AN ECONOMETRIC ANALYSIS OF INDIA'S BALANCE OF PAYMENTS

A Thesis Submitted to the University of Hyderabad
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IN
ECONOMICS

BY

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C E R T I F I C A T E

I certify that the thesis entitled **"An Econometric Analysis of India's Balance of Payments"** submitted by K.G. Sahadevan to fulfil the requirement for the award of the degree of **Doctor of Philosophy** in Economics, has been carried out under my supervision.

Hyderabad,
06-9-1993

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D E C L A R A T I O N

This is to state that the thesis entitled **"An Econometric Analysis of India's Balance of Payments"** submitted to the University of Hyderabad for the award of the degree of Doctor of Philosophy in Economics, is the original work done by me under the supervision of Dr. B Kamaiah, Reader, Department of Economics, University of Hyderabad, and the same has not previously formed **the** basis for the award of any degree, diploma, associateship, fellowship or **any** other similar title of recognition.

Hyderabad - 500 134, K.G. Sahadevan
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CHAPTER 1

THE THEME, OBJECTIVES AND METHODOLOGY OF THE STUDY

1.0. INTRODUCTION

Ever since independence, balance of payments (BoP) has been a matter of concern for economic policy making authority in India. Though the economic planning era ushered in with an element of optimism, the First Five Year Plan ended with an uncomfortable BoP situation, and since then the external sector has been experiencing considerable stresses and strains. The magnitude of BoP deficit increased at an alarming rate hindering every attempt to project India's image internally as well as externally. After the collapse of the Bretton Woods system in 1971, the Indian economy became all the more vulnerable to external shocks. Severe challenges came up from the need to adapt to the changing international economic environment and to solve the unprecedented international liquidity problem.

In the context of the recent tendency for globalisation of economies, acquisition of external strength becomes a prerequisite of economic growth, which ultimately depends upon international trade and BoP performance. It has been recognised by policy makers that an external imbalance could distort the development process through its impact on output, employment and price levels. Hence, the need for maintaining a desired level of BoP consistent with other economic goals has attracted the attention of policy makers.

Although many macro-models relating to India are available, the external sector has not been given much importance in most of them. The present study is an attempt towards an econometric analysis of BoP, the main focus being on investigating into the applicability of various theories/approaches to BoP in the Indian context.

1.1. THEME OF THE STUDY

In literature, the BoP problem has been analysed in different ways by addressing the question of correcting BoP disequilibrium from different angles. While the traditional analysis with Keynesian orientation views BoP as being determined exclusively by the real variables like income, expenditure, relative prices etc., and concentrates on what happens to separate components of BoP, the modern analysis with classical foundation formulates BoP as a monetary phenomenon determined essentially by the domestic money market conditions and concentrates on what happens to overall balances in the long-run. Hence any attempt to analyse BoP should resolve this issue. Accordingly, the basic issue whether the existing theories/approaches explain BoP in the Indian context assumes relevance.

A proper understanding of the determinants of BoP is of crucial significance for successful operation of policy programmes aiming at sustainable level of BoP. In the last forty five years that have passed since Independence, the efforts at planned rapid economic development have brought about many new situations in India's external sector, leading to far reaching changes in BoP policies. However, the policies have never been consistent with economic structure of the country. Mainly, a three-pronged policy viz., (i) import substitution; (ii) containing of imports through curbing consumption of some products; and (iii) export promotion, has been pursued to bridge the gap between imports and exports and to maintain BoP at a manageable level.

' Though the government has accorded high priority to improving the BoP position through acceleration of export growth, import substitution and economic utilisation of scarce foreign exchange resources, India has been having an adverse trade balance all through the planning period, except in 1972-73 and 1976-77 when a modest favourable balance was registered to the tune of Rs. 104 crore and Rs. 68 crore respectively. This perennial trade and BoP problems in the Indian context may be attributed to the basic lacuna of specific policy packages envisaged during the planning era. The trade and BoP policies suffer from an insufficient recognition of the root cause of the problems.

The intent of the study, however, is not to evaluate the BoP policies pursued by the government and to suggest policy options. Rather, the study aims at an analysis of BoP within the framework of established theories in literature.

1.2. OBJECTIVES OF THE STUDY

The present study primarily seeks to examine whether the existing theories/approaches to BoP explain India's international reserve movements or BoP. Accordingly, the study sets the following objectives :

(i) To attempt a critical review of various theories/approaches to identify possible determinants of India's BoP. Such a review might throw some light on the need for a broad analytical framework consistent with the prevalent institutional realities in the Indian context.

(ii) To assess empirically the validity of the Keynesian approaches to BoP in the Indian context, more specifically to formulate and estimate a simple Keynesian model of BoP, and to test a particular scheme of causal relationships among income, absorption and trade balance underlying the income-absorption model of trade balance, and to examine the underlying policy prescriptions.

(iii) To examine the significance of monetary variables in determining India's payments position. An empirical test of monetary approach to balance of payments (MABP) under the fixed exchange rate is carried out to examine the link between money market conditions and BoP.

(iv) To study the combined movement in exchange rate and BoP under the managed floating exchange rate system within the framework of monetary model of exchange market pressure. This attempt aims to bring out. the relevance of a prudent monetary management to maintain a BoP and exchange rate at desired levels.

(v) To test the exogeneity specifications underlying the MABP and to examine the relevance of its policy prescriptions for correcting BoP disequilibrium.

1.3. METHODOLOGY OF THE STUDY

The empirical investigation is carried out on annual time series spanning the period from 1950-51 to 1990-91. The choice of the initial period coincides with the inception of economic planning in India and the final period being the latest year for which all the required data are available. The source of data and definition of variables used in the study are given in appendix II.

To test the empirical validity of the various theories/approaches to BoP in the Indian context, the present study makes use of econometric techniques **and** time series (causality tests) procedures.

For testing the causal relationships underlying both the Keynesian income-absorption approach and monetary approach, the bivariate causality tests formulated by Granger (1969) and Sims (1972) are used. For choosing an appropriate lag structure in the Granger causality model, the final prediction error (FPE) criterion has been employed. A new test of causality proposed by Holmes and Hutton (1990) has also been used to examine the sensitivity of causal inference to form of the test.

A simple three equation Keynesian model of BoP, and monetary model of exchange market pressure are estimated using Ordinary Least Square (OLS) method. However, wherever the presence of the first-order serial correlation in OLS estimation was detected, the Cochrane-Orcutt corrective procedure has been used.

The Three Stage Least Square (3SLS) method is applied to a simultaneous estimation of reserve flow and sterilisation equations for a test of the absence of sterilisation, an important proposition of the MABP. In addition to this, the exogeneity specification underlying the MABP model is formulated as a testable hypothesis and verified using a multivariate systems test of exogeneity under the framework of complete dynamic simultaneous equation model (CDSEM) originally developed by Geweke (1978). For the CDSEM system, both Wald and Likelihood ratio statistics are estimated and used to test the block exogeneity.

1.4. LIMITATIONS OF THE STUDY

Since the present study is an econometric study using time series data on various economic indicators, the availability of reliable and consistent data and selection of best-represented proxies for price level, interest rates etc., are of crucial significance. However, the study inherits certain limitations from its data base which are listed below :

(i) The major data constraint of the study is the non-availability of quarterly time series on income measure which limits the use of quarterly series on other variables. Since the study uses various time series techniques such as causality tests and CDSEM which require large number of observations, the reliability of the evidence, however, is limited to that. extent.

(ii) The monetary aggregate considered for the present study is unadjusted narrow money (Ml). Since the Ml series has undergone definitional changes in terms of its coverage in March, 1978, it needs to be adjusted for making the series consistent throughout the sample period.

(iii) In the absence of an appropriate proxy for interest rates, the call-money rates and one-year deposit rates are used in two different contexts. They are administered rates and do not represent the equilibrium rate at which respective markets are cleared. Hence, they may not represent the real opportunity cost of holding money in the Indian context.

(iv) The assumption of the 'law of one price' underlying the MABP makes domestic price level to represent the world price level. The price-taking assumption refers specifically to price equilibration in tradable goods sector. Hence an index of traded goods i.e., a composite index of export and import price indices should represent the price level. However, the present study uses whole-sale price index as a proxy for price level, though it retains non-tradables. Since consumer goods prices are a biased estimator of traded goods, and include service content, it is not used in the present study.

1.5. ORGANISATION OF THE STUDY

The rest of the thesis is organised into four chapters. The summary, findings and policy implications of the study are given towards the end of the thesis. The second chapter deals with a critical review of various theories/approaches of BoP. It is hoped that, an examination of relative strength and weaknesses of each theory would help understanding the nature of BoP phenomenon in the Indian context. Since the study aims at verifying the applicability of various theoretical explanations of BoP, a review of those explanations will advance certain inadequacies in a given context.

The third chapter provides an econometric analysis of India's BoP within the simple Keynesian and income-absorption approaches. This chapter is designed to fulfill two objectives. The first objective is to formulate and estimate a simple model of trade balance and BoP within the traditional Keynesian theoretical framework. The Keynesian equations for trade balance, capital flow and BoP are estimated to see whether the propositions underlying the Keynesian model of BoP hold good in the Indian context. The second objective is an empirical investigation of the relationships among income, expenditure and trade balance underlying the income-absorption approach. This chapter, on the whole, is expected to throw light on the significance of devaluation, interest rate etc., as policy tools of BoP adjustment.

The intend of the fourth chapter is to see whether monetary factors exert influence on BoP and exchange rates. Accordingly, a detailed analysis of India's BoP within the theoretical and empirical framework of the MABP under the fixed and managed floating exchange rate regimes has been carried out. The chapter is organised into three sections. The first section deals with the MABP under fixed exchange rate for a period from 1950 to 1975. The validity of the propositions of the MABP are tested by estimating the reserve flow and sterilisation equations within a simultaneous equation framework using 3SLS method. It is also attempted to incorporate a modified money demand function as suggested by Tsiang (1977) into the monetary model of BoP and estimate the model. In the second section, an analysis of combined movement of India's international reserves and exchange rates has been done for the period from 1976 to 1990 within the framework of exchange market pressure (EMP) model originally developed by Girton and Roper (1977). The third section summarises the findings and implications.

The last chapter tries to verify the applicability of the policy prescriptions of the MABP to maintain BoP equilibrium. Accordingly, a comprehensive econometric test is carried out to verify the exogeneity assumptions underlying the MABP that the determinants of money demand, and domestic credit are exogenous with respect to changes in reserves. The study investigates into the validity of the exogeneity assumptions in three different ways. First, a simultaneous estimation of the reserve flow and sterilisation equations is carried out to confirm the absence of sterilisation. Secondly, using three causality tests viz., the Granger, Sims and multiple rank F-tests bi-variate causality pattern is examined. Finally, the exogeneity specification is formulated as a testable hypothesis and verified using a multivariate systems test of exogeneity within the framework of complete dynamic simultaneous equation model (CDSEM).

CHAPTER 2

THEORIES OF BALANCE OF PAYMENTS - A CRITICAL REVIEW

2.0. INTRODUCTION

Theories of BoP are concerned with identifying possible determinants of BoP, and specifically analysis of policies for preserving BoP equilibrium. Analysis of BoP is essentially a post-war phenomenon. Prior to the Keynesian revolution, problems of international disequilibrium were discussed within the classical conceptual framework of 'the mechanism of adjustment', the actions of the monetary and other policy-making authorities being subsumed in the system under consideration. The Keynesian revolution however, has introduced the notion of chronic disequilibrium into the analysis of international monetary system. The present chapter intends to critically review the several competing theories of BoP. The diversified views on the nature of BoP phenomenon culminated in its partial understanding. The question whether the phenomenon is real or monetary remains as yet an unsettled issue. While the conventional theories view BoP as a real phenomenon determined by real forces like income, expenditure and relative prices, the modern monetary theory formulates BoP as a monetary phenomenon establishing a link between state of domestic money market and level of international reserves. An examination of relative merits and demerits of each theory, it is hoped, would provide a basis for understanding the BoP phenomenon.

2.1. CLASSICAL 'MECHANISM OF ADJUSTMENT'

Prior to 1930s, no comprehensive theory was available for analysis of BoP Instead there was a well worked out theory of mechanism of international adjustment under the gold standard. This approach, known as the Classical

Price-Specie-Flow mechanism or Humes mechanism sought to analyze automatic adjustments that would take place pursuant to a particular exogenous change. Deriving motivation from the classical model, the mechanism assumes that citizens in deficit(surplus) country would experience a negative(positive) real balance effect. And because of changed relative prices and real balances, residents of deficit country would purchase less from abroad, and citizens of surplus country would increase their imports. This process would continue until payments balance is restored.

The classical approach to BoP adjustment contained no analysis, however, of the effect of exchange rate changes as a substitute in a fixed-price world for flexible domestic prices, which was more relevant to the period after 1931 when the gold standard collapsed as a system of international payments. David Hume used this mechanism to refute the mercantilist belief that a country could achieve a persistent balance of trade surplus by the mercantalist policies of import protection and export promotion.

The history of BoP theory since the early 1930s has been one of successive "approaches" of increasing degree of theoretical sophistication. Johnson (1977a) has classified the various approaches into five types viz., (i) the simple "elasticity" approach, (ii) the "absorption" approach, (iii) the Keynesian "multiplier" approach, (iv) the Keynesian "policy" approach, and (v) the "monetary" approach. It may also be possible to broadly classify these approaches into two depending on whether BoP is treated as a real or a monetary phenomenon.

2.2. TRADITIONAL APPROACHES

The first attempt to view BoP as a real phenomenon has been made by Joan Robbinson (1937) who formulated the elasticity approach as a response to the need for a theory of BoP adjustment under flexible exchange rate. The elasticity approach and its extension Keynesian multiplier are concerned with the following three questions :

(i) What are the conditions for currency devaluation to improve a country's BoP on current account ?

(ii) What will be the effect of currency devaluation on the level of domestic activity, and how will this affect BoP ? And what are the conditions for devaluation to be successful ?

(iii) What will be the effect of devaluation on terms of trade of the devaluing country ?

The elasticity approach finds answers to the above questions in terms of the Marshall-Lerner condition which is derived in a two-country two-commodity context on the assumption that underemployment exists in each country and that domestic price of each country's exports goods is given.

The basic equation of the Marshall-Lerner condition is given by

$$dB/de = -X(1 + \eta_x + \eta_f) \qquad ...(2.1)$$

where dB is the change in home country's trade balance, measured in units of domestic currency, de is the change in exchange rate, X is exports, x and f are suffixes representing exports and imports respectively (both measured in units of domestic currency) and n_i is elasticity of demand for i_{th} good, i = x,f.

From equation(2.1)

$$dB/de > 0 \text{ if } |\eta_x + \eta_f| > 1 \qquad ...(2.2)$$

That is, devaluation of a currency will Improve BoP position if the sum of domestic elasticity of demand for imports and foreign elasticity of demand for exports exceeds unity.

The Keynesian multiplier approach is a modified and extended version of the elasticity analysis in the sense that it takes care of the limitations of the latter. A major drawback of the elasticity approach has been that it employs partial equilibrium analysis for analyzing an aggregate phenomenon like BoP. As a result, it ignores cross-correlations among relative goods prices and demand and supply. The Multiplier approach is based on a mixture of Hicks-Mosak general equilibrium analysis with Keynesian income-multiplier analysis which finds its development in the works of Harberger (1950), Laursen and Metzler (1950), and Meade (1951). From the Keneysian point of view, the elasticity analysis ignores the net multiplier effects of changes both in export proceeds and in spending on home and exportable goods associated with changes in import expenditure - changes in trade balance. , The assumptions underlying the derivation of the Marshall-Lerner condition imply that terms-of-trade changes are the only initial effect of devaluation. This approach does not take into account the effect of any change in exchange rate on real output and money variables of the economy. It explicitly assumes that any improvement in trade balance following devaluation is matched by saving in the form of accumulation of foreign exchange reserves, and that the resulting accumulation of hoards of foreign exchange has no feedback on the real economy.

The focus of foreign trade multiplier analysis centers on the automatic adjustment that would take place if a shift in a country's payments position occurred. Suppose that a country, initially in equilibrium, experiences a downward shift in demand for its exports, with a consequent initial deficit. The reduction in exports would lead to a decline in home-country income, which in turn would reduce expenditures via the multiplier. With a positive marginal propensity to import and to save , imports would decline by some fraction of the initial adverse shift in trade balance. This could partially offset the initial shift in equilibrium position.

The multiplier approach makes good the deficiency of the simple elasticity approach by recognizing and allowing for the implications of changes in expenditure on output, income, expenditure, and again output on BoP equilibrium. The analysis is based on the following assumptions :

a. The existence of unemployed resources whose rate of utilization can vary without ulterior consequences as a result of devaluation.

b. An infinite elasticities of supplies, making changes in exchange rate and terms-of-trade.

c. Exchange rate is merely a control device over terms-of-trade.

According to this model the effect of devaluation on trade balance may be obtained from the following equation :

$$\frac{1}{M}\frac{d(B_h/r)}{dr} = \frac{s_h\, s_f\, (\eta_h + \eta_f - 1)}{s_h\, m_f + s_f\, m_h + s_f\, s_h} \qquad .(2.3)$$

where M is imports, r is price of foreign currency in domestic currency, subscripts h and f denote home and foreign countries, s and m refer to marginal propensities to save and to import, and *n* represents elasticity of imports. This formula seems to suggest that apparently the more sophisticated Keynesian general equilibrium model is similar to the earlier elasticity model, since both seem to depend on the Marshall-Lerner condition - "sum-of-the-elasticities-minus-one".

The post-war economic conditions rendered the elasticities approach unsuitable and necessitated an alternative approach to analysis of BoP under conditions of post-war open inflation. Alexander's absorption approach is a major post-war development to this effect. This approach has been considered as the first step towards development of a BoP model within a macro-economic framework. The approach portrays a country's deficit in foreign trade as an excess of absorption over income, ie., of investment over saving. Devaluation can remedy this over-absorption. Consequent upon a devaluation domestic prices of imports would rise, so that to restore real cash balances to the desired level, it becomes necessary to 'hoard' money, thereby reducing absorption. The main formal development of the absorption approach is found in the works of Alexander (1952), though many others including Meade (1951), Tinbergen (1952) and Johnson(1958) have contributed. The "absorption" approach of Alexander was an attempt to bypass the "elasticities" issue and go to the heart of the matter, the then prevalent inflationary conditions. Johnson (1977b) describes it as half-way house to the full Keynesian analysis of BoP policy, another half-way house on a different route to the same destination being the extension of the "elasticities" approach by the addition of Keynesian multiplier theory.

The absorption approach treats BoP not simply as excess of residents' receipts from foreigners over residents' payments to foreigners but rather as excess of residents' total receipts over total payments. Formally,

$$B = R_f - P_f \qquad .(2.4)$$

where R_f is the excess of receipts of residents from foreigners, and P_f is payments by residents to foreigners. Since all payments by residents to residents (R_r) are simultaneously receipts by residents from residents (P), equation (2.4) can be written as

$$B = R_f + R_r - (P_f + P_r) \qquad (2.5)$$

Hence,

$$B = R - P \qquad (2.6)$$

where R is total receipts by residents, and P is total payments by residents.

At the heart of the absorption approach is the accounting identity viz.,

$$B \equiv X - M \equiv Y - A \qquad ...(2.7)$$

where B is trade balance, X is exports, M is imports, Y is income and A is absorption. The above identity may be written in first differences (A) as :

$$\Delta B = \Delta Y - \Delta A \qquad (2.8)$$

Equation (2.8) reflects change in B as a difference of changes in Y and A. Further, a change in A as a result of devaluation may be decomposed into a direct and an indirect change, the latter being the result of a change in Y due to devaluation. The indirect change in absorption depends on propensity to absorb. Devaluation may directly change the amount of real absorption associated with any given level of income. The change in A may be written as

$$\Delta A = c\Delta Y + \Delta D \qquad .(2.9)$$

where c is the sum of marginal propensities to consume and invest, and ΔD represents the direct effect of devaluation on absorption. By substituting (2.9) in (2.8), we get

$$\Delta B = (1-c)\Delta Y - \Delta D \qquad (2.10)$$

The above equation states that the effect of devaluation on trade balance depends on : (i) the effect of devaluation on real income; (ii) the magnitude of marginal propensity to absorb 'c' and (iii) how devaluation directly affects absorption at any given level of income - how large is AD. Alexander divides his subsequent discussion in to two parts viz., indirect effect and direct effect. The income effects of devaluation are: (1) idle resource effect and (2) terms-of-trade effect. Under direct effects he recognizes (1) cash-balance effect, (2) income re-distribution effect, (3) money illusion effect and (4) various miscellaneous effects.

If there are unemployed resources, increase in exports following devaluation brings about an increase in income via foreign multiplier. Also, devaluation causes a deterioration in terms-of-trade and hence a reduction in the country's real income. Hence the "idle-resource" and "terms-of-trade" effects upon income are opposite in direction, so that AY may have either sign. As a result, the effect of devaluation on AY remains ambiguous. As regards the effect of devaluation upon income and consequent income effect upon absorption, trade balance will improve only if c is smaller than unity. But, while marginal propensity to consume is usually less than unity, c, the combined marginal propensity (to consume, invest, and spend publicly) may well be greater than unity. If so (1 - c)AY will be negative and trade balance will deteriorate. As long as c is less than unity, any increase in income will increase absorption by less than the increase in income, and thus trade balance will improve. If c is larger than unity, devaluation will have a negative effect on trade balance, because the induced effects on absorption will be larger than the original effects on production.

The absorption approach suggests that removal of BoP deficits would normally require a simultaneous adoption of expenditure-switching and expenditure-reducing policies. An expenditure-switching policy implies that devaluation reduces imports and encourages exports in deficit country and switches demand in surplus countries for imports. If the Marshall-Lerner condition is met, these effects tend to improve the deficit country's trade balance but at the same time raise the level of aggregate demand in the deficit country via increased net exports. If resources in the country are near full capacity use, then a domestic expenditure reducing policy, such as a tax increase, would be necessary to avoid inflation.

The popularity of this theory has been due to its apparent close linkage with monetary sector of the economy in the sense that real expenditure can exceed real income if supply of real money exceeds demand for real money balances. In other words, deficit (or surplus) in BoP can be linked with excess supply (or excess demand) in money market.

Economists especially Machlup (1955) have questioned (1) the validity of the underlying framework of analysis, and (ii) Alexander's concentration on aggregate magnitudes and neglect of relative prices. Alexander's approach recognizes the need to rebuild real balances in the face of price rises after devaluation, but ignores reduction in money supply which is the counterpart of deficit which caused devaluation.

2.2.1. Elasticities and Absorption Approaches : Controversy and Synthesis

The absorption approach has been the target of a heated debate in the 1950's. Machlup, who is a strong critique of the absorption approach points out that it is not correct to neglect relative price of imports and exports (and so elasticities) to concentrate on absorption and income. These prices have a crucial importance in determining terms-of-trade effect and may also influence marginal propensity to spend. According to Machlup, Alexander's fundamental equation was nothing more than a definition, and therefore his absorption analysis was nothing more than an implicit theorizing based on tautologies." The accounting definitions do not allow one to draw causal inferences - that B depends on Y and A in a causal sense. Furthermore, in Alexander's analysis, all quantities are real variables, while from a BoP stand point what ought to be considered are money values. Since it is clearly possible for "real" and money balances to move in opposite directions, an analysis based on real values may well be misleading from a policy maker's point of view.

Several attempts have been made to reconcile the elasticity and absorption approaches to analysis of devaluation. The spirited controversy between Alexander and Machlup on the relative merits of these approaches to the problem of determining the effect of devaluation appears to have ended in the former's attempt to synthesize the two approaches. His synthesis consists of treating the initial effect of a devaluation on BoP (determined by the elasticities) as multiplicand to which a multiplier (determined by the propensities) is applied to obtain the final changes in national incomes of the two countries concerned and hence the induced changes in home country's imports and exports.

Alexander's synthesis has been criticized by Tsiang (1961). He pointed out an inconsistency in super-imposing of a multiplier upon the elasticities solution of effect of a devaluation. According to him, unless the supplies of exportables and domestic goods in both countries concerned are all infinitely elastic, so that prices in both countries (except prices of imports) will remain constant, the multiplier effect of the initial change in trade balance will bring about further changes in relative prices, and hence further substitution between imports and domestically produced goods in both countries. Thus if the conventional elasticities solution is treated as a sort of multiplicand to which a multiplier is to be applied to obtain the final effect, then multiplier itself should again involve the relevant elasticities that are in the multiplicand. There can be no neat dichotomy of the final effect of a devaluation into a part that consists of the elasticities solution and another that consists of the multiplier (or absorption) solution. The total effect of a devaluation must be analyzed in a comprehensive system in which changes in incomes, prices and outputs are all taken into consideration.

Alexander in his approach has brought out n fundamental fact viz..that, a negative trade balance necessarily implies national expenditure in excess of national income. This obvious truth has been underscored by Machlup who emphasized the role played by credit creation in sustaining excess expenditure in case of trade deficit and concluded that "nothing can be said about the effects of a devaluation unless exact specifications are made regarding the supply of money and credit". According to Tsiang, the contribution of Alexander-Machlup dispute is the rediscovery of the important role played by supply of money in BoP analysis. Tsiang has demonstrated the crucial role that could be played by monetary factors and showed in a more comprehensive way how relative prices and income-expenditure adjustments combine to determine the effect of a devaluation.

In an attempt towards a fuller reconciliation of elasticity and absorption approaches Yeager(1970) has pointed out that if the points of contract between the absorption and elasticity approaches had been obvious, the two would have amounted to one single approach, requiring no reconciliation. Actually, each employs its own distinct concepts. These give each approach an advantage over the other in drawing implications from certain types of empirical facts and in handling certain questions.

2.2.2. Keynesian "Policy" Analysis : The Meade - Tinbergen Model

The question of attaining external balance in foreign trade and BoP, and internal balance in domestic price stability and full-employment simultaneously finds its expression in the Keynesian "policy" analysis. This integrated model in an open economy has originated in Meade (1951) and Timbergen (1952). The model assumes that the country under analysis has a policy authority which utilizes "financial" (fiscal and monetary) and exchange rate policies in order to implement objectives with respect to full employment (internal balance) and BoP (external balance).

The central point of this theory for policy is that, if a country seeks to attain a BoP surplus while maintaining full employment, the solution is to combine a devaluation with a deflation in exactly the right proportions to maintain full employment total demand for output (foreign plus domestic) while reducing total domestic demand for foreign and domestic goods below the level of total domestic output by fiscal or monetary restraint. Similarly, the non-devaluer must inflate expenditure.

The association of a trade balance improvement with a devaluation depends on fulfillment not only of the "elasticity criterion" (the sum of the elasticities of import demand being greater than unity) but also of the "classical transfer criterion" (the sum of the marginal propensities to import out of expenditure being less than unity).

Johnson (1976a) has pointed out that the Keynesian "policy" approach ignores the stock-flow adjustment consequences of reserve flow associated with a BoP deficit or surplus. This adjustment process means that the combined policies of devaluation and deflation cannot produce a flow equilibrium BoP surplus. Instead, period-by-period expansion of cash balances consequent on BoP surplus will gradually raise the level of expenditure with an increase in domestic price level sufficient to reduce exports and increase imports sufficiently to make room for additional domestic demand. Such an increase is equivalent to an appreciation of foreign exchange rate, which partially offsets the initial devaluation; and in the long run the economy must return to equilibrium position ie., nominal devaluation is exactly offset by an inflation of domestic prices.

It may be remarked that the absorption approach is analytically superior to elasticity approach. However, neglect of the importance of elasticities and relative prices is not justifiable because price effects and income effects cannot be dichotomised. Relative price changes, combined with elasticities, affect income, and income changes affect relative prices and elasticities. Hence it may be concluded from the foregoing discussions that the absorption and elasticity approaches to the analysis of devaluation would lead to the same conclusions.

2.3. THE MONETARY APPROACH

The monetary approach to BoP (MABP) represents a revival of the price-specie-flow theory originally advanced by David Hume. The monetary approach was first outlined in the treatment by Hahn (1959) and further developed by Mundell (1968), Johnson (1972), Swoboda (1973), Dornbusch (1973), and Mussa (1974). It suggests that reserve flows are essentially a monetary phenomenon and thus, can be analyzed in relation to small country's money market. Hence it is argued that any disequilibrium in BoP is a reflection of disequilibrium in money markets.

The Monetary approach emphasizes on the monetary aspects of BoP adjustments under a system of fixed exchange rates rather than relative price and income effects that were the preoccupation of the elasticities approach and formed a major part of the absorption approach. It recognizes the fact that real variables affect BoP and exchange rates but they operate only through monetary channels.

The MABP may be explained with the help of a model which consists of five equations. The first element of the model is demand for money. This is taken to be a stable function of real income(Y), rate of interest(i) and price level(P)

$$M_d = L(Y, i, P) \qquad (2.11)$$

$$L'(Y), L'(P) > 0 \; ; \; L'(i) < 0$$

The second element is supply of money, which is defined as the sum of domestic assets of the banking system (domestic credit, D) and country's foreign exchange reserves (R)

$$M_s = D + R \qquad .(2.12)$$

Abstracting from the short-run adjustment process, in the long-run there is equilibrium in money market. Thus

$$L(Y, i, P) = D + R \qquad (2.13)$$

From equation (2.13), we have

$$\Delta R = \Delta L(Y, i, P) - \Delta D \qquad (2.14)$$

Since $\Delta D = DCE$ (domestic credit expansion), we have

$$\Delta R = \Delta L(Y, i, P) - DCE \qquad .(2.15)$$

The above equation summarizes the basic contention of the MABP that a deficit or surplus - as represented by changes in country's foreign exchange reserves is equal to the difference between change in demand for money and change in domestic credit. It follows that a continuous BoP deficit can occur only if authorities allow domestic credit to expand faster than demand for money.

The essence of the MABP is based on the Walras' Law according to which the sum of excess demands for goods and services, bonds and securities and money is zero. Thus

$$ED_g + ED_b + ED_m = 0 \qquad (2.16)$$

when subscripts g, b and m represent goods, bonds and money respectively.

In a fully employed economy closed to international trade in goods and assets, excess demand will be eliminated by changes in prices. But in an open economy such excess demand will be reflected in different net international flows in BoP accounts.

The BoP is constrained by :

$$(X_g - M_g) + (X_B - M_b) + (X_m - M_m) = 0 \qquad \ldots(2.17)$$

where X and M represent exports and imports. Thus the three accounts, current, capital and money must sum to zero. The budget constraint implies that if two markets are in equilibrium so too must the third market be. Thus an analysis of BoP could concentrate on current and capital accounts and ignore money account.

Though the MABP has emerged as the most celebrated model of BoP in international monetary theory, it is argued that, the model suffers from some internal contradictions. Many economists have questioned the validity of fundamental propositions of the approach that a surplus or deficit in BoP reflects stock disequilibrium between demand for and supply of money. The direct link between BoP and excess demand for money is of questionable validity. Rabin (1979) has demonstrated that a surplus in the BoP may be accompanied by an excess supply of money, while a deficit in the BoP may be accompanied by an excess demand for money by considering equilibrium in the market for non-traded goods. According to him a change in tastes in the home country away from traded goods to non-traded goods creates an excess supply of money through a BoP surplus. This excess supply helps generate upward pressure on price of non-traded goods.

Another notable point is that the proponents of the MABP contradict themselves with regard to specification of money demand function. Different versions of demand for money function are used either for exposition of the theory or for application of the theory to particular problems. According to Tsiang (1977) "there are two basic types of demand function for money employed in the monetary theory of BoP. Either nominal money balances are described as a function of real income, interest rate, and price level, or nominal money balances are treated as a function of money value of total real wealth and interest rate".

The MABP has been criticised for ignoring fiscal aspects of creating domestic credit. Kreinin and Officer (1978) has recognised the need to treat government budget constraint as one of the sources of domestic credit. According to them, government deficit may be financed by sales of government securities to private sector. However, the implications of government budget constraint are ignored by the MABP. Thus no specification is given of the means by which the money supply is expanded.

2.4. ANALYSES OF BoP DISEQUILIBRIUM : A SUMMARY

The three major approaches viz., elasticity, absorption and monetary approaches are distinct in their nature because each employs its own distinct concepts and looks upon the question of correcting BoP disequilibrium from different angles. These give each approach an advantage over the other in drawing implications from certain types of empirical facts and in handling certain questions.

The elasticities approach attributes a deficit on current account of BoP to wrong prices, including exchange rates, and centers attention on how sensitively imports and exports respond to price changes. The absorption approach views a deficit specifically on current account as an excess of country's total absorption of goods and services over its total production. The MABP on the contrary links a deficit to an excess supply of money. The elasticities and absorption approaches deal with BoP surpluses or deficits as flow equilibria, assuming either explicitly or implicitly, that the monetary implications of a lasting deficit or surplus on external account can be offset or sterilized by monetary authorities. A distinctive feature of the MABP however, is that it examines the implications for stock equilibrium of continuing flow of financial assets required to finance a continuing BoP surplus or deficits. According to Johnson (1976b) : "the essential difference between the MABP and the other post-Keynesian approaches ... is that the MABP formulates the problem of BoP as a monetary phenomenon to be analyzed with the tools of monetary theory, whereas the other approaches formulate it as a residual difference between real flows determined by other flows and relative prices".

2.5. THE MISSING LINKS

In one way or other, the various approaches/theories reviewed above are insufficient to analyze BoP. None of the underlying macro-theoretical frameworks in isolation can be used as a guide for the construction of an integrated model of BoP for a developing country like India because all of the models do omit certain essential components of analysis of BoP.

Miller (1978) questions the very monetarists' perspective on the relationship between state of money market and level of international reserves or BoP. He has pointed out that there are two situations where BoP bears no necessary relationship to money market. First is the situation when the central bank pursues an interest rate target type monetary policy rather than using a monetary aggregate as target. At any point in time the authorities will automatically adjust money supply so that money market clears at the desired rate of interest. Thus the MABP cannot be used to explain BoP when the authorities control interest rates.

The second situation as Currie (1976) has pointed out, arises when there is a nonzero value for the government budget. The MABP formally ignores government spending and taxing, and government budget constraint. Currie has argued that the MABP had implicitly omitted to allow for the effects of government budget constraint and necessary longer run interrelationship between government fiscal surplus and BoP surplus. Further, BoP can be seen not to be automatically equilibrating (except perhaps through slow working and costly price adjustments), so that discretionary government intervention is seen as necessary to maintain external equilibrium.

Currie has pointed out that a disequilibrium in money market does not necessarily have to be reflected in a BoP surplus or deficit, because it could be offset instead by a deficit or surplus on government budget ie., inflow (outflow) of money from a BoP surplus (deficit) need not disturb equilibrium of money market if accompanied by a government budget surplus (deficit). Any model for a developing country must recognize the linkage that exists between government fiscal operations and supply of money because government budget constraint and BoP constraint are precisely analogous to an open economy, and must necessarily be analyzed together. Against this, Nobey and Johnson (1977) counterpose the argument that governments are neither able to sustain continuing depletion of foreign reserves nor willing to accumulate reserves indefinitely.

Adherents of the MABP tend to assert that only monetary policy can have a lasting effect on BoP by reducing growth of domestic credit relative to growth in money supply; and that conventional policies like tariff, quota, devaluation etc.,can have only a transitory effect. In this context Mussa (1976) argues that, for both the Keynesian fixed-price models and monetarist flexible price models, "in the long run, tariff has no effect on the BoP but does have an effect (under fixed exchange rates) on the level of a country's foreign exchange reserves, brought about by a temporary change in the BoP". Currie has pointed out that this view is erroneous for underemployment Keynesian fixed-price models. For such models expenditure-reducing and expenditure-switching policies in the form of changes in government expenditure or tax revenues, imposition of import quotas or tariffs, or devaluation are shown to have permanent effects on BoP. With regard to the Keynesian model of BoP, Kuska (1978) argues that almost all models in the Keynesian BoP literature suffer from internal contradictions and deficiencies which make them unsuitable to provide a comprehensive Bop theory.

2.6. CONCLUDING REMARKS

This chapter has examined the basic theories of BoP found in the literature. It is observed that the conventional models including the Keynesian model are not adequate for analysis of BoP phenomenon. The survey reveals that omission of certain essential components of analysis of BoP including fiscal operations of the government and monetary policy of the central bank, render the theories unsuitable in certain contexts. In a country like India where persistent budget deficits exist, the link between budget deficit and BoP has to be recognized. None of the models reviewed seem to emphasize on this linkage. However, the monetary model to a certain extent can explain the problem. While all the theories together have identified the most important causes of BoP problem, each of the theories in isolation seem inadequate. It is evident from this review that the existing theories do not fare well in the Indian context in view of the fact that they do not agree upon the simultaneous interaction of real and monetary forces, consistent with institutional realities to determine the payments position. Hence, a broader analytical approach/model should be developed so that all the proximate causes - both monetary and non-monetary - of BoP problem be properly identified and corrective mechanisms suggested.

CHAPTER 3

THE KEYNESIAN APPROACHES TO BALANCE OF PAYMENTS
AN EMPIRICAL VALIDATION

3.0. INTRODUCTION

The recent emergence of the MABP to the forefront in BoP literature attracted the attention of economists on the question of the nature of BoP phenomenon. The analysis with Keynesian framework characterises BoP as real phenomenon determined by real forces while the monetarists hold the view that BoP deficits/surpluses have monetary causes. The traditional 'component approach' which refers to 'Keynesian' approaches seeks to explain BoP by way of modeling individually the determinants of various component accounts of the BoP. This is in contrast to the monetarists explanation of the behaviour of overall BoP. Comparing the policy implications of the Keynesian and monetary approaches, Laidler (1981) pointed out that if details of various component accounts of BoP are important for particular policy issues, the Keynesian approaches could be considered as appropriate tool for BoP analysis.

The present chapter has a two-fold objective. First, it intends to formulate and estimate a simple model of trade balance and BoP within the Keynesian theoretical framework. This model represents the traditional mode of analysis in terms of income and price changes. Secondly, it aims at verifying the causal relationships underlying the Keynesian income-absorption approach to analysis of trade balance as formulated by Alexander (1952).

3.1. THE SIMPLE KEYNESIAN MODEL

The Keynesian approach to BoP theory may be summarized by the following equations :

$$B = B\ (Y,\ e,\ P) \tag{3.1.1}$$

$$K = K\ (Y,\ r) \tag{3.1.2}$$

$$\Delta R = R\ (Y,\ e,\ P,\ r) \tag{3.1.3}$$

Equation (3.1.1) is nominal trade balance equation wherein B is trade balance, Y is domestic income, e is exchange rate and P Is price level. Equation (3.1.2) is net capital flow equation which is specified as a function of Y and interest rate (r). BoP is the sum of nominal trade balance and net capital flow. In this model trade balance is an inverse function of Y and P, and net capital flow a direct function of domestic interest rate, given constant foreign rates of interest. The exchange rate is a factor in this model because it influences the price competitiveness of exports and import substitutes and thereby net exports.

Equations (3.1.1) to (3.1.2) are estimated in the following form :

$$B_t = a_0 + a_1 Y_t + a_2 e_t + a_3 P_t + u_{1t} \tag{3.1.4}$$

$$K_t = b_0 + b_1 Y_t + b_2 r_t + u_{2t} \tag{3.1.5}$$

$$\Delta R_t = c_0 + c_1 Y_t + c_2 e_t + c_3 P_t + c_4 r_t \tag{3.1.6}$$

The major propositions of the Keynesian model comprising of the above three equations can be illustrated as follows :

(i) When income (Y) rises, the BoP deteriorates, for given price and exchange rate. Within the framework of a small country assumption and fixed exchange rate, a typical Keynesian model assumes that exports are exogenously determined and imports are a positive function of Y implying that BoP deteriorates with economic growth. Through a higher marginal propensity to import the real Y growth increases demand for imports and widens the current account deficit and contributes to currency depreciation.

(ii) When price level (P) rises, BoP deteriorates, for a given Y and interest rate. An increase in domestic price level, given the world price level, worsens trade balance in two ways. First, unless the country in question has monopoly in export supply, an increase in P leads to loss of price competitiveness and market. Consequently, volume of export falls and trade balance deteriorates. Secondly, an increase in P weakens the process of import substitution through substituting imports to domestic production.

(iii) When interest rate (r) rises, the BoP improves, for given Y and P. Since the net inflow of capital from abroad varies directly with domestic rate of interest, BoP improves with a higher r compared to rest of the world interest rate. This is on the basis of the argument, that international capital movements depend on the rate of return from holding assets domestically as compared with the rate of return on holding assets abroad.

(iv) When exchange rate (e) rises (devaluation), BoP improves, for a given Y, P and r. This is one of the controversial and widely debated proposition in economic literature. The assumption underlying the Keynesian model is that BoP improves consequent up on a relative price change favourable to devaluation-induced export expansion and acceleration of the pace of import substitution through devaluation-induced import compression. The elasticity approach explains devaluation in terms of Marshall-Lerner condition that devaluation will improve BoP position if the sum of a country's elasticity of demand for imports and foreign elasticity of demand for its exports exceeds unity. The Marshall-Lerner proposition has triggered off controversy between the 'elasticity optimists' and 'elasticity pessimists' on the magnitude of elasticities. According to the absorption approach, devaluation improves BoP if the income effect of devaluation on absorption (expenditure) is less than its original effects on production. That is, the combined marginal propensity to consume, invest and spend publicly is less than unity so that an increase in income will increase absorption by less than the increase in income. Contrary to these traditional analysis, the modern monetary analysis postulated that devaluation will not improve a country's BoP or if it improves, the effect will be transitory.

Another notable proposition of the Keynesian model is that when domestic money supply rises, BoP does not change unless Y, P or r change. Money supply influences BoP, but only through changes in Y, P and r.

3.1.1. Empirical Results

Equations (3.1.4) to (3.1.6) are estimated using OLS method the results of which are presented in table 3.1. The estimated results of the Keynesian trade balance equation showed that while all the coefficients carry expected sign, only those of Y and P are statistically significant. Since real bilateral exchange rate of the rupee (e) against US dollar are indirect exchange rates (foreign currency units per Rs. 100), a rise (fall) in e indicates appreciation (depreciation) of the rupee.

A negative and significant coefficient of Y nas two implications. First, as the Keynesian model assumes marginal propensity to import is high and hence the rate of growth of imports exceeds the rate of growth of Y. Secondly, it signifies the import intensity of economic growth. In an input-import dependent country like India, higher level of import is inevitable for higher growth rate of production which signifies that import substitution is not taking place in the economy corresponding to economic growth because of the inability to transform the domestic resources to importables. As long as the supply bottlenecks exist, high doses of imports have to be injected into the economy for every attempt to increase economic growth, which means that a curb on imports is possible only at a cost, of economic growth.

A rise in domestic price level given the world price level makes the country's export less competitive on the one hand and develops a tendency to substitute imports to high cost domestic goods on the other. Hence a price inflation will be followed by less exports and more imports which ultimately will deteriorate trade balance.

The model assumes that devaluation of currency improves trade balance by making export more competitive and imports more costly. However, the estimated coefficient of e is found to be insignificant. The ineffectiveness of exchange rate to improve trade balance especially in the Indian context has many implications.

(i) The Government resorts to devaluation anticipating a change in production and consumption patterns through a relative price change. But devaluation may not make any permanent improvement in trade balance in the case or India where both imports and exports are not very sensitive to relative price changes. It has been argued that most of the developing countries like India export goods which have low price and income elasticities but at the same time import goods for which price elasticity is very low and own income elasticity is high. This is supported by the fact that, the share of capital goods, components and raw-materials constitute more than 85 7. of India's imports which are termed as development imports. This high level of input-import dependency along with a devaluation/depreciation of currency can only deteriorate trade balance and BoP performance.

(ii) It is presumed that devaluation/depreciation could boost up exports only if it is sensitive to competitive conditions in the world market. But in practice only around 40 7. of India's exports is prone to competitive conditions.

(iii) If a rise in domestic price level as the model assumes, deteriorates BoP, it is an untenable proposition in the Indian context that devaluation/depreciation improves BoP, because devaluation creates an inflationary spiral in the economy. Devaluation affects domestic price directly by raising the prices of imports which ultimately enter into production process as inputs.

Given this reality, it is illogical to expect devaluation to exert a favourable effect on BoP in a country like India [Sahadevan (1992)]. Hence, the non-viability of the policy of devaluation in the Indian context has been indicated.

It is also observed from the estimated results of the capital flow equation (3.1.5) that relative interest rate is found to be insignificant in attracting foreign capital. The study considered one year deposit rates in India and one year Euro-dollar rate respectively for domestic and foreign interest rates. The ineffectiveness of interest rate in India may be justified on the ground that it is largely administrated during the sample period and a market-determined interest rate is desirable to attract more capital inflow.

The equation (3.1.6) for overall BoP proved to be a poor fit of the data with low R^2 . Except the price variable others are not statistically significant, but carry expected signs. According to the model, an increase in income and output has an uncertain effect on the BoP. Since a < 0 in (3.1.4) and b > 0 in (3.1.5), the combined effect of a_1 and b_1 on BoP is uncertain ; $c_1 \gtrless 0$ in (3.1.6). This is due to the operation of two basic forces on BoP in the processes of economic growth. On the one hand, growth in output tends to deteriorate trade balance, while it improves the capital account on the other. The relative strength of these two counteracting forces determines the course of BoP of a growing economy.

The model presumes that devaluation/depreciation would reduce foreign purchases as the relative price of foreign goods increases. Against the theory, depreciation of domestic currency may accelerate the import expecting the depreciation to continue. Hence, the possibility for anticipatory changes in exchange rate to affect the volume of international transactions is considered in the study by introducing in all equations an exported exchange rate (E) variable with an expected negative sign.

Following Warner and Kreinin (1993) a proxy for E is worked out as follows :

$$E = \left[0.7\ (e_t - e_t) + 0.3\ (e_{t-1} - e_{t-2})\right] \qquad (3.1.7)$$

where e is the defined as units of foreign currency per units of domestic currency.

The estimated results of the model incorporating E are presented in table 3.1. Though overall performance of the model has not improved, E is found to be significant with expected sign in trade balance and BoP equations. On the whole, it may be considered that the Keynesian model has not identified all possible determinants of trade balance, capital flow and BoP in the Indian context.

3.2. A TEST OF CAUSAL RELATIONS UNDERLYING THE ABSORPTION APPROACH

The absorption approach as suggested by Alexander (1952) has been considered as an early attempt towards development of a balance of payments model within a macro-economic framework. The approach portrays a country's deficit in foreign trade as an excess of absorption (ie., domestic expenditure) over income, ie., of investment over saving. Devaluation can remedy this over absorption.

At the heart, of the absorption approach is the accounting identity viz., $B \equiv X - M \equiv Y - A$, where B is trade balance, X is value of exports, M is value of imports, Y is income and A is total domestic absorption. From the above identity, it. may be written as $AB = AY - AA$ to reflect the change in B as a difference of the changes in Y and A. Further, a change in A as a result of devaluation may be decomposed into a direct and an indirect change, the latter being the result of a change in Y due to devaluation. The indirect change in absorption depends on propensity to absorb.

The absorption approach hypothesizes that a devaluation leads to trade balance via an income-induced change in absorption and a nonincome-induced, or directly effected, change in absorption. The net changes in income **and** absorption due to devaluation determine the change in trade balance. The approach suggests that, if foreign balance is to be improved, the community as a whole must reduce its absorption of goods and services relative to income.

The absorption approach has been the topic of heated debate in 1950's. Machlup, who is the strong critique of absorption approach accuses the approach of implicit theorizing based upon definitional tautologies such as $B \equiv Y - A$ or $\Delta B = \Delta Y - \Delta A$. These accounting definitions do not allow one to state that B depends on A and Y in a causal sense. It may be noted that causation can never be inferred from identities. Even in respect of non-identity functional relationships, there should be adequate theorizing and reference to facts governing a particular case. The approach specifies a unidirectional causal relation from income to absorption, and also from absorption to trade balance. The approach, however, conceals the possibility of a reverse causation from autonomous absorption to income. While income leads to an induced change in absorption, an autonomous change in absorption may lead to a change in income which is initially caused by devaluation. Hence, income and expenditure are interdependent ; expenditure depends on and varies with income, and income depends on and varies with expenditure because part of expenditure is devoted to home produced goods. Consequently, any change in either income or expenditure will initiate multiplier changes in both.

The omission of the effect of changes in absorption on income is a major weakness of Alexander's original analysis. When the effect of changes in absorption on income is incorporated into the model, the condition for the balance of payments to improve as a result of devaluation can be interpreted in the same way as before; but the magnitude of the change in the balance of payments will be different. If the net sum of the direct effect of devaluation on absorption is negative, this can be treated as an exogenous decrease in the autonomous components of expenditure which may cause via **the** multiplier a decrease in income, with a chain of further effects, neglected by the absorption approach (see also Gandolfo (1987), chapter 14).

The absorption approach is thus silent about a possible bidirectional causal relationship between income and expenditure. Hence, it is attempted to verify the nature of the causal relationship underlying the absorption approach. More specifically, an attempt is carried out to examine the causal relationship between income and absorption, and absorption and trade balance.

Tests are carried out on the Indian annual data spanning the period 1966-1988. The choice of the initial period coincides with India's devaluation of her currency in 1966, and the final period 1988 being the latest year for which all the required data are available. Data are in both aggregate and *per capita* terms. Granger's, Sims' and Hsiao's tests are used for testing causation. Also, following Holmes and Hutton (1990) an improved method of multiple rank F-test is carried out. A brief discussion of the tests is given in appendix **I.**

3.2.1. **Results of the** Study

The result of Granger, Sims, Hsiao and Multiple rank F tests are reported in table 3.2 to 3.7. A discussion of these tests is presented in appendix I. in order to remove the possible time trend component, a time trend variable is added to all equations for both Granger and Sims tests. Since the results of the two sets - without time trend and with time trend - did not make any difference, the results relating to the latter set are not reported. The

Final Prediction Error (FPE) criterion (as discussed in appendix I) is employed for fixing the optimum lag length for the Granger test. The relevant empirical results relating to FPE estimation are given in Table 3.7. While Granger test has been carried out for different lag combinations as dictated by FPE criterion, Multiple rank F-test is experimented with all combinations of lags 1 to 3. In case of Sims' test, all combinations of leads and lags ranging from 1 to 3 are experimented.

Table 3.2 reports the result of Granger test. It has not shown any evidence of causal relationship between income and absorption which in fact, does not provide any scope for deriving a conclusion in the light of any of the theoretical propositions. However, it shows a unidirectional causality running from absorption to trade balance which is the major link in the scheme of causation underlying the Alexander's analysis. The results of Sims' test reported in Tables 3.3 and 3.4 provide ample scope for supporting the Keynesian conception of interdependence between income and absorption. The Sims' test concerning absorption and trade balance shows a feedback between the two which goes beyond the scope of Alexander's analysis.

The Multiple rank F-test results presented in table 3.5 and 3.6, by and large, support Alexander's specification of unidirectional causality from income to absorption and the conventional Keynesian conception of interdependence of the two is rejected. Further, the test results bring into focus the absorption approach by providing support to the Alexander's hypothesis of absorption to be the cause of trade balance.

The results of Hsiao's two stage procedure (table 3.7) also make the study inconclusive by establishing a unidirectional causality running from absorption to income and a feedback between absorption and trade balance.

In short, while Multiple rank F-test provides consistent evidence in support of the scheme of causation underlying the absorption approach to devaluation, the other tests do not seem to provide any consistency of findings across them nor, any support to the absorption approach.

3.3. SUMMARY AND CONCLUDING REMARKS

In this chapter, an empirical analysis of Keynesian approaches to trade balance and BoP has been attempted. The results of the simple Keynesian model of BoP showed that the propositions and policy prescriptions underlying the model do not hold good in the Indian context. The estimated result of the BoP equation indicated that the payments position was not significantly explained by domestic income, exchange rate and interest rates. According to the model specification there exists a possibility for BoP position being unaffected by income. The deterioration in trade balance due to change in income may be compensated by a corresponding inflow of capital, ultimately offsetting each other with no net effect on BoP. The ineffectiveness of devaluation is of crucial significance in the Indian context, and is supported by the structuralists' argument that the Marshall-Lerner condition may not be satisfied in practice due to the persistence of certain rigidities in domestic production which keep both the supply of exports and the demand for imports inelastic to a change in relative price. It may be concluded from the overall estimated results that the international payments position of India was not explained by the model.

An attempt is also made in the present chapter to test the bivariate causal relationship among income, absorption and trade balance using the Granger, Sims, Hsiao and multiple rank F-tests. The evidences from the first two tests rejects the basic contention of the absorption approach - a unidirectional causal relationship running from income to absorption. While the Granger test established independence between the two, the Sims test showed a bidirectional causality. The feedback from absorption to income may be justified from the Keynesian line of argument wherein absorption causes via a multiplier, a change in income with a chain of further effects, depending on the magnitude of propensity to spend, which are neglected by the absorption approach.

The interdependence of income and absorption impart an element of complexity in the analysis of impact of devaluation on trade balance. However, the condition for BoP to improve as a result of devaluation still holds good. But the circular causal relationship between income and absorption leads to a significant change in the magnitude of trade balance as against what Alexander prescribed. This in fact, makes its policy prescription (that the simultaneous adoption of expenditure-switching and expenditure reducing policies when output is at near full employment level) more effective to improve trade balance.

A major link in the scheme of causation underlying Alexander's analysis is the unidirectional causation running from absorption to trade balance which has been empirically supported by the Granger and multiple rank F-tests. The implication of this finding is that an excess of absorption over income, according to the approach, leads to a trade deficit. Hence, a cut in domestic expenditure is suggested to improve the external position. The results of the multiple rank F-test justify the causal framework underlying the absorption approach viz., a unidirectional causality from income to absorption, and absorption to trade balance.

TABLE 3.1

Estimated Results of the Keynesian Model

$$B_t = 4148.2 - \underset{(-2.50)}{0.097}\, Y_t^{*} - \underset{(-2.40)}{69.15}\, P_t^{*} - \underset{(-0.73)}{13.90}\, e_t + \underset{(4.54)}{475.99}\, T^{*}$$

$$R^2 = 0.94 \quad D\text{-}W = 2.29 \quad \rho = 0.62$$

$$K = -6926.3 + \underset{(9.26)}{0.187}\, Y_t^{*} + \underset{(0.78)}{502.92}\, r_t - \underset{(-5.86)}{501.3}\, T^{*}$$

$$R^2 = 0.95 \quad D\text{-}W = 1.93 \quad \rho = 0.55$$

$$\Delta R_t = -615.9 + \underset{(0.769)}{0.0168}\, Y_t - \underset{(-1.72)}{26.40}\, P_t - \underset{(-0.46)}{4.88}\, e_t + \underset{(0.30)}{105.69}\, r_t + \underset{(1.12)}{57.59}\, T$$

$$R^2 = 0.41 \quad D\text{-}W = 1.83 \quad \rho = 0.56$$

$$B_t = 5953.0 - \underset{(-3.8)}{0.178}\, Y_t^{*} + \underset{(0.121)}{2.697}\, P_t - \underset{(-1.21)}{372.78}\, e_t - \underset{(-2.45)}{286.56}\, E_t^{*} + \underset{(0.20)}{473.7}\, T$$

$$R^2 = 0.92 \quad D\text{-}W = 1.82$$

$$K_t = -6858.9 + \underset{(12.5)}{0.178}\, Y_t^{*} + \underset{(1.58)}{964.9}\, r_t + \underset{(1.61)}{634.1}\, E_t^{***} - \underset{(-9.5)}{495.1}\, T^{*}$$

$$R^2 = 0.93 \quad D\text{-}W = 1.33 \quad \rho = 0.01$$

$$\Delta R = 742.41 - \underset{(-0.23)}{0.041}\, Y_t - \underset{(-0.67)}{7.63}\, P_t - \underset{(-1.07)}{9.70}\, e_t + \underset{(2.12)}{476.2}\, r_t^{**} - \underset{(-2.80)}{135.95}\, E_t^{*} + \underset{(1.34)}{42.37}\, T$$

$$R^2 = 0.43 \quad D\text{-}W = 1.76$$

* Significant at 1 % level
** Significant at 5 % level
*** Significant at 10 % level
Values in parentheses are the t-statistics
In the cases where estimates of coefficients are adjusted for first-order auto correlation using the Cochrane-Orcutt procedure, the auto-correlation coefficient p is given.

TABLE 3.2

GRANGER TEST : Causality between Income and **Absorption and Absorption** and **Trade Balance**

Hypothesis	(m,n)	$\bar{R}^2$	F-statistics	sig. level	Inference
Income —> Absorption	(1.1)	0.98	0.3221	0.58	Absorption and income are independent of each other.
Absorption —> Income	(1,3)	0.99	1.6261	0.23	
T.balance —> Absorption	(1,3)	0.98	1.7417	0.20	A unidirectional causality from absorption to trade balance.
Absorption —> T.balance	(1,2)	0.82	6.3864	0.01	

m and n represent own lag and lag of other variable respectively, and the F statistics correspond to the test that the sum of the n coefficients is zero.

TABLE 3.3

SIMS TEST : Causality between Income and Absorption

Hypothesis	(n1,n2)	$\bar{R}^2$	F-statistics	sig.level	Inference
Income —> Absorption	(1,1)	0.99	0.0853	0.77	
	(1,2)	0.99	1.5372	0.23	Income and
	(1,3)	0.99	5.7559	0.03	absorption
					are inter-
Absorption —> Income	(1,1)	0.99	0.7090	0.41	dependent
	(1,2)	0.99	2.9800	0.11	of each
	(1,3)	0.99	9.2898	0.01	other.
Income —> Absorption	(2,1)	0.99	0.4062	0.67	Income and
	(2,2)	0.99	1.1120	0.36	absorption
	(2,3)	0.99	3.0300	0.09	are inter-
					dependent
Absorption —> Income	(2,1)	0.99	0.6674	0.53	of each
	(2,1)	0.99	3.0492	0.08	other.
	(2,3)	0.99	5.5263	0.01	
Income —> Absorption	(3,1)	0.99	0.9604	0.44	Income and
	(3,2)	0.99	1.6470	0.24	absorption
	(3,3)	0.99	2.3810	0.14	are inter-
					dependent
Absorption —> Income	(3,1)	0.99	0.5660	0.65	of each
	(3,2)	0.99	2.0308	0.17	other.
	(3,3)	0.99	3.1515	0.08	

nl and n2 denote lead and lag values respectively of the right hand side variable, and the F statistics correspond to the test that the sum of lead coefficients is zero.

TABLE 3.4

SIMS TEST : Causality between Absorption and Trade Balance

Hypothesis	(n1,n2)	$\bar{R}^2$	F-statistics	sig.level	Inference
T.balance —> Absorption	(1,1)	0.64	3.7960	0.06	Absorption and
	(1,2)	0.73	3.2208	0.09	trade balance
	(1,3)	0.78	1.8965	0.19	are interde-
					pendent of
Absorption —> T.balance	(1,1)	0.52	0.3090	0.59	each other.
	(1,2)	0.59	0.0003	0.99	
	(1,3)	0.61	0.0713	0.79	
T.balance —> Absorption	(2,1)	0.72	4.9991	0.01	Absorption and
	(2,2)	0.76	3.7580	0.05	trade balance
	(2,3)	0.84	1.9566	0.19	are interde-
					pendent of
Absorption —> T.balance	(2,1)	0.62	2.0689	0.16	each other.
	(2,2)	0.70	1.6748	0.23	
	(2,3)	0.70	0.5918	0.57	
T.balance —> Absorption	(3,1)	0.73	4.5134	0.02	Absorption and
	(3,2)	0.81	3.6600	0.05	trade balance
	(3,3)	0.88	3.5098	0.06	are interde-
					pendent of
Absorption —> T.balance	(3,1)	0.79	7.0814	0.01	each other.
	(3,2)	0.78	3.3022	0.06	
	(3,3)	0.75	1.3917	0.31	

nl and n2 denote lead and lag values respectively of the right hand side variable, and the F statistics correspond to the test that the sum of lead coefficients is zero.

TABLE 3.5

MULTIPLE RANK F - TEST : Causality between Income and Absorption

Hypothesis	(k1,k2)	$\bar{R}^2$	F-statistics	sig.level	Inference
Income —> Absorption	(1,1)	0.98	14.778	0.00	Income and
	(1,2)	0.99	15.294	0.00	absorption
	(1,3)	0.98	10.073	0.00	are inter-
					dependent
Absorption —> Income	(1,1)	0.99	1.7616	0.20	of each
	(1,2)	0.99	4.8263	0.02	other.
	(1,3)	0.99	4.7000	0.02	
Income —> Absorption	(2,1)	0.98	4.8787	0.04	A unidirec-
	(2,2)	0.99	6.9860	0.01	tional cau-
	(2,3)	0.98	5.0621	0.02	sality from
					income to
Absorption —> Income	(2,1)	0.99	1.2590	0.28	absorption.
	(2,2)	0.99	0.7538	0.49	
	(2,3)	0.99	1.4452	0.27	
Income —> Absorption	(3,1)	0.98	2.2868	0.15	A unidirec-
	(3,2)	0.98	4.3934	0.03	tional cau-
	(3,3)	0.98	3.6926	0.04	sality from
					income to
Absorption —> Income	(3,1)	0.99	1.9729	0.18	absorption
	(3,2)	0.99	1.3026	0.30	
	(3,3)	0.99	1.0465	0.41	

kl and k2 indicate own lag and lag values of other variable respectively, and F statistics correspond to the test that the sum of k2 coefficients is zero.

TABLE 3.6

MULTIPLE RANK F - TEST : Causality between Absorption and Trade Balance

Hypothesis	(k1,k2)	$\bar{R}^2$	F-statistics	sig. level	Inference
T.balance —> Absorption	(1,1)	0.97	0.0013	0.97	A unidirectional causality from absorption to trade balance.
	(1,2)	0.96	1.5362	0.34	
	(1,3)	0.95	0.7616	0.53	
Absorption —> T.balance	(1,1)	0.66	4.1965	0.06	
	(1,2)	0.73	5.2240	0.02	
	(1,3)	0.70	2.6660	0.09	
T.balance —> Absorption	(2,1)	0.98	0.0209	0.89	A unidirectional causality from absorption to trade balance.
	(2,2)	0.98	0.8512	0.45	
	(2,3)	0.97	1.3126	0.31	
Absorption —> T.balance	(2,1)	0.67	5.2654	0.04	
	(2,2)	0.75	6.5424	0.01	
	(2,3)	0.73	3.5910	0.04	
T.balance —> Absorption	(3,1)	0.98	0.9205	0.35	A unidirectional causality from absorption to trade balance.
	(3,2)	0.98	2.4494	0.12	
	(3,3)	0.98	2.4889	0.11	
Absorption —> T.balance	(3,1)	0.65	4.2664	0.06	
	(3,2)	0.73	5.3862	0.18	
	(3,3)	0.71	3.3532	0.05	

kl and k2 indicate own lag and lag values of other variable respectively, and F statistics correspond to the test that the sum of k2 coefficients is zero.

TABLE 3.7

FPE Values for Univariate and Bivariate Processes

(m,n)	FPE(m) values: Income (Y)	Absorption (A)	Trade balance (B)	FPE(m*,n) values: Y_t on Y_{t-m}^* and A_{t-n}	A_t on A_{t-m}^* and Y_{t-n}	A_t on A_{t-m}^* and B_{t-n}	B_t on B_{t-m}^* and A_{t-n}
1	2575.7*	2985.1*	0.014*	2824.2	3217.1*	3193.7	0.01379
2	2873.6	3268.0	0.016	3036.0	3552.2	3013.5	0.01040*
3	2762.4	3355.7	0.018	2456.4*	3300.3	2970.9*	0.01193
Causal direction				$A_t \rightarrow Y_t$	$Y_t \not\rightarrow A_t$	$B_t \rightarrow A_t$	$A_t \rightarrow B_t$

Inference (i) Absorption causes income and not vice versa.
Hsiao Test (ii) Trade balance and absorption are interdependent of each other

m and n indicate own lag and lag of other variable respectively.
* indicates the lowest FPE values.

CHAPTER 4

MONETARY MODEL OF BALANCE OF PAYMENTS UNDER FIXED AND MANAGED FLOATING EXCHANGE RATE REGIMES

4.0 INTRODUCTION

The objective of the present chapter is to examine the validity of the MABP and its variant, the Girton-Roper monetary model of exchange market pressure, in the Indian context. The Indian economy provides the conditions necessary for empirical test of MABP because India suits the description of a "small, open" economy in the sense that world monetary conditions and world prices for goods, services and capital faced by India are given and over which India has little control.

Most of the previous studies in the Indian context [Uddin (1985), Kannan(1989), Raghavan and Saggar (1989)] have used only the monetary model under fixed exchange rate without distinguishing the two distinct exchange rate regimes - fixed regime up to 1975 and managed floating regime after 1975 - prevalent over the period of study. Hence, in this chapter two distinct models are fitted to the Indian data. First, a prototype monetary model has been fitted for the fixed exchange rate period 1950-1975. Second, the monetary model of exchange market pressure is applied to investigate the link between domestic money market and a combined variation in reserves and exchange rate for the managed floating exchange rate regime from 1976 to 1990.

For the convenience of presentation, the present chapter is divided into three parts. Part I deals with an econometric analysis of the MABP under fixed exchange rate regime from 1950 to 1975. Part II examines the MABP under managed floating exchange rate system and its empirical test for the period 1976 to 1990. Part III carries the summary of results and conclusion.

I

4.1 AN OUTLINE OF MABP

The MABP in recent years emerged as an alternative to various Keynesian approaches. The approach, developed in the later half of 60s and early 70s by Mundell (1968) and Johnson (1972) is deeply rooted in David Hume's "price-specie-flow mechanism". Johnson (1977c) attributes development of MABP theory to two recent historical events. First, the initial failure of British devaluation of 1967 falsified the policy prescriptions and predictions of elasticity approach with respect to the manipulation of exchange rate of currency to improve trade balance. Secondly, the failure of orthodox Keynesian theory to suit to inflationary conditions after 1965 contributed to the revival of classical Humean line of thought which attributed inflation to excess growth of world money supply initiated by the US monetary policy. Some writers have emphasized on the monetary aspects of BoP even prior to Mundell and Johnson leg., Tsiang, (195?,), Polak (1957)1. However, the approach attained its refinement at. the Chicago School and is identified with the names of Mundell and Johnson.

The MABP asserts that money demand function and money supply process play a central role in BoP analysis particularly in the long-run. It, however, is not identified with the view that "only money matters". Instead, it provides a broad framework of analysis for BoP problem through explicit specification of monetary behaviour, and its integration with "real" factors. This does not mean that real forces do not affect BoP (or vice versa). It only means that the 'real' factors must first affect demand for and supply of money to influence the BoP.

Mussa (1974), a prominent advocate of the MABP summarizes the broad principles underlying the MABP into three basic features :

(i) BoP is essentially (but not exclusively) a monetary **phenomenon**
According to the MABP, the only analytically valid definition of BoP is the balance on "money account", that is official settlements balance (OSB) which shows flow of international reserves. Thus BoP position represents a net flow of money between residents of one country and rest of the world. The OSB is in surplus (deficit) when the monetary authorities of a country are purchasing (selling) foreign-exchange assets in order to prevent their own money from appreciating (depreciating) relative to other monies. Thus, analysis of BoP only makes sense in an explicitly monetary mode), and, in this sense, BoP is essentially a monetary phenomenon.

The MABP is different from other approaches in the sense that it interprets equilibrium on BoP in terms of 'below the line[1] transactions. It constitutes an aggregative approach to BoP analysis instead of a component-wise analysis. The rationale for this contention is that various sub-aggregates such as trade balance, current account balance, basic balance are interdependent **and** may be affected by mutually offsetting transactions. Consequently, any of these conventional sub-aggregates constitute an unreliable proxy for a country's net balance of total international transactions. Elasticity and absorption approaches consider equilibrium in terms of autonomous transactions, and treat the analysis from a flow view point since capital transaction is ignored.

(ii) Demand for and supply of money : The fundamental behavioral determinants of BoP emanate from domestic money market. More precisely, the MABP finds the relationship between demand for and supply of money as critical determinants of BoP. Demand for money is assumed to be a stable function of a small number of variables such as price (P), real income (Y), and rate of interest (i). Symbolically it may be written as

$$M_d = P\ f(Y,i) \qquad (4.1.1)$$

Multiplication of demand for money f(y,i) by P assumes the standard homogeneity postulate of monetary theory. Supply of money (Ms) is money multiplier (m) times the monetary base (B). Symbolically it may be written as

$$Ms = m\ B \qquad (4.1.2)$$

Monetary base (B) comprises of a domestic component (D) and an international reserve component (R). Hence,

$$B \equiv D + R \quad (4.1.3)$$

Equation (4.1.3)is called the "monetary-base identity". Since $M_s \equiv M_d$,

$$R = (1/m)\ M_d - D \quad \text{or} \quad (4.1.4)$$

$$\frac{dR}{dt} = \frac{1}{m}\ \frac{dM_d}{dt} - \frac{dD}{dt} \quad (4.1.4a)$$

provided m is a constant (at the estimation stage the assumption of constant money multiplier is relaxed). Since dR/dt is nothing but BoP and is identically equal to the difference between rate of change of money stock and rate of domestic credit creation, equation (4.1.4a) underlines that BoP is a monetary phenomenon.

The **MABP** does not assume a constant domestic component of monetary base. Any change in domestic component of monetary based is ultimately offset by an equal and opposite change in international *reserve* component through BoP. An important assumption underlying this fundamental monetarist proposition is that money demand is a stable function of a very few variables which are independent of the factors that influence money supply.

(iii) Long-run horizon : One of the crucial elements in monetarists' methodology is that the relationships are hypothesized to hold in the long-run. The assumption of full- employment in the model is defended on this ground. Further, the assumption of stable supply process and a stable **money** demand **function** applies to long-run.

4.1.1 Econometric Implementation

For an econometric implementation of the model, let us assume without loss of generality that f(Y,i) is given by

$$f(Y,i) \;=\; Y^{\beta_y} \; i^{-\beta_i} \qquad .(4.1.4b)$$

where β and β_i are income and interest elasticities respectively of demand for money.

Taking logs on both sides of equations (4.1.1) and (4.1.2), and using equation (4.1.4b) and the identity M = ML, we have

$$\ln P + \beta_y \ln Y - \beta_i \ln i = \ln m + \ln B \qquad .(4.1.4c)$$

Using equations (4.1.3) in equation (4.1.4c) we get

$$\ln P + \beta_y \ln Y - \beta_i \ln i = \ln m + \ln (R+D) \qquad (4.1.5)$$

Differentiating (4.1.5) with respect to time (t) we get,

$$\frac{d \ln P}{dt} + \beta_y \frac{d \ln Y}{dt} - \beta_i \frac{d \ln i}{dt} = \frac{d \ln m}{dt} + \frac{d \ln (R+D)}{dt}$$

$$= \frac{d \ln m}{dt} + \frac{1}{R+D}\frac{dR}{dt} + \frac{1}{R+D}\frac{dD}{dt}$$

$$= \frac{d \ln m}{dt} + \frac{1}{R+D} R \left[\frac{1}{R}\frac{dR}{dt}\right] + \frac{1}{R+D} D \left[\frac{1}{D}\frac{dD}{dt}\right]$$

$$= \frac{d \ln m}{dt} + \frac{R}{R+D}\frac{d \ln R}{dt} + \frac{D}{R+D}\frac{d \ln D}{dt} \qquad (4.1.5a)$$

Writing $\frac{d}{dt} = \Delta$ in (4.1.5a), we get

$$\Delta \ln P + \beta_y \Delta \ln Y - \beta_i \Delta \ln i = \beta_m \Delta \ln m$$

$$+ \frac{R}{R+D} \Delta \ln R + \frac{D}{R+D} \Delta \ln D \qquad (4.1.5b)$$

By rearranging the terms, equation (4.1.5b) may be written as :

$$r = \Delta \ln P + \beta_y \Delta \ln Y - \beta_i \Delta \ln i - \beta_m \Delta \ln m - d \quad ....(4.1.6)$$

where $r = \{R/(R+D)\} \Delta \ln R$ and $d = \{D/(D+R)\} \Delta \ln D$

The above equation is estimated in the following form :

$$r_t = \beta_0 + \beta_1 \Delta \ln P_t + \beta_2 \Delta \ln Y_t + \beta_3 \Delta \ln i_t + \beta_4 \Delta \ln m_t + \beta_5 d_t + \mu_t \qquad .(4.1.7)$$

Where βs are parameters to be estimated and μ is the error term.

The MABP can be tested by estimating equation (4.1.7) which is known as the reserve flow equation. The coefficient of d i.e., β_5 is known as the "offset coefficient". It shows the degree to which changes in domestic component of monetary base are offset by changes in international component. The MABP postulates that for a given amount of money demanded and a given money multiplier, changes in domestic component of monetary base (D) **will** cause equal and opposite changes in R. The expected value of the offset coefficient (β_5) is therefore -1. It is the most crucial value from the point of view of verification of the MABP.

4.1.2. Propositions of the Model

While estimating equation (4.1.7), it is assumed that Y, P, i and d are all exogenous. Exogeneity of Y is justified on the ground of long-run full-employment; i and P are assumed exogenous on the ground that a country is small in world goods and financial markets; and since it is assumed that the authorities do not sterilize the effects of reserve changes on money supply (ie., if R increases D is not decreased) D may be assumed exogenous. A detailed discussion of these assumptions is given in chapter 5.

The coefficient of income variable is expected to be positive and around unity. According to the MABP, if an economy is growing over time it will *ceteris paribus* possibly run a BoP surplus. This is because income growth in this model increases demand for money which for a given rate of increase in domestic component of money supply, can only be satisfied via foreign exchange market. This is in sharp contrast with the Keynesian view that real income growth increases demand for imports, widens current account deficit and contributes to currency depreciation.

Under the monetarist assumption of absence of money illusion, the coefficient on price variable is expected to be unity. To quote Zecher (1974) "an increase in prices will reduce real money balances **and, other** things equal, lead to a reserve inflow just sufficient to restore real money balances to their previous level". The MABP suggests that an increase in home interest rate results in a BoP deficit. It views, as Kreinin and Officer (1978) noted, a rise in domestic interest rate as increasing the opportunity cost of holding money. The increased cost reduces demand for money as people switch over from money to bonds, and produces an excess supply of money leading to a BoP deficit. Hence, the coefficient on interest rate variable is expected to be negative. Finally, the coefficient associated with money multiplier is expected to have a value of -1, as money multiplier is a multiplicative factor in supply of money. Non-monetary theories, according to Kreinein and Officer, would accept a negative coefficient on the ground that increase in money supply causes BoP to deteriorate. But the coefficient is expected to be below unity in absolute value, because a unitary coefficient implies complete offsetting of an increase in money supply through an outflow of reserves. All these exogeneity restrictions commonly considered to provide a test of reserve flow proposition of the MABP, are in contrast with the traditional Keynesian views.

If there is no sterilisation of reserve changes and if the above exogeneity conditions are satisfied, then equation (4.1.7) may be estimated using OLS method. If Y, P and i are not exogenous and are affected by supply of money, and/or authorities sterilize reserve flows, then OLS estimates may be affected by simultaneous equation bias.

4.1.3. STERILISATION OF RESERVE FLOWS

Sterilisation equation or "government policy reaction function" reflects government's policy to sterilize reserve flows. Bank credit being a major source of fund of government, and monetary authorities not having much control over government's borrowing from the banking system, sterilisation equation assumes significance in empirical testing. As David Cobham (19R3) rightly puts : "sterilisation is essentially a complicating factor which should be allowed for in empirical testing to avoid biased estimates".

Following Genberg (1976), sterilisation equation may be specified as :

$$d_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \Delta \ln GD_t + \varepsilon_t \qquad .....(4.1.8)$$

where GD represents government's domestic debt outstanding, r and d are as defined earlier, as are parameters, and c is error term. Equation (4.1.8) assumes that open market operations are dictated by change in international reserves (sterilisation hypothesis) and change in government debt outstanding (on the hypothesis that the central bank is a large source of finance for the government). The coefficient of r i.e., (a) in the above equation is called the "sterilisation coefficient". It measures the thrust of monetary policy to sterilize the impact of reserve flows on monetary base. Under complete sterilisation, this coefficient would be -1. It may however, be noted that the MABP assumes that no sterilisation takes place and therefore, postulates a zero value for sterilisation coefficient.

4.1.4. Issues and Evidence : a Note

In the '80s attempts to examine the validity of the MABP have not been scarce in the Indian context. An early attempt was made by Bhatia(1982) who examined BoP and monetary policies during the fixed exchange rate period 1951-1973. He estimated reserve flow and demand for money equations ignoring the possibility of sterilisation, and consequent simultaneous equation bias. It may however be noted that exogeneity of domestic component of monetary base (D) as the model assumes, becomes invalid in cases where central bank follows sterilisation policy. An autonomous reserve inflow will, according to Genberg (1976) cause the central bank to contract D by the same amount in order to prevent BoP surplus from affecting money supply. Sterilisation thus, can lead to a close inverse relationship between reserve flows and D. Hence it is necessary to relax the assumption of absence of sterilisation in empirical testing to avoid biased estimates of the model.

Sohrab Uddin (1985) estimated the reserve flow and sterilisation equations simultaneously and found that the monetary model was inadequate in the context of India, Pakistan and Thailand for the period 1960-1980 . On similar lines Kannan (1989) tested whether disequilibrium in domestic money market exerted any influence on BoP of India during 1968-85, but concluded that domestic monetary disequilibrium had a dominant influence on India's international reserve flows. For the period 1961-85 Raghavan and Saggar (1989) estimated the reserve flow equation which supported the MABP, while their sterilisation equation cast - doubt on the direction of causation between international reserves and domestic credit. They reported a value of -1.18 for the sterilisation coefficient against the predicted zero value.

In a recent study Joshi (1990) tested the usefulness of this approach by estimating the reserve flow equation with annual data for the period 1953-72. The study has also employed the exchange market pressure (EMP) model on quarterly data for the period 1976-85. That aspect is reviewed in part II of this chapter. Showing high R^{-2} and statistically significant but less than -1 offset coefficient, the study concluded that the performance of the model was good. The study however, ignored to include the sterilisation equation in his model.

The sterilisation equations of Sohrab Uddin (1985), Kannan (1989) and Raghavan and Saggar (1989) had domestic credit (D) as a function of reserves (R) along with other variables. While Sohrab Uddin used change in R and change in government domestic debt outstanding (GD), Kannan considered change in R, income, expected rate of inflation, money multiplier and price index as explanatory variables. Raghavan and Saggar confined to only R and prices in sterilisation equation. In fact, except Sohrab Uddin, others had not provided any justification for inclusion of additional variables in their equations. Sohrab Uddin justified inclusion of change in GD on the ground that the central bank had been a major source of finance for the government. Kannan used expected rate of inflation as a proxy for interest rate on the ground that the range of financial assets is fairly limited in India. However, considering changes in domestic expected rate of inflation as proxy for world interest rate may be called into question.

The results of the Indian studies seem inconsistent. Uddin's study shows values of 0.52 and 0.64 respectively for the offset and sterilisation coefficients, which contradict the underlying basis of the MABP. Kannan's model despite being a variant of the original MABP model in a limited sense, has shown values of -1.1 and -0.32 respectively for the offset and sterilisation coefficients, Raghavan and Saggar obtained -1.2 value for sterilisation coefficient which reflects complete sterilisation of changes in R.

With the exception of that of Joshi, the studies reviewed above seem to share a common limitation of not taking into account the shift in exchange rate system from fixed to managed float in India in 1975. The combined movement of exchange rate and international reserves needs to be studied in a different model framework.

The inconsistent evidence across the studies may have been due to a specification error by way of omitting certain key variables in reserve flow equation. As Magee(1976) pointed out, exclusion of exchange rate change might result in a specification error. According to him, increase in D will lead to a depreciation of exchange rate. This absorbs some of excess supply of money so that reserves do not fall equi-proportionately. Thus, estimates of the offset coefficient less than unity in absolute value may imply specification error rather than a refutation of the MABP [Magee (1976)1. Hence, in a managed floating exchange rate system where there is combined variations in foreign reserves and exchange rates, specification of the model has to be modified in order to accommodate exchange rate changes as one of the arguments in money demand function.

The task of interpreting the coefficients of P, Y and i is complex due to certain restrictions imposed on the model. The chief arguments in money demand function ie., P, Y and i are supposed to represent not only the domestic economy but also the whole world, because the MABP presumes that one country's domestic monetary conditions relative to that of the world is the determining factor for reserve flows. The assumption of the 'law of one price' makes domestic price level to represent the whole world. In all the studies either wholesale price index or consumer price index has been taken to proxy price level. The price-taking assumption refers specifically to price equilibration in tradeable goods sector. Hence, Bean (1976) has suggested an index of traded goods. According to him a composite of export and import price indices should represent the price level. Consumer goods prices according to him are a biased proxy of traded goods because of high service content. Wholesale prices though retain non-tradables, do not include services.

Most of the studies validate the monetarist's assumption of negative coefficients on the interest rate variable. However, in most cases the value of β_{7} [in equation (4.1.7)] is very less signifying that changes in interest rate do not significantly affect holding of money. Justifying a very low value of β in the case of Honduras, Wilford and Wilford (1978) pointed out that in less developed financial markets, cost of rearranging portfolios on the basis of interest rate movement is higher than developed financial markets since there are fewer asset alternatives. On the other extreme, it is argued that the estimate of β can be positive if changes in domestic interest rates are dominated by changes relative to the rest of the world. As Mundell-Fleming model postulates, other things equal, increase in domestic interest rate relative to rest of the world improves BoP position through a net inflow of capital. This is on the basis of the argument that international capital movement depend on the rate of return from holding assets domestically as compared with the rate of return on holding assets abroad.

It may be argued that the MABP is applicable to those cases where the offset coefficients have the expected sign. A generalisation is possible only if we take into account the sterilisation equation too. In most of the studies the estimated sterilisation coefficient lies between zero and -1 which supports presence of certain degree of sterilisation. According to Magee (1976), sterilisation will lead to a magnification of the coefficient on domestic credit variable : it will be greater than one in absolute terms. If the monetary authorities sterilize partially, reducing domestic credit by some fraction of reserves inflow, then home money demand is still unsatisfied and more reserves will flow in. Thus sterilisation leads to a magnification effect on reserves.

4.1.5. Discussion of Results

In the present study the reserve flow and sterilisation equations [equations (4.1.7) and (4.1.8)] are estimated in a simultaneous equation framework using 3SLS method. The data used are annual and relate to the period 1950-1975. Three different interest rates i.e, bazar bill rate, commercial banks advance rate and call money rate are used to estimate the equations. The results of the estimated equations where call money rate is used only are reported. The OLS estimates are also presented for comparison sake. The results are presented in table 4.1a.

The 3SLS estimates of the reserve flow equation seem to contradict the predictions of the MABP. The coefficients of income and domestic credit though carry the expected signs, are not significant. The offset coefficient is -0.22 against the expected value of -1. This signifies that a change in domestic credit is not offset by an equal and opposite change in international reserves. This can be justified on the ground of strict exchange control policies pursued by the government wherein the residents will not be able to get rid of excess supply or excess demand for domestic credit through foreign commodities or securities markets. Thus, one obvious implication here is that the magnitude of the offset coefficient varies with the degree of openness of the economy.

The coefficient of price variable carries a negative sign which is contrary to the monetarists' assumption. The interest rate coefficient bears a positive sign. In the Indian context this only reflects the fact that domestic interest rates are higher compared to the rest of the world. It may signify that in the Indian context interest rate on financial assets may not represent opportunity cost of holding money because of a higher rate of inflation which motivates people to prefer real assets. The goodness of fit of the equation has not been encouraging as shown by a low R^2 value (0.30). The equation explains only 30 7. of the movements in international reserves.

The estimated sterilisation coefficient is significant and has a value of -0.86 against the predicted value of zero. The coefficient of government domestic debt outstanding has the expected sign and turns out to be significant at the 1 7. level. The equation has 0.63 as R^2 value. On the whole, the sterilisation equation supports the presence of high degree of sterilisation of reserve flows thereby rendering the exogeneity assumptions underlying the monetary model invalid.

In the present study, the criticisms leveled against specification of money demand function in the MABP model are taken into account. As pointed out by Tsiang (1977), instead of income received or output produced, expenditure has to be a chief argument in demand for money function. Also, it is not proper to neglect the effect of aggregate volume of trade on demand for money, as trade volume creates demand for transactions balances in additions to income. Hence, demand for money function in an open economy should include both national expenditure (EXP) and total volume of trade (T). Both the reserve flow and sterilisation equations are re-estimated by accommodating these variables. The result are presented in table 4.1b under the head modified MMBP. The corresponding OLS estimates are also given there. The estimates of money demand functions are given in table 4.2.

The modified version of the model has not. shown any improvement in the estimated reserve flow and sterilisation equations. Though the coefficients of expenditure, trade volume and domestic credit carry expected signs, they are not significant. Even after replacing GDP with expenditure and total trade volume, the explanatory power of the reserve flow equation is not improved. The goodness of fit is poor with a low R^2 of 0.30. The sterilisation equation improved marginally with a negative and highly significant sterilisation coefficient of -0.90 against the predicted value of zero. This implies that the foreign exchange authority undertakes sterilisation partially reducing (increasing) domestic credit by some fraction of reserve inflows (outflows). This is in conformity with the assumption, often implicit, underlying the Keynesian view of BoP viz., that monetary authorities sterilize the impact of international reserve flows on domestic money supply, ensuing from payments imbalance.

Though the modified version of the model has shown some improvement in respect of the sterilisation equation, on the whole, both the versions fail to explain the BoP phenomenon in the Indian context during 1950-75.

The auto-correlation adjusted OLS estimates of the reserve flow equation gives a better general fit. In the case of both the original and modified reserve flow equations, coefficients of all explanatory variables carry the expected signs, though only domestic credit variable turns out to be significant.

It may be necessary to mention that the MABP has often been criticised for ignoring fiscal aspects of creating domestic credit. In the Indian context, government budget deficit is one of the sources of domestic credit. The government budget deficit and BoP constraints are precisely analogous in an open economy and must necessarily be analysed together. Hence, the fiscal influence on domestic credit should be incorporated into the structure of the MABP without endangering internal consistency of the general model. This exercise has not been done in this study. On the whole, it may be concluded from the empirical results that the MAHP model is not an appropriate model to explain movements in international reserves in the Indian context. This justifies the truth that applicability of the theory in a particular context depends up on economic characteristics of the country in question.

4.2. EXCHANGE MARKET PRESSURE MODEL

The intent of this section is to test a monetary model under managed floating exchange rate system in order to examine simultaneous adjustment of both exchange rate and BoP in India. The monetary model of exchange market pressure originally developed by Girton and Roper (1977), and later modified by Connolly and Silveira (1979), is chosen for the present context. The exchange market pressure (EMP) model as explained in Connolly and Silveira states that "an increase in the rate of growth of domestic credit, for a given rate of growth of world prices and permanent income, will result in an equi-proportionate loss in reserves with no change in exchange rate, or an equi-proportionate depreciation of domestic currency with no change in reserves or some combination of the two". The model has been found to be relevant in the context of managed floating exchange rate system of the developing countries during the 70s. Modeste (1981), Kim (1985) and Wohar and Lee (1992) also applied the EMP model in the context of Argentina, Korea and Japan respectively. An attractive feature of this model is that it draws upon the monetary models of BoP and of exchange rate determination.

The monetary model of BoP lost its relevance in the Indian context since the adoption of managed floating exchange rate system in September 1975. Under the changed system the rupee has been linked to a basket of currencies of India's major trade partners. The RBI actively intervenes in the foreign exchange market to buy and/or sell foreign currencies in order to maintain the desired basket related parity of the rupee. As a consequence, a simultaneous adjustment of both exchange rate and international reserves should be taking place depending upon the supply of and demand for the rupee in foreign exchange market.

Despite the RBI Intervention to maintain exchange rate stability and comfortable foreign exchange reserves, external value of the rupee has been depreciating heavily especially during the 80s. The depreciation of rupee with respect to the US dollar has been 58.15 7. in the last one decade. The depreciation against other hard currencies has been equally steep, drop against the pound sterling being 58.26 7., the Deutsche mark 68.14 7. and yen as much as 75 7.. Simultaneously, there have been frequent ups and downs in foreign exchange reserves of India. At the end of 1979-80 the quantum of reserves was to the tune of Rs. 5,163.66 crores which came down to Rs. 3,354.47 crores in 1981-82. It reached a peak level of Rs. 7,645.17 crores in 1986-87 and started declining to reach a low of Rs. 2,152.39 crores at the end of 1990. A combination of changes in exchange rate and international reserves has been the practice since the adoption of managed floating exchange rate system. This necessitates a different model to analyse the combined movements of exchange rate and BoP.

4.2.1. Girton-Roper Model

The Girton-Roper (G-R) model explains the "exchange market pressure", that is, the pressure on foreign exchange reserves and exchange rate when there exists an imbalance between money supply and demand. The model brings out a mechanism by which domestic money market attains equilibrium through a combined variations in BoP and exchange rate in the context of a managed floating exchange rate sytem.

The two basic elements of the G-R model are the demand for and supply of money. The demand for money is a stable function of real income(Y), price level(P) and the Cambridge constant(k) and is specified as :

$$M_d = kPY \qquad (4.2.1)$$

The money supply (Ms) is defined as money multiplier(m) times monetary base(R+D). Thus,

$$M_s = m\ (R+D) \qquad (4.2.2)$$

where R is net foreign assets and D is domestically originated money supply.

The model assumes that in the long run there is equilibrium in money market. That is,

$$M_d \equiv M_s \qquad (4.2.3)$$

An important condition in the model is the purchasing power parity (PPP) relationship, given by :

$$P = E\ P_f \qquad (4.2.4)$$

where P is domestic price, E is exchange rate (in units of domestic currency) and P_f is foreign price.

Taking logs on both sides of equations (4.2.1) and (4.2.2) and using equation (4.2.3), we get

$$\ln P + \ln k + \ln Y = \ln m + \ln (R+D) \quad \ldots \quad (4.2.5)$$

Further, taking logs on both sides of equation (4.2.4) and using it in equation (4.2.5), we get

$$\ln P_f + \ln E + \ln k + \ln Y = \ln m + \ln (R+D) \quad \ldots\ldots \quad (4.2.5a)$$

Differentiating equation (4.2.5a) with respect to time t, we get

$$\frac{d \ln P}{dt} - \frac{d \ln E}{dt} + \frac{d \ln Y}{dt} = \frac{d \ln m}{dt} + \frac{d \ln (R+D)}{dt}$$

since k is a constant

$$= \frac{d \ln m}{dt} + \frac{1}{R+D}\frac{dR}{dt} + \frac{1}{R+D}\frac{dD}{dt} \qquad (4.2.5b)$$

Writing lower case letters for changes in logarithms of variables, m for logarithmic changes in m and writing $\frac{d}{dt} = \Delta$, we get

$$p_f - e + y = m^* + \frac{\Delta R}{R+D} + \frac{\Delta D}{R+D} \quad \text{or}$$

$$\frac{\Delta R}{R+D} - e = p_f + y - m^* - \frac{\Delta D}{R+D} \quad \text{or}$$

$$r - e = p_f + y - m^* - d \qquad (4.2.6)$$

where $r = (dR/dt)/(R+D)$, $d = (dD/dt)/(R+D)$. In equation (4.2.6), r and d are ratios of changes in reserves to monetary base and changes in domestic credit to monetary base respectively, p_f is the rate of world inflation, y is rate of growth of income, m is the rate of growth of money multiplier and e is growth rate of exchange rate.

If exchange rate is measured in terms of foreign currency units, then equation (4.2.6) may be estimated in the following form:

$$r_t + e_t = \gamma_0 + \gamma_1 p_{ft} + \gamma_2 y_t + \gamma_3 m_t^* + \gamma_4 d_t + \xi_{1t} \quad (4.2.7)$$

where ξ is error term. The sum of r and e represents EMP. Equation (4.2.7) is also known as exchange market pressure (EMP) equation. The model hypothesizes the following restrictions on coefficients of the variables :

$$\gamma_1 = \gamma_2 = 1 \text{ and } \gamma_3 = \gamma_4 = -1. \quad (4.2.8)$$

The EMP equation contains a number of important propositions of the model which are as follows :

(a) As Connolly and Silveira (1979) noted, r+e in the equation measures "exchange market pressure"; i.e, "the pressure on foreign exchange reserves and the exchange rate when there exists an excess of domestic money supply over money demand in a managed floating exchange rate system". This provides a measure of the volume of intervention necessary to achieve any desired exchange rate and foreign exchange reserves in a managed floating exchange rate system.

(b) An increase in rate of growth in domestic money supply(demand) will be removed and domestic monetary equilibrium restored by some combination of exchange rate depreciation appreciation) and an outflow(inflow) of foreign reserves. For example, an excess supply of money will induce domestic residents to adjust the composition of their portfolios through exchange of money for foreign goods and assets. The resulting increase in demand for foreign currency will be accommodated by a depreciation of exchange rate or a fall in foreign exchange reserves or a combination of the two.

(c) An increase in rate of growth in real income increases the demand for money which can only be met, in the absence of domestic money expansion, through an appreciation in exchange rate and an inflow of foreign reserves.

(d) An increase in rate of growth in world price level will result in a combined appreciation in exchange rate and an inflow of foreign reserves.

(e) An increase in rate of growth in money multiplier will result either in appreciation of exchange rate or in an outflow of foreign reserves, or in a combination of the two.

Empirical studies on EMP model in the Indian context have been far and few between the works of Pradhan *et al* (1989) and Joshi (1990). Pradhan et *al* (1989) examined the applicability of EMP model in the Indian context over the period of 1976-85. The study showed that the government had absorbed exchange market pressure in foreign reserves more than in exchange rate. Their estimated EMP equation showed a poor fit of the model.

Joshi (1990) estimated the EMP equation with quarterly data from 1976 II to 1983 I. Though the results were not reported in the paper, it was mentioned that the estimated coefficients and "goodness of fit" of the model were satisfactory. Joshi's observations seem to contradict the findings of Pradhan *et al* though imposition of money market equilibrium condition and purchasing power parity on quarterly observations is a common feature of the studies. As Joshi himself remarked, one could expect a better result with annual data.

4.2.2. Empirical Evidence

The basic hypothesis formulated in this study is that domestic monetary disequilibrium will cause a combination of changes in exchange rate of domestic currency and international exchange reserves. This has been tested in line with the monetary approach to BoP and exchange rate under managed floating exchange rate system in India for the period 1976-1990. In the present study exchange rate used is the real effective exchange rate of the rupee.

The estimated coefficients of the EMP equation (equation (4.2.7)1 are reported in table 4.3. While the coefficients of domestic credit (d) and money multiplier(m) variables are of expected sign and significant, those of income(y) and price(p_f) are not significant in the model. However, the goodness of fit of the model is satisfactory as shown by the R^2 value of 0.74 which signifies that the equation is capable of explaining up to 74 7. of the combined movements in exchange rate and foreign exchange reserves. It is interesting to note that the coefficient of domestic credit which is of crucial importance in the model is highly significant at the 1 7. level.

The original EMP equation is modified as given below to test whether EMP is independent of its composition ie., whether the measure of exchange market pressure is sensitive to its composition of movements in exchange rate and international reserves. For this purpose, a measure of absorption (Q) suggested by Connolly and Silveira(1979) is introduced in the original equation.

$$r_t + e_t = \gamma_0 + \gamma_1 p_{ft} + \gamma_2 y_t + \gamma_3 m_t^* + \gamma_4 d_t + \gamma_5 Q_t + \xi_{2t} \quad ..(4.2.8)$$

where Q = (e-l)/(r-l). It indicates whether the monetary authorities absorb exchange market pressure in the exchange rate or in foreign exchange reserves. A high R^2 value of 0.77 of the above equation shows that the explanatory power of the EMP equation has increased marginally. The coefficients of d and m are of expected sign and significant also. Even though p* and y are not. statistically significant in explaining the EMP, the relevant coefficients carry the expected signs. The variable Q is not significant, even at the 10 7. level, implying that exchange market pressure is not sensitive to its distribution between exchange rate and foreign reserve effects i.e, the monetary authorities in India do not make choice between reserves and exchange rate changes in response to monetary shocks. A higher (lower) value of Q implies that the monetary authorities alleviate exchange market pressure more by depreciation (appreciation) relative to reserve losses(gains). The values of Q are given in table 4.5.

It is clear from the table 4.5 that the value of Q has been increasing since 1979 implying that the EMP is being absorbed through changes in exchange rate compared to changes in reserves. The negative values of EMP except for the yearl984 signify that there has been a continuous pressure either to devalue the rupee or to sell more foreign exchange reserves to maintain an equilibrium in the domestic money market. If we compare e and r separately with EMP it is clear that exchange rate had been decreasing (devaluation) since 1984 corresponding to which the reserve component showed an increasing trend barring 1985 and 1987.

To test whether the exchange market pressure is absorbed through adjustment in foreign exchange reserves or exchange rate, e and r are independently specified as functions of all independent variables in EMP equation. That is,

$$r_t = \delta_0 + \delta_1 p_{ft} + \delta_2 y_t + \delta_3 m_t^* + \delta_4 d_t + \xi_{3t} \qquad \ldots(4.2.9)$$

$$e_t = \theta_0 + \theta_1 p_{ft} + \theta_2 y_t + \theta_3 m_t^* + \theta_4 d_t + \xi_{4t} \qquad \ldots(4.2.10)$$

When r alone is the dependent variable [equation (4.2.9)1, the explanatory power of the equation has improved with a high R^2 (0.85). Except d, all other variables are insignificant and p_f and y carry the perverse signs. Hence, r alone as dependent variable has not yielded a better general fit than the original EMP equation.

Equation (4.2.10) is estimated to test whether movements in e are consistent with the monetary approach. In the equation, all the estimated coefficients carry expected signs but none of them are significant. The low value of R^2 shows poor fit of the equation. The results of equations (4.2.9) and (4.2.10) on the whole, are inconclusive in the sense that it is not easy to figure out what proportion of external adjustment represents change to foreign reserves and/or exchange rate. But the test is important because governments generally try to avoid exchange rate adjustments because of its economic and political Impacts and normally prefer to absorb exchange market pressure through frequent adjustments in foreign exchange reserves.

4.2.2.1. Supplementary Results

In addition to this, the EMP equation is estimated for the rupee-pound sterling and the rupee-dollar exchange rates the results of which are reported in table 4.4. Real exchange rate indices are constructed for rupee-dollar and rupee-pound sterling rates which are expressed in foreign currency units per Rs. 100. The real index is nominal index adjusted for relative inflation rates. These exchange rates are considered because the UK pound sterling acts as intervention currency and the US dollar being the major currency in terms of which most of the international transactions are performed. The results show that the performance of the model has not been encouraging. In both cases the domestic credit variable (d) proved to be insignificant. The EMP equations poorly fit the data with low R^2 0.19 for the rupee-pound sterling exchange rate. In the case of rupee-dollar exchange rate, though the explanatory power of the EMP equation happened to be high as shown by R^2 value of 0.75, the coefficients of income and price carry unexpected signs. The specifications which include the Q - variable however, explain the EMP better, by restoring the significance of d and showing high R values in both rupee-dollar and rupee-pound sterling cases.

The equations having rupee-sterling and rupee-dollar rates separately as dependent variables have respectively 0.38 and 0.56 as R^2. Compared to the composite exchange rate equations, the bilateral rates show some improvement. This indirectly signifies that the government control over exchange rate is lower with respect to pound sterling and dollar than with respect to the rupee-composite-currency. This is amply clear from the frequent changes in rupee-sterling rate. For example, the rupee-sterling rate has changed 252 times In 1989-90, 12G times In 1983-84 and 140 times In 1987-88.

As in the case of the MABP, the exogeneity assumptions underlying the EMP model make its interpretation more difficult. One of the crucial propositions of the EMP model is that the domestic credit is exogenous with respect to exchange market pressure or its components - international reserves and exchange rates. However, it is not illogical to suspect on some theoretical and empirical grounds that domestic credit may in turn be influenced by EMP or by its components. The possibility of reverse causation in EMP model has been verified by way of bivariate causality tests by using the Granger, the Sims and the multiple rank F tests (these test procedures are explained in appendix I).

The causality tests are carried out on monthly observations for the period from January, 1981 to June, 1990. The results are presented in table 4.6, 4.7 and 4.8 respectively for the Granger, the multiple rank and the Sims tests. For the Granger test, lag structure of the variables is fixed according to the minimum FPE criterion. The results, on the whole, reject the assumption of exogeneity of d with respect to EMP, and its components, r and e. While the results of the Granger and multiple rank F tests consistently maintained that d and EMP are independent of each other, the results of the Sims test showed that they are interdependent of each other.

III

4.3. SUMMARY OF RESULTS AND CONCLUSION

In this chapter, an empirical analysis of monetary models under fixed and managed floating exchange rate regimes has been attempted. The first part of the chapter deals with an empirical verification of the monetary approach to BoP for the period 1950-1975. The limitations of the earlier studies viz., failure to take cognizance of the shift in exchange rate system In 1975, and ignoring the sterilisation activities of the monetary authorities, are overcome in the present study by estimating the reserve flow and sterilisation equations simultaneously.

The estimated results of reserve flow equation do not lend any support to the monetarists' proposition that an increase (decrease) in domestic money supply will lead to a corresponding outflow (inflow) of International reserves. The evidence indicates that India's reserves movements cannot be explained by the monetary model. The unsuitability of the model in the Indian context may be attributed to among other factors, a low degree of openness of the economy, strict foreign exchange control policy of the government and a relatively inflexible financial market. It is also argued that the MABP theory suffers from some in-built contradictions. The MABP model is a long-run model for analysing a short-run problem. The inadequacy of the model emerges from the fact that its assumption of long-run equilibrium assumes away all of the problems that make BoP a problem.

In part II of the present chapter, the Girton-Roper exchange market pressure (EMP) model is used to test whether domestic monetary disequilibrium brings forth some combination of changes in exchange rate and international reserves for the period 1976 to 1990. The results show that the EMP equation fits reasonably well to the data and explain 74 7. of the combined movements in exchange rate and international reserves. The test of sensitiveness of EMP to its distribution between r and e does show that the measure of EMP is not sensitive to its distribution. This implies that the monetary authorities in India do not make choice between international reserves and exchange rate changes in response to domestic monetary disequilibrium. However, the tests conducted to see whether exchange market pressure is absorbed through exchange rate adjustment or through foreign exchange reserves, remain inconclusive in the sense that it is not clear to figure out what proportion of external adjustment represents change in foreign reserves and/or exchange rates.

The findings also validate the prediction of the EMP model that an increase in rate of growth of domestic credit will result in a fall in foreign exchange reserves or depreciation of domestic currency or some combination of the two. However, the results of causality tests reject the assumption of exogeneity of domestic credit with respect to exchange market pressure, or its components - international reserves and exchange rate. This casts doubts on the specification of the EMP model.

TABLE 4.1a

Estimates of Monetary Model of Balance of Payments (MMBP)

1. Reserve Flow Equation :

Dep. variable	Method	Coefficients of constant	Δ ln P	Δ ln Y	Δ ln i	Δ ln m	d	R^2	D-W	ρ
r	CORC	0.097	0.073 (0.65)	0.035 (0.15)	-0.039 (-1.02)	-0.080 (-1.67)	-0.59* (-3.58)	0.68	1.68	0.64
r	3SLS	-0.030	-0.122 (-0.79)	0.369 (0.10)	0.021 (0.94)	0.020 (0.32)	-0.22 (-0.55)	0.30	1.15	-

2. Sterilisation Equation :

		Coefficients of constant	r	Δ ln GD			
d	CORC	0.018	-0.594* (-5.29)	0.595* (3.86)	0.63	1.85	-0.34
d	3SLS	0.030	-0.856** (-1.98)	0.434* (2.45)	0.55	2.09	-

* Significant at 1 % level
** Significant at 5 % level
Values in parentheses are the t-statistics
D-W is the Durbin-Watson statistic
CORC refers to Cochrane-Orcutt procedure

Table 4.lb

Estimates of the Modified MMBP

1. Reserve Flow Equation :

Dep. variable	Method	Coefficients of Δ ln P	Δ ln EXP	Δ ln i	Δ ln m	d	Δ ln T	R^2	D-W	ρ
r	CORC	0.051	0.243	-0.572	-0.050	-0.58*	0.087	0.73	1.89	0.67
		(0.49)	(0.87)	(-1.56)	(-1.08)	(-3.53)	(1.68)			
r	3SLS	-0.105	0.436	0.017	0.026	-0.23	0.022	0.30	1.10	-
		(-0.77)	(1.07)	(0.81)	(0.43)	(-0.60)	(0.36)			

2. Sterilisation Equation :

		Coefficients of constant	r	Δ ln GD	R^2	D-W	ρ
d	CORC	0.184	-0.594*	0.595*	0.63	1.85	-0.34
			(-5.29)	(3.86)			
d	3SLS	0.030	-0.895*	0.427*	0.53	2.03	-
			(-2.10)	(2.36)			

* Significant at 1 % level
•* Significant at 5 % level
Values in parentheses are the t-statistics
D-W is the Durbin-Watson statistic
CORC refers to Cochrane-Orcutt procedure.

TABLE 4.2

Estimates of the Money Demand Equation

Dependent variable	Method	Coefficients of ln Y	ln i	ln EXP	ln T	R^2	D-W	ρ
ln Md/P	OLS	0.7209* (5.6188)	0.1334 (1.6400)	-	-	0.87	2.077	-
ln Md/P	CORC	-	0.1458 (1.4296)	0.7016* (6.1197)	0.0251 (0.0105)	0.87	1.712	-0.17
ln Md/P	OLS	-	0.1388 (1.7673)	0.6852* (5.7826)	-	0.87	2.072	-
ln Md/P	CORC	-	0.1451 (1.3175)	-	-0.1481 (-0.6275)	0.78	2.363	-0.26

* significant at 1 % level
Values inside parentheses are t-statistics

TABLE 4.3

Estimates of Exchange Market Pressure (EMP) Model

Dependent variable	Coefficients of							
	y	p_f	d	m^*	Q	R^2	D-W	ρ
r+e	0.2378 (0.7846)	0.4283 (1.0752)	-0.5225* (-2.5496)	-0.4723* (-2.5357)		0.74	1.462	0.61
r+e	0.1581 (0.4862)	0.2554 (0.5716)	-0.6126* (-2.8936)	-0.4423* (-2.7598)	-0.2541 (-0.7965)	0.77	1.512	0.59
r	-0.0508 (-0.2640)	-0.1050 (-0.4010)	-0.4023* (-3.5620)	-0.1539 (-1.5350)		0.85	1.210	0.66
e	0.3227 (1.3399)	0.6168 (1.7586)	-0.1330 (-0.9155)	-0.3103 (-1.4643)		0.54	1.162	0.76

• Significant at 1 % level
** Significant at 5 % level
D-W is the Durbin-Watson statistic
Values inside parentheses are the t-statistics.
@ Coefficient estimates are auto-correlation adjusted using the Cochrane-Orcutt (CORC) procedure, p is the estimate of first order **auto-correlation.**

TABLE 4.4

Estimates[@] of EMP Model with Rupee-Pound Sterling (**e_U**)
and Rupee-Dollar (e_A) Exchange Rates

Dependent variable	Coefficients of y	p_f	d	m^*	Q	R^2	D-W	ρ
$r+e_U$	-0.0213 (-0.0334)	0.2408 (0.3298)	-0.2859 (-0.8112)	-0.0121 (-0.0384)	-	0.19	1.913	0.40
$r+e_U$	-0.3766 (-0.6133)	0.1138 (0.3085)	-1.2448* (-3.1120)	-0.6579 (-1.8184)	-0.6546* (-4.2110)	0.65	1.891	-0.36
e_U	0.0562 (0.1016)	0.4746 (0.5954)	0.1403 (0.4427)	0.1715 (0.6017)	-	0.38	2.014	0.39
$r+e_A$	-1.6685* (-3.1588)	-0.4278 (-1.2114)	-0.4672 (-1.5229)	-1.1376* (-3.2082)	-	0.75	2.246	-0.52
$r+e_A$	-1.2820* (-2.0372)	-0.2662 (-0.6805)	-0.8245** (-1.8260)	-1.0993* (-3.1856)	-0.3213 (-1.0649)	0.78	1.931	-0.47
e_A	-0.3130* (-2.7281)	-0.4565 (-1.3786)	0.2632 (1.0138)	-0.6362* (-2.1219)	-	0.56	2.307	-0.45

* Significant at 1 % level
*• Significant at 5 % level
D-W is the Durbin-Watson statistic
Values inside parentheses are the t-statistics.
@ Coefficient estimates are auto-correlation adjusted using the Cochrane-Orcutt (CORC) procedure. p is the estimate of first order auto-correlation.

TABLE 4.5

Exchange Market Pressure (EMP) in India 1976-1990

Year	e	r	EMP(=r+e)	(e-l)/(r-l) (Q)
1976	-0.055	0.131	0.076	1.124
1977	0.006	0.166	0.173	1.192
1978	-0.029	0.094	0.065	1.136
1979	0.002	-0.012	-0.009	0.987
1980	0.035	-0.103	-0.068	0.875
1981	0.004	-0.090	-0.087	0.914
1982	-0.014	-0.085	-0.098	0.935
1983	0.014	-0.030	-0.016	0.957
1984	-0.007	0.034	0.028	1.042
1985	-0.007	-0.002	-0.009	1.005
1986	-0.036	0.005	-0.030	1.041
1987	-0.031	-0.004	-0.035	1.027
1988	-0.027	0.005	-0.022	1.032
1989	-0.050	0.002	-0.048	1.051
1990	-0.055	0.039	-0.016	1.097

TABLE 4.6

Granger Test : EMP Model

Equation	(m,n)	F-statistic	Sig.level	Inference
EMP	(5,1)	0.434929	0.51155	d and EMP are
	(5,2)	0.316578	0.72959	independent of
	(6,12)	0.976252	0.48170	each other.
d	(24,7)	2.051117	0.07773	
	(6,12)	0.843831	0.60614	
e	(5,1)	0.360213	0.55015	d and e are
	(5,2)	0.256059	0.77476	independent of
	(6,12)	1.017369	0.44555	of each other
d	(24,11)	1.819753	0.09649	
	(6,12)	0.914041	0.53893	
r	(13,3)	1.278056	0.29025	d and r are
	(6,12)	1.189119	0.31256	independent of
				each other.
d	(24,1)	0.380079	0.54114	
	(24,2)	0.520578	0.59835	
	(6,12)	1.058635	0.41081	

m and n represent own lag and lag of other variable respectively, and the F-statlstics corresponds to the test that the sum of the n coefficients is zero

TABLE 4.7

Multiple rank F-test : EMP Model

Equation	(kl,k2)	F-statistic	Sig.level	inference
EMP	(5,1)	0.023789	0.87783	d and EMP are
	(5,2)	0.220091	0.80296	independent of
				each other
d	(24,7)	1.280814	0.28997	
e	(5,1)	0.005842	0.93927	d and e are
	(5,2)	0.235316	0.79090	independent of
				each other
d	(24,11)	0.940329	0.51790	
r	(13,3)	1.122186	0.34744	d and r are
				independent of
d	(24,1)	0.184030	0.67029	each other
	(24,2)	0.507472	0.60604	

kl and k2 indicate own lag and lag of other variable respectively and F statistics corresponding to the test that the sum of k2 coefficients is zero.

TABLE 4.8

Sims Test : EMP Model

Equation	(nl,n2)	F-statlstic	Sig.level	Inference
EMP	(6,12)	1.138688	0.35371	d and EMP are
	(12,12)	1.370069	0.22137	interdependent
				of each other
d	(6,12)	0.566014	0.75532	
	(12,12)	0.437827	0.93759	
e	(6,12)	1.215251	0.31387	d and e are
	(12,12)	1.380064	0.21658	interdependent
				of each other
d	(6,12)	0.456086	0.83731	
	(12,12)	0.426547	0.94314	
r	(6,12)	1.112032	0.36847	d and r are
	(12,12)	0.943824	0.51550	interdependent
				of each other.
d	(6,12)	0.602285	0.72716	
	(12,12)	0.540082	0.87468	

nl and n2 denote lead and lag values respectively of the right hand side variable, and the F-statistics correspond to the test that the sum of nl coefficients is zero.

CHAPTER 5

TESTING THE EXOGENEITY SPECIFICATION UNDERLYING THE MONETARY MODEL OF BALANCE OF PAYMENTS

5.0. INTRODUCTION

The monetary approach to balance of payments(MABP) has been built upon the fundamental proposition of exogeneity of price level, real income, interest rate, money multiplier and change in domestic credit with respect to reserve flows. This assumption has triggered off a controversy between the proponents and antagonists of the theory. As Johannes (1981; p.29) states, "_____no general consensus has been reached as to the validity of the monetary model because the task of interpreting results of plethora of empirical tests of the MABP has been complicated by the controversy over accuracy of exogeneity assumptions underlying the MABP that are implicit in those studies". The focus of the present chapter is to investigate into the validity of the exogeneity assumptions underlying the monetary model.

Three different methods are used here for testing the assumptions. First, the reserve flow and sterilisation equations are estimated simultaneously to test the fundamental assumption of the MABP that the government do not resort to sterilisation of reserve flows. The assumptions of absence of sterilisation, and exogeneity of domestic component of money supply (d) are correlative on the basis of which the reserve flow equation [equation (4.1.7) in chapter 4) is explained. The d is assumed to be exogenous in the sense that changes in the magnitude of d are independent of changes in reserve flows (r). The possibility of dependency of d, and hence its exogeneity, on r and vice versa is indicated by the sign and magnitude of the sterilisation coefficient ie., the coefficient of r in the sterilisation equation [equation (4.1.8) in chapter 4] and the offset coefficient [ie., **the** coefficient of d in equation (4.1.7) in chapter 4]. Hence, equations (4.1.7) and (4.1.8) are estimated simultaneously to test the exogeneity of d.

Secondly, using three bi-variate causality tests viz., the Granger, Sims and Multiple rank F tests, causality between r and each of the 'explanatory' variables in reserve flow equation is examined. The interdependence between d and other explanatory variables is ruled out in the model by assuming that nominal money demand is a stable function of price level, real income and interest rate which are independent of the factors that influence money supply.

Finally, a multivariate systems test of causality within the framework of complete dynamic simultaneous equation model (CDSEM) is applied to test the joint exogeneity of the right hand side variables in the reserve flow equation.

5.1. EXOGENEITY ASSUMPTIONS

One of the key assumptions underlying the MABP is the exogeneity of price level (P), real income (Y), interest rate (i), money multiplier (m) and change in domestic credit (d) with respect to international reserve flows (r). This assumption is crucial for the working of the automatic BoP adjustment mechanism by which BoP surplus or deficit is removed by the adjustment of money supply to money demand.

In the monetary model Y is assumed to be given which in turn, is justified by assuming long-run full employment. Most of the monetarist literature concerned with BoP considers a non-growing economy. Only Johnson (1972) considers a growing economy, but on the simplifying assumption that rate of growth is exogenously given. As Currie (1976) stated, "it might reflect an unwillingness of the community (including the government) to carry out net saving, or it might reflect a lack of profitable investment opportunities. More plausibly, it may be regarded as a convenient simplifying assumption to derive results which, it is hoped, would then be shown to have continued validity when growth is explicitly allowed for".

The variables P and i in the reserve flow equation represent not only the domestic economy but also the whole world, because the MABP presumes that one country's domestic monetary conditions relative to that of the world is the determining factor for reserve flows. The assumption of the 'law of one price' sates that there is a single price which prevails for each good throughout the world which makes domestic price level to represent the world price level. If a country unilaterally tries to reduce its own rate of inflation below the world level by pursuing a contractionary monetary policy, there will be a switch of demand towards that country's goods and services and an inflow of money. As a result the country's rate of inflation will be pushed up to the world rate; and vice versa. Thus there is a world rate of inflation to which national rates of inflation must conform.

The 'law of one price' is also assumed to be applied to the financial assets, so that interest rate as well as commodity prices conform to their corresponding world rates on which no single country has any control. The domestic component of money supply i.e., d in the reserve flow equation is characterised as exogenous to r, which implies that the former is no way affected by the latter. This is justified on the ground that the monetary authorities do not compensate/cancel out domestic credit corresponding to outflow/inflow of reserves. Thus the assumptions of absence of sterilisation underlying the MABP states that if r increase (decrease) d is not decreased (increased), and hence d is assumed to be exogenous. However, it is not illogical to suspect on some theoretical and empirical grounds that all the explanatory variables in reserve flow equation may in turn be influenced by r. As Magee (1976) pointed out, causation can be the other way also. An exogenous increase in reserves which increases money supply should increase y, p and reduce i.

Exogeneity of domestic credit as the model assumes, cannot be valid in cases where the central bank follows sterilisation policy. An autonomous reserve inflow will, according to Genberg(1976) motivate the central bank to contract domestic credit by the same amount in order to prevent BoP surplus from affecting money supply. Sterilisation thus, can lead to a close inverse relationship between reserve flows and domestic credit changes. This "alternative explanation", known as the reverse causation hypothesis [Connolly and Taylor (1976), and Cobham (1983)] poses a serious challenge to the MABP. An empirical examination of the "alternative explanation" that changes in R triggering offsetting changes in D (to neutralise the effects of changes in reserves on money supply), is important in the sense that if the reverse causation hypothesis holds good, investigations conducted within the framework of the MABP reveal nothing about the determinants of BoP.

5.2. SOME PREVIOUS STUDIES

In the literature, exogeneity specification has been tested in three different ways. First, taking into account the possibility of sterilisation of reserve flows, a sterilisation equation is estimated along with a reserve flow equation [g., Genberg (1976), Connolly and Taylor (1979) and Taylor

(1986)]. Secondly, direction of causality between r and **each** of Y, P, i, **m** and d, pair-wise, is tested [eg., Blejer (1979), Sundararajan et al (1988), Kannan (1989), Raghavan and Saggar (1989)]. Thirdly, a test of exogeneity in a multivariate (CDSEM) framework is conducted to examine the block exogeneity of **the** exogenous variables [eg., Johannes (1981), and Taylor **(1987)]**

Pointing out the limitations of the first two approaches, Cobham (1983) proposed an indirect test of reverse causation hypothesis. According to him, the bi-variate causality procedures and the simultaneous (2SLS) test of sterilisation are devoid of "subject matter considerations". The empirical inconclusiveness of causality tests has been attributed to the fact that the tests have ignored the underlying theory. Since the sterilisation equation omits growth of demand for money, the 2SLS test implicitly assumes that monetary authorities respond only to reserve flow itself, in isolation from its context of growth in demand for money. In view of these limitations a more appropriate test procedure which pays attention to "subject matter considerations" on the basis of the relationship between domestic credit expansion and its constituents.

In the Indian context, Sundararajan et *al* (1988) tested the exogeneity specification using Sims' causality test for the period 1950 to 1986, and rejected the same. Kannan (1989), and Raghavan and Saggar (1989) also tested the direction of causality between changes in reserves (AR) and changes in domestic credit (AD) using the Granger and Sims tests. While the former showed evidence of strong causality from AD to AR and weak causality from ΔR to AD, the latter brought out evidence of a strong causal relationship from AR to AD and a weak causal relationship from AD to AR. Raghavan and Saggar have rightly pointed out that in cases where restrictions are imposed on foreign exchange, excess money supply/demand cannot be drained through balance of payments deficit/surplus. There is an apparent divergence between the findings of Kannan and rest of the studies in the Indian context. Joshi (1990) also attempted to examine the relevance of MABP, though the focus as such was not on testing the exogeneity specification. A limitation of these studies however, is that, exogeneity assumptions ate tested pair-wise, ignoring other variables typically associated with the monetary model. Examining causal relationships, pair-wise, as is done in Sundararajan *et al* (1988), can also seriously bias any causality findings as such a procedure omits other important variables from the functional specification.

There were no studies in the Indian context examining the exogeneity specification as a testable hypothesis. However, most recently Joshi (1992) attempted to test the exogeneity assumptions employing a systems test. He estimated the reserve flow equation using the data for the period 1970-71 through 1991-92 to test the propositions of the MABP and found that the reserve movements in India are essentially due to a mismatch between the demand for and supply of money. However, the reason why interest rate variable is excluded from the reserve flow equation is not explained. In addition to precautionary and transaction demand for money which is determined by income, there is an interest rate determined speculative demand for money. One must not be tempted to argue that the MABP is applicable in all those cases where the offset coefficient is of expected sign. The generalisation is possible only if sterilisation equation too is taken into account. However, this is not done in his study. Also the study has carried out a systems test and showed evidence of exogeneity of P, Y, m and d with respect to r. The reliability of the result would have strengthened, had the study been undertaken on the basis of more observations.

It may be of interest to mention two recent studies outside India viz., Johannes (1981) and Taylor (1987). These studies used a multivariate test (CDSEM) to examine the exogeneity issue. Johannes tested the exogeneity of P, Y, i and d for several European countries and rejected the assumed exogeneity specification for each and every country in the sample. Johannes omitted money multiplier from the system of equations. The exclusion of an important variable like money multiplier might have influenced the overall findings of his study. Using quarterly data and similar methodology, Taylor found evidence in favour of rejecting the exogeneity specification in case of the UK, especially for the 1964-71 period of fixed exchange rate regime.

5.3. STERILISATION HYPOTHESIS

In the monetary model, exogeneity of d is justified on the ground that the authorities do not sterilise the effects of changes in R on money supply (i.e., if R increases D is not decreased). However, in real situations, there is a possibility of counteraction on the part of foreign exchange authority to nullify the impact of exchange reserve flow on the equilibrium state of domestic money market. Through sterilisation activity, the central bank tries to contract (increase) domestic credit component (D) of the monetary base [B(=R+D)] by the same amount of an autonomous reserve (R) inflow (outflow) in order to prevent BoP surplus (deficit) from affecting money supply. Sterilisation thus, possibly leads to a close inverse relationship between changes in reserves and domestic credit which makes the assumption of exogeneity of d invalid. Hence in the present study the assumption of absence of sterilisation is relaxed and reserve flow and sterilisation equations [equations (4.1.7) and (4.1.8) in chapter 4] are estimated in a simultaneous equation framework [three stage least squares (3SLS)]. OLS results are also presented for comparison sake.

The estimates of the reserve flow and sterilisation equations for the sample period 1950-90 are presented in table 5.1b. To confirm that d is not affected by the levels of other explanatory variables included in the reserve flow equation, the relevant correlation matrix of the variables is presented in table 5.1a. From this table, it is evident that the problem of multicollinearity among the explanatory variables is not there. From **table** 5.1b, it is also clear that both OLS and 3SLS estimates of the offset coefficient [coefficient of d in equations (i) and (iii) of table 5.1b) carry the expected sign. But it is not found statistically significant in case of the latter. The OLS and 3SLS estimates of the sterilisation coefficient [coefficient of r in equations (ii) and (iv) of table 5.1b] are -0.55 and -0.15 respectively, which indicate a partial sterilisation of reserve flows. This renders the exogeneity assumption invalid.

5.4. **BI-VARIATE** CAUSALITY TESTS AND MABP

The exogeneity assumptions are tested here using the bi-variate causality tests - Granger, Sims and the recently developed Multiple Rank F test. These test procedures are explained in appendix I. The tests are conducted on two sets of variables. In the first set, the variables are defined as in equation (4.1.7) in chapter 4. The results for this set are presented under the caption 'version 1'. The second set consists of variables in first differences. These results appear under 'version 2'. All the three tests have used alternative lengths of lead-lags with a maximum of two lags and two leads. The test experiments with four different lag combinations in the case of the Granger and Multiple Rank F test and four different lead-lag combinations for the Sims test. Different combinations are chosen in order to check the consistency of test results over various lag combinations.

From the test results (tables 5.2, 5.3 and 5.4), the following conclusions may be drawn :

(i) The results of the tests are sensitive to the way variables are measured. In version 2, both the Granger and Sims tests show exogeneity of real income and domestic credit by way of showing a unidirectional causal relationship running from AY, AD to ΔR. While the Granger test supports independence of AP, Ai with respect to AR, the Sims test supports feedback between AP and AR, and Ai and AR. In version 1, the Sims test establishes a feedback between r on the one hand and $\Delta \ln Y$, $\Delta \ln P$, $\Delta \ln i$ and d on the other. However, under version 1, the tests, by and large, show that exogeneity of m does not hold good. Rather, it (m) proves to be endogenous in the model.

(ii) While the Granger and Sims tests in version 2 validate the monetarists' hypothesis of a unidirectional causality running from AD to AR, the alternative reverse causation from r to d is reported in version 1. The exogeneity of d in the reserve flow equation is of crucial importance in the monetary model. A bi-directional causality between r and d invalidates the monetarists' assumption of absence of sterilisation underlying the monetary model. It signifies a deliberate attempt of the monetary authority to reduce (increase) the domestic component of monetary base to compensate a rise (fall) in foreign exchange reserves through sterilisation.

(iii) The Multiple Rank F test, in isolation, supports the exogeneity assumptions across both the versions.

(iv) On the whole, the results vary across the tests and hence do not seem to help resolve the problem of reverse causation. The inconclusiveness of these bi-variate causality tests may be attributed to what Cobham pointed out the non-use of theory, A limitation of the conventional bi-variate tests Is that they focus on pair-wise causal relationship and consequently omit potentially relevant variables. Hence multivariate or system causality test is called for for testing the exogeneity of a set of variables.

5.5. **SYSTEMS** TEST

Two different specifications of the MABP model are considered **for** the system test. One is as specified in equation (4.1.7) in chapter 4 and for the sake of identifying it, labelled as a general model. The other is a linear model where the first differences of R, D, P, Y, i and m are used. The motivation for the linear model is derived from the assumption of a linear money demand function. The essential difference between the 'general' and linear versions is the way variables in the reserve flow equation are measured. According to Johannes (1981), the logic of considering a linear model lies in the fact that if the test data are defined as in equation (4.1.7), then the share weights for R and D will appear on both sides of equation (4.1.7) and hence there is a possibility for a spurious simultaneity that might creep into the specification.

Following the work of Geweke (1978) and its application in Johannes (1981), and Taylor (1987), a Complete Dynamic Simultaneous Equation Model (CDSEM) may be specified as :

$$\underset{g\times g}{B(L)}\,\underset{g\times 1}{Y_t} + \underset{g\times k}{\Gamma(L)}\,\underset{k\times 1}{X_t} = \underset{k\times 1}{\varepsilon_t} \qquad (5.1)$$

where Y_t is a gx1 vector of realization of a time series of g endogenous variables, X_t is a gxl vector of realization of k exogenous variables, and c is a gx1 vector of realization of *p*, disturbances. The operators B(L) and r(L) are matrices of polynomials of infinite order in non-negative powers of the lag operator L.

The system specification in (5.1) is conditioned by the following assumptions :

(i) E e = 0 for all t

(ii) $\mathrm{cov}(\varepsilon_t, \varepsilon_{t-s}) = 0$ for all t and all $s \neq 0$

(iii) $\mathrm{cov}(\varepsilon_t, X_{t-s}) = 0$ for all t and all $s \geq 0$

(iv) $\mathrm{cov}(\varepsilon\ ,\ Y\quad) = 0$ for all t and all $s > 0$

Geweke has drawn two testable implications of CDSEM. The first implication is that since current and past X are inputs while Y is output, only past and current (and not future) values of X affect Y_t in the CDSEM. The second implication is that since X is determined outside the CDSEM which in turn is a complete description of interactions between X_t and Y , a proper specification of the determination of X_t will not include any values of Y_t (Geweke, 1978, p. 166). Thus, assuming Y_t and X_t be jointly covariance-stationary with autoregressive representation, the linear regression of X on all past values of itself and Y_t is given by

$$X_t = \sum_{s=1}^{\infty} F_s X_{t-s} + \sum_{s=1}^{\infty} G_s Y_{t-s} + \varepsilon_t , \qquad \text{... (5.2)}$$

There exists a CDSEM with exogenous X_t and endogenous Y_t and no other variables if and only if, $G_s = 0$ for all $s > 0$. One of the important points discussed in Dent and Geweke (1979) is that if the implications of exogeneity are false, then there can exist no CDSEM with exogenous X . However, it does not mean that in every CDSEM relating X_t and Y , the variable X must be exogenous just because the implications are true.

It is possible to view the exogeneity specification as a testable hypothesis and that the same may be formally tested using the CDSEM framework. In choosing a finite parameterization for estimating the system of equations [that is (5.2)1, four alternative combinations of lag lengths for X and Y with a maximum lag of two are considered. Since the data used for estimating the model are annual, a maximum lag length of 2 is felt adequate. Both the 'general' and linear models are considered for testing the exogeneity.

Two tests are used to test the null hypothesis that G = 0; the Wald test and the Likelihood Ratio (LR) test. These test statistics follow the chi-square distribution with degrees of freedom equal to the number of restrictions, which is equal to the number of equations multiplied by number of coefficients on lagged endogenous variable. In addition to these, the F test is used for each individual equation to test the null hypothesis that the coefficients on lagged r in each equation individually are zero. The vector process [equation(5.2)l consists of a system of equations; one for each exogenous variable in reserve flow equation. Each exogenous variable is regressed on past values of itself, all other exogenous variables and the endogenous variable and tested the hypothesis that all the coefficients on lagged endogenous variable are jointly zero for each equation. However, in case of systems test the lone hypothesis tested is that coefficients on lagged endogenous variable across equations are jointly zero. As Johannes observed, the F-statistics are useful in identifying the exogenous variables which are causing the overall test to reject the exogeneity of the entire set. The F-values are presented in table 5.5.

The system of equations (in the present study) is estimated equation by equation using OLS method. In literature the two tests - Wald and Likelihood ratio - are generally based on maximum likelihood estimation. But in the case of general linear constraints and same regressor set in every equation as in the present case, the OLS estimation is equivalent to the full information maximum likelihood estimation (see Berndt and Savin (1977)].

The LR statistics test the restrictions on systems of several equations by forming a likelihood ratio statistic from the covariance matrices of the two sets of residuals under the restricted and unrestricted maximum likelihood estimates of the system. The LR test statistic takes the form

$$LR = T \ln \left[S(\omega/v_{\omega}) \;/\; S(\Omega/v_{\Omega}) \right] \qquad (5.3)$$

where T is number of observations, $S(\omega/v\;\;)$ is the restricted maximum likelihood estimator and $S(\Omega/v_{\Omega})$ is the maximum likelihood estimator of the unrestricted system [Savin (1976)]. Wald procedure suggests estimation of disturbance matrix jointly with the parameters under unrestricted system and comparison of the parameter estimates with the linear restriction [Kmenta and Ramsey (1980), p.317). The estimated results of the unrestricted and restricted systems of equations are presented in table 5.7a to 5.10.

The results of the Wald and LR tests are presented in table 5.6. The null hypothesis tested in the model is that all the coefficients on lagged reserves in all five equations are jointly zero. In all the four cases, both the statistics are uniformly highly significant except in one case where the LR test is significant only at the 0.05 level (since the results based on the general and linear models happened to be the same, results relating to the general model are only reported). Hence the null hypothesis is rejected implying that price level, real income, interest rate, money multiplier and domestic credit are not jointly exogenous with respect to the reserve flows. However, the results of the single equation test using the F statistics, by and large, contradict those of the systems test. Except price level in the general model and money multiplier in the linear model, all other variables prove to be independently exogenous with respect to reserve flows. For facilitating a comparison with Joshi (1992) the present study has also experimented with a sample period of 1970-71 to 1990-91, the result of which are presented in table 5.11 and 5.12. The values of LR statistics for systems test by and large, reject the exogeneity assumption, while the single equation estimation uniformly supports the exogeneity assumption. The results of the systems test are at variance with Joshi (1992).

5.6. SUMMARY AND CONCLUSION

The present chapter attempted to test the exogeneity specification underlying the MABP that price level, real income, interest rate, money multiplier and changes in domestic credit are exogenous with respect to exchange reserve flows i.e., reserve flows are determined by these variables which in turn are not influenced by the inflow or outflow of reserves. Three different approaches are adopted to empirically verify the exogeneity assumptions.

The overall results of the study do not support the MABP specification of exogeneity of determinants of demand for money and domestic credit component of monetary base, with respect to foreign exchange reserves. While the Granger, Sims and Multiple Rank F tests collectively fail to provide a consistent pattern of causality between reserve flows and its possible 'determinants', the OLS and 3SLS estimation of sterilisation and reserve flow equations, and Wald and LR tests for the system uniformly reject the exogeneity assumptions.

It would have been more appropriate to reach this conclusion by conducting a separate analysis for the fixed and floating exchange rate regimes in the present context. This could not be done, as the 1975-90 period would give only 16 annual observations which are not adequate to implement the systems test. To turn to quarterly observations, the limitation is the non-availability of income data on quarterly basis. This point has been emphasized in chapter 4. The endogeneity of price level, real income, interest rate, money multiplier and domestic credit leads to a specification error in the reduced form equation of the MABP. It introduces simultaneity and makes the policy propositions of the MABP invalid. That is, domestic credit as the theory prescribes cannot be a policy variable for solving temporary balance of payments disequilibrium.

Table 5.1a

Correlation Matrix of the variables in the Monetary **Model**

	Δ ln Y	Δ ln P	Δ ln i	Δ ln m	r	d
Δ ln Y	1.00	-0.086	-0.12	-0.11	0.12	-0.06
Δ ln P	-	1.00	0.17	0.04	-0.08	0.22
Δ ln i	-	-	1.00	0.03	-0.10	-0.03
Δ ln m	-	-	-	1.00	-0.29	-0.08
r	-	-	-	-	1.00	-0.57
d	-	-	-	-	-	1.00

Table 5.1b

Estimates of Reserve Flow and Sterilisation Equations

OLS Estimation :

(i) $r = 0.067 - 0.95\ \Delta \ln P + 0.02\ \Delta \ln Y + 0.03\ \Delta \ln i - 0.29\ \Delta \ln m$
(-0.88) (0.097) (1.237)** (-2.67)*

$- 0.58\ d$
(-5.496)*

$R^2 = 0.69$, D-W = 1.95 and $\rho = 0.61$

(ii) $d = 0.021 - 0.55\ r + 0.66\ \Delta \ln GD$
(-6.28)* (6.685)*

$R^2 = 0.61$, D-W = 1.83 and $\rho = -0.33$.

3SLS Estimation :

(iii) $r = 0.01 + 0.048\ \Delta \ln P + 0.13\ \Delta \ln Y - 0.005\ \Delta \ln i - 0.40\ \Delta \ln m$
(0.398) (0.576) (-0.172) (-2.603)*

$- 0.16\ d$
(-0.70)

$R^2 = 0.26$, D-W = 0.94

(iv) $d = 0.029 - 0.15\ r + 0.58\ \Delta \ln GD$
(-0.39) (4.409)*

$R^2 = 0.43$, D-W = 2.06

---

* Significant at 1 % level
** Significant at 5 % level
Values in parentheses are t-statistics
D-W is Durbin-Watson statistic
Wherever p values are given the Cochrane-Orcutt procedure is used in estimating the equations.

Table 5.2

Granger Test : MABP

Hypotheses	(m,n)	Variant 1 F-value	Variant 1 sig.level	Variant 2 F-value	Variant 2 sig.level
Income —> Reserves	(1,1)	0.1679	0.68	5.6769	0.02
"	(2,1)	0.0791	0.78	4.5429	0.04
"	(1,2)	0.4657	0.63	6.9200	0.00
"	(2,2)	0.4993	0.61	5.9134	0.00
Reserves —> Income	(1,1)	0.2499	0.62	0.4537	0.50
"	(2,1)	0.1699	0.68	1.1060	0.30
"	(1,2)	2.0295	0.15	0.2357	0.79
"	(2,2)	1.9696	0.16	0.5438	0.59
Price —> Reserves	(1,1)	3.6285	0.06	0.0628	0.80
"	(2,1)	1.8025	0.19	0.0002	0.99
"	(1,2)	6.9103	0.00	0.0368	0.96
"	(2,2)	8.2562	0.00	0.0074	0.99
Reserves —> Price	(1,1)	0.9919	0.33	1.1397	0.29
"	(2,1)	0.5131	0.48	0.9981	0.33
"	(1,2)	1.5019	0.24	0.8298	0.45
"	(2,2)	1.4437	0.25	0.8116	0.45
Int. rate —> Reserves	(1,1)	4.3054	0.04	0.0311	0.86
"	(2,1)	1.2487	0.27	0.0001	0.99
"	(1,2)	2.1050	0.14	0.0546	0.95
"	(2,2)	1.2536	0.30	0.0674	0.94
Reserves —> Int.rate	(1,1)	1.9947	0.16	0.0497	0.82
"	(2,1)	0.6642	0.42	0.0970	0.76
"	(1,2)	2.4492	0.10	0.0860	0.92
"	(2,2)	1.4554	0.25	0.0795	0.92
Multiplier —> Reserves	(1,1)	0.1347	0.72	0.0331	0.85
"	(2,1)	0.1111	0.74	0.4029	0.53
"	(1,2)	0.8773	0.43	1.0604	0.36
"	(2,2)	0.2442	0.78	0.7679	0.47
Reserves —> Multiplier	(1,1)	4.8490	0.04	7.1881	0.01
"	(2,1)	4.4184	0.04	7.1494	0.01
"	(1,2)	2.5531	0.09	3.6718	0.03
"	(2,2)	2.4296	0.10	3.6304	0.03
D.Credit —> Reserves	(1,1)	0.0329	0.86	13.796	0.00
"	(2,1)	0.1103	0.74	15.670	0.00
"	(1,2)	0.0862	0.92	9.7448	0.00
"	(2,2)	2.4456	0.10	33.891	0.00
Reserves —> D.Credit	(1,1)	0.0001	0.99	0.8180	0.37
"	(2,1)	0.0231	0.88	0.2117	0.65
"	(1,2)	1.9187	0.16	0.3945	0.68
"	(2,2)	6.4983	0.00	5.5964	0.00

m and n represent own lag and lag of other variable respectively, and the F statistics correspond to the test that the sum of the n coefficients is zero

Table 5.3

Sims Test : **MABP**

Hypotheses	(n1,n2)	Variant 1		Variant 2	
		F-value	sig.level	F-value	sig.level
Income —> Reserves	(1,1)	0.1700	0.68	0.3882	0.54
"	(1,2)	0.1961	0.66	0.7250	0.40
"	(2,1)	1.6477	0.21	0.8436	0.44
"	(2,2)	1.0870	0.35	0.9304	0.41
Reserves —> Income	(1,1)	0.0791	0.78	3.2721	0.08
"	(1,2)	0.0144	0.91	3.1319	0.09
"	(2,1)	0.8961	0.42	4.6173	0.02
"	(2,2)	0.7784	0.47	4.3176	0.02
Price —> Reserves	(1,1)	0.5131	0.48	0.0014	0.97
"	(1,2)	0.5700	0.46	0.3832	0.54
"	(2,1)	2.0394	0.15	0.7103	0.50
"	(2,2)	2.1673	0.13	0.1875	0.83
Reserves —> Price	(1,1)	1.8025	0.19	0.0124	0.91
"	(1,2)	1.2895	0.27	0.0156	0.90
"	(2,1)	6.1775	0.01	2.5601	0.09
"	(2,2)	6.7799	0.00	2.0213	0.15
Int.rate —> Reserves	(1,1)	0.6642	0.42	0.0497	0.83
"	(1,2)	0.9914	0.33	0.1375	0.71
"	(2,1)	0.3588	0.70	0.0580	0.94
"	(2,2)	0.4859	0.62	0.4127	0.67
Reserves —> Int.rate	(1,1)	1.2486	0.27	0.0004	0.98
"	(1,2)	1.1293	0.30	0.0412	0.84
"	(2,1)	0.8626	0.43	0.6430	0.53
"	(2,2)	0.8663	0.43	1.1197	0.34
Multiplier —> Reserves	(1,1)	4.4184	0.04	6.3019	0.02
"	(1,2)	3.3833	0.07	6.0785	0.02
"	(2,1)	2.2222	0.13	4.9972	0.02
"	(2,2)	1.7530	0.19	4.9298	0.02
Reserves —> Multiplier	(1,1)	0.1111	0.74	0.3057	0.58
"	(1,2)	0.0881	0.77	0.2194	0.64
"	(2,1)	0.6483	0.53	0.9137	0.41
"	(2,2)	0.5851	0.56	0.8195	0.45
D.Credit —> Reserves	(1,1)	0.0231	0.88	0.5739	0.45
"	(1,2)	0.0771	0.78	0.4801	0.49
"	(2,1)	3.3801	0.04	0.7139	0.50
"	(2,2)	3.1677	0.05	0.8687	0.43
Reserves —> D.Credit	(1,1)	0.1103	0.74	40.864	0.00
"	(1,2)	0.3736	0.55	56.211	0.00
"	(2,1)	1.8151	0.18	26.952	0.00
"	(2,2)	2.4587	0.10	35.114	0.00

nl and n2 denote lead and lag values respectively of the right hand side variable, and the F statistics correspond to the test that the sum of nl coefficients is zero.

Table 5.4
Multiple Rank F-Test MABP

Hypotheses	(k1,k2)	F-value	sig.level
Income —> Reserves	(1,1)	7.2254	0.01
"	(1,2)	3.2383	0.05
"	(2,1)	5.9853	0.02
"	(2,2)	2.9076	0.07
Reserves —> Income	(1,1)	0.0095	0.92
"	(1,2)	0.1436	0.87
"	(2,1)	0.0004	0.98
"	(2,2)	0.3289	0.72
Price —> Reserves	(1,1)	6.5724	0.01
"	(1,2)	4.5664	0.02
"	(2,1)	5.5710	0.02
"	(2,2)	4.5436	0.02
Reserves —> Price	(1,1)	0.0890	0.77
"	(1,2)	0.5367	0.59
"	(2,1)	1.0305	0.32
"	(2,2)	0.8075	0.45
Int.Rate —> Reserves	(1,1)	6.1072	0.02
"	(1,2)	5.7291	0.01
"	(2,1)	5.8072	0.02
"	(2,2)	5.0825	0.01
Reserves —> Int.Rate	(1,1)	1.7413	0.19
"	(1,2)	2.3747	0.11
"	(2,1)	2.8545	0.10
"	(2,2)	3.4084	0.44
Multiplier —> Reserves	(1,1)	2.3669	0.13
"	(1,2)	1.4546	0.25
"	(2,1)	1.1385	0.29
"	(2,2)	0.6385	0.53
Reserves —> Multiplier	(1,1)	7.1265	0.01
"	(1,2)	3.0355	0.06
"	(2,1)	5.2931	0.03
"	(2,2)	2.6170	0.09
D.Credit —> Reserves	(1,1)	7.6222	0.01
"	(1,2)	3.5675	0.04
"	(2,1)	6.5924	0.02
"	(2,2)	3.9860	0.03
Reserves —> D.Credit	(1,1)	0.2487	0.62
"	(1,2)	0.1418	0.86
"	(2,1)	0.0753	0.79
"	(2,2)	0.6517	0.53

kl and k2 indicate own lag and lag of other variable respectively and F statistics correspond to the test that the sum of K2 coefficients is zero.

Table 5.5

Complete Dynamic Simultaneous Equation Model (CDSEM) : **Regression Results**

Dependent variable	(m,n)	General Model R^2	F-value	sig.level	Linear Model R^2	F-value	sig.level
Income	(1,1)	0.12	0.1339(1,32)	0.72	0.49	0.0342(1,32)	0.86
"	(1,2)	0.25	2.8189(2,30)	0.08	0.54	1.4778(2,30)	0.24
"	(2,1)	0.39	0.5032(1,26)	0.48	0.66	0.0038(1,26)	0.95
"	(2,2)	0.40	0.2515(2,25)	0.78	0.66	0.0023(2,25)	0.99
Price	(1,1)	0.54	19.043(1,32)	0.00	0.52	2.7680(1,32)	0.11
"	(1,2)	0.49	6.4254(2,30)	0.01	0.52	1.3931(2,30)	0.26
"	(2,1)	0.63	7.8040(1,26)	0.01	0.67	2.5116(1,26)	0.13
"	(2,2)	0.63	4.1247(2,25)	0.03	0.67	1.3687(2,25)	0.27
Int.rate	(1,1)	0.11	0.9536(1,32)	0.33	0.03	0.6122(1,32)	0.81
"	(1,2)	0.16	1.5286(2,30)	0.23	0.03	0.0458(2,30)	0.96
"	(2,1)	0.38	0.2460(1,26)	0.62	0.31	0.9281(1,26)	0.34
"	(2,2)	0.38	0.1292(2,25)	0.88	0.32	0.5658(2,25)	0.58
Multiplier	(1,1)	0.22	3.9297(1,32)	0.06	0.27	7.0908(1,32)	0.01
"	(1,2)	0.25	2.5108(2,30)	0.10	0.28	3.6371(2,30)	0.04
"	(2,1)	0.29	1.3651(1,26)	0.25	0.51	8.3513(1,26)	0.01
"	(2,2)	0.29	0.6710(2,25)	0.52	0.51	4.1050(2,25)	0.03
D.Credit	(1,1)	0.19	0.0004(1,32)	0.99	0.69	1.2568(1,32)	0.27
"	(1,2)	0.32	3.2990(2,30)	0.05	0.69	0.6937(2,30)	0.51
"	(2,1)	0.28	0.1425(1,26)	0.71	0.84	1.0519(1,26)	0.32
"	(2,2)	0.64	12.800(2,25)	0.00	0.88	4.8069(2,25)	0.02

m and n represent lag length of exogenous and endogenous variables respectively.
Values in parentheses along with F statistics are degrees of freedom

Table 5.6

Wald and LR Statistics of Uniform General Linear Constraints in CDSEM

(f,g)	Wald	sig.level	LR	sig.level
(1,1)	34.778(5)	0.0000	33.305(5)	0.0000
(1,2)	45.283(10)	0.0000	22.903(10)	0.0111
(2,1)	19.175(5)	0.0018	10.658(5)	0.0586
(2,2)	59.505(10)	0.0000	35.598(10)	0.0001

f and g represent lag of exogenous and endogenous variables respectively.
Values in parentheses along with Wald and LR statistics are degrees of freedom.

Table 5.7a

Estimates of Restricted Equations in CDSEM with one-period lag

Independent variable	Dependent variable				
	Income(Y)	Price(P)	Int.rate(i)	Multi.(m)	D.credit(d)
Y_{t-1}	-0.2866 (-1.7170)	0.6049 (-1.923)	0.9842 (0.7954)	0.2677 (1.0313)	0.0370 (0.1198)
P_{t-1}	-0.0953 (-0.1153)	0.1433 (0.9201)	-0.3738 (-0.6104)	0.0836 (0.6511)	0.1266 (0.8277)
i_{t-1}	-0.0098 (-0.4544)	-0.0452 (-1.1029)	0.1550 (0.9629)	0.0531 (1.5685)	-0.0521 (-1.2923)
m_{t-1}	-0.0673 (-0.6508)	0.1399 (0.7180)	0.1153 (0.1505)	0.0438 (0.2727)	0.1141 (0.5962)
d_{t-1}	0.0673 (0.7884)	0.3403 (2.0882)	-0.6078 (-0.9483)	0.1113 (0.8276)	0.3299 (2.0615)
constant	0.0458 (3.6785)	0.0450 (1.9154)	0.0915 (0.9917)	-0.0359 (-1.8562)	0.0612 (2.6550)
R^2	0.11	0.27	0.09	0.13	0.19
D-W	2.15	1.73	1.89	2.13	1.95

Values **in** parentheses are t-statistics
D-W is Durbin-Watson statistic

Form of equation estimated is : $X_t = a_0 + \sum_{s=1}^{1} F_s X_{t-s} + \varepsilon_{1t}$

Table 5.7b

Estimates of Unrestricted Equations in CDSEM with one-period lag

Independent variable	Dependent variable				
	Y	**P**	**i**	**m**	**d**
Y_{t-1}	-0.2841 (-1.6776)	-0.6508 (-2.5701)	0.9339 (0.7536)	0.2881 (1.1574)	0.0368 (0.1171)
P_{t-1}	-0.0060 (-0.0710)	0.0801 (0.6356)	-0.4430 (-0.7381)	0.1119 (0.9026)	0.1262 (0.8075)
i_{t-1}	-0.0112 (-0.5015)	-0.0218 (-0.6509)	0.1807 (1.1050)	0.4258 (1.2960)	-0.0519 (-1.2529)
m_{t-1}	-0.8506 (-0.7365)	0.4571 (2.6468)	0.4628 (0.5475)	-0.0979 (-0.5751)	0.1157 (0.5403)
d_{t-1}	0.0414 (0.3671)	0.8027 (4.7634)	-0.1013 (-0.1228)	-0.9530 (-0.5751)	0.3324 (1.5902)
r_{t-1}	-0.0442 (-0.3659)	0.7874 (4.3637)	0.8625 (0.9765)	-0.3517 (-1.9823)	0.0042 (0.0187)
constant	0.0480 (3.4365)	0.0059 (0.2819)	0.0487 (0.4769)	-0.0185 (-0.9002)	0.0609 (2.3541)
R^2	0.12	0.54	0.11	0.22	0.19
D-W	2.15	2.00	1.85	2.04	1.95

Values in parentheses are the t-statistics
D-W is the Durbin-Watson statistics

Form of estimated equation is :

$$X_t = b_0 + \sum_{s=1}^{1} F_s X_{t-s} + \sum_{s=1}^{1} G_s Y_{t-s} + \varepsilon_{2t}$$

Table 5.8

Estimates of Unrestricted Equations in CDSEM with 1 and 2 lags respectively on Exogenous and Endogenous Variables

Independent variable	Dependent variable				
	Y	**P**	**i**	**m**	**d**
Y_{t-1}	-0.3763 (-2.2807)	-0.6405 (-2.5466)	0.7036 (0.5563)	0.2816 (1.0866)	0.2061 (0.6824)
P_{t-1}	0.0251 (0.3104)	-0.0732 (-0.5935)	-0.3544 (-0.5706)	0.1121 (0.8824)	0.0675 (0.4561)
i_{t-1}	0.0098 (0.4215)	-0.0134 (-0.3764)	0.1995 (1.1157)	0.0501 (1.3694)	-0.0856 (-2.009)
m_{t-1}	-0.1594 (-1.3178)	0.3436 (1.8628)	0.6598 (0.7102)	-0.1716 (-0.9029)	0.1973 (0.8907)
d_{t-1}	0.0573 (0.4889)	0.6489 (3.6302)	0.4169 (0.4630)	-0.1797 (-0.9757)	0.2343 (1.0913)
r_{t-1}	0.1286 (0.8495)	0.5381 (2.3309)	2.0179 (1.7352)	0.0553 (0.2765)	-0.4174 (-1.5053)
r_{t-2}	-0.2822 (-2.2984)	0.1618 (0.8640)	-1.1154 (-1.1827)	-0.4688 (-1.9710)	0.5775 (2.5686)
constant	0.0497 (3.3170)	0.0219 (1.0137)	-0.0347 (-0.0347)	-0.0096 (-0.4326)	2.7014 (0.0700)
R^2	0.25	0.49	0.16	0.25	0.32
D-W	2.21	1.91	1.90	2.00	2.01

Values in parentheses are t-statistics
D-W is Durbin-Watson statistics

Form of estimated equation is

$$X_t = b_0 + \sum_{s=1}^{1} F_s X_{t-s} + \sum_{s=1}^{2} G_s Y_{t-s} + \varepsilon_{3t}$$

Table 5.9a

Estimates of Restricted Equations in CDSEM with two-period lags

Independent variable	Dependent variable				
	Y	P	i	m	d
Y_{t-1}	-0.4872 (-2.8519)	-0.7782 (-2.7758)	0.0130 (0.0104)	0.1994 (0.6732)	0.0365 (0.1030)
Y_{t-2}	-0.2603 (-1.4172)	-0.5035 (-1.6705)	-2.7276 (-2.0419)	-0.2654 (-0.8334)	0.1656 (0.4349)
P_{t-1}	-0.1798 (-1.8679)	0.0934 (0.5913)	-1.1915 (-1.7021)	0.0444 (0.2660)	0.1984 (0.9938)
P_{t-2}	0.0180 (0.2237)	0.3036 (0.2301)	-0.3191 (-0.5458)	-0.0218 (-0.1559)	-0.1454 (-0.8722)
i_{t-1}	0.0257 (1.0698)	-0.0003 (-0.0070)	0.2730 (1.5618)	0.0557 (1.3374)	-0.0595 (-1.1939)
i_{t-2}	-0.0117 (-0.5212)	-0.0979 (-2.6610)	-0.5147 (-3.1558)	0.0565 (1.4518)	0.0158 (0.3398)
m_{t-1}	-0.1495 (-1.4032)	0.1965 (1.1238)	0.9135 (1.1789)	-0.0215 (-0.1163)	0.1097 (0.4966)
m_{t-2}	0.1034 (1.0670)	-0.2215 (-1.3931)	-0.0560 (-0.0795)	0.8392 (0.4997)	-0.3204 (-1.5956)
d_{t-1}	-0.0585 (-0.6376)	0.3151 (2.0933)	-0.8113 (-1.2164)	0.1359 (0.8545)	0.3397 (1.7862)
d_{t-2}	0.3304 (3.2026)	-0.2593 (-1.5338)	0.4423 (0.5903)	0.0370 (0.2071)	0.0717 (0.3356)
constant	0.0533 (3.2439)	0.1058 (3.9218)	0.3111 (2.6033)	-0.0290 (-1.0168)	0.0480 (1.4075)
R^2	0.38	0.51	0.38	0.25	0.28
D-W	2.17	1.93	1.30	1.77	2.23

Values in parentheses are t-statistics
D-W is Durbin-Watson statistics

Form of estimated equation is :

$$X_t = b_0 + \sum_{s=1}^{2} F_s X_{t-s} + \varepsilon_{4t}$$

Table 5.9b

Estimates of Unrestricted Equations in CDSEM **with 1 and 2 period lags** respectively on Endogenous and Exogenous variables

Independent variable	Dependent variable				
	Y	P	i	m	d
Y_{t-1}	-0.5057 (-2.8998)	-0.8838 (-3.4880)	-0.0813 (-0.0638)	0.2512 (0.8445)	0.0570 (0.1565)
Y_{t-2}	-0.2987 (-1.5465)	-0.7227 (-2.5760)	-2.9234 (-2.0716)	-0.1577 (-0.4787)	0.2082 (0.5164)
P_{t-1}	-0.2019 (-1.9788)	-0.0328 (-0.2212)	-1.3042 (-1.7495)	0.1064 (0.6111)	0.2228 (1.0465)
P_{t-2}	0.0247 (0.3021)	-0.0687 (0.5782)	-0.2849 (-0.4773)	-0.0405 (-0.2908)	-0.1528 (-0.8960)
i_{t-1}	0.0282 (1.1514)	0.0141 (0.3666)	0.2858 (1.5954)	0.0486 (1.1632)	-0.0623 (-1.2117)
i_{t-2}	-0.0039 (-0.1530)	-0.0531 (-1.4509)	-0.4747 (-2.5788)	0.0344 (0.8012)	0.0071 (0.1350)
m_{t-1}	-0.1113 (-0.9245)	0.4155 (2.3767)	1.1091 (1.2613)	-0.1291 (-0.6286)	0.0672 (0.2675)
m_{t-2}	0.1150 (1.1600)	-0.1548 (-1.0747)	0.0035 (0.0048)	0.0512 (0.3027)	-0.3334 (-1.6109)
d_{t-1}	0.0072 (0.0547)	0.06906 (3.6315)	-0.4760 (-0.4976)	-0.0487 (-0.2176)	0.2667 (0.9763)
d_{t-2}	0.3538 (3.2425)	-0.1250 (-0.7886)	0.5622 (0.7050)	-0.0290 (-0.1555)	0.0456 (0.2003)
r_{t-1}	0.1084 (0.7093)	0.6202 (2.7936)	0.5538 (0.4959)	-0.3046 (-1.1684)	-0.1204 (-0.3775)
constant	0.0472 (2.5233)	0.0707 (2.6025)	0.2798 (2.0478)	-0.0118 (-0.3685)	0.0548 (1.4028)
R^2	0.40	0.63	0.38	0.29	0.28
D-W	2.25	1.91	2.17	1.84	2.18

Values in parentheses are t-statistics
D-W is Durbin-Watson statistics
Form of estimated equation is :

$$X_t = b_0 + \sum_{s=1}^{2} F_s X_{t-s} + \sum_{s=1}^{1} G_s Y_{t-s} + \varepsilon_{5t}$$

Table 5.10

Estimates of Unrestricted Equations in CDSEM with 2 period lag

Independent variable	Dependent variable				
	Y	P	i	m	d
Y_{t-1}	-0.5048 (-2.8377)	-0.8767 (-3.4294)	-0.0744 (-0.0572)	0.2531 (0.8340)	0.1049 (0.4007)
Y_{t-2}	-0.3061 (-1.4985)	-0.7822 (-2.6643)	-2.9821 (-1.9977)	-0.1733 (-0.4972)	-0.1961 (-0.6521)
P_{t-1}	-0.2136 (-1.5840)	-0.1263 (-0.6513)	-1.3966 (-1.4171)	0.0819 (0.3559)	-0.4132 (-2.0816)
P_{t-2}	0.0222 (0.2598)	0.0486 (0.3968)	-0.3047 (-0.4889)	-0.0458 (-0.3147)	-0.2890 (-2.3020)
i_{t-1}	0.0281 (1.1214)	0.0128 (0.3558)	0.2845 (1.5560)	0.0483 (1.1317)	-0.0714 (-1.9375)
i_{t-2}	-0.0054 (-0.1926)	-0.0654 (-1.6220)	-0.4868 (-2.3750)	0.0312 (0.6522)	-0.0766 (-1.8544)
m_{t-1}	-0.1073 (-0.8510)	0.4471 (2.4682)	1.1403 (1.2380)	-0.1208 (-0.5617)	0.2821 (1.5205)
m_{t-2}	0.1268 (0.9553)	-0.0612 (-0.3207)	0.0961 (0.0991)	0.0757 (0.3344)	0.3039 (1.5555)
d_{t-1}	-0.0024 (-0.0157)	0.6150 (2.8446)	-0.5507 (-0.5009)	-0.0684 (-0.2665)	-0.2480 (-0.1198)
d_{t-2}	0.0373 (2.1108)	0.0241 (0.0951)	0.7097 (0.5501)	0.0101 (0.0334)	1.0608 (4.0828)
r_{t-1}	0.0904 (0.4444)	0.4776 (1.6330)	0.4128 (0.2776)	-0.3419 (-0.9849)	-1.0905 (-3.6408)
r_{t-2}	0.0302 (0.1370)	0.2394 (0.7573)	0.2366 (0.1472)	0.0627 (0.1671)	1.6290 (5.0322)
R^2	0.40	0.63	0.38	0.29	0.64
D-W	2.25	1.91	2.15	1.87	1.86

Values in parentheses are t-statistics
D-W is Durbin-Watson statistics
Form of estimated equation is :

$$X_t = b_0 + \sum_{s=1}^{2} F_s X_{t-s} + \sum_{s=1}^{2} G_s Y_{t-s} + \varepsilon_{6t}$$

Table 5.11

CDSEM : Regression Results
(Period : 1970-'90)

Dependent variable	(m,n)	General Model R^2	F-value	sig.level	Linear Model R^2	F-value	sig.level
Income	(1,1)	0.20	1.5195(1,12)	0.24	0.41	0.0674(1,12)	0.80
"	(1,2)	0.43	2.6830(2,10)	0.12	0.50	0.5840(2,10)	0.58
"	(2,1)	0.71	0.4150(1,06)	0.54	0.75	0.6680(1,06)	0.45
"	(2,2)	0.71	0.2386(2,05)	0.80	0.76	0.4696(2,05)	0.65
Price	(1,1)	0.50	5.8080(1,12)	0.03	0.26	0.0743(1,12)	0.79
"	(1,2)	0.55	3.2492(2,10)	0.08	0.29	0.1746(2,10)	0.84
"	(2,1)	0.85	0.3286(1,06)	0.59	0.62	0.0411(1,06)	0.85
"	(2,2)	0.86	0.2760(2,05)	0.77	0.63	0.0952(2,05)	0.91
Int.rate	(1,1)	0.23	2.5885(1,12)	0.13	0.07	0.0010(1,12)	0.98
"	(1,2)	0.25	1.1613(2,10)	0.35	0.03	0.0052(2,10)	0.99
"	(2,1)	0.66	0.6194(1,06)	0.46	0.44	0.0440(1,06)	0.84
"	(2,2)	0.68	0.4298(2,05)	0.67	0.44	0.0272(2,05)	0.97
Multiplier	(1,1)	0.58	1.6862(1,12)	0.22	0.39	1.6588(1,12)	0.22
"	(1,2)	0.68	0.8995(2,10)	0.44	0.54	0.8716(2,10)	0.45
"	(2,1)	0.73	0.2039(1,06)	0.67	0.69	1.9664(1,06)	0.21
"	(2,2)	0.73	0.0866(2,05)	0.92	0.69	0.8244(2,05)	0.49
D.Credit	(1,1)	0.28	0.7600(1,12)	0.40	0.57	0.3043(1,12)	0.59
"	(1,2)	0.49	1.7067(2,10)	0.23	0.56	0.1611(2,10)	0.85
"	(2,1)	0.75	1.8724(1,06)	0.22	0.85	0.0333(1,06)	0.86
"	(2,2)	0.92	7.9090(2,05)	0.03	0.86	0.3488(2,05)	0.72

m and n represent lag length of exogenous and endogenous variables respectively.
Values in parentheses along with F statistics are degrees of freedom

Table 5.12

Wald and LR Statistics of Uniform General **Linear Constraints in CDSEM**
(Period : 1970-'90)

(f,g)	Wald	sig.level	LR	sig.level
(1,1)	16.880(5)	0.0050	12.490(5)	0.0060
(1,2)	26.209(10)	0.0040	20.669(10)	0.0230
(2,1)	4.8726(5)	0.4320	4.4440(5)	0.7290
(2,2)	54.753(10)	0.0000	10.239(10)	0.4200

f and g represent lag of exogenous and endogenous variables respectively.
Values in parentheses along with Wald and LR statistics are degrees of freedom.

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS OF THE STUDY

The present study is carried out to examine whether the behaviour of India's BoP is in line with various theoretical explanations that have been advanced in the literature. More specifically, the study attempts to test the empirical validity of the traditional and modern approaches to BoP in the Indian context. In order to assess the merits and demerits of each theory in the given context, the study has reviewed the various theories/approaches to BoP. The review is carried out with an aim of examining the adequacy of Keynesian and monetary approaches to BoP.

A simple Keynesian model of BoP incorporating the conventional theoretical propositions is formulated, and its fundamental propositions and policy prescriptions are examined. In this context, the feasibility of exchange rate (devaluation) and domestic interest rate policies to tide over payments problem is discussed. The causal relationships underlying the absorption approach have also been tested.

A detailed analysis of BoP is carried out within the empirical framework of the monetary approach to BoP (MABP). The study investigated the relationship between domestic monetary conditions and BoP during the period of fixed exchange rate from 1950 to 1975. The reserve flow and sterilisation equations are estimated simultaneously to see whether the domestic monetary expansion is offset by an equal and opposite changes in international reserves or BoP. The study also examined the influence of domestic monetary disequilibrium condition on combined movement in foreign exchange reserves and exchange rate during the period of managed floating exchange rate from 1975 to

1990. The monetary model of exchange market pressure is formulated and estimated to see the impact of changes in domestic component of money supply on BoP and exchange rate. It is also attempted to see the response of monetary authorities to monetary shocks by incorporating a measure of absorption into the exchange market pressure equation.

A comprehensive test of the assumptions of the MABP is also carried out in the study. The relevance of the policy prescriptions of the MABP depends upon the validity of its exogeneity assumptions that the determinants of money demand, and changes in domestic credit arc exogenous with respect to changes in international reserves. In this study, the exogeneity specification is formulated as a testable hypothesis and verified using a multivariate systems test of exogeneity within the framework of complete dynamic simultaneous equation model (CDSEM) framework.

The findings and implications of the study are as follows :

(i) From the critical review of the earlier work attempted in this study, it was observed that the conventional models including the Keynesian model are not adequate for analysis of BoP phenomenon. The review revealed that omission of certain essential components of analysis of BoP including fiscal operations of the government and monetary policy of the central bank, render the theories unsuitable. In a country like India where persistent budget deficits exist, the link between budget deficit and BoP has to be recognised and must necessarily be analysed together. None of the models reviewed seem to emphasise on this linkage. While all the theories together have identified the most important causes of BoP problem, each of them in isolation seem inadequate. It is evident from the review that the existing theories do not fare well in the Indian context in view of the fact that they do not agree upon the simultaneous interaction of real and monetary forces, consistent with the institutional realities, to determine the payments position.

(ii) The estimated results of the Keynesian trade balance, capita! How and BoP equations showed that exchange rate and interest rate are ineffective in determining payments position. When exchange rate rises (devaluation) the model assumes an improvement in trade balance through a favourable terms-of-trade effect. But the Indian situation may not conform to a text-book example of the case for devaluation. The Marshall-Lerner condition may not be satisfied in practice due to the persistence of certain bottlenecks in domestic production which keep both the supply of exports and demand for imports inelastic to a change in relative price. It is presumed that devaluation could boost up exports if it is sensitive to competitive conditions in the world market. But in practice, only around 40 7. of India's exports is prone to competitive conditions. Given this reality it is illogical to expect devaluation to exert a favourable effect on BoP in an input-import dependent country like India. Hence, the non-viability of the policy of devaluation in the Indian context has been indicated.

(iii) It is also observed that, since interest rates in India are largely administrated (during the sample period), a market-determined interest rate is desirable to attract more capital inflow.

(iv) An empirical test of the scheme of causal relationships underlying the Keynesian income-absorption approach has been tested using the Granger, Sims and multiple rank F tests. The results, by and large, rejected the basic contention of the absorption approach - a unidirectional causal relationship running from income to absorption, and instead established the interdependence between them. This in fact, makes its policy prescription (that the simultaneous adoption of expenditure-switching and expenditure reducing policies when output is at near full employment level) more effective to improve trade balance. Alexander hypothesises that a devaluation leads to change in trade balance via an income-induced change in expenditure and a non-income induced, or directly effected, change in expenditure. The net changes in income and expenditure due to devaluation determine the change in trade balance. However, when the effect of changes in expenditure on income is incorporated into the model, the magnitude of change in trade balance however, would be different.

(v) A detailed analysis of India's BoP within the theoretical and empirical framework of the MABP under fixed exchange rate revealed that the movements in international reserves are not explained by domestic money market conditions. The estimated results of the reserve flow equation showed that a change in domestic credit is not offset by an equal and opposite change in reserves. This may be due to strict exchange control policies pursued by the government wherein the residents will not be able to get rid of excess supply or excess demand for domestic credit through foreign commodities or securities market. The poor performance of the model may be attributed to the fact that a disequilibrium in the money market does not necessarily have to be reflected in a BoP deficit or surplus, because it could be offset by a deficit or surpluses on the government budget. The inflow of money from a BoP surplus need not disturb the equilibrium of the money market if accompanied by a government budget surplus. The reason is that in an open economy with fixed exchange rate budget imbalance and BoP imbalance would neutralise one another. The estimated sterilisation equation supports the presence of a high degree of sterilisation reducing (increasing) domestic credit by some fraction of reserve inflows (outflows) either through open market operations or through bank credit/debit to government. This indicates that at least some degree of sterilisation can be undertaken in the short-run to neutralise the inflows and outflows of money associated with BoP surpluses or deficits. The unsuitability of the model may be attributed to among other factors, a low degree of openness of the economy, strict foreign exchange control policy of **the** government and a relatively inflexible financial market.

(vi) An analysis of combined movements of international reserves and exchange rates has been carried out within the framework of exchange market pressure (EMP) model. The EMP model states that an increase in the rate of growth of domestic credit for a given rate of growth of domestic income and world prices will result in an equi-proportionate loss in reserves with no change in exchange rate or an equi-proportionate depreciation of domestic currency with no change in reserves, or some combination of the two. The estimated result of the EMP equation showed that only the coefficients of domestic credit which is of crucial importance in the model and money multiplier are of expected sign and significant. In addition to this, a measure of absorption is incorporated in to the EMP equation and estimated to see whether the monetary authority makes choice between reserves and exchange rate changes in response to monetary shocks. The estimated coefficient of the measure of absorption was found to be insignificant implying that the measure of EMP is not sensitive to its composition of changes in reserves and exchange rates. On the whole, the evidence indicated that while MABP under fixed exchange rates failed to explain reserve movements, combined movements in exchange rates and international reserves during the managed floating exchange rate system **are** explained to a certain extent by the EMP model. This contradiction in result may be attributed to the fact that under managed floating exchange rate system residents are able to get rid of a part of the excess real balances through foreign exchange market since the market forces partially determine the exchange rate.

(vii) Tests are carried out to verify the exogeneity assumptions underlying the **MABP** that the determinants of money demand, and domestic credit are exogenous with respect to changes in reserves. The study investigated into the validity of the exogeneity assumptions in three different ways. First, a simultaneous estimation of reserve flow and sterilisation equations is made to confirm the absence of sterilisation. Secondly, using three causality tests viz., the Granger, Sims and Multiple rank F-tests, bivariate causality is examined. Finally, a multivariate systems test of causality within the framework of CDSEM is applied to test the joint exogeneity of price level, real income, interest rate, money multiplier and changes in domestic credit with respect to reserve flows. The result of the study do not support the MABP specification of exogeneity. While the Granger, Sims and Multiple rank F-tests collectively fail to provide a consistent pattern of causality between reserve flows and its possible determinants, the OLS and 3SLS estimation of sterilisation and reserve flow equations, and the Wald and likelihood ratio tests for the CDSEM uniformly reject the exogeneity assumptions. This introduces simultaneity between change in reserves and its determinants, and makes the policy propositions of the MABP invalid. Unless domestic component of monetary base is exogenous, it cannot be considered as a policy variable. Hence the monetarists' proposition that a continuous BoP deficit can occur only if the authorities allow domestic credit to expand faster than the demand for money, is of questionable validity in the Indian context.

APPENDIX 1

BI-VARIATE CAUSALITY TESTS

GRANGER'S TEST

According to Granger (1969), a variable Y is caused by another variable X if Y can be predicted better from past values of Y and X than from past values of Y alone. Two regressions must be performed to test for causality between them. These regressions provide an F statistic with which the statistical significance of the coefficients of past values of a variable can be tested. In order to test if Y causes X, X is to be regressed on past Y and past X. If the explanatory power of the past Y is significant, then the data are consistent with the hypothesis that Y causes X. In the next step, Y should be regressed on X to check if X does not cause Y, so that the unidirectional causality from Y to X is confirmed.

The Granger test may be explained with the help of the following equations :

$$X_t = a_0 + \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{n} b_j Y_{t-j} + e_t , \qquad (1.1)$$

$$Y_t = c_0 + \sum_{j=1}^{m} c_j Y_{t-j} + \sum_{j=1}^{n} d_j X_{t-j} + w_t , \qquad .(1.2)$$

where X and Y are two stationary time series, a_0, c_0, a_i., b_i, c_i, and d_i. are coefficients, e_t and w_t are uncorrelated white-noise series. The definition of causality given above implies that if Y_t is to cause X_t , then some b_i are non-zero. Similarly X_t causes Y_t if some d_i are non-zero. If both the events occur simultaneously, there is said to be a feedback between X_t and Y_t .

Since the F-test of the Granger test is sensitive to lag length, it is important to fix an appropriate lag-length to avoid spurious inference. In literature the Final Prediction Error (FPE) criterion initially suggested by Akaike (1969) has been used to determine the lag length.

FINAL PREDICTION ERROR (FPE) CRITERION

The FPE criterion is implemented according to a two-stage procedure to determine the optimal lag length. In the first stage, the optimal value of *m* is found by estimating an auto regressive equation with only lagged values of X (1 to m) and by determining the minimum value of FPE(m) given by the formula

$$FPE(m) = \frac{(T + m + 1) / (T - m - 1)}{T / SSR(m)} \qquad (1.3)$$

where T is the number of observations and SSR is the sum of squared residuals. Let FPE(m) attains its minimum at m = m* . In the second stage the lagged values of Y (1 to n) are added along with the lagged values of X (1 to m*). The optimal value of n is the one that minimizes FPE(m* ,n) whose formula is shown below :

$$FPE(m^*, n) = \frac{(T + m^* + n + 1) / (T - m^* - n - 1)}{T / SSR(m^*, n)} \qquad (1.4)$$

Let FPE(m*,n) attains its minimum at n • n . Then the appropriate lag lengths are m* and n* for equation (1.1). The optimum lag length for the second equation may be obtained in a similar manner by interchanging Y and X.

SIMS TEST

The Sims (1972) test is based on the logic that future cannot cause past. It may be explained with the help of the following two equations :

$$Y_t = \alpha + \sum_{i=-n1}^{n2} \beta_i X_{t-i} + u_t \qquad (1.5)$$

$$X_t = \gamma + \sum_{j=-n1}^{n2} \delta_j Y_{t-j} + v_t \qquad .(1.6)$$

According to Sims, a unidirectional causal relationship running from Y to X exists if :

$$\text{(i)} \quad \sum_i \delta_j \quad (j<0) = 0 \text{ and} \qquad (1.7)$$

$$\text{(ii)} \quad \sum_i \beta_i \quad (i<0) \neq 0. \qquad (1.8)$$

HSIAO'S FINAL PREDICTION ERROR TEST

This test is applied by Hsiao (1979). A step-wise procedure based on Granger's concept of causality and Akaike's final prediction error (FPE) criterion is suggested by Hsiao to test causality in a bivariate auto-regressive model. The test procedure is as follows :

(1). Let X_t and Y_t be two time series. The order of the one-dimentional auto-regressive process for say, Y_t is determined by using the FPE criterion.

(2). Considering the order of lag of Y_t obtained from step 1 as given, and treating X_t. as the manipulated variable, the lag of X_t is fixed based on the FPE criterion.

(3) Compare the smallest FPEs of steps (1) and (2). If the value of FPE in step (2) is less than that in step (1), then it may be inferred that X_t causes Y_t

(4) To test the reverse causation, steps (1) to (4) may be repeated by interchanging X_t and Y_t .

MULTIPLE RANK F TEST

This test has been proposed and applied by Holmes and Hutton (1988, 1990) mainly to examine the issue of sensitivity of causal inference to form of the test. In a bivariate causal framework, the hypothesis of a *prima facie* causal relationship between X and Y involves a test of a subset of K2 coefficients in each of the following general linear models :

$$g(Y_t) = \alpha_0 + \sum_{i=1}^{k1} \beta_i \, g(Y_{t-i}) + \sum_{i=1}^{k2} \gamma_i \, h(X_{t-i}) + e_t \quad ...(1.9)$$

$$h(X_t) = \delta_0 + \sum_{i=1}^{k1} \theta_i \, h(X_{t-i}) + \sum_{i=1}^{k2} \psi_i \, g(Y_{t-i}) + v_t \quad ...(1.10)$$

where g and h are functions of Y and X. It may be noted that equations (1.1) and (1.2) may be obtained as special cases of (1.9) and (1.10) respectively by assuming $g(Y_t) = Y_t$, $g(Y_{t-i}.) = Y_{t-i'}$ $h(X_t) = X_t$ and $h(X_{t-i})$

$= X_{t-i}$'

X is not a *prima facie* cause of Y in equation (5) if $\gamma_1 = \gamma_2 = \ldots = \gamma_{k1} = 0$ and Y is not a *prima facie* cause of X in equation (6) if $\psi_1 = \psi_2 = \ldots = \psi_{k2} = 0$.

A multiple rank F test of the *prima facie* causal relationship between X and Y involves the conversion of variables in to ranks, that is $g(Y_{t-i}) = R(Y_{t-i})$ and $h(X_{t-i}) = R(X_{t-i})$ for all i, where R stands for rank transformation.

APPENDIX II

DEFINITION OF VARIABLES AND SOURCES OF DATA

The study makes use of annual time series spanning 1950-51 through 1990-91. Variables in real terms are measured at 1980-81 prices.

In the study aggregate income is represented by Gross Domestic Product (GDP) at factor cost and aggregate or total absorption is taken to be the sum of government general consumption expenditure, private expenditure and gross domestic investment.

The monetary aggregate chosen for this study is stock of narrow money (Ml) ie., deposit money and currency money with the public. M3 is not chosen as M3 contains a considerable amount of time deposits which reflects saving behaviour of households. Further, the MABP suggests the use of Ml and not M3 as Ml is related to the transaction behaviour of the public.

Wholesale price index (1980-81 = 100) is taken to represent the price level. In many other studies consumer price index has been considered as a proxy for price level. But as Bean(1976) explained consumer goods prices are a biased estimator of traded goods because of the high services content. Wholesale prices do not include services. Hence it is considered in the study. However., while constructing real bilateral exchange rates with respect to US dollar, and UK pound relative changes in consumer price indices (CPI) is considered for deflating the nominal exchange rate.

Narrow money (Ml) is considered in the study to compute money multiplier which is defined as Ml multiplied by high powered money (B).

International reserve is the domestic currency value of the net foreign assets of the RBI consisting of gold, SDRs, reserve position in the IMF, and foreign currency assets of the RBI. Domestic credit consists mainly of central banks net holdings of assets and liabilities and is defined as monetary base less international reserves.

Two different interest rates are considered in the study. The weighted average of call-money rates of scheduled commercial banks in three major money markets in India viz., Bombay, Calcutta and Madras is used for estimating the demand for money function. For estimating the Keynesian capital flow equation one-year deposit rates in India and one-year euro-dollar rates are considered respectively for domestic and world interest rates.

Domestic debt outstanding of the government includes market loans and bonds, treasury bills and small savings outstandings. Total volume of trade is taken as the sum of the values of aggregate exports and imports.

Exchange rate used in the study is Real Effective Exchange Rate (REER) index of the rupee. It is trade weighted exchange rate of India's thirteen major trade partners against the rupee. Since exchange rates are expressed in foreign currency units per Rs. 100, a rise (fall) in the index indicates appreciation (depreciation) of the rupee. Bilateral exchange rates of the rupee against pound sterling and US dollar are indirect exchange rates (foreign currency units per Rs. 100) and the real indices for these bilateral rates are obtained by adjusting the respective nominal indices with the relative inflation rates.

Data relating to domestic economy are mainly collected from various issues of Reserve Bank of India's (RBI) *Monthly Bulletin,* and *Report on Currency and Finance, National Accounts Statistics* of the Central Statistical Organisation, *Economic Survey* of the Ministry of Finance, and the trade weighted exchange rate index of the rupee is collected from the *Journal of Foreign Exchange and International Finance* published from National Institute of Bank Management, Pune. The study mainly depended up on various issues of *International Financial Statistics* of the International Monetary Fund (IMF) for the rest-of-the-world variables.

BIBLIOGRAPHY

Akaike, **I!.,** 1969 "Fitting Autoregressive Models for Prediction", ***Annals*** *of the Institute of Statistical Mathematics*, Vol.2, pp.243-247.

Alexander, S.S., 1952, "Effects of a Devaluation on the Trade Balance", ***IMF*** *Staff Papers,* Vol.2, April, pp.263-278. Reprinted in Caves and Johnson.

Bean, D.L., 1976, "International Reserve Flows and Money Market Equilibrium: The Japanese Case", in Frenkel and Johnson (Eds), *The Monetary Approach to Balance of Payments,* Allen and Unwin, London.

Berndt, E.R, and Savin, N.E., 1977, "Conflict among Criteria for Testing Hypotheses in the Multivariate Linear Regression Model", *Econometrica,* Vol.45, pp. 1263-1278.

Bessler, D.A and Kling, J.L., 1984 "A Note on Tests of Granger Causality", *Applied Economics,* Vol. 16, pp.335-342.

Bhatia, S.L., 1982, "The Monetary Theory of Balance of Payments under Fixed Exchange Rates : An Example of India : 1951- 73", *Indian Economic Journal,* Vol XXIX (3), pp.30-39.

Blejer, M.I., 1979, "On Causality and the Monetary Approach to the Balance of Payments - European Experience", *European Economic Review,* Vol.12, pp. 289-296.

. Brems, H., 1957, "Devaluation, A Marriage of the Elasticity and the Absorption Approaches",*The Economic Journal,* Vol 67, March, pp.49-64.

Caves, R.E and Johnson, H.G., (Eds), 1968, *"Readings in International Economics,* George Allen and Unwin Ltd., London.

Cobham, D., 1983, "Reverse Causation in the Monetary Approach : An Econometric Test for the UK", *Manchester School of Social Studies,* Vol 51 (4), pp.360-79.

Connolly, M and Taylor, D., 1976, "Testing the Monetary Approach to Devaluation in Developing Countries", *Journal of Political Economy,* Vol.84, pp.849-859.

——————1979, "Exchange Rate Changes and Neutralization : A Test of the Monetary Approach to the Balance of Payments Applied to Developed and Developing Countries", *Economica,* Vol.46(3), pp.281-294.

Connolly, M and Silveira, J.D., 1979, "Exchange Market Pressure in Post-War Brazil : Application of the Girton-Roper Model", *American Economic Review,* Vol.69(3), pp.448-454.

Currie, D., 1976, "Some Criticisms of the Monetary Analysis of Balance of Payments Correction", *The Economic Journal,* Vol.86, September, pp. 508-522.

——————1977, "Some Criticisms of the Monetary Analysis of Balance of Payments Correction : A Reply Nobey and Johnson", *The Economic Journal,* Vol.87, December, pp.771-773.

Dent, W and Geweke, J., 1978, "On Specification in Simultaneous Equation Models", Social Systems Research Institute Workshop Series Paper No.7823, University of Wisconsin - Madison. Reprinted in J. Kmenta and J.B. Ramsey (Eds.) *Evaluation of Econometric Models* (1980), Academic Press, New York.

Dornbusch, R., 1973, "Devaluation, Money and Nontraded goods", *American Economic Review,* Vol.63, pp.871-80.

Fausten, D.A., 1979, "The Humean Origin of the Contemporary Monetary Approach to Balance of Payments", *Quarterly Journal of Economics,* Vol. 93(4), November, pp.655-673.

Frenkel, J.A, Gylfason, T and Helliwell, J.F., 1969, "A Synthesis of Monetary and Keynesian Approaches to Short-run Balance of Payments Theory", *The Economic Journal,* Vol.90(359), September, pp.582-592.

Frenkel, J.A and Johnson, H.G., 1976, "The Monetary Approach to Balance of Payments : Essential Concepts and Historical Origins", in Frenkel and Johnson (ed.), *The Monetary Approach to the Balance of Payments Theory,* George Allen and Unwin, London.

Gandolfo, G., 1987, *International Economics.II,* Springer-Verlag Berlin.

Genberg, H.A., 1976, "Aspects of the Monetary Approach to the Balance of Payments Theory : An Empirical Study of Sweden", in Frenkel and Johnson (Eds), *The Monetary Approach to the Balance of Payments,* Allen and Unwin, London.

Geweke, J., 1978, "Testing the Exogeneity Specification in the Complete Dynamic Simultaneous Equation Model", *Journal of Econometrics,* Vol.7, pp. 163-185

Girton, L and Roper, D., 1977, "A Monetary Model of Exchange Market Pressure Applied to the post-war Canadian Experience", *American Economic Review,* Vol.67(4), pp.537-548.

Granger, C.W.J., 1969, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica,* Vol.37, No.3, pp.424-438.

Guitian, M., 1976, "The Balance of Payments as a Monetary Phenomenon : Empirical Evidence, Spain 1955-71", in Frenkel and Johnson (Eds), *The Monetary Approach to the Balance of Payments.*

Hahn, F.H., 1959, "The Balance of Payments in a Monetary Economy", *Review of Economic Studies,* Vol.26, pp. 110-125.

Harberger, A.C., 1950, "Currency Deparciation, Income, and the Balance of Trade", *Journal of Political Economy,* Vol.58, pp.47-60.

Holmes, J.M and Hutton, P.A., (1990), "On the Causal Relationship between Government Expenditures and National Income", *The* Review *of Economics and Statistics,* Vol. LXXII (1), pp.87-95.

————————1992, "A New Test of Money/Income Causality", *Journal of Money, Credit and Banking,* Vol.24(3), pp.338-355.

Hsiao, C, 1979, "Auto-regressive Modeling of Canadian Money and Income Data", *Journal of American Statistical Association,* Vol.74, pp.553-560.

——————1981, "Auto-regressive Modeling and Money-Income Causality Detection", *Journal of Monetary Economics,* Vol. 7, pp.85-106.

—————1982, "Auto-regressive Modeling and Causal Ordering of Economic Variables", *Journal of Economic Dynamics and Control,* Vol.4, pp.243-259.

Johannes, J.M., 1981, "Testing the Exogeneity Specification Underlying the Monetary Approach to the Balance of Payments", Review *of Economic and Statistics,* Vol.63, pp.29-34.

Johnson, H.G., 1958, "Towards a General Theory of Balance of Payments", in his *International Trade and Economic Growth,* London : Irwin University Books.

——————1972, "The Monetary Approach to the Balance of Payments Theory", in *Further Essays in Monetary Theory,* George Allen and Unwin, London.

.——————1976a, "Elasticity, Absorption, Keynesian Multiplier, Keynesian Policy, and Monetary Approaches to Devaluation Theory : A Simple Geometric Exposition", *The American Economic Review,* Vol. 66(3), *The American Economic Review,* Vol.66(3), June, pp.448-452.

——————1976b, "The Monetary Theory of Balance of Payments Policies", in Frenke and Johnson (eds.), *The Monetary Approach to Balance of Payments Theory,* George Allen and Unwin, London.

——————1977a, "The Monetary Approach to Balance of Payments Theory and Policy : Explanation and Policy Implications", *Economica,* Vol.44(175), August, pp.217-229.

———————1977b "The Monetary Approach to Balance of Payments : A Non-technical Guide", *Journal of International Economics,* Vol. 7, pp. 251-268.

——————1977c, "Money, BoP Theory, and International Monetary Problem", *Essays in International Finance,* No. 124, Princeton University, Princeton.

Joshi, H., 1992, "The Monetary Approach to the Balance of Payments", Reserve *Bank of India Occasional Papers,* Vol. 13(4), pp.275-289.

Joshi, V.G., 1990, "The Monetary Approach to the Balance of Payments and Exchange Rates : Empirical Evidence Relating Specifically to India", *Artha Vijnana,* Vol.32(3 and 4), pp.270-280.

Kannan, R., 1989, "The Monetary Approach to the Balance of Payments : A Case Study of India, 1968-85", *Economic and Political Weekly,* Vol.25, pp. 67.7-636, March 75.

Kim, I., 1985, "Exchange Market Pressure in Korea : An Application of the Girton-Roper Monetary Model", *Journal of Money, Credit and Banking,* Vol. 17(2), pp.258-263.

. Kmenta, J and Ramsey, J.B., 1980, *Evaluation of Econometric Models,* Academic Press, New York.

Kreinin, M.E., and Officer, L.H., 1978, "The Monetary Approach to the Balance of Payments : A Survey", *Princeton Studies in International Finance,* No.43, Princeton University.

Krueger, A.O., 1969, "Balance of Payments Theory", *Journal of Economic Literature,* Vol.7(1), March, pp.1-26.

Kuska, E.A., 1978, "On the Almost Total Inadequacy of Keynesian Balance of Payments Theory", *The American Economic* Review,Vol 68 (4), September, pp.659-670.

Kyle, J.F., 1976, *The Balance of Payments in a Monetary Economy,* Princeton University Press.

Laidler, D., 1981, "Some Policy Implications of the Monetary Approach to Balance of Payments and Exchange Rate Analysis", *Oxford Economic Papers,* Vol.33, July(supl), pp.70-84.

Laursen, S, and Metzler, L.A., 1950, "Flexible Exchange Rates and the Theory of Employment", *Review of Economics and Statistics,* Vol.32, pp.281-299.

Machlup, F., 1955, "Relative Prices and Aggregate Spending in the Analysis of Devaluation", *American Economic Review,* Vol.65, June, pp.255-278.

——————1966, *International Monetary Economics,* George Allen and Unwin Ltd., London.

Magee, S.P., 1976, "The Empirical Evidence on the Monetary Approach to the Balance of Payments and Exchange Rates", *American Economic Review,* Vol 66, pp. 163-169.

Miller, N.C., 1978, "Monetary Vs Traditional Approaches to Balance of Payments Analysis", *The American Economic Review,* Vol. 68(2), May, pp.406-411.

Modeste, N.C., 1981, 'Exchange Market Pressure during the 1970s in Argentina : An Application of the Girton-Roper Monetary Model", *Journal of Money, Credit and Banking,* Vol. 13(2), pp.234-240.

Mundell, R.A., 1968, *International Economics,* The Macmillan Company, New York.

Mussa, M., 1974," "A Monetary Approach to Balance of Payments Analysis", *Journal of Money, Credit and Banking,* Vol 6, pp.333-351.

——————1976, "Tariffs and Balance of Payments - A Monetary Approach", in **Frenkel and Johnson (eds.),** ***The Monetary Approach to Balance of Payments*** *Theory,* George and Unwin, London.

Nobey, A.R and Johnson, H.G., 1977, "Comment on D.A Currie, "Some Criticisms of the Monetary Analysis of Balance of Payments Correction", *The Economic Journal,* Vol. 87, December, pp.771-773.

Polak, J.J., 1957, "Monetary Analysis of Income Formation and Payments Problem", *IMF Staff Papers,* Vol.6, pp. 1-50.

Pradhan, H.K., Paul, T.M, and Kulkarni, K.G.,1989, "Exchange Market Pressure in India : An Empirical Test of Monetary Hypothesis", *Prajnan,* Vol.XVIII (1), pp.25-37.

Rabin, A. A., 1979, "A Note on the Link between Balance of Payments Disequilibrium and the Excess Demand for Money", *Southern Economic Journal,* Vol.45(4), pp. 1233-38.

Raghavan, V.S., and Saggar, M. K., 1989, "Applicability of Monetary Approach to the Balance of Payments", *Economic and Political Weekly,* Vol 24 (32), pp. 1855-1859.

• Sahadevan, K.G and Kamaiah, B., 1991, "Balance of Payments Theories : A Survey", *Prajnan,* Vol. XX (2), pp. 145-163.

Sahadevan, K.G., 1992, "Devaluation : Missing the Target", *Economic Times,* Bombay, 17 September, p.9.

. Sahadevan, K.G and Kamaiah, B., 1992, "Income, Absorption and Trade Balance - A Causal Test of Alexander's Hypothesis", *Indian Journal of Economics,* vol. LXXII (287), pp.473-484.

Sahadevan, K.G and Kamaiah, B., 1993, "On Testing Exogeneity Specification Underlying the MABP : The Indian Case", *Arthaviznana* (forthcoming).

Sims, C.A., 1972 "Money , Income and Causality", *American Economic Review,* Vol. 62, pp.540-552.

Swoboda, A.K., 1973, "Monetary Policy under Fixed Exchange Rates : Effectiveness, the Speed of Adjustment and Proper Use", *Economica,* Vol.41, pp.136-154.

Uddin, M.S., 1985, "Monetary Approach to the Balance of Payments : Some Evidence from Less Developed Countries", *The Indian Economic Journal,* Vol XXIII (1), pp.92-103.

Sundararajan, S, Bhole, L.M, and Patil, P.R., 1988, "Causality and the Monetary Approach to the Balance of Payments in India", *Asian Journal of Economic **and** Social Studies,* Vol. 7(4), pp.239-254.

Taylor, M.P., 1986, "A varying-Parameter Empirical Model of Balance of Payments Determination Under Fixed Exchange Rates : Results for the UK and West Germany", *Applied Economics,* Vol.18, pp.567-82.

——————1987, "Testing the Exogeneity Specification Underlying the Monetary Approach to the Balance of Payments : Some UK Evidence", *Applied Economics,* Vol. 19, pp.651-661.

Thirwall, A.P., 1980, Balance *of Payments Theory and the United Kingdom Experience,* The Mc Millan Press Ltd.

Tinbergen, J., 1952, "On the Theory of Economic Policy, North-Holland, Amsterdam.

Tsiang, S.C., 1961, "The Role of Money in Trade Balance Stability : A Synthesis of the Elasticity and Absorption Approaches", *The American Economic Review,* Vol.51, December, pp.912-936.

——————1977 "The Monetary Theoretic Foundation of the Modern Monetary Approach to Balance of Payments", *Oxford Economic Papers,* Vol.29(3), (November), pp.319-38.

Warner, D and Kreinin, M.E., 1983, "Determinants of International Reserve Flows", *Review of Economics and Statistics,* Vol. LXV (1), pp. 96-104.

Wilford, S.D., and Wilford, T.W., 1978, "On the Monetary Approach to the Balance of Payments : The Small, Open Economy", *The Journal of Finance,* Vol XXXIII (1), pp.319-323.

Wohar, M.E and Lee, B.S., 1992, "An Application of the Girton-Roper Monetary Model of Exchange Market Pressure Model : The Japanese Experience, 1959-1986", Indian *Journal of Economics,* Vol. LXXIK287), pp.379-407.

Yeager, L.B., 1970, "Absorption and Elasticity : A Fuller Reconciliation", *Economica,* February, pp.68-77.

Zecher, R., 1974, "Monetary Equilibrium and International Reserve Flows in Australia", *Journal of Finance,* Vol 29 (5), pp. 1523-30.