimated.

It needs to be noted that this type of analysis, which is characteristic of the "Chicago version" of the monetary approach to the balance of payments (see Frenkel and Johnson 1976), applies only when the domestic price level is determined by foreign prices through the purchasing power parity (or the "law of one price") so that the demand for money is independent of changes in domestic credit. However, in any actual formulation of adjustment programmes, the relevance of this assumption needs to be carefully analyzed. In the present context, we shall treat it only as an accounting relation which establishes the equality between the assets and liabilities of the monetary system.

It has been argued that central banks can sterilize capital inflows, i.e., prevent capital inflows from increasing domestic money supply, by attempting to offset the resulting expansion in reserves by a corresponding contraction of domestic credit. Sterilization may be necessary because capital inflows, by expanding money supply, increase domestic price levels thereby causing the real exchange rate to appreciate. From eq. (2.9), it can be seen that sterilization could help to stabilize money supply because it would have the effect of increasing foreign exchange reserves while decreasing the indebtedness of the government and private sectors to the monetary system.

With a well-developed capital market, the government would be able to compensate for its inability to borrow from the domestic monetary system by selling bonds to the private sector. Otherwise, the private sector will have to bear the entire brunt of sterilization and the resulting credit squeeze could, unless counterbalanced by foreign capital inflows, lead to a crowding out of private sector investment.

2.3.5 The savings-investment balance

Equating the sum of the entries in row 5 and column 5 shows:

$$S_g + S_p + CAD = I_g + I_p \quad (2.10)$$

Similarly, substituting eq. (2.9) in eq. (2.7) yields:

$$S + CAD = I \quad (2.11)$$

Both results are identical indicating that the overall savings-investment balance is a macroeconomic budget constraint obtained by summing up the sectoral budget constraints.

The expressions state that domestic investment ($I=I_g+I_p$) is financed by domestic savings ($S=S_g+S_p$) and foreign savings ($Z-X$).

2.4 Flow Of Funds Versus Market Equilibrium

The link between savings and investment of each sector and its associated financial transactions with the other sectors must be clearly understood so that appropriate financial policies, based on reliable and consistent macroeconomic forecasts, can be formulated and executed. In this context, flow-of-funds accounts are essential prerequisites for the formulation of any financial programme as they form the basis for ensuring consistency.

The procedure in formulating a financial programme is therefore to construct flow-of-funds matrices for each year (which usually forms an accounting period) so that the pattern of financial transactions is broadly discernible, if possible. Based upon such patterns, it is usually possible to fill in the elements of a flow-of-funds matrix for a future period, consistent with each sector's savings and investment behaviour, the monetary and fiscal policies likely to be in force, as well as the prevalent financial conditions. Of course, while doing so, certain assumptions have to be made regarding the behaviour of each variable, whether it is purely exogenous, policy controlled or endogenous. Since the flow-of-funds matrix depends on financial conditions which can be influenced by financial policies and which interact with the behaviour of income and expenditure flows, the construction of such a consistency matrix often involves an iterative procedure to adjust the initial estimates until overall consistency is achieved (see Bain 1973). However, if a simultaneous equation financial programming model is properly specified and constructed, such as the one estimated in Section 5, this iterative process can be avoided.

In Tables 2.2(a)-(d), we have presented the flow-of-funds matrices for the last four years, i.e., 1990-91 to 1993-94, which together comprise the liberalization phase. The construction of a flow-of-funds matrix for the current year (1994-95) will be postponed to Section 5, after we have specified a model capable of projecting some of the variables of the overall system.

In all the tables, reading across rows provides the sources of finance for each sector while reading down columns indicates the uses of finance. Ex post, each sector's deficit must be financed and, as such, the sum of the rows is always equal to the sum of the columns. Ex ante, these sectoral balances become constraints for modelling sectoral behaviour, be it financial or non-financial. It is these constraints that will be included while specifying the financial programming models that follow.

The fundamental difference between the flow-of-funds and the market equilibrium approaches while formulating a model is that sectoral balances are treated as constraints in the former while the latter treats market equilibria as constraints. In the case where market forces and instantaneous adjustments co-exist, these two types of constraints are equivalent since when all sectoral accounts are balanced, all markets must be cleared. However, any market imperfections and lag adjustments would create a situation where sectoral balances are not equivalent to market equilibria. For instance, when credit rationing is in force, the money market cannot be in equilibrium by definition. The resulting disequilibrium in the money market must co-exist with disequilibrium in at least one other market in the economy. In such cases, sectoral balances yield more reliable constraints.

2.4.1 Flow-of-funds matrices and financial patterns

Based upon the flow-of-funds matrices presented in Tables 2.2(a)-(d), as well as the supplementary information on GDP at current market prices (GDP), the growth rate of real GDP (g) and the inflation rate (π), the following patterns emerge:

- (1) There has been a general stagnation in the growth rate as a result of the current economic policies. However, this is an inevitable consequence of any stabilization policy aimed at reducing trade deficits (via devaluation) and controlling inflation (via reduced fiscal deficits and monetary expansion).
- (2) While the inflation rate rose steeply following devaluation, the rise in prices seems to have been checked in the last two years as a result of moderate growth as well as the controlled monetary expansion. However, the sudden increase in money in 1993-94 could once again generate inflationary pressures.
- (3) After an initial increase, public sector savings (S_g) decreased from 2.1 percent of GDP in 1992-93 to 1.3 percent in 1993-94 reflecting, once again, growing fiscal indiscipline.
- (4) With public sector investment (I_g) registering a marginal increase to 10.2 percent of GDP in 1993-94, the contemporaneous decrease in public sector savings implied a widening government investment-savings gap ($I_g - S_g$) or, equivalently, a widening gross fiscal deficit (both, centre and state) which increased from 8.0 percent of GDP in 1992-93 to 8.9 percent in 1993-94.
- (5) Private savings (S_p) increased sharply from 20.0 percent of GDP in 1992-93 to 22.9 percent in 1993-94. However, over the same period, private sector investment (I_p) fell from 14.3 percent of GDP to 14.1 percent - a definite indication of crowding-out.

Table 2.2(a)
FLOW OF FUNDS MATRIX (1990-91)

$g=5.2\% ; \pi=10.3\%$ (Rs. crores at current prices)

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 24426$	$\delta NFB = 3181$	$\delta DC = 23042$	$S = 5591$	56240
Private Sector			$\delta NFB_p = 17950$	$\delta DC_p = 20065$	$S_p = 120366$	158381
External Sector				$\delta R = 3763$	$Z-X = 17368$	21131
Monetary Sector		$\delta M = 46870$				46870
Investment	$I = 56240$	$I_p = 87085$				143325
TOTAL	56240	158381	21131	46870	143325	GDP= 532030

Table 2.2(b)
FLOW OF FUNDS MATRIX (1991-92)

$g=1.1\% ; \pi=13.7\%$ (Rs. crores at current prices)

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 30242$	$\delta NFB = 5421$	$\delta DC = 18070$	$S = 10466$	64199
Private Sector			$\delta NFB_p = 10389$	$\delta DC_p = 16225$	$S_p = 137907$	164521
External Sector				$\delta R = 10624$	$Z-X = 5186$	15810
Monetary Sector		$\delta M = 44919$				44919
Investment	$I = 64199$	$I_p = 89360$				153559
TOTAL	64199	164521	15810	44919	153559	GDP= 615655

Table 2.2(c)
FLOW OF FUNDS MATRIX (1992-93)

$g=4.0\%$; $\pi=10.1\%$

(Rs. crores at current prices)

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 33091$	$\delta NFB = 5319$	$\delta DC = 7826$	$S = 14817$	71053
Private Sector			$\delta NFB = 14169$	$\delta DC = 28380$	$S = 141113$	183662
External Sector				$\delta R = 3809$	$Z-X = 15679$	19488
Monetary Sector		$\delta M = 50015$				50015
Investment	$I_g = 71053$	$I_p = 100556$				171609
TOTAL	71053	183662	19488	50015	171609	$GDP = 705566$

Table 2.2(d)
FLOW OF FUNDS MATRIX (1993-94)

$g=3.8\%$; $\pi= 8.2\%$

(Rs. crores at current prices)

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 39922$	$\delta NFB = 3837$	$\delta DC = 27697$	$S = 10447$	81903
Private Sector			$\delta NFB = 25864$	$\delta DC = 20829$	$S = 184032$	230725
External Sector				$\delta R = 28713$	$Z-X = 988$	29701
Monetary Sector		$\delta M = 77239$				77239
Investment	$I_g = 81903$	$I_p = 113564$				195467
TOTAL	81903	230725	29701	77239	195467	$GDP = 803632$

In order to analyze the factors leading to such a crowding-out of private sector investment, we must look at its proximate determinants, given below, using the flow-of-funds methodology.

- (1) An event which has had a profound influence on the pattern of financial transactions in 1993-94 and which can be considered the genesis behind this crowding-out has been the unprecedented foreign capital inflows (δNFB) which increased from 2.8 percent of GDP in 1992-93 to 3.7 percent in 1993-94.
- (2) Moderate imports as a result of modest growth rates led to an improvement in the current account deficit (CAD) which was barely 0.1 percent of GDP in 1993-94 as against 2.2 percent in 1992-93. Consequently, aggregate investment ($I=S+CAD$) in 1993-94 was bound to a lower level than what could otherwise have been attained had the CAD been of the same order of magnitude as in 1992-93.
- (3) However, as a consequence of the increase in capital inflows, coupled to the negligible CAD, there was a massive accretion in foreign exchange reserves (δR) amounting to 3.6 percent of GDP in 1993-94 as against barely 0.5 percent in 1992-93. The consequent pressure on the rupee to appreciate was staved off by the intervention of the RBI in the foreign exchange market.
- (4) This brought into sharp focus the need for an appropriate monetary policy consistent with the given exchange rate policy (of holding the nominal exchange rate constant) and it is in this context that the RBI undertook large-scale sterilization through open-market operations to counter the forces of monetary expansion emanating from the accumulation of foreign exchange reserves. As a result, domestic credit expansion (δDC) decreased from 6.5 percent of GDP in 1992-93 to 6.0 percent in 1993-94.

(5) However, and herein lies the crux of the matter, the credit squeeze fell only on the private sector whose entitlement ($\delta DC_p/GDP$) decreased from 4.0 percent in 1992-93 to 2.6 percent in 1993-94; while that of the public sector ($\delta DC_g/GDP$) actually increased from 2.5 percent in 1992-93 to 3.4 percent in 1993-94.

(6) This inability to contain government sector credit implied that the overall credit squeeze was not tight enough and, consequently, monetary expansion (δM) amounted to 9.6 percent of GDP in 1993-94 as against 7.1 percent in 1992-93.

(7) The intention of the government to completely phase out its recourse to ad hoc Treasury bills implied that it would, in future, need to meet its entire needs from the market as it would cease to have direct credit from the RBI for financing its deficit. This commitment, along with the large-scale open market operations which were carried out to sterilize reserves, implied that market borrowings (δNDB_g) increased from 4.7 percent of GDP in 1992-93 to 5.0 percent in 1993-94.

(8) Such a pattern of money-financing (δM) and debt-financing (δNDB_g) to cover increasing fiscal deficits implied that the distribution of private sector asset formation was skewed more towards financial, as against physical, assets. Thus, while in 1992-93, the ratio of financial asset creation ($\delta NDB_g + \delta M$) to physical asset creation (I_p) in the private sector was about 45:55; the ratio abruptly switched to 51:49 in favour of financial assets in 1993-94. This turnaround has led to a crowding-out of private sector investment which is a trend that must be contained, if not reversed, if the recently initiated macroeconomic policies are to result in higher growth.

2.5 Stabilization And Adjustment

One feature of the current stabilization policy has been the sterilization of reserves to minimize the loss of control over the monetary base as a result of intervention. While this would be possible with a well developed capital market, under the current circumstances, it would imply raising domestic interest rates which could be a source of large losses to the RBI if there is a substantial difference between the rate at which the RBI is selling debt instruments through open market operations and the rate which it is earning from its reserves. Moreover, there is the danger of still larger capital inflows as a result of the rise in domestic interest rates. In order to avoid these complications, the RBI has decided to reduce the interest rate, tacitly implying that the government has to bear the major brunt of sterilization by decreasing its indebtedness to the monetary system in order to preempt the possibility of crowding out private sector investment which would adversely affect growth.

Using a merged Bank-Fund framework and financial programming techniques, the study intends to set out a framework for analyzing all these measures and to, consequently, chart out the stabilization policy needed to manage the pace at which the exchange rate and the interest rate equilibrate with attempts to modify the impacts of the adjustment process on foreign exchange reserves so that they corroborate with market-dictated outcomes. Such a strategy should hopefully produce reasonable policy guidelines for ensuring a gradualist path which would lower the probability of stagflation since the inflation and growth effects of the stabilization policy would be absorbed more smoothly.

3. THE BASIC MODEL: ENDOGENIZING INFLATION AND RESERVES

The previous section described the methodology underlying the specification and construction of a flow-of-funds matrix as well as the possibility of using it as a basis for designing a structural adjustment programme. While programme specification may differ considerably in their details, in this context, an adjustment programme is defined as a package of policy measures designed essentially to restore balance of payments (BOP) equilibrium in the medium term, while maintaining, if not strengthening, the conditions for achieving a satisfactory rate of long-run output growth in a noninflationary manner.

As a necessary condition for achieving this outcome, the basic structure of our analytical approach is specified around a financial analysis that aims at ensuring consistency between the impact of alternative policy measures and the desired inflation as well as BOP outcomes. This consistency, which is incorporated into a set of balance sheet accounting relationships on the lines set out in Section 2, technically follows from, what has been termed as, the "monetary approach to the balance of payments" and forms the cornerstone for much of the subsequent "theory" which is employed in this study for specifying an analytical approach to monetary stabilization and fiscal adjustment programmes.

While the financial programming model (FPM) of the IMF has certainly influenced its design structure which has been utilized in some form or the other in Bank/Fund-supported programmes, the actual approach adopted here in this section is only the first element, albeit the central one, underlying the specification of an FPM for the Indian economy.

This section will outline the basic financial programming framework of an open economy with fixed exchange rates and discuss some of the principal advantages associated with such an approach, leaving to Section 4 the extension of the basic framework related to achieving medium-term growth objectives. The model serves as a convenient starting point for a more detailed study, attempted in Section 5, of the various transmission mechanisms between the array of instruments typically included in any adjustment programme and the ultimate objectives of such a programme: sustainable BOP, reasonable price stability and rapid economic growth. While one may design programmes on alternative theoretical relationships, such as the ones suggested by the IMF, it is shown here that monetary consistency, as incorporated in the flow-of-funds framework, must always hold.

3.1 Derivation Of The Basic Framework

The basic framework assumes that the economy, as described in Section 2, consists of the government, private, external and monetary sectors. The budget or financing constraints for the external and monetary sectors form the cornerstone of our model.

The external sector's financial constraint is given by eq. (2.6) which states that:

$$Z - X = \delta NFB - \delta R \quad (3.1)$$

where Z is imports of goods, X is exports of goods and net export of services, δNFB is the change in total (government and private) foreign borrowing and δR is the change in foreign exchange reserves. Eq. (3.1) states that the current account balance of a country has to be financed either by foreign borrowings (i.e., capital inflows) or by a drawing down of reserves or both.

The monetary sector's financial constraint is given by eq. (2.8) which states that:

$$\delta DC + \delta R = \delta M \quad (3.2)$$

where, given the definition of the monetary system as a financial intermediary, the change in money supply (δM) consists of the changes in reserves (δR) and the claims on the public and the private sectors ($\delta DC_g + \delta DC_p = \delta DC$).

In both these equations, foreign exchange reserves appear explicitly and, consequently, the external and monetary sectors can be linked together to identify proximate sources of temporary BOP disequilibria and inflation. In this basic framework comprising the external sector accounts, eq. (3.1), and the assets and liabilities position of the monetary system, eq. (3.2), there are two equations and six unknowns (i.e., Z , X , δNFB , δR , δDC and δM). Thus, by imputing values to any four of these, it is possible to solve uniquely for the remaining two variables. We solve the two simultaneous equations by making a series of assumptions which are briefly described below.

We assume that changes in net foreign borrowings (δNFB) is exogenously given. Exports (X), imports (Z) and changes in money supply (δM) are endogenized by linking them up to the inflation rate (π) and the nominal exchange rate (E), amongst other variables, by means of behavioural equations. We are thus left with four variables of which two need to be known in order to solve for the remaining two. To do so, we designate changes in reserves (δR) and the inflation rate (π) as the target variables whose desired levels can be attained using domestic credit (δDC) and the nominal exchange rate (E) as the instrument variables.

3.1.1 Monetary sector equilibrium

The financial programming approach starts with the accounting identity, given by eq. (3.2), expressing monetary sector equilibrium which can be re-written as:

$$\delta R = \delta M - \delta DC \quad (3.3)$$

The second building block of this model is the specification of a money demand function. While we could have postulated a general function relating the (nominal) demand for money to a set of variables including real income, domestic prices and the opportunity cost of holding money, at the outset, we initially invoke the Quantity Theory of Money and specify a more restrictive version by relating changes in nominal money demand (δM^d) to changes in nominal income (δY), i.e.,

$$\delta M^d = (1/v)\delta Y \quad (3.4)$$

where v is the (incremental) income velocity of money which is assumed to be constant over time (although this assumption will be relaxed during the empirical estimation of the model).

The third and final building block is a condition defining flow (or continuous) equilibrium in the money market which merely states that the change in the demand for money must equal the change in the actual supply of money, i.e.,

$$\delta M^d = \delta M \quad (3.5)$$

Substituting eqs. (3.5) and (3.4) into eq. (3.3) yields:

$$\delta R = (1/v)\delta Y - \delta DC \quad (3.6)$$

The BOP position, as reflected by changes in reserves, is thus expressed as the difference between the demand for money and the flow of domestic credit. When the change in domestic credit exceeds the change in money demand, reserves will be reduced.

In eq. (3.6) it is assumed that changes in nominal income and, consequently, nominal money demand are independent of variations in domestic credit (although this assumption will be partially relaxed when we specify the FPM in Section 5). Given these assumptions, it is seen that reductions in domestic credit yield a one-to-one increase in reserves. Such an approach is termed as the monetary approach to the balance of payments.

Now, from the identity: $Y = Py$ where Y is nominal GDP, P is the price level and y is real GDP; we have:

$$\begin{aligned}\delta Y &= Y - Y(-1) = Py - P(-1)y(-1) \\ &= \left[\frac{Py}{P(-1)y(-1)} - 1 \right] P(-1)y(-1)\end{aligned}\quad (3.7)$$

where $Y(-1)$, $P(-1)$ and $y(-1)$ are nominal income, the price level and real income in the previous period, respectively.

As real output growth rate (g) and the inflation rate (π) are defined as: $g=\{y/y(-1)\}-1$ and $\pi=\{P/P(-1)\}-1$, we incorporate these definitions into eq. (3.7) yielding:

$$\begin{aligned}\delta Y &= [(1 + \pi)(1 + g) - 1] Y(-1) \\ &= (g + \pi) Y(-1)\end{aligned}\quad (3.8)$$

which is obtained by ignoring the interaction term πg .

Substituting eq. (3.8) into eq. (3.6), yields:

$$\delta R = (1/v)(g + \pi) Y(-1) - \delta DC \quad (3.9)$$

where v is a parameter; δR and π are the endogenous variables; g and $Y(-1)$ are exogenous variable; and δDC is the instrument.

Such a re-grouping yields:

$$\delta R = [(g/v) Y(-1) - \delta DC] + (1/v) Y(-1) \pi \quad (3.10)$$

which is a straight line in δR and π space with a positive slope equal to $(1/v) Y(-1)$. This is shown by the MM line in Figure 3.1.

Eq. (3.10) contains three unknowns: δR , π and δDC . For any given value of δDC , it is not possible to solve uniquely for δR and π . However, it is obvious from the negative coefficient of δDC that any reduction in domestic credit will shift the MM line upwards implying either an increase in reserves (for a given π) or a fall in inflation (for a given δR).

It is also obvious that given a targeted reserve position and a desired inflation rate, it is possible to determine the level of domestic credit compatible with these targets which theoretically justifies the use of credit ceilings as a conditionality in IMF programmes.

But within an overall credit ceiling, sub-ceilings can also be specified. For example, a desired level of credit expansion to the private sector (δDC_p^*) can be established based on the private sector's "demand for domestic credit" function given by:

$$\delta DC_p^* = (\delta DC_p/Y)\delta Y \quad (3.11)$$

which assumes that there is a ratio of domestic credit (to the private sector) to nominal income that is the norm (and is given exogenously) and that changes in nominal income are independent of the variations in domestic credit. The idea behind such sub-ceilings is to pre-empt the crowding out of the private sector. Now, given the ceiling on total credit expansion (δDC), the allowable credit expansion to the government (δDC_g) can be derived residually using the identity:

$$\delta DC_g = \delta DC - \delta DC_p^* \quad (3.12)$$

implying that if the desired level of reserves (inflation rate) is high (low) and, consequently, the overall credit ceiling is very tight, the crunch falls on public sector credit expansion.

3.1.2 External sector equilibrium

However, needless to say, the desired levels of reserves and the rate of inflation cannot be arbitrarily chosen because these targets also affect some of the variables (specifically, imports) defining external sector equilibrium. Thus, the values of π , δR and δDC which satisfy eq. (3.10) may not necessarily satisfy eq. (3.1) and in order to eliminate this indeterminacy, we need to specify eq. (3.1) more elaborately.

The accounting identity, given by eq. (3.1), expressing external sector equilibrium can be re-written as:

$$\delta R = \delta NFB - (Z - X) \quad (3.13)$$

where δNFB is assumed to be exogenous.

Total imports (Z) can be re-written as:

$$Z = Z(-1) + \delta Z \quad (3.14)$$

where $Z(-1)$ is imports in the previous period (also assumed to be exogenous) and δZ is the change in imports.

Substituting eq. (3.14) into eq. (3.13) yields:

$$\delta R = [\delta NFB - Z(-1)] - \delta Z + X \quad (3.15)$$

The next building block of this model is the specification of an import demand function. While we could have postulated a nonlinear function relating the (real) demand for imports to a set of variables including real income and the real exchange rate, at the outset, we assume that the change in nominal imports (δZ) is a linear function of the change in nominal income (δY) and the change in the nominal exchange rate (δE), i.e.,

$$\delta Z = b \delta Y - z \delta E \quad (3.16)$$

where $b > 0$ and $z > 0$ are assumed to be constants (although this assumption will be relaxed during the estimation of the model).

Substituting eq. (3.16) into eq. (3.15) yields:

$$\delta R = [\delta NFB - Z(-1)] - b \delta Y + z \delta E + X \quad (3.17)$$

The final building block of this model is the specification of an export supply function. Most models of the Polak-Fund genre assume that exports are exogenous, implying that they are independent of variations in the exchange rate and Khan, Montiel and Haque (1986) argue that the incorporation of a positive export supply response to increases in the exchange rate would have no qualitative effects on the analysis.

However, to the extent that exports respond positively to devaluations, the more effective would be the exchange rate as an instrument for reaching a given target of reserves and, consequently, endogenizing exports is a theoretically more correct specification especially in a model such as ours which includes reserves (the exchange rate) amongst the set of targets (instruments). Empirically, such a formulation would yield widely differing quantitative results and, under the circumstances, using the orthodox variant of exogenous exports could considerably jeopardize the resulting policy implications, thereby attenuating the very purpose of this study.

While we could have postulated a nonlinear function relating the supply of exports to a set of variables including world income and the real exchange rate, at the outset, we assume that nominal exports, X , are a linear function of its lagged value, $X(-1)$, and the change in the nominal exchange rate, δE , i.e.,

$$X = k X(-1) + x \delta E \quad (3.18)$$

where $k > 0$ and $x > 0$ are assumed to be constants (although this assumption will be relaxed during the estimation of the model).

Substituting eq. (3.18) into eq. (3.17) yields:

$$\delta R = [\delta NFB - Z(-1) + kX(-1)] - b \delta Y + (x+z) \delta E \quad (3.19)$$

Substituting eq. (3.8) into eq.(3.19) and regrouping yields:

$$\begin{aligned} \delta R = & [\delta NFB - Z(-1) + kX(-1) - bgY(-1) + (x+z)\delta E] \\ & - bY(-1)\pi \end{aligned} \quad \dots(3.20)$$

where k , b , x and z are parameters; δR and π are endogenous variables; g , $X(-1)$, $Z(-1)$, $Y(-1)$ and δNFB are exogenous variables; and δE is an instrument.

Eq. (3.20) is a straight line in δR and π space with a slope equal to $-bY(-1)$. This is depicted by the EE line in Figure 3.1 which indicates external sector equilibrium. Eq. (3.20) contains three unknowns: δR , π and δE . For any given δE , it is not possible to solve uniquely for δR and π . However, the positive coefficient of δE ensures that increasing the exchange rate (devaluation) will shift the EE line outwards implying either an increase in reserves (for a given π) or an increase in inflation (for a given δR). Obviously, given a targeted reserve position and a desired inflation rate, it is possible to determine the level of the exchange rate compatible with these targets.

In Figure 3.1, at the intersection of the MM and EE lines, denoted by A, we have values of π_0 and δR_0 that simultaneously satisfy the budget constraints of the monetary and external sectors. If the objective now is to attain point B ($\pi^*, \delta R^*$), which signifies an improvement in the reserve position and the inflation rate vis-a-vis point A, then the structure of the model would suggest the following strategy: first, a reduction in domestic credit will shift the MM line upwards towards B and, second, a devaluation will shift the EE line outwards towards B.

Both policies are necessary to attain point B because, for example, a decrease in domestic credit will only shift the MM line, and there is no guarantee that it will intersect the EE line at the point B. The impossibility of reaching the two desired targets with only one instrument illustrates a general principle in the modelling of such deterministic systems: it is not possible to attain n targets with less than n instruments.

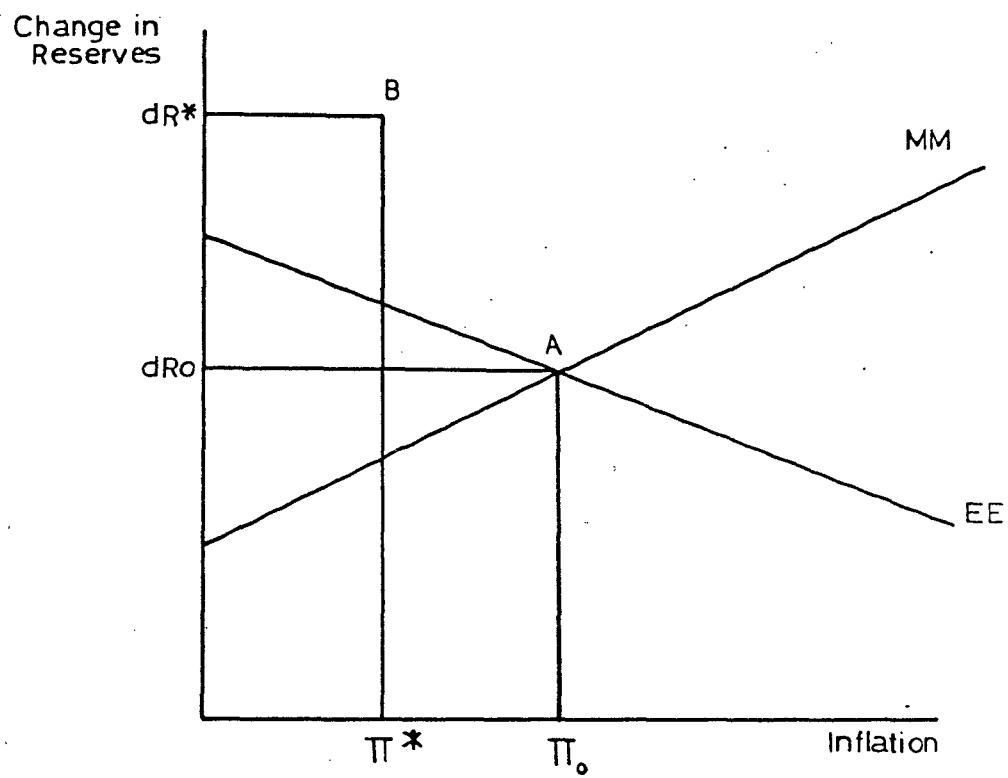
The above analysis is a simplified representation of the actual dynamics of inflation and reserves which, for the present, can be considered as a first-approximation of how these two variables interact. Important modifications in its dynamic structure will be carried out while empirically estimating these equations after we have derived their reduced-form solutions.

The structure of the model is set out in Table 3.1 below.

Table 3.1
STRUCTURE OF THE MODEL

Targets:	δR	: change in foreign exchange reserves
	π	: rate of inflation
Endogenous:	δM	: change in money supply
	Z	: imports
	X	: exports
Exogenous:	δNFB	: change in net foreign borrowings
	g	: real growth rate
	Y(-1)	: nominal income in the previous period
	Z(-1)	: imports in the previous period
	X(-1)	: exports in the previous period
Instruments:	δDC	: change in domestic credit
	δE	: change in the nominal exchange rate
Parameters:	v	: (incremental) income velocity of money
	b	: marginal propensity to import
	z	: coefficient of exchange rate impact on imports
	k	: coefficient of lagged exports
	x	: coefficient of exchange rate impact on exports

Figure 3.1
THE POLAK MODEL



3.1.3 The solution of the model

To solve for the two target variables, π and δR , we initially equate the right-hand-sides of eqs. (3.10) and (3.20) as they are both equal to δR . This yields:

$$[(g/v) Y(-1) - \delta DC] + (1/v) Y(-1) \pi = \\ [\delta NFB - Z(-1) + kX(-1) - bgY(-1) + (x+z) \delta E] - bY(-1) \pi \dots(3.21)$$

Solving eq. (3.21) in terms of π yields:

$$\pi = \frac{\delta NFB - Z(-1) + \delta DC + kX(-1) - [(1/v)+b]gY(-1) + (x+z)\delta E}{[(1/v)+b]Y(-1)} \dots(3.22)$$

which can be written as:

$$\pi = \frac{1}{[(1/v)+b]} \left[\frac{\delta NFB - Z(-1) + \delta DC}{Y(-1)} \right] + \frac{k}{[(1/v)+b]} \left[\frac{X(-1)}{Y(-1)} \right] \\ + \frac{(x+z)}{[(1/v)+b]} \left[\frac{\delta E}{Y(-1)} \right] - g \dots(3.23)$$

Substituting eq. (3.23) into eqs. (3.10) or (3.20) yields the following expression for δR after simplification:

$$\delta R = \frac{1}{[1+bv]} \left[\frac{\delta NFB - Z(-1) + \delta DC}{Y(-1)} \right] + \frac{k}{[1+bv]} \left[\frac{X(-1)}{Y(-1)} \right] \\ + \frac{(x+z)}{[1+bv]} \left[\frac{\delta E}{Y(-1)} \right] - \delta DC \dots(3.24)$$

To estimate the model, we need to determine the six composite reduced-form parameters in eqs. (3.23) and (3.24). We shall do so using both error correction mechanisms as well as Kalman filters in order to evaluate their relative superiority.

3.2 List Of Variables: Classification And Definition

Before we commence the estimation process, it is necessary to provide all the relevant information on the variables.

Target variables: (1) Foreign exchange reserves (R) is synonymous with net foreign exchange assets of the banking sector; and (2) The inflation rate (π) is defined as the rate of change in the (average) wholesale price index (1980-81=1).

Instrument variables: (1) Domestic credit (DC) includes bank credit to the government and commercial sectors; and (2) The nominal exchange rate (E), defined in terms of rupees per US dollar, is measured as weekly averages over the financial year.

Endogenous variables: (1) Money supply (M) is broad money (M3) adjusted to include government currency liabilities (GCL) and net non-monetary liabilities (NNML). Therefore, by our definition of money supply, we have: $M=M3-GCL+NNML$. By doing so, we ensure that monetary sector equilibrium is given by: $M=DC+R$; (2) Imports (Z) include only merchandise imports; and (3) Exports (X) comprise exports of goods as well as net official transfers and net other invisibles. Thus, $X-Z$ is the net current account.

Exogenous variables: (1) Changes in net foreign borrowings (δNFB) is synonymous with net private, banking and official inflows on the capital account. By adjusting it to include errors and omissions, we ensure that external sector equilibrium is given by: $(X-Z)+\delta NFB=\delta R$; (2) The growth rate (g) is defined as the growth rate of GDP at factor cost at constant (1980-81) prices; and (3) Nominal income (Y) is defined as GDP at factor cost at current prices (obtained by multiplying GDP at constant factor prices by the corresponding wholesale price index).

3.3 Modelling Cointegrated Series By Error Correction Mechanisms

In this section, we describe how cointegrated nonstationary variables can be used to formulate and estimate our model with an error correction mechanism (ECM). The fact that variables are cointegrated implies that there is some adjustment process which prevents the errors in the postulated long-run relationship from becoming increasingly large. The Granger Representation Theorem (see Engle and Granger 1987) established that any cointegrated series have an ECM and its converse, that cointegration is a necessary condition for an ECM to hold, is also true (see Engle and Granger 1991). A detailed analysis of cointegration and ECMs is provided by Hylleberg and Mizon (1989), while Phillips and Lorentan (1991) have explored a variety of ways of representing cointegrated systems with emphasis on ECMs. Such models currently represent the most commonly used approach in situations where one wishes to incorporate both the economic theory pertaining to the long-run relationship between the variables, as well as short-run disequilibrium behaviour. We now describe one of the simplest and most widely invoked procedure which requires only the use of the ordinary least squares (OLS) estimation method.

This approach suggested by Engle and Granger (1987) is particularly convenient for the case in which all the variables appearing in the long-run relationship are integrated of order 1, denoted by $I(1)$, or where the dependent variable is $I(1)$ and the explanatory variables are cointegrated of order $d+1$, d , denoted by $CI(d+1,d)$. We will illustrate the case with one explanatory variable in the long-run relationship (The extension to our multivariate case is direct). Consider the long-run relationship:

$$y(t) = \beta x(t) + u(t) \quad (3.25)$$

where both $y(t)$ and $x(t)$ are $I(1)$. Assume that for the OLS estimate $\hat{\beta}$, the Dickey-Fuller (DF) test and/or the Augmented Dickey-Fuller (ADF) test indicate stationarity of the residuals $u^*(t)$. In other words, cointegration of $y(t)$ and $x(t)$ of order $(1,1)$ with the cointegrating vector being $[1, -\hat{\beta}]$ can be positively accepted, implying that deviations of $y(t)$ from its long-run path are $I(0)$. Logically, the next move would be to switch over to a short-run model with an ECM given by:

$$\delta y(t) = \alpha(1)\delta x(t) + \alpha(2)[y(t-1) - \hat{\beta}x(t-1)] + \varepsilon(t) \quad (3.26)$$

As the dependent variable $\delta y(t)$ and the regressors $\delta x(t)$ and $[y(t-1) - \hat{\beta}x(t-1)]$ are $I(0)$, there is no possibility of estimating a spurious regression as a result of stochastic/deterministic trends being present in the data. The model incorporates both a long-run solution as well as a short-run ECM provided $\alpha(2) < 0$.

The long-run equilibrium solution is obtained by setting $\delta y(t) = \delta x(t) = 0$ in eq. (3.26) and, as $\alpha(2) \neq 0$, this yields eq. (3.25) which is, indeed, the postulated long-run relationship.

The short-run dynamics of the ECM are obtained by re-writing $\delta y(t) = y(t) - y(t-1)$ and $\delta x(t) = x(t) - x(t-1)$ in eq. (3.26) yielding:

$$\begin{aligned} y(t) = & [1 + \alpha(2)]y(t-1) + \alpha(1)x(t) \\ & - [\alpha(1) + \alpha(2)\hat{\beta}]x(t-1) + \varepsilon(t) \end{aligned} \quad (3.27)$$

In essence, the Engle-Granger method comprises two steps: First, estimate eq. (3.25) by OLS and test for stationarity of the residuals. Second, if this is not rejected, estimate eq. (3.26) replacing β by its previously computed OLS estimate $\hat{\beta}$. Under the circumstances, the condition of the identical order of integration for all the variables in eq. (3.26) is satisfied.

3.3.1 Modelling inflation using an ECM

Eq. (3.23) which models inflation can be written as follows:

$$(\pi+g) = \alpha(1) BZDY + \alpha(2) XY + \alpha(3) EY \quad (3.28)$$

where the composite regressors are defined as:

$$BZDY = [\delta NFB - Z(-1) + \delta DC]/Y(-1) \quad (3.29a)$$

$$XY = X(-1)/Y(-1) \quad (3.29b)$$

$$EY = \delta E/Y(-1) \quad (3.29c)$$

and where the composite reduced-form parameters are defined as:

$$\alpha(1) = v/(1+bv); \alpha(2) = kv/(1+bv); \alpha(3) = [(x+z)v]/(1+bv)$$

Using annual time-series data from 1970-71 to 1993-94 and testing the order of integration of the variables using the DF and ADF tests indicated that they were all I(1).

Estimating eq. (3.28) using OLS yielded the following result (where the figures in parentheses are t-statistics):

$$(\pi+g) = 1.0802 BZDY + 0.6469 XY + 4983.8 EY + u$$

$$(1.8) \quad (1.2) \quad (1.7)$$

$$\bar{R}^2 = 0.1506; \quad S.E.R. = 0.0285; \quad D.W. = 1.5 \quad \dots (3.30)$$

As the assumption of stationarity of the residuals (u) in eq. (3.30) was not rejected, we modelled the short-run dynamics of $(\pi+g)$ using an ECM with the estimated equation being given by:

$$\delta(\pi+g) = 1.4331 \delta(BZDY) + 2.8327 \delta(XY) + 10999.1 \delta(EY)$$

$$(3.3) \quad (1.8) \quad (3.3)$$

$$- 1.6609 u(-1) + \epsilon$$

$$(-3.0)$$

$$\bar{R}^2 = 0.5836; \quad S.E.R. = 0.0219; \quad D.W. = 1.9 \quad \dots (3.31)$$

The short-run dynamics of $(\pi+g)$ are therefore obtained by substituting eq. (3.30) into eq. (3.31) yielding:

$$\begin{aligned} \pi+g = & -0.6609 (\pi+g)(-1) + 1.4331 BZDY + 0.3610 BZDY(-1) \\ & + 2.8327 XY - 1.7583 XY(-1) + 10999.1 EY - 2721.5 EY(-1) \end{aligned} \quad \dots (3.32)$$

3.3.2 Modelling reserves using an ECM

The postulated long-run relationship for foreign exchange reserves is given by eq. (3.24) which can be written as follows which imposes the necessary restriction that the coefficient of δDC in the equation is unity:

$$\delta R + \delta DC = \beta(1) BZD + \beta(2) X(-1) + \beta(3) \delta E \quad (3.33)$$

where the composite regressor is defined as:

$$BZD = \delta NFB - Z(-1) + \delta DC \quad (3.34)$$

and where the composite reduced-form parameters are defined as:

$$\beta(1) = 1/(1+bv); \beta(2) = k/(1+bv); \beta(3) = (x+z)/(1+bv)$$

As before, using annual time-series data from 1970-71 to 1993-94 and testing the order of integration of the variables using the DF and ADF tests indicated that they were all I(1).

Estimating eq. (3.33) using OLS yielded the following:

$$(\delta R + \delta DC) = 0.8168 BZD + 0.8461 X(-1) + 1760.77 \delta E + u \quad (5.3) \quad (6.5) \quad (2.3)$$

$$\bar{R}^2 = 0.9628; \quad S.E.R. = 3108.8; \quad D.W. = 2.0 \quad \dots (3.35)$$

As the assumption of stationarity of the residuals (u) in eq. (3.35) was not rejected, we modelled the short-run dynamics of $(\delta R + \delta DC)$ using an ECM and the estimated equation was given by:

$$\begin{aligned} \delta(\delta R + \delta DC) &= 0.6319 \delta(BZD) + 0.5310 \delta X(-1) + 2285.9 \delta(\delta E) \\ &\quad (4.7) \quad (2.0) \quad (3.9) \\ &- 0.6927 u(-1) + \epsilon \\ &\quad (-1.5) \end{aligned}$$

$$\bar{R}^2 = 0.4580; \quad S.E.R. = 2404.8; \quad D.W. = 1.1 \quad (3.36)$$

The short-run dynamics of $(\delta R + \delta DC)$ are therefore obtained by substituting eq. (3.35) into eq. (3.36) yielding:

$$\begin{aligned} \delta R + \delta DC &= 0.3073 (\delta R + \delta DC)(-1) + 0.6319 BZD - 0.0661 BZD(-1) \\ &+ 0.5310 X(-1) + 0.0551 X(-2) + 2285.9 \delta E - 1066.3 \delta E(-1) \\ &\dots (3.37) \end{aligned}$$

3.3.3 Predicting inflation and reserves through ECMs

Eqs. (3.32) and (3.37) can be re-written as follows to provide predictions of inflation and the change in reserves:

$$\begin{aligned}\pi = & -0.6609 \pi(-1) + 1.4331 \text{BZDY} + 0.3610 \text{BZDY}(-1) \\ & + 2.8327 \text{XY} - 1.7583 \text{XY}(-1) + 10999.1 \text{EY} \\ & - 2721.5 \text{EY}(-1) - g - 0.6609 \text{g}(-1)\end{aligned} \dots (3.38)$$

$$\begin{aligned}\delta R = & 0.3073 \delta R(-1) + 0.6319 \text{BZD} - 0.0661 \text{BZD}(-1) \\ & + 0.5310 \text{X}(-1) + 0.0551 \text{X}(-2) + 2285.9 \delta E \\ & - 1066.3 \delta E(-1) - \delta DC + 0.3073 \delta DC(-1)\end{aligned} \dots (3.39)$$

Using eqs. (3.38) and (3.39), we predicted π and δR over the period 1972-73 to 1993-94 and these predictions, along with their actual values, have been graphed in Figures 3.2(a) and 3.2(b).

Given that π and δR are highly volatile variables, both equations perform creditably well. Eq. (3.38) captures precisely the dramatic turnaround in the inflation rate from an all-time high of 25.1 percent in 1974-75 to an all-time low of -0.01 percent in 1975-76. Thereafter, its predictions hover in the neighbourhood of the actual inflation rates with the tracking performance improving considerably over the period 1990-94 as the predictions closely mimic the U-turn in π after liberalization.

As far as eq. (3.39) is concerned, it predicts well initially by tracking the change in reserves quite accurately until 1979-80. Thereafter, its forecasts go awry with large under-predictions cropping up especially over the period 1986-90. However, its most creditable feature is that it tracks almost precisely the surge in reserves in 1990-91 and 1991-92, the equally sudden downturn in 1992-93 and, most importantly, the incredibly rapid acceleration in 1993-94.

Figure 3.2 (a)
PREDICTING INFLATION USING AN ECM

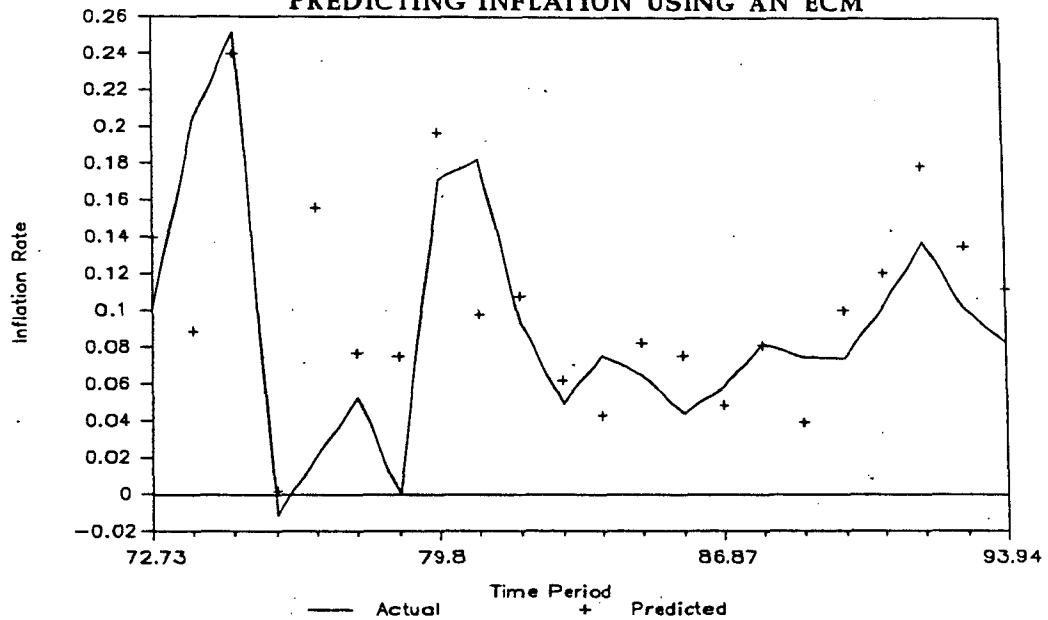
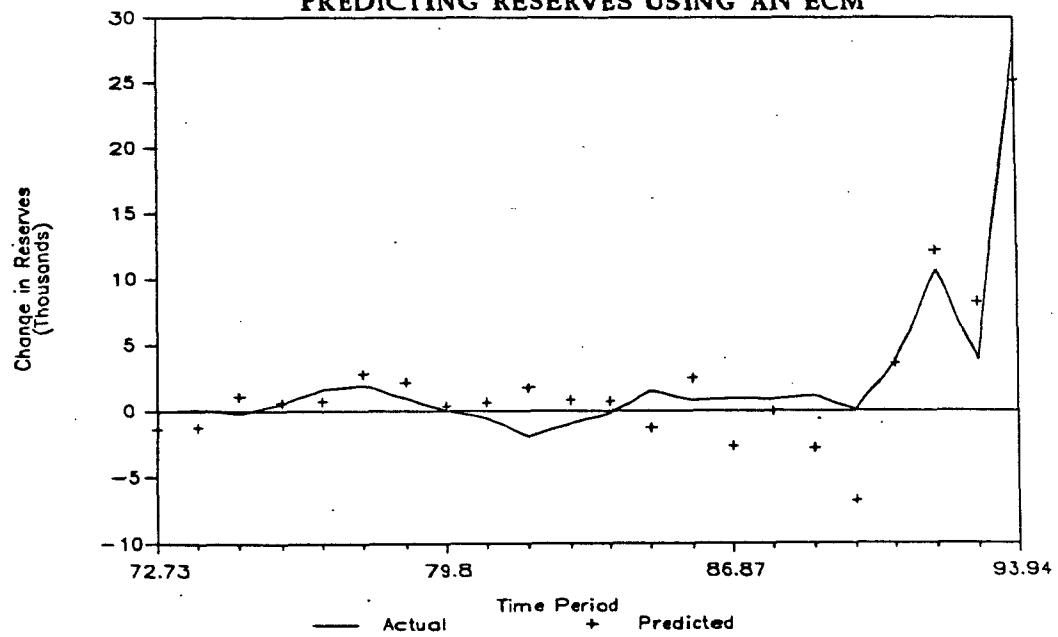


Figure 3.2 (b)
PREDICTING RESERVES USING AN ECM



3.4 Modelling Time-Series By Kalman Filters

Strictly speaking, the term Kalman filter refers to an estimation method commonly used to estimate state-space models, rather than the model itself (see Rao 1987). As with many time series methods used by economists (such as ARIMA and VAR models), state-space models originated in engineering (Kalman 1960, Kalman and Bucy 1961) and were imported into economics by Rosenberg (1968), Vishwakarma (1974), Chow (1975), Aoki (1976) and others.

The Kalman filter model (KFM) consists of two parts: the transition equation, which describes the evolution of a set of state variables; and the measurement equation, which describes how the data actually observed is generated from the state variables. The KFM is an updating method that bases the regression estimates for each time period on the estimates of the last period updated by the data for the current period, i.e., it bases estimates only on data upto and including the current period. As it recursively updates the regression coefficients (as well as their variances), the Kalman filter can be viewed as a Bayesian method. Its importance in economics is partly due to its ability to model time-varying parameters (TVPs) and this makes it highly useful for investigating structural changes or constructing forecasts based only on historical data.

The general form of the KFM comprises two equations: the measurement and transition equations (see Harvey 1989).

The measurement equation is given by:

$$y(t) = X(t) \beta(t) + u(t), \quad \text{Var}[u(t)] = R \quad (3.40)$$

The transition equation is given by:

$$\beta(t) = \tau \beta(t-1) + v(t), \quad \text{Var}[v(t)] = Q \quad (3.41)$$

In the formulation above, $y(t)$ is the dependent variable and there are n independent variables $X(t)$. The measurement equation, eq. (3.40), is an ordinary regression equation with time-varying parameters, $\beta(t)$, while the transition equation, eq. (3.41), defines the evolution of the parameters over time.

If we have an estimate of $\beta(t-1)$ and its covariance matrix $\Sigma(t-1)$, then the updated estimate of $\beta(t)$, given $y(t)$ and $X(t)$, is given by the following Kalman filter algorithm:

$$S(t) = \tau \Sigma(t-1) \tau' + Q \quad (3.42a)$$

$$\Sigma(t) = S(t) - K(t)X(t)S(t) \quad (3.42b)$$

$$\beta(t) = \tau \beta(t-1) + K(t) [y(t) - X(t-1)\beta(t-1)] \quad (3.42c)$$

Thus, the calculation of the Kalman filter estimators proceeds by forward recursions. In eq. (3.42c), the one-step forecast, $\tau\beta(t-1)$, is a strict update of the previously estimated value, whereas the best estimator involving current data, $\beta(t)$, is a weighted average of the one-step forecast and the error that one makes in predicting $y(t)$. The weighting matrix, $K(t)$, referred to as the Kalman gain, is given by:

$$K(t) = S(t)X(t)'[X(t)S(t)X(t)'+R]^{-1} \quad (3.43)$$

where the covariances are updated using eqs. (3.42a) and (3.42b). If the estimator for $\beta(t)$ is to be based on all the data, $y(t)$, $t=1,\dots,T$, we need the Kalman smoother estimators. These smoothers, denoted by $\beta^*(t)$, can be developed by successively solving the following backward recursions for $t=T,T-1,\dots,1$:

$$\beta^*(T-1) = \beta(T-1) + J(T-1) [\beta(T) - \tau\beta(T-1)] \quad (3.44)$$

where the $\beta(T)$'s are the original Kalman filter estimators and where the weighting matrix is given by:

$$J(t-1) = \Sigma(t-1)\tau'[S(t-1)]^{-1} \quad (3.45)$$

If a forecast is required, we need only to extend the forward recursions, eqs. (3.42)-(3.43), into the future under the convention that $K(t)=0$ for $t > T$ in eqs. (3.42b) and (3.42c).

The Kalman filter and smoother recursions provide a convenient means for calculating the conditional expectations which are of greatest interest during forecasting. The main problem that remains is to develop appropriate estimators for the five unknown parameters of the model, i.e., $\beta(0)$, $\Sigma(0)$, R , τ and Q , that are required to generate the recursions.

In this context, the initial state vector, $\beta(0)$, was set equal to the initial estimates of the parameters obtained by using OLS over the entire sample period; the initial covariance matrix of the states, $\Sigma(0)$, was formed by using the corresponding variances of the parameters along its principal diagonal; and the variance of the measurement equation, R , was the square of the standard error of regression (SER) of the OLS equation.

To obtain τ and Q , we initially estimated the concerned equation in a recursive manner, allowing the coefficients $\beta(t)$ to evolve as random walks (with a signal-to-noise ratio of 1) with $\beta(0)$ being estimated from the first m data observations where m was the number of coefficients in the equation; $\beta(1)$ from the first $m+1$ observations, and so on. We then regressed the coefficient values, $\beta(t)$, on their corresponding lagged values, $\beta(t-1)$, and the state transition matrix (τ) was formed by using these estimated autoregressive parameters along its principal diagonal; while the covariance matrix of the transition equation (Q) was formed by using the standard errors of each of these estimated coefficients along its principal diagonal.

3.4.1 Modelling inflation using the Kalman filter

The postulated relationship for predicting ($\pi+g$) is:

$$(\pi+g)_t = \alpha_1_t BZDY_t + \alpha_2_t XY_t + \alpha_3_t EY_t \quad (3.46)$$

where the TVPs of the equation, i.e., α_1 , α_2 , and α_3 , need to be estimated using the Kalman filter.

The following estimators for the five unknown parameters were used to model the TVPs of eq. (3.46) above.

The initial state vector $\beta(0)$ was given by:

$$\beta(0) = [1.0802 \quad 0.6469 \quad 4983.8]' \quad (3.47)$$

which were the OLS estimates of the parameters [see eq. (3.30)].

The initial covariance matrix of the states $\delta(0)$ was:

$$\Sigma(0) = \begin{bmatrix} 0.3451 & 0.0 & 0.0 \\ 0.0 & 0.2769 & 0.0 \\ 0.0 & 0.0 & 8258036.7 \end{bmatrix} \quad (3.48)$$

which were the variances of these parameter estimates.

The variance of the measurement equation, which was the square of the SER of eq. (3.30), worked out to be $R = 0.00081060$.

The coefficient matrix in the transition equation (T) was:

$$T = \begin{bmatrix} 0.8119 & 0.0 & 0.0 \\ 0.0 & 0.9243 & 0.0 \\ 0.0 & 0.0 & 0.3946 \end{bmatrix} \quad (3.49)$$

while the variance of the transition equation (Q) was given by:

$$Q = \begin{bmatrix} 0.0061 & 0.0 & 0.0 \\ 0.0 & 0.0014 & 0.0 \\ 0.0 & 0.0 & 0.0348 \end{bmatrix} \quad (3.50)$$

Based upon the above estimates, and using the Kalman filter and smoother recursions, we obtained an evolving set of time-varying parameters for eq. (3.46) which yielded the following final Kalman filter estimator for generating one-step ahead predictions of ($\pi+g$) for 1994-95:

$$(\pi+g) = 0.4584 BZDY + 1.3133 XY + 2273.7 EY \quad (3.51)$$

3.4.2 Modelling reserves using the Kalman filter

The postulated relationship for predicting $(\delta R + \delta DC)_t$ is:

$$(\delta R + \delta DC)_t = \beta_1 t BZD_t + \beta_2 X_{t-1} + \beta_3 \delta E_t \quad (3.52)$$

where, as before, the TVPs of the equation, i.e., β_1 , β_2 and β_3 , need to be estimated by the Kalman filter.

- The following estimators for the five unknown parameters were used to model the TVPs of eq. (3.52) above.

The initial state vector $\beta(0)$ was given by:

$$\beta(0) = [0.8168 \quad 0.8461 \quad 1760.8]' \quad (3.53)$$

which were the OLS estimates of the parameters [see eq. (3.35)].

The initial covariance matrix of the states $\Sigma(0)$ was:

$$\Sigma(0) = \begin{bmatrix} 0.0233 & 0.0 & 0.0 \\ 0.0 & 0.0170 & 0.0 \\ 0.0 & 0.0 & 608103.6 \end{bmatrix} \quad (3.54)$$

which were the variances of these parameter estimates.

The variance of the measurement equation, which was the square of the SER of eq. (3.35), worked out to be $R = 9664513.1$.

The coefficient matrix in the transition equation (T) was:

$$T = \begin{bmatrix} 0.9613 & 0.0 & 0.0 \\ 0.0 & 0.9603 & 0.0 \\ 0.0 & 0.0 & 0.6151 \end{bmatrix} \quad (3.55)$$

while the variance of the transition equation (Q) was given by:

$$Q = \begin{bmatrix} 0.0047 & 0.0 & 0.0 \\ 0.0 & 0.0021 & 0.0 \\ 0.0 & 0.0 & 0.0277 \end{bmatrix} \quad (3.56)$$

As before, using the above estimates to initialize and solve the filter and smoother recursions, we obtained a set of time-varying parameters for eq. (3.52) as well as the following final Kalman filter estimator for generating one-step ahead predictions of $(\delta R + \delta DC)$ for 1994-95:

$$(\delta R + \delta DC) = 0.3040 BZD + 0.9899 X(-1) + 285.44 \delta E \quad (3.57)$$

3.4.3 Predicting inflation and reserves through Kalman filters

Using these time-varying parameters, we predicted π and δR over the period 1972-94 and these predictions, along with their actual values, are graphed in Figures 3.3(a) and 3.3(b).

The estimated TVPs of both the equations display a high level of predictive accuracy. Eq. (3.46) tracks the sudden rise in the inflation rate in 1979-80 and later on its predictions are in the vicinity of the actual inflation rates with the tracking being very accurate over the period 1989-94 as the predicted rates perfectly simulate the U-turn in π during that phase.

As far as eq. (3.52) is concerned, its predictive performance is quite flawless right through the sample period. Its most impressive feature is that it tracks perfectly the upswing in reserves in 1990-91 and 1991-92, the rapid downturn in 1992-93, as well as the sudden unprecedented surge in 1993-94.

Table 3.2 below provides the comparative performances of the ECM and the KFM in tracking inflation (π) and the change in reserves (δR) over the sample period 1972-94.

Table 3.2
COMPARISON OF ACTUAL AND PREDICTED SERIES
Sample Period: 1972-73 to 1993-94

Summary statistics:	Using:			
	Error correction	Kalman filter	π	δR
Root-mean-squared error:	0.0504	2597.1	0.0610	932.96
Mean absolute error:	0.0376	2014.9	0.0429	780.73
Inequality coefficient:	0.4545	0.3883	0.5493	0.1395
Regression coefficient of actual on predicted:	0.7642	0.9158	0.5939	1.0379

Figure 3.3 (a)
PREDICTING INFLATION BY A KALMAN FILTER

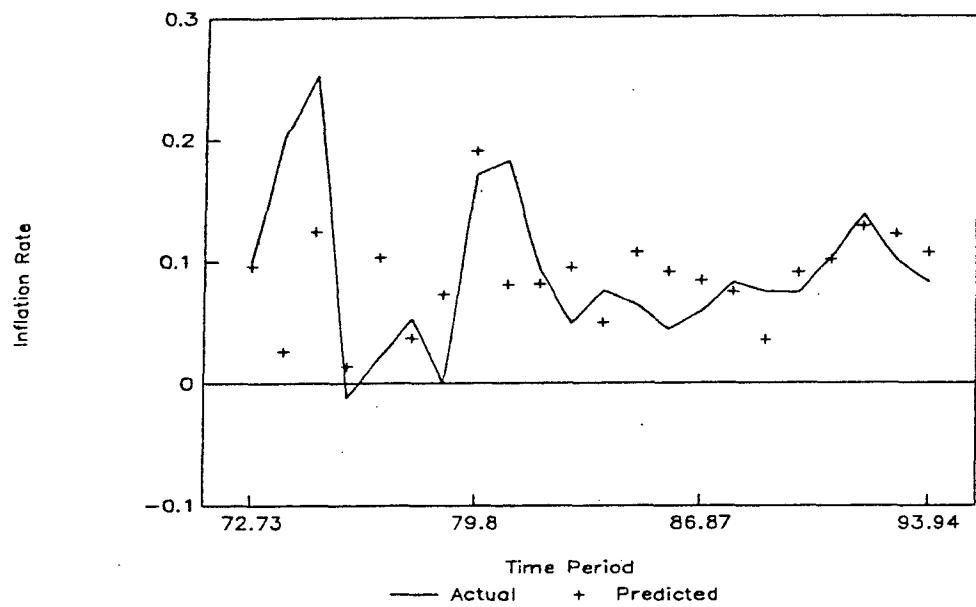
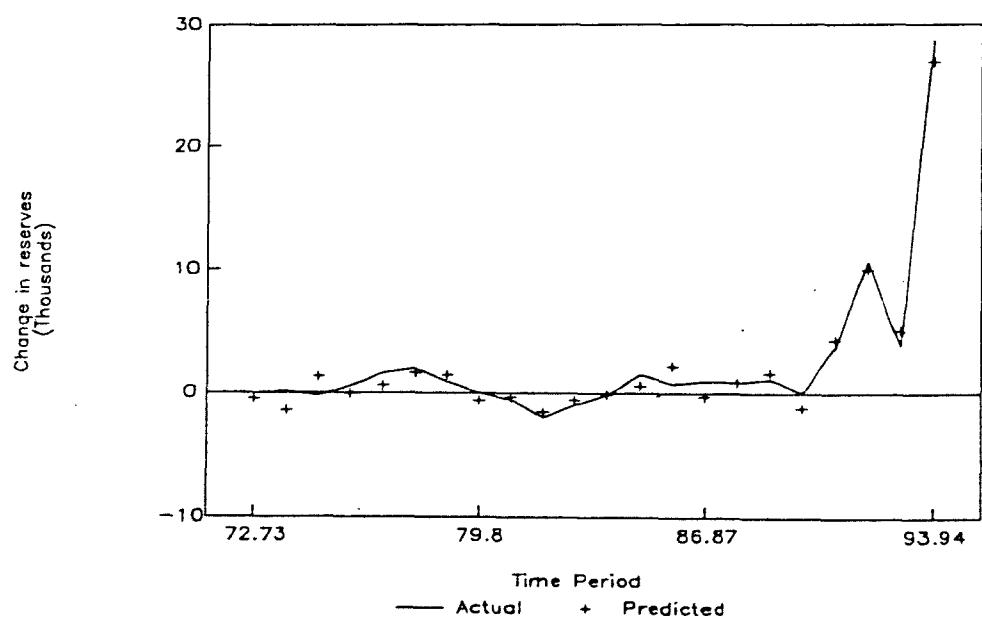


Figure 3.3 (b)
PREDICTING RESERVES BY A KALMAN FILTER



The results indicate that, although the ECM has an edge over the KFM in predicting inflation, it is completely outclassed as far as predicting reserves is concerned. This is evident from the fact that the RMSE, the MAE and Theil's Inequality coefficient are almost three times higher in the case of the ECM for this variable as against the KFM; with the regression coefficients of actual (changes in reserves) on predicted (changes in reserves) indicating that the ECM overpredicts δR by about 8.5 percent while the KFM underpredicts δR by about 3.8 percent.

Based upon the above summary statistics, we conclude that KFMs are generally preferable to ECMs for forecasting time series and, as such, the remainder of the study will use only Kalman filters whenever parameter estimation is required.

The reason as to why Kalman filtering is a natural way to model multivariate time series vis-a-vis cointegration is that the latter involves a differencing operation and, while differencing does increase the probability that the transformed series is stationary, if the relationship, when specified in level terms, is subject to both temporary and permanent disturbances, differencing results in a deterioration of the signal-to-noise ratio and less well-determined coefficients. In contrast to regression and cointegration techniques, Kalman filters are designed to work with nonstationary data because the filters produce distributions of the state variables that are conditional on the previous realization of the states. For that reason, nonstationarity in itself presents no problem and ergodicity can be satisfied implying that the distribution of the coefficients have a meaningful interpretation (see Shumway 1988).

3.4.4 Ex-ante forecasts of inflation and reserves

To forecast π and δR for 1994-95, we need values for all the predetermined variables appearing in eqs. (3.51) and (3.57) which can be re-written as follows:

$$\pi = 0.4584 BZDY + 1.3133 XY + 2273.7 EY - g \quad (3.58)$$

$$\delta R = 0.3040 BZD + 0.9899 X(-1) + 285.44 \delta E - \delta DC \quad (3.59)$$

The historical values of the lagged exogenous variables for 1993-94 (denoted by '-1') are given below:

$$Z(-1)=75241; \quad Y(-1)=619331; \quad X(-1)=74253.$$

The projected values of the current exogenous variables for 1994-95 (denoted by '0') are given below:

$$\delta NFB(0)=32600; \quad \delta DC(0)=56500; \quad \delta E(0)=0.0; \quad g(0)=0.05.$$

These projections were based on the following assumptions: (1) The projected increase in net capital inflows (δNFB) was based upon its trend over the last 3 years; (2) The projected increase in domestic credit (δDC) was based upon its trend over the first 7 months of the current financial year; (3) The change in the exchange rate (δE) was projected to be negligible given its present stability; (4) The projected increase in the growth rate (g) was based upon the RBI Annual Report (1993-94).

Contingent upon all these assumptions, we obtained:

$$BZDY=0.0224; \quad XY=0.1199; \quad EY=0.00; \quad BZD=13859.$$

Substituting the above values into eqs. (3.58) and (3.59), along with the estimates of $X(-1)$ and δE as well as g and δDC , yields the following projections for 1994-95:

$$\pi = 0.1177 \quad \delta R = 21216$$

implying an inflation rate of about 11.8 percent and a reserve build-up of slightly over Rs. 21000 crores in 1994-95.

Given that the latest inflation rate (as on December 26, 1994) was 10.25 percent and that the latest estimate of reserve accumulation (as on November 25, 1994) was Rs. 18690 crores, both these forecasts seem reasonably plausible, although seemingly on the high side as far as the inflation rate is considered.

In this context, two important points have to be considered. Firstly, in both cases, the Kalman filter has reversed the trends of inflation and reserve accumulation sharply, something which few regression models would have been capable of doing. In the former, it has forecast an increase in the inflation rate after accurately predicting a downturn in 1993-94; while in the latter, it has forecast a decrease in foreign exchange build-up after accurately predicting a large upswing in 1993-94.

Secondly, as the Kalman filter estimator is expected to predict only $(\pi+g)$ and $(\delta R + \delta DC)$, any error in projecting g and δDC would affect the predictions of π and δR . These possibilities will be considered initially in Section 3.6 where we apply stabilization theory to determine optimal settings of δDC with respect to desired levels of π and δR ; then in Section 4 where we endogenize the growth rate in order to ascertain the nature of interaction between inflation and growth; and finally in Section 5 where we construct a FPM with feedbacks between the monetary and real sectors being modelled more comprehensively. It will be seen at every stage that the predictions of inflation and reserve accumulation undergo modifications which reflect the increasing complexity of the model-building process.

In order to render the above model amenable for further analysis, we will need to introduce velocity into its framework.

3.5 Modelling The Income Velocity Of Money

Since the early 1980s, many economists have become convinced that the demand for money schedule has become too unstable to be used successfully for monetary policy purposes. One reason for this scepticism has been the rather influential paper by Cooley and LeRoy (1981) which cast serious doubts on the identification of a money demand function. Another cause was the breakdown of several money demand relations when used for ex-ante forecasting, as well as the claim that domestic financial deregulation and/or currency substitution have the capability to shift the demand for money function in an unpredictable manner.

As prescriptions about monetary policy that are formulated in terms of a trajectory for some monetary aggregates are generally based on a demand for money function, doubts about the stability of that function generate doubts about such recipes for policy. This is one of the primary reasons for the current trends in research on trying to formulate policy prescriptions based on velocity or nominal income targeting, because these policy rules can, under certain assumptions, be extracted from analytical macroeconomic models that do not require identification of a money demand schedule, or precise knowledge about the interest rate or income elasticities of the demand for money.

Even if one regards the substantial evidence on money demand instability with scepticism and relies on the fact that money, income and a relevant interest rate could be cointegrated, implying a long-term relationship between them, subsequent statements on the stability of velocity which is the relationship between money and nominal income do not follow directly.

The work by Bordo and Jonung (1987) on the long-run behaviour of velocity in many countries indicates that velocity has a stochastic trend and that neither income nor institutional variables that represent monetization or economic development can provide more than a partial explanation of velocity movements.

Under the circumstances, perhaps the best response is to give up the ambition of trying to forecast velocity via an estimated money demand function and try to forecast the income velocity of money either independently (see Bomhoff 1991) or residually, even though it may not be possible to classify the forecast formula as an inversion of the money demand schedule.

In such a case, the principal connections between the forecasting formula and economic theory would be the choice of explanatory variables which must be legitimized by their association with the demand for and supply of money, with the estimated coefficients being sensitive to measurement errors.

Given such a framework for constructing the forecast formula, it is interesting to note that within the framework of our model, it is possible to endogenize velocity.

The income velocity of money (v) in our model is technically the incremental velocity [see eq. (3.4)] defined as: $v = \delta Y / \delta M$.

From eq. (3.8), we have $\delta Y = (g + \pi)Y(-1)$; while from eq. (3.2), we have $\delta M = \delta DC + \delta R$; implying that:

$$v = [(g + \pi)Y(-1)] / [\delta DC + \delta R] \quad (3.60)$$

Thus, given eqs. (3.46) and (3.52) which predict $(g + \pi)$ and $(\delta DC + \delta R)$, respectively, using the Kalman filter (which accounts for measurement error) we can estimate the income velocity of money given the lagged value of nominal income.

From the viewpoint of internal consistency, we have defined velocity as GDP at current factor prices divided by adjusted money supply (see Section 3.2 on the definition of variables). Thus, our estimates of velocity will not correspond to those used by the RBI which defines velocity as GDP at current market prices divided by actual M3. However, the basic trends displayed by both these definitions of velocity are identical.

Figures 3.4(a) and 3.4(b) provide the predictions of velocity, along with their actual values, over the sample period. In the former case, these predictions correspond to average velocity ($v^* = Y/M$); while in the latter, they correspond to incremental velocity ($v = \delta Y/\delta M$). The predictions of v^* are extremely accurate and, except for an initial divergence, they track the steady decline in average velocity since the latter half of the 1970s perfectly. On the other hand, the initial predictions of v do diverge considerably, but taking into consideration that, despite the volatile nature of incremental velocity, its predictions over the period 1989-94 are quite accurate, we forecast v for 1994-95 using the Kalman smoother estimators provided in eqs. (3.51) and (3.57).

The forecast for $(\pi+g)$ for this year is 0.1677 while that for $\delta M (= \delta R + \delta DC)$ is Rs. 77716 crores. Given that GDP at current factor prices was Rs. 619332 crores in 1993-94, it implies that δY would be about Rs. 103862 crores in 1994-95. This yields a predicted incremental velocity of 1.336 for 1994-95.

We shall use this forecast of v in the next section when we discuss how stabilization theory can be applied within the framework of our estimated model to determine optimal policy.

Figure 3.4 (a)
PREDICTING VELOCITY BY A KALMAN FILTER

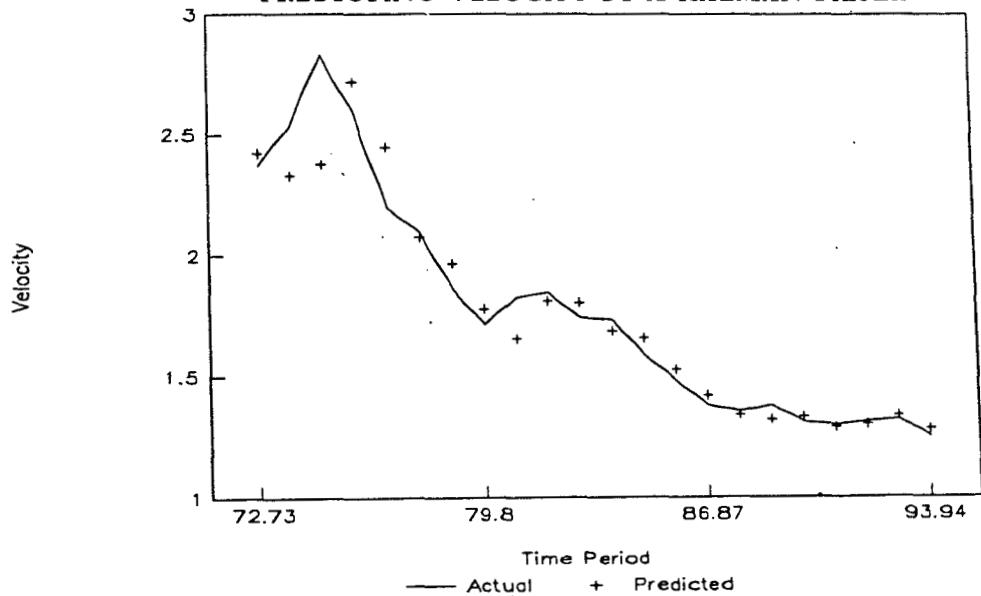
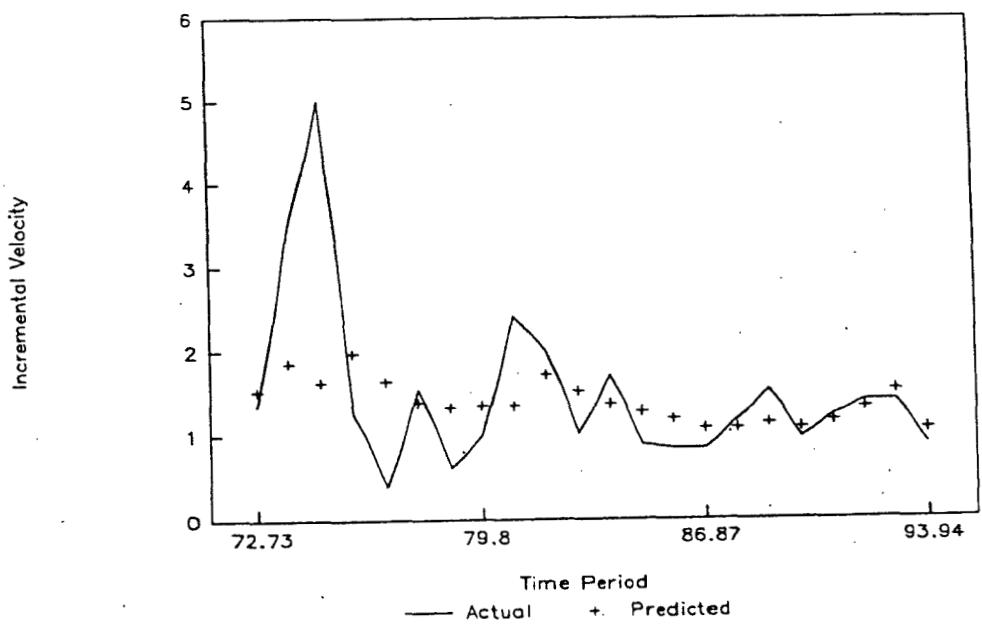


Figure 3.4 (b)
PREDICTING INCREMENTAL VELOCITY



3.6 Stabilization Theory

3.6.1 The analytical framework

The theory of macroeconomic stabilization is an extremely broad one and is discussed in several different senses in the literature (see Turnovsky 1977). In this section, we consider only that part dealing with the stabilization of static, linear, non-stochastic systems. Section 5 extends this concept to the stabilization of dynamic, nonlinear, non-stochastic systems.

In order to examine how stabilization theory can be applied within the analytical framework of our specified model, we re-write eqs. (3.10) and (3.20) in matrix notation as follows:

$$\begin{bmatrix} 1 & -(1/v)Y(-1) \\ 1 & bY(-1) \end{bmatrix} \begin{bmatrix} \delta R \\ \pi \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & (x+z) \end{bmatrix} \begin{bmatrix} \delta DC \\ \delta E \end{bmatrix} + \begin{bmatrix} (g/v)Y(-1) \\ \delta NFB + kX(-1) - Z(-1) - bgY(-1) \end{bmatrix} \dots (3.61)$$

which can be written as:

$$Ax = Bu + z \quad (3.62)$$

where: $x = [\delta R \ \pi]'$ is a (2x1) vector of targets;
 $u = [\delta DC \ \delta E]'$ is a (2x1) vector of instruments;
 $z = (2x1)$ vector of exogenous variables;
 $A = (2x2)$ matrix of time-varying coefficients; and
 $B = (2x2)$ matrix of constant coefficients.

Solving eq. (3.62) for u yields:

$$u^* = B^{-1}[Ax^* - z] \quad (3.63)$$

where x^* is the desired target vector and u^* is the corresponding instrument vector which achieves these targets. In our case, as B is non-singular, u^* will exist and will be unique.

In order to apply the above theory and determine heuristic guidelines regarding the conduct of optimal stabilization policy for the Indian economy over the year 1994-95, we need numerical estimates of the matrices listed out in eq. (3.62). This implies that we need to project the five parameters of the model, i.e., y , b , z , k and x , as the exogenous variables, i.e., $Y(-1)$, $Z(-1)$, $X(-1)$, δNFB and g , have already been projected in Section 3.4.4.

As our model is over-identified, unique estimates of these parameters cannot be directly recovered from its reduced-form. As such, we estimate eqs. (3.16) and (3.18) directly using the Kalman filter in order to obtain the final smoothed estimators which are necessary for forecasting. The final estimates were:

$$b=0.1524; \quad z=511.6; \quad k=1.1265; \quad x=551.9.$$

The above parameter values, along with the already forecast value of $v (=1.336)$ as well as the other exogenous variables, yields the following estimated version of eq. (3.61):

$$\begin{bmatrix} 1 & -464267 \\ 1 & 94386 \end{bmatrix} \begin{bmatrix} \delta R \\ \pi \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & 1064 \end{bmatrix} \begin{bmatrix} \delta DC \\ \delta E \end{bmatrix} + \begin{bmatrix} 23213 \\ 33388 \end{bmatrix} \dots (3.64)$$

which will form the basis of all our stabilization experiments. Before such an experimentation, we need to obtain base-line forecasts of the two targets (δR and π) for 1994-95 which can be obtained merely by setting the two instruments (δDC and δE) at their projected levels, i.e., $\delta DC=56500$ and $\delta E=0$.

This yields: $\delta R=22123$ and $\pi=0.1193$; which is quite close to our earlier forecasts using the reduced-form version of the model. Thus, having tested the robustness of the parameter estimates, we are in a position to provide heuristic guidepost solutions for the conduct of stabilization policy.

3.6.2 Some policy options

EXPERIMENT 1: Re-writing eq. (3.64) in the conventional form suggested by eq. (3.63) yields:

$$\begin{bmatrix} \delta DC^* \\ E^* \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & 0.000939 \end{bmatrix} \begin{bmatrix} \delta R^* - 464267 \pi^* - 23213 \\ \delta R^* + 94386 \pi^* - 33388 \end{bmatrix} \quad \dots(3.65)$$

Thus, it is seen that domestic credit is inversely related to reserves and positively related to inflation; while the exchange rate is positively related to reserves and inflation.

Such a formulation implies that target values must initially be assigned in order to obtain unique values of the instruments. However, in the current Indian context, unique values for all the targets have not been made explicit. Thus, while the RBI Annual Report (1993-94, p.6) implicitly assumes that the desired inflation rate for 1994-95 is around 7 percent, i.e. $\pi^*=0.07$, there is no mention of the target level for reserves.

As such, we initially set $\delta R^*=25000$ with $\pi^*=0.07$ and solve eq. (3.65) yielding: $\delta DC^*=30712$ and $\delta E=-1.67$; implying that domestic credit expansion should not exceed Rs. 30712 crores in 1994-95 and that this should be accompanied by a revaluation of the nominal exchange rate to Rs. 29.7 per U.S. dollar.

With domestic credit expansion already at Rs. 30579 crores (by November 25, 1994), the former constraint will not be met. As such, it would be more realistic to settle for a 10 percent inflation rate and examine the resulting implications. Setting $\pi^*=0.1$ and re-working the experiment yields: $\delta DC=44640$ and $\delta E=0.99$; which seems a more feasible "second-best" solution although it would entail devaluing the exchange rate by 0.99 rupees, i.e., to Rs. 32.36 per U.S. dollar.

EXPERIMENT 2 : To obtain greater insights into the trade-offs implicit in stabilization policy, we re-write eq. (3.65) as:

$$\delta DC = -1(\delta R - 464267 \pi - 23213) \quad (3.66)$$

$$\delta E = 0.000939(\delta R + 94386 \pi - 33388) \quad (3.67)$$

As eqs. (3.66) and (3.67) together have four unknowns, at least two of them (not necessarily the targets) must be assigned values exogenously in order to solve for the remaining two (which need not necessarily be the instruments).

Setting $\pi=0.1$ and $\delta E=0$, and substituting these into eq. (3.67) yields: $\delta R=23949$; which when substituted into eq. (3.66), along with the desired value of π , yields: $\delta DC=45691$. Thus, $\delta M (= \delta DC + \delta R)=69640$, which implies a 14.1 percent growth rate in money supply which is well within the range suggested in the RBI Annual Report (1993-94, p.7).

EXPERIMENT 3 : With the RBI targeting an overall M3 growth rate of about 14-15 percent for 1994-95, it would imply that $\delta M=74207$. As $\delta M=\delta DC+\delta R$, we have $\delta R=\delta M-\delta DC$ or $\delta R=74207-\delta DC$. Now, carrying out this substitution in eqs. (3.66) and (3.67) yields:

$$\delta DC = -1(50994 - \delta DC - 464267 \pi) \quad (3.68)$$

$$\delta E = 0.000939(40819 - \delta DC + 94386 \pi) \quad (3.69)$$

With δDC dropping out of eq. (3.68), we have: $\pi=0.1098$; and this solution, when substituted into eq. (3.69), yields:

$$\delta E = 48.06 - 0.000939 \delta DC \quad (3.70)$$

Setting $\delta DC=52171$, which is the lower bound of its growth rate, yields: $\delta E=-0.92$. This option implies a reserve build-up of about Rs. 22036 crores and an inflation rate of nearly 11 percent, although accommodating them both simultaneously would entail a revaluation of the rupee to Rs. 30.45 per U.S. dollar.

EXPERIMENT 4 : If, however, exchange rate movements are ruled out as a feasible policy option, then we have to set $\delta E=0$ in eq. (3.70) and solve the resultant in terms of δDC .

This yields: $\delta DC=51182$; implying that the targeted level of M3 growth, in conjunction with a fixed exchange rate, would yield a 11 percent inflation rate provided domestic credit is not allowed to exceed Rs. 51182 crores.

EXPERIMENT 5 : It is also possible to envisage a "worst-case" scenario, where domestic credit and prices expand along the upper bound of their growth rates in line with some of their more-recent trends before fiscal and monetary discipline was imposed. Under such a case, we would have: $\delta DC=60000$ and $\pi=0.137$.

This would yield: $\delta R=26818$ and $\delta E=5.97$; implying a 19 percent devaluation to almost Rs. 37.34 per US dollar which would lead to reserve accumulation of the order of about Rs. 26818 crores. This build-up of foreign exchange, in conjunction with the increase in domestic credit, would imply a monetary expansion of about 17.5 percent.

These heuristic experiments, by and large, seem to suggest that the best stabilization policy option in this simple set-up is to ensure that M3 growth does not exceed 14 percent with the ceiling for domestic credit expansion being about Rs. 46000 crores. This would yield an inflation rate of about 10 percent and there would be no need to intervene in the foreign exchange market to ward off any untoward pressures on the rupee. Under this scenario, the projected reserve build-up would be about Rs. 24000 crores. By enlarging the scope of the model, we will refine these projections in the subsequent chapters.

3.7 Conclusions

In this section, we specified a macro-analytical framework on the lines of the Polak-Fund model in order to explain variations in the inflation rate and foreign exchange reserves.

The reduced-form parameters of the model were then estimated using, both, error-correction mechanisms and Kalman filters. The tracking performance of these alternative specifications clearly indicated the superiority of the filtering approach in as far as the modelling and forecasting of time series are concerned.

The superior tracking capability of the Kalman smoother estimators was partly because we used the standard errors of the regression coefficients, rather than the conventional SERs of the concerned equation, in the diagonal elements of the Q matrix. This method was a generalization of the adaptive-regression model of Cooley and Prescott (1973) who suggested using a diagonal matrix for Q whose elements represented the relative variability of the different regression coefficients.

The endogenizing of velocity residually enabled us to obtain numerical estimates of the state space form of the model which, in turn, allowed us to determine some possible stabilization policy options for the Indian economy over the period 1994-95. Needless to say, these experiments are of a heuristic nature as the model does not include all the vital feedbacks which are de rigueur in the design of any macroeconomic policy.

In the next section, we shall expand the basic framework in order to endogenize growth as well as the interest rate. By doing so, we shall be able to assess more comprehensively the extent of feedback that exists between inflation, reserves and growth.

4. THE EXTENDED MODEL: ENDOGENIZING GROWTH AND INTEREST RATES

Beginning with the building blocks of national income accounting in Section 2, an attempt was made in Section 3 to construct a model, in terms of simple macroeconomic relationships and identities, capable of predicting inflation and reserves. Its analytical framework focused on the short-run and used a flow-of-funds methodology to determine a sustainable BOP position while ensuring reasonable price stability.

Taking into cognizance the mainstream critique that the Polak-Fund model does not endogenize the real growth rate (Dornbusch 1982, 1990), the purpose of this section is to extend our efforts and formulate a growth-oriented financial programming framework on lines considerably simpler than the ones suggested by the merged Bank-Fund model (see Khan, Montiel and Haque 1990).

The merged Bank-Fund model is an outcome of the increased collaboration witnessed in the 1980s and 1990s between the World Bank and the IMF. With increased conditional lending to LDCs by these institutions, there has arisen a perception that for stabilization and adjustment purposes, the demand and supply sides need to be integrated into a consistent framework linking government policies and availability of foreign resources to targets such as growth, inflation and the BOP. This is known as "growth-oriented adjustment programmes" and involves merging the Fund's monetary model of the balance of payments with the Bank's two-gap approach. This section will outline a novel approach to growth-oriented financial programming, leaving to Section 5 the actual specification and construction of a financial programming model for the Indian economy.

4.1 Extension of the Basic Framework

4.1.1 An overview

In the extended framework, inflation and foreign exchange reserves continue to be defined by eqs. (3.23) and (3.24), i.e.,

$$\pi = \alpha(1) BZDY + \alpha(2) XY + \alpha(3) EY - g \quad (4.1)$$

$$\delta R = \beta(1) BZD + \beta(2) X(-1) + \beta(3) \delta E - \delta DC \quad (4.2)$$

which is a model with two targets (π and δR), two instruments (δE and δDC) and two exogenous variables (δNFB and g).

The investment constraint, derived from the external sector's financial constraint, now forms the link between reserves and growth. The external sector's financial constraint is given by eq. (2.6) which states that:

$$Z - X = \delta NFB - \delta R \quad (4.3)$$

The investment constraint, given by eq. (2.11), states that:

$$I = S + (Z - X) \quad (4.4)$$

In both these equations, the current account deficit ($Z-X$) appears explicitly and, consequently, investment can be linked to reserves and integrated into a Harrod-Domar type growth equation to identify the impacts of a temporary BOP disequilibria on investment and the proximate sources of growth and inflation.

In this expanded framework comprising the budget constraints of the external sector and the monetary system, along with the savings-investment balance and the growth equation, there are four targets (π , δR , I and g), two instruments (δE and δDC) and one exogenous variable (δNFB). The additional variable in the system, i.e., savings, is endogenized by linking it up to changes in nominal income (Y) which, as before, makes it dependent on growth and inflation, which are themselves endogenous.

4.1.2 The two-gap accounting framework

The purpose of two-gap models is to estimate the levels of investment, imports and external finance needed to achieve a targeted real GDP growth rate. Thus, its framework is essentially a planning model reflecting the needs, or requirements, approach. However, the operational relevance of two-gap models can be extended and used to arrive at the actual real GDP growth rate that is possible given the committed amount of foreign capital. This is called the constraints, or availabilities, approach.

The structure of the model is a two-gap accounting framework which ensures consistency between the BOP and the national accounts through the resource gap. Currently, the Revised Minimum Standard Model (RMSM), which is a disaggregated version of the two-gap model, is used by the World Bank to determine the resource needs of each country (see Addison 1989).

The essence of our approach which merges the Polak-Fund model with the two-gap model constitutes in substituting the external sector's financial constraint, given by eq. (4.3), into the investment constraint, given by eq. (4.4), to yield:

$$I = S + \delta NFB - \delta R \quad (4.5)$$

where, as before, δNFB is assumed to be exogenous. The above equation provides the crucial link between foreign exchange reserves which is endogenized in Section 3 and investment which is needed to endogenize real growth.

Savings (S) can be written as:

$$S = S(-1) + \delta S \quad (4.6)$$

where $S(-1)$ is savings in the previous period (also assumed to be exogenous) and δS is the change in savings.

Substituting eq.(4.6) into eq. (4.5) yields:

$$I = \delta NFB + S(-1) + \delta S - \delta R \quad (4.7)$$

The next building block is the specification of a savings function. While we could have postulated one with differential impacts of growth and inflation, at the outset, we assume that the change in savings (δS) is a linear function of the change in nominal income (δY), i.e.,

$$\delta S = s \delta Y \quad (4.8)$$

where s is the marginal (as well as average) propensity to save. Substituting eq. (4.8) into eq. (4.7) yields:

$$I = \delta NFB + S(-1) + s \delta Y - \delta R \quad (4.9)$$

Substituting eq. (3.8) into eq. (4.9) yields:

$$I = \delta NFB + S(-1) + s(g+\pi)Y(-1) - \delta R \quad (4.10)$$

which establishes the link between investment and reserves.

4.1.3 Investment and growth

The Harrod-Domar growth equation provides the link between real GDP (y), the ICOR (k) and real capital stock (K) given by:

$$\delta y = y - y(-1) = (1/k) \delta K \quad (4.11)$$

where as before ' δ ' is the backward difference operator.

In order to eliminate capital stock from the above analysis, we define a capital-stock generating forward recursion equation:

$$K = (1-d) K(-1) + (I/P) \quad (4.12)$$

where (I/P) is gross real investment, i.e., gross nominal investment (I) divided by the price level (P), and d is the fraction of capital stock depreciated each period.

Eq. (4.12) can be written as follows where c denotes the average capital-output ratio:

$$\delta K = (I/P) - c dy(-1) \quad (4.13)$$

Substituting eq. (4.13) into eq. (4.11) above yields:

$$y = [1-(cd/k)] y(-1) + (1/k) (I/P) \quad (4.14)$$

As eq. (4.10) provides the link between reserves and nominal investment and eq. (4.14) provides the link between real GDP (and, consequently, real growth) and real investment, model closure can only take place by postulating the link between nominal and real investment without using the price level as a deflator as that variable is not explained by the model. This final step will be taken up in the next section.

The structure of the expanded model, comprising eqs. (4.1), (4.2), (4.10) and (4.14), is set out in Table 4.1 below.

Table 4.1
STRUCTURE OF THE EXPANDED MODEL

Targets:	δR	: change in foreign exchange reserves
	π	: rate of inflation
	I	: investment
	g	: real growth rate
Endogenous:	δM	: change in money supply
	S	: savings
	Z	: imports
	X	: exports
Exogenous:	δNFB	: change in net foreign borrowings
	$Y(-1)$: nominal income in the previous period
	$S(-1)$: savings in the previous period
	$Z(-1)$: imports in the previous period
	$X(-1)$: exports in the previous period
Instruments:	δDC	: change in domestic credit
	δE	: change in the nominal exchange rate
Parameters:	v	: income velocity of money
	k	: incremental capital-output ratio
	c	: average capital-output ratio
	d	: depreciation factor
	s	: marginal propensity to save
	b	: marginal propensity to import
	z	: coefficient of exchange rate impact on imports
	k	: coefficient of lagged exports
	x	: coefficient of exchange rate impact on exports

4.1.4 Solution of the model

To solve for the growth rate, we write eq. (4.14) as:

$$\delta y = (1/k) (I/P) - (cd/k) y(-1) \quad (4.15)$$

Dividing throughout by $y(-1)$ yields:

$$g = (1/k) [(I/P)/y(-1)] - (cd/k) \quad (4.16)$$

where g is the growth rate of real GDP, i.e., $g = \delta y/y(-1)$.

By replacing $y(-1)$ by $Y(-1)/P(-1)$ which is its definitional equivalent, eq. (4.16) can be re-written as:

$$g = \frac{1}{k} \cdot \frac{I}{P} \cdot \frac{P(-1)}{Y(-1)} - \frac{cd}{k} \quad (4.17)$$

From the definition: $\pi = [P-P(-1)]/P(-1)$, we have:

$$P(-1)/P = 1/(1+\pi) \quad (4.18)$$

Substituting eq. (4.18) into eq. (4.17) yields:

$$g = \frac{1}{k} \cdot \frac{1}{1+\pi} \cdot \frac{I}{Y(-1)} - \frac{cd}{k} \quad (4.19)$$

Substituting eq. (4.10) into eq. (4.19) above yields:

$$g = \frac{1}{k} \cdot \frac{1}{1+\pi} \left[\frac{\delta NFB + S(-1) - \delta R}{Y(-1)} + s(g+\pi) \right] - \frac{cd}{k} \quad (4.20)$$

Solving eq. (4.20) for g yields after simplification:

$$g = \frac{1}{[k(1+\pi)-s]} \cdot \left[\frac{\delta NFB + S(-1) - \delta R}{Y(-1)} - (cd-s)\pi - cd \right] \quad (4.21)$$

Eq. (4.21) is a nonlinear function of the inflation rate (with g and π being observed to be negatively related) and only the parameters k , s , c and d are needed to predict growth rates.

Thus, the final form of the "growth-oriented" financial programming model is given by:

$$\pi = \alpha(1) BZDY + \alpha(2) XY + \alpha(3) EY - g \quad (4.1)$$

$$\delta R = \beta(1) BZD + \beta(2) X(-1) + \beta(3) \delta E - \delta DC \quad (4.2)$$

$$g = \frac{1}{[k(1+\pi)-s]} \left[\frac{\delta NFB + S(-1) - \delta R}{Y(-1)} - (cd-s)\pi - cd \right] \quad (4.21)$$

Given the structure of the above model, it is seen that investment per se drops out of the ensuing analysis as it is directly absorbed in the growth equation with the final version of the model being given just by eqs. (4.1), (4.2) and (4.21).

An analytical solution of this model provides the results in Table 4.2 which indicates the signs of the effects of changes in policies (δDC and δE), as well as the parameter (s) and exogenous variable (δNFB), on the endogenous variables (π , δR and g).

Some of these effects are already familiar from the earlier section. In summary, from eqs. (4.1) and (4.2), an increase in domestic credit will result in a increase in inflation as well as a deterioration in the reserve position. Thus, the impact of domestic credit on the growth rate is ambiguous since high inflation reduces the growth rate while lower reserves would increase investment and, thereby, growth.

Eqs. (4.1) and (4.2) postulate a positive relationship between changes in the exchange rate and inflation, as well as changes in reserves. This, in turn, through eq. (4.21), implies that an increase in the exchange rate will unambiguously result in decreasing growth, both, directly, via inflation, as well as indirectly, via the impact of reserves on investment.

From eqs. (4.1) and (4.2), an increase in capital inflows will increase both inflation as well as reserves. There will be a marginal impact on investment because, from eq. (3.57), it is seen that increasing capital inflows are partially offset by rising reserves. Therefore, although the growth, rather than the inflation, effect will dominate, this domination will not be to the extent envisaged by Mills and Nallari (1992) which serves to illustrate the usefulness of analytical solutions.

From eq. (4.21), an increase in the savings rate (s) will have a positive effect on investment and, therefore, real output which, in turn, will result in lower inflation from eq. (4.1). The impact on the BOP is difficult to determine.

Table 4.2
EFFECTS OF CHANGES IN INSTRUMENTS ON TARGETS

Effects of increases in:	Changes in:		
	Inflation π	Reserves δR	Growth g
Domestic credit (δDC)	> 0	< 0	?
Exchange rate (δE)	> 0	> 0	< 0
Capital inflows (δNFB)	> 0	> 0	> 0
Savings rate (s)	< 0	?	> 0

Such a merged framework can, in theory, be expanded to endogenize, both, the domestic interest rate as well as capital flows (see Balassa 1989). Endogenizing the former presents no problems and will be carried out in Section 4.5. However, no attempt will be made to endogenize the latter since in practice the empirical modelling of capital flows has in most cases proved to be exceedingly difficult.

4.2 Modelling ICORs And Growth

In order to obtain an understanding of the inflation-growth nexus in the Indian economy, we initially attempt to predict the real growth rate using eq. (4.19) which merely states that, for a given ICOR, inflation and growth are inversely related. To do so, we estimated the parameters of eq. (4.14) using the Kalman filtering and smoothing algorithm with the resulting time-varying estimates of k yielding the necessary information on the dynamic nature of ICORs in the Indian economy. These estimated ICORs are graphed in Figure 4.1(a).

The ensuing pattern indicates that these ICORs have exhibited rather random behaviour making it difficult to predict using standard techniques. More importantly, its volatility implies that any assumption regarding its constancy, say, over a particular planning period, is likely to be seriously vitiated. It is therefore fortuitous that the ICOR has decreased gradually from 1991-92 onwards reaching its present level of about 4.33.

Based upon these exogenously determined estimates of the ICORs, we predicted growth using eq. (4.19) with the results being provided in Figure 4.1(b). Considering the simplicity of the formulation, the equation predicts fairly well (with an RMSE of 0.0243) and captures nearly all turning points (with a U-statistic of 0.44). The maximum prediction error occurs in 1979-80 when the predicted growth rate, although simulating the downturn, was unable to track the magnitude of the recession. Its performance over the later period is excellent as it captures the upswing in 1988-89 and the downturn in 1991-92 very well. Its final prediction for 1993-94 is almost perfectly on line.

Figure 4.1 (a)
PREDICTING ICORs BY A KALMAN FILTER

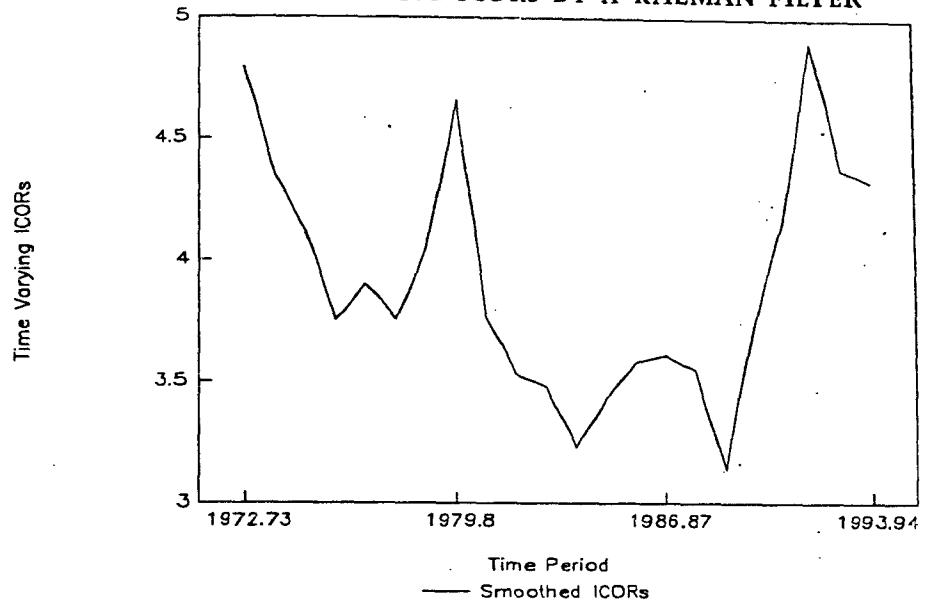
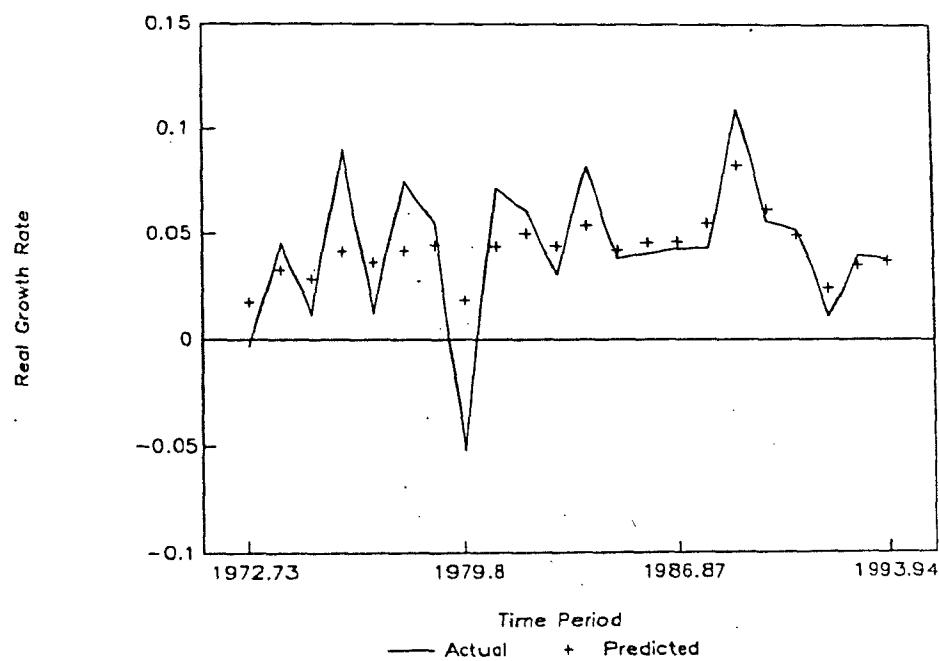


Figure 4.1 (b)
PREDICTING GROWTH BY A KALMAN FILTER



4.3 Modelling Inflation, Reserves, Investment And Growth

The 4-equation model linking inflation, reserves, investment and growth is given by eqs. (4.1), (4.2), (4.10) and (4.19).

The block structure of the model is given below:

Block	Eq#	Equation	Dep.Var.	1	2	3	4
1R	1	Reserves	δR	1	0	0	0
1S	2	Inflation	π	0	1	0	1
1S	3	Investment	I	1	1	1	1
1S	4	Growth	g	0	1	1	1

The column denoted "Block" shows the number of each block of equations and the type (R for recursive and S for simultaneous). The '1' and '0' indicate the presence or absence of the variable in the equation. The nature of the ordering is such that reserves is determined recursively, while the remaining three variables are determined simultaneously with almost complete closed-loop feedback between inflation, investment and growth (which is indicated by the fact that 5 out of 6 off-diagonal elements in the 3×3 partitioned matrix linking π , I and g are non-zero).

The summary statistics pertaining to a dynamic full-model simulation are provided in Table 4.3 below:

Table 4.3
COMPARISON OF ACTUAL AND PREDICTED SERIES
 Sample Period: 1972-73 to 1993-94

Summary statistics:	π	δR	I	g
Root-mean-squared error:	0.0615	932.96	5065.8	0.0268
Mean absolute error:	0.0437	780.73	3407.2	0.0191
Inequality coefficient:	0.5542	0.1395	0.0595	0.4892
Regression coefficient of actual on predicted:	0.7823	1.0379	1.0118	2.0655

As δR is determined recursively, there is no change in its summary statistics vis-a-vis those provided in Table 3.2. Despite the feedback, the model tracks investment levels very closely with minor variations only in the last two years of the sample. It is seen that, both, π and g have fairly low and nearly identical inequality coefficients indicating their ability to interact well. The rather high regression coefficient of actual on predicted for g (=2.0655) is entirely because of the inability of the growth equation to pick out output peaks earlier on in the sample period, although its performance after 1984-85, except for an underprediction in 1988-89 when it was unable to track the growth surge, is almost perfect. This is especially so over the period 1989-94 as it captures the recession of 1991-92 and the recovery of 1992-93 effortlessly.

4.4 Stabilization With Growth

In order to derive forecasts of growth and inflation in 1994-95, as well as to obtain stabilization policy options, we use eq. (3.61) which is reproduced below:

$$\begin{bmatrix} 1 & -(1/v)Y(-1) \\ 1 & bY(-1) \end{bmatrix} \begin{bmatrix} \delta R \\ \pi \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & (x+z) \end{bmatrix} \begin{bmatrix} \delta DC \\ \delta E \end{bmatrix} + \begin{bmatrix} (g/v)Y(-1) \\ \delta NFB + kX(-1) - Z(-1) - bgY(-1) \end{bmatrix} \dots (3.61)$$

along with eqs. (4.10) and (4.19) which are reproduced below:

$$I = \delta NFB + S(-1) + s(g+\pi)Y(-1) - \delta R \quad (4.10)$$

$$g = \frac{1}{k} \cdot \frac{1}{1+\pi} \cdot \frac{I}{Y(-1)} - \frac{cd}{k} \quad (4.19)$$

and these 4 equations will form the basis of all our experiments.

From the earlier section, we know that $v=1.336$, $b=0.1524$, $(x+z)=1064$, $k=1.1265$ and $Y(-1)=619332$. The smoothed estimates of s , k and (cd/k) for 1993-94 using the Kalman filter were:

$$s=0.3230 \quad k=4.3275 \quad (cd/k)=0.0382$$

while $S(-1)=194479$. The reason for this high value of s is because the savings rate is defined as a percentage of GDP at current factor prices (and not as a percentage of GDP at current market prices as is the usual convention).

Using these estimates yields the following reduced form:

$$\pi = 0.00000179 \delta DC + 0.00190458 \delta E + 0.00000179 \delta NFB - g + 0.0150 \quad \dots(4.22a)$$

$$\delta R = -0.1690 \delta DC + 884.2 \delta E + 0.831 \delta NFB + 6986 \quad (4.22b)$$

$$I = 200043.9 (g + \pi) - \delta R + \delta NFB + 194479 \quad (4.22c)$$

$$g = 0.000000374 [1/(1+\pi)] I - 0.0382 \quad (4.22d)$$

4.4.1 Differential impacts of alternative policy options

A baseline forecast of the four targets (π , δR , I and g) for the year 1994-95 can be obtained merely by setting the two instruments (δDC and δE) at their projected levels, i.e., $\delta DC=56500$ and $\delta E=0$; along with the projected value of the exogenous variable, i.e., $\delta NFB=32600$.

This yields: $\delta R=22123$; $\pi=0.1210$; $I=239322$ and $g=0.0484$. As reserves are determined recursively, there is no change in its projected level vis-a-vis the baseline forecast of Section 3.6.1. However, there is a marginal increase in the inflation rate from its earlier projection of 11.9 percent to its present level of 12.1 percent which can be explained by the slippage in the growth rate from its earlier exogenously projected level of 5 percent to its currently endogenized prediction of about 4.85 percent.

The analytical solution of the model provided in Table 4.2 provided only the signs of the effects of changes in domestic credit (δDC), exchange rate (δE), net capital inflows (δNFB) and the savings rate (s) on the three target variables (π , δR and g).

We now carry out four experiments, in each of which we increase one of the four exogenous variables listed above by 10 percent, in order to quantitatively assess the differential impacts of alternative policy options on the target variables and thereby provide a numerical interpretation to Table 4.2.

The overall results are provided in Table 4.4 below.

Table 4.4
DIFFERENTIAL IMPACTS OF ALTERNATIVE POLICY OPTIONS

Effects of a 10 percent increase in:	Percentage change in:		
	Inflation π	Reserves δR	Growth g
Domestic credit (δDC)	7.9	-4.0	0.7
Exchange rate (δE)	12.3	6.0	-2.4
Capital inflows (δNFB)	4.4	10.9	0.4
Savings rate (s)	-1.1	0.0	2.8

The results, apart from validating our earlier analytical reasoning, indicate that domestic credit has a marginally positive impact on growth and the savings rate has no impact on reserves. It is also seen that increased capital inflows raise the inflation rate with a barely imperceptible impact on growth. By way of illustration, it is seen that a 10 percent increase in δDC and δNFB coupled to a 10 percent decrease in the exchange rate (revaluation) would leave the inflation rate and reserve level unchanged, while increasing the growth rate by 3.5 percent.

4.5 Interest Rate Determination

The merged model is now extended to endogenize the domestic interest rate on the lines suggested by Edwards and Khan (1985). Ignoring the effects of taxation on the relation between expected inflation and the nominal interest rate (see Darby 1975, Tanzi 1976) and following the standard Fisher approach, we have:

$$r = i + \pi^e \quad (4.23)$$

where r is the nominal rate of interest, i is the real (ex-ante) rate of interest and π^e is the expected rate of inflation.

The real interest rate can be specified as:

$$i = i^* - \Gamma ESM + \epsilon \quad (4.24)$$

where i^* is the long-run equilibrium real interest rate. The variable ESM represents the excess supply of money, $\Gamma > 0$ is a parameter and ϵ is a random error term (see Mundell 1963).

Substituting eq. (4.24) into eq. (4.23) yields the following solution for the nominal interest rate in a closed economy:

$$r = i^* - \Gamma ESM + \pi^e + \epsilon \quad (4.25)$$

The excess supply of money is defined as:

$$ESM = \ln m - \ln md \quad (4.26)$$

where m ($=M/P$) is the actual real stock of money and md ($=MD/P$) is the desired equilibrium stock of real money balances.

The equilibrium demand for money is given by:

$$\ln md = \alpha(0) + \alpha(1) \ln y - \alpha(2) [i^* + \pi^e] - \alpha(3) \pi^e \quad (4.27)$$

It should be noted that the long-run equilibrium demand for money is assumed to be a function of the equilibrium nominal interest rate, defined as the sum of the equilibrium real interest rate (i^*) and the expected rate of inflation (π^e), rather than of the current nominal interest rate.

The model is then closed by assuming that the stock of real money balances adjusts according to:

$$\delta \ln m = \beta [\ln m_d - \ln m(-1)] \quad (4.28)$$

where β is the coefficient of adjustment, $0 \leq \beta \leq 1$.

Eq. (4.28) can be written as:

$$\ln m = \beta \ln m_d + (1 - \beta) \ln m(-1) \quad (4.29)$$

Combining eqs. (4.26) and (4.29) yields:

$$ESM = (1 - \beta) [\ln m(-1) - \ln m_d] \quad (4.30)$$

If an economy is completely open with no impediments to capital flows, domestic and foreign interest rates will be closely linked. In particular, under certain assumptions, the following uncovered interest arbitrage relation must hold:

$$r = r_f + \dot{e} \quad (4.31)$$

where r_f is the world interest rate and \dot{e} is the expected rate of change in the nominal exchange rate.

Assuming a lagged response of r to changes in r_f and \dot{e} (due to friction arising from transactions costs, information lags, and the like) leads to a partial-adjustment mechanism given by:

$$r = \Theta (r_f + \dot{e}) + (1-\Theta) r(-1) \quad (4.32)$$

If, however, the economy under consideration has some restrictions on capital movements, as most developing countries (including India) do, then we can combine the closed- and open-economy extremes by assuming that the nominal interest rate is a weighted average of eq. (4.25) and eq. (4.32), i.e.,

$$\begin{aligned} r &= (1 - \Omega) (i^* - \Gamma ESM + \pi^e + \varepsilon) \\ &\quad + \Omega [\Theta (r_f + \dot{e}) + (1-\Theta) r(-1)] \end{aligned} \quad (4.33)$$

where Ω can be interpreted as an index measuring the degree of financial openness of the economy.

Substituting eq. (4.27) into (4.30) and the resultant into eq. (4.33) above yields the following reduced-form equation for the nominal interest rate in a semi-open economy:

$$r = \emptyset(0) + \emptyset(1) [r_f + \dot{e}] + \emptyset(2) \ln y + \emptyset(3) \ln m(-1) + \emptyset(4) \pi^e + \emptyset(5) r(-1) + \varepsilon \quad (4.34)$$

where the composite reduced-form parameters are:

$$\emptyset(0) = (1 - \Omega)[i^* + \Gamma(1 - \beta) \{\alpha(0) - \alpha(2)\}] \quad (4.35a)$$

$$\emptyset(1) = \Omega\Theta \quad (4.35b)$$

$$\emptyset(2) = (1 - \Omega)\Gamma(1 - \beta)\alpha(1) \quad (4.35c)$$

$$\emptyset(3) = -(1 - \Omega)\Gamma(1 - \beta) \quad (4.35d)$$

$$\emptyset(4) = (1 - \Omega)[1 - \Gamma(1 - \beta)\{\alpha(2) + \alpha(3)\}] \quad (4.35e)$$

$$\emptyset(5) = \Omega(1 - \Theta) \quad (4.35f)$$

and ε is the random error term.

4.5.1 Equilibrium interest rates

To apply the above methodology and obtain approximations of the equilibrium interest rate for the Indian economy, we initially need estimates of r_f , \dot{e} and π^e .

The foreign rate of interest (r_f) was proxied by the 1-year LIBOR although, strictly speaking, we should have chosen a financial asset of the same characteristics (maturity and so on) as the 3-year term deposit rate. The expected rate of devaluation between periods t and $t+1$, i.e., \dot{e} , was replaced by the actual rate of devaluation in period t . This assumption technically implies that, during the period under consideration, the rate of devaluation could have been represented approximately as a random walk with zero drift (see Edwards 1985). The expected rate of inflation (π^e) was proxied by the actual rate of inflation (i.e., the perfect foresight model).

The final Kalman smoothed estimators for eq. (4.34) were:

$$\begin{aligned} r = & -38.1489 + 0.0540 [r_f + \dot{e}] + 5.4894 \ln y \\ & -2.0874 \ln m(-1) + 6.8609 \pi^e + 0.4594 r(-1) \end{aligned} \quad \dots(4.36)$$

Based upon the composite reduced-form parameters, we can deduce the following: (i) The adjustment coefficient (Θ) is about 0.1052 implying slow adjustment of the domestic interest rate, and (ii) The current index of financial openness is about 0.5134 on a scale ranging from 0 (completely closed economy) to 1 (completely open economy). This estimated index of openness thus provides some information on the actual degree of integration of the Indian capital market with the world financial market.

We now attempt to estimate the equilibrium rate of interest using the Kalman filter algorithm. As the actual interest rate is an administered rather than a market-determined one, we cannot use predicted estimates of the interest rate using the Kalman smoothed estimators (which are based upon the backward recursion principle) as proxies for the equilibrium rate of interest. As such, we use the one-step ahead forecasts of the interest rates using the Kalman filter estimator (which are based upon the forward recursion principle, i.e., predictions using data available only until that point) as proxies for these equilibrium interest rates. These would be reasonable approximations as all these forecasts are strict updates of the previously estimated values with no allowances being made for prediction errors.

Using such a methodology allowed us to generate values of the equilibrium rate of interest for the Indian economy over the 15-year period 1978-79 to 1993-94 and these are provided in Figure 4.2 along with the actual interest rate.

Figure 4.2
EQUILIBRIUM INTEREST RATES

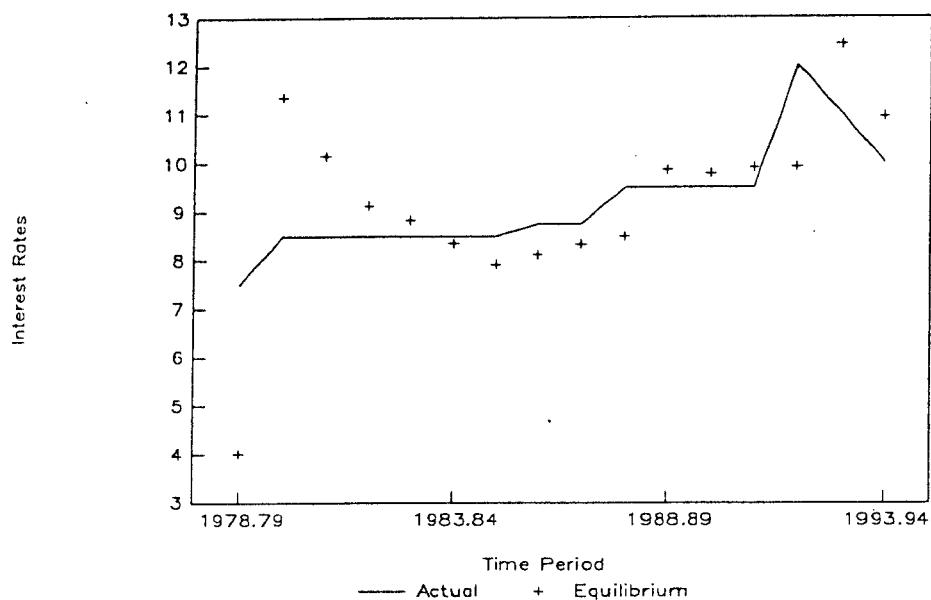
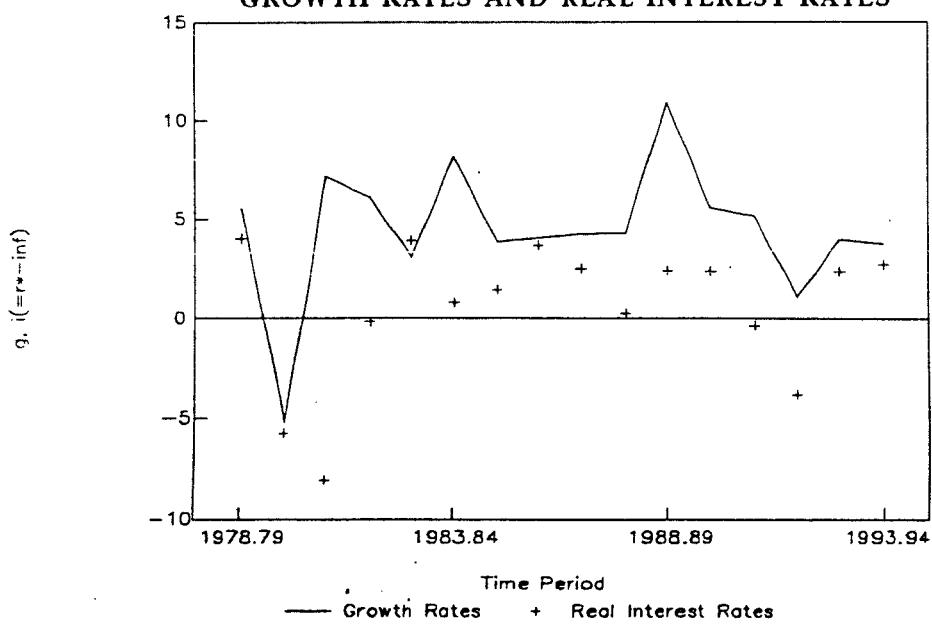


Figure 4.3
GROWTH RATES AND REAL INTEREST RATES



When one examines the comparative interest rates over the post-liberalization phase, the results indicate that the sudden increase in the rate of interest in 1991-92 and its gradual decrease thereafter was exactly one-period too early. The rate of interest should have been raised, not in 1991-92, but rather a year later in 1992-93, and the reversal should have come, not in 1992-93, but rather in 1993-94. As matters stand, the model indicates that the interest rate in 1993-94 was approximately one percentage point below its equilibrium level.

In Figure 4.3, we have provided the relationship between the real (ex-post) rate of interest and the real growth rate over this period. Given that theory predicates a long-run relationship between these two variables with eventual congruence indicated, the results are interesting as such a pattern seems to be emerging over the last 5 years with both these variables moving closer together almost in lock-step sequence. Whether or not this is a purely statistical phenomenon needs to be researched.

In order to predict the equilibrium rate of interest for 1994-95, we initially have to project the exogenous variables in eq. (4.36). To do so, we assume: (i) That $g=0.0484$ and $\pi=0.1210$ as per their baseline forecasts obtained in Section 4.4.1, (ii) That $r_f=0.0377$ implying no change in the LIBOR from its earlier level, (iii) $\epsilon=0.0$ implying no expected depreciation of the rupee. Substituting these projections, along with the lagged values of the interest rate and money stock, i.e., $r(-1)=0.10$ and $\ln m(-1)=158355$, into eq. (4.36) yields: $r = 10.48$, implying that the 3-year term deposit rate, which is currently 10 percent, is about half a percentage point below its equilibrium level.

4.6 Conclusions

In this section, we provided an analytical framework capable of endogenizing both inflation and growth, along with reserves and investment, along lines much simpler than those suggested by the merged Bank-Fund model.

It was shown, using Kalman filters, that the predictions provided by such an integrated model are quite robust with the tracking ability of inflation and growth, both extremely volatile variables, improving substantially over the sample period. The forecasts generated by the model broadly indicate that, over the period 1994-95, the inflation rate would be about 12.1 percent and the growth rate would be about 4.85 percent. The results also suggest that capital inflows are not exactly the boon that they are usually made out to be in the sense that their potential for inflation outweighs their potential for growth.

The endogenizing of the interest rate, apart from providing an index of financial openness for the Indian economy in 1993-94, allowed us to predict equilibrium interest rates over the sample period. By and large, these predictions indicated that the current interest rate is slightly lower than its equilibrium level predicated upon future inflation and growth prospects.

In the next section, we shall expand the framework to accommodate a full-fledged FPM specified broadly the lines suggested by the study so far. By doing so, we shall be able to fine-tune our forecasts still further, besides providing guidelines for the conduct of optimal stabilization policy which would generally indicate the nature of potential trade-offs that are likely to exist in the current macroeconomic set-up.

5. FINANCIAL PROGRAMMING

5.1 Introduction

A financial programme comprises a set of coordinated policy measures intended to achieve certain short-term macroeconomic targets and such financial programmes have come to be closely associated with stand-by or extended arrangements of member countries with the IMF. The activity that is required to formulate these targets and to establish the coordination between policy instruments is referred to as financial programming.

While financial programming has been the common practice for the financial authorities of many countries, it has yet to receive general recognition from the economic profession in India. The purpose of this section is to build upon the framework developed in the earlier sections so as to strengthen the logical rigour of financial programming thereby making it more oriented towards policy prescription.

For such a purpose, we initially specify a financial programming model (FPM) based on the flow-of-funds approach which incorporates all the sectoral budget constraints presented in Section 2 and developed in Section 3. The model also integrates the foundations of "growth-oriented" financial programming on lines broadly similar to the one adopted in Section 4.

The Kalman filter is used to estimate time-varying parameters for the FPM and optimal control theory is then invoked to discuss the relative effectiveness of alternative stabilization options from a financial programming viewpoint where, both, coordination as well as specialization of policies amongst the financial authorities are equally important.

5.2 A Financial Programming Model For The Indian Economy

5.2.1 The model: Framework

Financial programming requires a model so that the macroeconomic outcomes, defined in terms of the elements of a flow-of-funds matrix, expected to occur in the absence-of deliberate policy manipulation and the required changes in the magnitude of policy instruments in order to attain pre-specified targets can be estimated precisely on an empirical basis.

In the model outlined below, the economy is classified into a private, government, foreign and banking sector. The first three sectors involve income as well as financial transactions, whereas the income transactions of the banking sector are assumed to be negligible. An increase in the deficit or a reduction in the non-financial savings of a sector will result in either an increase in its financial liabilities or a decrease in its financial assets or both. Furthermore, given its non-financial savings or deficit, a sector can acquire more of one financial asset only at the expense of its holdings of other financial assets or in exchange for additional financial liabilities.

At each period, specified as a year, each sectoral account has to be balanced and, therefore, the model revolves around a set of sectoral budget constraints. In addition, certain behavioural relations are required to explain some of the intermediate economic and financial activities of various sectors, as well as to determine real output and the price level which represent the final outcomes, contingent upon the targeted flow-of-funds matrix. All the definitional identities needed to effect model closure are assumed implicitly.

In Table 5.1 below, we have provided a listing of all the 32 variables used in the model of which the first 20 are endogenous, the next 9 are instruments and last 3 are exogenous. (It needs to be noted that all scale variables, unless specified otherwise, are at current prices).

Table 5.1
LIST OF VARIABLES USED IN THE MODEL

-
1. CAD : Current account deficit
 2. ED : Total external debt of the government
 3. EL : Total net external liabilities of the private sector
 4. G : Total public sector expenditures
 5. ID : Total internal debt of the government
 6. I_g : Gross investment of the public sector
 7. I_p : Gross investment of the private sector
 8. δM : Change in nominal money supply
 9. MD : Demand for real money balances
 10. P : GDP deflator (1980-81=1.00)
 11. δR : Change in foreign exchange reserves
 12. S_g : Gross savings of the public sector
 13. S_p : Gross savings of the private sector
 14. T : Total public sector revenues
 15. X : Exports of goods and net invisibles
 16. XGS : Exports of goods and services
(excluding investment income)
 17. XIY : Net investment income
 18. y : GDP at factor cost at constant (1980-81) prices
 19. Y_m : GDP at current market prices
 20. Z : Imports of goods
-

Table 5.1 (Continued)
LIST OF VARIABLES USED IN THE MODEL

1.	δDC_g	: Change in domestic credit to the government
2.	δDC_p	: Change in domestic credit to the private sector
3.	E	: Nominal exchange rate (Rs. per U.S. \$)
4.	δNDB_g	: Change in domestic borrowings of the government
5.	δNFB_g	: Change in foreign borrowings of the government
6.	δNFB_p	: Change in foreign borrowings of the private sector
7.	r	: Rate of interest (3-year term deposit rate)
8.	t_d	: Direct tax rate
9.	t_i	: Indirect tax rate
1.	r_{ed}	: Rate of interest on external debt
2.	r_{id}	: Rate of interest on internal debt
3.	r_r	: Rate of interest on private sector external liabilities

5.2.2 The model: Structural form

The 20-equation financial programming model is given below:

$$\delta R = X - Z + \delta NFB_g + \delta NFB_p \quad (5.1)^*$$

$$\delta M = \delta DC_g + \delta DC_p + \delta R \quad (5.2)^*$$

$$I_g = S_g + \delta DC_g + \delta NDB_g + \delta NFB_g \quad (5.3)^*$$

$$I_p = S_p + \delta DC_p + \delta NFB_p - \delta NDB_g - \delta M \quad (5.4)^*$$

$$\begin{aligned} y = & a(1) y(-1) + a(2) [I_g/P] + a(3) [I_g/P]^2 \\ & + a(4) [I_p/P] + a(5) [I_p/P]^2 \\ & + a(6) [(I_g/P).(I_p/P)] \end{aligned} \quad (5.5)$$

$$\ln MD = b(0) + b(1) \ln y - b(2) r \quad (5.6)$$

$$\ln P = \ln M - (1-\beta) \ln (M/P)_{-1} - \beta \ln MD \quad (5.7)$$

$$ID = c(0) + c(1) ID(-1) + c(2) \delta NDB_g \quad (5.8)$$

$$ED = d(0) + d(1) ED(-1) + d(2) \delta NFB_g \quad (5.9)$$

$$EL = EL(-1) + \delta NFB_p \quad (5.10)$$

$$S_g = T - G \quad (5.11)^*$$

$$T = t(0) + t(1) Y_m + [t_d + t_i] Y_m \quad (5.12)$$

$$G = g(0) + g(1) Y_m + r_{id} ID(-1) \quad (5.13)$$

$$S_p = s(0) + s(1) [Y_m - T + r_{id} ID(-1)] \quad (5.14)^*$$

$$Y_m = [1/(1 - t_i)] Py \quad (5.15)$$

$$\ln (Z/E) = z(0) + z(1) \ln y - z(2) \ln E \quad (5.16)$$

$$X = XGS - XIY \quad (5.17)$$

$$\ln (XGS/E) = x(0) + x(1) \ln y + x(2) \ln E \quad (5.18)$$

$$XIY = r_{ed} ED(-1) + r_r EL(-1) \quad (5.19)$$

$$CAD = Z - X \quad (5.20)^*$$

Of the 20 equations, 7 of them have been starred (*) to indicate that the solution of the concerned endogenous variable provides one of the 12 non-zero entries in the 4-sector flow-of-funds matrix constructed in Section 2.2. The remaining 5 entries are provided directly by the exogenous values assumed by δDC_g , δDC_p , δNDB_g , δNFB_g and δNFB_p . Needless to say, eqs. (5.1)-(5.4) would ensure that these solutions are internally consistent.

Eqs. (5.1)-(5.4) are the budget constraints for the external sector, the monetary sector, the government sector and the private sector, respectively.

Eq. (5.5) is a production function with the following features: (i) It incorporates differential ICORs for public and private sector investment, (ii) The parabolic terms allow for the modelling of intertemporal changes in the sectoral ICORs, and (iii) The interaction term determines whether I_g and I_p are complementary to each other (if $a(6) > 0$) or whether absorptive capacity constraints limit output expansion (if $a(6) < 0$).

Eq. (5.6) specifies a money demand function which assumes substitution to take place only between money and financial assets. Thus, the demand for real money balances is a function only of real income and the nominal rate of interest.

The specification of the price equation, eq. (5.7), is based on the assumption that prices equilibrate to adjust nominal money supply (M) to real money stock (M/P). Specifically, we have:

$$\ln P = \ln M - \ln (M/P) \quad (5.21)$$

The equation is then closed by assuming that the stock of real money balances adjusts according to:

$$\delta \ln (M/P) = \beta [\ln MD - \ln (M/P)]_1 \quad (5.22)$$

where β is the coefficient of adjustment, $0 \leq \beta \leq 1$. As nominal money supply has already been endogenized, eq. (5.22) technically describes an adjustment mechanism for prices which is obtained by substituting eq. (5.22) into eq. (5.21) yielding eq. (5.7) above.

Eqs. (5.8) and (5.9) describe the mechanism by means of which internal and external debt increase in response to increased net domestic and foreign borrowings of the government.

In the absence of much information on the net external liabilities of the private sector, we used the Census of India's Foreign Liabilities and Assets as on March 31, 1987 (RBI Bulletin, April 1991) which provided the relevant data as on 31 March 1986 - 88. The differences between these three successive stocks were approximately equal to private capital inflows during the corresponding period suggesting that the best way to model this variable would be a simple identity given by eq. (5.10).

Eq. (5.11) is an identity defining public sector savings. Total tax collections (T) are split up into:

$$T = CR + T_d + T_i \quad (5.23)$$

where CR is miscellaneous capital receipts, T_d is direct tax collections and T_i is indirect tax collections (less subsidies). Assuming CR to be some fraction (t_1) of GDP at market prices (Y_m), and letting $t_d (=T_d/Y_m)$ and $t_i (=T_i/Y_m)$ represent the direct and indirect tax rates, respectively, yields eq. (5.12).

Total government expenditures (G) are split up into:

$$G = C_g + I_{id} \quad (5.24)$$

where C_g is public sector consumption expenditure and I_{id} is the interest payment on internal debt. Assuming C_g to be some fraction (g_1) of GDP at market prices (Y_m) and assuming that:

$$I_{id} = r_{id} ID(-1) \quad (5.25)$$

where r_{id} is the average rate of interest on internal debt and $ID(-1)$ is the lagged stock of internal debt yields eq. (5.13).

Private sector savings are assumed to be some fraction (s_1) of personal disposable income (Y_d) which is defined as:

$$Y_d = Y_m - T + I_{id} \quad (5.26)$$

and substituting eq. (5.25) into eq. (5.26) yields eq. (5.14).

GDP at current market prices is the sum of GDP at current factor prices (P_Y) and indirect taxes less subsidies (T_i), i.e.,

$$Y_m = P_Y + T_i \quad (5.27)$$

and replacing T_i by $t_i Y_m$ yields eq. (5.15).

The import function, eq. (5.16), assumes that the total imports of goods (in terms of U.S. dollars) i.e., Z/E , is a logarithmic function of real income and the nominal exchange rate. Thus, the elasticity of nominal imports (Z) with respect to the nominal exchange rate (E) is equal to $1-z(2)$.

Eq. (5.17) defines total exports which is the difference between exports of goods and services (XGS) and net investment income (XIY). The export function, eq. (5.18), assumes that the exports of goods and services (in terms of U.S. dollars) i.e., XGS/E , is a logarithmic function of real income and the nominal exchange rate. Thus, the elasticity of nominal exports (Z) with respect to the nominal exchange rate (E) is equal to $1+x(2)$.

Net investment income is split up into:

$$XIY = I_{ed} + I_{el} \quad (5.28)$$

where I_{ed} is government interest payments on its external debt and I_{el} is private sector interest payments (including profits and dividends) on its external liabilities. Now assuming that:

$$I_{ed} = r_{ed} ED(-1) \quad (5.29)$$

$$I_{el} = r_p EL (-1) \quad (5.30)$$

where r_{ed} is the average rate of interest on external debt and r_p is the average rate of return offered by the private sector on its external liabilities, yields eq. (5.19) after substituting eqs. (5.29) and (5.30) into eq. (5.28). Eq. (5.20) which defines the current account deficit effects model closure.

5.2.3 The model: Estimated form

The 20-equation model comprises 10 behavioural equations and 10 identities. All these behavioural equations were estimated using annual time-series data over the 24-year period 1970-71 to 1993-94. The time-varying parameter estimates were obtained using the Kalman filtering and smoothing recursion algorithms.

We have provided below only the final Kalman smoother estimators of each equation for 1993-94 which would forecast the conditional means of each of the concerned endogenous variable for 1994-95 based on the complete data span.

The final set of equations were:

$$\begin{aligned} y = & 0.8426 y_{-1} + 0.8338 (I_g/P)_{-1} - 0.00006931 (I_g/P)^2_{-1} \\ & + 1.1150 (I_p/P) - 0.00001943 (I_p/P)^2 \\ & + 0.00005311 (I_g/P).(I_p/P) \end{aligned} \quad \dots(5.31)$$

$$\ln MD = -10.3495 + 1.8324 \ln y - 0.0292 r \quad (5.32)$$

$$\ln P = \ln M - 0.2295 \ln (M/P)_{-1} - 0.7705 \ln MD \quad (5.33)$$

$$ID = 2610.6 + 1.0736 ID_{-1} + \delta NDB_g \quad (5.34)$$

$$ED = -275.77 + 0.9979 ED_{-1} + 0.8210 \delta NFB_g \quad (5.35)$$

$$T = -2476.3 + 0.0452 Y_m + [t_d + t_i] Y_m \quad (5.36)$$

$$G = -1922.6 + 0.1200 Y_m + r_{id} ID_{-1} \quad (5.37)$$

$$S_p = -7561.7 + 0.2746 [Y_m - T + r_{id} ID_{-1}] \quad (5.38)$$

$$\ln (Z/E) = -40.1660 + 4.2997 \ln y - 1.4838 \ln E \quad (5.39)$$

$$\ln (XGS/E) = -3.8802 + 0.8957 \ln y + 0.2179 \ln E \quad (5.40)$$

Eq. (5.31) supports the hypotheses of increasing ICORs in both the public and private sectors as well as the existence of inter-sectoral complementarity. The one-period gestation lag for public sector investment was found to be the best specification.

Alternative specifications including expected inflation were attempted in the case of eq. (5.32) but, in each case, their dynamically evolving structures indicated either rapidly decaying coefficients or regime changes and were therefore rejected.

Eq. (5.33) indicates that the coefficient of adjustment of actual real money stock to its desired level is about 0.77. The time-constant of the lag is 0.68 ($= -1/\ln 0.2295$) years.

Eqs. (5.34) indicates that other factors, besides government domestic borrowings, dictate the course of internal debt; while eq. (5.35) suggests that government foreign borrowings is primarily responsible for the growth of external debt.

Eqs. (5.36) and (5.37) reveal that the comparative effect of a rise in GDP at market prices is much higher on government expenditures than on government (non-tax) revenues.

With eq. (5.38) suggesting an mps of about 0.275, it indicates that for every rupee transferred from the government to the private sector on account of the national debt, aggregate savings would decrease by about Rs. 0.725.

Eqs. (5.39) and (5.40) indicate that the elasticities of import demand and export supply with respect to the nominal exchange rate is fairly low at about -0.48 and quite high at 1.22, respectively. Alternative specifications were attempted for eq. (5.40) but the final accepted version, which has been used in several FPMs (see Barth and Chadha 1989), was the most robust.

5.2.4 The model: Solution

To solve the model, we initially ordered the equations into a recursive block structure which, apart from providing increased understanding of the system, allows for an efficient solution. The recursive block ordering was formed by operations on the "adjacency" matrix of the system, a matrix of ones and zeroes relating the dependent variables to the equations in which they appear (see Steward 1962). This method involves viewing the adjacency matrix as a network and systematically seeking closed loops that define the systems of simultaneous equations.

Table 5.2 below provides the incidence matrix of the model.

Table 5.2

INCIDENCE MATRIX OF THE FINANCIAL PROGRAMMING MODEL

Type	Var	Eq#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
P	ID	1	x																			
P	ED	2		x																		
P	EL	3			x																	
P	XIY	4		x	x	x																
C	Z	5				x															x	
C	XGS	6					x														x	
C	X	7				x	x	x													x	
C	CAD	8					x	x	x													
C	δR	9				x	x	x														
C	δM	10						x	x													
C	MD	11								x											x	
C	P	12						x	x	x												
C	Y	13								x	x										x	
C	T	14							x	x												
C	G	15	x							x		x										
C	S	16									x	x	x									
C	S^g	17	x								x	x		x								
C	I^p	18										x		x								
C	I^g	19										x		x	x							
L	y	20							x						x	x	x	x				

"Type" implies whether it is a prologue (P), core (C) or a loop (L) variable (see Gabay *et al* 1980). The x's mark the equations in which each dependent variable appears.

The ordering indicates that, apart from the first four prologue variables, the rest of the model, comprising 15 core variables and one loop (i.e., output), is fully simultaneous.

The model was then solved using the Fletcher-Powell method (see Fletcher and Powell 1963) as both the Gauss-Seidel and the Jacobi methods did not converge efficiently. This method uses numeric derivatives with respect to the endogenous variables as opposed to the other two methods which use analytic derivatives.

The solution of the model for 1993-94 is provided below.

TABLE 5.3
FULL MODEL SOLUTION: 1993-94

Variable	Actual Value	Predicted Value	% Error	Variable	Actual Value	Predicted Value	% Error
1. δR	28713	28881	0.59	11. S_g	10447	10635	1.80
2. δM	77239	77407	0.22	12. T	143242	143506	0.18
3. I_g	81903	82091	0.22	13. G	132795	132872	0.06
4. I_p	113564	112827	-0.65	14. S_p	184032	183464	-0.31
5. y	228965	228514	-0.20	15. Y_m	799000	800419	0.17
6. MD	158355	157817	-0.34	16. X	74253	73975	-0.37
7. P	3.1241	3.1358	0.37	17. XGS	86805	86526	0.32
8. ID	478186	477351	-0.17	18. XIY	12552	12551	-0.01
9. ED	46452	46455	0.01	19. Z	75241	74795	-0.59
10. EL	103148	103148	0.00	20. CAD	988	820	-17.00

It is seen that the predicted values of the endogenous variables using the final Kalman smoother estimators provide an almost flawless simulation of the economy except for the current account deficit (CAD) which yields a 17 percent underprediction which is acceptable given its relatively low level in 1993-94.

In this context, it needs to be noted, that the above results are not the final prediction of the model at the end of a dynamic simulation over the sample period but rather its static solution only at a single instant in time, i.e., 1993-94.

While a full-model dynamic simulation would have yielded much larger terminal prediction errors, the results of the earlier sections demonstrate that the prediction errors over the sample period would have decayed over time due to the backward-recursion property of the Kalman smoother estimator although they would not have converged to (near) zero as in the manner above. Nevertheless, the accuracy of the estimation procedure can now be exploited in order to provide forecasts, as well as alternative stabilization policy options, for 1994-95 which is the primary purpose of this study.

5.3 Baseline Forecasts: 1994-95

In order to forecast the values of the endogenous variables in 1994-95, we initially have to project the 9 instrument variables and 3 exogenous variables for the period.

These projections were as follows: (i) Based upon the latest available data and its past trends, we set: $\delta DC_g = 31750$, $\delta DC_p = 24750$, $\delta NDB_g = 45000$ and $\delta NFB_p = 25000$; (ii) The nominal exchange rate was assumed to remain unchanged, i.e., $\delta E = 0.0$; (iii) Based upon the budget proposals, we set: $\delta NFB_g = 7600$, $t_d = 0.0325$ and $t_i = 0.11$; (iv) All rates of interest were assumed to remain unchanged vis-a-vis their 1993-94 levels.

Using these estimates, we solved the model for 1994-95 thereby obtaining a baseline projection for the Indian economy which is set out in terms of a flow-of-funds matrix in Table 5.4.

Table 5.4

FLOW OF FUNDS MATRIX (1994-95): BASELINE PROJECTION

$$g = 5.1\% ; \pi = 9.4\%$$

(Rs. crores at current prices)

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 45000$	$\delta NFB = 7600$	$\delta DC = 31750$	$S_g = 13130$	97480
Private Sector			$\delta NFB = 25000$	$\delta DC = 24750$	$S_p = 200088$	249838
External Sector				$\delta R = 20981$	$Z-X = 11619$	32600
Monetary Sector		$\delta M = 77481$				77481
Investment	$I_g = 97480$	$I_p = 127357$				224837
TOTAL	97480	249838	32600	77481	224837	GDP= 911680

The above baseline projection was not the point-forecast of a "one-off" simulation but rather the mean values obtained over a series of 20 simulations which involved: (i) Using alternative values of the exogenous variables in the "near-neighbourhood" of their projections; (ii) Shocking certain key parameters of the model within a tolerance limit of ± 0.5 standard deviations about their mean values predicted by the Kalman smoother estimators; and (iii) Carrying out a stochastic simulation under varying assumptions regarding the distribution of the error terms.

These experiments yield growth rates ranging from 4.3 - 5.4 percent, with a mean of 5.1 percent; and inflation rates ranging from 8.4 - 10.9 percent, with a mean of 9.4 percent. Similarly, all the endogenous elements of the flow-of-funds matrix above represent their means over all these alternative simulations.

It is thus seen that linking all the sectors within the framework of a financial programming model helps us to revise our earlier forecasts considerably. While, by and large, the growth rate seems to be fairly stable, regardless of the approach used to forecast it, the inflation rate is seen to be quite volatile as it is scaled downwards considerably in this integrated set-up.

The money growth rate would be 15.7 percent with a reserve accumulation of Rs. 20981 crores. As the link between the rate of inflation ($\pi=9.4$), money growth ($\mu=15.7$) and output growth ($g=5.1$) is given by: $\pi = \mu - \Theta g$, where Θ is the elasticity of money demand with respect to output, it implies that: $\Theta=1.24$. As this is much lower than its estimated value of 1.83 in eq. (5.32), the results provide a caveat against directly using (possibly unstable) money demand functions to compute δ .

The aggregate investment rate would increase to 24.7 percent in 1994-95, while the aggregate savings rate would decrease to 23.4 percent in 1994-95. This widening investment-savings gap would imply a CAD of 1.3 percent.

Public sector savings (S_g) would be 1.4 percent of GDP while public sector investment (I_g) would be 10.7 percent yielding a fiscal deficit of 9.3 percent in 1994-95. Private sector savings (S_p) would decrease to 21.9 percent although private sector investment (I_p) would remain constant at about 14.0 percent. This near constancy in the rate of private sector investment, implying no further crowding-out, along with the fact that the ratio of financial asset creation to physical asset creation in the private sector re-switches back to 49:51 in favour of physical assets could be reasons for the increase in the growth rate.

5.4 Financial Programming Within The Framework Of Optimal Control

Studies on applying control theory within the framework of an estimated econometric model in order to derive macroeconomic stabilization policies for the Indian economy are numerous and include Rao (1984, 1990), Singh (1992, 1993), amongst others.

The idea of control theory is to derive an optimal policy capable of steering the economy towards its desired targets (see Kendrick 1977). Before doing so, however, one has to specify an objective function which evaluates the outcomes associated with each optimal policy. Such a loss function is usually given by:

$$L = \frac{1}{2} \sum_{t=1}^{\tau} [(x_t - x^*)' Q (x_t - x^*) + (u_t - u^*)' R (u_t - u^*)] \quad \dots(5.41)$$

where x^* and u^* indicate the desired values of the targets and instruments, respectively; Q and R are diagonal matrices of rank q and r indicating the number of targets and instruments to be tracked, respectively; and τ is the time horizon. The elements in Q and R are the penalties that are incurred as a result of any deviations between the desired values of the instruments and targets from their optimal levels. Given such a welfare loss function and an estimated dynamic model, a policy choice (sequence) can be found which minimizes the (expectation of the) welfare loss function over a given time point (horizon).

By specifying an objective function, the estimated FPM was formulated in terms of a control problem and solved using GAMS to derive alternative macroeconomic policies for tracking a 6 percent output trajectory and a 7 percent price trajectory in 1994-95. These optimal solutions, unlike conventional financial programming exercises, required no further consistency checks.

5.5 Growth With Limited Inflation: Some Policy Options

5.5.1 Fixed exchange rates and unsustainable deficits

We initially used fixed exchange rates to attain our growth and inflation targets. The results yielded the following matrix with the optimal control settings being provided at the top:

Table 5.5

FLOW OF FUNDS MATRIX (1994-95): SCENARIO I

$g=5.4\%$; $\pi=7.8\%$; $r=10.0\%$; $t_d=0.031$; $t_i=0.109$; $E=31.37$

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 41308$	$\delta NFB = 3000$	$\delta DC = 27794$	$S = 13543$	85645
Private Sector			$\delta NFB = 25419$	$\delta DC = 25533$	$S = 209686$	260638
External Sector				$\delta R = 10088$	$Z-X = 18331$	28419
Monetary Sector		$\delta M = 63415$				63415
Investment	$I = 85645$	$I = 155915$				241560
TOTAL	85645	260638	28419	63415	241560	GDP= 912241

The high growth is brought about by increased private sector investment, while reduced inflation is because of tight money policy (with money growth being 12.8 percent), accompanied by a drastic reduction in credit to the public sector, indicating that the composition of money supply (in terms of intersectoral credit allocation) is as important as its volume. The increase in growth, in the face of the pegged exchange rate, puts an enormous pressure on the CAD which expands to 2.0 percent of GDP. As a result, reserve accumulation amounts to barely Rs. 10088 crores.

5.5.2 Flexible exchange rates and unsustainable reserves

In order to pre-empt such a rise in the CAD which inevitably accompanies growth with fixed exchange rates, we switch over to a flexible exchange rate. The results yielded the following matrix:

Table 5.6

FLOW OF FUNDS MATRIX (1994-95): SCENARIO II

$g=5.5\% ; \pi=9.0\% ; r=9.9\% ; t_d=0.033 ; t_i=0.101 ; E=34.31$

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB_g = 45272$	$\delta NFB_g = 6842$	$\delta DC_g = 30497$	$S_g = 7667$	90278
Private Sector			$\delta NFB_p = 20457$	$\delta DC_p = 22534$	$S_p = 211870$	254861
External Sector				$\delta R = 23623$	$Z-X = 3676$	27299
Monetary Sector		$\delta M = 76654$				76654
Investment	$I_g = 90278$	$I_p = 132935$				223213
TOTAL	90278	254861	27299	76654	223213	GDP = 914604

The optimal policy entails a 9.4 percent devaluation. As a result, the CAD falls to 0.4 percent of GDP. Consequently, reserve accumulation mounts to Rs. 23623 crores increasing money growth to 15.5 percent which brings in its wake an accompanying inflation rate of 9.0 percent. With greater emphasis on public sector investment, the government is forced to expand its market borrowings to Rs. 45272 crores. While the reduction in the indirect tax rate increases private sector savings, the increased market borrowings, coupled to reduced domestic credit and foreign capital, leads to a crowding-out of private sector investment.

5.5.3 Optimal exchange rates and sustainable capital flows

In order to pre-empt such a devaluation leading to high inflation as well as private sector crowding-out, we provide limited (increased) flexibility to exchange (tax) rates. The results yielded the following matrix:

Table 5.7

FLOW OF FUNDS MATRIX (1994-95): SCENARIO III

$g=5.4\% ; \pi=8.3\% ; r=9.9\% ; t_d=0.032 ; t_i=0.096 ; E=31.60$

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 47285$	$\delta NFB = 7527$	$\delta DC = 31452$	$S = 2092$	88386
Private Sector			$\delta NFB = 30719$	$\delta DC = 22563$	$S = 210706$	263988
External Sector				$\delta R = 21845$	$Z-X = 16401$	38246
Monetary Sector		$\delta M = 75860$				75860
Investment	$I = 88356$	$I_p = 140843$				229199
TOTAL	88356	263988	38246	75860	229199	GDP = 903449

With the exchange rate being devalued by barely 0.7 percent, the CAD increases to 1.8 of GDP. Consequently, the increase in reserves is of the order of Rs. 21845 crores while money growth is 15.3 percent. Both these factors help to lower the inflation rate to 8.3 percent. With reduced tax rates, public sector savings shrinks considerably leading to a fiscal deficit of the order of 9.5 percent of GDP. As a result, the government has to resort to massive public borrowings which, in turn, forces the private sector to seek increased foreign capital.

5.5.4 Optimal credit allocation and sustainable tax rates

To prevent such high fiscal deficits, we attempt to increase public sector savings with flexible credit controls. The results yielded the following matrix:

Table 5.8

FLOW OF FUNDS MATRIX (1994-95): SCENARIO IV

$g=5.7\%$; $\pi=8.7\%$; $r=9.6\%$; $t_d=0.046$; $t_i=0.091$; $E=31.74$

	Govt.	Priv.	Ext.	Mon.	Savings	TOTAL
Government Sector		$\delta NDB = 39704$	$\delta NFB = 7678$	$\delta DC = 30697$	$S = 12322$	90401
Private Sector			$\delta NFB = 30105$	$\delta DC = 26203$	$S = 212910$	269218
External Sector				$\delta R = 20986$	$Z-X = 16797$	37783
Monetary Sector		$\delta M = 77886$				77886
Investment	$I = 90401$	$I = 151628$				242029
TOTAL	90401	269218	37783	77886	242029	GDP= 924194

The optimal policy calls for a sharp increase (decrease) in the direct (indirect) tax rates. Such a policy helps to increase public sector savings and investment considerably. With increased savings, the borrowing needs of the government from domestic sources reduces considerably, thereby allowing sufficient scope for expanding private sector investment. The aggregate savings (investment) rate increases to 24.4 (26.2) percent which helps to increase the growth rate to 5.7 percent. With increased credit expansion however, money growth is 15.7 percent and the resulting inflation rate of 8.7 percent is slightly on the higher side.

5.6 Conclusions

The objective of this section was to present a small FPM which could be used in the design of growth-oriented adjustment programmes (see Wong and Pettersen 1979). Estimated using Kalman filters, the model was able to evaluate the short-run impacts of alternative policy measures on all the macroeconomic targets.

While the model contains many desirable features such as internal consistency, variable ICORs and lagged money market adjustment, it clearly could be improved especially with regard to the formation of expectations as well as certain functional specifications and lag structures. Nevertheless, from an operational perspective, its flexibility with regard to economic and estimation structure should enhance its potential to provide a framework for growth-oriented adjustment programmes.

In this context, several control experiments were carried out to gauge the impacts of alternative policies and the results suggested, the Lucas (1976) critique notwithstanding, that the most desirable policy to accommodate stabilization with growth was to increase (stabilize) private (public) sector savings via reduced (increased) indirect (direct) taxes. Such a policy, together with: (i) a greater allocation of domestic credit to the private sector, (ii) reduced domestic borrowings and (iii) reduced interest rates, would increase private sector investment considerably thereby resulting in higher output growth. Under the circumstances, even a slightly higher order of monetary expansion would not be very inflationary. With the required depreciation of the exchange rate being minimal, moderately higher capital inflows are needed to finance the desired level of investment.

6. OVERVIEW AND RECOMMENDATIONS

6.1 Theoretical Overview

Much of the theoretical debate on structural adjustment focuses on the relation between the gross fiscal deficit (GFD) and the current account deficit (CAD). From eq. (2.10), we have:

$$(S_g - I_g) + (S_p - I_p) = -CAD \quad (6.1)$$

Based upon eq. (6.1), which shows that improvements in the CAD can take place only if sectoral savings rise relative to sectoral investment, Dornbusch and Helmers (1986) concluded forcefully that policies which do not have any effect on savings cannot be expected to improve the external balance.

However, eq. (6.1) can also be written in terms of the linkages between the GFD and the CAD as follows:

$$\begin{aligned} I_p &= S_p - (I_g - S_g) + CAD \\ &= S_p - GFD + CAD \end{aligned} \quad (6.2)$$

Eq. (6.2) indicates that increases in external savings, i.e., the CAD, offset public sector dis-saving thereby pre-empting the crowding out of private sector investment.

Now, if the government deficit is corrected, will that eliminate the trade deficit? Based upon the results of Feldstein and Horioka (1986), the answer is "No", because their evidence indicates, just as forcefully, that cutting the budget deficit (thereby increasing the national savings rate) will only increase investment with very little impact on the external deficit.

Thus, whether changes in the savings rate are reflected primarily in the external balance a la Dornbusch and Helmers or in investment levels a la Feldstein and Horioka becomes a policy issue of very great practical relevance in the Indian context.

Thus, any effort to study this issue must examine the factors which caused these deficits in the first place. The CAD as well as the GFD are usually linked within a general equilibrium framework because their basic proximate determinants - mainly the rates of inflation and growth - are themselves endogenous variables. Thus, any meaningful analysis of these deficits would require that their fundamental causes be specifically identified because the general equilibrium nature of the problem is not merely a theoretical finepoint. The conclusions of most economists who have studied these issues (see Bruno 1989) is that the twin deficits are largely the result of the development strategies being followed by the country as well as the macroeconomic policies pursued by its major trading partners. Therefore, reducing these deficits would probably, although not necessarily, entail a significant reversal of these policies in order to correct the imbalances.

The literature provides three lines of approach for analyzing responses towards such imbalances. The conventional method usually involves an eclectic model in which trade and fiscal flows are determined by price and income flows. Another approach is known as dual-gap analysis which can be expanded into a three-gap model. In such a framework, one can view these imbalances as reflective of the savings-investment behaviour of a nation. A third strand of thought involves the neoclassical model of public debt (see Diamond 1965) which provides a theoretical analysis of the implications of funding a public sector deficit by borrowing from abroad. Studies based upon the open-economy characteristics of such a model (see Blejer and Khan 1984) have

indicated that the adjustment towards a higher external debt implied by a higher public debt is shown to involve an extended period of current account deficits followed by an initial government budget deficit. This result involves the use of foreign savings (and therefore current account deficits) to supplement domestic savings both during the initial period of the government deficit as well as during subsequent periods when domestic savings are depressed by taxes which are used to service the higher debt. In fact, such an analysis of the interaction between the debt, the fiscal deficit and the current account deficit reflects the more-or-less conventional view in academic circles of the relationship that seems to exist between the twin deficits in most countries, including India.

The fact that the Indian CAD did very nearly correct itself in 1993-94 has less to do with the dynamics of debt accumulation than with the fact that the import growth rate was moderate (as a result of a relatively stagnant economy) and that the persistent upward pressure on the rupee as a result of the large capital inflows was staved off by the intervention of the RBI in the foreign exchange market. As a result, there was very little movement in the nominal exchange rate and therefore the economy was no longer operating on the envelope of a series of shifting "J-curves" which often mask improvements in the actual CAD.

However, such an exchange rate policy of intervention has raised the major problem of monetary management because the resulting increase in foreign exchange reserves has, by increasing money growth, put considerable upward pressure on the inflation rate. To the extent that (nominal) exchange rate stability has co-existed

with inflation, there has been a steady appreciation in the real exchange rate which is bound to adversely affect the CAD in the near future. Needless to say, much will depend on how rapidly trade volumes react to the changes in prices and incomes as well as the lag with which exports and imports would respond to real exchange rates.

This implies that external resources could well be a continuing feature of the Indian transition and it may not be possible to envisage a zero balance in the current account in the foreseeable future. Thus, it will be necessary to determine a sustainable CAD for a specified (constant) level of the debt-income ratio and an assumed growth rate of income and inflation rate contingent upon the stabilization policy being followed.

6.2 Policy Recommendations

The results of Section 5.5 indicate that the following policies would have accommodated price stabilization with higher growth for the Indian economy in 1994-95: (i) An increase in direct tax rates to 4.6 percent (as against 3.25 percent proposed for the current year), (ii) A decrease in the indirect tax rates to 9.1 percent (as against 11 percent proposed for the year); (iii) A reduction in the 3-year term deposit rate to 9.6 percent (as against 10 percent currently); (iv) A slight depreciation of the exchange rate to Rs. 31.74 per US dollar (as against Rs. 31.21 per US dollar currently); and (v) An expansion of domestic credit to the extent of about Rs. 57000 crores (as against Rs. 48500 crores last year), with the shares of the public and private sector being approximately in the ratio of 54:46 (as against 57:43 last year).

These policies would have ensured an aggregate savings rate of 24.4 percent, an aggregate investment rate of 26.2 percent and a growth rate of 5.7 percent. However, the resulting CAD would have been high at 1.8 percent of GDP. While a devaluation of 9.4 percent would have reduced the CAD to 0.4 percent of GDP, the results indicated such a step to be sub-optimal given the comfortable level of foreign exchange reserves.

The results also indicated ceilings on borrowings from the private sector (Rs. 40000 crores), i.e., the same order of magnitude as last year, as higher levels would have crowded out private sector investment. With foreign capital inflows projected at Rs. 37750 crores (as against Rs. 29701 last year), reserve build-up would have been Rs. 21000 crores. This foreign exchange accretion, coupled to the expansion in domestic credit, would have implied a money growth of approximately 15.7 percent (which would have been in the neighbourhood of the range suggested by the RBI) yielding a minimal inflation rate of 8.7 percent.

These policies suggest the possibility of designing a stabilization 'game-plan' which is needed for the coming year to manage the pace at which the exchange rate and the interest rate equilibrate with attempts to modify the impacts of the adjustment process on foreign exchange reserves. Such a gradualist path would lower the probability of stagflation since the inflation and growth effects of these adjustments would be absorbed smoothly. Such a strategy, comprising monetary stabilization as well as fiscal adjustments, should produce high growth, stable inflation and a sustainable trade balance. If, however, for any reasons, such a fiscal adjustment programme proves unfeasible, then the effects of any other monetary stabilization policy aimed at correcting these imbalances would be considerably attenuated.

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