DEMAND FOR MONEY AND THE CONDUCT OF MONETARY POLICY IN DEVELOPING COUNTRIES

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CONTENTS

ABSTRACT

Conventional error-correction and cointegration techniques are utilized to derive demand for money models for eleven developing countries. The performance of these models is assessed using a battery of statistical tests than is commonly reported in previous studies. We show that the cointegration equations outperform the conventional error-correction specifications in terms of statistical and theoretical considerations.

Once a stable demand for money function has been obtained for each country, the traditional St. Louis equation is modified and estimated to examine the efficacy of fiscal and monetary policies. Although the results indicate a strong monetary impact on output, the Granger causality tests are so ambiguous that we cannot discriminate between the two competing policies. Given a closer linkage between government expenditure and monetary growth in many LDCs., an independent monetary or fiscal policy may not achieve a desired objective. We argue that the authorities in LDCs. should design a comprehensive financial programme which simultaneously takes into account the two policy options.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The main objective of this thesis is to build statistically well-defined and theoretically acceptable demand for money functions for a number of developing countries. This will be followed by the equally important but often neglected task of assessing the potency of monetary policy in these countries. In this chapter, we shall provide a brief discussion of the role of money in LDCs and present a summary of the conventional and 'general to specific' modelling approaches to demand for money. Finally, we set the purpose, scope and limitations of this thesis and define our data set.

1.2 The Importance of Money in Developing Countries

The role of money and monetary policy has been one of the often-debated issues in developing economies for a long time. Despite Schumpeter's dramatization of money and credit as a 'phenomenon of development', the nature of monetary policy remained indistinct and ill-defined until very recently. This is because monetary policy was viewed

in a narrow perspective as influencing aggregate spending via the regulation of interest rates and the allocation of credit.
In the Keynesian approach, any discrepancy between the money supply and the target money demand due to, say, an expansionary monetary policy will cause fluctuations in interest rates and these fluctuations will continue until equilibrium is restored. Given that prices and incomes are subject to inertia, interest rates must fluctuate violently to achieve instantaneous equilibrium.

However, as Goodhart (1984) noted, regression of interest rates on changes in the money stock have hardly produced the required interest rate 'overshooting'. Laidler (1984) argues that an increase in money supply in excess of the target demand will lead to a positive real balance effect in all markets. The observation here is that the excess money supply will initially cause interest rate fluctuations but the changes in interest rate are not sufficient to eliminate the entire discrepancy (at least in the short run). This means that agents will undertake some expenditure flows until the excess money supply is eliminated.

The argument outlined above has been related to a situation where financial and capital markets are well-developed. In developing countries, the relation between the rate of interest and movements in monetary aggregates are even weaker because interest rates in LDCs are institutionaly determined and often repressed. The proponents of this view, notably Mckinnon (1973) and Shaw (1973) argue that the fragmentation of capital and financial markets in these economies is the most important factor limiting the effects of monetary policy. According to these authors, the major aim of monetary policy in LDCs should be the promotion of the development of financial markets rather than short term stabilization.

The arguments of the monetarists are also closely related to the Keynesians in many respects. The monetarists case is that short term stabilization policy is ineffective because these countries seldom have financial markets and banking institutions sufficiently developed to permit what has commonly know as fine tuning of monetary policy. Thus Friedman (1972) writes:

> Good monetary policy cannot produce development. Economic development depends on the amount of capital, the method of economic organization, the skill of the people, the available knowledge, the willingness to work and save, the receptivity of the members of the community to change.
>
> Given favourable preconditions, good monetary policy can facilitate development. Perhaps even more important, however favourable may be the preconditions, bad monetary policy can prevent development.

In addition to the arguments put forward by the Keynesians and monetarists, the limited source of government finance in many LDCs creates a close linkage between monetary and fiscal policies, restricting the authorities ability to use two independent policy instruments for short term stabilization. Furthermore, the impact of these policies on output and price is likely to be subject to longer lags and uncertainties. The authorities should, therefore, concentrate more on the medium term goals of price stability and growth and to engage in short-term stabilization only when the shocks to the economy are sever and well-defined, Coats and Khatkate (1981).

Whichever view one may wish to entertain, money plays an important role in the development process of LDCs. Because of the absence of financial assets in these economies, variations in real money balances would have a price effect rather than an interest rate effect. If inflation expectations are sluggish, a given change in money supply will affect output and employment in the short run, (see chapter 9). A necessary condition for monetary policy to have a predictable effect on the ultimate economic objectives is that there must exist a well-defined and stable demand for money function. A comprehensive survey of the empirical evidence on demand for money in developed and developing countries is documented in chapter 4. To capture the flavour of the arguments, we consider a study on the demand for money and monetary policy in selected LDCs by three applied economists - Aghevli, Khan, Narvekar and Short, (1979). This study characterizes current modelling practice in developing countries in the context of the text book approach to econometric modelling.

1.3 The Traditional Approach to Demand for Money

Following the text-book approach, Aghevil *et al.* invoked a theory for econometric verification, derived a parsimonious equation from the long-run implications of the theory and then conducted a simplification search to test any departures from some of the assumptions regarding the validity of the theory. Like the other investigators before them, these authors have apparently raised the old controversy about the statistical significance of the determinants of demand for money in LDCs. They estimated the following partial adjustment model for seven Asian developing countries:

$$m^d_t = \beta o + \beta_1 y_t + \beta_2 \pi^e_t + \beta_3 m_{t-1} + u_t \qquad (1.1)$$

The model is related only to a scale variable and the expected rate of inflation (π^e_t) as interest rates are subject to control by the authorities. The βs are composite coefficients of the 'true' parameters and the adjustment coefficients, $\lambda 1$ and $\lambda 2$, obtained from the minimization of the one period cost function given by:

$$C = \lambda 1 (m^*_t - m_t)^2 + \lambda 2 (m_t - m_{t-1})^2 \qquad (1.2)$$

Since the D-W statistics is biased in models with lagged dependent variable, equation (1.1) was estimated with the assumption that the errors, (u_ts) followed a first-order autoregressive process:

$$u_t = \rho u_{t-1} + \varepsilon_t, \quad \varepsilon_t \text{ WN} \tag{1.3}$$

Equation (1.1) was then corrected for serial correlation when the Ho: $\rho = 0$ is rejected, i.e.,

$$m^d_t = (1-\rho)\beta o + \beta_1 y_t - \rho\beta 1 y_{t-1} + \beta_2 \pi^e_t - \rho\beta_2 \pi^e_{t-1} + (\beta_3 + \rho) m_{t-1} - \rho\beta_3 m_{t-2} + v_t \tag{1.4}$$

On the basis of the statistical significance of the estimated parameters, the R^2 and the D-W criteria, the authors conclude:

> Based on these statistical tests, it is apparent that the two major requirements for the effectiveness of monetary policy - namely, the existence of a well-defined money demand function and a significant relationship between money and price - are met for this group of Asian countries. Aghevli *et al*. pp. 793-94.

Clearly, these conclusions are indefensible given that: (a) equation (1.1) is assumed to be correctly specified in the sense that all the relevant variables are included; (b) the error term is assumed to follow an AR(1) process and (c) the diagnostic tests are not sufficient to draw any conclusion with reasonable confidence. Sargan (1959) showed that (1.4) is a special case of the more general model:

$$m^d_t = \gamma_0 + \gamma_1 y_t + \gamma_2 y_{t-1} + \gamma_3 \pi^e_t + \gamma_4 \pi^e_{t-1} + \gamma_5 m_{t-1} + \gamma_6 m_{t-2} + v_t \qquad (1.5)$$

He argued that instead of estimating (1.4) directly it might be preferable to estimate (1.5) subject to the non-linear common-factor restrictions:

$$\gamma_2 + \rho\beta 1 = 0 \qquad (1.6)$$

$$\gamma_4 + \rho\beta 2 = 0 \qquad (1.7)$$

$$\gamma_6 + \rho\beta 3 = 0 \qquad (1.8)$$

When (1.4) is valid but the common factor restrictions (1.6)-(1.8) are invalid, then (1.1), with or without (1.3), is misspecified and both the OLS and GLS estimators of the βs are biased and inconsistent with most of the routinely used testing procedures related to these models being invalid, (see Spanos 1988). It appears that the conventional approach of 'correcting' for detected residual autocorrelation by adopting (1.1) and (1.3) is seriously undermined. If one is interested in policy analysis, it is important to determine whether (1.3) is due to omitted variable bias or the result of 'genuine' error dynamics.

1.4 An Alternative Approach

Several fresh methodological ways of estimating the demand for money emerged in the literature over the last decade or so. One alternative methodology is the 'General to Specific', which, unlike the traditional approach described above, emphasizes intended over-parameterization of a model, followed by a data based simplification, usually along the lines suggested by the underlying theoretical framework. This approach ultimately yields an error correction model, which is popular in the UK, but is also catching up elsewhere. Error correction models usually encompass several classes of dynamic specifications, (see chapter 6) including the partial adjustment specification. In this respect an ECM may be described as general, but it is also simple since the initially over-parameterized Autoregressive Distributed Lag (ADL) model is reduced through reparameterization and variable deletion to achieve parsimony. Otherwise, problems like collinearity may creep in and make the model operationally useless.

Several varieties of error correction models exist in the literature, but for our purpose, we consider the conventional ECM and the cointegration approach. The significance of these approaches can be illustrated by the following simple model:

$$y_t = \alpha + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 y_{t-1} + u_t \qquad (1.9),$$

and (1.9) may be reparameterized as:

$$\Delta y_t = \alpha + (\beta_3 - 1) y_{t-1} + \beta_1 x_t + (\beta_1 + \beta_2) x_{t-1} + u_t \qquad (1.10)$$

On further rearrangement, this becomes

$$\Delta y_t = \alpha + \beta_1 \Delta x_t + \gamma [y_{t-1} - \Theta x_{t-1}] + u_t \qquad (1.11)$$

where $\gamma = \beta_3 - 1$ and $\Theta = (\beta_1 + \beta_2)/1 - \beta_3$. Within this framework, a model cast in levels and first differences may be regarded as an approximation to a more general dynamic model. However, the approximation is only reasonable when y_t and x_t stay close to a steady - state growth path. If the observation begins to deviate from this path, the behavior of the system can be adequately captured only by the more general model (1.10). The term in square bracket in (1.11) now plays a crucial role in the working of this class of dynamic models. If y begins to grow at a faster rate than is consistent with the steady - state solution, then $(y_{t-1} - \Theta x_{t-1})$ becomes positive, since y_{t-1} has drifted above the steady - state growth path. However, because the coefficient γ is required to be negative (for dynamic stability) the effect of the term in the square bracket being positive is to reduce the growth rate of y and derive y_t back towards its long run path. For this reason the last term in equation (1.11) is referred to as the error correction mechanism.

As it stands, (1.10) is not empirically attractive because it entails a non-linear estimation technique and, therefore, many writers prefer to set Θ equal to unity to obtain:

$$\Delta y_t = \alpha + \beta \Delta x_t + \gamma (y_{t-1} - x_{t-1}) + u_t \qquad (1.12)$$

An important property of (1.12) is that the terms Δx_t and $(y_{t-1} - x_{t-1})$ are near orthogonal and one can interpret Δx_t

as equilibrium and $(y_{t-1}-x_{t-1})$ as disequilibrium responses. In practice, γ might turn out to be insignificant or of the wrong sign due to collinearity between the constant and the error correction term. Dropping one of these terms may tackle the problem, but if the level terms are omitted, (1.12) will lose its long-run properties and, therefore, the constant term is often suppressed (see Davidson *et al.*(1978)).

The steady-state solution of (1.12) can be derived by setting the growth rate of x_t equal to g, (i.e., $g= \Delta x_t = \Delta y_t$). Then solving (1.5), yields:

$$Y_t = kX_t \tag{1.13}$$

where $k = \exp\{[-\alpha+g(1-\beta_1)]/\gamma\}$ and is a function of the growth rate g unless β_1 in (1.11) is equal to unity. Expression (1.13) ensures that the dynamic equation reproduces the relevant equilibrium theory and the assumption of proportionality between Y_t and X_t.

If x and y are I(1) and there exists a linear combination of these variables which is stationary, i.e., I(0), then x and y are said to be cointegrated. Engle and Granger,(1987). proposed a two stage procedure of investigating the relationship between x and y..This would require running a static OLS regression and use the derived residuals to construct an EC term in the general ADL model. Wickens and Breusch (1988), argue that the two-step estimation procedure is, in fact, unnecessary and that the long-run and short-run effects can be captured in a single equation. The reformulation of (1.9) using the method proposed by Bewley (1979) produces this equation which looks like:

$$y_t = a\Delta y_t + bx_t + c\Delta x_t + u_t \qquad (1.14)$$

One problem which arises in estimating (1.14) is that OLS will not produce a consistent estimator because the vector of regressors is now asymptotically correlated with the error term. Thus, only instrumental variable (IV) estimation of (1.14) with instruments given by the regressors in (1.9) will give consistent estimates of the short-run elasticities and the long-run multiplier b. The advantage of estimating (1.14) instead of the Engle-Granger 2-step procedure is that direct estimation of long-run standard errors is now possible. But,the two-stage procedure may be preferable in small samples because, the separate estimation of the long-run elasticities means that more degrees of freedom are available in the estimation of the dynamic model. However, the long run elasticities obtained from the static model may suffer from small-sample bias but the cointegration literature does not tell us when , for example, sample bias becomes acute enough to warrant one stage instead of two-stage estimation.

1.5 Purpose and Scope of this Thesis

Demand for money studies have gone a long way in developed market economies, while the simple partial adjustment specifications are still dominant in LDCs. There are some theoretical grounds for the continuous use of such simple models rather than the more complicated dynamic specifications, which are rationalized on the minimization of a multi-period cost function, (see Cuthbertson 1985). Given low per capita income and the devotion of almost all output to the maintenance of an exceedingly low standard of living, more concern is devoted to current than to future welfare. Thus, when one is considering the behavior of economic agents in LDCs, the assumption of a single-period loss function may be a closer approximation to reality than that of an infinite-horizon planning process on the part of the agent. Although these assertions seem reasonable on a priori grounds we have shown that a partial adjustment model is potentially misspecified and any statistical inference based on this model is at best misleading. We believe that the performance of equation (1.1) can be improved considerably if the data is allowed to play a role in the model design exercise.

The purpose of this thesis is three fold. The first aspect concerns the application of the conventional error correction and the cointegration approaches to money demand functions in eleven developing countries, namely, Mexico, Brazil, Peru, Colombia, India, Sri Lanka, Korea, Philippines, Thailand, Kenya and Malawi. It is hoped that the methods employed herein will have some relevance to other developing countries which are not included in this study. The second objective is the comparison of the empirical performance and theoretical consistency of these competing approaches against a large battery of statistical tests not reported in previous studies. The third objective is the assessment of the potency of fiscal and monetary policy in LDCs using the St. Louis equation. It follows that the perceived contribution of this study to the literature lies in: (a) the first direct application of the cointegration approach to LDC data; (b) testing the relevant strength and dependability of monetary policy by estimating an export version of the St. Louis model.

1.6 Limitations

One obvious short-coming of this study is the use of a few variables, namely, money stock broadly defined, m(2), gross domestic product, the discount rate and the consumer price index. We have not considered the narrow money stock, m(1) or the possible influence of wealth on the demand for money. There are some practical and theoretical reasons for being so limited to the above variables. For one thing, the use of m(1) or m(2) does not really make much difference, as agents in LDCs draw on their savings accounts with much ease to finance their day to day transactions. The choice of the broader money stock is in fact preferable as the monetary authorities in LDCs can better control m(2) than m(1). On the other hand, the choice of current income instead of wealth is justified on the ground that wealth series in developing countries do not exist. Existence near the subsistence level and the social, political and environmental uncertainties limit the economic time horizon of consumers and producers. Thus, current income rather than wealth is the appropriate budget constraint in the demand for money function in LDCs.

Second, because of the absence of market rates of interest, we have used government discount rate as a measure of the opportunity cost of holding money. The use of this variable as an opportunity cost of holding broad money stock might be questionable. However, one peculiar characteristics of LDCs is that during periods of tight credit policies, economic agents rely more on the lenders in the non-organized markets to provide the finance that could not be obtained from the organized market. Unobservable interest rates are thus higher even if they cannot be recorded.Interest rates in the non-organized market, whether observable or not, reflect the cost of credit or the opportunity cost of holding money. They go up as bank credit becomes less available and vice versa. It follows that if interest rates are unobservable, credit restraint variables can be used to proxy interest rates in the demand for money. In fact, one of the credit restraint variables suggested by Wong (1977) and applied in small developing economies by Arestis (1988) is the government discount rate. This variable is, therefore, intended to replace the role of interest rates in the demand for money function as lending and deposit rates of banks in LDCs are pegged and, therefore, cease to be the key linkage variables between holdings of alternative assets.

Third, most of the countries we considered are small open economies. This implies that domestic monetary policy is fairly ineffective and domestic financial markets are highly vulnerable to changes in foreign financial and monetary developments. To take account of foreign monetary developments, we experimented with expected changes in exchange rates and the average of UK, US and French interest rates in the conventional error correction models. The results are not worth reporting as both variables were insignificant and of the wrong sign in all countries. This may be due to data problems as we used the official published data which displayed very little variation over the sample period in our study. Severe foreign exchange controls in some of these countries also suppress the degree of substitutability between real money balances and foreign balances. A proper investigation of currency substitution would entail incorporating black market exchange rates. Since black market exchange rates are not observable, we decided not pursue the open economy aspect in this study.

Fourth, the countries we chose are few in number and may not be representative enough to enable us draw firm conclusions. The non-availability of data long enough to provide meaningful statistical inferences and the desire to reduce the number of equations to be estimated means that we have to work on only a small number of countries. At the same time, we have considered as many countries as the data would permit from every geographical area of the developing world so that inter-country or regional differences (if any) could be reflected in our preferred models.

1.7 Outline of the Study

The thesis falls fairly into three parts. Part one contains the background material which is presented in four chapters. Chapter 2 stands on its own as a broad survey of the main theories of the demand for money upon which we constructed several models at a latter stage. Any task of monetary analysis must address the problem of defining and measuring the money stock. Chapter 3 discusses definitional and measurement problems of the variables used in this study by taking into account the special characteristics of developing countries. Chapter 4 completes the first part of the thesis with the discussion of selected empirical evidences obtained from developed and developing countries.

The second part of this thesis concentrates on econometric issues. Chapter 5 is concerned with the estimation of the conventional partial adjustment model. The limitations of PA models are also discussed in this chapter using Hacche's UK money demand study as a special case. Chapter 6 outlines the main features of the so-called 'General to Specific' modelling strategy. We highlight the theoretical and statistical foundations of this approach and evaluate the estimated error correction equations against a set of statistical criteria. Chapter 7 discusses the theoretical basis of cointegration, the main integration and cointegration tests and assesses the empirical results of cointegration models.

The third and final part of the thesis deals with monetary policy and presents the concluding chapter. Since only a limited variety of monetary policy techniques have so far proved practicable in many LDCs, chapter 8 first describes the nature of the money supply process with reference to developing countries. We then examine the potency of fiscal and monetary policy by modifying the traditional St. Louis model. Finally, chapter 9 provides some concluding remarks on the work undertaken in this study and sets an agenda for possible future work on the modelling of demand for money in less developed countries.

1.8 Data

All the data series in this study were taken from the various issue of the International Financial Statistics, (IFS). The data frequency is annual and covers the period

1966 - 87 for Kenya and Malawi and, 1960 - 87 for the remaining countries. We use the natural logs of the variables but the level of interest rates for the reasons explained in Fair (1987). The variables used in this study have the following meaning.

m(2): Broad money stock comprising of currency, demand deposits, and time and saving deposits of the banking system, IFS series 351.

y: Gross Domestic Product deflated by the consumer price index, IFS series 99b.

p : Consumer Price Index (1980 = 100), IFS series 64.

i : Discount rate at which the monetary authorities lend or discount eligible papers for deposit money banks, IFS series 60.

G : Gross government expenditure, IFS series 82.

x : Merchandise export (FOB), IFS series 70.

Having defined the data set and outlined the purpose, scope and limitations of this thesis, we now turn to a brief discussion of the main theories of the demand for money.

PART 1

THEORIES, DEFINITIONS, MEASUREMENT PROBLEMS AND EMPIRICAL EVIDENCE

CHAPTER 2

THEORIES OF THE DEMAND FOR MONEY

2.1 An Overview

At least four theories purporting to explain the motives for holding cash balance exist in the vast literature of monetary economics. These are the portfolio theory, the inventory theory, the quantity theory and the buffer stock approach. We shall take up the buffer stock approach in chapter four in relation to partial adjustment models. For the moment, we shall briefly discuss the remaining three theories in this chapter. These theories are of course well-established and are based upon explicit motives for holding money, (for example transactions and speculative motives). One difficult problem is, however, to isolate the best theory that would explain the behaviour of the monetary sector out of the competing demand for money theories. If it were to turn out that all the variations in the demand for money could be explained by the variables in question and the model passes a battery of statistical tests, it might be concluded that the theory was perfect. On the other hand, if these variables turned out to explain nothing at all and the model is rejected by the statistical tests, the theory might be judged perfectly useless. In the real world situation, neither of these outcomes is very likely. The theory may turn out to explain 50 per cent of the variations and passes some of the tests.

Provided there is no difference between these theories in terms of scope or consistency with other economic models, one can say that a theory that explains 90 per cent of the variations in the demand for money is better than the one that explains only 50 per cent. A theory is accepted if it passes empirical tests better than some other theory, and is rejected if it fails to do so. If we wish to learn about economic theory by referring to empirical evidence, we will need not one but several hypotheses that can be put to statistical tests simultaneously, for it is only in this way that useful theoretical ideas can be sorted out from those that are misleading.

The hypothesis that the demand for money measured in real terms depends on the level of real national income and the rate of interest is well established in developed market economies. However, there has been little systematic analysis of the behaviour of the private desired money balance in those economies commonly referred to as less developed. Theoretical models developed to explain monetary behaviour, and conclusions and opinions based on the interpretation of monetary experience in advanced countries may not be applicable in developing countries. Data limitations and the peculiar characteristics of developing countries require modifications to these theories before they can be applied in these economies. We shall discuss these issues in chapter 3, but now we turn to a brief survey of the theories of the demand for money starting with the classical quantity theory.

2.2 The Classical Quantity Theory

The quantity theory of money has its genesis in the classical economist, David Hume (1826). The basis of Hume's theory is what can nowadays be called the homogeneity postulate: if the quantity of money in every citizen's pocket is doubled overnight, although trade might be stimulated in the short run, prices would eventually double.

Hume not only stated the basic tenets of the quantity theory; but he also outlined a transmission mechanism whereby an increase in money has favourable effects in the short run on employment and output. Only eventually do prices rise and they do not rise proportionately to increases in the money supply.

Later on, Ricardo restated Hume's quantity theory much more precisely and also provided a theory of output determination. According to Ricardo, the short run increase in output and employment resulting from a monetary expansion which Hume pointed out were temporary transient disturbances around the long run level. Thus he was dismissive of the determination of output in the short run and factors such as a bad harvest which may cause output to deviate from its normal level. The long run output is determined by real factors such as labour supply, capital stock and natural resources.

Irving Fisher (1911) translated the Ricardian proposition into a mathematical formula suitable for statistical testing. In his celebrated book 'The Purchasing Power of Money' he formulated the famous Equation of Exchange:

$$MV = PT \tag{2.1}$$

where M is the stock of money, V the transaction velocity of circulation, P the general price level, and T an index of the volume of trade. Fisher realized however that (2.1) is an identity and, to give this identity some behavioural content, he assumed that the payments mechanism is constant in the short run and varies slowly, and in a predictable way in the long run as payments mechanisms in the economy change. What is most crucial and is a direct replica of the Ricardian theory is; variations in M produce no changes in

Y and by implication variations in the money stock are reflected in P. He thus reiterates the fundamental importance of the classical dichotomy - money has no influence in real output determination but only in the determination of the absolute price level. Effectively, the quantity theory says that, since the demand for real balance must always be constant, the supply of real balances must also be constant. Hence, changes in nominal money must be matched by equivalent changes in prices to keep the real money supply constant.

However, the above proposition ignores the possibility that shortages in commodities might also cause a change in the price level. Desai (1981) has this to say regarding this point:

> This tendency to neglect the commodities side of the equation of exchange persists when discussing many war-induced inflation or inflation in countries recovering from the effect of war. Thus, it is seldom pointed out that the German hyperinflation was accelerated if not initiated by the French occupation of the Ruhr and other German territories, which produced up to one third of German output. The price of the dollar in marks had risen from 4.2 Marks in July 1914 to 14.0 Marks by July 1919 and 493.2 by July 1922. In January 1923 this rose to 17,972 and in the next ten months it rose to 4,200 billion marks. An exogenous reduction of one third in output cannot easily be said to have no effect on prices, whatever the course of the

money supply...... The hyperinflation in Kuomintag China in the 1940s was also preceded by a long period of Japanese occupation of Manchuria. Since 1933,....... Large parts of Chinese territory were occupied by Mao Tse Tung's forces and the loss of output could not have been negligible.

2.3 The Portfolio Theory

Keynes found the traditional quantity theory of money too narrow in scope as it sets up a direct and proportional relationship between the quantity of money and prices. Keynes' theories of the demand for money, are like the rest of his theories of a more general, i.e., he neither assumes the absences of money illusion nor takes the causal relationship between money and prices as direct or proportional. He found the orthodox quantity theory to be quite inadequate as it failed to integrate monetary theory with the general theory of value, disregarding at the same time the theory of income and output.

In the traditional Keynesian framework, there are three motives for holding money: first to facilitate the desired level of transactions, second as a precaution against unexpected events, and third as a speculation against a fall in the price of alternative assets. These three distinctions were collapsed into a two part distinction by Hicks following Keynes' exposition in the General Theory (chapter 15). Thus the total demand for money is given by:

$$m^d = D_1 (y) + D_2 (r, r^e) \qquad (2.2)$$

D_1 being the transaction and precautionary demand for money and D_2 the speculative demand. Y is real income and r^e, the expected rate of interest. It follows that when the rate of interest is expected to fall, the demand for money is relatively low, since people hold bonds in anticipation of capital gains; when it is expected to rise, however, the demand for money is greater, as people seem to avoid making capital losses on bonds.

The speculative motive for holding money arises because, unlike most financial assets, the capital value of money does not vary with change in the interest rate and also there is uncertainty about the manner in which the interest rate will change in the future. Keynes suggested that, as far as the choice between holding bonds and money is concerned, each individual acts as if he is certain about what is going to happen to interest rates and hence holds either bonds or money depending on his expectation. It was suggested that different people, at any time, would have different expectations about the rate of change of the interest rate, but that in the aggregate Keynes achieved a smooth relationship between the speculative demand for money and the rate of interest.

In practice the formulation actually estimated tends to differ from (2.2). This is because there may be more than one rate of interest which is appropriate. In the simplest case more than one interest rate will be required if money is broadly defined to include some money holdings which themselves attract a rate of interest, for example bank deposit account. The theory as stated thus far lacks a variable to tell us when the rate of interest is expected to change and in what direction. Keynes' solution to this problem was to consider the current level of the rate of interest.

One particular criticism of Keynes' speculative theory is that each financial investor is assumed to assign to the future rate of interest only one value which he holds with certainty, rather than a range of possible values. This rather peculiar characterization of uncertainty means that each investor holds an undiversified portfolio of all bonds or all money, and does not hold both. In order to overcome this problem, Tobin (1958) applied what has become known as portfolio theory to the analysis of the asset demand for money.

Tobin concentrated on producing a more sophisticated analysis of the behaviour of the economic agent. This is obviously necessary, since people hold diversified portfolios, a mixture of assets. If people really did behave as if they were certain about the future, they would hold only the asset they expected to yield the highest return. The rational for holding money is that doing so reduces the riskiness of an asset portfolio. The opportunity cost of risk reduction is the expected return foregone by not holding bonds.

If the rate of return on bonds rises, then the opportunity cost of holding money increases. The substitution effect will cause portfolio-holders to increase their bond-holdings and reduce their demand for money. However, there is also an income effect. An increase in the expected return from bonds means that fewer bonds need to be held in order to maintain the same level of expected income from the portfolio at the cost of less risk. The income effects will cause risk-averse financial investors to hold more money and fewer bonds. Thus the portfolio model yields an ambiguous prediction about the effect of an increase in the interest rate on the demand for money. So long as the substitution effect outweighs the income effect in the aggregate, then a rise in the rate of interest will reduce the demand for money.

The portfolio model also deduces that wealth and expectation affect the demand for money. Since the model is concerned with the allocation of wealth among different kinds of assets, the greater the level of wealth, the larger is the demand to hold money.Expectations about future interest rates affect the riskiness of bonds. The lower the riskiness of bonds the smaller one would expect the demand for money to be. Tobin's analysis can be extended to the selection of a large number of risky assets. Wealth-owners first decide in which proportions the risky asset should be held. Each wealth owner then decides what proportion of his portfolio to hold in money, the remaining fraction in the optimal combination of risky assets.

To summarize, the predictions from Keynes's transactions motive of holding money are similar to those of the quantity theory. The speculative motive explicitly introduces uncertainty about the future yield on bonds. Volatile expectations may cause permanent parameter instability. Also expectation formation may be such as to cause a highly elastic response of money holdings to a small change in the interest rate.

2.4 Inventory Theoretic Models

The inventory theoretic approach to transactions demand for money was originally developed by Baumol (1952) and Tobin (1956) and later extended by Fiege and Parkin (1971). The assumptions of the model are:

(i) the individual receives a known lump sum cash payment of T periods (say per annum) and spends it all evenly over the period;

(ii) the individual may invest in 'bonds' paying a known interest rate r per period, or hold cash (money) paying zero interest rate;

(iii) the individual sells bonds to obtain cash in equal amounts k, and incurs (fixed) brokerage fee b, per transaction. The key element in this inventory model is that all relevant information is known with certainty. The model yields a square root relationship between the demand for money and the level of income, the brokerage fee and the bond interest rate. If the individual holds no bonds he incurs no brokerage fee but also earns no interest. He will therefore choose to withdraw an amount k so as to 'trade off' brokerage costs against interest income. The number of times he sells bonds is $n = T/k$, incurring a total brokerage cost of $nb = b(T/k)$. Since expenditure is a constant flow, a withdrawal of k involves an average cash balance of $m^d = k/2$ and a loss of interest (opportunity cost of holding money) of $(k/2)r$ per period.

In the inventory approach, the quantity of money balance held to finance transactions is determined by cost-minimization considerations. When an individual's income is not sizable or is paid at frequent intervals, it is not worthwhile to incur the brokerage charges of moving into and out of bonds. Hence, the approach is more relevant to explaining firms' demand for transaction balances. Once income is sufficiently large to justify bond transactions economies of scale begin to apply. As income rises it becomes worthwhile to engage in more bond transactions per income period because each bond sale incurs a fixed cost regardless of its value. The inventory approach, therefore, predicts that the demand for money balances will rise with income but less than proportionately (that is, the income elasticity of money demand is positive but less than 1.0). Additional predictions are that the demand for transactions balances will be inversely related to the rate of interest and positively related to the length of the income period. A decrease in bond transactions costs will reduce the demand for money as well as any institutional or technical changes to the payment mechanism, such as credit cards, which enable people to economise cash on holding money balances.

2.5 The Modern Quantity Theory

By taking Hicks' formulation of the money demand curve as a point of departure, Friedman developed the quantity theory as a theory of the demand for money. Thus, in his classic article, (1956), he says:

> The Quantity Theory of Money is in the first instance a theory of the demand for money. It is not a theory of output, or of money income, or of the price level.

Although Friedman gives no detailed analysis of the motives for holding money, he does suggest that money is held for the services it provides its owner, and because these services arise from its being an 'abode of purchasing power', it follows that the demand for money function is one that determines the demand for real balance. Thus, the transaction motive play a role in Friedman's demand for money.

Friedman discusses the utility function and the budget constraint in very general terms. He merely notes that there will be diminishing marginal utility from money, and that a whole host of other financial assets, liabilities and real assets may provide alternatives to holding money. This is a particular application of the general principle of the diminishing marginal rate of substitution between goods in consumer expenditure. As with any other application of demand theory to a special case, the bulk of the effort is put into closely analyzing the nature of the budget constraint and picking out the relevant cost of holding money. Wealth is the appropriate constraint on asset holding and, therefore, on the demand for money and the rates of return to be earned by holding assets other than money are the relevant opportunity costs. As regards the budget constraint, the maximum amount an individual can convert into money consists of his net financial wealth and his physical wealth held in the stock of housing and consumer durables. Furthermore, the individual has 'human' wealth in the form of the discounted present value of his future labour income. In principle, 'wealth' should include human wealth. Non-human wealth can be bought and sold, and there can be substitution almost without limit within this category of wealth. But human wealth is basically non-marketable, and the existence of uncertainty concerning the future limits the scope for substitution between human and non-human wealth. To overcome this problem, Friedman argues that the ratio of non-human wealth to human wealth (h) should be included as an argument in the demand for money function. As (h) falls, the demand for money increases. This increased demand for liquid asset balances the movement towards greater illiquidity in the wealth stock. Such a principle is generalizable to all forms of wealth (i.e., human wealth plus non-human wealth) so that an index of the liquidity of an individual's wealth stock could influence the demand for money.

Having established wealth as the scale variable in the budget constraint, Friedman then considers the yield on alternative assets. If money earns interest, this may influence the demand for money positively. In general terms, the alternative to holding money consists of holding near-moneys, such as bank deposits; long term 'bonds'; equities, real assets such as consumer durables and housing and in the case of firms, capital equipment. For capital certain assets such as bank deposits, the relevant yield is simply the current (after tax) interest rate. Long term bonds, if they are sold before their date of maturity, earn not only an interest rate or running yield but also capital gain or loss due to changes in bond prices. Similarly equities earn a dividend which is uncertain and the market price may also vary. Finally, if the individual holds real assets, the rate of return on such assets is given by the expected rate of inflation over the holding period (less any depreciation and storage costs). A higher rate of inflation increases the return to be obtained from holding real assets such as housing, consumer durables, stocks of finished goods and capital equipment. It also encourages a substitution into real assets but it is by no means certain that there will be a substitution out of money: substitution out of bonds to real assets, rather than from money to real assets. However, Friedman did assume a substitution from money to real assets at a higher rate of inflation.

In its simplest form, the 1956 version of the quantity theory looks like the following equation.

$$(m/p)^d = f\left(r, y^p, h, \Delta p^e, \phi\right) \qquad (2.3)$$

y^p is a measure of total wealth (permanent income), Δp^e is the expected rate of inflation, ϕ stands for variables reflecting tastes and preferences of wealth holders and p, r and (h) as defined before.

As it stands, (2.3) may be comparable to the Keynesian specification but equation (2.3) explicitly states demand for real cash balance. The crucial new element in a quantity theoretic demand for money is the inclusion of Δp and the assertion that it is homogeneous (of degree zero) in income and the price level.

Friedman states three other grounds on which (2.3) would differ from (2.2): (i) the stability and importance of the demand function for money; (ii) the independence of the factors affecting demand and supply of money; (iii) the form of the demand for money function:

Equation (2.3) was reformulated explicitly for secular data (long term averages arrived at after removing cyclical fluctuations) as:

$$M/NP^* = \gamma\ (Y^P/NP^*)^{\delta} \qquad (2.4)$$

N is population, and P* the permanent price level. The most notable omission from (2.4) is the interest rate when compared to the Keynesian specification. This particular omission constitutes a prior restriction on the derivative attached to interest rate in (2.4), i.e., $\delta m/\delta r = 0$.

From the estimates of (2.3), Friedman has drawn two important conclusions. First, that given the stability of the long run (or permanent) income velocity, any short run variations in the stock of money would rapidly translate into changes in measured (rather than permanent) income. Once this had happened, the demand for money would rise permanently and further rises in income would not be sustainable without further increases in the money stock. This meant that the impact multiplier of a change in M on Y is greater than the long-run multiplier.' Second, that monetary policy acted on income directly through changes in the money stock rather than indirectly via the rate of interest. These two conclusions implied that money multipliers were larger in the short run than investment multipliers and that the transmission mechanism of monetary policy was direct and much simpler than that of fiscal policy.

2.6 A Comparison

Each of the three theories of the demand for money provides competing explanation of the monetary sector . Although these models do not tell us directly about the aggregate demand-for -money functions, they do give us several hints about its possible nature. Thus, if economies of scale exist in individual demand function they may also exist in the aggregate; if brokerage fees influence individual behaviour and these involve costs measured in terms of time and trouble, it may be that the aggregate demand for money varies with the level of real wages ruling in the economy; and if the riskiness of bonds influence individual behaviour, it may be that such a factor is also important in the aggregate.

Researchers favour theories with 'strong' testable restrictions, for then a model is capable of refutation. These theories differ in the scope of their a priori restrictions. The 'modern' quantity theory does not impose strong a priori restrictions, whereas the simple Baumol model implies income and interest rate elasticities of 0.5 (in absolute value). On the other hand, Friedman's restatement of the quantity theory has a formidable list of potentially independent variables but in the main their sign and magnitude are to be determined by the data and are not suggested by a priori considerations.

Sprenkle (1969), provides a damaging critique of the inventory model when applied to large firms. Firstly, Sprenkle argues that cash holdings of large firms may be explained by the existence of multiple accounts as much as by optimal inventory behaviour.

Second, it may not be profitable for firms to undertake optimal cash management if the receipts of each branch of the firm are small; the firm can minimize costs by keeping all its receipts in cash.

Third, Sprenkle shows that if firms hold some optimal and some non-optimal balances, the proportion of non-optimal receipts in total receipts does not have to be very large for non-optimal balances to dominate money holdings. Further,the inventory theoretic model is too rigid in its specified form and also one would have to face serious practical difficulties in finding the necessary data series on brokerage costs and other forms of transaction costs.

It is interesting to note that, if from (2.3), $y^P = y$ and the parameters of Δp^e and h are zero, then it is difficult to tell whether (2.2) characterizes a Keynesian theory of demand for money or a special case of (2.3). This is the well known problem of observational equivalence in the literature. In practice, researchers do not worry about this problem and have adopted elements of equations (2.2) and (2.3). The wealth variable is normally replaced either by current income representing a more transactions based view to the demand for money, or by permanent income. Since permanent income and wealth are the discounted present values of future incomes, variations in the two will move together.

2.7 The Relevance of these Theories to Developing Countries

As we have already explained, the inventory theory model is too rigid and data on brokerage costs do not exists in developing countries. Thus, this theory has very little practical use in LDCs. Also, the Keynesian model treats money as a form of wealth that competes with other assets, whereas, in the real life situation, the financial markets in LDCs are under-developed and asset substitution takes place between money and real assets. Although these two theories are applicable to advanced market economies, they don't transfer quite well to poor, fragmented economies.

On the other hand, it was believed for a long time that an increase in the quantity of money tends to bring about a more or less proportionate rise in the price level in LDCs. This is because the process of planning for development in such economies requires some amount of a deficit financing with consequent increase in money supply, and also movements of prices in these economies are generally in the upward direction. Such a coincidence of a simultaneous increase in the money supply and the price level is said to be a proof of the applicability of the quantity theory to developing economies.

As we shall see in the next chapter, there are some specific characteristics of developing economies which limit the applicability of the classical quantity theory. The most important of these characteristics is the existence of a relatively large non-monetized sector, which does not require the use of money. Developing economies generally have a large proportion of non-commercial agricultural output and agricultural production varies more randomly due to the vagaries of climatic factors rather than changes in the prices level. Thus, the non-monetary factors play an important part in the determination of prices, especially those of agricultural commodities. Given these factors, an initial increase in the money supply may not lead to a proportionate increase in the price level.

Unlike the classical/neo-classical approach, the modern version of the quantity theory does not view velocity as an institutional datum or a numerical constant, but rather as a functional relationship of a number of variables some of which are relevant to developing countries, (for example expected inflation). In addition, this approach does not impose restrictions on the size of parameters or require a one to one correspondence between changes in the money supply and the price level. To see this consider the following correlation coefficient between money and price (r_1), and money and income (r_2) for developed and developing countries.

	r_1	r_2
developed countries	.32	.05
developing countries	.87	.07

Source: Based on twenty eight year data (1960-1987) of GDP, money broadly defined (m2) and the consumer price index as given in International Financial Statistics, IMF, various issues.

It appears that money supply variations bear a very low impact on income change in both developed and developing countries. The difference in the economic structure of the two groups is reflected not in terms of income effect but in terms of price effect of money supply variations. In developing economies the correlation coefficient between money supply and the price level is much higher than that in developed economies. This result is important given that the data series is differenced to remove trends and spurious relationships.

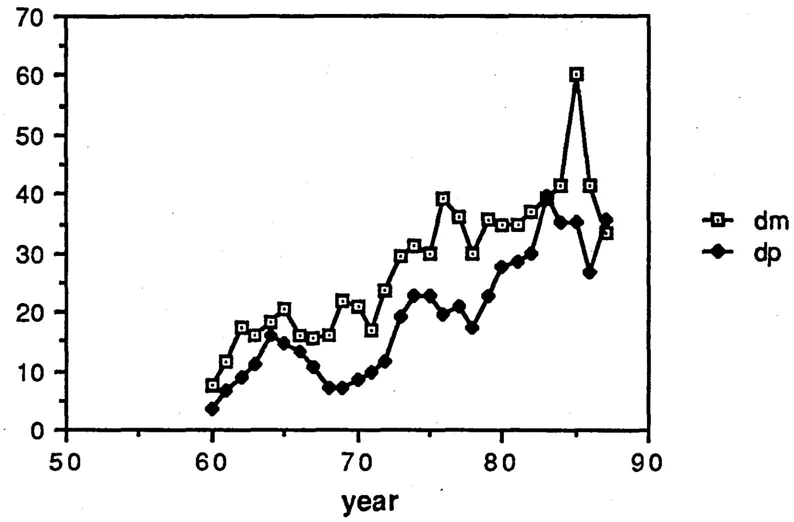
However, this is not to say that changes in money supply and the price level are proportional as implied by the simple quantity theory. Figure 2.1 plots the behaviour of Δm and Δp from 1960-1987. Looking at the whole period, there seems to be a close relationship between changes in money supply and the rate of inflation in LDCs. However, the relationship is not instantaneous as Δm leads Δp by an average of two years.

Except for the initial years, there is no close relationship between Δm and Δp in developed countries, (Fig. 2.2). There is evidence of the rate of inflation 'overshooting' of the rate change in money supply in 1980 and 1981 thus, making the relationship between the two variables much more imprecise. Although we cannot seriously contend that it is a plausible model, a simple regression of Δp on Δm and a constant has produced data points wildly scattered around a least square line, (Fig. 2.4) while the fit is reasonably good in the case of LDCs, (Fig. 2.3).

What has emerged from the above analysis is that there cannot be a separate monetary theory for the so-called developing countries. In fact, the modern version of the quantity theory appears to be more relevant to LDCs than to developed market economies. It might also be appropriate to raise the importance of the issue of exogeneity of the money stock at this stage. Given the fact that there is direct link from a fiscal deficit to money creation (due to the absence of a bond market in which the non-bank private sector operates), the money stock could be endogenous. One might then be tempted to treat the money stock as endogenous and invert the conventional demand for money model to determine the price level. Such procedure is,however, arbitrary since one could as well choose income as the dependent variable. If the price level or nominal money were strictly endogenous, then it would be almost impossible to estimate a demand for money function due to the well known problem of identification. The fact that we managed to identify a stable demand for money functions (see chapters six and seven) means that our explanatory variables are at least weakly exogenous. Furthermore, Hendry (1985) warns against the practice of inverting the demand for money equations in that 'such equations cannot be inverted and still remain constant'; inevitably such procedure should produce 'predictive failure. A similar study by Arestis (1988) for developing countries provides additional evidence against the practice of 'inverting' a demand for money function to determine the price level or inflation.

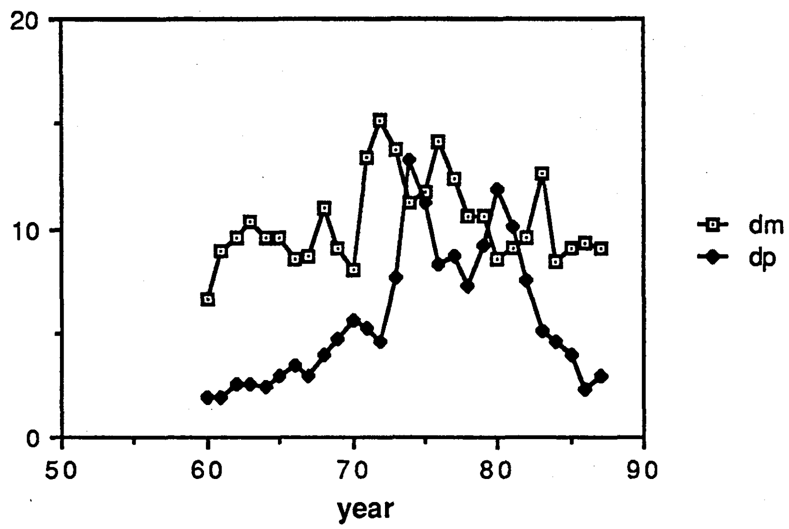
The nature of the demand for money function also raises some interesting questions when we relate it to developing countries. Is it wealth or income that is important? How do we measure permanent income? Should we use the narrow or broadly defined money stock in the money demand function? Is it inflation or the rate of interest which is the opportunity cost of holding money? We now turn to the discussion of these issues in the next chapter.

Fig.2.1



Relationship between change in the money stock and the rate of inflation in developing countries.

Fig. 2.2



Relationship between change in the money stock and the rate of inflation in developed countries.

Fig 2.3 LDCs: $dp = \alpha_1 + \alpha_2\, dm$

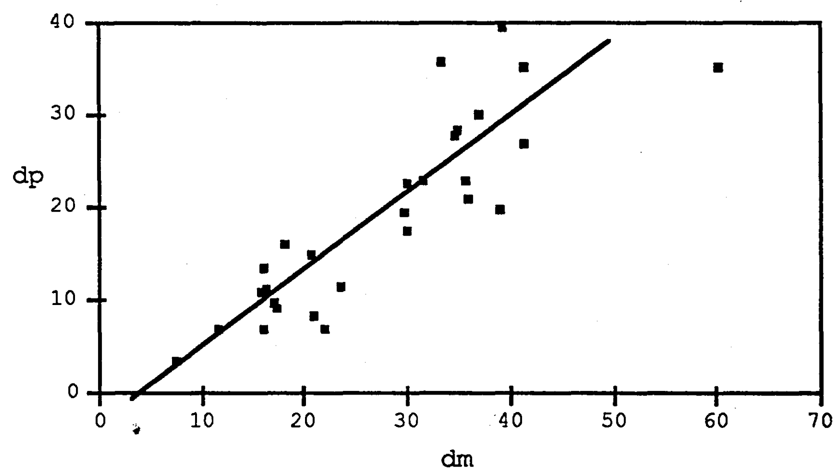
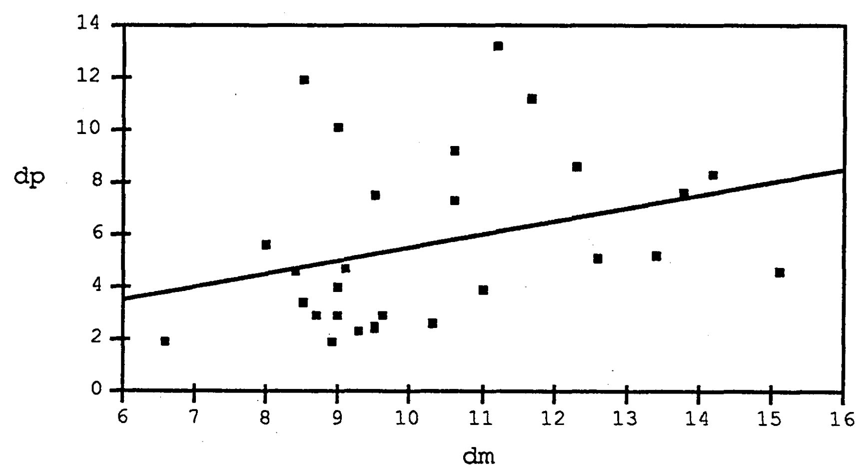


Fig. 2.4 DCs: $dp = \beta_1 + \beta_2 dm$



CHAPTER 3

DEFINITIONS, MEASUREMENT AND INSTITUTIONAL PROBLEMS

3.1 Structure of the Financial Sectors of LDCs

An important feature of less developed countries is the ability to identify two types of money markets:[1] the organized and unorganized markets. While both markets are less integrated and narrower than the money markets in the developed economies, the unorganized markets are even more so. These unorganized markets have been described as follows by Wai (1977).

> They are less homogeneous than the organized market and are generally scattered over the rural sector. There is very little contact between the lenders and borrowers in different localities ...... the relationship between borrower and lender is not only that of a debtor and creditor but is also an integral part of a much wider socioeconomic pattern of village life land rural conditions.
>
> In unorganized money markets, moreover, loans are often contracted and paid for not only in money but in commodities.

This market is made up of largely indigenous bankers, money-lenders, traders, landlords, commission agents, some of whom combine money lending with trade and other activities. These participants in the market are outside the direct control of central banks. There is no means of measuring the size of the unorganized market, but it is reasonable to assume that it is very significant, Wai (1977). According to one estimate for India, the share of the unorganized money market in the total credit supply appears to range from 50 to 70 per cent, Chandavarkar (1971). Information on financial yields in the informal sector is not available in forms that are needed for systematic analysis. But it is believed that levels of these yields, which reflect high monopoly and risk elements are much higher than those in the organized sector. However, to the extent that there is some linkage between these markets, the yields would move together. This linkage may occur through:

(i) marketing boards, big land owners, exporters and traders who borrow from commercial banks and make advances to farmers either directly or through small merchants;

(ii) importers extending credit to village retailers;

(iii) cooperative credit societies, land mortgage banks, private agricultural banks and government agricultural credit institutions who operate mainly in the unorganized markets.

Thus, in theory, the unorganized money market has recourse to the organized sector as a marginal source of credit and, consequently, the monetary authorities could have some influence on the unorganized market through the regulation of the official market. However, in practice, in as much as those private lenders are not subject to the direct control of the authorities, the effects of any policy actions on the unorganized market would be marginal.

3.2 Financial Markets and Asset Substitution

In many LDCs, capital markets display all the characteristics of a narrow market. The number of buyers and sellers is very small, and hence, the average frequency of transactions is quite low. Dealers, who bear the risk of fluctuations in the capital value of the securities and provide a continuous service are totally absent. Furthermore, there is no wide spectrum of owners and ownership motives. According to Porter (1965), more than 80 per cent of the marketable securities in LDCs is held by central and commercial banks, insurance companies and provident funds.

Due to the absence of a broad range of financial assets in LDCs, asset substitution usually takes place between money and real assets. The composition of real individual wealth holdings in LDCs typically consists of land and land implements, simple handicrafts, livestock, inventories (notably foodstuffs) and durable consumer goods (especially housing and in some countries precious metals). The importance of real asset substitution to the holding of money is further accentuated in these countries due to low level of per capita income. This means that money holdings will be particularly sensitive to the yield on real assets.

To sum up, financial markets in LDCs are characterized by what is called financial dualism within the domestic economy. It manifests itself in terms of organized and unorganized money markets. The unorganized markets are unobservable and more fragmented while the organized markets are underdeveloped. Consequently, asset substitution takes place between money and real assets.

Having outlined the chief characteristics of the financial sector of LDCs, we turn to the discussion of the more crucial problems in estimating the demand for money. These are the definition of the money stock, the choice of the appropriate scale and opportunity cost variables, the measurement problems associated with monetization and expected inflation.

3.3 Definition and Measurement of the Money Stock

Any task of monetary analysis must begin from an appropriate definition of money; and any attempt to control the quantity of money must presume that this quantity is measurable. One can ask two fundamental questions. What is money? How can the quantity of money be measured? A good understanding of the difficulties involved in answering these apparently simple questions will go a long way towards providing an understanding of recent debates in monetary economics. This section is directed at exactly these two questions - the definition and measurement of money.

The crucial distinguishing feature of any object which is to be called 'money' is that it must be generally accepted as a medium of exchange. This definition does not, however, allow for a clear-cut distinction in practice between those assets which should be regarded as money, and those which cannot be so treated. Cash and checks drawn on banks are means of payments for transactions which are generally acceptable in most developed economies, and this fact has led many people to conclude that cash and demand deposits in banks are the only real monetary assets. In the case of check transfers, there are two main inherent credit relationships. First, the seller(creditor) has to trust that the buyer (debtor) has sufficient fund with the bank so that the check will be honored by him. On the other hand, possession of a balance on time deposits, or access to overdraft facilities, may allow a purchaser to draw a check on his bank account even when he has insufficient demand deposits to meet that check. Thus, professor Shackle (1971), writes:

> I cannot write a check on my deposit account, but I can write one on my current account which even if that account is empty, will be honored if it is covered by my deposit balance.

A much more difficult question is whether to include time deposits with banks, along with current accounts in the definition of money. Time deposits are formally transferable only after a period of notice, traditionally seven days (although higher interest bearing accounts require longer periods of notice). However, banks may waive this right in return for a loss of interest payable. This practice enables these deposits to be used for payment by transfer to sight deposits. There would seem no very strong basis on theoretical ground for excluding time deposits from the definition of money. A more fundamental point is that the set of assets which is acceptable as payment for transactions is not immutable over time, i.e., it changes over time. If people should find it economically advantageous to accept, and to proffer, other financial claims in payment for transactions, then the set of assets which is to be described as money will alter.

This difficulty in distinguishing exactly which sets of assets most nearly accord with the definition of money, has led some to emphasize other characteristics which monetary assets possess, fore example 'liquidity' or 'money as temporary abode of purchasing power'. Such alternative definition has, in general, proved too indistinct for practical, and more particularly analytical purposes. Others have argued, on a priori grounds, that one or another definition of money, though admittedly imperfect, is the best approximation to the underlying concept of money. Still others have argued that the matter can be determined empirically. If people should regard time deposits with deposit banks as close substitutes for demand deposits, then they should be included in the definition of money.

In the light of the foregoing arguments, it is hardly surprising that several definitions of money have been employed in the course of testing theories of the demand for money. The bulk of the work carried out down to the mid-1970s' confined the definition of money to currency plus demand deposits at commercial banks m(1) or currency plus demand deposits plus time deposits at deposit banks m(2). There was a good reason for limiting the definition of money to these categories. The empirical tests were supposed to throw light on the scope of monetary policy. One wished, then, to know about the role played in the economy by assets whose volume could be controlled by the monetary authorities.

J. Conlisk (1970) confronted the problem of measuring money in developing countries by constructing index numbers to measure the quantity of money. It has been argued that instead of simply adding up what are after all heterogeneous assets, only those assets that are more readily and cheaply transferred should be given more weight in measuring the monetary aggregates than those that are less liquid. Conlisk devised a technique to generate money supply series for 59 countries comprising of 20 advanced, 19 middle income and 20 least developed countries. Each type of asset to be included in the money supply is weighted by the difference between the rate of return it earns and some representative market rate of interest. The argument underlying this procedure is that the greater is this difference, the greater must be the 'liquidity services' the asset in question yields to its holder, and hence the more it is 'money'. Conlisk concludes that apart from developed countries, the weights of time deposits is not significantly different from zero for the remaining two groups and, therefore, savings and time deposits are better left out of the definition of money than included equally with currency and demand deposits. Villanuev and and Arya (1972) extended Conlisk's model to include a large number of countries and presented contrasting evidence. Whereas Conlisk found that only for the advanced group did the measure of the degree of moneyness show any positive significance, the results of the above two authors are overwhelmingly in favour of a broader definition of money which includes saving and time deposits. The most interesting result is that obtained for the least developed countries, where the estimate of the weight of time and saving deposits is positive and statistically significant. Villanuev and and Arya argue that their plausible result is due to a greater variation in the rates of inflation, growth rates of output, and increasing monetization in the least developed countries.

Thus, neither theoretical considerations nor empirical evidence are conclusive in demonstrating whether a broad definition of the money stock m(2) or a narrow definition m(1) is likely to be most stably related to the macroeconomic variables whose value it is desired to influence. It is generally accepted that the appropriate definition of the money supply should be that collection of money stock among which substitutability is highest and which is most stably related to a small set of determining variables. It is sometimes held, however, that to be operationally useful, a money stock definition should comprise an aggregates that the monetary authorities can adequately control. In developed economies, this principle is sometimes adduced in support of a narrow definition of money m(1) which tends to be more responsive to open market operations and interest rate policies. In developing economies, however, available policy instruments apply principally to the volume of credit extended by the banking system, which would tend to make total liabilities of the banking system m(2) easier to control than a particular aggregate. However, even if the monetary authorities are able to control m(2) better than m(1) in the short to medium term, developments in m(1) could still be a useful guide to the conduct of monetary policy in circumstances where an empirically stable relationship between m(1) and total output had been established. Accordingly, it seems desirable not to prejudge the issue of which definition of the money stock is likely to be the most appropriate.

3.4 Scale Variables

The level of real income is often thought of as standing as a proxy for the volume of transactions in an economy and hence plays an important role in empirical tests of transaction based theories of the demand for money. The measurement of this variable presents little problem because, although gross national product (GDP) and net national product series have been used to measure it, as well as gross domestic product series in some cases, these variables move rather closely together over time and no important difference in results is expected by using one or the other.

Wealth is another scale variable, which is often used as a budget constraint in the demand for money. For developed economies it is possible to construct data for financial wealth and Khusro (1952) and Grice and Bennett (1984) have used such series in studies of the demand for money in Britain. However, this is a very narrow wealth concept and only for the United States do data exist which permit the construction of long time series for various broad measures of aggregate level of non-human wealth, real as well as financial, owned by the private sector of the economy. Even in the context of work done in the United States, most researchers have been deterred from using this variable, both by the conceptual problems involved in measuring the 'correct' aggregate variable just discussed, and also by Friedman's arguments that an even more inclusive wealth concept,embodying the value of human as well as non-human capital should be used when measuring the constraint on money holding. Of course, to measure this more inclusive concept of wealth presents formidable difficulties of its own, and virtually all attempts to come to grips with them have started from the simple idea that wealth is the discounted present value of expected future incomes. If one is interested in studying the relationship between variations in the level of wealth and variations in the demand for money, it is not important whether wealth is measured directly or permanent income is used as its proxy.

In developed economies, it is usually found that expected income is the most appropriate scale variable. As far as developing countries are concerned, economists have expressed different views on the measurement of permanent income and on the question of which income variable (i.e. permanent or current income) to include in the demand for money function.

3.5 Measurement of Permanent Income

Since the PIH (permanent income hypothesis) has exciting policy implications for the saving efforts in the under developed countries, several studies have been made to test its validity in some of these countries. Time series as well as cross section data have been used in this connection. The time series analysis has been used by Friend and Taubman (1966) and Williamson (1968) for several countries and by Gupta (1970) for India. The time series analysis compute permanent income as a moving average of three years of current income, i.e., $y^P{}_t = 1/3(\Sigma y_{t-i})$, i = 0,1,2. This may be partly because Friedman in his calculation of the consumption function for the United States estimated consumer units horizon as approximately three years. Laumas and Laumas (1972) pointed out that this procedure is grossly misleading for the following reasons.

(1) It is based on a misinterpretation of the concept of horizon which is an integral part of PIH. As it has generally been used, 'horizon' implies a cutting off so

that the economic agent does not look beyond three years, if that is the length of his horizon. But what Friedman meant was that it is the dividing line between the effects the agent considers transitory and those he considers permanent. The consumer's permanent income for a three year period may differ from his average measured income for those three years just as the expected value of the mean of a sample of three observations may differ from the observed mean of a specific sample. The term 'horizon' is, therefore, used by Friedman to dichotomize factors affecting income into transitory and permanent. The numerical value of 'horizon' is determined by the data itself. A three years moving average to calculate permanent income, therefore, misrepresents PIH.

(2) The moving average method does not properly depict consumer behaviour. It appears to assume that consumer's memory is more or less fixed as time goes on and after a point it disappears altogether. Economists like H. Simon (1966) disagree with this view. Following Jost's Law they suggest that if two associations are of equal strength but of different age, the older diminishes less with time. On the assumption that learning is not homogeneous, only an exponentially forgetting function would be compatible with this view. Friedman's use of an exponentially declining lag function for calculating permanent income from time series data incorporates this point satisfactorily. The underlying

notion of such a function is that a consumer's rate of loss of retained material is dependent on the age of the memory or that the rate of loss is dependent on the completeness of original learning, or some combination of these. When there is a crisis situation, a consumer unit lengthens his memory. This is natural because when expectations have been badly upset it is prudent to use more information than before in making new decisions. Friedman's technique has the merit that the weighting pattern and the permanent income series that best represents the memory period of the consumer is determined by the data. Thus the moving average method has a very shallow psychological foundation and, therefore, does not properly depict agents behaviour.

(3) The moving average method does not take into account the impact of structural change in the economy. This point is particularly relevant to an evaluation of the tests of the validity of PIH for developing countries. The process of economic development inevitably involves structural changes. But due to the various obstacles to economic development, the pace of structural change may be very gradual. It is inevitable that the results of such change are registered in important economic variables such as national income, aggregate consumption, price level, etc. It is obvious, therefore, that if one were to use three years moving average to calculate permanent income, one is not adequately taking into account the process of economic development.

In order to test the extent of differences made in the results, Laumas estimated consumption functions for Canada (1944-1966) and for the US (1959-1970). For computing permanent income according to the Friedman method some variant of the adaptive expectations hypothesis was used. The first order adaptive expectation assume that revisions to expected income ($y_t - y^e_{t-1}$) are a fraction of Θ of the difference between current income and expected income ($y_t^e - y^e_{t-1}$).

$$y^e_t - y^e_{t-1} = \Theta (y_t - y^e_{t-1}) \qquad (3.1)$$

$$\text{or } [1 - (1 - \Theta)L]y^e_t = \Theta y_t$$

$$\text{or } [1-(1-\Theta)L]^{-1}(\Theta y) = \Theta\Sigma^{\infty}(1-\Theta)y_{t-j} \qquad (3.2)$$

Where y^e_t is expected or permanent income, L is the lag operator, $L^nY = Y_{t-n}$. The term ($y_t - y^e_{t-1}$) is the forecast error. Θ is the rate at which all future receipts are discounted to yield permanent income. Θ may also be referred to as the speed of adjustment of permanent to the measured value of income. $1/\Theta$ can be regarded as the horizon or 'number of years' that agents remember.

Equation (3.1) states that in each period, people revise their notion about the expected value of y in proportion to the difference between its observed value and what was previously expected. Expected income is a weighted average of past income with relatively higher weight being given to more recent income. If current income remains constant for a long period of time, expected income will eventually become equal to this constant level of actual income.[2]

Table 3.1 (page 83) compares the values of the marginal propensity to consume out of expected and transitory income estimated using the Friedman approach and the three years moving average method. The moving average method tends to lower somewhat the marginal propensity to consume out of permanent income. In addition, the computations reveal that the moving average method consistently overestimated transitory income and under-estimated permanent consumption for the United States and Canada.

In addition to the above findings, it may be argued that where permanent income, (defined as the moving average of three years of incomes), current income and the previous year's income get the same weight; whereas Friedman's formulation of current income has a larger weight than the previous year's income . Hence, some of what we call permanent income is included in transitory income and, therefore, yields incorrect results.

Expected variables generated by functions such as (3.2) have been interpreted in two ways in empirical investigation of the monetary sector. First is the Friedman approach, in which expected income enters into the relationship as a proxy for the expected yield on wealth. Friedman denies the validity of formulation of the demand for money relationship in which the transaction motive for holding money is important and, consequently, current income is not the appropriate scale effect. He contends that the asset motive predominates and thus only that part of income which is considered as permanent influences the demand for money. More explicitly, he argues that much of the theoretical literature on motives for holding money suggests interpreting money holdings as one of the balance sheet items that act as shock absorber for transitory components of income; as an asset item that is increased temporarily when the transitory component is positive and that is drawn down, if necessary, to finance consumption when the transitory component is negative. Viewed this way, the appropriate constraint in the money demand relationship would be current income. As an alternative, he argues for and interprets his results as suggesting the treatment of money as a 'durable consumer good' held for the services it renders and yielding a flow of services proportional to the stock. The shock absorber role is then filled by other items in the balance sheet (e.g. stock of consumer goods, outstanding consumer credit, personal debt and perhaps securities). This way of viewing money holdings implies that the appropriate constraint is the expected yield on wealth or permanent income.

The second approach is to interpret the expected variable generated by equation (3.2) simply as an optimal forecast of the current variable. This approach follows from Muth's (1961) demonstration that if the process generating measured income is such that the change in measured income is a first order moving average of random deviates, then the expectation generating function provides an optimal forecast of measured income. The primary interpretation given to expected income is thus a more direct one: it is interpreted as the optimal forecast of income.

If one believes that actual income is generated in a 'complete' model of the economy by a set of predetermined variables, then a regression of actual income on x_t and lagged income provides a 'weakly' rational predictor of expected income (assuming x_t is known at time t).

$$y_t = \hat{b} x_t + \hat{c}(L) y_{t-1} + u_t \qquad (3.3)$$

Where c(L) is a lag polynomial and u_t is a white noise error term. $\hat{y}_t = \hat{b} x_t + \hat{c}(L) Y_{t-1}$ provide an estimate of the one - period ahead expected income which can then be directly used in the demand for money. The predictions are unbiased since the error term (the residuals) are zero.

Another method employed in the RE approach is to use actual income as a proxy variable for expected income since the former is an unbiased predictor of the latter. The RE approach, therefore, replaces an expected variable by a suitable proxy variable and does not explicitly introduce any lagged dependent variables into the demand for money function.

The basic idea behind the rational expectation hypothesis as outlined above, is that in formulating his expectations, the agent uses all the available information about the economy. It is assumed that the individual has complete information on the true structure of the economy and immediately (and costlessly) learns about any changes in structure that occur. Economic agents do not persistently over or under predict a particular variable over several periods. Since the RE agent is assumed to use the true model, he therefore uses all relevant information when making his predictions: no information known at the time the forecast is made can improve the individual's forecast.

The Muthian rational expectation model is theoretically plausible but practically less applicable for developing countries. The basic assumption of the model, that agents form their expectations on the basis of the whole structure of the economy and also collect and process recent information (without cost) about a particular variable is presumably a very rigid and extreme assumption. In a real world situation, most economic agents are not in a position to grasp the actual working of the economy and also there is a substantial information gap between policy makers and economic agents. Further, even if adequate information is available, it is very unlikely that forecasts on the basis of available information will be unbiased predictions. This does not mean that economic agents in developing countries are irrational or do not process the available information when forming expectations. In a typical developing country, it is 'rumours', rather than documented information, which influence agents decisions. Usually the growth of money supply, government budget deficits, political instability, foreign exchange reserve positions contribute to the formation of expectations. But it is unlikely that people can get undistorted information of these factors. In reality, since rumours form and spread widely before any documented information becomes available, there is a huge scope for error in forming expectations and that the errors may not be randomly distributed as required by RE hypothesis. An adaptive expectation hypothesis, therefore, seems to be appropriate in developing countries. However, in some special circumstances, it is very difficult to distinguish between the two models of expectations formation. It will be recalled that from equation (3.1), $\Theta = 1 \Rightarrow y^e_t = y_t$. In this case the two expectation models are observationally equivalent. What this means is that expectations are static and it does not in any way imply rationality.

One may ask if there are any empirical or theoretical grounds to discriminate against current income or expected income. Fry (1978) estimated demand for money for 10 Asian countries. He found that substitution of permanent for current income is warranted. Chow (1966) suggested that in the equilibrium form of money demand function, permanent income is more relevant whereas in the short run or disequilibrium form of demand for money function, current income is better.

On the other hand, Laumas & Laumas (1976) report that even a loose version of the PIH does not hold in the context of LDCs. Their test takes the form of estimating a consumption function for India for the years 1929-1960. They find no significant difference between the marginal propensity to consume out of permanent income and out of current income. Adekunle (1968) claims that the value of Θ for a group 18 developing is closer to unity and, therefore, current income is the appropriate scale variable.

Several economists, on a priori basis, favour current income as an argument in the demand for money function in LDCs. Irving Fisher (1907) for example once observed:

> ....a small income implies a keen appreciation of future wants as well as of immediate wants. Poverty bears down heavily on all parts of man's life, both that which is immediate and that which is remote. But it enhances the utility of immediate

income more than that of future income. This result is partly rational, because of the importance of supplying present needs, of keeping up the continuity of present life and the ability to cope with the future, and partially irrational because the pressures of present needs blind one to the needs of the future.

Given low per capita income and the devotion of almost all output to the maintenance or improvement of an exceedingly low standard of living, it is clear that more concern will be devoted to current than to future welfare. In fact, because of the lack of knowledge, and the other imperfections that combine to make for relatively high risks and uncertainties, no other pattern of time preference may be rational. The rates of discount on the present value of future income are such that economic horizons are shorter. These factors affect not only the proportion of income that is saved but also the forms in which savings are held, as well as what investment decisions are made.[3] It means that available savings are held in forms that have relatively little risk, that are quickly convertible, and that are directly under the owner's control. This implies that the demand for assets is such that it reduces the scope - apart from the supply limitations - for promoting risk spreading assets and thus perpetuate the high risks present in this economic environment.

The social and political instabilities in LDCs also limit the economic horizon and bias investment in favour of short term projects such as inventory accumulation and commercial transactions, and against long-term projects, such as industrial and agricultural investment. In this environment where political changes often imply changes in other spheres, including official economic and commercial policies, a short term rhythm of operations make it easier to adapt to new situations and to avoid unforeseeable dangers. An industrial enterprise cannot be adopted so easily or quickly. It lacks the security that lies in liquidity and flexibility. The structure itself is characterized by relatively greater instability in less developed countries, who because of their greater dependence on the export of a few crops and the import of capital goods, are susceptible to externally generated fluctuations in income levels and in the level of economic activity. Apart from these external sources of fluctuations, abnormal seasonal patterns also constitute a major autonomous source of fluctuations in income. The available techniques of stabilization are very limited that these seasonal distablizing factors occur quite frequently.

While the foregoing discussion has not been exhaustive, it seems clear that the economic time horizon is shorter in developing countries than in developed countries, thus, in forecasting income, one would expect greater weight to be given to recent experience. However, the controversy surrounding the choice of an appropriate scale variable for money demand function in LDCs has not been settled. Different econometric studies reach conflicting conclusions and, given the available data, the traditional econometric methodology is not effective for deciding which conclusions are correct. On the other hand, a priori restriction should not be taken too seriously - it biases one's judgement.

3.6 Monetization: Concept and Measurement Problems

A further problem arises from the choice of an incomes measure in LDCs as a result of the effect of change in the degrees of monetization and financial deepening on the demand for money. Ram and Biswas (1983) argue that as long as the process of monetization increases at a faster rate, demand for real money balance cannot remain stable. Put differently, the velocity of circulation of money varies secularly and,therefore, in estimating demand for money, income data for the non-monetized sector, which uses and demands no money by definition, can simply be ignored. If the combined output of both sectors is used, then account should be taken of the rate at which output is being monetized. In other words, a proxy variable capable of capturing the degree of monetization should be included when estimating the demand for money function in LDCs.

The degree of monetization refers to the fraction of total output exchanged for money. It connotes the enlargement of the sphere of the use of money. It is important to distinguish this concept from financial deepening which refers to the extent that the monetized sector utilizes money and the services of financial intermediaries. Commercialization indicates the pervasiveness of the behavioural assumptions of profit maximization, regardless of the degree of monetization of either inputs or outputs.[4] For any operation to be largely commercialized, the bulk of the output must be salable in the market. For instance, a system of family farming may sell the bulk of its output on the market and may, therefore, be described as commercialized, even if the bulk of its inputs are non-monetized (e.g, use of non-wage labour); consequently, monetization is a necessary but not a sufficient condition for commercialization.

While all these increase the demand for money, monetization and commercialization tend initially to expand the use of money, and financial deepening expands the use of bank deposits. Further, financial deepening reflects the response of economic agents to the ease and relative yield (or cost) of using money. Hence, the geographic spread of banking offices analysed by Aghevli (1973) is an inducement to the broadening of monetized production and so increases the demand for money.

Historically, monetization has been an evolutionary process and has not been a conscious object of policy in most developing countries, except in tropical Africa and the South Pacific. In these regions the prime instruments of monetization have been the introduction of cash and export crops, such as cocoa in West Africa; the transformation of existing subsistence crops into export crops; the imposition of new money taxes, such as poll and hut taxes, to force workers into the use of money.

The historical trend of monetization is likely to be the shape shown in figure 3.1 (page 90), which plots a time path of the monetization ratio (MR) from the origin denoted by O, since there is no historical example of a completely non-monetized economy. The kinks in the rage Om reflect the irregular character of the monetization process. The family of curves P_1 to P_4 are intended to show that after a certain threshold (T), the time path m_{rt} becomes asymptotic to Om (the limit defined by a fully monetized economy). Monetization could be said to stop short of the complete absorption of the non-monetized sector because even the most developed economies would always have some irreducible minimum component of non-monetary imputations. There are, of course, major differences between the nature and rationale of the traditional production oriented non-monetary subsistence sector in LDCs and the consumption oriented households in developed countries. The path P, which is nearest to Om is likely to be typical of developed countries,[5] whereas the curves P_1 to P_4 approximate the typical range of MR (say, about .80 or a non-monetized sector of 20 per cent) in the less developed countries.

3.7 Measuring the Rate of Monetization

Many researchers have suggested that the ratio of money supply to national income can be regarded as a rough index of monetization.[6] However, a closer analysis shows that this ratio cannot be used even as an approximate index. A mere increase in the money supply does not necessarily connote an enlargement of the money economy, since it may well reflect an increase in the supply of money originating from the existing monetized sector rather than the absorption of the non-monetized sector. This distinction is crucial even if it is not always possible to disaggregate any given increase in money supply into these two separate components.

Monetization can also be expressed as the proportion of the monetized component to the total of relevant economic magnitudes - such as gross national product (GDP) at a given time. To derive a meaningful aggregative measure of monetization, it is essential to relate the monetized portion to the total volume of economic transactions. Consequently, monetization would be the monetization ratio, which may also be termed the monetization factor.

Unfortunately, published data on the non-monetized sector in the national accounts of of LDCs are either totally lacking or extremely fragmentary. The few available data are bench-mark estimates for a particular year. A survey by OECD for the year 1969/70 (table 3.2 pp.85-86) shows that the non-monetized sector accounts for 20 per cent or more of total GDP in nearly 40 per cent of the reporting countries, and for 10 per cent or more in about two-thirds of the countries in the survey. Although no country is known for which MR is below one-half or closer to this value, the non-monetized sector still seems to be substantial in tropical Africa,[7] South East Asia and the South Pacific, whereas Latin America appears to be the most monetized region of the Third World. It is thus possible to measure the level of monetization only if the national accounts are disaggregated into monetized and non-monetized sectors.

Because of the difficulties in constructing time series data on the non-monetized income, Emery (1973) made a different type of attempt to estimate the rate of monetization. On the assumption that velocity is constant, Emery developed the following model.

$$\Delta v/v = \Delta m/m - \Delta p/p - \Delta y/y \qquad (3.4)$$

This implies that the rate of monetization is equal to the rate of change in velocity ($\Delta v/v$), which is assumed to be constant. However, this method of estimating the rate of monetization does not produce plausible results unless one can separate velocity from monetization (which is impossible from equation (3.4). The assumption of a constant velocity is also unreasonable as velocity depends on the growth rates of the money stock, income and the price level.

3.7 Opportunity Cost Variables

In developed countries, the interest rate is usually considered as the most appropriate proxy for the opportunity cost of holding money. But the case for this has less force in LDCs, because nominal interest rates are institutionally determined at the rates which are usually below competition would otherwise have generated. The commonly cited reasons for the authorities in developing countries to control and repress domestic interest rates are:

(i) low interest rates will provide a stimulus to capital formation;

(ii) low interest rates will help small scale rural and other productive units who cannot afford to borrow at high interest rates;

(iii) while market determined interest rates tend to provide equilibrium in financial markets, in most LDCs these markets suffer from serious imperfections. Financial markets in these economies are very thin because of low income and limited degree of monetization. Other less plausible reasons have been given for the policy of low interest rates. There is the argument that low and stable interest rates may help to strengthen the stability of the financial institutions because the low cost of their liabilities help to protect their earnings; there is also the application of the well known 'usury law' which limits the payment of interest on moral grounds. A cursory look at table 3.3 (pp.87-88) reveals the general static nature of interest rates in LDCs over time. The real rate of return on bank deposits during 1970-80 was negative for the countries reported with the exception of Malesia, Thailand and Colombia where positive returns of only 1.2, 0.16 and 1.23 per cent were recorded respectively. It is, therefore, clear that there has been a great deal of financial repression in these countries. Such repression working through negative real interest rates poses important macroeconomic questions concerning the ability of the economy to accumulate financial assets, the volume of national savings and investment and the allocation of resources. It has thus been argued that an important reason for the reluctance of savers to use banking institutions is precisely that they offer such relatively low returns Mackinnon (1973).

The administration of interest rates in less developed countries, therefore, lacks flexibility, and over time, large divergencies between administered and market rates will emerge. Cagan (1956), argues that variations in the holding of money balance when the alternative is to hold consumers goods can be determined by the change in the real value of a given nominal balance - the rate of depreciation in the real value of money. The variations in the real value of goods due to their physical depreciation is fairly constant and can be ignored. That is, the opportunity cost can be represented by the rate of change in prices. Even when the rate of inflation is not discounted explicitly in these terms, there is a general theoretical agreement that it influences the holding of money balances. Thus, the willingness of individuals and business to hold and expand the quantity of money, or claims denominated in money terms, is influenced by their expectation about the future price levels. If prices are expected to rise markedly, holders of money will try to limit any increase in the money value of their holdings, or may even attempt to dispose of them.

Table 3.4 (p.89), presents data on inflation for both developed and developing countries from the mid 1960s onwards. The first point to note is that LDCs are clearly more prone to inflation than are developed market economies. Over the period 1967-76 the weighted average rate of inflation of the LDCs was approximately twice that of the developed economies. From 1977 onwards, the LDCs rate was approximately three times as great as that of the developed economies, and in the 1980s the gap widened even further.

A second point relates to the varied experience of LDCs with respect to inflation. The weighted average figures show that the Western Hemisphere LDCs typically experienced rates of inflation far above those of other LDCs. Asian LDCs in particular appear to have been remarkably successful in containing inflationary pressures. The variation in individual countries inflation rates explains the differences between the weighted average and median rate of inflation. The weighted average figures are according to the IMF 'dominated by the poor performance of a few large countries', and they thus tend to overstate the rise in inflation for the majority of LDCs. An examination of line three of table 3.4 clearly shows that for developed countries the median inflation rate is significantly less than the weighted average rate. The median inflation rate peaked in 1980, declined to 10 per cent in 1983 and is estimated to have fallen since then. The weighted average rate also reached a peak in 1980, declined marginally in the subsequent two years, but rose quite substantially in 1983 and 1984. This disparity is attributed to the 'quite atypical' inflationary experience of five countries: Argentina, Bolivia, Brazil, Israel and Peru - for which the composite rate of inflation accelerated from about 100 per cent in 1981-2 to almost 260 per cent in 1984.

From the above discussion, it appears that the effect of price change on the demand for money in many developing countries is very significant. On the other hand, the effect of price changes on money holdings in industrial countries may be negligible. This means that in a financially developed economy, the yields on financial and real assets move together. We may thus state the following relationship between the nominal interest rate and the expected rate of inflation.

$$i_t = r_t + \beta \Delta p^e_t \tag{3.5}$$

A strict Fisherian model is:

$$i_t = r_t + \Delta pe_t, \qquad \beta = 1 \tag{3.6}$$

Equation (3.6) shows that an increase in the expected rate of inflation produces an immediate equivalent jump in the nominal interest rate while keeping the real interest rate unaltered. It is also evident that if $i_t > \Delta p^e_t$, r_t will be positive. The Keynesian assumption that money is substituted for financial assets (but not for real assets) is based on the inequality constraint that $i_t > \Delta p^e_t$. This is because i_t is the implicit rate of return on financial assets, whereas real assets bear an implicit rate of return to Δp^e_t. So, only if $i_t > \Delta p^e_t$, it is profitable for a wealth holder to hold financial assets rather than real assets. But if $i_t < \Delta p^e_t$, real interest rates become negative and in such a situation asset holders would prefer real assets to financial assets. Indeed, Tanzi (1982) points out that under certain situations (i.e. if the returns on financial assets are taxed), real assets may be more attractive than financial assets even when $i_t > \Delta p^e_t$. In this case the expected rate of inflation more appropriately represents the opportunity cost of holding money. Thus, in a situation where prices are expected to change, the real interest rate is adjusted by the expected rate of inflation to give expected market interest rates.

The rate of inflation is usually measured with reference to a basket of goods, such as the Consumer Price Index (CPI) or the Whole sale Price Index (WPI). There are, however, several grounds for objections to the use of these indices and we consider these problems below.

3.8 The CPI and WPI

It can be argued that the CPI gives disproportionate weight to the prices of services relative to those of goods. Unlike the consumption of services, goods are an alternative to holding money. Wealth owners hold either commodities, the rate of return of which is given by the rate of change in their prices, or financial assets, the rate of return on which is denoted by the nominal interest rate. It follows from this that expected change in the price of commodities is more relevant to the allocation of savings by individuals than those of services. In economies where labour productivity as well as real wages are rising, prices of services tend to rise in relation to the prices of commodities (an outcome that can be traced to relatively slow technical change in the production of services). Thus, the use of the CPI will tend to overestimate the rate of inflation, and thus bias downwards an estimate of the real interest rate that depends on expected changes in the CPI. For this reason, use of the wholesale price index, which is composed wholly of goods, is often suggested as an alternative for deriving expected inflation

There are other, practical, objections to the use of the CPI in developing countries. First, in many of these countries, the index does not reflect actual changes in equilibrium market prices, because a large proportion of the commodities featured in the index have official prices that are administered or controlled by government. In Egypt in 1977-82, for instance, 27 per cent of the commodities represented in the CPI were subject to central government price control; in Mali in 1976-80, the proportion was around 25 per cent (see Khatkate, 1986). Second, in many developing countries the CPI records price changes in only a few cities, so that it may not measure change in purchasing power in the country as a whole. Third, even when the CPI is calculated for a particular city or region, the basket of goods and services it includes may be insufficiently representative of the consumption patterns of particular groups of the population.

In practice, the consumer price index and the wholesale price index generally move together in LDCs. Khatkate (1986) argues that in only 3 out 24 developing countries, for which a wholesale price index (1970-1980) was available, the correlation coefficient between changes in the CPI and WPI was less than 0.75; in 19 of these countries the coefficient of correlation was above 0.90. That is to say that the year to year changes in both series were very similar in magnitude and direction.

This pattern in developing countries is probably explained by two factors. First, expenditures that are measured are likely to be less important in the public's consumption pattern because of the relative underdevelopment of such economies. Therefore, commodities enter into both the CPI and WPI with more or less the same weights. Second, the effect of controls on prices of commodities entering the CPI may ultimately be reflected in the WPI, in which case percentage change in both would follow similar patterns.

3.9 The GDP Deflator

Perhaps a more fundamental disadvantage of the CPI and WPI is that they both give too much weight to the prices of consumer goods and too little to those of capital goods and long-lived assets. This suggests that a better index to use for estimating inflation is one that assigns weights to consumption goods, services, and long-lived goods that reflect an appropriate average of changes in their prices. For LDCs, the closest equivalent to such an index is the GDP deflator (which measures changes in the value of the total final output of the economy); the weights assigned to goods in these indices change as the pattern of expenditure shifts in response to movements in the relative prices of goods. Being more comprehensive in coverage than the CPI and WPI, the GDP deflator is a better indicator of the purchasing power of money.

Correlating the GDP deflator with the CPI and WPI, Khatkate finds a coefficient of correlation between changes in the GDP deflator and changes in the CPI to be 0.75 in only 10 of 55 LDCs for which data were available for the period 1970-80; and it was above 0.75 for only 15 out of 24 countries for which WPI was available. That is, the different indices give quite different impressions of the rate of price change in the economy.

3.10 Concluding Remarks

Like in many areas of economics, the controversy surrounding the choice of the appropriate scale and opportunity cost variables has not been settled. Different econometric studies have reached different conclusions. While this problem is common for all economic environments, there is an additional problem related to developing countries, i.e., the effect of a continuous process of monetization on the demand for money. It has been argued that velocity of circulation cannot be constant if an economy is undergoing rapid monetization. To see the validity of this argument, we have plotted the logarithm of py/m = k for both developed and developing countries for the period 1960-1987. Chart 3.1 (p.90) exhibits the variability of k in LDCs between 1960 and 1970 and the fluctuation was largely random after 1970. A cursory inspection of DC data tells the same story (chart 3.2), although the fluctuation is less erratic compared to LDCs. We also observe a similar behaviour of velocity when LDCs are sub-divided into Asian, African and Western Hemisphere developing countries.In the latter case, however, k shows a growing trend after 1975 due to a huge increase in the level of prices in some Latin American Countries.

The conclusion to be drawn from the charts 3.1- 3.5 is that observed velocity is not constant in both economic environments and, therefore, monetization does not pose a unique problem to LDC. Put differently, if velocity is unstable in LDCs, so it is in industrialized countries. However, in arriving at such conclusion, we have only taken a very crude look at the data. The stability of velocity is an outcome of estimation rather than a crude assumption. The next step is, therefore, to look at the existing empirical evidence undertaken by several researchers, and this we do in the next chapter.

Table 3.1 comparison of the Friedman and moving average methods of measuring permanent income.

	FRIEDMAN'S METHOD	THREE YEARS Moving Average
CANADA		
MPC:		
a) out of y^e_t	0.90	0.85
b) out of y^c_t	0.40	0.60
USA		
MPC:		
a) out of y^e_t	0.82	0.80
b) out of y^c_t	0.64	0.76

where y^c_t is transitory income.

Source: Laumas & Laumas (1972), p.437

Table 3.2 non-monetary output in relation to Gross Domestic Product (GDP) and the Monetization Ratio in LDCs.

Region and Country	Non-monetary output as a percentage of GDP[1] (a)	Monetization Ratio[2] (b)
ASIAIA AND MIDDLE EAST		
China, Rep. of	18	0.82
Hong Kong	5	0.95
India	20	0.80
Iran	10	0.90
Jordan	5	0.95
Korea (South)	5	0.95
Màlesia	21	0.79
Philippines	10	0.90
Thailand	10	0.90
Vietnam	12	0.88
AFRICA		
Angola	20	0.80
Botswana	21	0.79
Cameroon	17	0.83
Dahomey	23	0.73
Ethiopia	45	0.55
Ivory Coast	11	0.89
Kenya	22	0.78
Madagascar	19	0.81
Malawi	39	0.61
Mali	33	0.67
Mauritania	29	0.67
Mauritius	7	0.93
Mozambique	23	0.77
Niger	42	0.58
Rwanda	49	0.51
Senegal	13	0.87
Sieraleone	22	0.78

Cont. (table 3.2)

Swaziland	17	0.83
Tanzania	28	0.72
Togo	20	0.80
Uganda	34	0.66
Upper Volta	38	0.62
Zaire	10	0.90
Zambia	7	0.93
Zimbabwe	16	0.84
LATIN AMERICA		
Argentina	2	0.98
Dominican Rep.	13	0.87
Ecuador	8	0.92
Guyana	2	0.98
Jamaica	2	0.98
Mexico	2	0.98
Nicaragua	8	0.92
Venuezela	6	0.94

1 Adapted from Derek W. Blades, Non-monetary (subsistence) Activities in the National accounts of Developing Countries, Development Centre, Organization for Economic Cooperation and Development, (Paris, 1975), p.80.

2 The monetization ratios have been calculated on the basis of the shares in col. (a).

Table 3.3 Nominal and Real interest Rates in Selected Developing Countries, (1971 - 1980)

Region/country	Nominal interest Rates (1)	Change in GDP Deflator	Real Interest Rates (2)
AFRICA			
Ghana	5.29	46.99	-41.70
Ivory Coast	3.97	16.87	-12.90
Kenya	5.37	10.34	-4.97
Nigeria	5.54	16.34	-10.80
Tanzania	3.79	11.1	-7.31
Zambia	4.76	7.71	-2.95
ASIA			
Bangladesh	8.14	13.52	-5.38
India	6.79	9.03	-2.95
Indonesia	11.06	18.92	-7.86
Korea	15.64	18.13	-2.67
Malesia	7.61	6.41	1.20
Pakistan	8.39	8.86	-.40
Philippines	9.45	12.72	-3.27
Thailand	9.96	9.80	0.16
LATIN AMERICA			
Argentina	58.95	130.29	-71.34
Bolivia	13.66	34.67	-21.01
Brazil	31.07	44.32	-21.01
Chile	60.31	178.73	-118.42
Colombia	20.98	19.75	1.23
Mexico	15.40	19.05	-3.65
Peru	22.96	38.10	-15.14
Uruguay	44.10	62.68	-18.58

Cont. (table 3.3)

OTHERS			
Morocco	6.0	8.55	-2.55
Tunisia	4.0	8.11	-4.11
Yugoslavia	9.91	21.64	-11.73

(1) Observed rate on bank deposits

(2) Nominal rate less percentage change in GDP deflator (col.3)

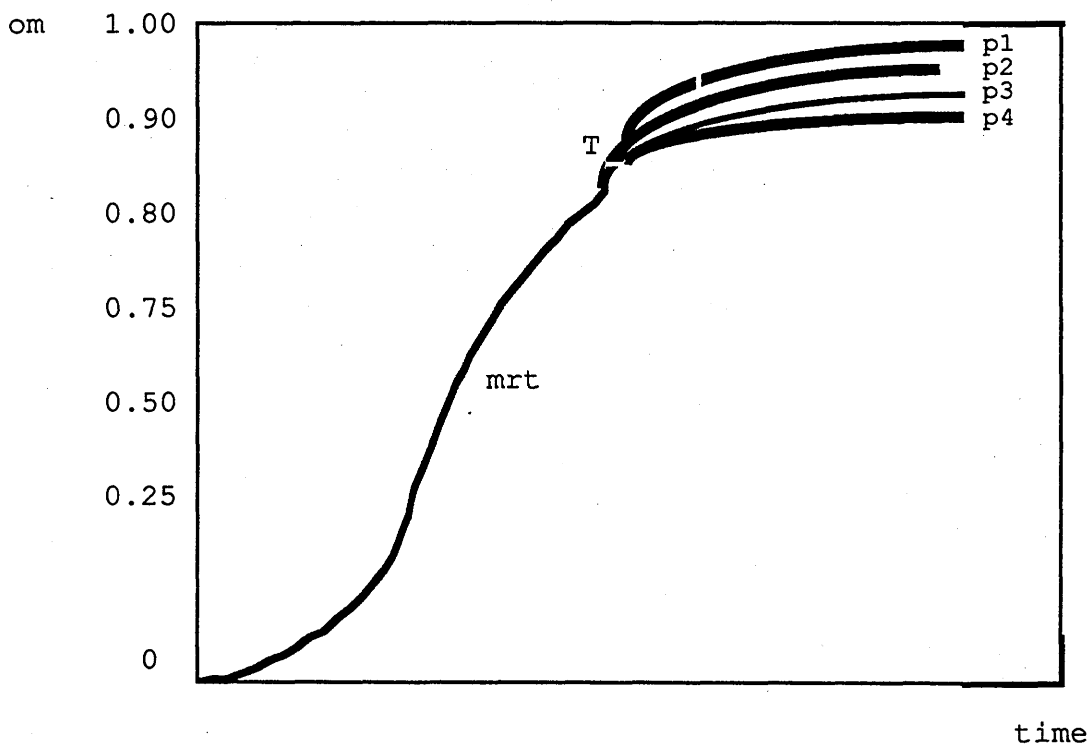
Source: D. Khatkate (1986) " Assessing the level of and impact of interest rates", Finance and Development, vol.23, No.2 (June 1986).

Table 3.4 Inflation: 1967-86 (percentages)

	Average 1967-76	77	78	79	80	81	82	83	84	85	86
Ind. Countries	6.7	7.5	7.6	8.0	9.2	8.7	7.2.	4.9	4.1	3.9	3.7
LDCs	13.8	24.8	18.8	21.5	27.3	26.1	24.7	33.0	37.7	34.8	22.6
Median inf.	7.8	11.3	9.8	11.5	14.5	13.3	10.7	9.8	10.0	9.3	8.0
AFRICA	8.5	18.8	16.9	16.7	16.6	21.4	13.4	19.0	17.8	16.1	12.7
ASIA	9.4	7.8	4.0	8.0	13.1	10.6	6.2	6.6	6.9	5.5	5.4
EUROPE	9.0	15.1	19.8	25.9	37.9	24.0	23.8	23.2	28.0	22.4	19.0
MIDDLE EAST	8.7	18.0	12.8	11.1	17.4	15.6	12.7	12.7	16.5	17.3	15.1
W. HEMISPHERE	24.5	49.9	41.9	46.5	54.0	58.6	65.5	100.5	119.8	113.7	59.7
By analytical criteria											
Fuel Exporters	9.7	18.1	12.5	11.8	15.9	16.4	18.0	25.5	20.1	15.3	12.1
Non-Fuel Exp.	16.2	28.0	21.4	25.7	32.2	30.6	28.0	36.9	47.1	45.0	27.9
Market Borrowers	18.7	32.6	28.2	31.8	36.3	38.7	38.5	55.5	65.7	60.3	35.0
Official Borrowers	9.7	17.3	13.7	19.5	22.3	28.4	17.2	21.9	15.8	13.8	13.4

source: IMF(1985, table 7, p.212)

Fig. 3.1



0 - fully barter economy

0m - fully monetized economy

mrt - Time path of monetization

p1,.......,p4 - typical limits
of monetization Ratios

Source: Chandavarkar, A. (1977) p.700

chart 3.1

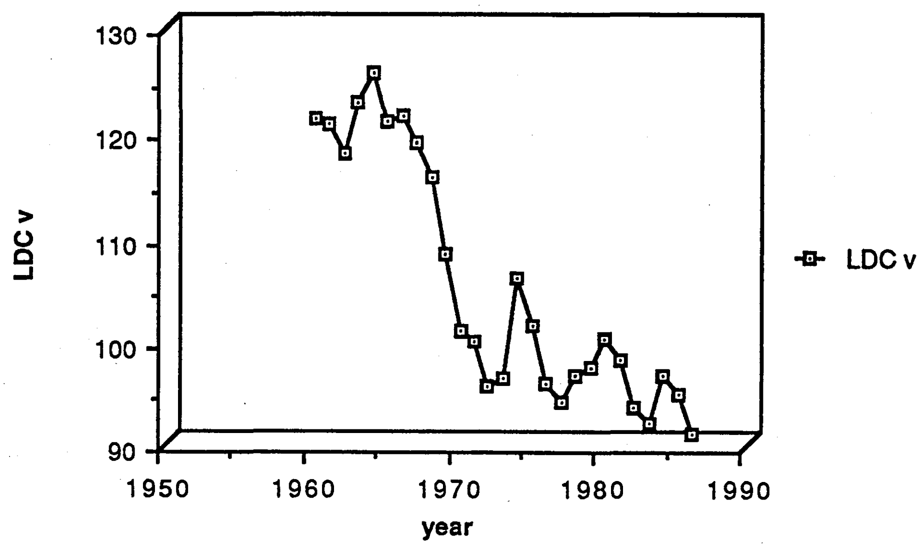


chart 3.2

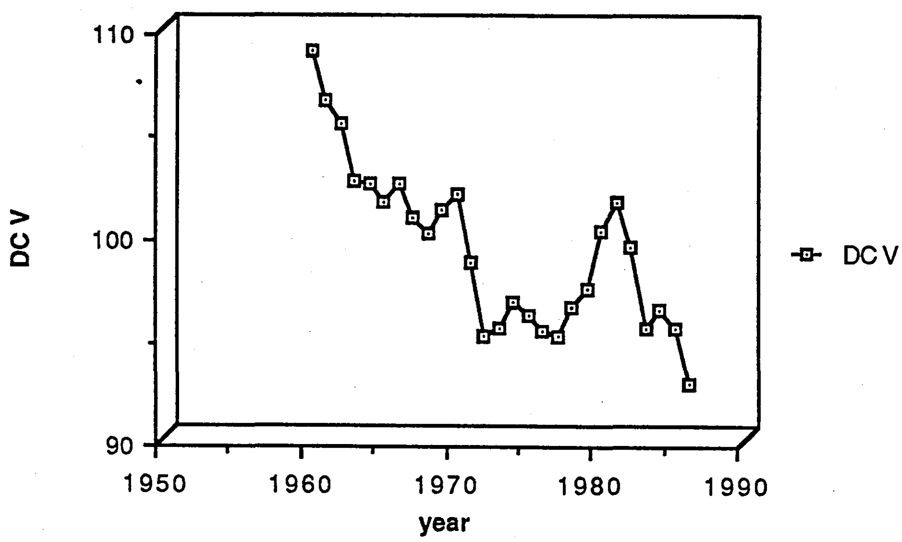


chart 3.3

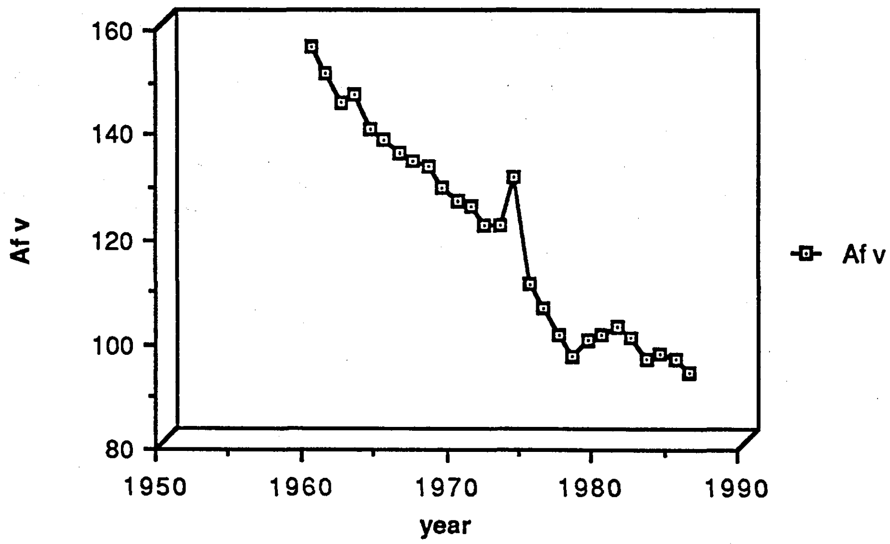


chart 3.4

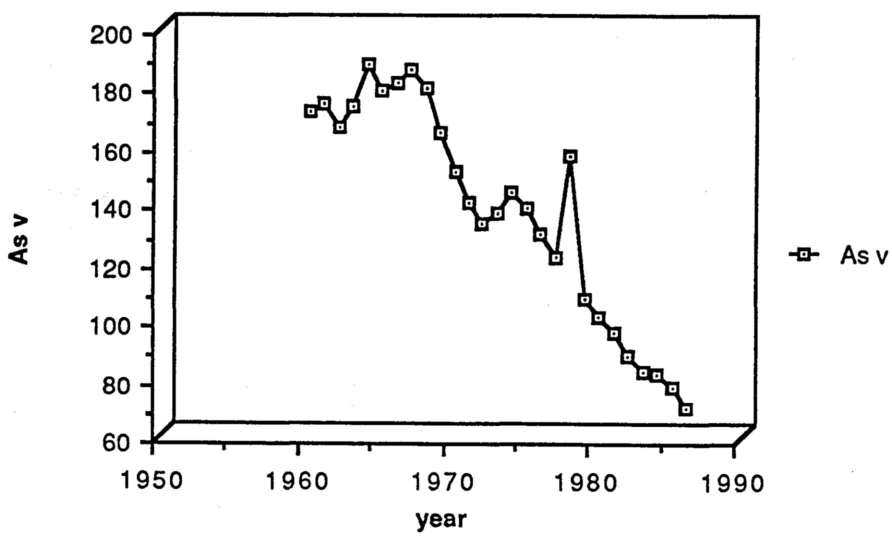
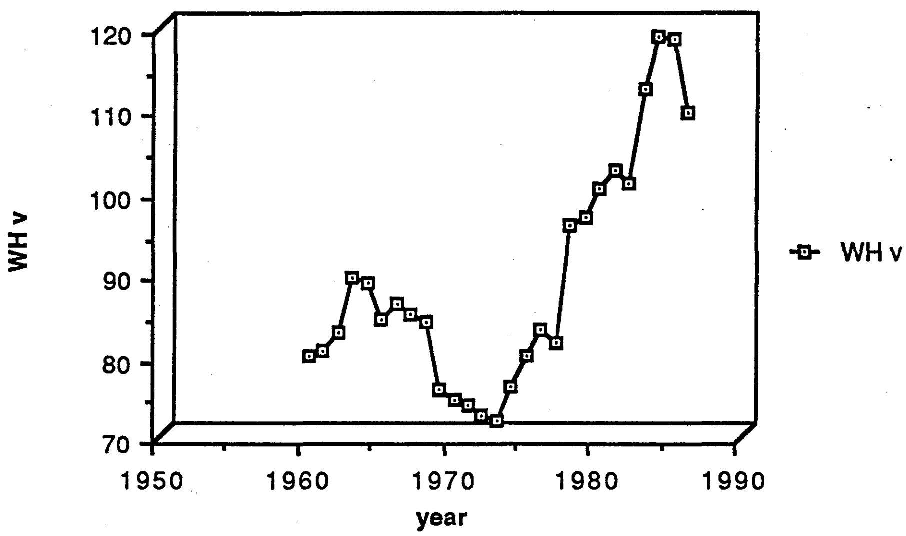


chart 3.5



Source: Based on data (1960-87) of income velocity of broad money (m2) as given in the 'International Financial Statistics', IMF, Supplement, 1988.

Key:

LDC v = Income velocity of Less Developed Countries

DC v = Income Velocity of Developed Countries

Af v = Income velocity of African Countries

As v = Income velocity of Asian Countries

WH v = Income velocity of countries belonging to the Western Hemisphere

NOTES

1. The money market is defined as a market for financial assets that are close substitutes for money and that mature in one year or less. The capital market is defined as a market for financial assets other than money and near money, namely, a market for long-term claims or securities. Any separation of the money market from the capital market is arbitrary , although it is customary to draw a line at a maturity of one year.

2. By expanding $(1-(1-\Theta)L)^{-1}$ in a Taylor series, we obtain

$$Y^e = [(1-\Theta)L + (1-\Theta)^2L^2 + \ldots]\Theta Y$$

$$= \Theta Y + (1-\Theta)\Theta Y_{t-1} + (1-\Theta)^2\Theta Y_{t-2} + \ldots\ldots; 0<\Theta<1$$

which gives Y^e as weighted average of current and past income levels with declining weights $\Theta > \Theta(1-\Theta) > \ldots$ This result may also be obtained by back substitution for $Y^e{}_{t-1}$. Using

$$Y^e{}_t = \Theta Y_t + (1-\Theta)Y^e{}_{t-1} \qquad (1)$$

lagging one period and substituting back into (1) we obtain

$$Y^e{}_t = \Theta Y + (1-\Theta)[\Theta Y_{t-1} + (1-\Theta)Y^e{}_{t-2}] \qquad (2)$$

Repeated back substitution yields the required expression.

If $Y_{t-1} = \bar{Y}$ for all past time periods then

$$Y^e = \Theta Y[(1 + (1-\Theta) + (1-\Theta)^2 + \ldots] = \Theta Y(1- (1-\Theta)^{-1} = \bar{Y} \qquad (3)$$

3. Although aversion to risk influences all producers no matter what their income levels, a rise in income seems to reduce the degree of risk aversion, [Baldwin (1965), p.242)].

4. Adelman and Dalton (1971) measured commercialization by the proportion of yearly Indian village produce sold to markets. This ranged from 100 per cent to zero, with the top group of villages selling over 50 per cent of production and the lowest group with less than 25 per cent of production. The authors also bring out the relationship between commercialization and monetization. Increased commercialization means greater dependence on market sales, a corresponding reduction in production for self-use, and a resulting increase in the proportion of cash receipts to real income.

5. More recently, Bordo and Jonung (1987) note that for most developed countries the velocity of circulation in developed countries displayed what may be broadly regarded as a U - shaped pattern over the last century. The authors' preferred explanation is that whilst the initial secular fall in the velocity of of M(2) was due to the 'monetization' process inherent in the replacement of metallic money and barter by bank money through the development of commercial banking system, the subsequent rise in the velocity of broad money was due to the introduction of money substitutes.

6. The ratio of money supply to national income serves as some guide to the extent of monetization achieved in the economies of different countries. The relevant data for 1954 show that the ratio varies

from 7 per cent in Ethiopia to 51 per cent in Lebanon. If we take the ratio of the money stock to GNP as a rough measure of monetization, we find a figure of 10-20 per cent common in underdeveloped countries compared to 40-50 per cent in the most advanced countries.

7. According to Walters, the rapid evolution of African rural markets has reached the point where it can no longer be said that there is a non-monetary sector, except perhaps among some small and economically insignificant groups in remote areas.... within the active smallholders of the agricultural sector, barter has all but disappeared and there is widespread reliance on the use of cash. This statement is not valid for a number of countries in Africa. Available evidence suggests that the non-monetized sector is over 15 per cent in 15 out of 25 African countries reported. Nearly 50 per cent of the GDP is non-monetized in Rwanda and Ethiopia.

CHAPTER 4

EMPIRICAL EVIDENCE

4.1 Introduction

It may be argued that the empirical literature on the demand for money in LDCs has provided little that is new in the method of approaching the problem of estimation compared to the large amount of equivalent work undertaken in developed countries. In terms of the choice of explanatory variables, goodness of fit and precision of the estimated coefficients, similar results to those obtained for advanced countries have been recorded for LDCs.

One constraint in money demand specification in LDCs is the non-existence of quarterly data (on income) which is readily available in developed countries. Some writers, fore example Cardoso (1983) and Battacharrya (1974) have generated quarterly GNP series and estimated demand for money functions for Brazil and India respectively. This line of inquiry provided better estimates for the short run demand function. However, whether one uses annual data (as most studies do) or quarterly data, the crucial problem of identifying a testable demand for money function and more importantly, the isolation of a representative opportunity cost of holding money still remains unresolved.

Since the majority of investigators have used similar approaches that are developed to explain the monetary sectors of developed countries, it is appropriate to begin the chapter with a brief summary of the evidence on money demand function in advanced market economies. Section (4.2), therefore, presents a survey of the studies on demand for money accumulated over the last two and half decades mainly in the United States and Britain. The problem of instability of the demand function in these countries will be addressed in section (4.3).

The evidence coming from the LDCs can be divided into two main categories - that dealing with individual countries and that which deals with a group of countries. Studies in the first group have tended to take a conventional approach which relates demand for money balances to a set of variables (for example, interest rates, income, expected inflation) with possibly some adjustment being made for disequilibrium in the short run.

The second group of studies have tended to concentrate on the influence of monetary structure, often through studying the determination of the velocity of circulation rather than the demand for money 'proper'. The dichotomy of money demand studies into individual and group of countries has produced some controversial results - adding yet another problem to the existing literature. A selective survey of the studies in these two areas will be discussed in sections (4.4) and (4.5) respectively. Section (4.6) summarizes the evidence obtained from developed and developing countries and 'speculates' on the possible causes of contradictory results in terms of dynamic specifications and structural stability.

4.2 Evidence from Developed Countries

Prior to 1973, the evidence that had accumulated from the large body of research done over the post war period was interpreted as showing that a stable demand for money function did in fact exist. For example Laidler (1966) finds that the interest elasticity of the short rate with respect to m(2) over the period 1892-1960 in the US varies roughly between -0.12 and -0.15 and with respect to the long rate between -0.2 and -0.6. Artis and Lewis (1981) report studies on UK data on 'old' m(2) (excluding building society deposits) over the period 1880-1960 as giving an income elasticity of about unity and an interest elasticity with respect to the long rate between -0.3 and -0.8. Extending the data period, Artis & Lewis (1984) found that a demand function for 'old' m(2), using annual UK data over the period 1920-57, accurately predicts demand over the period 1958-81, except for the years 1973-76. The result was that, by the early 1970s, money was given a significant role to play in quarterly empirical macroeconomic models of the US economy. This development was most obvious in the St. Louis model, which relied implicitly on the assumption of a stable money demand function, (e.g., Laidler, 1978). Whenever an observed stable relationship is used for policy purposes, it is likely to break down, (Goodhart's Law): this is what actually happened to money demand relationships in the turbulent 1970s. Forecasts of the demand for money in the early 1970s, derived on the basis of estimated coefficients in demand for money regressions from the earlier periods differed widely from the actual money stock. In the United Kingdom the demand for money was underestimated, and to a lesser extent, overestimated for the US. Attempts to re-estimate regression equations based on the pre-1970 models failed to give coefficients which remained stable over time. Evidence generated for the US and UK shows that certain widely accepted formulations of the demand for money function have performed very badly indeed. Not surprisingly, the post 1970 empirical work on monetary economics entirely concentrated on the stability of the demand for money function. We will consider the possible causes of instability in the following section.

4.3 Stability

The question of whether the demand for money is 'stable' or not is one of the most important recurring issues in the theory and application of macroeconomic policy. What is being sought is a stable demand for money to exert a predictable influence on the economy, so that the central bank's control of the money supply can be a useful instrument of economic policy. As such, the notion of a stable demand function involves three key elements. First, the demand for money relation should be highly predictable in a statistical sense as measured by the usual goodness of fit statistics and its ability to forecast accurately out of sample. Second, a stable demand function for money has relatively fewer arguments; a relationship that requires knowledge about a large number of variables in order to pin it down is, in effect, not predictable. Finally, the variables that appear as arguments in the function should represent significant links to spending and economic activity in the real sector. In sum, a stable demand for money means that the quantity of money is predictably related to a small set of key variables linking money to the real sector of the economy.

The problem of instability emerged, both in the United States and Britain,in the years 1972-74, when the demand for money began to grow much more slowly than would have been expected on the basis of past relationships; and this has been followed by an equally unexplained upward shift of the demand for money in 1981-82. In 1973, Stephen Goldfeld examined the issue of stability using quarterly post-war US data up to 1973. The form of Goldfeld's equation is shown below.

$$m_{1t}/p_t = a_o + a_1 y_t + a_2 smr + a_3 rsav + a_4 (m_{1t-1}/p_{t-1}) \qquad (4.1)$$

Where:

m1 = Currency plus demand deposits

p = The aggregate price level

y = Real Gross National Product

smr = A short term market rate of interest

rsav = rate of interest on saving deposits

One of the important stability tests that Goldfeld performed was to examine the ability of equation (4.1) to forecast outside the sample period. It showed no systematic tendency to drift off in such forecasts up to 1973. But starting in 1974, forecasts from this equation began to seriously over-predict real money balances. These forecasts were out of sample dynamic simulation, which used actual interest rates and income but last period's predicted money balances as the lagged dependent variable. These simulations showed a cumulative drift from 1974:I to 1976:II of nearly nine per cent.

Evidence that something was wrong with the standard money demand formulation showed in other ways as well. When equation (4.1) was re-estimated including the post-1973 data, the following problems were revealed:

1. the coefficient of the lagged dependent variable became very large (implying long adjustment lags) and sometimes

was greater than unity, (implying dynamic instability);

2. the impact elasticity for real income declined markedly, sometimes becoming not different from zero;

3. the long run elasticity of income and interest rates became implausibly large because of long adjustment lags.

Artis and Lewis (1974) estimated a version of equation (4.1) for the United Kingdom over the period 1963:II - 1970:IV. By normal statistical criteria the results obtained were plausible and the over-all fit of the equation was satisfactory. The authors put this equation to the task of forecasting the level of money demand in the period beyond 1971:I-1973:II, which was as far as data limitations allowed them to proceed. It turned out that the forecasting ability of this equation, [in common with alternative equations of the same general character i.e. for m(1) and m(3)], was quite good for 1971 but disastrously failed for 1972 and the first two quarters of 1973. The equation was then re-estimated up to the end of 1971, and the prediction exercise was repeated. Although the predictions were better than in the first case, the errors remained substantially larger than that obtained from the equation itself. In both cases the prediction errors were much larger, for example than those obtained by using 'naive' forecasting methods which do no more than extrapolate ahead the previous quarter's change. The errors were clearly systematic. Except for the second and third quarters of 1971, the equation under-predicted the actual rise in money stock by a very substantial margin. On the face of it, Artis and Lewis concluded that the standard demand for money function in the UK simply didn't fit the experience of the early 1970s.

There have been several attempts to explain these difficulties. The explanations can be grouped into two categories depending on whether or not one accepts the assumption that the short run demand for money is equal to the existing money supply. The first group of investigators suggest that the most likely cause of the observed instability in the demand for money after 1970 is innovation in the financial markets while the second group believe that disequilibrium in the money market is the likely cause of the break.

4.4 Financial Innovations

It has been noted that with rapid inflation and high market interest rates in the 1970s, the US banking system, which had been prohibited from paying any explicit interest rate on demand deposits and had been subject to a ceiling on the interest it could pay on time deposits, was given particularly strong incentives to find ways of providing assets to those yielded by more traditional forms of bank accounts. This innovation which allowed the public to economise on its holdings of transaction balances, appears to have been induced by the combination of high inflation rates (and therefore interest rates) and legal impediments to the payment of market rates of return on transaction balances. Paulus and Axilrod (1976) were among the first to investigate the presence of such a 'ratchet' effect in the relationship between the demand for money and nominal interest rates and they found evidence in favour of this hypothesis. Moreover, Garcia and Park (1979) claimed to have isolated an important factor contributing to it in the emergence of large-scale use by firms of repurchase agreements as a means of holding liquid assets.

Artis and Lewis considered three possible factors which might have influenced real balance holdings in Britain during the early 1970s. One of these was the strong growth of the Certificate of Deposits (CD) market following the clearing bank's entry into the business in 1971. This factor was allowed for by adopting a definition of money which excludes CDs from either m(1) or m(3).

A second factor of possible importance was the fact (amply illustrated by Morgan, 1973) that bond prices fluctuated more in the early 1970s than the previous period, as was indeed the clear implication of the progressive change in the 'authorities' dealing practice which culminated in competition and credit control. As a statistical measure of this influence, which was assumed to increase the attractiveness of money as opposed to bonds, a variable reflecting the volatility of bond prices around a trend was constructed and used.

The third factor of which Artis & Lewis were able to take explicit account was the 'own rate' on money. The introduction of competition and credit control encouraged the UK banks to increase the variety of their interest-bearing deposits and to offer more competitive rates of interest on them. An increase in this kind of activity would lead to an increase in the demand for money. The calculation of the rates of interest on money cannot be a direct one, since the terms offered for special deals were not known. The authors built up a proxy rate by dividing the money supply into various components for which rates of interest on competing assets were attached (or the actual rate offered, where known, as in the case of CDs). These components were then recombined to form a weighted average of 'own rate of interest' on money.

Equations incorporating these additional explanatory variables and the revised m(3) definition were estimated over the same periods as the other equations. By the conventional statistical criteria the new equations were equally satisfactory. The additional variables appeared to have exerted an impact on the demand for money and the elasticities bear sensible economic interpretations.[1] The new equations were subjected to two tests. They were first put to the test of 'predicting ' the observations for

1972:I to 1973:I. These observations were then included within the estimation period of the demand function to test whether they could be said to support the same interpretation as those in the original period.

On neither test do the equations incorporating the new variables perform any better than the standard demand function. In prediction, they, too, failed miserably to forecast the data for 1972-1973, and systematically understated the level and rate of growth of the money stock. Comparison of the full period estimates (i.e. 1963:II-1973:I) with those for shorter periods (1963:I-1970:IV) revealed considerable differences between the equations, in some cases, indeed, estimation over the whole period rendered the model economically meaningless.[2]

4.5 Disequilibrium Money

The second line of inquiry focuses on the specification of short-run adjustment in the money market. It argues that the correct dynamic specification is not independent of the direction of causation between the quantity of money on the one hand, and the arguments of the money demand function, i.e., interest rates, income and prices - on the other. Thus, tests of short-run money demand functions are really tests of a joint hypothesis of the form and arguments of the money demand function, and of the dynamic process by which equilibrium is restored in the money market. Money market disequilibrium refers to the gap between the desired supply and demand curves at a particular interest rate. This is quite different from 'disequilibrium' between the long run desired demand for money and the short run desired demand which involves only one side of the money market: examples are the inter-dependent asset demand system and the simple partial adjustment model.

Artis & Lewis (1976) apply a rather ad hoc disequilibrium model for broad and narrow money in the UK over the period 1963:II- 1973:I. The adjustment mechanism appears to be an attempt at a market disequilibrium model with the interest rate adjusting slowly to clear the money market. If the money supply is exogenous and prices and real output are sticky in the short run, the interest rate adjusts to achieve equilibrium and should appear as the dependent variable. This point is best illustrated by considering equation (4.1), which uses the partial adjustment scheme of Chow (1966), in which real money balance adjusts with a lag to changes in money demand caused by changes in interest rates and income. A close variant of this model has nominal money adjusting to these variables and to changes in prices as well: example, White (1978), Hafer and Hein (1980). For purposes of exposition, we consider the following demand for money functions.

$$m^d_t = a + br_t + cY_t \quad (4.2)$$

$$m^d_t = a + br^e_t + cY_t \quad (4.3)$$

$$m^d_t = a + br^e_t + cY^e_t \quad (4.4)$$

In the simple textbook money/bond framework, the rate of interest adjusts to equilibrate simultaneously the demand for and supply of money and bonds. If this market clearing process is completed within the period of observation, and the money supply is exogenous, then the appropriate estimation equation may be based on the solution of (4.2).

$$r_t = (m_t - a - cY_t)/b \qquad (4.5)$$

The implied estimation form of (4.5) was preferred by Artis and Lewis to the direct fitting of (4.2) to the data, since on the assumption of exogenous money supplies, the latter procedure involves misspecification and the resultant estimates of the parameters of the money demand function will be biased.

The assumption that the rate of interest fully clears the market within the period of observation is, however, questionable. It is quite conceivable that the rate will less than clear the market ('undershoot' its market clearing value), depending both on the type of disturbance which is hypothesized and the rate of interest which bears the burden of the clearing function. Failure of the interest rate to adjust fully may be interpreted as reflecting a failure to dispose of (or acquire) money balances fully by means of bond purchases (sales) within the period. In this respect, a less-than - full adjustment of the interest rate proves the appropriate rationale for the partial adjustment assumption when money supply is exogenous. Artis & Lewis also show the possibility of the current rate of interest 'overshooting' its equilibrium position particularly when the money demand function includes among its independent variables past as well as current values of the interest rate in equations (4.2) and (4.3).

Some writers, (e.g., Laidler,(1980) and Tucker, (1966) have, however, argued that an 'overshooting' of the rate of interest is predicted when exogenous money supplies are combined with the idea of partial adjustment of the demand for money. They assume that the money market always clears and this implies an overshooting of the arguments of the demand for money function. However, the assumption that the money market must always be cleared contrasts with the usual rationale for partial adjustment, i.e., the presence of a significant transaction costs, which prevent full and immediate adjustment of portfolios when equilibrium is disturbed. If the disturbance takes the form of an unexpected change in the quantity of money, the transaction cost hypothesis, presumably, would argue that money holders would passively accept much of the portfolio disequilibrium in the short run, and only gradually work it off over time by a large amount in the long run. The impact of these adjustments on the interest rates would show up as a smooth, cumulative effect, rather than as a sharp initial overshooting as implied by the conventional specification.

Another possible cause of instability, complimentary to adjustment to interest rates is the interaction of the conduct of monetary policy and the adjustment process underlying the short run demand for money function. The possibility that the short run dynamics implicit in the conventional formulation were misspecified was raised by several authors. Gondalfi and Lothian (1983) have shown, in the case of quarterly data for eight advanced countries over the period 1957-1976, that estimates of the adjustment coefficients in question are very sensitive to the autocorrelation structure of the residual as this residual, which is derived from the relevant regression equation, might possibly be reflecting adjustment processes of some unspecified kind. The implication of this evidence is that the interaction of the prices and the nominal money supply is complicated, volatile and ill-understood.[3]

The use of current income rather than wealth or permanent income as a scale variable was thought as a potential source of misspecification. However, some evidence also suggests that current income does have a role to play in explaining the demand for narrow money, and Goldfeld's 'missing money' was narrowly defined. Furthermore, measuring permanent income with adaptive expectations hypothesis gives the short run demand for money function very similar to that actually used by Goldfeld (see equation 4.2), and Laidler (1980) was able to confirm that instability of this equation after 1974 could not be attributed to the use of current rather than permanent income.

Some investigators held the view that if the scale variable of the function is not misspecified, the opportunity cost variable might well be. Thus, Heller and Khan (1979) attempted to relate the demand for money to the whole term structure of interest rates for the period 1960-1976, but this did not appear to create any special problems of goodness of fit for the later years. However, simulation tests similar to Goldfeld's carried out by Porter and Manskofpt (1978) suggest that this particular line of inquiry does not solve the problem at hand.

In 1966, Hamburger argued that the dividend price ratio ruling in the stock exchange should be included in the demand for money function. Stock market prices fell dramatically during the 1972-74 period while dividends did not, and Hamburger (1977b) was able to show that this version of the demand for money function generated little or no sign of a 'missing money' puzzle. Judd and Scadding (1982) argue, citing Hafer and Hein (1979) that this result seems to depend on Hamburger's specific assumption of a unit income elasticity of demand for money in his test. However, the relatively recent, and equally puzzling, increase in the demand for money in 1982-83 has also been associated with a marked fall in the dividend price ratio, as Hamburger (1983) has been able to point out.[4] Subsequent work by Solvin and Sushka (1983) shows that change in the variability of interest rates in the 1970s might also have a role to play in explaining these phenomena. Klein (1975) used such a measure of interest rate variability and in 1977 showed that over the period 1880-1973, it seemed to have a systematic influence on the demand for money. Unfortunately, Laidler (1980) showed that this relationship completely broke down after 1974 and, therefore, cannot be used to solve the problem of instability.

To sum up, although there may be some doubt as to whether Artis & Lewis have estimated a genuine market disequilibrium effect or not, the results indicate that the response of the interest rate to a change in money supply appears to be very different from that obtained from the conventional 'overshooting' partial adjustment model. The buffer stock approach provides an account that can reconcile these apparently contradictory results.

4.6 Buffer-Stock Money

The buffer stock approach essentially argues that money fulfills a special role in the economic system (Goodhart, 1984). Due to the liquid nature of money assets, the costs of adjusting money holdings are typically less than the costs involved in changing real or illiquid financial assets. In an uncertain environment, economic agents are likely to adjust their portfolios only when they perceive changes in the economic environment to be permanent rather than transitory.

Carr and Darby (1981) recognize that the real partial adjustment model under RE market clearing assumption is consistent with exogenous but anticipated changes in the money supply since the current price level adjusts fully and instantaneously and there is no overshooting. However, if the change in the money supply is anticipated, or prices are very 'sticky', a change in the money supply may produce substantial overshooting in the conventional model as argued in section (4.5). Carr and Darby, therefore, seek to amend the conventional partial adjustment model in three ways. First, they assume that a proportion of unanticipated changes in income y^T are willingly absorbed in buffer-stock money holdings, and second, that unanticipated changes in the money supply m^u, also lead to a 'temporary desire to hold more or less money' as the synchronization of purchases and sales of assets' is altered. Third, anticipated changes in money supply are immediately reflected in price level expectations. If prices are flexible, then real money balances are unaffected by anticipated changes in the money supply.

Carr and Darby test for the influence of unanticipated money demand using the following two equations.

$$(m-p)_t = \beta x_t + \alpha(m-m^a)_t + u_t \qquad (4.6)$$

$$m^a{}_t = \gamma z_{t-1} + v_t \qquad (4.7)$$

$$0 < \alpha < 1$$

The first equation is a conventional demand for money function with the addition of unanticipated money term. x_t is a vector of determining exogenous variables observed at time t, $m^a{}_t$ is the anticipated component of money supply and is determined as the prediction from equation (4.7) and z_{t-1} is a vector of variables known to agents at t-1 which has considered to have a systematic influence on money supply. The first two terms on the right-hand side of equation (4.6) can be taken as representing planned and unplanned components of money demand respectively.

Carr & Darby use a two-step estimation procedure: OLS on equation (4.7) yields predictions of $m^a{}_t$ which is then used in equation (4.6). Carr and Darby report OLS estimates of equation (4.6) which appears to support the buffer-stock or shock-absorber hypothesis for eight industrialized countries (i.e., UK, the Netherlands, Japan, Italy, Germany, France, Canada and the US). However, there are three main problems with the Carr-Darby model. First, Mackinnon and Milbourne (1984) formally demonstrate the obvious point that ($m-m^a)_t$ and u_t are correlated, and infer that OLS estimates are biased towards unity.[5] Carr and Darby recognized this problem and attempted to correct for the bias by using instrumental variable estimation techniques, but Mackinnon and Milbourne argue that their use of a large number of principal components as instruments is likely to be dogged by poor small sample performance. The second difficulty with the Carr-Darby model is one which relies on a very simple 'shock - absorbing' mechanism: anticipated changes in money stock are immediately reflected in price changes, while unanticipated change are not. There is no role for costs of adjustment, and no explicit microfoundations of the BSA are presented. The third problem is that it concentrates on money supply shocks, thus ignoring expected changes in the money demand determinants.

To circumvent these difficulties, alternative 'buffer-stock' models have been developed which are of interest because they purport to explain the reason for the parameter instability in demand for money functions by means of forward looking behaviour.

4.7 Multiperiod Quadratic Costs

The familiar one-period cost minimization problem which has inspired so much money demand literature imposes myopic behaviour on the agents whose behaviour it tries to explain. This is so since these agents are depicted as computing their optimal current period money holdings without regard for the condition into which this decision puts next period's minimization problem. It is assumed that the individual has a known long run desired money stock ${m^*}_{t+j}$ $(j=0,.......,T)$ in all future periods and, at time t, has to choose m_t to minimize current and future quadratic costs of being out of equilibrium and the costs of adjustment. These costs are given by:

$$c = \Sigma^{T}_{t=1} \ a(m_t - m^*_t)^2 + b(m_t - m_{t-1})^2 \qquad (4.8)$$

The first order- condition for the 'last' period T is the same as the one period partial adjustment model of the form:

$$\partial c/\partial m_T = 2a(m_T - m^*_T) + 2b(m_T - m_{T-1}) = 0$$

and,

$$m_T = A_1 m^*_T + B_1 m_{T-1} \qquad (4.9)$$

where $A_1 = a/(a+b)$, $B = b/(a+b)$ and $A_1 + B_1 = 1$.

For $t < T$, we have

$$\partial c/\partial m_t = 2a(m_t - m^*_{t-1}) + 2b(m_t - m_{t-1}) - 2b(m_{t+1} - m_t) = 0$$

$$= A_2 m^*_t + B_2 m_{t-1} + B2 m_{t+1} \qquad (4.10)$$

where $A_2 + 2B_2 = 1$ and the coefficient on m_{t-1} and m_{t+1} are equal. From (4.10), as expected, future values of m influence current period short-run desired holdings of money .

The solution (for T => ∞) to the forward looking (Euler) equation (4.10) can be obtained using the Sargent (1979b) forward operator which, after some tedious mathematical manipulation yields:[6]

$$m_t = c_1 m_{t-1} + (a/b) c_1 \sum_{0}^{\infty} c^i_1 m^*_{t+i} \qquad (4.11)$$

If we assume that agents minimize expected multiperiod costs, based on information available at period t-1, then we replace m^*_{t+i} by its expected value $E_{t-1}(m^*_{t+i})$, where E is the expectations operator conditional on information available at t-1 or earlier. The optimal short-run demand for money then depends on the lagged actual stock and future expected values of the variables that determine m^*, that is,

$$m_t = c_1 m_{t-1} + (a/b) c_1 k \sum_0^{\infty} (c_1)^i z^e_{t+i} \qquad (4.12)$$

where z^e_{t+i} is the future values of the independent variables. To estimate equation (4.12), we require expected future values of the determinants of m^*. One technique is to use a 'weakly' rational predictor for these expected variables. For example, a purely autoregressive model for income is given by

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots\ldots + u_t = a(L) y_t + u_t \qquad (4.13)$$

Estimation of (4.13) allows us to generate future values of y_t by the chain rule of forecasting.The same procedure is applied to generate future values of the remaining variables. Having obtained the one step, two step, etc., predictions from (4.13), these variables can then be directly included in the short-run demand for money functions.

Artis and Cuthburtson (1985) have tested the above model for narrow money for the UK. They also include current period income 'surprise' ($y-y^e$) in their equation to proxy the buffer stock role of income. The expected series for income are generated using an autoregressive model as described above. Although their results are encouraging, they face some acute econometric problems. Pagan (1984) has demonstrated that the two-step estimator produces inconsistent estimates of the variance of the expectations parameters. In addition, because of the use of future expectations, one might expect moving average errors which, with a lagged dependent variable yield inconsistent parameter estimates.

To summarize, the multiperiod quadratic cost implies that expected future values of variables such as income, as well as current values , influence current money holdings. The omission of such forward-looking variables may be one reason for some money demand functions to exhibit parameter instability. The multiperiod quadratic cost model is derived independently of the way people make their expectations and, therefore, both rational and non-rational models of expectations behaviour can be appended. The buffer-stock approach may also be incorporated in the multiperiod model provided another set of possibly omitted variables, i.e., current actual shocks and expected future shocks are properly captured.

The impact of a current independent variable on the current period demand for money can be much more varied than in the (fixed coefficient) one period partial adjustment model. An increase in current income, for example, may have a small effect on the demand for money working via m^*_t in equation (4.9). However, if a change in current income influences expectations about future incomes, the impact on current money balance could be substantial. Conventional empirical studies that use only current (and lagged) income, may find the current period income elasticity unstable.

4.8 Evidence from Developing Countries

The empirical evidence for developing countries can be divided into two main categories - individual countries and group of countries. Studies in the first group have tended to take a conventional approach which relates demand for money balances to a set of variables (interest rate, income, inflation) with possibly some adjustment being made for disequilibrium in the short run. Estimation has proceeded from linear regression to non-linear and simultaneous techniques, (see Fry, 1976, and Wong, 1977). The second group of studies have tended to concentrate more on the influence of monetary structure rather than investigating the demand for money directly. A selective survey of studies in these two areas will be used to develop some of the points mentioned in section 4.1

4.9 Results for Individual Countries

Gujarati (1968) provided a relatively early study for India making the usual distinction between long and short run behaviour through the standard partial adjustment specification. Gujarati's empirical results are based on annual data from 1948 -1964 and the estimated value of the adjustment parameter was about 0.47, a result much similar to that found by Chow (1966) for the United States. Income proved to be the most significant determinant of the demand for money and the interest rate was not significant. Gujarati argues that the Indian money market is comparatively under-developed and hence the finding on interest rates supports the contention that the interest elasticity of the demand for money function would be more insignificant in countries with underdeveloped financial markets. The long run income elasticity was also found to be greater than unity, and this result was interpreted as indicating that money can be viewed as a luxury asset. However, collinearity, introduced into such models by the use of both the lagged dependent variable and income when both are strongly trended variables might cause one to be rather skeptical on this conclusion.

Bhattacharya (1974), investigated demand for money for the same country for the period 1949-1968, using the following model:

$$m_t = f(my^d, R_t, nw_{t-1}) \qquad (4.14)$$

where my^d is monetized disposable income and nw_{t-1} is the net worth of private sector. This model leaves out the importance of expected inflation because the author found this variable to be statistically insignificant. But, most importantly, he was able to investigate the relation between money demand and 'monetized' income. Bhattacharya estimates three equations- differentiated by the use of monetized income, total disposable income and both monetized and total incomes as scale variables. He concludes that demand for money balance depends on monetized income and that the use of total income leads to the under-estimation of the income elasticity of money balances. One other interesting finding is that demand for money in India is inversely related to the rate of interest, a results which was later supported by Deadman & Ghatak (1981). However, looking at these results, it is very difficult to distinguish between the equation with 'monetized' income and that which uses total disposable income as a scale variable. Bhattacharya also doesn't explain how he actually derived the 'monetized' income.

The significance of these findings is also diminished by different results obtained by Paul (1981) Sampath and Hussien (1981) for the same country. These authors found the rate of inflation to be an important variable in the Indian demand for money function. Ram & Biswas (1983), using the conventional money demand function for India, found that the function was unstable. On the other hand, Darrat (1988), modifying the standard demand model by introducing technological variables in the argument, finds a stable demand function for the same country.

A more extensive analysis covering Japan, Taiwan, Korea, India, Pakistan, Burma, Sri Lanka, Philippines and Thailand was conducted by Fan and Liu (1971). Essentially the same model used by Gujarati was adopted with broadly similar results. The summary of the results using annual data from 1953-1968 is given in table 4.1.

These results indicate very low interest rate elasticities (except for Taiwan). All income elasticities are statistically significant, and nearly all are inelastic, including India. Burma provided a high income elasticity. This was discounted largely on the ground that, over the period considered, the growth of the money stock had been extremely irregular compared to other countries, reflecting a state of severe disequilibrium in the Burmese money market. The authors also tried to estimate a partial adjustment model. However, the inclusion of a lagged dependent variable along with income and interest rates clouded rather than clarified the results, once again reflecting the problem of collinearity.

Table 4.1 $\ln M_t = \ln K + \alpha \ln Y_t + \beta \ln R_t$

Country	k	α	β	R^2	s.e
1. Japan	-.586	1.02	-.067	.99	.021
		(.024)	(.130)		
2.Taiwan	-.528	1.1	-.516	.995	.027
		(.055)	(.211)		
3.Korea	-.827	.919	-.009	.965	.079
		(.113)	(.190)		
4. India	-.557	.906	.101	.987	.017
		(.066)	(.081)		
5. Pakistan	-.477	.855	.026	.957	.032
		(.149)	(.097)		
6. Burma	-1.82	2.55	-.274	.823	.061
		(.956)	(.459)		
7. Sri Lanka	-.697	.818	.747	.660	.021
		(.102)	(.106)		
8. Phil.	-.732	.857	.408	.989	.018
		(.039	(.028)		
9. Thailand	-.348	.787	-.015	.988	.015
		(.047)	(.094)		

1.Standard errors are given in parenthesis

2. Interest rates used: discount rate (Japan, Korea, Philippines, Thailand, Burma) call money rate(Taiwan, India, Pakistan) government bond yield (Sri Lanka)

Abe *et al.* (1978), have provided a study that has as one of its main aims the re-estimation and re-evaluation of an earlier study for Pakistan by Akhtar (1975). In contrast to Akhatar's use of the current rate of inflation as a proxy for the expected rate , Abe *et al.* estimated the expected rate from an Almon Lag Scheme involving the use of both current and lagged values of inflation. In this way, the authors found a significant role for price expectations in the demand for money function for Pakistan. Akhtar's finding that income was the primary determinant of the demand for money was reinforced, and when a narrow definition of money was employed, the rate of interest appeared as a statistically significant variable.

Wong (1977), has presented some interesting evidence on the role of credit restraint variables in the demand for money functions over the period 1954 to 1971 for five Asian developing countries (Korea, Philippines, Sri Lanka, Taiwan and Thailand). Short data runs and collinearity introduced by the inclusion of a lagged dependent variable among the explanatory variables make the results less than completely convincing, but they are at least suggestive of the conclusion that in LDCs, where relatively under-developed money markets make interest rate variables largely unimportant, some attempt to include measures of credit restraint could prove useful.

The role of price expectations has also been central to the studies of Chile by Hynes (1967) and Deaver (1970). Hynes used estimates of both the expected price and income (rather than current income) based on exponentially weighted sums of current and past observations. When combined with the partial adjustment mechanism, the resulting demand for money relation relates the actual quantity of real money balance per capita to measures of the expected rate of change in prices and expected income. Hynes also included a shift variable to allow for differences between war time and peace time levels. The model was estimated from annual data for the period 1935 to 1960. Preliminary tests indicated that the demand for money function could be taken as being homogeneous of degree one in the price level, thus allowing the results to be presented in terms of real rather than nominal cash balances. Similar to the Almon Lag Scheme mentioned above in relation to Abe *et al.*, the model allows the weighting pattern on both expected price changes and income variables to rise and fall (if the data indicates this) rather than to simply fall geometrically from the current values as the use of simple exponential weights would imply. In Hynes' study, interest rates were excluded, as the necessary data were not available, but since it was believed that the major changes in the money rate of interest were due to alteration in the expected rate of change of prices, this later variable may be taken to represent the cost of holding money. The long run inflation rate elasticity was calculated to be about -.36 and was significant. The evidence on the long run income elasticity was surprising, however, in that it was found that a narrow definition of money had a higher elasticity than a broader definition. This reverses the pattern found for most studies of developed countries [e.g. Fisher,(1968); Meltzer (1963)].

The demand for money in Chile has also been investigated by Deaver (1970). Like Hynes, Deaver recognized that Chile provided an intermediate case between countries whose demand for money had been dominated by expected price changes during hype-inflationary periods, and other countries (such as the US), where changes in income have out-weighted alterations in the cost of holding money over the long run. Thus, Deaver asked 'what would be the result if the cost of holding money were high and variable relative to that occurring in developed countries, yet low by comparisons with the hyper-inflation? And what if, at the same time, income were changing substantially, so that according to the experience of the United States, it should have an effect on money holdings also?' Demand for real cash balance was taken to be a function of the expected rate of inflation and income. Higher income elasticities were obtained when permanent income was used rather than measured income, though generally the income elasticity was found to be lower than unity. Time deposits were found to be more sensitive to changes in the cost of holding money. However, in contrast to Hyne's approach, exponentially declining weights were used to define expected inflation. Deaver's conclusion was that the tests show a stable demand function can be found for Chile that explains most of the variations that took place in the real money stock between 1878 and 1955.

A more comprehensive study of Latin American countries (Argentina, Brazil and Chile) was carried out by Khan (1977). Khan's main aim was to modify Cagan's (1956) model by allowing the coefficient of expectations itself to vary with inflation, and also test for the effects of uncertainty on this coefficient. More specifically, the coefficient is postulated to vary directly with the rate of inflation and the way the hypothesis is framed allows one explicitly to accept or reject this hypothesis empirically. The motivation for making this modification stemmed essentially from observing the actual behaviour of this coefficient over time in countries undergoing high inflation.[7] Khan argued that not making explicit allowance for the varying coefficient can involve a misspecification of the demand for money model which results in biased estimates of the parameters and possibly serial correlation in the residuals. His particular approach of relating the coefficient of expectations to only the current level of inflation is somewhat arbitrary, but nevertheless, it has some intuitive appeal.[8]

A second departure of Khan's study from the conventional specification is that the demand for money is specified in continuous time as a stochastic differential equation, and is estimated using the approximation discussed by Sargan (1974) and Wymer (1976).The reason for specifying the function in continuous rather than in discrete time is that although decisions by individual economic agents are made at regular time intervals, the aggregate variables observed are the outcomes of a large number of decisions of different individuals made at different points of time. These aggregated variables would tend to be continuous as the intervals between decisions may not correspond to the interval between observations. Once the assumption that the appropriate behavioural interval is the same as the observation interval is lifted,the behavioural relationship can be formulated in terms of infinitesimal intervals, and the lags in the model do not have to be multiples of the observation period. Cagan also formulated his original model in continuous time, but the problems involved in estimating such a model in the 1950's have led to the use of the popular discrete time version. Khan's demand for real per capita money balances in log-linear terms was written as follows

$$m_t = a_o + a_1\Delta p^e{}_t + a_2 y^e{}_t + u_t \qquad (4.15)$$

Following Cagan's formulation, the expected rate of inflation; (Δp^e) is revised per period of time in proportion to the difference between the actual rate of inflation and the rate of inflation that was expected to prevail in period 't'. This is given by a distributed lag formulation with exponentially declining weights:

$$\Delta p^e_t = \int_0^\infty \lambda e^{-\lambda\phi}\pi(t-\phi)\Delta\phi \qquad (4.16)$$

This adaptive expectations scheme, as formulated in continuous time, posed some theoretical problems. First, there is the mechanical nature by which the expected rate of inflation follows the actual rate so that if the actual rate continuously increases, expectations always lag behind. Second, sudden jumps in the price level have no effect on the expected rate of inflation..Finally, if λ is treated as a parameter and estimated, this would imply that individuals would adjust their expectation at the same speed irrespective of what the current level of inflation was.[9] Khan thus, allows for the variation in λ by specifying a function of the form:

$$\lambda_t = \alpha + \beta\ |\Delta p_t| \qquad (4.17)$$

λ is now a linear function of the absolute rate of inflation $|\Delta p_t|$. Since a higher absolute rate of inflation would increase the speed at which individuals change their expectations, it is expected that the coefficient β will be positive. If there is no influence of the rate of inflation on it, then the constant in (4.17) i.e α, would be equal to one. This makes the model equally applicable to periods of declining prices and negative change in inflation. Expected real income in (4.15) was also generated by adaptive expectations.

$$\Delta y^e_t = g\ (y_t - y^e_t) \qquad (4.18)$$

When the unobservables, Δp^e_t and y^e_t are eliminated and then substituted into (4.15), a second-order differential equation (complicated and messy) for real per capita money balances can be obtained.

The results for both definitions of the money stock for all three countries are presented in table 4.2. All estimated parameters have the correct signs and were in all cases statistically significant. The coefficients of expected inflation $(\hat{a}_1)$s, differed substantially across the three countries with the largest effect on money balances occurring in Argentina. Theses estimates are in general substantially larger than the inflation elasticities reported in other studies for the same countries. Expected long run income elasticities in Argentina and Brazil are very low compared to other studies (see for example Cardoso, (1983), for Brazil and Balino (1977) for Argentina) while in the Chilean case, they tend to be greater than unity.

A comparison of the results obtained for Latin American Countries with the Asian countries (table 4.1) yield some interesting points. The income elasticities in both regions

Table 4.2 Parameter estimates of equation 4.25 subject to 4.16, 4.17 and 4.18

Dep.v.		a_0	a_1	a_2	α	β	γ	ρ	R^2	D-W
:gent.	m(1)	.336	-.50	.390	.141	.413	1.4	.103	.78	2.0
		(3.7)	(4.4)	(6.4)	(3.4)	(21.1)	(1.1)			
	m(2)	.344	-7.8	.326	.101	.199	1.4	.081	.77	2.0
		(6.3)	(5.7)	(7.1)	(4.1)	(24.9)	(.071)			
Brazil	m(1)	1.47	-1.30	.214	.481	.086	1.15	.074	.82	1.9
		(12.5)	(6.5)	(9.4)	(8.2)	(14.6)	(.12)			
	m(2)	1.38	-1.49	.280	0.471	.128	1.19	.033	.84	2.0
		(16.0)	(9.1)	(14.9)	(10.9)	(4.6)	(18.6)			
Chile	m(1)	-1.8	-2.6	1.8	.39	.100	.533	.031	.79	2.0
		(7.2)	(9.0)	(13.9)	(10.8)	(5.4)	(14.6)			
	m(2)	-1.96	-2.94	2.31	.365	.045	.434	-.017	.82	2.3
		(8.0)	(8.6)	(13.4)	(10.5)	(3.3)	(13.5)			

a_0 = constant

a_1 = long-run inflation elasticity

a_2 = long-run income elasticity

α, β = expectation parameters of inflation

γ = expectation parameter of income are strikingly similar. However, Fan and Liu failed to isolate the cost of holding money for Asian countries while Khan managed to identify inflation as an important opportunity cost of holding money in Latin America. Khan also argues that his estimated demand for money function for the three Latin American countries is structurally stable. This seems to contradict his prior theorizing about inflation expectation.

Other studies for individual countries yield little more information than that outlined above. Fry (1973) finds income elasticity in excess of unity for Iran, Pakistan and Turkey during the 1960s. For each of these countries, expected inflation based on arbitrarily chosen weights for an adaptive expectations from a trend equation of rates of inflation, or a combination of both yielded at least marginally significant parameter estimates with correct signs.

The monetary sector of the African countries is the least researched compared to the equivalent work done for Asian and Latin American countries. The demand for money studies in this group of LDCs are 'sketchy' and overwhelmingly concentrated on one or two countries.

Ghosh and Kazi (1977) used a model for Nigeria which is similar to that used by Laidler and Parkin (1970) for the UK and like Hynes found evidence in favour of the demand for money in nominal terms being homogeneous of degree one in the price level. A broad definition of money yielded the most stable parameter estimates over the sample period which was from 1958-1974. The elasticity of demand for real balances with respect to permanent income came out at about unity with an insignificant parameter estimate on the interest rate variable, results which confirm earlier findings obtained for the same country. Darrat(1985) estimated a demand for money function for Kenya with a foreign interest rate as a cost of holding money. The argument is that foreign interest rates may be relevant alternatives to holding money. Darrat concludes that the long run elasticity of real money balances with respect to expected inflation, foreign interest rates and income are all significantly different from zero. Thus, all the three variables play an important role in portfolio decisions about money holdings in the Kenyan economy.

In a further effort to identify a testable demand for money function, Crocket & Evans (1980) covered nineteen Middle-Eastern developing countries. Their approach differ from earlier investigators in one important respect. While the earlier writers used Gross National Product or Gross National Income as a scale variable, Crocket and Evans argued that this may not be the best measure of transaction in the economies of Middle-Eastern countries due to the following reasons.

(1) Many Middle East countries have important oil sectors, which in a number of cases account for as much as half of their GDP. Decisions on the volume of oil to be produced and on its price neither affect nor are affected by monetary creation, and there is no direct effect on the liquidity of the private sector. The oil sector of these countries is perhaps best regarded as 'enclave' within the non-oil economy, and is best disregarded when constructing a time series of income that is considered to influence the demand for money.

(2) The second consideration is the treatment of remittances by expatriate workers. These have grown quite considerably in recent years, representing as much as half of non-oil GDP in the Yemen Arab Republic and constituting a significant part of GDP in the countries where these workers reside. Conventionally, GDP is a measure of output within a given economy, so that the earnings of expatriate workers constitute part of the GDP of the country in which they reside and not of their country of origin.

To decide whether this is an appropriate definition of the scale variable influencing the demand for money, one needs to consider the reasons for holding money balances. If it is to finance transactions taking place in the domestic economy, then it is the total income or wealth available to domestic residents that is the relevant determining factor for money demand. In the case of workers' remittances, in most of the countries investigated by Crocket and Evans, funds are normally sent back by workers to their families, who remain in the countries of origin. These funds then become part of nominal income receipts, against which transactions balances are held. In consideration of this, it seems appropriate to define national income for purposes of estimating the demand for money as including remittances.

Crockett and Evans specified a conventional demand for money with the scale variable modified to exclude 'oil' and include remittances. Percentage changes in consumer price index were used to capture the effect of opportunity costs. Three experiments were conducted. One including current and lagged real non-oil GDP as explanatory variables. In general, the results closely resembled those obtained from static models, the sum of the lagged and current non-oil income elasticity being close to the single income elasticity obtained from the static model. Experiments were also conducted with the Koyck transformation as a means of introducing the lagged dependent variable. The results had better overall fit, but the implied long-run income elasticities of money demand were somewhat more volatile. They also applied the stock adjustment transformation to nominal rather than real money balances (i.e. $\ln m_{t-1}/p_t$) instead of lagged real money balance. This line of investigation also produced better fit but again the implied long-run income elasticities became more volatile and in some cases assumed implausible values.

The evidence from pooled data contradicted the conclusions suggested by the estimates of individual countries. Income elasticities obtained from pooled data were much lower than those obtained from individual countries. The authors' explanation for such divergence is a possible existence of a common trend which might have increased financial intermediation across all countries in the region. If this is true, it suggests that the observed income elasticity for individual countries may be composed of a 'pure' income elasticity close to unity and an independent 'monetization' factor. The lesson to be learned from these analysis is the need to consider the fact that the income elasticities may be reflecting a combination of two separate phenomena.

The main conclusions to be drawn from these studies is that a relatively simple specification (static models) is to be preferred to partial adjustment or general distributed lag models. Income has been found as an important determinant of money holdings. The influence of inflation on the demand for money proved difficult to detect. Only in three out of nineteen cases was the inflation variable significant and of the correct sign.

4.10 Result for Group of LDCs

This branch of the literature stresses the structural differences between the developed countries and the less developed countries, and even between individual LDCs, resulting from varying levels of sophistication in monetary arrangements and institutions. Adekunle (1968) pooled the time-series data on countries classified as belonging to the same group (industrial developed countries, other developed countries, and less developed countries were the three groups he considered) and estimated demand for money function using these data. At the time, the short data available for each country (annual data 1950 to 1961) meant that individual country regression could not be estimated with great degree of confidence. Such regressions were performed, however, and indicated that within a group, differences were not so large as to imply that the pooling of the data would be inappropriate. From a number of models tried, the most satisfactory for the LDCs group was one in which desired money balances were expressed as a function of interest rate, current real income and the expected rate of inflation. The finding that current income rather than some measure of expected income was the appropriate income variable is at variance with a number of findings, but substitution possibilities involving both financial and real asset, as indicated by the statistical significance of both interest rates and expected inflation, is consistent with other works.

There are a number of statistical and theoretical limitations of Adekunle's demand for money functions, namely:

(1) his preferred model has not been tested for structural stability and for the presence of serial correlations. The model was judged only on the basis of the R^2 criteria;

(2) Adekunle specified different elasticities of expectation for income and inflation and assumed a geometrically declining expectations generating mechanism and a constant elasticities of expectation over time and across countries. However, a relatively recent study (Khan,1977) has indicated that inflation expectations, especially in countries with high inflation rates does not remain constant.

(3) Adekunle claims to have successfully derived the values of the expectations parameters of inflation and income from the coefficients of lagged inflation and lagged income respectively, but these parameters may contain adjustment effects as well. Under these circumstances, it is difficult to isolate expectation and adjustment effects from a single parameter. But Adekunle assumes instantaneous adjustment in the monetary sector of LDCs - an assumption that has not been tested. The conclusions implied by these findings cannot, therefore, be taken for granted.

The same grouping of countries that Adekunle used was also adopted by Park (1970), but Park investigated the variability of velocity rather than the demand for money proper. Park used three different definitions of velocity in an attempt to identify the major factors which are likely to give rise to differences in the variability of income velocity between the industrial countries and the LDCs. These definitions differ in so far as either demand deposits or demand deposits plus quasi money are added to currency held outside banks. Variability within any group is expressed as the average of all countries in the group over the period 1953 to 1968 divided by the standard error of estimates for each country, each expressed as a percentage. For all three velocity definitions, the LDCs had more variability than the industrial countries, though when countries with particularly high variability were discounted (namely Argentina, Costa Rica, Dominican Republic and Paraguay) the differences were less striking. Park argues that greater variability might perhaps be traced to greater divergence between current and permanent incomes in one group than the other.

Melitz and Corea (1970) found that income velocity could be explained at least in part by a 'degree of monetization' variable, z, and also by a rate of interest variable and the ratio of currency to currency plus demand deposits (c/m). Estimates were obtained from a cross section of fifty-one countries using eight year averages of data from

1958 to 1965. Only when z was excluded did the measures of the 'degree of development' of a country (energy per capita) became even of marginal importance. The introduction of rates of inflation lead to 'perverse' results. This particular approach has been challenged by Hanson & Vogel (1973) who used a combination of cross-section and time series data in their investigation of the determinants of income velocity in sixteen Latin American countries between 1950 and 1969. No specific 'degree of development' variables were used, but dummy variables acknowledged as being 'recognition of ignorance as to the specific causes of inter-country differences in velocity' were highly significant explanatory variables. Hanson and Vogel regard the use of such variables as z and the ratio of currency to currency plus demand deposits with suspicion, as lacking any unambiguous theoretical justification. Wallich (1971) has questioned the findings of Melitz & Correa that the rate of inflation was unimportant, and Campbell (1970) has confirmed that such rates are important at least for South Korea and Brazil where, over the sample period, trends in the rates of inflation in these countries were opposite in direction.

4.11 Summary of the Evidence

The evidence on the demand for money before 1973 clearly shows that it was not possible to distinguish empirically between competing hypotheses about the demand for money.

Especially in the cases of annual data, it did not seem to have mattered a great deal whether one defined money narrowly or used the broader definition. Similarly, the evidence was somewhat mixed on what interest rate should be included in money demand regressions. For the longer time series, stability did not seem much affected whether a long or short term interest rate was included. Only in the tests of the performance of income versus wealth does a relatively clear consensus emerged from the annual data. In most cases, the evidence points to the superiority of permanent income over current income.

The stability of the conventional equation went off track after 1971 in Britain, and 1973 in the US, leading some investigators to question whether the equation was misspecified. One response to this question was to concentrate on empirical issues- i.e., how to define money; which interest rate or rates measured the opportunity cost of holding money, and whether current income or wealth was the correct scale variable. With one possible exception, these studies were not able to find a reliable explanation for the instability,nor were they able to resolve the ambiguities in the pre-1973 literature. The exception to this conclusion is the equation of Hamburger (1977), which includes a broad range of interest rates in the money demand function. This met with success in explaining the shifts during 1974-76 but for all the problems discussed in the preceding pages, even these results should be regarded with caution.

The evidence on whether money is exogenous with respect to income and interest rates is mixed. Several researchers have looked at the question of whether nominal money is exogenous with respect to nominal income (GNP). The results are ambiguous and appear sensitive to the particular technique used to test for exogeneity. For interest rates, Pierce (1977) found that demand deposits appear to be exogenous with respect to the Fed. funds rate, but not with respect to the treasury bill rate. Mehra (1978) found that real money balances were not exogenous with respect to interest rates and real GNP.

Artis and Lewis (1974, 1976) have considered a possible monetary disequilibrium (i.e., $m^d \neq m^s$) in the UK money market. They concluded that the money market does not always clear, and income and interest rates adjust to supply rather than the other way round. However, they have also recorded the following 'caveat' regarding this conclusion.

> .... and neither our results nor the data are good enough to firmly discard the idea that there has been some shifts of the demand for money function........ Accordingly, some efficient estimates of the parameters of the demand function, and thus its stability must await the availability of additional evidence. [Artis & Lewis, 1976,pp.177-178]

Laidler (1980) examined several alternative specifications of short-run money dynamics to see if they improve money demand stability. Two of the alternatives which Laidler investigated are that of Artis and Lewis where interest rates adjust with a lag to changes in money and the Carr-Darby specification, which allows price to adjust to anticipated changes in money, with an unanticipated changes being temporarily held in portfolio. The results are best summarized by Laidler:

> The first thing to be said ...... is that whatever else they do, they do not rescue the demand for M1 function from the suspicions of instability .... the often unsatisfactory results.... indicate that further work is required rather than the line of inquiry that they represent should be abandoned. [Laidler, 1980, p.257].

The difference in the specification of the demand for money function in developed and developing countries is only marginal. However, the studies of the monetary sectors of LDCs have produced some useful additional evidence on the role of inflation in demand for money functions, and of the influence and effect of varying degrees of monetization in different developing countries.

The importance of income in the demand for money in LDCs has now been firmly established. Almost all the empirical work has confirmed this contention. But, there is a lot of disagreement on the theoretical value of the estimated income elasticities, and the definition of money and income. The choice of the opportunity cost of holding money in LDCs has also received mixed results. Expected inflation and interest rates are the main contenders but the empirical investigation undertaken so far could not isolate a 'single' opportunity cost variable common to all LDCs. Differences of opinions have also surfaced within the studies of a particular country. In 1981 alone, seven articles on the demand for money, all dealing with India, appeared in the Indian Journal of Economics. Nearly all of the authors disagree on the issue of stability, choice of the opportunity cost variable, the definition of the money stock and the dynamic structure of the demand function.

Those who think that the demand for money in LDCs is not stable believe that the causes of instability are, among other things,financial innovations, monetization, political and economic instabilities. However, structural breaks of estimated parameters of demand for money are not unique to developing countries. Developed market economies have also experienced instability in the early years of the 1970s & 1980s and to some extent similar reasons have been cited. Attempts to explicitly capture the alleged causes of instability by a 'proxy variable' and use of sophisticated estimation techniques (simultaneous equation instead of OLS) did not rescue the demand for money function from structural breaks in both economies. Thus,the demand for money function could not be saved by a recourse to the traditional demand for money theory alone. One possible reason why people could not identify a testable and more importantly stable demand for money function is the persistent usage of the conventional econometric methodology which is faulty in many respects. The way dynamics is introduced in the conventional econometrics techniques might have caused misspecification of the dynamic structure and this in turn might have led to instability. It is the task of the next three chapters to seek the causes of these problems and explain the interaction between economic theory and econometric techniques.

NOTES

1. Considering the equation for m(3) over the period 1963:II - 1971:IV, the estimated long run income elasticity was 1.13, the elasticity with respect to the differential between the consol rate and the own rate was -.29, the elasticity with respect to the standard deviation of bond yields was .19, and the coefficient on the lagged dependent variable was .80

2. It is a requirement of the validity of the partial adjustment hypothesis that the coefficient of the lagged dependent variable be less than unity, a condition not met in the case of the equation for m(3).

3. Laidler (1980) found evidence of a shift in the demand for money function in the US around 1974, but he also found that after that date the autocorrelation pattern in the residuals from the relevant equation changed. This latter result is consistent with the hypothesis that something in the dynamic adjustment mechanism is at work in the economy change at around the same time.

4. Although the scale variable in the demand function is probably not to blame for the 'missing money' puzzle, B. Friedman (1978) has shown that much of the variations in Hamburger's dividend price ratio over the relevant period was in the price term, hence, he argues that this variable may well be picking variations in the stock market rather than the opportunity cost of holding money. He then shows that there is evidence to suggest that the addition of wealth to Goldfeld's

equation improves its performance after 1974.

5. Since u_t determines m_t and $m^a{}_t$ is predetermined then u_t and $(m - m^a)_t$ are correlated.

6. From $\partial c/\partial m_t = 2a(m_t - m^*{}_{t-1}) + 2b(m_t - m_{t-1}) - 2b(m_{t+1} - m_t) = 0$, we obtain:

$$m_t = a/(a+2b)m^*{}_t + b/(a+2b)m_{t-1} + b/(a+2b)m_{t+1} \qquad (1)$$

Multiplying (1) through by (a+2b) and rearranging yields

$$(a + 2b - bL - bL^{-1})m = am^* \qquad (2)$$

Hence:

$$B(L)m = [(-L(a+2b/b) + L^2 + 1]m = -a/b\ m^*{}_{t-1} \qquad (3)$$

L^{-n} is the forward operator i.e. $L^{-n}\ m = m_{t+n}$. Factorizing B(L) and equating coefficients in power of L gives:

$$\begin{aligned}[-L(a+2b)/b + L^2 + 1] &= (1-c_1L)\ (1-c_2L) \\ &= 1-(c_1 + c_2)L + c_1c_2L^2 \qquad (4)\end{aligned}$$

Hence $c_1 + c_2 = (a/b) + 2$, $c_1c_2 = 1$

After multiplying through by $(1-c_2L)^{-1}$ equation (2) may be written as:

$$(1-c_1L)m = -a/b\ (1-c_2L)^{-1}m^*{}_{t-1} = -a/b(1-c_1{}^{-1}L)^{-1}m^*{}_{t-1}$$

7. For example, Silveira found that estimates of the coefficient based on only the latter observations during the inflationary period tend to be larger than those based on earlier observations.

8. Within the framework of Rational Expectation models, expectations about next period's inflation rate would be determined essentially by the (expected) money supply in all future periods. In such a context the idea of a variable coefficient of expectations depending on inflation is not theoretically plausible since adaptive expectations are 'rational' only if the rate of growth of the money supply is a random walk plus a white noise disturbance. The speed of adjustment of expectations is thus dependent on the variance of the increment in the random walk and the white noise. There does not appear any particular reason to expect that these relative variance should increase with the rate of inflation.

9. Sargent and Wallace (1973) have presented other more general reasons why the simple adaptive expectations may be inconsistent with a model of the demand for money in an inflationary context.

PART 2

PARTIAL ADJUSTMENT, ERROR CORRECTION AND COINTEGRATION

CHAPTER 5

THE PARTIAL ADJUSTMENT SPECIFICATION

5.1 Introduction

In this chapter, we outline the rationale for partial adjustment specifications and apply these models to the monetary data of developing countries. Then, we shall go on to test the plausibility of the estimated PA models, which is presented in section 5.3. In section 5.4, we discuss the limitations of these models using Hacche's (1974) article on UK demand for money as a special case of PA specification. In so doing, we expose the shaky theoretical and statistical foundations upon which such models are constructed, and show how these models omit several lagged explanatory variables.The general principles of statistical inference in relation to economic data are also exploited to place the issue in a wider methodological debate.

5.2 Partial Adjustment Specification

Most empirical works on the demand for money explicitly recognize the problem that adjustment towards the equilibrium position may not be complete within the period of observation. Thus, the model in general consists of two separate effects:

(a) the determination of the optimal (equilibrium) demand for money;

(b) the disequilibrium behaviour of individuals and the adjustment process undergone in attaining equilibrium.

Although all individuals will hold their equilibrium money stock in the long-run, this is not necessarily true in the short-run, where, for example, adjustment costs may make it optimal not to adjust immediately to equilibrium. In the context of LDCs, the equilibrium demand for money model is often written as:

$$m^{d*}_t = \alpha_0 + \alpha_1 y_t + \alpha_2 r_t + \alpha_3 \Delta p^e_t + u_t \qquad (5.1)$$

where all the variables are in natural logarithms except the interest rate.[1] Expected inflation is generated by using the adaptive expectations scheme due to Nerlove (1958).

$$\Delta p^e{}_t - \Delta p^e{}_{t-1} = \lambda(\Delta p_t - \Delta p^e{}_{t-1}) \quad (5.2)$$

combining (5.1) and (5.2) yields

$$m^d{}_t = \alpha_0\lambda + \alpha_1 y_t - \alpha_1(1-\lambda)y_{t-1} + \alpha_2 r_t - \alpha_2(1-\lambda)r_{t-1} + \alpha_3\Delta p_t + (1-\lambda)m_{t-1} - (1-\lambda)u_{t-1} + u_t \quad (5.3)$$

The commonest procedure which has been used in many specifications is to suggest that (5.1) or whatever direct demand equation is being used,represents the desired money holdings, not the actual one, and that there is a partial adjustment of the actual to the desired by some fraction,Θ, of the difference between the actual and desired levels, such that:

$$m_t - m_{t-1} = \Theta(m_t{}^* - m_{t-1}), \quad 0 \leq \Theta \geq 1, \quad (5.4)$$

This can be shown to be an optimal behaviour, in the sense that costs are minimized; if total costs consist of a disequilibrium cost and an adjustment cost. These costs are usually assumed to be proportional to the square of the extent of the disequilibrium and the square of the adjustment, i.e.,

$$C = \alpha(m_t{}^* - m_t)^2 + \beta(m_t - m_{t-1})^2 \quad (5.5)$$

On minimizing these costs we arrive at the partial adjustment model given by (5.4) where $\Theta = \alpha/\alpha+\beta$. If the disequilibrium cost is greater than the adjustment cost, then α dominates β, and Θ tends to unity. When $\Theta = 1$, equation (5.4) becomes $m_t = m_t{}^*$ and adjustment is instantaneous. Alternatively, if the adjustment cost dominate, then Θ tends to zero and equation (5.4) becomes $m_t = m_{t-1}$ and no adjustment takes place.

Some researchers assume that adjustment is instantaneous, and hence do not distinguish between actual and desired money demand. In this case the optimal money demand equation derived above can be estimated directly since $m_t^* = m_t$. However, the partial adjustment model represents a more general formulation and is, therefore, more desirable; if adjustment is actually completed within the period of observation, then Θ should be unity. To impose a value of unity in a situation in which adjustment is only partial will result in the estimation of a misspecified model and could produce biased parameter estimates. If we combine the PA model given by (5.4) with (5.1) and (5.2), we obtain the following reduced form:

$$m^d_t = \Theta\alpha_0 + \Theta\alpha_1 y_t + \Theta\alpha_2 r_t + \Theta\alpha_3 \Delta p^e_t + (1-\Theta) m_{t-1} + \Theta u_t \tag{5.6}$$

and substituting for Δp^e_t from (5.2)

$$m^d_t = \alpha_0\lambda\Theta + \Theta\alpha_1 y_t - \Theta\alpha_1(1-\lambda)y_{t-1} + \Theta\alpha_2 r_t - \Theta\alpha_2(1-\lambda)r_{t-1} + \Theta\alpha_3\lambda\Delta p_t + (2-\Theta-\lambda)m_{t-1} - (1-\lambda)(1-\Theta)m_{t-2} + v_t \tag{5.7}$$

where $v_t = \Theta u_t - \Theta(1-\lambda)u_{t-1}$. First, ignoring the disturbance term we see that equations (5.6) and (5.7) are identical if the elasticity of expectation, λ, is unity.

This follows from (5.2) since if $\lambda = 1$, then $\Delta p^e{}_t = \Delta p_t$, that is, expected and current price changes are equal. Thus, when adaptive expectation is posited, money stock lagged by one and two periods and the previous levels of income and interest rate appear as additional regressors. Secondly, the transformation changes the autocorrelation pattern of the disturbance term. If u_t in (5.6) is free of autocorrelation, then v_t in (5.7) is not. Thus, with $0 < \lambda < 1$, the error term in the adaptive expectation regression might exhibit negative autocorrelation and although this error is a moving average of the original error, many investigators have used the first-order autoregressive scheme $v_t = \rho v_{t-1} + \varepsilon_t$ as an approximation.

Straight-forward estimation of (5.7) by OLS is not feasible however, first because of the problem of an autocorrelated disturbance term combined with a lagged dependent variable and second, given equation (5.3), its parameters are over-identified. In practice, collinearity between r_t and r_{t-1}, y_t and y_{t-1}, and m_{t-1} and m_{t-2} is likely to lead to some imprecision in the estimators of the parameters of (5.7). If λ is constrained to unity, the coefficients of r_{t-1}, y_{t-1}, m_{t-2} and u_{t-1} are dropped from the regression reverting to the following partial adjustment specification.

$$m^d{}_t = \gamma_0 + \gamma_1 y_t + \gamma_2 r_t + \gamma_3 \Delta p_t + \gamma_4 m_{t-1} + u_t \qquad (5.8),$$

with the obvious correspondence between the γ's in (5.8) and the parameters of (5.6)

5.3 Estimation and Analysis of Results

Estimated results of equation 5.8 for 11 developing countries are reported in table 5.1. As it happens, the lagged dependent variable is highly significant in eight out of eleven equations. The omission of this variable, therefore, leads to misspecification. We also observe that the rate of interest does not appear to be important in most of the equations. In cases where it is significant, it assumes perverse signs and, therefore, is inconsistent with the underlying theory. The only exception is Kenya where it is negative and significant. On the other hand, the rate of inflation is correctly signed and significant in about three quarters of the countries under investigation. However, these results are volatile and too shaky to draw any unified conclusions. In terms of goodness of fit, (i.e.,sign and significance of the coefficients), the PA model is acceptable for Peru, Colombia, India, Sri Lanka and the Philippines. In the case of Brazil, Korea and Malawi, the coefficient of the lagged real money balance is not significantly different from zero. This implies that adjustment in the monetary sectors of these countries is instantaneous since the implied adjustment parameter, Θ = 1. The equations corresponding to Mexico and Korea are virtually useless as few of the parameters are significant. On the surface, it would seem that two sets of results have been obtained from the PA model. The model is a reasonably fit for Peru, Colombia, India, Sri Lanka and the Philippines but miserably fails in the cases of Mexico, Brazil, Korea, kenya and Malawi.

Where the PA model was proved to be inadequate, the lagged dependent variable was dropped and a static model was estimated for the the latter countries and the results are reported below.

1.Mexico

$$m^d_t = -3.2 + 1.5y + 1.5r - .74\Delta p$$
$$(-10.0) \quad (3.6) \quad (3.0) \quad (-1.3)$$

R2 = .96, T = 27, $\hat{\sigma}$ = .16, DW = .85, $\rho = .6$

2. Brazil

$$m^d_t = -.17 + .63y + .33r - .57\Delta p$$
$$(-.81) \quad (12.0) \quad (3.9) \quad (-3.6)$$

R^2 = .91, T = 27, $\hat{\sigma}$ = .12, DW = 1.3 , $\rho = .4$

3. Korea

$$m^d_t = -4.7 + 1.6y + .83r - .83\Delta p$$
$$(-8.1) \quad (18.0) \quad (1.0) \quad (-1.6)$$

R^2 = .95, T = 27, $\hat{\sigma}$ = .24, DW = .35, $\rho = .8$

4. Kenya

$$m^d_t = -4.6 + 1.6y - 1.5r - .16\Delta p$$

$$(-6.4) \quad (12.6) \quad (-2.6) \quad (-.42)$$

$R^2 = .96$, $T = 21$, $\hat{\sigma} = .06$, $DW = 2.3$, $\rho = -.2$

5. Malawi

$$m^d_t = -2.6 + 1.4y + 2.7r + .93\Delta p$$

$$(-7.3) \quad (6.7) \quad (1.3) \quad (1.3)$$

$R^2 = .89$, $T = 21$, $\hat{\sigma} = .11$, $DW = 1.4$, $\rho = .3$

Clearly, these are not a satisfactory set of results. Firstly, there is ample evidence of first order serial correlation in all the static models as indicated by the poor performance of the DW statistics.The standard procedure at this stage is to correct for serial correlation through the Cochrane-Orcutt transformation, but we do not adopt this technique for reasons which will be apparent later. Secondly, the variances of the static models are much larger than those obtained from the PA specifications, implying that the static equations are inferior to the simple dynamic models.

As argued earlier, equations 3,4,5,6 and 8 are seemingly well determined in terms of goodness of fit. A battery of specification and misspecification tests are required to establish the adequacy of these equations. Several tests exist in the literature but the use of the tests depends on the sample size. For the moment, we choose to apply only those tests which are crucial and can be used when the degree of freedom is very small. In particular, we test for the presence of serial correlation and parameter constancy.

The calculated values of LM(1) for equations 3,4,5,6 and 8 corresponding to Peru, Colombia, India, Sri Lanka and the Philippines respectively are:

Equations:	(3)	(4)	(5)	(6)	(8)
LM(1)	3.4	.10	2.3	2.0	.26

Since the critical value of χ^2 at the 95 per cent confidence level and 22 degrees of freedom is 4.4 for each of the above equations, we cannot reject the null hypothesis of no first order serial correlation. Having satisfied ourselves with the absence of an AR (1) error process, we proceed to the task of establishing the structural stability of the estimated parameters.

The computed CH-values for parameter stability are as follows.

Equation:	(3)	(4)	(5)	(6)	(8)
CH(5,14)	.60	2.6	22.0	.76	.31

As the critical value of the F-distribution is 2.96, there is evidence of parameter shift in the case of equation (5). Equation (4) marginally passes the test. However, the test

Table 5.1 parameter estimates of equation (5.8)*

country	γ_0	γ_1	γ_2	γ_3	γ_4	DW	R^2	T
1. Mexico	-.39	.21	-.22	-.17	.91	1.5	.98	27
	(-.53)	(.65)	(-.38)	(-.38)	(4.0)			
2. Brazil	-.06	.48	.33	-.61	.23	1.5	.89	27
	(-.26)	(3.1)	(3.9)	(-3.8)	(1.0)			
3. Peru	-1.2	.67	.49	-.42	.46	1.4	.91	27
	(-3.1)	(3.6)	(2.5)	(-2.0)	(3.0)			
4. Colombia	-.50	.13	.33	-1.1	.92	2.0	.98	27
	(-.70)	(2.3)	(.76)	(-5.4)	(10.0)			
5. India	-.77	.49	.29	-.85	.76	2.6	.99	27
	(-2.3)	(2.4)	(.59)	(-4.7)	(7.0)			
6. Sri Lanka	-1.2	.45	.59	-1.2	.69	1.4	.98	27
	(-1.5)	(2.8)	(.23)	(-2.3)	(3.6)			
7. Korea	.19	-.01	1.4	-1.4	.99	1.3	.96	27
	(.43)	(-.06)	(4.8)	(-5.0)	(12.2)			
8. Phil.	-.16	.28	-.70	-.93	.79	1.7	.98	27
	(-.85)	(2.6)	(-1.4)	(-6.4)	(7.5)			
9. Thailand	-.01	.20	1.6	-.82	.94	2.3	.99	27
	(-.04)	(1.4)	(2.2)	(-6.3)	(9.7)			
10. Kenya	-3.7	1.3	-1.4	-.36	.21	2.4	.99	21
	(-3.5)	(4.1)	(-2.3)	(-.87)	(1.1)			
11. Malawi	-1.3	.79	-1.3	.01	.47	1.9	.91	21
	(-1.6)	(1.9)	(-.50)	(1.2)	(1.7)			

* t-values are given in parenthesis

Table 5.2 prediction errors and the Chow inequality coefficient.[2]

Equations:	(3)	(4)	(5)	(6)	(8)
e_1	.069	.126	.147	.085	.009
e_2	-.158	.097	-.127	-.082	.001
e_3	-.62	.030	-.04	-.107	.022
e_4	-.147	.226	-.025	-.114	.063
e_5	-.387	.274	-.052	-.152	.073
U	0.64	0.72	0.81	0.58	0.42

Table 5.3 Implied long-run elasticities and the adjustment parameter, Θ.

Equations	constant	y	Δp	Θ
(3)	–2.2	1.2	–.78	.54
(4)	–6.3	1.6	–13.8	.08
(5)	–3.2	2.0	–3.5	.24
(6)	–3.9	1.3	–3.9	.31
(8)	–.76	.90	–4.0	.21

for the remaining three equations is unambiguous as the for the remaining three equations is unambiguous as the CH-test is well below its critical value implying parameter stability over the entire sample period. But, we must be cautious about this conclusion because this test has some limitations. Rea (1978) for example argues that in the case of $n_2 < (k+1)$, the prediction error can have a zero mean even when the parameters are unstable when the explanatory variables have moved in an offsetting manner. Rea's main conclusion is that the CH-test is incapable of testing the hypothesis of equality against inequality. It can never be argued from the Chow test itself that the two sets of regression coefficients are equal, although at times it may be possible to conclude they are equal. This does not, however,mean that the Chow test is useless. It is a good test for unbiasedness in prediction.

We have used the estimated equations to predict for the period 1982 to 1987 and the prediction errors are reported in table (5.2.)[3]. A moments reflection on table 5.2 will suggest that the estimated equations have over-predicted the real money growth for Peru, India and Sri Lanka and under-predicted for Colombia and the Philippines. The relatively high values of the Theil inequality coefficient, U also indicate a weakness in the predictive ability of the PA models, thus, reinforcing our suspicion of parametric drift over the sample period. Even if one believes that these equations are statistically well determined, the implied income and inflation elasticities are implausibly high due to sluggish adjustment towards the desired real money balances. This contention is supported by the low values of the adjustment parameter, Θ in table (5.3). In view of the above discussion, one might interpret the predictive failure of these models as a rejection of any particular theory of the demand for money. A more reasonable interpretation would be that the apparent predictive failure is in fact due to misspecification of the estimated statistical models.The conventional course of action used to tackle the problem is to revise the original specifications in the light of the negative outcome acquired from the testing exercise. This is achieved by adding a few shift variables (dummy variables) to account for structural breaks or serial correlation. However, this approach does not solve the problem at hand as respecified models have continued to systematically under or over predict real money growth as indicated in chapter 4. The root of the problem lies in the original specification of the empirical model.Many investigators argue in favour of very simple models because simple models are easier to understand, communicate and test empirically with the given data. The choice of a simple model to explain complex real-world phenomena leads to an oversimplified model built on unrealistic assumptions. In the following section, we attempt to critically evaluate the classical econometric methodology, with particular reference to the partial adjustment specification, and the modification adopted by analysts to improve its performance.

5.4 A Critical Appraisal

There are some aspects of the PA model that are open to criticism. These are related to the performance of the model and the assumptions on which the model is built. Firstly, the functional form adopted is a quadratic cost function, but there is no justification for its adoption, except perhaps for its convenience to obtain simple results. The use of quadratic form also implies symmetric costs, i.e., costs of being over and under the desired money holdings are the same. But it is likely that costs of being under equilibrium are greater than costs of being over equilibrium as borrowing rates are greater than lending rates.

Secondly, most quadratic form equations consider a single optimization period.This implies that agents do not take into account the fact that the minimization of cost during the current period will influence next period's money stock and, therefore, next period's cost of adjustment. This was indicated in the previous chapter where we argued that when optimization is extended to multi-period, future values of independent variables appear in the demand for money function.

Thirdly, the assumption of equal speed of adjustment for each argument in the demand function is apparent in equation (5.6) where money holdings adjust with the same coefficient Θ to changes in either output or interest rates. However,the cost of adjustment related to output and interest rate is quite different. For example, when income is paid in the form of money there is no portfolio adjustment cost in raising money holdings but only in reducing them as part of the portfolio reallocation. Thus, at the individual level adjustment costs make sense for the interest rate only.

The immediate adjustment implied by equation (5.6) has also led to some serious criticisms of partial adjustment specifications. For example, consider the dependent variable in equation (5.1) which is the log of real money balance. This is acceptable since nearly all theories of the demand for money suggest that the demand for money is a demand for real balance. However, when we apply the adjustment cost argument (5.5) to that equation, we obtain equation (5.6),which says that economic agents will adjust their real balances slowly over time in response to changes in the scale variables. As far as the individual agent is concerned, the price level is an exogenous variable and, to attain a given level of real money balance, the agent must take the price level as given to him by forces beyond his control and he can only vary his nominal money balances. This is important because equation (5.6) implies that, when the price level changes, nominal balances adjust instantaneously to keep real balances constant. It is not convincing to suggest that agents' adjustment to price level change be instantaneous when their adjustment to changes in other variables is sluggish. Milbourne (1983) and Fair(1987) conclude that equations (5.5) and (5.6) are inappropriate as applications of the adjustment cost idea to the demand for money, suggesting that they should be cast in terms of nominal rather than real balances. If that is done, we have:

$$m^d_t = \Theta\alpha_0 + \Theta\alpha_1 y_t + \Theta\alpha_2 r_t + \Theta\alpha_3 \Delta p^e_t + (1-\Theta)[m_{t-1}/p_t] + \Theta u_t \tag{5.9}$$

Equations (5.6) and (5.9) differ in the lagged money term. In (5.6), which is the real adjustment specification, m_{t-1} is divided by p_{t-1}, whereas in (5.9), which is the nominal adjustment specification, m_{t-1} is divided by p_t. A test of the two hypotheses is simply to put both lagged money variables in the equation and see which one dominates. If the real adjustment specification is correct, (m_{t-1}/p_{t-1}) should be significant and m_{t-1}/p_t should not, and vice versa if the nominal specification is correct. This test may be inconclusive if both terms are significant or insignificant.

Finally, the assumption of individual adjustment equation to analyse aggregate data is vulnerable to serious criticisms.It is a common practice in economics to construct micro models to depict the behaviour of an individual and then, having done that,assume the economy as a whole acts as if it was simply a scaled up version of that individual agent. Laidler (1985) forcefully argues that what is true for the individual is not always true for the aggregate of individuals acting together.It is possible to commit fallacies of composition when going from propositions about individuals to propositions about the economy as a whole. The variable under the control of the individual agent is nominal balance. This consideration justifies the derivation of the nominal adjustment short-run function (5.9). However,the real adjustment version (5.6) is quite common in the literature which assumes the nominal quantity of money as an exogenous variable determined in the supply side of the money market.But nominal money cannot simultaneously be a variable that is exogenous at the aggregate level and respond endogenously to variations in demand at the individual level.[4]

According to the quantity theory of money, equilibrium in the economy is maintained through variations in the general price level.If the price level is perfectly flexible,such adjustment is instantaneous, and only a long run aggregate demand for money function is observable.However, if prices are sticky, we would observe the economy moving slowly to equilibrium over time by way of price changes influencing the quantity of real balance. On this basis, the real adjustment version (5.6) appears appropriate. But,this argument is objectionable for the following reasons.

(i) The distinction between the long run and short run demand for money function arises from costs encountered by economic agents when attempts are made to alter money holdings, not from the existence of some degree of price level stickiness. If equation (5.6) is interpreted as price level adjustment, then the single parameter Θ captures the entire transmission mechanism, whereby the price level responds to discrepancies between supply and demand for nominal money and also adjustment costs. But if we are suspicious of this one parameter, then of course, we must be suspicious of the other parameters estimated from the real adjustment equation (5.6).

(ii) Even if it were possible that Θ satisfactorily captures all these discrepancies, the real adjustment version would only be appropriately specified if the nominal quantity of money is held constant over time and all disturbances to which the economy must react arise among the arguments of the demand for money function. To see this, consider the following specifications with long-run function as f(x) to save space,

$$m_t = f(x_t) + p^*_t + u_t, \qquad (5.10)$$

so that

$$p^*_t = m_t - f(x_t) - u_t \qquad (5.11)$$

Assuming an adaptive expectations mechanism of price adjustment towards its long run equilibrium, we have:

$$p_t - p_{t-1} = \Theta(p^*_t - p_{t-1}) \qquad (5.12)$$

then, after substitution and some algebraic manipulations, we obtain the following relationships.

$$(m-p)_t = \Theta f(x_t) + (1-\Theta)[m_t - p_{t-1}] + \Theta u_t \qquad (5.13)$$

This equation is equivalent to (5.6) only if m_t is constant, i.e., $m_t = m_{t-1}$. If the nominal money supply varies exogenously in the data set, (5.6) will be misspecified even if the transmission mechanism is appropriately captured by Θ.

Wymer (1976) recognized this problem and he suggests that the appropriate way to get to grips with the adjustment of cash holdings to their target values is to construct an explicit model of that adjustment process and to estimate it as a complete system. Wymer's procedure involves, first, specifying a complete macroeconomic model in which the transmission mechanism for monetary policy is highlighted and, second, estimating the parameters of the model, including those that purport to capture the process whereby, not just the demand for money, but all the other endogenous variables, move over time toward their equilibrium value. However, this technique is vulnerable to the criticism that any error made in specifying one component of the system, can, in principle, undermine the reliability not just of the estimates of that component, but of the rest of the model as well.

The first order PAM may also fail to hold if m^*_t rises over time. Under this situation the short run money balances differ continuously from m^*_t. Salmon (1982) argues that the short run mechanism should yield a zero steady-state error given the chosen target, m^*_t. Steady-state behaviour is that which prevails after any transient influence has died away. The steady-state error e_t is obtained from the standard PAM:

$$e_t = m^*_t - m_t \tag{5.14}$$

Salmon considers the response of agents to three different paths of m^*_t.

(a) static equilibrium : $m^*_t = k$

(b) constant growth: $m^*_t = kt$

(c) dynamic growth : $m^*_t = kt^2$

$t > 0$

A zero steady-state error is only guaranteed if the target level is constant in steady-state (Fig 5.1a). If the target path m^*t is constantly growing, the PA model will lead to a fixed offset and will, thus, never reach the target (Fig 5.1b). For higher order time paths, the PA mechanism will diverge from the target path, (Fig 5.1c). If the target path switches between two constant growth paths, the PA model will follow the switch but will still not converge to the target in steady-state.

A further problem can arise when a target is specified in such a way that it does not uniquely define the types of adjustment mechanism. For example, the quantity theory of money implies that in fig 5.1d, (m/py)* is the desired equilibrium position such that m = k*py and this is clearly consistent with a long run unit income and price elasticities. However, so is the steady-state (m/py)$^+$

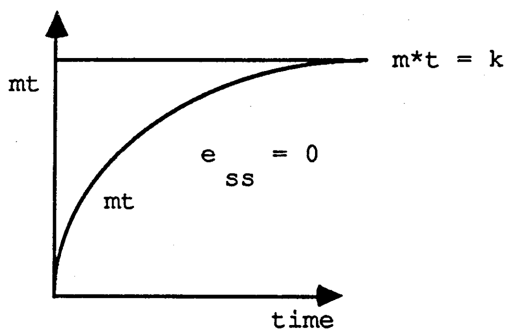


Fig. 5. 1a

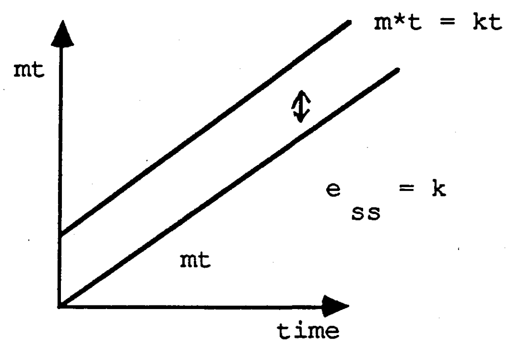


Fig. 5. 1b

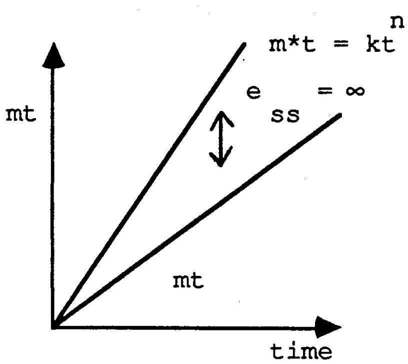


Fig. 5. 1c

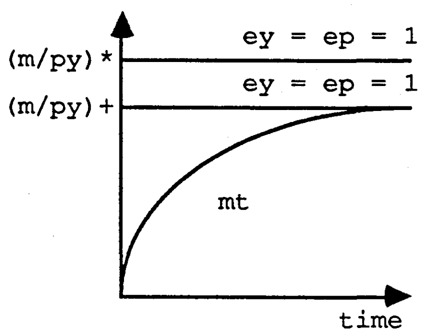


Fig. 5. 1d

Source: Salmon (1982). 'Error correction mechanism', Economic Journal, pp. 620-21.

defined by $m = k^{+}py$ towards which an adjustment path converges. So, the target, if defined in terms of unit price and income elasticity representation, the actual equilibrium k^{*} is never achieved. The poor performance of the PA model in this respect is a result of the order of adjustment. A higher order PA process can provide better results when the equilibrium follows a dynamic growth path.

5.5 Dynamic Specification, Revision and Assumptions

In this section, we take up three main problems of the classical econometric approach.These problems are related to:

(i) the introduction of dynamics into the statistical model;

(ii) revisions and modifications of the estimated model on the basis of negative outcomes;

(iii) the underlying assumptions of classical econometric methodology.

In the previous section, we argued that the theoretical justifications for imposing restrictive dynamics on the PAM and adaptive expectations are weak and the resulting dynamics are quite restrictive. The PAM and adaptive expectation specifications, therefore, omit several longer lags of the explanatory variables. These restrictions might lead to dynamic misspecification. In the absence of a priori assumptions, it seems more sensible to consider longer lags as an empirical issue. In other words, the performance of the demand for money function might improve if the data are allowed to determine the outcome. Thus, instead of trying to justify a very restrictive model, it would be better to start with a reasonably general dynamic model and only accept the former if the restrictions implied by it are valid. The starting general linear dynamic model might have complicated lag structures for each argument in the demand for money, but at least the dynamic structure does not arise from unrealistic assumptions.

The second criticism of the conventional approach is in the way investigators revise estimated equations. The initial equation is estimated, tested, and then modified on the basis of every previous negative outcome. The major problem with this procedure is that every test is conditional on arbitrary assumptions which are to be tested later and if they are rejected all earlier inferences are invalidated. A good example is that of Hacche's (1974) demand for money study in the UK. Hacche selected a few variables from those suggested by economic theory and specified a simple relationship. He started with the PA model very similar to equation (5.6), but estimated the model in first difference using OLS technique which is only optimal when the initially restricted model is correctly specified. The estimates were evaluated using the standard procedure which utilizes Durbin-Watson test for serial correlation. As we argued in chapter 1, this statistics could be the result of two completely different outcomes, i.e., the model might be misspecified or the true model might have been chosen but it exhibits serial correlation. Hacche adopted the latter assumption without either testing or providing sufficient reasons for his choice.

The presence of autocorrelation makes the estimates inefficient and, therefore, it is necessary to eliminate the residual correlation. This represents the last step in which Hacche revised and re-estimated the equation using the Cochrane-Orcutt transformation. However, there are some objections to this technique. First, it is not helpful to model in differences of variables, because in doing so, potentially valuable information about the relationship between the levels of the variables, which is likely to be related to steady-state or long-run equilibrium economic theory is lost. In other words, a model with only differenced variables is theoretically unattractive. Second, this approach imposes restrictions on the dynamics of the demand for money function without any previous test for their validity. Lack of adequate testing might lead to wrongly differencing the data set. It appears that while differencing removes spurious regression and induces stationarity,[5] there are circumstances where such a procedure becomes troublesome.

Hendry (1977) provides two interpretations of a difference transformation to an equation - operator form and restriction form. The operator ($\Delta = 1-L$) transforms the equation:

$$y_t = \gamma_1 + \gamma_2 x_t + \gamma_3 x_{t-1} + \gamma_4 y_{t-1} + w_t \tag{5.15}$$

to

$$\Delta y_t = \gamma_2 \Delta x_t + \gamma_3 \Delta x_{t-1} + \gamma_4 \Delta y_{t-1} + \Delta w_t \tag{5.16}$$

It appears that the properties of the error term in (5.16) are completely altered since Δw_t is white noise if, and only if, w_t is a random walk.

An equation in first difference can also be obtained from (5.15) by imposing the parameter restriction that $\gamma_2 = -\gamma_3$ and $\gamma_4 = 1$ which yields:

$$\Delta y_t = \gamma_1 + \gamma_2 \Delta x_t + w_t \tag{5.17}$$

If the restrictions are valid, the interpretations of both the intercept and the error term are unaltered in (5.17). If this is the true Data Generating Process (DGP) for the series x_t and y_t such that Δy_t, Δx_t and w_t are stationary and w_t is white noise, then so must be w_t in equation (5.15) in levels. Further, the validity of the difference restrictions is testable on the null hypothesis that w_t is stationary and the variables Δx_{t-1} and Δy_{t-1} added to (5.17) should have zero coefficients.

Hacche's assumption of first order serial correlation is also contestable as the presence of an AR(1) error process may arise from:

(a) spurious relationship between the endogenous and exogenous variables;

(b) the many forms of potential misspecification which afflict time series modelling, such as ignoring of simultaneity, omitted variables, measurement errors and incorrect functional form as well as dynamic misspecification;

c) genuine unmodeled error dynamics.

Therefore, the widely adopted interpretation of the low value of DW-statistics as suggesting that the error follows a first-order autoregressive process is unwarranted without further statistical investigation. In particular, it is extremely important to isolate the true cause of serial correlation, especially if one wishes to conduct policy analysis. One strategy for tackling this potential problem is to apply common factor analysis due to Sargan (1964), [see chapter 1]. The implied common factor restrictions in our models can be shown by rewriting the adaptive expectation equation (5.3) as

$$m^d_t = \beta^*_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 r_t + \beta_4 r_{t-1} + \beta_5 \Delta p_t + \beta_6 m_{t-1} + \beta_7 m_{t-2} + \beta_8 u_{t-1} + u_t \qquad (5.18)$$

and imposing common factor restrictions:

$$m^d_t = \beta^*_0 + \beta_1 y_t + \beta_3 r_t + \beta_5 \Delta pt + \Sigma_{i=1}\gamma_i \Delta p_{t-i} + \Sigma_{i=2}\phi_i m_{t-i} + u_t \tag{5.19}$$

where the β's in (5.19) correspond to the parameters of (5.3), $\beta^*_0 = \beta_0/(1-\beta_6)$, $\gamma = \beta_5\beta_6$ and $\phi = \beta_6\beta_7$. The reduction of equation (5.18) to a static model with only current dated variables implies two common factor restrictions plus the zero restrictions on all the γ's and ϕ's corresponding to lagged inflation and lagged real money balance given in (5.19). Since none of these restrictions are tested, the reduction of equation (5.18) with nine parameters to a static equation with only four parameters seems to be unwarranted. In the case of Hacche's demand for money studies, the PA specification was assumed to be correct with an AR(1) error process, thus common factor restrictions were implicitly imposed without empirical tests to back up these assumptions. Regarding this work, Hendry and Mizon (1978) commented that:

> It is neither necessary nor helpful to model in first differences and that the appropriateness of such model specification should be tested rather than assumed.

Further, Courakis (1978) shows two aspects of the Hacche model and the UK demand for money during the period 1973:4 - 1975:2. First, using the maximum likelihood estimators, he tests specifically the hypothesis that:

(i) Hacche's first differenced and autocorrelated model is to be preferred to the equation in levels but autocorrelated;

(ii) Hacche's constraints on the coefficients are to be preferred to including the same variables without constraints;

(iii) not only the first difference specification should be dropped but also the assumption of autocorrelation.

For (i) and (ii) Courakis does not find any evidence for preferring Hacche's specification and it is only when data from 1974:1 - 1975:2 are included that even (iii) was preferred.

Courakis also shows the enormous variation in the results obtained when Hacche's specifications were estimated with slight variations in the observation periods. With variations such as these, Courakis wanders if one can really produce any estimation of the demand for money which allows him to make any sensible judgement as to whether the Keynesian formulation is to be preferred to the monetarist one, or about many of the conflicting results in the area of macroeconomics. This represents the sheer frustration of several researchers who are committed to the conventional econometrics methodology.

The third problem of the classical econometrics methodology is related to its simplistic views concerning econometric modelling. To crystallize the ideas behind this methodology, we can characterize classical statistical inference in five steps - (1) select a theory; (2) propose a model; (3) collect relevant data and estimate; (4) perform statistical tests; (5) if the model is accepted, use it for prediction or policy evaluation, if rejected, start again with a new model and a new set of data.

A closer inspection of the five steps of the conventional methodology reveals a considerable weak link between theory, data, the empirical model and hypothesis testing. In particular, two main objections have been put forward regarding this scheme:

(1) there is no feedback from the econometric testing to the formulation of economic theory. This arises because the intended scope of econometrics is narrowly defined as the measurement of theoretical relationships. Theories are developed not for the sake of theorizing but in order to understand some observable phenomena of interest;

(2) the second main objection to this methodology is that the hypothesis testing refers only to the hypothesis suggested by the original economic model. Leamer (1978) has argued that the classical testing of equations selected by preliminary regressions requires the assertion of the 'Axiom of Correct Specification' which implies:

(i) the set of explanatory variables that are thought to determine the dependent variable must be:

(a) unique

(b) complete

(c) small in number

(d) observable

(ii) other determinants of the dependent variable must have a probability distribution with at most a few unknown parameters;

(iii) all unknown parameters must be constant

Leamer went on to say:

> If these axiom were,in fact, accepted, we would find one equation estimated for every phenomena, and we would have books that compiled these estimates published with the same scientific fanfare that accompanies estimates of the speed of light or the gravitational constant. Quite the contrary, we are literally deluged with regression equations, all offering to 'explain' the same event, and instead of a book of findings we have volumes of competing estimates.

This is to say the least a good reason for abandoning applied economics. But that is not an attractive course of action because it would leave economics with almost no way of selecting from among a plethora of possible explanations the one that best explains economic events. Fortunately, investigators have suggested at least three alternative methodologies to scientifically discriminate between competing theories. Leamer has preferred to adopt a Bayesian approach which continues to estimate structural models but admits the fragility of the resulting estimates. Sims developed Vector Autoregression (VAR) methodology which reverts to reduced form estimation. The third approach is the General to Specific Modelling originally spelled out by Sargan (1964) and popularized by DHSY (1978), Hendry (1979,1983,1987), Hendry & Mizon (1978). A detailed discussion and comparison of these methodologies is outside the scope this study. An excellent exposition of these methodologies is documented in Gilbert (1988) and Pagan (1987). For our purpose, the General to specific Modelling strategy is adopted because we believe that this approach has sound scientific status and strong statistical rationalization. In the next chapter, this approach is discussed and applied to the money demand function in developing economies.

NOTES

1. Interest rates can at times be quite low, and it may not be sensible to take the interest rate variable in its log form.

2. Theil's inequality coefficient is defined as:

$$U = \frac{\sqrt{1/T \sum_{t=1}^{T} (S_t - A_t)^2}}{\sqrt{1/T \sum_{t=1}^{T} S_t^2} + \sqrt{1/T \sum_{t=1}^{T} A_t^2}}$$

where S_t = simulated values and A_t = actual values. The numerator is the root mean squared error, and the scaling of the denominator ensures independence of the expression from the units of measurement of the variables.

3. There are objections raised against the use of dynamic simulation as a means of model selection, Hendry & Richard, (1982). Therefore, the simulation results (and diagnostic based upon them) reported in the text should be interpreted with care.

4. The endogeneity of money causes trouble for the interpretation of the estimated parameters of the demand for money. The extreme view is that we cannot devise a statistical technique which enables us to identify a demand for money function, [see Le Roy (1981)]

5. Stationarity is important because the properties of OLS estimates and normal statistical tests rely on the assumption that the error term is stationary.

CHAPTER 6

THE GENERAL TO SPECIFIC MODELLING APPROACH (GSMA)

6.1 An Overview

The 'general to specific' approach to econometrics is the product of work on dynamic specification undertaken initially at the London School of Economics. This approach essentially contains the following three steps.

1. Formulation of a general model that is consistent with economic theory.

2. Simplification of the general model through variable deletion and re-parameterization to obtain explanatory variables that are near orthogonal and interpretable in terms of equilibrium theory.

3. Evaluation of the resulting model by extensive analysis of the residuals and predictive performance, aiming at finding the weakness of the model at the different stages of estimation.

The first step of the GSMA commences from theories which are drastic abstractions of reality. A small number of explanatory variables are selected from an infinite number of explanatory variables affecting a single variable, (the money stock, for example). These forcing variables (price,interest rates, income,etc.) are related to the money stock, m, by a structural relationship. Economic theory suggests that for appropriately defined money stock, $m_t-p_t-y_t$ (i.e. velocity if the variables are in logs), should be a function of the nominal interest rate, i_t along any steady-state growth path. We may, therefore, write $m^*_t-p^*_t-y^*_t = \alpha i^*_t$ where the starred quantities indicate equilibrium values.

Since equilibrium quantities are not observed, we need to relate these variables to actual values. For time series data, it is natural to do this by allowing the relation between the variables m_t, p_t, y_t, and i_t, to be governed by a dynamic equation of the form:

$$m_t = \Sigma^p_{j=1} a_j m_{t-j} + \Sigma^q_{j=0} b_j p_{t-j} + \Sigma^r_{j=0} c_j y_{t-j} + \Sigma^s_{j=0} d_j i_{t-1} \qquad (6.1)$$

Equation (6.1) implies that the money stock should be regressed on a large number of independent variables. The first step in the general to specific approach sets p,q,r and s to be as large as possible. Degree of freedom constraints and the nature of the data set usually determine the lag length. Having determined the lags, the estimation of (6.1) serves as a bench mark against which all other models are ultimately compared. Despite its generality, (6.1) may be inadequate and, therefore, diagnostic tests should be carried out to check its validity.

The second stage of the GSMA probably represents the core of this methodology. We can think of the second stage as a process going through three different steps. First, reparameterization and economically meaningful restrictions yield an equation which is theoretically interpretable and has plausible long-run solutions. Second, a simplification procedure ensures a more parsimonious dynamic specification with fewer explanatory variables. Third, diagnostic checks are carried out on the restrictions imposed at the various stages of the final parsimonious model.

It is interesting to note that the re-parameterization exercise produces different outcomes; for example, equation (6.1) can be written in many different ways all of which would produce similar estimates of the unknown parameters, but each of which utilizes the information differently and, consequently, is easier to interpret and understand. To illustrate this point, consider the following simple model.

$$y_t = b_1 y_{t-1} + b_2 x_t + b_3 x_{t-1} \qquad (6.2)$$

Despite its simplicity, (6.2) is sufficiently general to nest several possible specifications which economic theory suggests as possible candidates for the ultimate regression to be chosen. Hendry and Richard (1982) have extracted nine different equations through various parameter restrictions and reparameterization (see table 6.1). For example, the simple partial adjustment model discussed in the previous chapter can be obtained by setting $b_3 = 0$. An equation in first difference requires $b_1 = 1$, and $b_2 = -b_3$. A common factor representation is obtained if $b_2 = -b_1 b_3$. Perhaps more importantly, the dynamics in (6.2) can be re-formatted as an error correction mechanism (ECM) by imposing the restrictions $\Sigma b_i - 1 = 0$, $i = 1,2,3$. The result of this restrictions is then:

$$\Delta y_t = b_1 \Delta x_t + (1-b_3)[x-y]_{t-1} + \varepsilon_t \qquad (6.3)$$

Although (6.3) is not different from (6.2), it is to be preferred because if x_t and x_{t-1} are highly collinear, x_t and Δx_t will be near independent. More generally, if x follows a process which is close to a random walk, a general distributed lag $\Sigma^k_{i=1} x_{t-i}$, the term of which is highly collinear, may be replaced by the distributed lag $\Sigma^{k-1}_{i=1} \beta_i \Delta x_{t-i} + \beta_k x_{t-k}$, whose terms will again be independent, (see Gilbert, 1986). From this simple representation, we can get some feeling about the demand for money function given by equation (6.1). The reparameterization exercise discussed so far would normally produce the following class of error correction model.

$$\Delta m_t = c + \Theta(m-y-p)_{t-1} + \Sigma^k_{i=0} (\alpha_i \Delta y_{t-i} + \beta_i \Delta p_{t-i} + \delta_i \Delta r_{t-i} + \gamma_i r_{t-i} + \lambda_i \Delta m_{t-i-1}) + u_t \qquad (6.4)$$

and the steady-state solution is obtained by setting $g_m = g_y = g_p = g_r = 0$ (where g is the rate of growth). Thus, the

Table 6.1: models nested in equation 6.2

Type of Model	Θ	Entailed Restrictions on (6.2)
1) Static Regression	$(0,b_2,0)$	$b_1 = b_3 = 0$ (No dynamics)
2) Univariate Autoregressive Process	$(b_1,0,0)$	$b_1 = b_2 = 0$ (No covariates)
3) Leading Indicator	$(0.0,b_3)$	$b_1 = b_2 = 0$ (No contemporaneity)
4) Growth Rate	$(1,-b_3,b_3)$	$b_1 = 1$, $b_2 = -b_2$ (No levels)
5) Distributed Lag	$(0,b_2,b_3)$	$b_1 = 0$ (Finite lags)
6) Partial Adjustment	$(b_1,b_2,0)$	$b_3 = 0$ (No lagged x)
7) Autoregressive Error (COMFAC)	$[(1-b_1),b_2,b_2+b_3)]$	$b_3 = -b_1b_2$ (One common factor)
8) Long-run propo-rtionality: Error-Correction	$(b_1,b_1,1-b_1-b_2)$	$\Sigma bi = 1$ (Long-run unit response)
9) Dead-Start	$(b_1, 0, b_3)$	$b_2 = 0$

long-run static solution of (6.4) is.

$m-p = k + y + \gamma^* r$

where $k = c/\Theta$ and $\gamma^* = \Sigma\gamma_i/\Theta$. The error-correction mechanism of (6.4) has a lot of desirable properties. In the context of equation (6.1), one might be interested to test a long run unit price and income elasticities. This hypothesis implies that from (6.1), $\Sigma a_j + \Sigma b_j + \Sigma c_j = 1$. The test can easily be conducted by adding $\Sigma\lambda_j y_{t-j}$ and $\Sigma\gamma_j p_{t-j}$ (for $j > 1$) to the right hand side of (6.4) and observing whether $\Sigma\lambda_j = \Sigma\gamma_j = 0$. In other words, under long-run proportionality, the previous levels of income and prices are irrelevant. Furthermore, ECM representation ensures that the dynamic equations reproduce equilibrium theoretical models and that the relationship between the parameters of the dynamic models and the implied long-run elasticities are made explicit.

Having reparameterized (6.1) as an ECM representation, we are now in a position to simplify (6.4). This procedure involves variable deletion and regrouping of parameters with similar values. Unfortunately, the empirical studies usually report the final equation without providing a description of the routes followed to the simplified version. In this respect, this step is the vaguest of the general to simple modelling approach. In Hendry (1986) for example, the transition from a model with thirty-one parameters to the one with only fourteen was explained in the following manner.

> These equations......were then transformed to a more interpretable parameterization and redundant functions were deleted; the resulting parsimonious models were tested against the initial unrestricted forms by the over all F-test. (p.29)

Another example of a simplification search is the common factor analysis we discussed in chapter 1 and 5. In that occasion we described a technique in which one can start with a static model with an AR(1) error process and eventually obtain a dynamic specification. We now reverse that procedure and show how COMFAC analysis can be used to simplify a general dynamic model using equation (6.2). This equation can be rewritten as:

$$(1-b_1L)y_t = (b_2 + b_3L)x_t + \upsilon_t \qquad (6.5)$$

or $$(1-b_1L)y_t = b_2(1 + (b_3/b_2)L)x_t + \upsilon_t \qquad (6.6)$$

where $|b_1| < 1$, v_t is white noise. A common factor is present if $b_3/b_2 = -b1$. If this restriction holds, we can then reparameterize (6.5) as:

$$y_t = b_2x_t + \varepsilon_t \qquad (6.7)$$

where $\varepsilon_t = \Sigma_{i=0}b^i{}_1\upsilon_{t-i} + \zeta_t$. Thus, if a common factor is present, then the initial dynamic model given by equation (6.2) with a white noise error and three parameters, (b_1, b_2, b_3), can be reduced to (6.7) with geometrically declining random error process but with only two parameters (b1,b2). Thus, according to Hendry and Mizon (1978),serial correlation can be regarded as a convenient simplification rather than a nuisance. This simple example, which is restricted to one period lag and one regressor can of course be generalized to higher order lags and several regressors.

The third step in the GSMA is concerned with the role of model evaluation. It represents a very important part of the GSMA and it has shifted the emphasis of econometric techniques from estimation towards a more careful evaluation of estimated models. Several model selection criteria exist in the literature, but the main ones are related to: (1) goodness-of fit; (2) absence of serial correlation; (3) validity of exogeneity assumptions; (4) accuracy of predictions and parameter constancy; (5) absence of residual heteroscedasticity; (6) signs, magnitudes, precision and interpretability of estimated coefficients and (7) validity of prior restriction on parameters. The third step, therefore, provides an excellent general research tool to asses if a particular specification is acceptable or not. Essentially, this procedure checks if sample moments, involving the product of specified variables with functions of the data (typically residuals), are zero. The above model evaluation criteria are not only important within a modelling cycle for the detection of inadequate models, but they are also useful in the reporting phase, where they provide evidence that the conventions underlying almost any modelling exercise are not violated by the chosen model. Routine examination of such items as the autocorrelation function and recursive estimation of parameters has proved to be indispensable to a large number of investigators undertaking applied econometrics. More than anything else, it is this step which differentiates GSMA from other competing methodologies. There are also important features which distinguish this particular methodology. In the following sections, we attempt to discuss the scientific status, statistical foundations and theoretical basis of the general to specific modelling approach.

6.2 Scientific Appraisal

The French physicist Duhem (1906) was quoted as saying:

> ...... a crucial experiment is impossible in physics because to uphold such an experiment would require that we were able to enumerate completely the various hypotheses which may cover a determinate group of phenomena. Thus, crucial experiments can neither reject the target hypothesis, because of the jointness of testing; nor serve to confirm the alternative hypothesis, since the only truth established by a falsification is the denial of the hypothesis, and denial does not imply any single 'opposite' hypothesis but rather, entails various alternative conjunctions of hypotheses, some of which contain the target hypothesis. (Cross, 1982, p.321)

The main idea behind this argument is that it is wrong to appraise a single target hypothesis in isolation from its supportive auxiliary hypotheses. Cross (1982) applies this line of reasoning to economics using the 1970s debate on the stability of the demand for money as a case study. Cross argues that the traditional methodology is misguided because:

(a) when testing for stability in the demand for money function, we are not only testing this target HO but a large number of other HOs;

(b) given this jointness of testing, a group of HOs, in which the hypothesis of stability is embedded, can only justifiably be appraised by using methods for assessing groupings of HOs rather than a single hypothesis;

(c) the denial of the stability hypothesis does not imply the opposite but rather the alternative conjunction of the hypotheses some of which may contain the stability hypothesis.

In view of the above argument, tests of the hypothesis of stability in the demand for money function inevitably involve the testing of a substantial baggage of auxiliary hypotheses. Given this, it is ludicrous to appraise the stability hypothesis in isolation from the potentially many interrelated hypotheses. Some of the main additional hypotheses are outlined below.

(1) Definition and Measurement of the Relevant Variables. The definition and measurement system filters the economic outcomes to observed data, and so is a crucial factor in both the modelling and evaluation exercise. Data accuracy and coverage are far from optimal in economics and seriously limit what can be learned about behaviour without putting much effort into the measurement process (Hendry 1980).

(2) Functional Form. The linearity assumptions are crucial in a large class of econometric models. Time trend and seasonal effects can be easily accommodated as part of the constant term. The non-linearities of interest are the ones which cannot be accommodated into a linear conditional mean after log transformations. RESET type tests (Ramsey,1974) are useful indicators of non-linearity especially in cases where the degrees of freedom are very small.

(3) Economic Theory. The main problem here is whether the chosen model is pertaining to an equilibrium state of the economy or a disequilibrium state. The partial adjustment model introduces a lagged dependent variable, either from adaptive expectations when permanent income is posited, or from a one period quadratic cost function. In general, the theoretical underpinning of dynamic models are weak and given this, one should aim at the design of a well-defined statistical model.In particular, the choice of lag lengths is very crucial in the design of a good model. It is

important to see if the lag chosen is too large or too small and a wide range of 'tests' are available in the literature (see Spanos 1986).

(4) The Error Term. The concept of data coherency in Hendry (1983) is related to the history of the sample observation. It is not very clear precisely how to define 'data coherency' and how to detect its presence or absence. Approximately, it implies goodness of fit and absence of residual autocorrelation. The Box-Pierce portmanteau test for autocorrelation and the LM tests are utilized to detect serial correlation. Forecast and stability tests should also detect serial correlation as models with dynamic error structure quite often fail these tests. This assertion reinforces the importance of the jointness of hypotheses testing.

(5) Boundary Conditions. Until now, the GSMA has been applied in developed economies. If this research programme is to be sustained, it should also hold when extended to different economic environments. Domowitz and Elbadawi (1987) and this study show that the General to Specific methodology can be employed to investigate LDCs data.

To recap, we note that the grouping of hypotheses being tested should be seen as a structured whole. Evidence against a particular hypothesis will not, in general, result in that hypothesis being immediately discarded, since this would have a great cost in terms of the credibility of related hypotheses within the same research programme. Hendry (1985) warned:

> it is no longer a legitimate defense to claim: I have not tried it because it won't work or I have not tried it because I can't.

6.3 Statistical Foundation

If the data generation process were known (as in a Monte Carlo experiment), then the population outcome of any combination of prior model specification and estimation method could be deduced analytically. In other words, the DGP entails the empirical model. The required analytical derivation would involve reducing the DGP to the desired model. Thus, empirical econometric models are implicitly being derived from the economic DGP by a sequence of transformations and reductions. Typical transformations include aggregations (over time, space,agents, and commodities) as well as standard mathematical operations of divisions,logarithms, etc. Typical reductions comprise eliminating unwanted variables (e.g.,disaggregated information), usually referred to as marginalizing and conditioning these variables on other variables which are not to be explained. Every transformation and reduction applied to the data series entails a corresponding transformation and reduction of the original parameters of the DGP to produce the reduced parameterization of the econometric model. Also, given the observed data and some formal model specification, its error process is then a derived function rather than an autonomous innovation and, by construction, that error must contain everything in the data which is not explicitly allowed for by the model. Consequently, models are open to design possibilities whereby undesirable features of either the error process or the parameterization can be eliminated by appropriate respecification.

Quite often, the transition from observed data to the statistical model is made by assuming that the observed data constitutes a realization $W^1{}_T = (w_1, w_2, \ldots\ldots, w_T)'$, which is generated by simulating a random process using the random numbers as $D(W^1{}_T | W^o; \Theta)$. This assumption provides the necessary link between the actual DGP and the probability theory. It enables us to postulate a probability structure for $\{w_t, t \in T\}$ in the form of its joint density function:

$$D(w_1, w_2, \ldots, w_T, | W^o : \Theta) \qquad (6.8)$$

Where T is the number of observations on w_t, $W^o{}_t$ denotes the initial conditions: $(W^o{}_t = (w_t, w_{t-1}, \ldots, w_1)$, Θ is the relevant parameterization (which may include transient parameters dependent on t.), D(.) is a function of complexity and high dimensionality of an evolving mechanism, involving many latent variables. Limitations on data, time, and knowledge preclude estimating the complete model.

An econometric model containing a vector of observable variables, $\{x_t\}$ can be conceptualized as arising by first transforming w_t so that x_t is a tiny sub-vector, and then marginalizing the joint density D(.) with respect to all variables in w_t other than x_t (i.e. eliminating from D(.) those variables not considered in the analysis). That provides the reduced form $\Pi^{T}{}_{t=1}\ F(x_t | x_{t-1}, \ldots, x_1, \lambda_t)$. Economic theory offers guidance on sensible selection of x, and the associated choice of F(.).

Ignoring initial conditions (for convenience), we can partition x_t into y_t and z_t i.e. $x_t' = (y_t;z_t)'$ where the set y_t is classified as endogenous and z_t exogenous. Using the basic statistical operation of conditioning and marginalizing, we can write $x_t' = (y_t;z_t)'$ as.

$$F(x_1,\ldots,x_T;\ \lambda) = \Pi^{T}{}_{t=1}\ F(y_t | z_t, x_{t-1}, \ldots, x_1;\ \alpha 1) \quad \mathrm{X}$$
$$\Pi^{T}{}_{t=1}\ F(z_t | x_{t-1}, \ldots x_1;\ \alpha 2) \qquad (6.9)$$

The first factor on the right-hand side in (6.9) is the conditional model for $\{y_t\}$ and the second is the marginal model for $\{z_t\}$. λ is assumed to be constant and α is the transformation of λ needed to sustain factorization. This being the case, the marginal distribution of the second term on the right hand side of (6.9) can be ignored as it contains no new information on the parameters of interest.If we restrict ourselves to linear approximation (after suitable data transformation), the generic result would end up something like:

$$y_t = \beta_o z_t + \Sigma^{m1}_{i=1} \alpha_i y_{t-i} + \Sigma^{m2}_{i=1} \beta_i z_{t-i} + u_t \qquad (6.10)$$

For the linear statistical model (6.10) to be valid, the following assumptions should hold.

(1) m is chosen properly to avoid near collinearity.

(2) The parameters of interest, Θ, defined as $\Theta = (\alpha_1, \ldots\ldots, \alpha_m, \beta_o, \beta_1, \ldots\ldots, \beta_m, \sigma^2)$ are parsimonious.

(3) z_t is exogenous with respect to the parameters Θ for t = m+1,....,T. The Granger (1969) causality test requires that all the coefficients of lagged z_t must be zero, i.e., $\beta i = 0$, (i = 1,2,....,m)

(4) Equation (6.10) is:

(i) normal

(ii) linear in its explanatory variables and;

(iii) has a homoscedastic variance;

(5) Θ is times invariant;

(6) $y = (y_{m+1}, y_{m+2}, \ldots\ldots, y_T)'$ is a stationary, asymptotically independent sample sequentially drawn from $D(y_t | x_{t-1}, x_t; \Theta^*)$, t = m+1, m+2, ...,T, respectively.

Before any attempt is made to relate the statistical parameters to theoretical parameters of interest, we need to ensure that the estimated statistical model is well-defined, that is, the underlying assumptions (1)-(6) are valid. Otherwise, any statistical arguments based on invalid assumptions will be misleading. Checking the validity of these assumptions is the task of misspecification testing in the context of the dynamic linear regression model. The concept of a 'well-defined' statistical model plays a vital role in the general to specific modelling approach. The statistical model is not constrained to coincide (one-to-one) with the theoretical model. For example, there is no adherence to one period lag in the explanatory variables involved if the temporal structure of these variables require more than one period in order to yield a well defined statistical model.

In the case where misspecification testing leads to the rejection of one or more of the assumptions underlying the model, the GSMA proceeds by respecifying the model so as to take account of the invalid assumptions. This contrasts with the conventional approach which engages in a local surgery by drafting the alternative hypothesis of misspecification testing into an otherwise unchanged model such as postulating an AR(1) error process. Instead, the GSMA starts with a well-defined statistical model and then proceeds to testing any theoretical restrictions which can be related to the statistical specification. The specification of the empirical econometric model can be viewed as a reparameterization of the estimated statistical model, so as to to be expressed in terms of the theoretical parameters of interest. Any parameterization which imposes restrictions on the statistical parameters can be tested within the conventional hypotheses-testing framework and can be accepted or rejected. The aim of the GSMA is to construct an approximation of the actual DGP in terms of the theoretical parameters. Although one needs to ensure that the theoretical parameters of interest ϕ (say) are uniquely defined in terms of the statistical parameters Θ^*, there is nothing unique about ϕ. Numerous theoretical parameterization are possible for any well-defined set of statistical parameters. In practice,we need to choose one of such possible reparameterization of the estimated general model.

To sum up, the main feature of the GSMA is the broadening of the intended scope of econometrics. Econometric modelling is viewed not as the estimation of theoretical relationships, nor as a procedure in establishing the 'trueness' of economic theories, but as an effort to understand observable economic phenomena of interest, using observed data in conjunction with some underlying theory within the framework of sound statistical foundations.

6.4 Quasi-Theoretical Basis

Since the publication of the influential paper by Davidson *et al* (1978), the error correction mechanism has become an important feature of the general to specific modelling approach. Error correction models are not new and their origin can be traced back to the works of Phillips

(1954,1957) on 'servomechanism' control rule in control engineering. Equation (6.3) is a typical error correction model in the spirit of DHSY (1978), but Hendry and Ungern-Sternberg (1981) have re-written the consumption function as:

$$\Delta c_t = c_o(c-y)_{t-1}+c_1\Delta y_t+c_2(a_{t-1}-y_{t-1})+u_t \qquad (6.11)$$

where a_t is a proxy for the influence of liquid assets on consumption. They interpret c_o, c_1 and c_2 as parameters of derivative, proportional and integral controls. The new element here is the interpretation of flow variables (liquid assets) as integral correction mechanism in the context of error correction models.

Error correction models similar to (6.11) are also expected to be consistent with the underlying economic theory and the extended version of the familiar one-period loss function discussed in chapter 1. For ease of reference, we reproduce the quadratic cost function.

$$c_1(m_t-m_t*)^2 + c_2(m_t-m_{t-1})^2 \qquad (1.2)'$$

where m* is the logarithm of 'desired' or optimal money balance and m is planned balances, also in logs. As noted by Hendry (1980), penalizing the individual by adjusting balances by $c_2(m_t-m_{t-1})^2$ is useful only if the system remains in the near neighbourhood of m_{t-1}. This might be true if other forces affecting real balances are constant, but will not hold if for example all variables are known to be growing at a constant rate. One way to correct the situation is to add a term such as $-c_3(m_t-m_{t-1})(m^*_t-m^*_{t-1})$ to (1.2)'. Lower costs are associated with changes in cash balances when the direction of change in desired balances is known to the agent, and the individual moves in the right direction. Such an approach is defended by Hendry and von Ungern-Sternberg (1981) in the context of consumption analysis, and is further developed for money demand by Domowitz and Elbadawi (1987).

The minimization of (1.2)', or a variant such as that suggested above represent some myopia on the part of economic agents. In a fully 'rational' world, an individual bases his decisions on a discounted sum of future expected losses. We now follow Nickell (1985) in the derivation of an error correction model based on a stochastic dynamic equation.

Let the intertemporal loss function at time t be

$$L_t = \sum_{s=0}^{\infty} \alpha^s [\lambda_1 (m_{t+s} - m^*_{t+s})^2 + (m_{t+s} - m_{t+s-1})^2 - 2\lambda_2 (m_{t+s} - m_{t+s-1})(m^*_{t+s} - m^*_{t+s-1})], \quad (6.12)$$

$$\lambda_1, \lambda_2 > 0$$

Where $\lambda 1$ and $\lambda 2$ represent the weights attached to the cost of being away from desired money holdings and α is a subjective discount factor. The second term of (6.12) is the standard quadratic adjustment cost on which we normalize, and the third term implies that the loss is attenuated if the individual moves in the 'right' direction. The minimization of (6.12) is an exercise in the discrete time calculus of variation (see Sargent,1979). The problem facing the economic agent is finding a sequence of $\{m_{t+s}\}^{\infty}_{s=0}$ so as to minimize the expectation of L_t conditional on information available at time t. To find a solution to this problem, we first differentiate (6.12) with respect to m_{t+s} to obtain the first order condition. Abstracting from expectations signs, the first order condition may be written as:

$$[\alpha L^{-1} - (1+\alpha + \lambda 1) + L] x_{t+s} = \lambda 1 (\lambda 2 - 1) m^{*}_{t+s} \qquad (6.13)$$

where $x_{t+s} = m_{t+s} - \lambda 2 m^{*}_{t+s}$, and L^{-1} is the forward-shift operator: $L^{-k} w_t = w_{t+k}$ for any variable w. We can factorize the left-hand side of (6.13) as:

$$\rho_0(1-\mu L)(1-\rho_1 \mu L^{-1}) x_{t+j} \qquad (6.14)$$

and matching coefficients, $\rho_0 = -1/\mu$, $\rho_1 = \alpha$, while μ satisfies:

$$\rho\mu^2 - (1+\alpha+\lambda)\mu + 1 = 0 \qquad (6.15)$$

The roots of (6.15) are positive and on either side of unity.[1] This procedure generates (after some tedious algebraic manipulation) the optimal policy at time t in terms of conditional expectations of x_{t+j}, i.e.

$$\Delta m_t = \lambda 2 \Delta m^{*}_t + (1-\mu)[(\lambda_2 m^{*}_{t-1} + (1-\lambda_2)(1-\alpha\mu) \times \Sigma^{\infty}_{s=0} (\alpha\mu)^{s} E_t m^{*}_{t+s}) - m_{t-1}] \qquad (6.16)$$

An important feature of (6.16) is that it is a structural version of what is termed 'the error correction rule', in which the long run target is a geometrically weighted combination of expected target values, starting at time t-1. The ECM representation usually employed in the literature lacks the expectational terms, and deviations from the target are measured as proportional to $(m^{*}-m)_{t-1}$. The error correction model conveniently nests the usual partial adjustment paradigm if $\lambda 2$ in (6.16) is set to zero.[2] This eliminates considerations of a growing target from the objective function, and equation (6.16) becomes a partial adjustment model, incorporating forward-looking behaviour, i.e.

$$\Delta m_t = (1-\mu)\{1-\alpha\mu)\Sigma^{\infty}_{s=o}(\alpha\mu)^s m^*_{t+s}-m_{t-1}\} \qquad (6.17)$$

In order to estimate equation (6.16) or (6.17), we should obtain values for m^*_{t+s}. Nickell (1985) shows that a second order autoregressive scheme with unit root and drift well characterizes a fairly wide class of macroeconomic time-series.[3] We write this stochastic process as:

$$\Delta m^*_t = g + \beta\Delta m^*_{t-1} + \varepsilon_t \qquad (6.18)$$

ε_t is white noise

Given (6.18), the expectations in (6.16) can be calculated for the case in hand. Recursion yields

$$E_t m^*_{t+s} = m^*_{t-1}+(1-\beta)g^s+g(\beta^s-1)/(1-\beta)^2+[(1-\beta^{s+1})/1-\beta]\Delta m^*_t \qquad (6.19)$$

Substituting (6.19) into (6.16), letting $\lambda = 1-\lambda_2$, and rearranging terms, we arrive at the final error correction rule, given by

$$\Delta m_t = \delta_0 + \delta_1 \Delta m^*_t + \delta_2 (m^*_{t-1} - m_{t-1}) + u_t \qquad (6.20)$$

where $\delta_0 = [(1-\mu)\lambda\alpha\mu g]/[(1-\alpha\mu)(1-\alpha\mu\beta)]$

$$\delta_1 = \{1-\alpha\mu\beta(1-\lambda)-\lambda\mu\}/(1-\alpha\mu\beta)$$

$$\delta_2 = (1-\mu)$$

There are a number of points to mention about (6.20):

1.the constant term, (δ_0) enables the equation to track the growing target;

2. the ECM model will arise only when $\lambda_2 \neq 0$.

3. equation (6.20) suggests that as soon as we allow the target(m^*_t) to follow anything more complex than a first-order autoregression, the structural equation (6.16), which is fundamentally a partial adjustment mechanism, will reduce to a genuine ECM in terms of observable variables.

From the above discussion, it appears that the ECM representation may be consistent with forward-looking expectation models. However, this feature of the GSMA will have to be examined very carefully before any firm conclusions are drawn about it. For example, Cuthberthson (1985b, 1988) argues that if the forward- looking model is the true model, then the parameters of the ECM equation are mixtures of expectations and adjustment cost parameters and are exposed to the Lucas (1976) critique. However, one can also ask what if the ECM representation is the true model? In fact, Muscatelli (1987), has shown that the performance of 'forward-looking' models, compared to models obtained using the general to specific approach is poor. He also claims that the conventional error correction models 'variance dominate' the forward-looking models. Thus, error correction models are not only consistent with rational expectation, but also beat forward-looking models. In addition, Cuthberson's solution to the problem of the Lucas critique, by explicitly modelling the expectations generating process through autoregressive forecasting equations has been challenged by Hendry (1988) on the evidence that autoregressive forecasting equations, (marginal models), are not constant and hence all the analysis and claims made by Cuthbertson do not have the 'forward-looking' interpretation.

Another problem of error correction models is raised by Currie (1981), where he argues that the static long-run properties of error correction models are well determined, but the dynamic long-run properties are not. This point can be demonstrated by considering the following conventional error correction model.

$$\Delta y = c_o(y-x)_{t-1} + c_1\Delta x_t + c_2 x_{t-1} + u_t \qquad (6.21)$$

For dynamic stability we require that $c_o < 0$ and, in static equilibrium all growth rates are zero and (6.21) yields

$$y = [(c_o - c_2)\ x]/c_o \tag{6.22}$$

Hence, the ECM has an elasticity with respect to x that is greater than, equal to or less than unity depending on whether c_2 is greater than, equal to or less than zero. In a dynamic equilibrium where y grows at a constant rate $\pi 1$, we have $y_t = y_{t-j} + j\pi 1$, and similarly for $x_t = x_{t-j} + j\pi 2$ if it grows at a rate of $\pi 2$. Substituting these expressions in the ECM equation (6.21) and rearranging, we obtain

$$c_o y_t = (c_o - c_2) x_t + \pi 1 (1 + c_o) - \pi 2 (c_o + c_1 - c_2) \tag{6.23}$$

Differencing (6.22) and noting that $\Delta\pi i = 0$, we get

$$\pi 1 = [(c_o - c_2)/c_o]\pi 2$$

and substituting this in (6.23) yields

$$y_t = \frac{(c_o - c_2) x_t}{c_o} + \frac{[c_o (1 - c_1) - c_2]\pi_2}{c_o^2} \tag{6.24}$$

Thus, in general, the relationship between y and x depends on the growth rate in x. This conclusion is still valid in a more general model where a long-run dynamic relationship between y and k explanatory variables $x_i = (x_1, \ldots, x_k)$ comprises all the terms of the static long-run relationship, and also the rate of growth of each independent variable x_i. Currie's argument is that the coefficients of the rate of growth are not reliable since their values are very sensitive to the sample size and to the number of lags considered. An interesting special case of (6.24) occurs when there is a unit elasticity in static equilibrium between y and x, i.e., $c_2 = 0$, and

$$y_t - x_t = [(1-c_1)c_o]\pi_2 \tag{6.25}$$

Now c_o must be negative so that the first order difference equation (6.21) can be dynamically stable. Therefore, if c_1 is less than unity, the ratio Y/X (or in logarithms, y-x) depends negatively on the rate of growth of X. For example if Y is real money balance and X is real income, then the money-income ratio is lower the higher the rate of growth in real income. A negative growth effect occurs when the impact effect of x_t, i.e., c_1 is less than the long-run effect of unity. Such undershooting also gives rise to a negative growth effect in the more general equation (6.21).

In general, EC models have weak theoretical basis, and some people argue that the growth effects described above are implausible in the sense that negative growth effects are nothing more than the persistent underprediction noted in chapter 5 in relation to partial adjustment models. Not withstanding this criticism, the error correction approach is consistent with agents' cost minimization efforts and 'weak' rational expectations. Furthermore, this approach provides a more coherent framework than the text-book econometric methodology by using the distinction between a statistical and an empirical econometric model. This distinction enables us to separate the issues of statistical adequacy, which are related to the statistical model, and model selection which can be best viewed as choosing among several empirical models nested within the same adequate statistical model. In view of this framework, Leamer's critique also loses its cutting edge because the assumptions about the uniqueness or completeness of the chosen regressors are made in the context of a statistical model.

Having outlined the scientific, statistical and theoretical basis of the GSMA, we now turn to the estimation and analysis of 'error correction' models.

6.5 Estimation

The strategy adopted by the majority of investigators is to specify an intentionally overparameterized model with as many lags as possible. As our sample size is not sufficiently large, we choose to begin our investigation with a very restricted lag structure. This is particularly important given that our data is annual with only 27 observations. Following the customary practice, we reformulated equation (6.1) in terms of real money balance, which gives

$$(m-p)_t = a_0 + \Sigma^{m1}{}_{j=1} a_j m_{t-j} + \Sigma^{m2}{}_{j=0} b_j y_{t-j} + \Sigma^{m3}{}_{j=0} c_j r_{t-j} + \Sigma^{m4}{}_{j=1} d_j (m-p)_{t-j} + \Sigma^{m5}{}_{j=0} e_j p_{t-j} + u_t \qquad (6.26)$$

engage in a simplification search,i.e., reparameterize the model in order to obtain a model with an ECM term eventually. However, there is no guarantee that this will necessarily yield an ECM, (as McAcleer *et al.* (1985), and Pagan (1987)) pointed out that the simplification and reparameterization steps in the GSMA are often merged together. An alternative strategy is to begin by transforming (6.26) which reverts to (6.4) with an ECM term being introduced at the outset. The implied restriction imposed on (6.24) is unit price and income elasticities.The validity of this restriction can be tested by adding the terms $\gamma_1 y_{t-1}$ and $\gamma_2 p_{t-1}$ to equation (6.4) and then test the null hypothesis, $\gamma_1 = \gamma_2 = 0$ We have explicitly tested the validity of equation (6.4) in the context of the countries under consideration and only in two cases (Brazil and Kenya) that the F-test rejected the unit elasticity restriction.[4]

Two types of equations have been estimated for each of the countries in this study. The first equation is a relatively general model (with a maximum lag of one year for each variable). This procedure enables us to detect the presence of common factors among the regressors. The second equation is the simplification of the unrestricted model using the techniques described in section 6.1.

When type-one equation was estimated for 11 developing countries covering the period 1960-1987, the results detailed in table 6.2 were obtained. As it stands, such a general model is rather unhelpful in its existing form. It is grossly overparameterized as few of the regressors are significant, and the ECM term which captures the long-run relationship between the variables is only significant in four cases. This is probably due to collinearity between the constant and the ECM term. From the statistical point of view, we can either drop the constant or the ECM term to tackle the problem. When the equation was estimated without the ECM term and the resultant specification was reduced, a statistically plausible model,(not reported to save space), was obtained for each country. However, dropping the ECM term leads to loss of long run information while suppressing the constant does not. DHSY (1978) prefer to drop the constant term so that the resulting specification is consistent with economic theory. Accordingly, we have retained the error correction term in all cases, and only included the constant where such knock out effects are absent.

The next task is to reduce the overparameterized model to manageable proportions, but this exercise is quite formidable. For example,in the absence of acceptable procedures or 'codes' for variable deletion or combination, how can one impose only credible restrictions on the ADL model so as to move to a more parsimonious representation? Naturally, it is essential to impose restrictions which, while being theoretically sensible, are not rejected by the

Table 6.2: parameter estimates of a relatively unrestricted ADL model

Variable	Mexico	Brazil	Peru	Colombia	India	Sri Lanka
Con.	-.17	.76	-.74	-.21	.13	-.61
	(.40)	(2.7)	(2.5)	(1.6)	(1.4)	(2.4)
(m-y-p)1	.13	.32	-.47	-.196	.02	-.40
	(.69)	(2.1)	(2.4)	(2.5)	(.48)	(2.3)
Δp	.28	-.25	.26	-1.02	-1.1	-.96
	(.51)	(1.8)	(1.6)	(4.8)	(4.8)	(1.9)
Δp-1	-.11	-.21	-.11	.06	-.60	-.46
	(.24)	(1.1)	(.69)	(.27)	(2.3)	(.72)
i-1	-.001	.001	-.001	.01	.01	.02
	(.19)	(.68)	(.36)	(2.9)	(2.7)	2.6)
Δi	-.004	.004	.003	.001	.01	-.005
	(.85)	(4.0)	(1.6)	(.10)	(2.1)	(.28)
Δy	.13	.13	1.3	.11	.11	-.59
	(.15)	(.58)	(3.7)	(1.7)	(.41)	(1.6)
Δm-1	.36	-.46	.50	.38	-.26	.24
	(1.2)	(1.9)	(2.7)	(1.3)	(1.3)	(.92)
R^2	.31	.79	.65	.61	.83	.65
s	.12	.15	.07	.06	.04	.08
DW	1.8	2.1	2.3	1.6	2.3	2.2
RSS	.2997	.4341	.0958	.0810	.0361	.0870

table 6.2 (continued)

Variable	Korea	Phil.	Thailand	Kenya	Malawi
Con.	.02	-.59	.10	-.63	-.62
	(.28)	(2.4)	(1.2)	(1.8)	(1.3)
(m-y-p)1	-.001	-.43	.03	-.54	-.37
	(.02)	(2.9)	(.88)	(2.1)	(1.5)
Δp	-1.5	-.84	-.66	-.33	-.73
	(6.5)	(6.0)	(3.2)	(.53)	(.53)
Δp-1	-.68	.09	.04	.68	-.73
	(2.1)	(.40)	(.16)	(1.1)	(.97)
i-1	.01	.002	.003	-.005	.02
	(3.9)	(.38)	(.68)	(.85)	(.76)
Δi	.008	-.005	-.001	.01	-.04
	(2.0)	(1.1)	(.10)	(.62)	(1.2)
Δy	.14	-.16	.51	.85	.33
	(.43)	(.48)	(1.6)	(1.7)	(.94)
Δm-1	.23	.44	-.21	.18	.02
	(.69)	(2.3)	(1.7)	(.30)	(.07)
R^2	.87	.87	.56	.65	.42
s	.06	.05	.04	.08	.10
DW	1.8	2.2	1.8	2.3	2.2
RSS	.0689	.0386	.5580	.0810	.1340

Where the dependent variable is Log Δm, t-values are shown in parenthesis, s = standard error of the regression and RSS is the Residual Sum of Squares.

data and do not induce serial correlation by omitting significant (autoregressive) factors. On the other hand, because of collinearity, the 'incorrect' inclusion of a variable is often concomitant with the 'exclusion' of appropriate factors.Thus, the process of model reduction is one of trial and error, involving the examination of a variety of models. When the general dynamic specification given by (6.4) was estimated and reduced, we got hold of the following 'best' results for each of the countries under consideration.

1. Mexico

$$\underset{}{\Delta m} = \underset{(2.7)}{-.056(m-y-p)_{-1}} \ \underset{(1.4)}{+.25\Delta m_{-1}} \ \underset{(1.6)}{-.001\, i}$$

$R^2 = .47$, $s = .117$, $DW = 1.9$, $RSS = .3168$, $z_1 = .356$,
$n_1 = .31$, $n_2 = 0$, $SK = 1.03$, $EK = 2.53$, $z_2(2) = 10.3^*$,
$n_3 = 1.2$, $z_3 = 2.4$, $n_4(5,18) = 1.7$

2. Brazil

$$\Delta m = \underset{(2.3)}{-.08(m-y-p)_{-1}} \ \underset{(3.5)}{-.38\,\Delta p} \ \underset{(2.0)}{+ .34\Delta y} \ \underset{(1.4)}{-.256\,\Delta m_{-1}} \ \underset{(6.4)}{+ .005\Delta i}$$

$R^2 = .75$, $s = .161$, $DW = 2.0$, $RSS = .5437$, $z_1 = .244$
$n_1 = .19$, $n_2 = 1.35$, $SK = .350$, $EK = -2.44$, $z_2(2) = 1.09$
$n_3 = 5.9^*$, $z_3 = 105.6^*$, $n_4(5,16) = 9.6^*$

3. Peru

$$\Delta m = \underset{(2.6)}{-.756} \ \underset{(2.5)}{-.48(m-y-p)_{-1}} \ \underset{(3.8)}{+1.26\Delta y} \ \underset{(1.6)}{+.003\Delta i} \ \underset{(1.7)}{+.24\Delta p} \ \underset{(1.8)}{-.15\Delta p_{-1}} \ \underset{(2.8)}{+ .51\Delta m_{-1}}$$

$R^2 = .64$, $s = .091$, $DW = 2.3$, $RSS = .09656$, $z_1 = 5.2^*$,
$n_1 = 2.6$, $SK = -.90$, $EK = -1.6$, $z_2(2) = .65$, $n_2 = .154$,
$z_3 = 3.17$, $n_4(5,14) = 1.4$

4. Colombia

$$\Delta m = -.221 \underset{(1.8)}{} -.21(m-y-p)-1 \underset{(2.9)}{} - 1.04\Delta p \underset{(5.0)}{} +.008i. \underset{(4.0)}{} +12\Delta y \underset{(1.8)}{} -.008\Delta i \underset{(1.3)}{}$$

R^2 = .61, s = .063, DW = 1.6, RSS = .083, z_1 = .903
n_1 = -.69, n_2 = .68, SK = -.43, EK = 1.8, $z_2(2)$ = .19
n_3 = .21, z_3 = 14.0*, $n_4(5,16)$ = 3.49*,

5. India

$$\Delta m = -.04(m-y-p)-1 \underset{(2.8)}{} -1.09\Delta p \underset{(8.2)}{} -.338\Delta p-1 \underset{(2.5)}{} +.016i \underset{(5.7)}{} +.015\Delta i \underset{(2.9)}{}$$

R^2 = .86, s =.045, DW = 2.7, RSS = .04308, z_1 =3.2
n_1 = 2.8, n_2 =.05, SK = 2.3, EK = 7.08, $z_2(2)$ = 1.7,
n_3 = .599, z_3 = .19, $n_4(5,16)$ = .18

6. Sri Lanka

$$\Delta m = -.567 \underset{(2.4)}{} -.378(m-y-p)-1 \underset{(2.3)}{} -.1.13\Delta p \underset{(2.7)}{} +.021i \underset{(2.8)}{} +.56\Delta y \underset{(1.6)}{} +.36\Delta m-1 \underset{(2.0)}{}$$

R^2 = .63, s = .073, DW = 2.4, RSS = .091, z_1 = 2.6,
n_1 = 2.1, SK = .339, EK = .19, z_2 (2) = .352, n_2 = .33
n_3 = 1.6 z_3 = .79, $n_4(5,12)$ = .23

7.Korea

$$\Delta m = -.048(m-y-p)-1 \underset{(1.9)}{} +.01i_{-1} \underset{(7.9)}{} -1.7\Delta p \underset{(7.7)}{} +.58\Delta p-1 \underset{(2.5)}{}$$

R^2 = .90, s = .065, DW = 1.5, RSS = .09329, z_1 = 1.8
n_1 = 1.6, SK = -.55, EK = -.415, $z_2(2)$ = 1.3, n_2 = .02
n_3 = .516 z_3 = .20, $n_4(5,17)$ = .18

8. Philippines

$$\Delta m = -.52 +-.41(m-y-p)-1 -.004\Delta i -.78\Delta p + .32\Delta m-1$$
$$(3.0) \quad (3.8) \quad (1.1) \quad (7.5) \quad (3.4)$$

R^2 = .84, s = .093, DW = 1.9, RSS = .043, z_1 = .09,
n_1 = .07, n_2 = .01, SK = -.381, EK = .205, $z_2(2)$ = .545,
n_3 = .71, z_3 = 1.89, $n_4(5,16)$ = 1.3

9.Thailand

$$\Delta m = -.126(m-y-p)-1 -.96\Delta p +.39\Delta m-1 +.45\Delta y$$
$$(3.3) \quad (3.5) \quad (2.7) \quad (1.2)$$

R^2 = .75, s = 103, DW = 1.0, RSS = .2358, z_1 = 10.0*
n_1 = 13.2*, n_2 = .30, SK = -.745, EK = .206, $z_2(2)$ = 2.1,
n_3 = 1.1, z3 = .88, $n_4(5,17)$ = .64

10. Kenya

$$\Delta m = -.369 -.349(m-y-p)-1 -.004i_{-1} +.99\Delta y$$
$$(2.0) \quad (2.3) \quad (.80) \quad (2.9)$$

R^2 = .59, s = .075, DW = 2.3, RSS = .098, z_1 = 1.4, n_1 = 1.2
n_2 = 1.3, SK = .138, EK = -1.273, $z_2(2)$ = 2.03, z3 = 4.6,
$n_4(5,12)$ = .89

11.Malawi

$$\Delta m = -.086(m-y-p)-1 -.745\Delta p-1 -..037\Delta i$$
$$(3.1) \quad (1.7) \quad (1.3)$$

R^2 = .40, s =.098, DW = 2.1, RSS = .165, z_1 = .51, n_1 = .41
n_2 = .07, SK = .387, EK = -1.283, $z_2(2)$ = 1.6, n_3 = 2.5,
z_3 = 4.9, $n_4(4,13)$ = 2.2

* = significant at α = 5%
t-values in parenthesis

Table 6.3

Country	short-run impact of inflation	Disequilibrium coefficient	Equilibrium impact of inflation	Interest impact
Mexico	....	-.06	...	-.02
Brazil	-.38	-.08	-4.8	
Peru	-.15	-.48	-.19	
Colombia	-1.03	-.21	-4.9	
India	-1.4	-.04	-35.0	
Sri Lanka	-1.1	-.37	-2.9	
Korea	-1.7	-.05	-34.0	
Phil.	-.78	-.41	-1.8	
Thailand	-.96	-.13	-7.3	
Kenya	....	-.35	....	-.01
Malawi	-.75	-.08	-8.7	

The diagnostic tests reported above are the following: first, $n_1(l)$ is the Lagrange Multiplier test for serial correlation in the residuals of lags up to l (see Godfrey,1978, Harvey,1981). In small samples, and where the equation contains lagged dependent variable, the $n_1(l)$ statistic appears to be the most useful test of serial correlation. $n_2(l)$ is a test for Autoregressive Conditional Heteroscedasticity in the residuals (Engle,1982), which is reported in its F-form. $z_1(l)$ is the Box-pierce portmanteau test for autocorrelation (Box and Pierce,1970). It is distributed asymptotically as central χ^2 with (l) degrees of freedom where l is the order of autocorrelation under the null hypothesis of no serial correlation in the error term (Harvey, 1981). Sk stands for skewness and EK stands for excess kurtosis. $z_2(2)$ is, therefore, a test for 'normality' and it is called 'skewness-kurtosis' test, (Jarque and Bera,1980), which is distributed as chi-squared(2) (see also Spapnos,1986). $n_3(l)$ is the RESET(l) test for any possible departures from the linearity assumption in the structure of the equations (Ramsey, 1974). $n_4(k_1,k_2)$= Chow (1960) test for parameter stability. It has an F-distribution with k_1(= the number of post-sample observations) and k_2(= T-k) degrees of freedom, under the null hypothesis of constant parameters in the two sample periods. Finally, $z_3(l)$ is the so-called 'Hendry Forecast Test' for l periods ahead (Hendry, 1979) which is an asymptotically valid test for parameter constancy, and is a useful indicator of the model's ex ante forecasting performance.

6.6 Evaluation of Results

The usual model selection criteria is not followed in this study as the sample size is very small to embark on such venture. We have, therefore, chosen to be more practical in undertaking the model evaluation exercise. However,a good model must at the very least meet the following model evaluation criteria:

(a) theory consistency;
(b) goodness of fit;
(c) predictive accuracy and parameter constancy;
(d) absence of residual heteroscedasticity;
(e) validity of a prior restrictions on parameters;
(f) parsimony.

From the various test statistics reported along with the error correction models, we conclude that most of the equations pass the most important tests. In the case of Peru, two lags proved sufficient, in terms of the LM statistic, to generate white noise errors. The n_2 statistic clearly shows that there is no misspecification due to heteroscedasticity at 5% in all equations. Similarly, the $z_2(2)$ diagnostic implies that, to the extent that the other assumptions underlying the regression models are valid, the null hypothesis of SK = 0 and EK = 0 is rejected only in two case (Mexico and India). Put another way, the assumption of normality is valid in nine out of eleven cases. Five observations were retained for the Chow stability and ex ante forecasting tests. The Chow test indicates no parametric shift in almost all equations with the exception of Brazil. Over all,the performance of two equations (Brazil and Thailand) is not satisfactory. In the case of Thailand there is clear evidence of serial correlation up to three periods. The Brazilian equation fails the stability, forecast and the RESET tests. The error correction representation does not hold for Brazil and Kenya as the F-test rejects the homogeneity assumptions imposed on equation (6.4). Three equations also fail the forecasting test.[5]

Another aspect of our preferred equations is the significance of the error correction coefficient in all countries. A separate regression which includes y_{t-1} and p_{t-1} (not reported to save space) has also confirmed the homogeneity assumption with the exception of Brazil and Kenya. Inflation appears to be very important in all cases with the exception of Mexico and and Kenya. The role of interest rate in the demand for money is not important in our equations. It has the right sign in Mexico, Philippines, Kenya and Malawi but not significant. This phenomena may not be surprising as nominal interest rates are fixed for most of the sample period while the rate of inflation is quite high.

The long-run properties of these equations are very interesting. Table 6.3 documents the disequilibrium coefficient, the short-run and equilibrium elasticities of inflation. The levels impact of inflation is surprisingly low in Latin American countries (ranging from .08 to .21) given that the average annual rate of price changes in this group is very high over the sample period. On the other hand, the equilibrium effect for the Asian and the two African countries is extremely high, although these countries experienced mild inflation compared to the Latin American group. over all, the equilibrium inflation impact is higher in all countries, the lowest being .31 (Peru) and India and Korea have registered a record level of 23.0. Such a value is even higher than those reported by Cagan (1956) for countries experiencing hyperinflation. These abnormally high equilibrium magnitudes are partly due to the low value of the error correction coefficient. The absolute value of the ECM term is less than 0.5 in all countries and it exceeds 0.1 only in six cases. But, these values are,perhaps, surprisingly similar to the UK money demand as reported in Hendry and Ericson (1987), and Rose (1985) for the US where the absolute value of the error correction coefficient in these countries is .05 and .06 respectively.

To conclude, we have estimated demand for money functions for eleven developing countries using the conventional error correction approach. Eight of the equations we estimated meet a number of statistical criteria set for model evaluation. Compared to the partial adjustment model, which has dominated the money demand literature regardless of the country specific applications, the ECM specification is more general and nests the partial-adjustment process. However, the long-run impact of inflation is implausibly high in all equations. Also, the case of three equations which failed a host of statistical tests is perplexing because these equations correspond to countries which have relatively sophisticated financial systems. In particular, the financial system of Brazil is well organized and has expanded during the period under consideration and it is hard to understand why the ECM specification miserably failed to characterize the Brazilian data.One explanation could be an invalid conditioning on the explanatory variables such as imposing a unit income elasticity. To overcome this problem we shall re-estimate our models without imposing such restrictions using the 'co-integration' techniques developed by Granger and Engle (1987).In the next chapter, this approach will be discussed in some detail and the results of this class of 'error correction' models shall be contrasted with those obtained from the general to specific approach.

NOTES

1. Let $q(\mu)$ denote the quadratic expression. We have $q(0) > 0$, $q(1) < 0$, and $q(\mu) \to \infty$ as $\mu \to \infty$

2. Note that this example provides an argument against the objective function (6.12), not against the error correction specification per se. It has been demonstrated that error correction specifications can be generated by the cost function (6.12) even when $\lambda 2 = 0$, (see Nickell, 1985. p.125).

3. The importance of accounting for unit root has been stressed, for example by Nelson and Plosser (1982).

4. The computed F-test for Brazil and Kenya are 2.8 and 6.78 while the critical values are 2.56 and 2.59 respectively.

5. However, we do not worry too much about this diagnosis as Kivet (1981) has shown that this test rejects too often even if the parameters are constant across the two samples.

CHAPTER 7

THE COINTEGRATION APPROACH

7.1 Some Theory

Engle and Granger (1987) show that if a vector of variables is cointegrated, then there exits a valid error correction representation of the data which is not liable to the problem of spurious regression. Cointegration analysis provides a method of investigating the possible existence of equilibrium relationship and of estimating any such relationships if they exist. If we have two economic variables x and y, the requirement for cointegration is that these variables must be of the same degree of integration. The first stage in testing for cointegration between y and x is to determine the order of integration, that is, how many times the variables need differencing in order to induce stationarity.

Consider first the single series x_t, measured at equal interval of time. We want to know whether or not the underlying stochastic process that generated x_t can be assumed to be invariant with respect to time. If the stochastic process is fixed in time, i.e.,if x_t is stationary, then it is possible to model the process via an equation with the fixed coefficients that can be estimated from past data. Such a series is called I(0), meaning the series is integrated of order zero.Some series need to be differenced ones to achieve these properties and this is referred to as integrated of order one, denoted as $x_t \sim I(1)$. More generally, if a series needs differencing d times to become stationary, then it is said to be integrated of order d, denoted $x_t \sim I(d)$. Various tests have been suggested for this purpose but we only consider three tests which are commonly used in the literature.

7.2 Tests for Order of Integration

(1) Sargan and Bhargava (1983) propose a test of the hypothesis that the errors on the regression equation follow a random walk. According to this procedure, to test whether a series x_t is I(0), the regression $x_t = c + u_t$ is run and the null hypothesis $u_t = u_{t-1} + \varepsilon_t$, ε_t i.i.d. is tested against the alternative that the errors are stationary. Under the null hypothesis, the t-statistic on the coefficient of u_{t-1} does not have a limiting normal distribution since u_{t-1} is non-stationary implying the violation of classical assumptions. The appropriate test can, therefore, be performed by using the cointegration Durbin-Watson statistic (CRDW) with the critical values provided by Sargan and Bhargava.

(2) An alternative test has been suggested by Dickey and Fuller (1981) which tests the significance of β in the regression

$$\Delta x_t = \beta x_{t-1} + v_t, \; v_t \sim \text{i.i.d. } (0, \sigma v^2) \qquad (7.1)$$

To test the null hypothesis of non-stationarity, a t-test is performed on β using the special critical values. A negative and significant t-ratio of β rejects the null hypothesis, but if it is accepted, then (7.1) should be differenced to yield

$$\Delta^2 x_t = \beta \Delta x_{t-1} + v_t, \quad v_t \sim \text{i.i.d.} \qquad (7.2)$$

(3) One problem with the Dickey-Fuller (DF) method is that the tests are not invariant to the assumption of the underlying data generation process. Indeed, this is one reason why CRDW is preferred by some researchers (Banerjee et al., 1986) to the D-F based tests. However, in practice, Monte Carlo tests show that the D-F approach can be augmented to allow for higher order autoregressive model of the form:

$$\Delta x_t = c + \beta x_{t-1} + \Sigma^p{}_{i=1} d_j \Delta x_{t-j} + v_t \qquad (7.3)$$

The OLS estimator of β and its t-statistic (ADF) has the same limiting distribution as the ADF (with drift). ADF is usually preferred in most applied works because equation (7.3) allows for extra lags of the independent variable. Here, the null hypothesis is that x_t is I(1), which may be rejected in favour of I(0) if β is negative and significant.

Inspection of the residual correlogram may also reveal some information about the time series properties of macroeconomic variables.If the variable under consideration is I(0), the correlogram will soon decrease from positive values to insignificance as the number of lags increase. If the variable is I(1),the sample first order auto-correlation should be close to unity and the correlogram should not radically decrease with increasing lags.

Another related issue to cointegration is the presence of a time trend. Suppose x_t is drifting up through time. This may not be due to the appearance of a drift term in a random walk model but, more traditionally, due to the appearance of a deterministic time trend in the mechanism generating x, such as:

$$x_t = \beta o + \rho x_{t-1} + \gamma t + u_t \qquad (7.4)$$

This unrestricted model contains both a constant and a trend as regressors. Dolado et al. (1990) show that if the unit root process contains a linear trend or a drift, its variability will be dominated by a quadratic or a linear trend which, appropriately normalized, converges to a constant. It is only when $\beta o = \gamma = 0$, both in the DGP and in the model that direct application of the Dickey-Fuller statistics is feasible. However, if a model with a constant is chosen then, the right critical value for the t-ratio will be found in the standardized normal distribution table, rather than in the Dickey-Fuller tables (West, 1988).

7.3 Testing for Cointegration

The second stage of cointegration analysis is to test for cointegration between x and y, which are expected to be I(1) and this involves running the following static regression.

$$u_t = x_t - \alpha' y_t \tag{7.5}$$

If u_t, generated by (7.5) is I(0), then x_t and y_t are said to be cointegrated, with α' being the cointegrated parameter. The relationship $x_t = \alpha y_t$ can be considered as a long-run or equilibrium relationship, perhaps as suggested by some economic theory, and u_t given by (7.5) thus measures the extent to which the system x_t and y_t is out of equilibrium, and can thus be called 'equilibrium error'. Here the term is not used to imply anything about the behaviour of economic agents but rather describes the tendency of an economic system to move towards a particular region of the possible outcomes.

Despite the complete omission of dynamics from (7.5), such a static regression has been shown to have a number of desirable properties. For example, Stock (1987) has shown that if cointegration holds, the estimates will be supperconsistent, in the sense that they will converge to their true values at a faster rate than standard OLS estimation. However, the omitted variables in (7.5) will bias the estimates of the standard errors of the estimated parameters. Thus, we cannot test for the significance of individual variables by checking their t-statistics against the t-distribution. In fact, the limiting distribution of α' from equation (7.5), under the null of non-cointegration, depends on the nuisance parameters which means that such conventional tests are not possible.

If we convince ourselves that the residuals generated by (7.5) are I(0),these residuals can then be utilized to construct the familiar error correction term in the following general ADL model.

$$\Delta x_t = c+\rho u_{t-1}+ \Sigma^{q}{}_{i=0}[\alpha_i \Delta x_{t-i-1}+ \beta \Delta y_{t-i}] + \varepsilon_t \qquad (7.6)$$

A simplification search discussed in chapter 6 can be carried out on (7.6) to obtain a more parsimonious model, with the long-run solutions imposed at the first stage.

It is important to note that unless x_t and y_t are integrated of degree (1,1), u_{t-1} in (7.5) will not be I(0) and will, therefore, has an estimated coefficient tending rapidly to zero. Under this situation, the model will not have a steady-state solution. The implication of this is that if a set of variables are cointegrated, then there always exists an error correcting formulation of the dynamic model, and vice versa.

Wickens and Breusch (1988) argue that the 2-step estimation procedure described above is unnecessary and that the long-run and short-run effects can be captured in a single equation. We describe this approach by considering the following general autoregressive-distributed lag model.

$$y_t = \Sigma^m_{i=1}\alpha_i y_{t-i} + \Sigma^n_{i=0}\beta_i x_{t-i} + e_t \qquad (7.7)$$

Now, (7.7) can be reparameterized by subtracting $(\Sigma^m_{i=1})y_{t-i}$ from both sides. Re-normalizing the x's and rearranging terms give:

$$y_t = -\lambda\Sigma^m_{i=1}\alpha_i(y_t - y_{t-i}) + \Theta x_t - \lambda\Sigma^n\beta_i(x_t - x_{t-i}) + \lambda\varepsilon_t \qquad (7.8)$$

where

$$\lambda = 1/1 - \Sigma^m_{i=1}\alpha_i \qquad (7.9)$$

$$\Theta = \lambda\Sigma^n\beta_{i=0} \qquad (7.10)$$

Thus, the coefficient of x_t, Θ is the long-run multiplier. Direct estimation of (7.8) would, therefore, give a point estimate of Θ and its long-run standard error. Another expression of (7.7) involves terms obtained by differencing i times to yield:

$$y_t = \Sigma^m_{i=1}\phi_i\Delta^i y_t + \Theta x_t + \Sigma\gamma_i\Delta^i x_t + \lambda\varepsilon_t \qquad (7.11)$$

Equation (7.11) has several uses. It provides estimates of steady-state paths which are not in static equilibrium. For example, if x and y are logarithms and $\Delta y_t = g_y$, $\Delta x_t = g_x$ (non-zero constants), then along the steady-state growth path, we have $\Delta^i y_t = \Delta^i x_t = 0$ for i > 1 and hence

$$y = [\phi_1 g_y + \gamma_1 g_x] + \Theta x \qquad (7.12)$$

Instrumental variable estimation of (7.12) with instruments given by the regression in (7.7) will give consistent estimates of the short-run elasticities and the long-run multipliers, Θ as well as its standard error.[1] The Engle-Granger two-stage procedure might be preferable in small samples since the separate estimation of the long-run elasticities will release more degrees of freedom which can then be used in the second stage estimation. However, the efficiency of the short-run parameters is gained at the cost of omitted variable bias in the first stage, but the literature on cointegration does not tell us when such bias is serious enough to warrant the choice of the one stage estimation instead of the two-step procedure.

7.4 Relationship with Conventional ECM

Although many writers believe that there is a strong relationship between cointegration and conventional EC models,there are some crucial difference between the two approaches. One main difference between the two approaches is that the conventional ECM imposes the following restriction on equation (7.7)

$$\Sigma^{m}{}_{i=1}\alpha_i + \Sigma^{n}{}_{i=0}\beta_i = 1 \qquad (7.13)$$

Imposing this restriction and for m = n = 1, we can write equation (7.7) as:

$$\Delta y_t = \beta o \Delta x_t - (1-a_1)(y_{t-1} - x_{t-1}) u_t \qquad (7.14)$$

The term $(y_{t-1} - x_{t-1})$ is the error which is to be corrected. It also contains the long-run solutions which in effect has been separated from the short-run dynamics, (see chapter 6 for detailed discussion of this issue). Thus the ECM implies the restriction that the long-run multiplier, Θ as defined in (7.9) equals to unity. If we relax this restriction, then (7.14) becomes:

$$\Delta y_t = \beta o \Delta x_t - (1-\alpha_1)(y_{t-1} - \Theta x_{t-1}) u_t \qquad (7.15)$$

Equation (7.15) is basically a cointegration equation with the value of Θ imposed at the very beginning. Whether it is optimal to do so depends on a number of factors. Firstly, though the first stage of the Engle-Granger procedure yields consistent estimates of the cointegrating vector, in the sense that they converge rapidly to their true values, in small samples the bias may still be quite significant. Banerjee *et al*. (1986) show that there may still be gains in estimating the long-run effects by taking into account the short-run dynamics. Thus the 2-step procedure may be imposing incorrect long-run properties on the model from the very beginning of the specification process.

Secondly, the 2-step procedure will yield an error correction mechanism which from the outset has a one period lag. In contrast, in the conventional ECM approach, the precise lag of the ECM is data determined.

7.5 An Application

Prior to testing the set of variables determining the demand for money in LDCs for cointegration, we wish to establish the time series properties of the individual series. The natural logarithms of the nominal money stock (m2), real gross domestic product (y), the consumer price index(p) and the level of nominal discount rate (i) have been tested for I(1). We specified a general model which contains a constant and time trend for each variable. However, these two variables were insignificant in all cases and, consequently, a pure random walk model is estimated for each variables. The CRDW, DF and ADF statistics are reported for each of these variables in table 7.1. With few exceptions, the ADF and DF tests reported are negative and greater than two. The exceptions are Korea and Thailand where the absolute values of these tests are smaller than 2. In the case of Korea, the lower values of our tests for the log of real GDP might also suggest that this variable could be I(2). However, the larger value of the CRDW in all countries indicate that the first differences of theses variables are stationary. We may, therefore, conclude that m_t, y_t, p_t and i_t are integrated of order one. Note that we have excluded the inflation variable from the static regression because its presence will break up the cointegrability condition.

Table 7.1: Testing for unit root in money demand variables number of observation = 27

Country/var.	CRDW	DF	ADF
1. Mexico			
Δm	2.1	-4.0	-6.6
Δy	1.3	-6.3	-6.7
Δp	1.7	-2.9	-3.1
Δi	1.7	-6.6	-11.7
2. Brazil			
Δm	2.3	-3.4	-5.8
Δy	1.8	-4.6	-6.3
Δp	2.7	-3.3	-2.8
Δi	2.3	-7.5	-10.9
3.Peru			
Δm	2.2	-3.7	-5.4
Δy	3.1	-4.9	-6.4
Δp	2.8	-3.9	-6.5
Δi	3.2	-7.5	-11.7
4. Colombia			
Δm	2.7	-4.7	-7.1
Δy	2.7	-5.1	-8.1
Δp	3.0	-4.2	-5.8
Δi	2.9	-5.1	-7.2

Table 7.1 (cont.)

5.India			
Δm	3.2	-6.1	-7.9
Δy	2.9	-5.6	-8.9
Δp	2.5	-4.1	-6.0
Δi	3.2	-6.6	-8.9
6. Sri Lanka			
Δm	2.6	-2.9	-3.8
Δy	2.9	-3.6	-4.6
Δp	2.5	-2.8	-3.6
Δi	2.9	-4.6	-6.4
7. Philippines			
Δm	2.5	-2.7	-3.4
Δy	2.6	-2.5	-3.1
Δp	2.4	-4.4	-7.6
Δi	3.3	-7.6	-10.4
8. Thailand			
Δm	1.4	-1.8	-1.2
Δy	2.7	-3.7	-4.9
Δp	2.3	-2.1	-2.6
Δi	2.9	-4.5	-6.2
9. Korea			
Δm	1.4	-1.5	-1.2
Δy	2.7	-.54	-.56
Δp	2.3	-2.1	-2.6
Δi	2.9	-4.6	-6.2
10.Kenya			
Δm	2.9	-3.2	-3.6
Δy	2.8	-3.6	-5.5
Δp	2.7	-2.2	-2.9
Δi	3.0	-3.8	-5.0
11. Malawi			
Δm	2.4	-4.0	-6.8
Δy	2.8	-3.5	-4.8
Δp	2.2	-3.5	-5.2
Δi	2.4	-3.1	-4.9

Table 7.2: Cointegration regression.

Dependent variable is log of nominal money balance (m2)

country	con	y	p	i	DW	DF	ADF	R^2
1.Mexico	-2.9	1.4	1.04	.003	1.5	-2.3	-3.1	.99
	(12.0)	(8.8)	(7.6)	(.48)				
2.Brazil	-1.1	.86	.88	.03	1.9	-4.5	-4.4	.99
	(2.0)	(5.9)	(3.0)					
3.Peru	-2.3	1.3	.92	.01	1.2	-3.0	-2.9	.99
	(7.7)	(13.5)	(29.2)	(2.4)				
4.Colombia	-4.5	.25	1.2	-.09	1.1	-3.2	-2.6	.99
	(5.5)	(2.6)	(22.0)	(1.1)				
5.India	-2.8	1.9	.95	-.01	2.8	-2.9	-2.4	.87
	(20.1)	(8.6)	(7.2)	(.78)				
6.Sri Lanka	-.39	.92	.76	.07	2.2	-2.9	-3.1	.99
	(.46)	(3.9)	(3.9)	(2.7)				
7.Korea	-8.1	2.6	.46	.01	1.0	-1.5	-3.1	.96
	(5.8)	(6.6)	(2.1)	(1.9)				
8.Phil.	-1.6	.99	.99	.003	1.9	-2.6	-3.3	.99
	(10.9)	(10.8)	(19.1)	(.39)				
9.Thailand	-8.1	2.5	.46	.01	1.2	-1.5	-3.1	.99
	(5.8)	(6.6)	(7.1)	(3.5)				
10.Kenya	4.8	1.7	.88	-.01	2.7	-3.8	-2.7	.99
	(7.0)	(10.8)	(9.5)	(.37)				
11.Malawi	-3.5	1.3	1.4	-.04	2.4	-3.3	-3.5	.98
	(8.9)	(6.7)	(9.5)	(1.3)				

Having established that our variables are all I(1), we run a static Ordinary Least Squares regression of the nominal money stock on the level of each explanatory variable. If the variables are cointegrated then the residuals should be I(0). We can apply the three tests for unit root to check for cointegration. These results are reported in table 7.2. Once again, the values of both the DF and ADF statistics in nine out of eleven countries are considerably high. In the case of Korea and Thailand, the DF statistic rejects cointegration. On the other hand, the large values of the ADF and CRDW statistics may well suggest that the variables are cointegrated.[2] Consequently, the coefficients of the demand for money reported in table 7.2 should represent the long-run elasticities of the demand for nominal money balance. However, critical values for the DF and ADF statistics have been calculated using Monte Carlo methods for 2 and 3 variables for a sample size of over 50. Since we have considered four variables with a sample size of 27, our tests should be treated as indicative rather than conclusive.

Following the Engle-Granger approach, lagged residuals obtained from the static regressions reported in table 7.2 are used as error correcting variables in dynamic demand for money functions. A simple search procedure produced the following parsimonious equations.

1.Mexico

$$\Delta m = .57\Delta m\text{-}1 + .31\Delta m\text{-}2 + 1.2\Delta p + -.93\Delta p\text{-}1 \quad -.01\Delta i -.41\ u\text{-}1$$
(3.1) (1.7) (3.7) (2.6) (1.6) (2.7)

R^2 = .93, RSS = .2518, s = .11, DW = 1.9, n_1 = .12, z_1 =.16, n_2 =.11, SK = .2314, EK = .1749 z_2 = .19, n_3 = .01, z_3(5) = 3.2, n_4(5,14) = 1.2

2.Brail

$$\Delta m = .25 -.28\Delta m\text{-}1 -.26\Delta m\text{-}2 +.85\Delta y + .86\Delta p+.004\Delta i+ .005\Delta i\text{-}1 -.50u\text{-}1$$
(6.2) (2.0) (1.8) (4.5) (9.4) (6.6) (4.1) (2.3)

R^2 = .95, RSS = .099, s = .08, DW = 2.5, n_1 = 2.0, z_1 = 22.8, n_2 =..03, sk = -.513, EK = .-2.1, z_2 = .76, n_3 = -1.0, z_3 = 27.9, n_4 (3,13) = 2.8

3.Peru

$$\Delta m = .45\Delta m\text{-}1 + .95\Delta y + 1.0\Delta p + -.52\Delta p\text{-}1 +.003\Delta i - .58u\text{-}1$$
(3.0) (3.9) (8.5) (3.2) (2.2) (3.4)

R^2 = .98, RSS = .0799, s = .06, DW = 1.9, n_1 = -.11, z_1 = -.16 n_2 =.06, SK = -.258, EK = -1.058, z_2 = 1.2, n_3 = 1.1, z_3 = 2.4, n_4 (5,15) = 2.9

4.Colombia

$$\Delta m = .57\Delta m\text{-}1 + .09\Delta y + .51\Delta p - .42u\text{-}1$$
(2.8) (1.5) (1.9) (2.5)

R^2 = .89, RSS =.147, s =.08, DW = 2.1, n_1 = .67, z_1 =.81, n_2 = .01, SK = -.29607, EK = -.83, z_2 = .95, n_3 = 2.3, z_3 = 2.4, n_4(5,17) = .05

5. India

$$\Delta m = .29\Delta m\text{-}1 + 1.1\Delta y + .62\Delta p -.32u\text{-}1$$
(1.7) (4.1) (2.9) (2.2)

R^2 =.87, RSS = .07416, s = .06, DW = 2.5, n_1 = 2.7, z_1 = 5.5 n_2 = 2.6, SK = .607, EK = .994, z_2 = 2.3, n_3 = 2.1, z_3 = .14, n_4(5,17) =.11

6. Sri Lanka

$\Delta m = .58\Delta m\text{-}1 + .87\Delta y - .49u\text{-}1$
(4.2) (2.9) (2.8)

$R^2 = .85$, RSS = .108, s = .07, DW = 2.5, $n_1 = 2.1$, $z_1 = 2.3$, $n_2 = .08$, SK = .008, EK = -.219, $n_3 = .01$, $z_3 = 1.3$, $n_4(5,15) = .56$

7. Philippines

$\Delta m = .10 + .38\Delta m\text{-}1 + .18\Delta p - .27\Delta p\text{-}1 - .42u\text{-}1$
(3.8) (2.4) (1.6) (2.3) (3.6)

$R^2 = .49$, RSS = .0419, s = .04, DW = 2.1, $n_1 = .17$, $z_1 = .23$, $n_2 = .54$, SK = -.38, EK = -2.166, $z_2 = .54$, $n_3 = .42$, $z_3 = 1.7$, $n_4\ (5,16) = 1.1$

8.Korea

$\Delta m = .87\Delta m\text{-}1 - .57\Delta p + .79\Delta p\text{-}1 - .23u\text{-}1$
(10.5) (2.5) (3.7) (3.2)

$R^2 = .96$, RSS =.095, s =.06, DW =1.5, $n_1 = 2.5$, $z_1 = 2.7$, $n_2 = 1.1$, SK = .287, EK = -.119, $z_2 = .315$, $n_3 = .945$, $z_3 = .40$, $n_4(5,17) = .39$

9.Thailand

$\Delta m = .82\Delta m\text{-}1 + .50\Delta y - .31u\text{-}1$
(7.1) (1.4) (3.5)

$R^2 = .93$, RSS = .1419, s = .08, DW = 1.6, $n_1 = .01$, $z_1 = .01$, $n_2 = 2.6$ SK = -.07, EK = -.302, $z_2 = .102$, $n_3 = .78$, $z_3 = .46$, $n_4(5,17) = .38$

10. Kenya

$\Delta m = .06 + .84\Delta y + .53\Delta p - .97u\text{-}1$
(1.8) (2.8) (2.0) (4.6)

$R^2 = .64$, RSS = .0539, s = .05, DW = 1.9, $n_1 = .09$, $z_1 = .11$, $n_2 = .46$, SK = .644, EK = -.3907, $z_2 = 1.3$, $n_3 = 2.4$, $z_3 = .73$, $n_4(5,15) = .66$

11. Malawi

$\Delta m = .97\Delta y + 1.5\Delta p - .06\Delta i - .75u\text{-}1$
(2.9) (6.1) (1.6) (2.5)

$R^2 = .80$, RSS = 1096, s = .08, DW = 1.8, $n_1 = .09$, $z_1 = .12$, $n_2 = .16$, SK = .563, EK = -.2098, $z_2 = .76$, $n_3 = .44$, $z_3 = 4.1$, $n_4(5,9) = 1.5$

7.6 Evaluation of Cointegration Results

From the statistical tests reported above, it appears that the empirical performance of the cointegration equations is quite satisfactory. There is no sign of first order serial correlation. The n_2 statistic clearly shows that there is no misspecification due to heteroscedasticity at 5% in all equations. Similarly, the $z_2(2)$ diagnostic implies that, to the extent that the other assumptions underlying the regression models are valid, the null hypothesis of SK = 0 and EK = 0 is not rejected. When five periods were set aside for the Chow-test, no parametric drifts were observed. The z_3 (q) statistic also indicates no predictive failure. We also adopted the recursive estimator to investigate the constancy of our estimated equations since the one-step innovations allow the construction of the entire feasible sequence of parameter constancy tests. The diagrams presented in Appendix 7.2 record the numerical values of two central coefficients namely, those for Δp_t and $\hat{u}_{t-1}$, together with twice their sequentially estimated standard errors which provide an approximate 95% confidence interval. It is visually apparent that the two coefficients display a remarkable constancy over the sample period[3] in ten out of eleven cases. There are some wild fluctuations in the time path of these crucial parameters in the case of India during the years 1979 and 1980 but they lie well inside the confidence region based upon (+) or (-) $2\hat{\sigma}$.

The performance of our models is also illustrated by the diagrams showing the fitted and actual values of the dependent variable (Δm_t) over time, including the prediction period. As the pictures indicate, the forecasts seem to approximate the observed pattern reasonably well in the equations for which the recursive least squares estimators display parameter constancy but the forecasts show a tendency to overshoot the peaks (1979) and undershoot the troughs (1980) in Mexico, and India. Such behaviour also correspond to the periods of major structural changes shown by RLS estimation. This might be explained by the second oil price rise in 1979 which subsequently pushed up world commodity prices. Apart from these particular years, the forecasts produce the general shape of the observed pattern and such evidence together with the Chow statistics reported in Appendix 7.1 may well indicate a reasonable parameter constancy in our cointegration equations.

Perhaps, the most important result from the dynamic models is that the error correction terms,(u_{-1})s, are all statistical very significant. Once again the rate of interest rate show up positive signs in in Brazil and Peru and is not significant in the rest of the countries. A positive interest rate effect might be interpreted as a measure of the own rate of return . However, this interpretation is not reasonable as the quasi money component of the money stock in these countries is too small compared to currency and demand deposits. On the other hand, a strong inflation impact is present in nine out eleven countries. Such strong inflation impact on the demand for money is consistent with theoretical priors,(Adekunle, 1968).[4] However, the long-run properties of the cointegration equations seem a bit strange. With the exception of Philippines, (where the income elasticity is unity),the evidence clearly indicates income elasticities greater than one, leading us to the conclusion that the income elasticity of demand for money in LDCs is greater than unity, (between 1 and 2.6). Two countries (Korea and Thailand) have registered abnormal income elasticities, i.e., 2.6 and 2.5 respectively. On the other hand, the hypothesis of long-run price homogeneity is supported by our data, suggesting that demand for money in LDCs can be expressed in real terms. Again, the evidence rejects unit price elasticity in the case of Korea and Thailand. Although a higher income elasticity might seem strange for a developed country (see for example Muscatelli and Papi, 1988), it is not unreasonable for developing countries. Limitations of asset substitutions in LDCs, instability due to periodic economic and political chaos and the shorter economic time horizon, all go towards increasing the demand for money balance more than proportionately. Furthermore, the process of monetization of the subsistence economies of LDCs leads to a higher income elasticity and as development proceeds and the financial systems are integrated, the income elasticity of the demand for money is expected to fall.

7.7 Conclusions

In this chapter, we have considered the application of cointegration techniques to the demand for money in eleven developing countries. All of the cointegration equations pass the most stringent testes proposed for model evaluation. In nine out of eleven cases, the results indicate that the income elasticity of the demand for money range between 1.0 and 2.6. On the other hand, a unit price elasticity is evident from the results, implying that the demand for money can be cast in real rather than in nominal terms. In two cases, (Korea and Thailand) the evidence is not particularly a desirable one, in the sense that income elasticities are abnormally high, and the price coefficient is much lower than unity. Compared to the standard EC specifications, the cointegration models have displayed higher coefficient of determination (R^2) and lower residual variances. This means that cointegration models variance dominate the conventional error correction specifications. It is also fair to conclude that: (1) nominal broad money, real income, price, and the discount rate - all follow a random walk without drift; (2) the short run-effect of inflation is precisely estimated from the standard ECM specifications but its implied long-run impact is implausibly high. It appears that the cointegration approach, which effectively excludes the long-run impact of inflation from static regressions is to be preferred to either PA models or the conventional EC specifications.

NOTES

1. The regression in (7.11) may be a linear function of the dependent variable in (7.6) and under such conditions, direct OLS estimation may yield inconsistent estimates, (see Wickens and Breusch, 1988).

2. The lower bounds of CRDW (with four variables and 31 observations) is reported as .699 (Sargan and Bhargava, 1983)

3. We have used seven observations to initialize estimation in the case of Kenya and Malawi and nine observations in the remaining countries.

4. Note that a positive coefficient appears on current inflation in most of the dynamic equations. This is not, however, unreasonable as the dependent variable is a change in nominal money balance.

Appendix 7.1 Forecasting and Parameter Stability Tests

1. MEXICO

Modelling dm From 1963 1 To 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.58685	.28536	.29150	2.05650	.2320
dm-2	.24622	.23695	.13373	1.03911	.0716
dp	1.41517	.47205	.61132	2.99793	.3910
di	-.0007	.01363	.01054	-.00064	.0000
dp-1	-1.16983	.89004	.88274	-1.31435	.1098
u- 1	-.40841	.27733	.19424	-1.47265	.1341

R^2 = .8993462, s = .11188585 F(5, 14) = 25.02 DW = 1.743
F(5, 14) Crit Val = 2.96

ANALYSIS of 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.488797	.780972	-.292175	.236027	-1.237887
1984	1	.512399	.284279	.228120	.571826	.398932
1985	1	.281114	.450039	-.168926	.209871	-.804902
1986	1	.579101	.745595	-.166495	.238247	-.698832
1987	1	.905120	.993724	-.088604	.334369	-.264990

Tests of Parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5) = 3.22
CHOW TEST (5, 14) = 1.22
F(5, 14) Crit Val = 2.96

2. BRAZIL

Modelling dm From 1963 1 TO 1987 1 Less 3 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
CONSTANT	.28044	.07495	.07118	3.74188	.5000
dp	1.00617	.18556	.19128	5.42228	.6774
dy	.66381	.20525	.17791	3.23412	.4276
di	.00276	.00097	.00050	2.85801	.3685
di-1	.00422	.00095	.00039	4.45369	.5862
dm-1	-.38449	.18708	.18721	-2.05523	.2318
dm-2	-.27880	.14508	.14066	-1.92169	.2087
u- 1	-.58722	.20120	.18807	-2.91861	.3783

R^2 = .9399684 e + .07487613 F(7, 14) = 31.32 DW = 2.143
F(7, 14) Crit Val = 2.76

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1985	1	1.507147	1.451220	.055926	.187866	.297693
1986	1	.299430	.140185	.159245	.279249	.570261
1987	1	.300104	.915658	-.615554	.320103	-1.922984

Test of Parameter CONSTANCY Over : 1985 (1) - 1987 (1)
Forecast Chi^2 (3)/ 3) = 4.22
CHOW TEST(3, 14) = 1.39
F(3, 14) Crit Val = 3.34

3. PERU

Modelling dm From 1962 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dy	1.00772	.30132	.21672	3.34435	.4271
dp	.88448	.31416	.34515	2.81541	.3457
di	.00089	.00489	.00411	.18249	.0022
dm-1	.36372	.16338	.19636	2.22620	.2483
dp-1	-.30207	.34621	.37967	-.87250	.0483
u- 1	-.60716	.20100	.16230	-3.02072	.3782

R^2 = .9731338 s= .06183157 F(5, 15) = 108.66 DW = 2.200
F(5, 15) Crit Val = 2.90

ANALYSIS OF 1-step FORECASTS

DATE	ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983 1	.710238	.569071	.141167	.093431	1.510927
1984 1	.842446	.723442	.119004	.133696	.890108
1985 1	.945373	.954290	-.008917	.212968	-.041871
1986 1	.423272	.463511	-.040239	.179390	-.224308
1987 1	.425269	.527955	-.102686	.081035	-1.267175

Test of Parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi (5)/ 5 = 2.42
CHOW TEST(5, 15) = 1.38
F(5, 15) Crit Val = 2.90

4. COLOMBIA

Modelling dm from 1962 to 1987 less 3 forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.67782	.20565	.19068	3.29595	.3638
dy	.13854	.09669	.20703	1.43287	.0975
dp	.38524	.26393	.28119	1.45964	.1008
u- 1	-.31915	.16917	.17452	-1.88655	.1578

R^2 = .9088769 s = .0747707 F(4, 19) = 47.38 [.0000] DW = 2.177

ANALYSIS OF 1-step FORECASTS

DATE	ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1985	.184148	.302406	-.118258	.114574	-1.032158
1986	.353207	.257254	.095953	.083928	1.143279
1987	.261044	.337850	-.076806	.080292	-.956584

Tests of parameter CONSTANCY over: 1985 - 1987
Forecast Chi^2 (3)/ 3)= 1.73
CHOW TEST (3, 19) = 1.29
F (3,19) Crit.val = 3.08

5. INDIA

Modelling dm From 1962 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.24451	.22086	.25609	1.10709	.0672
dy	1.17019	.34137	.35269	3.42790	.4087
dp	.67364	.26151	.30923	2.57592	.2807
u- 1	-.32321	.17116	.20061	-1.88836	.1734

R^2 = .8422924 , s = .06497923 F(3, 17) = 30.26 DW = 2.267
F(3, 17) Crit Val = 3.20

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.156038	.163233	-.007195	.070792	-.101635
1984	1	.131984	.093790	.038194	.067702	.564154
1985	1	.189388	.222856	-.033468	.077316	-.432867
1986	1	.164952	.158477	.006475	.068940	.093928
1987	1	.126590	.141938	-.015348	.067299	-.228055

Tests of Parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5) = .14
CHOW TEST(5, 17) = .11
F(5, 17) Crit Val = 2.81

6. SRI LANKA

Modelling dm From 1962 1 TO 1984 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.33569	.21943	.18054	1.52981	.1350
dy	1.19475	.38409	.34337	3.11064	.3921
u- 1	-.52882	.19919	.21444	-2.65486	.3197

R^2 = .8290829, s = .07801778 F(2, 15) = 36.38 DW = 2.059
F(2, 15) Crit Val = 3.68

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1980	1	.252401	.084224	.168177	.106398	1.580640
1981	1	.181241	.143643	.037598	.086468	.434819
1982	1	.226085	.178440	.047645	.085323	.558403
1983	1	.189976	.145139	.044837	.085126	.526712
1984	1	.146795	.082103	.064692	.084027	.769897

Tests of parameter CONSTANCY Over : 1980 1 - 1984 1
Forecast Chi^2 (5)/ 5 = 1.25
CHOW TEST(5, 15) = .56
F(5, 15) Crit Val = 2.90

7. KOREA

Modelling dm From 1962 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.36140	.16188	.12700	2.23253	.2375
dp	.21140	.17295	.17897	1.22232	.0854
dp-1	-.43902	.19590	.18433	-2.24101	.2389
u- 1	-.53895	.13410	.09254	-4.01907	.5024
CONSTANT	.11197	.03004	.02758	3.72736	.4648

R^2 = .5830990, s = .04423876 F(4, 16) = 5.59 DW = 1.918
F(4, 16) Crit Val = 3.01

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.197246	.095196	.102050	.048442	2.106634
1984	1	.137865	.130132	.007733	.071863	.107608
1985	1	.126760	.049561	.077199	.072057	1.071370
1986	1	.088811	.092623	-.003812	.054133	-.070415
1987	1	.134813	.138564	-.003751	.048165	-.077879

Tests of parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5 = 1.68
CHOW TEST(5, 16) = 1.09
F(5, 16) Crit Val = 2.85

8. PHILIPPINES

Modelling dm From 1962 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.86755	.09319	.08365	9.30922	.8360
dp	-.64230	.25568	.19322	-2.51212	.2707
dp-1	.83839	.24044	.17163	3.48693	.4170
u- 1	-.23286	.08647	.07883	-2.69295	.2990

R^2 = .9561805, s = .07397987 F(3, 17) = 123.65 DW = 1.330
F(3, 17) Crit Val = 3.65

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.141874	.185637	-.043762	.079104	-.553228
1984	1	.074251	.084006	-.009755	.075338	-.129481
1985	1	.145136	.055089	.090047	.074266	1.212495
1986	1	.169254	.173531	-.004277	.075122	-.056936
1987	1	.174418	.204109	-.029691	.077910	-.381091

Tests of parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5 = .40
CHOW TEST(5, 17) = .39
F(5, 17) Crit Val = 2.81

9. THAILAND

Modelling dm From 1962 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dm-1	.72939	.12382	.09606	5.89066	.6584
dy	.87563	.43131	.28837	2.03015	.1863
u- 1	-.34065	.10026	.10627	-3.39778	.3908

R^2 = .9387837, s = .08497701 F(2, 18) = 138.02 DW = 1.694
F(2, 18) Crit Val = 3.55

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.141874	.166010	-.024135	.089458	-.269794
1984	1	.074251	.111860	-.037609	.087129	-.431647
1985	1	.145136	.119067	.026069	.089689	.290656
1986	1	.169254	.226188	-.056934	.091960	-.619114
1987	1	.174418	.298269	-.123851	.095586	-1.295697

Tests of parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5 = .29
CHOW TEST(5, 18) = .47
F (5, 18) Crit Val = 2.77

10. KENYA

Modelling dm From 1967 1 TO 1987 1 Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
CONSTANT	.06464	.04133	.04199	1.56384	.1693
dy	.92762	.35357	.36711	2.62359	.3645
dp	.58403	.31157	.32817	1.87448	.2265
u- 1	-.95267	.26281	.33147	-3.62488	.5227

R^2 = .6279289, s = .05988424 F(3, 12) = 6.75 DW = 1.924
F(3, 12) Crit Val = 3.49

ANALYSIS OF 1-step FORECASTS

DATE		ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1983	1	.047709	.057138	-.009429	.068229	-.138202
1984	1	.120968	.119524	.001444	.062763	.023011
1985	1	.063542	.118473	-.054930	.063195	-.869220
1986	1	.282930	.252515	.030415	.067416	.451159
1987	1	.105537	.200611	-.095074	.064457	-1.474989

Tests of Parameter CONSTANCY Over : 1983 1 - 1987 1
Forecast Chi^2 (5)/ 5 = .73
CHOW TEST(5, 12) = .66
F (5, 12) Crit Val = 3.11

11. MALAWI

Modelling dm From 1968 (1) TO 1984 (1) Less 5 Forecasts

VARIABLE	COEFFICIENT	STD ERROR	H.C.S.E.	t-VALUE	PARTIAL r^2
dy	.60101	.37273	.38155	1.61245	.2453
dp	2.54926	.55914	.69647	4.55923	.7221
di	-.14225	.05522	.06331	-2.57600	.4534
u-1	-1.03347	.34439	.38337	-3.00084	.5296

R^2 = .8509251 e = .08239597 F(3, 8) = 15.22 DW = 2.025
F(3, 8) Crit Val = 4.07

ANALYSIS OF 1-step FORECASTS

DATE	ACTUAL	FORECAST	Y - Yhat	FORECAST SE	t-value
1980 1	.110610	.409207	-.298597	.139678	-2.137744
1981 1	.236664	.309313	-.072648	.120922	-.600787
1982 1	.135080	.148550	-.013470	.092513	-.145598
1983 1	.056155	.259700	-.203545	.098600	-2.064359
1984 1	.280833	.542482	-.261649	.148133	-1.766317

Tests of Parameter CONSTANCY Over : 1980 1 - 1984 1
Forecast Chi (5)/ 5 = 6.02
CHOW TEST(5, 8) = 1.63
F (5, 8) Crit Val = 3.69

Key:

dm = percentage change in money stock (lnm - lnm-1)
dy = percentage change in real GDP (lny - lny-1)
dp = percentage change in CPI (lnp - lnp-1)
di = change in interest rate (i - i-1)
u-1 = lagged residuals (u^-1)

APPENDIX 7.2: Derivation of 'Recursive Least Square Estimates'

We have generated three graphs (where applicable) for each country using the PC GIVE econometric package. The first two graphs plot the time path of the recursive estimates of the coefficients of the error correction term - u_{t-1} and the rate of inflation - Δp. The objective is to inspect whether these crucial parameters of interest are time invariant or not. This is easily visualized from the Recursive Least Square estimates.

To see how this is done, let $\hat{\beta}_t$ be the OLS estimator based on the first t observations and let $X_t = (x_1, \ldots, x_t)'$ and $Y_t = (y_1, \ldots, y_t)'$. Then:

$\hat{\beta}_t = (X'_t X_t)^{-1} X'_t Y_t$. If the sample were one observation longer, then:

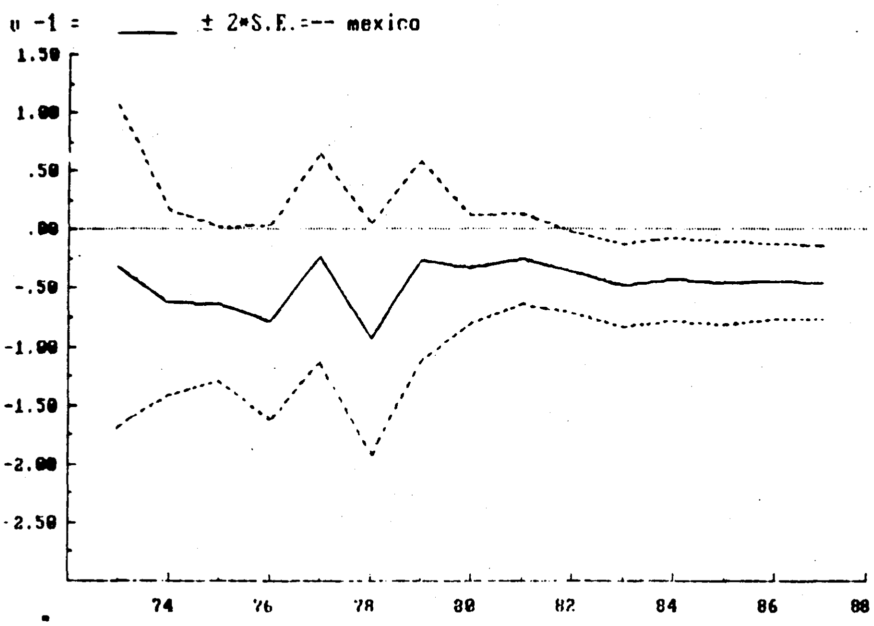
$$X'_{t+1}X_{t+1} = X'_t X_t + x'_{t+1}x_{t+1}$$
$$X'_{t+1}Y_{t+1} = X'_t Y_t + x_{t+1}y_{t+1}$$

Given $(X'_t X_t)^{-1}$, one does not need to invert $(X'_{t+1}X_{t+1})$ to calculate $\hat{\beta}_{t+1}$. Rather,

$$X'_{t+1}X_{t+1} = (X'_t X_t)^{-1} - \eta_{t+1}\eta'_{t+1}/(1 + \eta'_{t+1}x_{t+1})$$

where $\eta_{t+1} = (X'_t X_t)^{-1} x_{t+1}$. Thus, the inverse can be sequentially updated and $\hat{\beta}_{t+1}$ follows directly. The graphs show $\hat{\beta}_{it}$ + or - $2SE(\hat{\beta}_{it})$ for each selected i (i = 1,....k) over t = T_1 + N, T_2 . See Harvey, (1981, pp.54-59) on the calculation of recursive least squares and the associated statistics.

Finally, the third graph shows the fitted and actual values of the dependent variable (Δm_t) over time , including the prediction period.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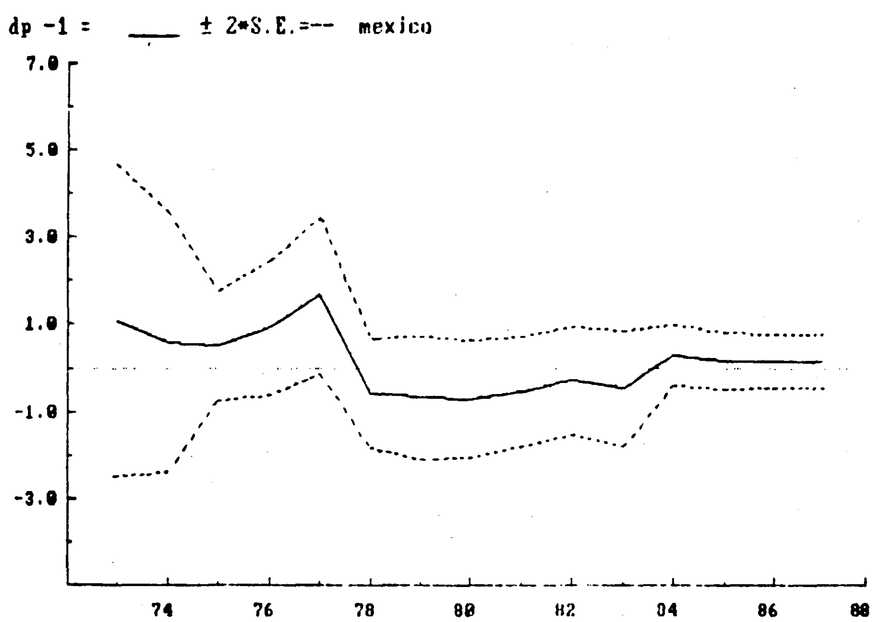
1.50
1.00
.50
.00
-.50
-1.00
-1.50
-2.00
-2.50
74
76
78
80
82
84
86
88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1.0
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-3.0
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76
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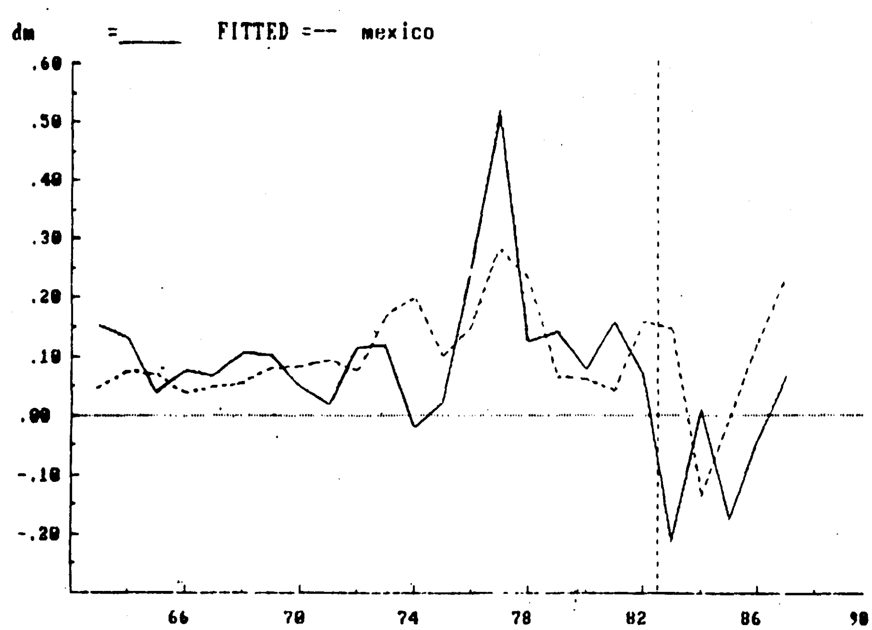
80
82
84
86
88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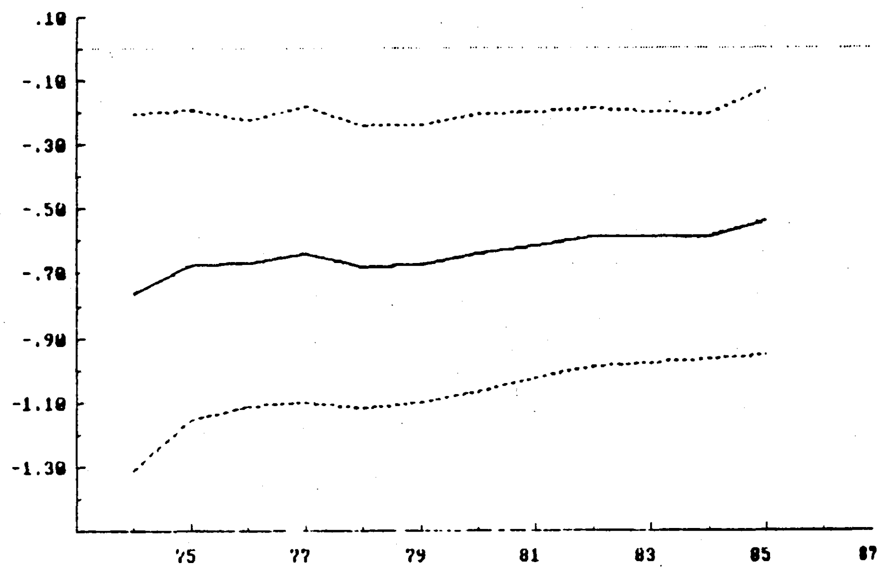
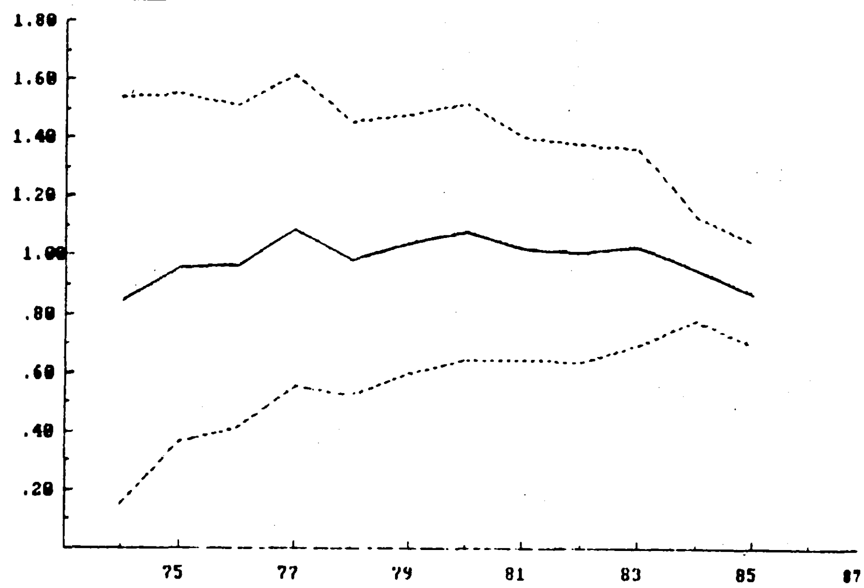
.50
.40
.30
.20
.10
.00
-.10
-.20
66
70
74
78
82
86
90

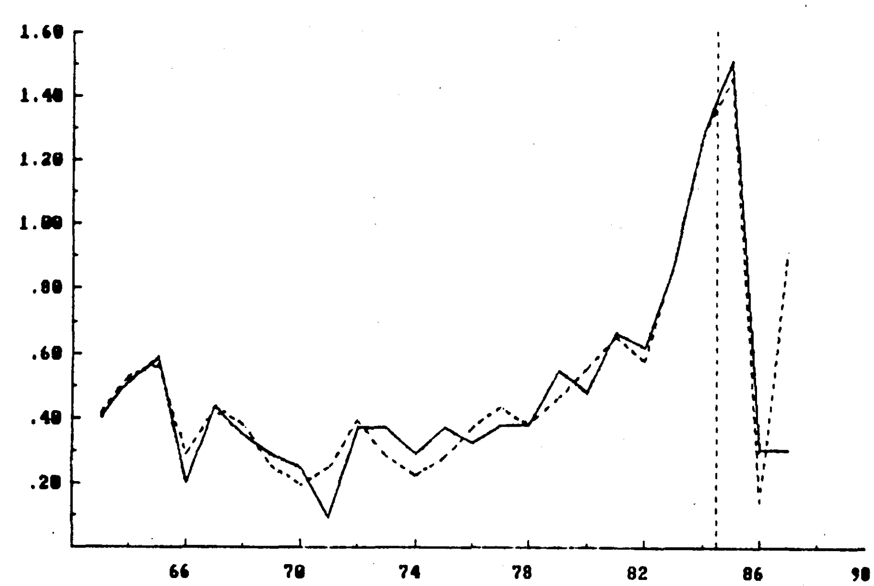
u -1 = ____ ± 2*S.E.=-- brazil

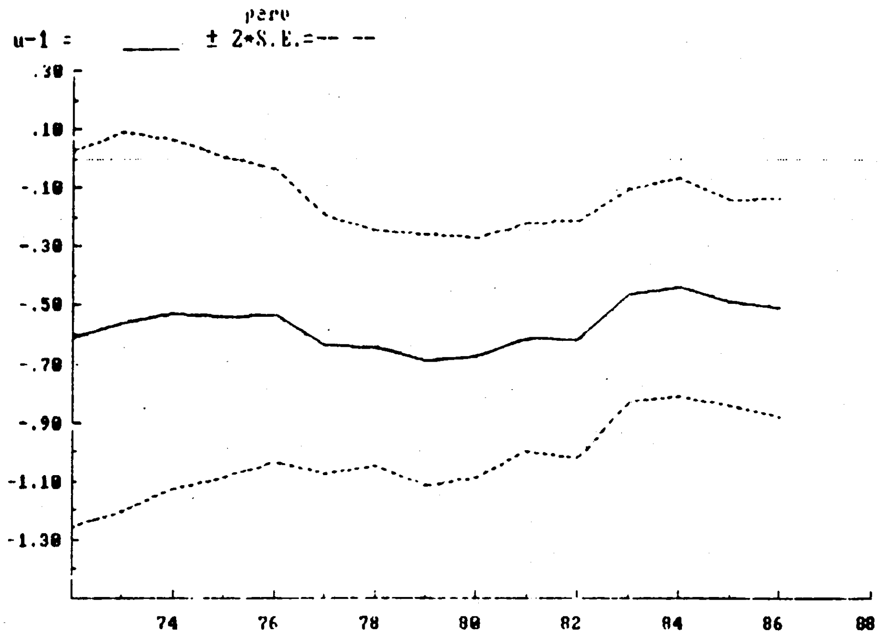


dp = ____ ± 2*S.E.=-- brazil



dm = ____ FITTED =-- brazil

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u-1 = ± 2*S.E.=-- --
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.10
-.10
-.30
-.50
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-.90
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-1.30
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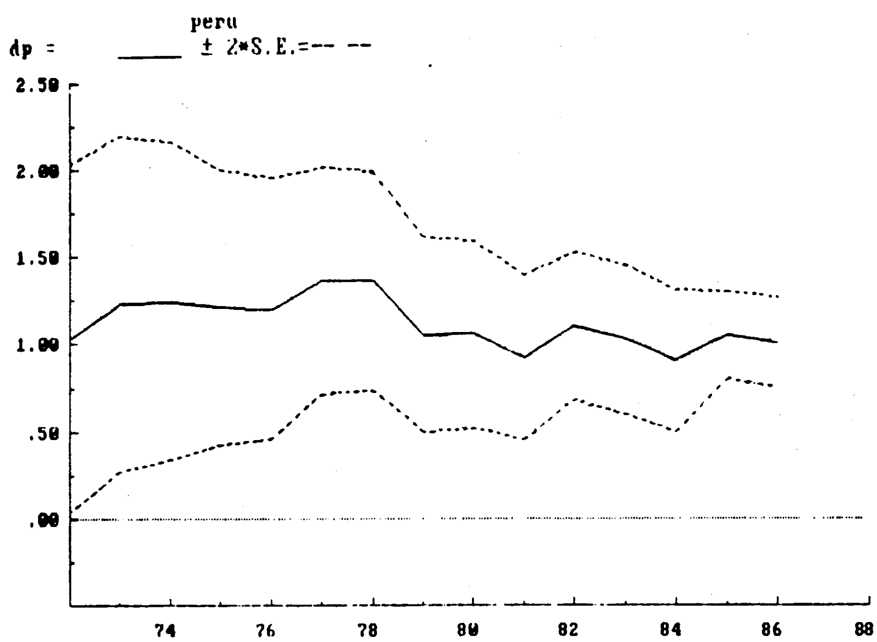
80
82
84
86
88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dp = ± 2*S.E.=-- --
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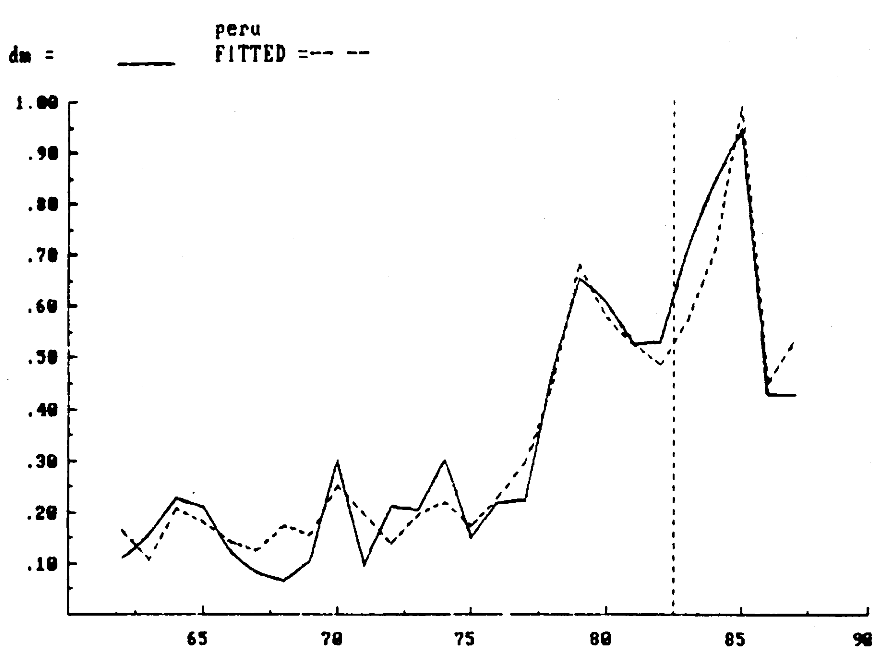
2.00
1.50
1.00
.50
.00
74
76
78
80
82
84
86
88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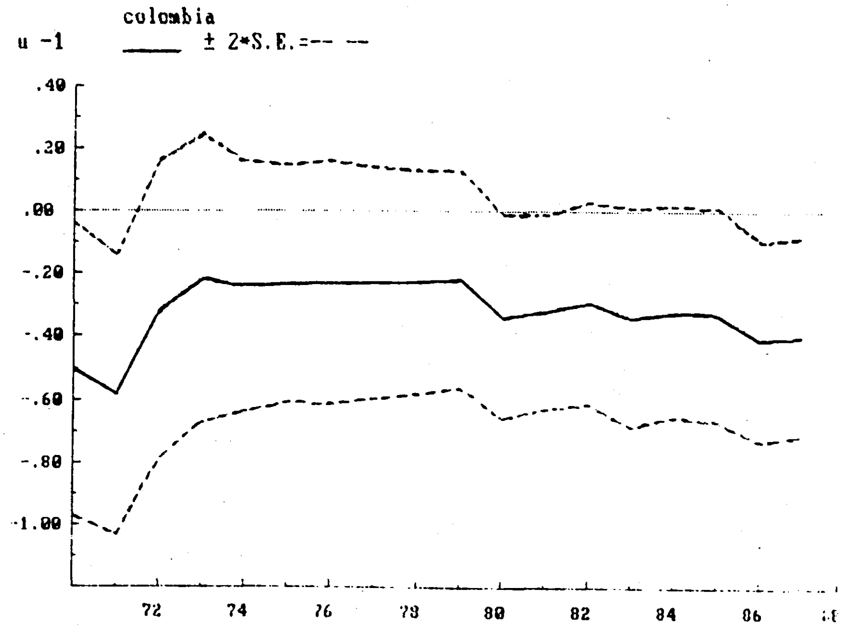
.80
.70
.60
.50
.40
.30
.20
.10
65
70
75
80
85
90


colombia
u -1 ____ ± 2*S.E.=-- --
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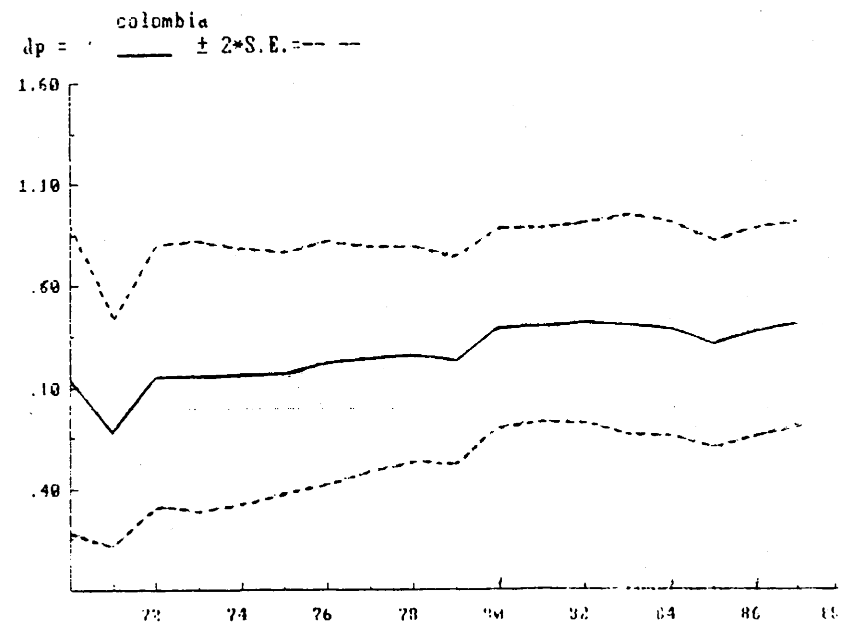
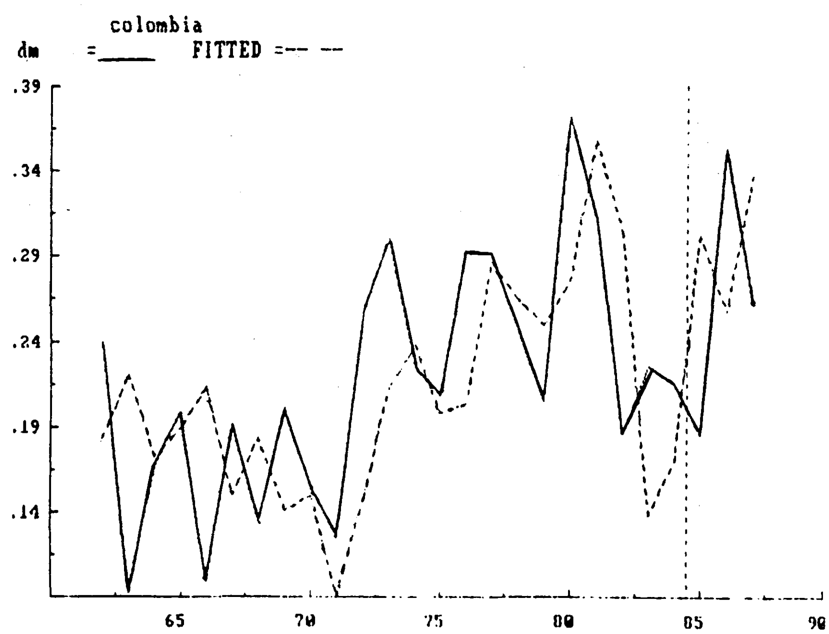
.20
.00
-.20
-.40
-.60
-.80
-1.00
72
74
76
78
80
82
84
86


colombia
dp = ____ ± 2*S.E.=-- --
1.60
1.10
.60
.10
.40
74
76
78
86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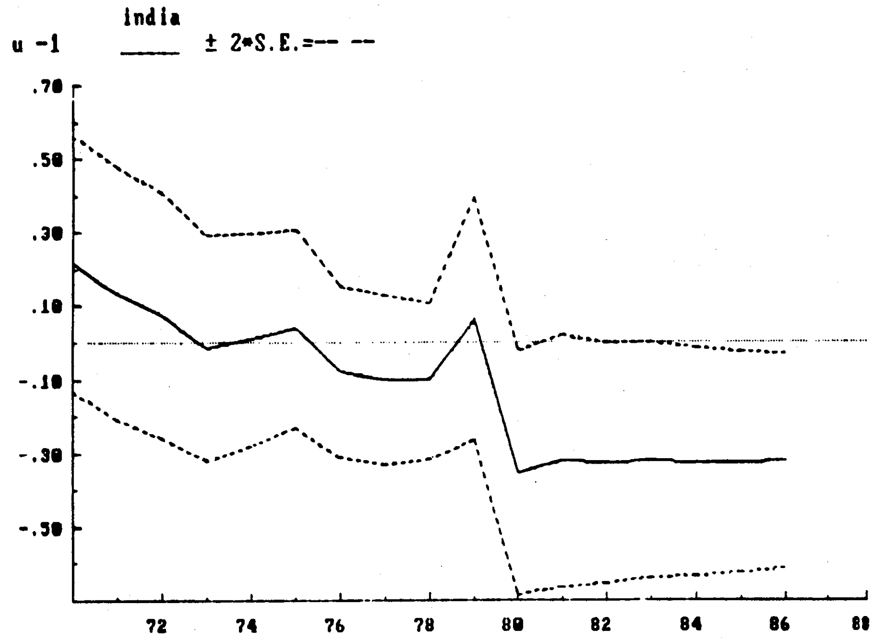
.29
.24
.19
.14
65
70
75
80
85
90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u -1
± 2*S.E.=-- --
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.50
.30
.10
-.10
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-.50
72
74
76
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80
82
84
86
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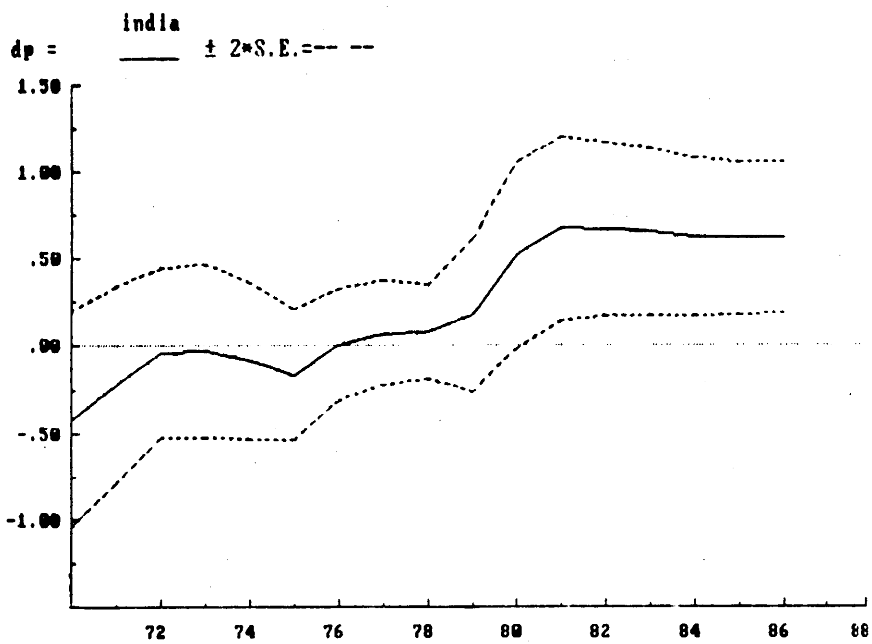
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74
76
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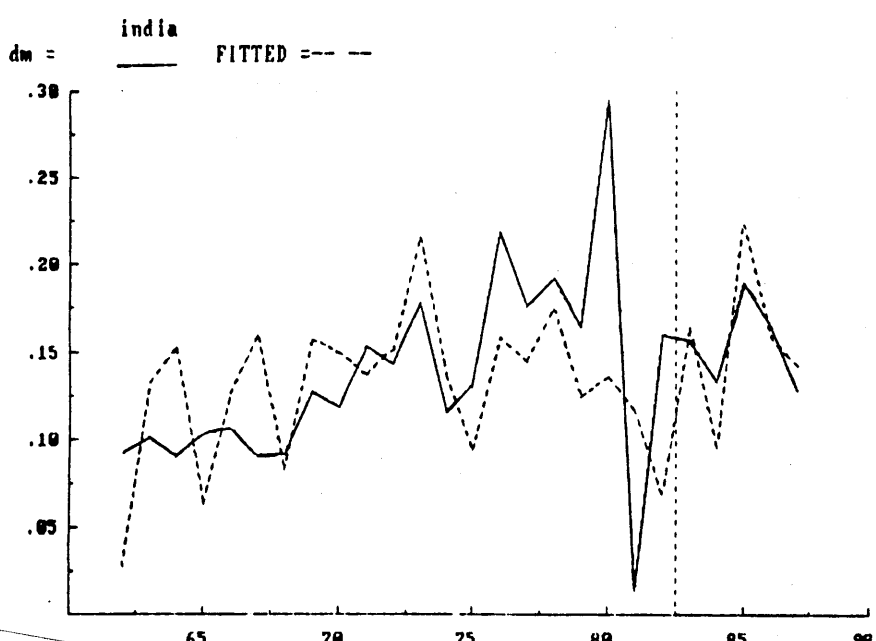
80
82
84
86
88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FITTED =-- --
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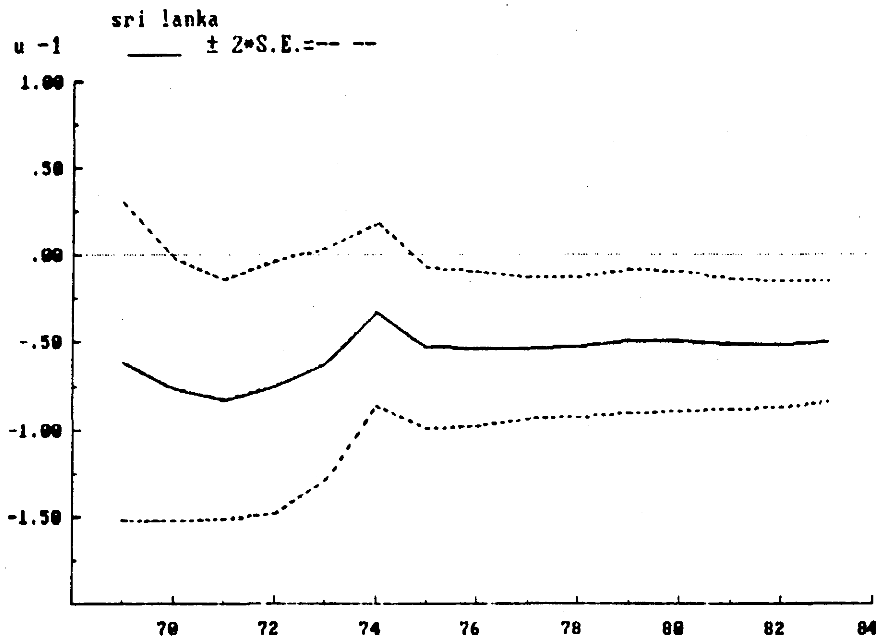
.25
.20
.15
.10
.05
65
70
75
80
85
90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u -1
± 2*S.E.=-- --
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-1.00
-1.50
70
72
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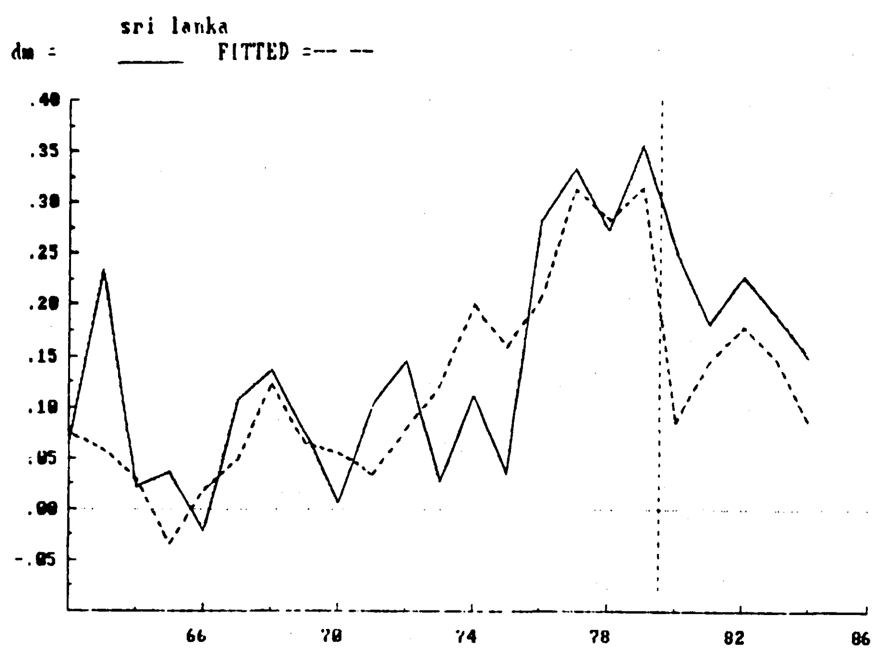
76
78
80
82
84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.25
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.00
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70
74
78
82
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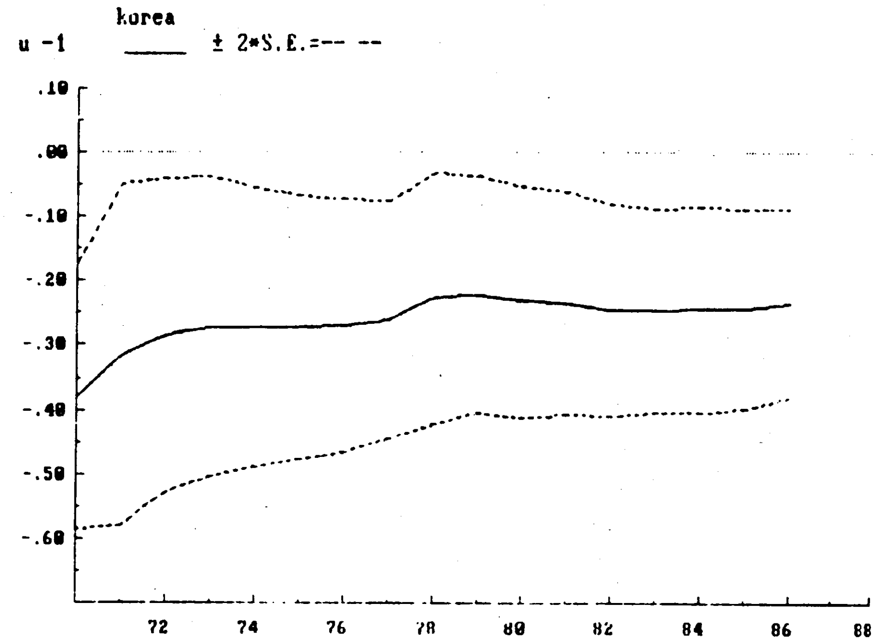
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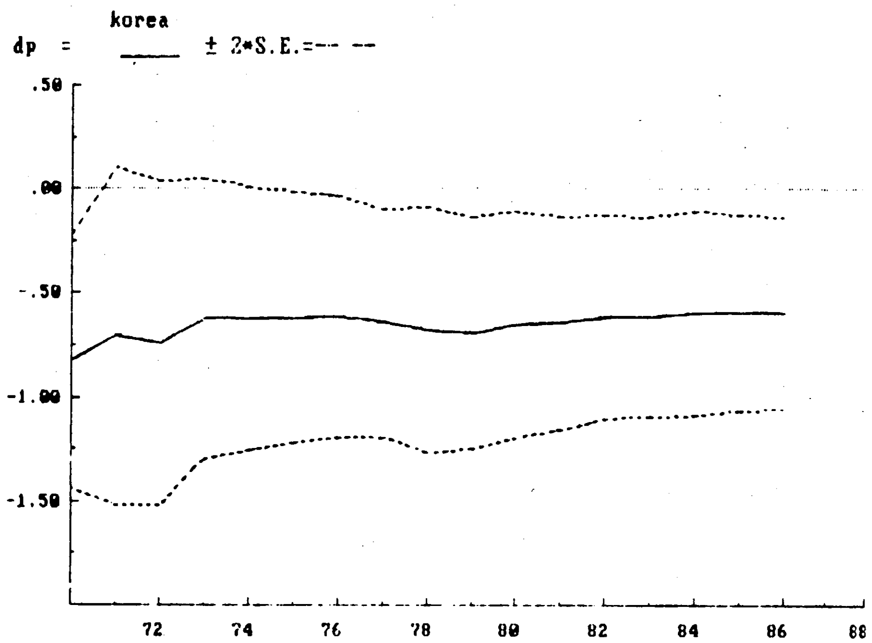
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76
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80
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korea
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.25
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85
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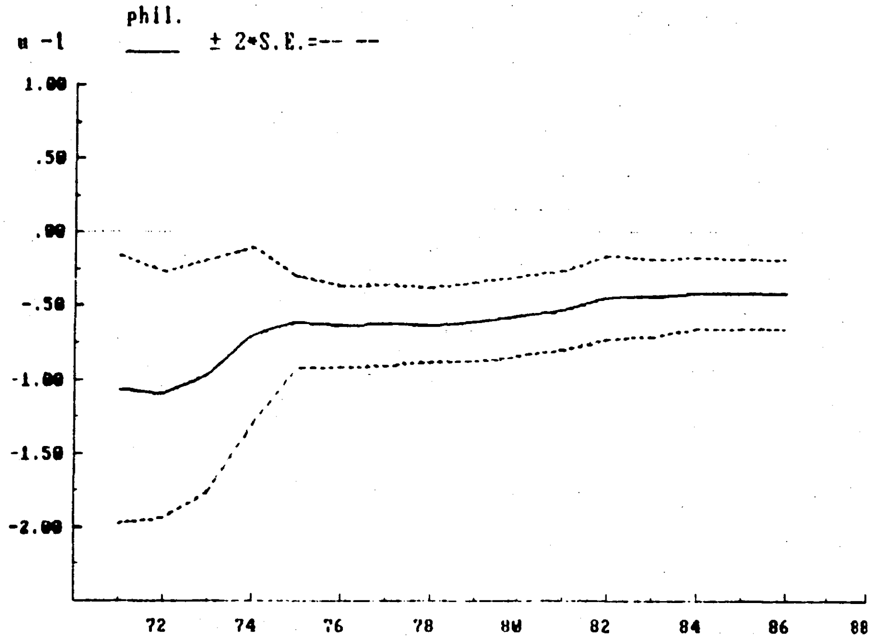
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± 2*S.E.=-- --
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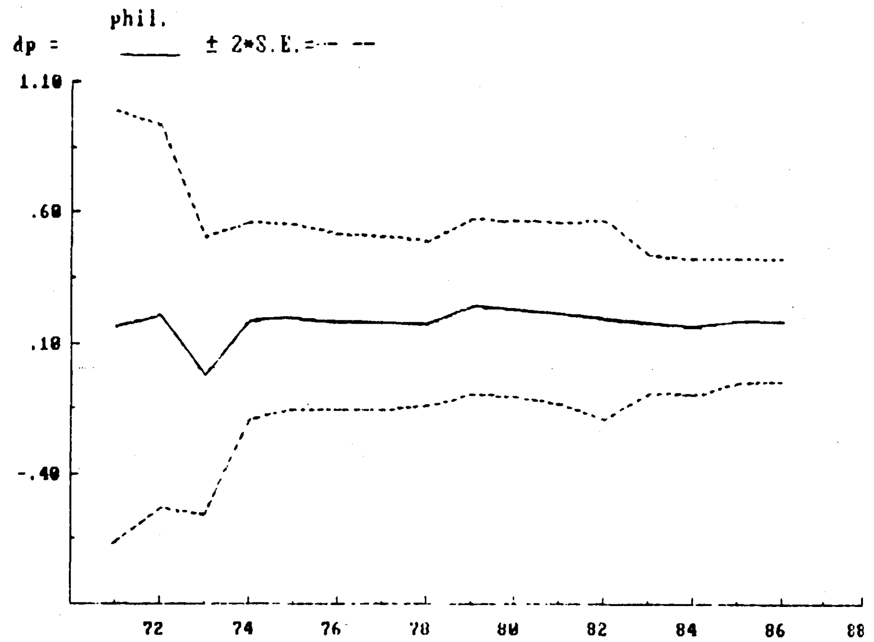
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80
82
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86
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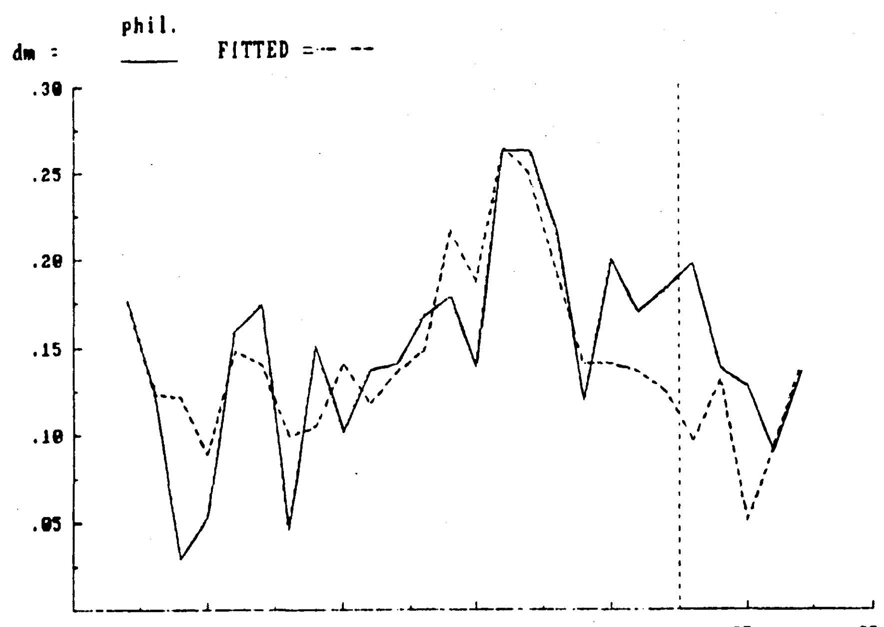
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.05
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75
80
85
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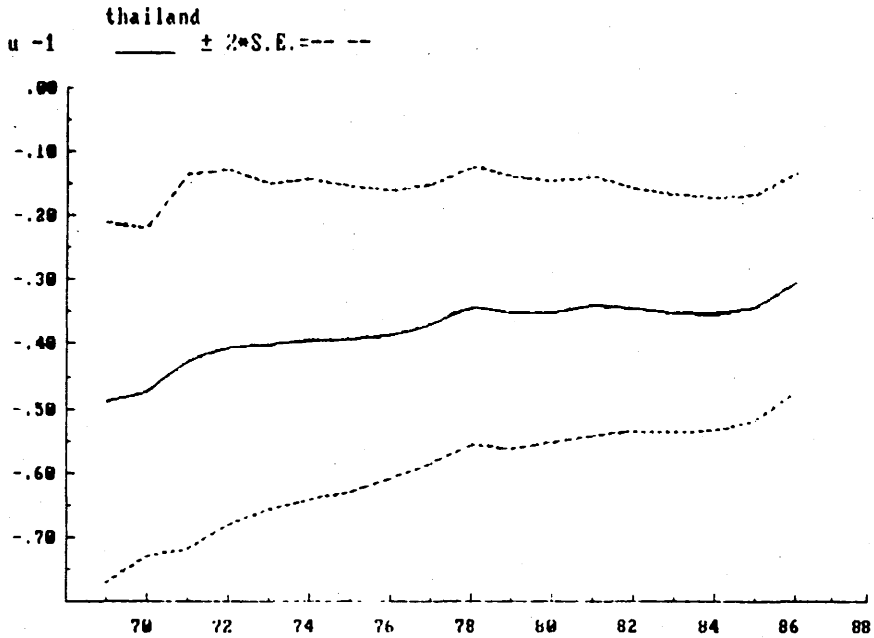
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u -1
± 2*S.E.=
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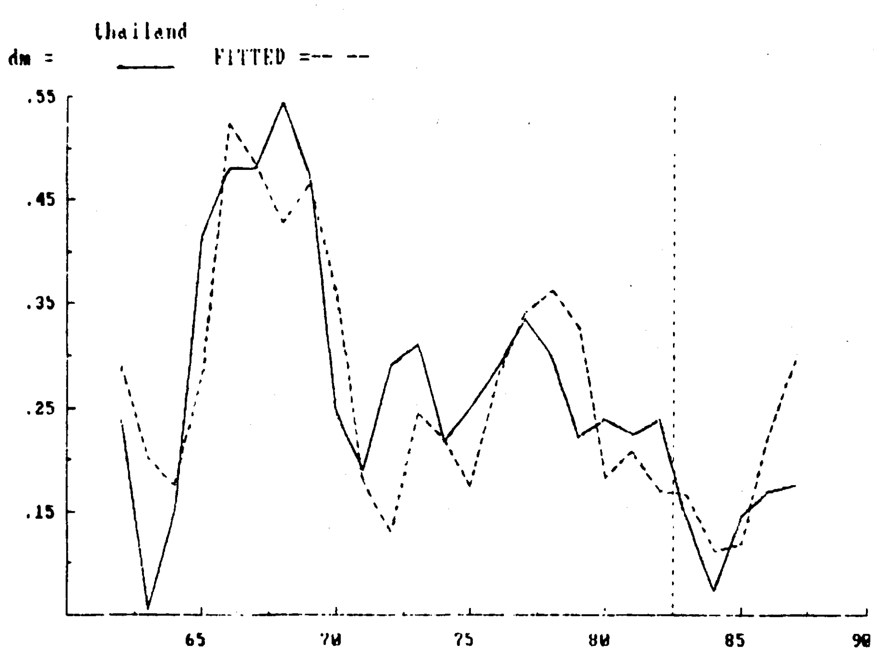
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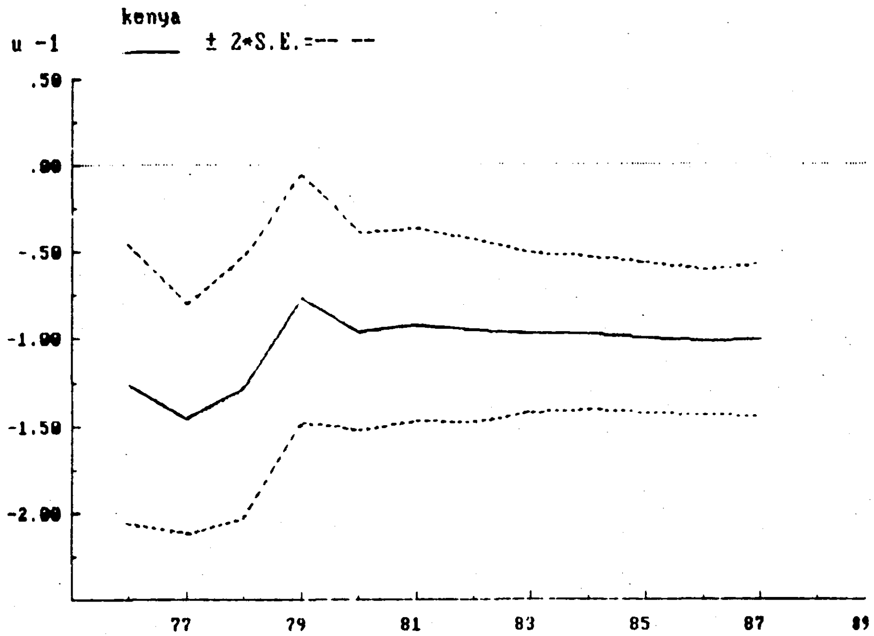
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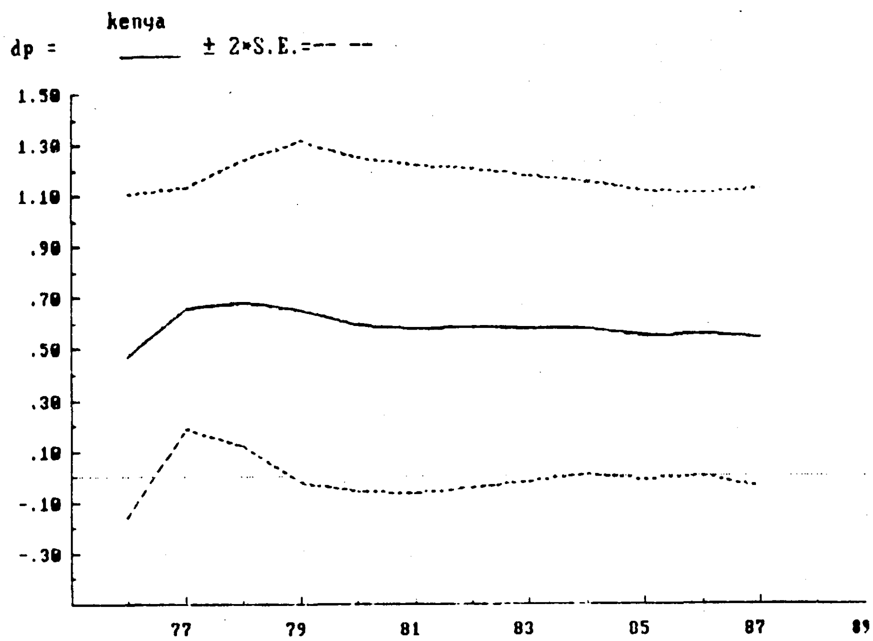
-1.50
-2.00
77
79
81
83
85
87
89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77
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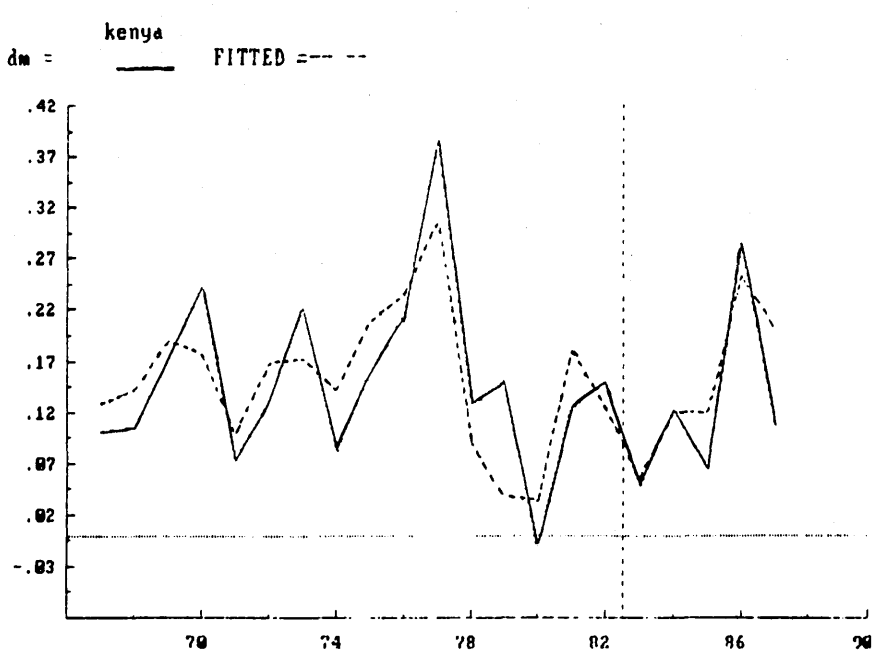
81
83
85
87
89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.02
-.03
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74
78
82
86
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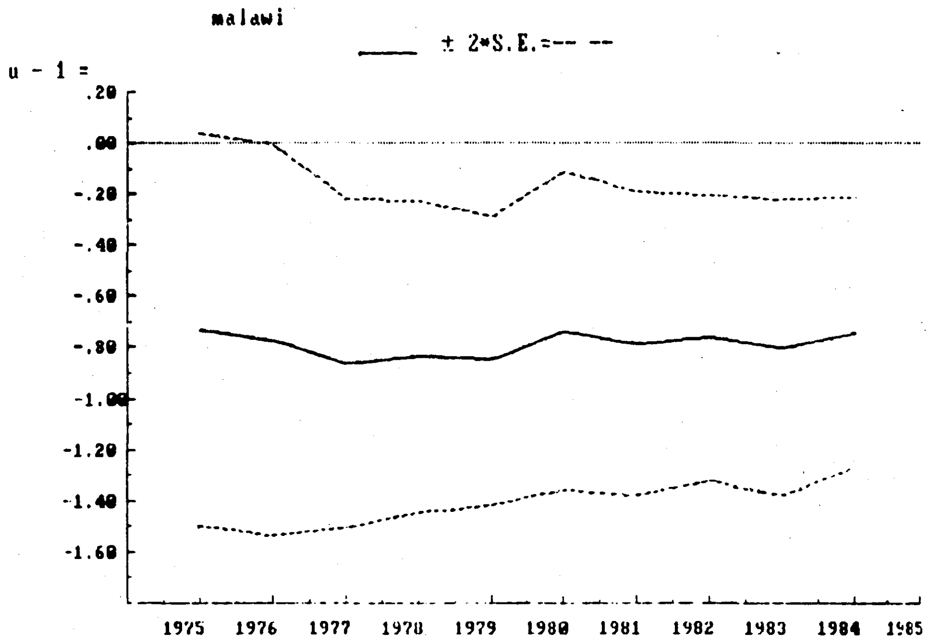
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± 2*S.E.=-- --
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.00
-.20
-.40
-.60
-.80
-1.00
-1.20
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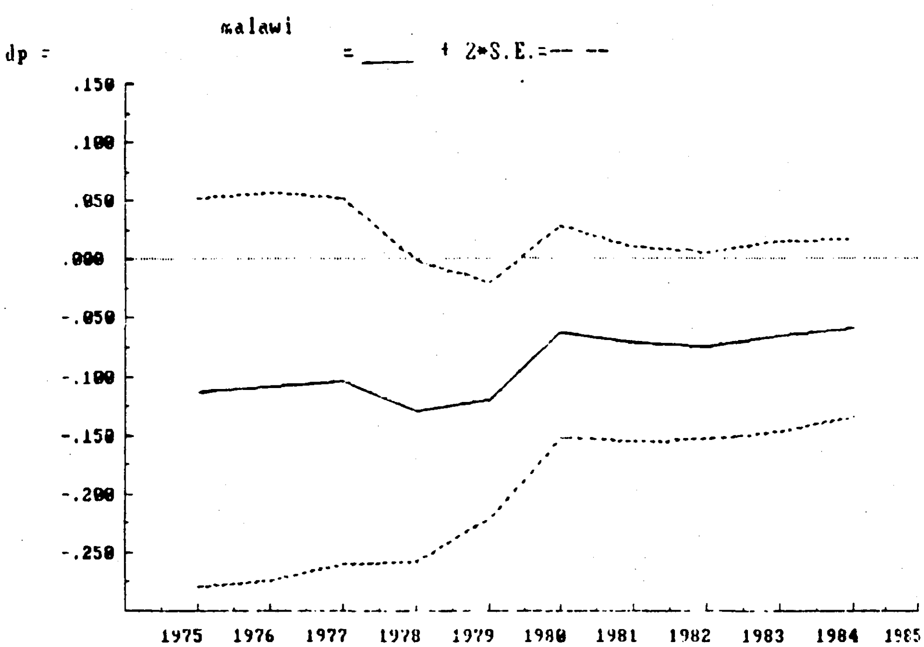
1980
1981
1982
1983
1984
1985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= ____ ± 2*S.E.=-- --
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.100
.050
.000
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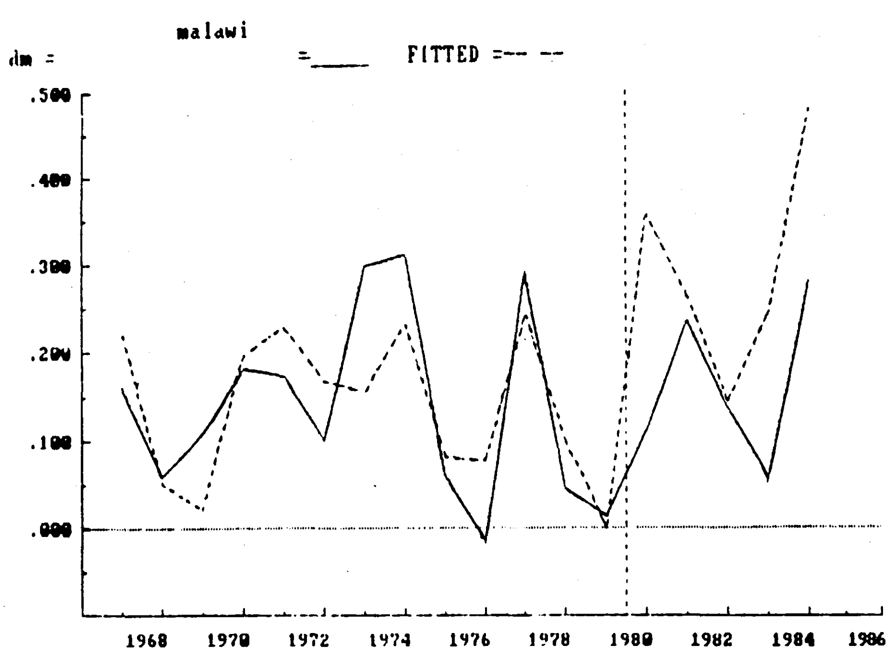
-.100
-.150
-.200
-.250
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985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=____ FITTED =-- --
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.200
.100
.000
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986

PART 3

POLICY ISSUES AND CONCLUSIONS

CHAPTER 8

THE ROLE AND SIGNIFICANCE OF MONETARY POLICY IN LDCs

8.1 Introduction

A substantial amount of information has been assembled about the demand for money function in the previous three chapters in relation to developing countries. The objective was to discover a well-defined demand for money function through appropriate econometrics techniques. However, the discovery of a 'good' model by itself serves very little purpose unless it is put to some practical use. In the following quotation from the Bank Of England Quarterly Bulletin, a possible use for estimated demand for money function is recommended.

In practice, the authorities do not know the current level of income in the economy as a whole; a reasonable comprehensive and reliable picture emerges only some months after the event. Meanwhile, they must grasp at straws in the wind. As interest rates are known from day to day and monthly data on the money stock are received quite quickly, the demand for money equations can be applied to discover what level of income would be consistent with observed interest rates and money stock; this provides an early, if approximate, indicator of movements in income besides those already available.

Goodhart,(1984, p.79) went even further to suggest that:

by taking steps to counteract the divergence of monetary aggregates from their expected path - when such divergence were not held to be due to money market disturbances - one could hope to use such information to stabilize the path of income.

This suggestion accords with the more commonly expressed view that changes in the money stock can influence output. However, the size of the effect of change in money supply on output is still a matter of considerable controversy. The simple version of the monetary approach to the balance of payments suggests, for example, that in the long-run and under a fixed exchange rate regime, a reduction in domestic credit will be completely offset by international reserve flow which restores the money stock to the level desired by the public. Consequently, monetary policy would have no long-run effect on the level of output relative to its trend. It is clear, however, that during the adjustment process, a decline in domestic credit may be associated with a reduction in capacity utilization and a possible rise in unemployment since prices are not completely flexible in a downward direction. The estimated size and duration of the deflationary effect created by a restrictive monetary policy depends on a number of factors, such as (1) the speed with which the initial credit restriction is offset by international reserve movements; (2) the response of domestic inflation to the excess demand for real money balance created by the credit restraint policy; (3) the extent to which the excess demand for money reduces aggregate demand;[1] and (4) the effect on private investment of a rise in the cost, or a reduction in the availability of credit. As these factors can interact in complex ways, the net outcome is clearly an empirical question. The purpose of this chapter is to investigate: (i) the scope of monetary policy; (ii) the money supply process;(iii) instruments of monetary policy; (iv) the potency of fiscal and monetary policy.

8.2 Scope of Monetary Policy in LDCs

The primary objective of monetary policy in LDCs is the achievement of monetary stability without inflation, balance of payments equilibrium and economic growth. It is important to note that an expansionary monetary policy to stimulate output may cause inflation. Thus, the monetary authorities should ensure that the rate of growth of the money supply is compatible with the rate of growth of output so that deflationary, as well as inflationary pressures could be avoided. A price rise of between 5 and

10 per cent in LDCs is believed to boost economic growth without causing inflation (Ghatak, 1981).

To see the price and output effects of an expansion in money supply, we reconsider the following demand for money function which is expressed within the framework of the quantity theory.

$$m = kpy \tag{8.1}$$

Differencing (8.1) logarithmically yields

$$\Delta m = \Delta p + \Delta y \tag{8.2}$$

Equation (8.2) states that change in money supply determines changes in nominal income and price levels, but no one knows (even the IMF) how much of this money supply change will go into prices and how much into output. To determine the actual split between price and output changes, we specify the expectations augmented Phillips curve relation as

$$\Delta p_t = b_o + b_1 U + \Delta p^*_t \tag{8.3}$$

where U is the unemployment rate' Δp^* is the expected rate of inflation and is determined by an adaptive expectations scheme, i.e.

$$\Delta p_t^* = \lambda \Delta p_{t-1} + (1-\lambda)\Delta p^*_{t-1} \tag{8.4}$$

$$0 > \lambda < 1.$$

Solving for Δp^* from (8.4) and rearranging (8.2) yields the following equations.

$$\Delta y_t = \Delta m_t - \Delta p_t \qquad (8.5)$$

$$\Delta p_t = -b_o\lambda + b_1 U_t - b_1(1-\lambda)U_{t-1} + \Delta p_{t-1} \qquad (8.6)$$

This rearrangement enables us to see the role of money, which is the only exogenous variable in the model. Given initial values of U_t , U_{t-1} and Δp_{t-1} , it is the money stock which determines the path of unemployment or income and hence inflation.

Next, we consider the equilibrium mechanism which works through the adjustments of the rate of change in output and the unemployment rate. Suppose nominal income is divided into a full employment trend, y* and the deviation from it, dy. It follows that when actual output growth exceeds y*, unemployment falls and when dy is below y*, unemployment rises, and therefore:

$$\Delta U = \gamma(dy - y^*), \quad \gamma < 0 \qquad (8.7)$$

We now exploit the Ghatak-Deadman diagram (Fig. 8.1) to show the relationship between money, output and inflation (see Ghatak and Deadman,1989). Equation (8.3) is presented in an inflation-unemployment space where pc shows the trade off and the expected rate of inflation dp* is a horizontal line. y* is the fixed long-run rate of growth of nominal output, which is consistent with the long-run growth of

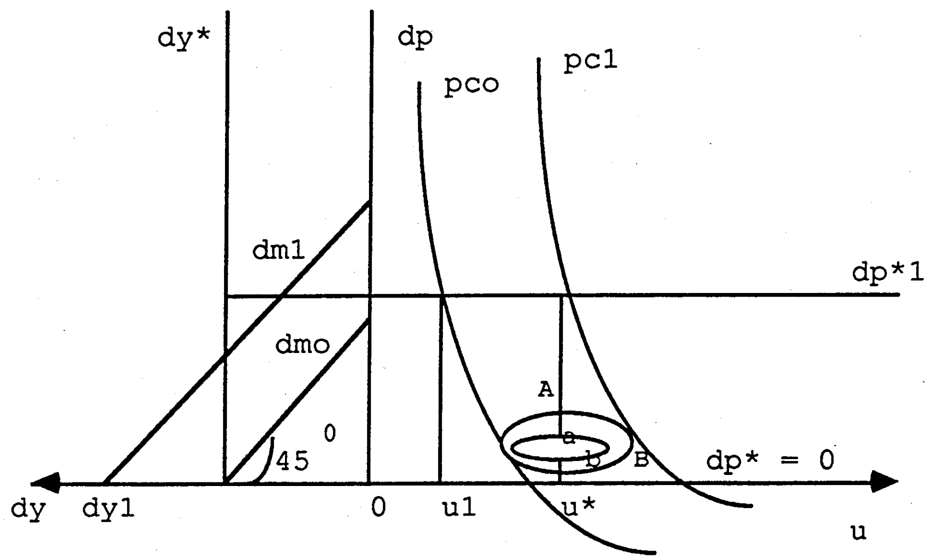

Fig. 8.1

labour productivity. Starting from an initial position of equilibrium where dm = dmo, dy = y*, dp = 0 and U = U*, a rise in dmo to dm1 changes these equilibrium position as follows: dy = dy1, dp = dp1 and U = U1. An increase in money supply has led to a reduction in unemployment below its natural rate, U* and output has risen to dy1. However, this position cannot be sustained for long since in the long-run, inflation expectations are fully captured by economic agents and equilibrium is restored with dy = y*, dp = dp1 and U = U*. The long-run effect of an expansionary monetary policy is, therefore, fully reflected in price increases alone which is consistent with the quantity theory of money. The problem here is that the precise time lag required for the monetary shock to have its effect on income and prices is unknown. If expectation adjusts slowly, which is more likely in LDCs due to imperfect information and structural rigidities, (A) will be the probable path of adjustment while a rapid adjustment process will produce a path like (a). On the other hand, a contractionary monetary policy is likely to produce adjustment paths like (B) or (b) depending on the speed of adjustment. This analysis is based on the tacit assumption that the monetary authorities can control the money stock. We now turn to a brief discussion of the determinants of money supply and the controlability of the money stock in LDCs.

8.3 The Money Supply Process in LDCs

The determinants of the change in money supply, m(2), can be analysed in terms of four factors: (a) credit to the private sector, (b) net lending to the government, (c) net foreign assets and, (d) other assets (net). These factors add up to the total money stock or private sector liquidity. If we postulate a simple banking system with only one kind of deposit and define the money stock as the currency and deposits of the non-bank public, we have

$$m = C + D \qquad (8.8)$$

The money stock can also be expressed in terms of the monetary base, H, i.e.,

$$m = kH \qquad (8.9),$$

and H in turn can be written as

$$H = CG + CB + NFA + OAN \qquad (8.10)$$

where CG = Central Bank Credit to the Government usually net of government deposits, CB = Central Bank Credit to the domestic banks, NFA = Net Foreign Assets, OAN = Other Assets (Net):

The bank multiplier, k, given by (8.9) is determined by the reserve requirement (r), the desired currency to deposit ratio (c), and the desired excess reserve ratio (e), and by definition r = rD, c = cD and e = eD. Given these, the high powered money can now be written as:

$$H = rD + cD + eD = (r + c + e)D \qquad (8.11),$$

and

$$m = C + D = (1+ c)D \qquad (8.8)'$$

We can now derive k from (8.11) and (8.8)'

$$k = \{1+c/e+r+c\} \qquad (8.12)$$

Substituting for H from (8.9) and for k from (8.12) gives us the following total money stock.

$$m = \{1+c/e+r+c\}[CG + CB + NFA + OAN] \qquad (8.13)$$

Equation (8.13) says that in an open economy with fixed exchange rates, the money supply is determined by a central bank lending to the government and the domestic banks.

Changes in a central bank's credit to the government (CG) reflects, by and large, the borrowing needs of the government. In many LDCs, the Finance Ministry's borrowing from the central bank dominates the base through CG. The net foreign assets (NFA) component of the monetary base changes as a result of a central bank's foreign exchange trading and thus, when committed to a particular exchange rate policy for its currency, it reflects changing conditions in import and export markets and international capital movements. In this way, changes in the monetary base in developing countries are brought about by fiscal policy, monetary policy and the balance of payments. Other things being equal, the stock of monetary base is increased by a fiscal deficit, a balance of payments surplus and central bank lending to the banking system. Therefore, although the supply of the monetary base is under the control of the authorities, in the sense that it comprises the liabilities of the central bank, in reality the action of the monetary authorities to control the monetary base may affect interest rates, prices or incomes in a manner which feeds back to one or more of the elements in the budget deficit.

Having outlined the factors which determine the stock of high powered money, can we be sure of a stable and predictable relationship between the base and the stock of money? The central banks's control of the money supply requires accurate prediction of the multiplier (by estimating the behaviour of its currency, required reserve and excess reserve components) and control of the base. This requires a stable multiplier and the ability to dominate those base components that it does not control with those that it does. It is important to note that the bank reserve ratio and the currency to deposit ratio are necessarily identities since one can always measure r as actual bank reserves divided by actual bank deposits and c as a ratio of currency actually held to actual bank deposits. The money supply process described by equations (8.9) to (8.13) is criticized as mechanistic because it treats r, c and e as fixed parameters and does not take into account the behaviour of banks and the public which determine these variables. In the behavioural model, the money supply is partly endogenous because the reserve ratio and the currency ratio vary with interest rates, and hence with the demand for the various assets and liabilities created by the financial system.

Commercial banks in LDCs sometimes hold higher and somewhat less stable, levels of excess reserves. The currency to deposit ratio is usually dominated by fairly regular seasonal patterns with its secular behaviour reflecting such things as the pace of monetization, growth of the banking habit and the convenience of banking offices. The currency ratio can also shift with the change in the magnitudes of illegal transactions (for tax evasion) as cash payments are easier to hide than payments by check.

These factors suggest a somewhat larger role for short-run variations in the money multiplier in LDCs than in developed economies. None the less, the multiplier is invariably found to be at least moderately predictable in LDCs and contributes very little to monetary changes over longer periods of time (Coats and Khatkate,1980). The fact that interest rates play a minor role in money supply (demand) also means that r and c are reasonably constant. To this effect, we may argue that H is more exogenous in LDCs than in developed market economies. In the long run, however, money's behaviour is almost always overwhelmingly dominated by the base. The base, in turn, is invariably dominated by the balance of payments and/or the government deficit. The government's deficit is important in this respect if it affects the monetary base.Government deficits financed by commercial banks do not alter the base and generally have negligible effects on the multiplier and, therefore, on the money supply, while deficits financed by the central bank lead directly to an increase H and a multiple increase in m. (Coats and Khatkate,1978).

8.4 Instruments of Monetary Control

The preceding discussion of the factors determining money supply helps us to place the role of the traditional instruments of monetary control in their proper context. The types of monetary instruments usually used in developing countries are similar to those used in developed countries, viz. the bank rate, open market operations (OMO), reserve requirements (RR) and selected credit controls (SCC). However, these instruments have some serious limitations in the context of developing countries and we shall briefly consider these problems in the following paragraphs.

(1) The bank rate is sometimes given independent monetary significance as an indicator of the intention of the central bank and as the cost of one source of funds. Higher rates are interpreted as reflecting a restrictive monetary policy and vice versa. Such an interpretation is misleading as the willingness of banks to borrow from the central bank depends on the difference between the discount rate and commercial bank loans rates, and not on the absolute level of discount rate. This explains why monetary policy is more often expansionary when the bank rate is high.

The excess liquidity that many commercial banks experience in LDCs also hinders the growth of rediscounting bills. Under such circumstances, even if the bank rate is raised to squeeze the credit market, the commercial banks may not be obliged to raise their interest rates. Secondly, the narrow size of the bill market and the presence of barter transactions can render the bank rate rather ineffective. In a country where the non-monetized sector is quite substantial, change in the bank rate will have very little effect.

(2) Open market operations give the central bank more initiative and flexibility in its efforts to influence the monetary base. The use of this instrument requires the existence of a sufficiently deep financial market in high quality securities that the central bank's activities can alter the base (and bank reserves) without seriously disrupting that market itself. Unfortunately, the efforts of Finance Ministries to suppress the cost of servicing their governments' debts have frequently thwarted the development of such markets in LDCs. When yields are held artificially low and government securities are forced one way or another on the public, secondary markets, which generally enhance the liquidity and attractiveness of such securities to the public, are not likely to develop (Porter,1965). Consequently, open market operations have been far more important in developed than in developing countries.

(3) The reserve requirement ratio has a profound effect on the size of the bank multiplier and hence the quantity of money resulting from a given base or change in the base. Furthermore, for a given base, changes in the ratio can cause a dramatic change in the multiplier, and hence in the money supply. This makes reserve requirements potentially one of the most important instruments of monetary control in LDCs (Coats, 1976e). However, reserve requirement cannot be very effective because of the existence of a large unorganized money market. However, the reserve requirement

has a greater chance of success than OMO or the change in bank rates even when it operates in under-developed money markets (Ghatak,1981). To strengthen the reserve requirements' role in controlling the money stock, it is desirable to avoid discriminatory effects. For example, changes in reserve requirements will not influence the credit creation capacity of non-bank financial intermediaries. To avoid such discriminatory effect, some central banks in the LDCs, (example, Guatemala, India, Philippines) have decided to enforce additional reserves against any future increase in deposits. For commercial banks which maintain an excess liquidity, the additional RR could be raised to 100 per cent, which would effectively limit their credit creating capacity.

(4) Many LDCs have found selective credit controls very useful devices in the light of their under-developed money and capital markets. The techniques for implementing selective credit varies. Some of these are differential interest rates, import pre-deposits which do not earn interest rates, credit ceilings for different types of loans, controls on capital issue, etc. The case for selective credit policy rests on the argument that the financial intermediation process does not by itself ensure the socially optimum use of resources.

The arguments for SCC have some serious flaws. For instance, the purpose of credit control may be defeated if the credit allocated to a certain sector is lent to other sectors or borrowers not intended by the monetary authorities. The assessment of the efficiency of selective credit control requires a knowledge of where the control is applied (i.e.,lenders, borrowers or credit instruments), since the conditions governing efficiency depend on where the control is imposed.

A far more serious impediment to efficiency is poised by the institutional constraints in LDCs that continually raise the odds against indigenous entrepreneurs, and even more against new entrepreneurs. The risk of failure that they face is formidable and deters financial institutions from supplying their credit needs. Imperfections in credit markets and the other institutional impediments to enterepreneural growth may be worsened by selective credit controls rather than lessened. If market imperfections result from the lack of information among prodution and consumption units in the economy, the remedy ideally should lie in the interventionist approach of selective credit policies, but in a more liberalized regimen under which all special subsidies and taxes are removed. Unfortunately, the empirical evidence on SCC is so sketchy that it is difficult to form a definitive judgement about their effectiveness in LDCs.

To sum up, the discount rate, open market operations and selective credit controls have proved to be very ineffective. On the other hand, the reserve requirement has a greater chance of success compared to the rest of the traditional monetary instruments. It must, however, be noted that RR could only be fully successful if it is used as an integral part of a 'comprehensive financial programme' by the central bank. Put another way, there is no single instrument which gives monetary authorities the power to completely control the money supply; each monetary tool must be reinforced by other instruments.

8.5 Testing the Plausibility of Monetary and Fiscal policies

Since the advent of the 'Monetarist Counter Revolution', a lot of theoretical and empirical interests have been shown in the monetary vs fiscal policy debate. Although several studies have been undertaken in an attempt to resolve the controversy, most of the empirical and theoretical works were concentrated on the experience of developed countries. Little attention, if any, has been devoted to the economies of developing countries. This is, therefore, an attempt to fill this gap and evalulate empirically the relative strength and dependability of these policy options.

We begin our analysis of the above issue with the following model.

$$\Delta y_t = a + \Sigma_{i=0} b_i \Delta m_{t-i} + \Sigma_{i=0} c_i \Delta G_{t-i} + u_t \qquad (8.14)$$

where Δy is a change in nominal income, Δm is a change in nominal money stock and ΔG is some measure of a change in fiscal policy: either high-employment expenditure or the high-employment budget surplus. Equation (8.14) is also known as a 'St. Louis' model after the affiliation of its authors (Anderson and Jordan, 1968) with the Federal Reserve Bank of St. Louis. Equation (8.14) has advantages over the more elaborate structural equations in terms of its simplicity. It avoids the problem of specifying and measuring specific links between monetary and fiscal actions on one hand and economic activity on the other hand. Thus, with relatively few variables, (8.14) can explain much of the complexities of the real world.

In the context of the countries under investigation, the St.Louis equation will have to be modified to take account of international transactions. Batten and Haffer (1983) have suggested that some variable, measuring the impact of exports should be included as an additional regressor in the case of open economies. The export oriented version of the St.Louis equation has the form:

$$\Delta y_t = a+\Sigma_{i=0}b_i\Delta m_{t-i}+ \Sigma_{i=0}c_i\Delta G_{t-i} + \Sigma_{i=0}d_i\Delta x_{t-i} + u_t \quad (8.15)$$

where all the variables are as defined before and Δx is a change in merchandise exports. When estimating (8.14) or (8.15), the choice of the appropriate indicators of monetary and fiscal actions are very crucial. Firstly, there is the need to provide theoretical and to a large extent, practical justifications for using particular economic variables. Secondly, one must also ensure that changes in the variables selected as surrogates of fiscal and monetary actions must be controllable by the fiscal and monetary authorities. As a result, we have modified the variables in the traditional St.Louis equation as follows:

(a) Gross Domestic Product (GDP) is used as a proxy variable for economic activity as time series data on GDE or GNP is not available for all the countries in this study;

(b) due to the non-availability of data on high-employment budget deficit and surplus, we have employed total government expenditure as proxy for fiscal policy;

(c) the broadly defined money stock (m2) is chosen to represent monetary action.

The fiscal and monetary variables selected above fulfill, at least partly, the requirements of being under the control of the monetary and fiscal authorities. With these adjustments, we have estimated equation (8.14) and the results are presented in table 8.1.

A closer look at the results show that change in money supply (m2) has a positive and significant impact on nominal output in all our equations. The fiscal variables are also significant in six countries, namely: Mexico, Peru, India, Korea, Thailand and Kenya. They have zero effects in Colombia, Sri Lanka, Philippines and Malawi

Table 8.1 Typical St. Louis Results for 11 developing countries.

Country	Coefficients		Summary statistics
1. Mexico			
	bo .16	(1.5)	R^2 = .94 DW = 1.4
	b1 .18	(1.5)	s = .07 , χ^2 (1) = 2.0
	b2 .21	(2.0)	LM(1) = 1.7, ARCH(1) = 1.6
			Chow(3,15) = .75 F(5) = 1.1
	Σbi	.55	
	co .36	(3.2)	
2.Brazil			
	bo .54	(4.1)	R^2 = .94 s = .18 DW = 2.3
	b1 .36	(2.0)	χ^2(1) = 2.2 LM(1)= 1.9
	b2 .54	(2.1)	ARCH(1)=3.2 Chow(2,19)=.31
	Σbi	1.23	F(2) = 41.5*
	co -.09	(1.8)	
3.Peru			
	bo .68	(9.6)	R^2 = .98 s = .06 DW =1.6
	c1 .35	(4.8)	χ^2(1) = -.10 LM(1)= -.09
			ARCH(1) = 1.1 Chow(5,18)=2.6
			F(5) = 3.9
4.Colombia			
	bo .26	(1.7)	R^2 = .87 s = .05 DW =1.7
	b1 .36	(2.5)	χ^2 = .31 LM(1) = .00
	Σbi	.62	Chow(5,17) = .65 HF(5)=.68
	c1 .12	(1.4)	
5.India			
	bo .31	(2.3)	R^2 = .31 s = .04 DW = 1.7
	b1 .35	(2.6)	χ^2(1) = .50 LM(1)=.43
	Σbi.66		ARCH(1) = .88, Chow(5,17)=.73
	c2 18(2.3)		HF(5) =.78
6.Sri Lanka			
	b1 .50	(3.8)	R^2 = .88 s = .25 DW = 1.2
	b2 .25	(1.7)	χ^2(1) = 2.5 LM(1) = 2.4
	Σbi.75		ARCH(1) = .01 Chow(5,14)=.13
	co .14	(1.4)	HF(5) = .13

Table 8.1 (continued)

7.Korea				
	b1	.25	(2.1)	R^2 = .92 s = .06 DW=1.2
	c1	.38	(4.2)	$\chi^2(1)$ = 3.3 LM(1)= 3.2 ARCH(1)=.21
	c2	.18	(1.6)	Chow(5,14) = .32 F(5) = .32
	Σci	.56		
8.Philippines				
	bo	.37	(1.5)	R^2 = .82 s = .07 DW = 1.7
	b1	.56	(2.3)	$\chi^2(1)$ = .48 LM(1) = .41 ARCH(1)=.0
5				
	Σbi	.93		Chow(5,17) = 1.9 F(5) = 1.9
	c1	.03	(.29)	
9.Thailand				
	b1	.35	(3.1)	R^2 =.90 s = .08 DW = .79
	co	.36	(1.5)	$\chi^2(1)$ = 10.5*LM(1) = 13.6
	c1	.52	(2.1)	ARCH(1) = .01 Chow(5,17) = .31
	Σci	.88		HF(5) = .31
10. Kenya				
	bo	.38	(3.5)	R^2 = .89 s = .05 DW = 1.6
	b1	.26	(2.3)	$\chi^2(1)$ = .02 LM(1) = .01 ARCH(1)=.99
	Σbi	.64		Chow(5,11) = 1.8 HF(5)=1.8
	c2	.21	(2.2)	
11. Malawi				
	bo	.37	(2.2)	R^2 = .81 s =.07 DW = 2.1
	b1	.33	(2.1)	$\chi^2(1)$ = -1.6 LM(1) = -1.2
	Σbi	.70		ARCH(1) = 2.9 HF(5) = 1.4
	c2	-.01	(.06)	

(i) t-ratios in parenthesis.

(ii) $\chi^2(1)$ is Box-Pierce test statistic for the randomness of residuals distributed as χ^2 (1).

(iii) LM(p) is the Lagrange Multiplier test statistic for up to pth order autocorrelation.

(iv) ARCH(p) is the F-test for Autoregressive Conditional Heteroscedastic residuals.

(v) HF(p) is the p periods ahead forecast test.

and a negative impact in the case of Brazil.

In order to avoid invalid inferences, we have conducted a number of statistical tests. First order serial correlation appears to be a problem in Thailand and the Brazilian equation fails the forecast test. The remaining nine equations pass all of the crucial tests.

The next task is to consider the openness of the countries under investigation. This amounts to estimating equation (8.15) which includes merchandise export as an additional explanatory variable and the results are given in table 8.2. Once again, the results from the modified St. Louis equation indicate that change in money supply remains the dominant explanatory variable. The cumulative monetary impact is closer to unity in Mexico and Brazil but less than unity in the rest of the countries.[2] The fiscal impact is now zero in Mexico, Colombia, India, Philippines, Kenya and Malawi and negative in the case of Brazil. A positive and significant fiscal impact is reported in four countries. These are Peru, Sri Lanka, Korea and Thailand. Even here, the cumulative fiscal impact is consistently lower than the monetary impact.

Table 8.2 The Modified version of The St. Louis Equation

country	coefficients			summary statistics
1.Mexico				
	bo	.49	(4.7)	R^2 = .93 s = .09 DW = 1.3
	b1	.43	(3.1)	$\chi^2(1)$ = 3.9 LM(1) = 3.5
	Σbi	.92		ARCH(1) = 1.4 Chow(3,17) = 1.4
	co	-.002	(.29)	F(5) = 2.4
	do	-.27	(2.2)	
	d1	.17	(1.4)	
	Σdi	-.01		
2. Brazil				
	bo	.63	(4.7)	R^2 = .95 s = .09 DW = 1.3
	b1	.63	(5.1)	$\chi^2(1)$ = 3.9 LM(1) = 3.5 ARCH(1)=1.4
	Σbi	1.26		Chow(3,17) = 1.4 F(5) = 2.4
	c1	-.20	(5.3)	
	do	-.56	(2.2)	
	d1	.65	(2.4)	
	Σdi	.09		
3.Peru				
	bo	.47	(4.6)	R^2 = .99 s = .05 DW = 1.7
	co	.39	(3.0)	$\chi^2(1)$ = .03 LM(1) = .03
	c1	.17	(2.2)	ARCH(1) = .54 Chow(5,16) = .92
	Σci	.56		
	d1	-.19	(3.0)	
4.Colombia				
	bo	.33	(2.0)	R^2 = .87 s = .05 DW = 1.6
	b1	.36	(2.6)	$\chi^2(1)$ = .79 LM(1) = .66
	Σbi	.69		ARCH(1) = .07 Chow(5,17) = .56
				F(5) = .96
	co	.09	(1.2)	
	do	-.05	(.81)	
5. India				
	bo	.40	(2.6)	R^2 = .86 s = .05 DW = 1.7
	b1	.43	(2.9)	$\chi^2(1)$ = .22 LM(1) = .19
	Σbi	.83		ARCH(1) = .07 Chow(5,17) = .92
	c1	.02	(.23)	F(5) = 1.01
	d1	-.06	(.43)	

Table 8.2 (continued)

Country	Coefficient	Estimate	(t)	Statistics
6.Sri Lanka				
	b1	.54	(5.7)	R^2 = .90 s = .05 DW = 1.8
	c1	.19	(2.4)	$\chi^2(1)$ = -.21 LM(1) = -.17
	d1	.27	(2.7)	ARCH(1) = .06 Chow (5,15) = 0.5
				F(5) = .80
7.Korea				
	bo	-.35	(2.3)	R^2 = .95 s = .06 DW = 1.5
	b2	.29	(2.9)	$\chi^2(1)$ = .69 LM(1) = .51
	Σbi	-.6		ARCH(1) = .53 Chow(5,14) = .76
	co	.26	(2.5)	F(5) = .81
	c1	.11	(1.2)	
	Σci	.37		
	do	.30	(3.1)	
	d1	.26	(2.3)	
	Σdi	.56		
8.Philippines				
	bo	.28	(1.3)	R^2 = .88 s = .06 DW = 1.5
	b1	.40	(2.0)	$\chi^2(1)$ = 1.8 LM(1) = 1.5 ARCH(1) = .01
	Σbi	.68		Chow(3,18) = .57 F(3) = .57
	co	.05	(.60)	
	do	.24	(2.9)	
	d1	.13	(1.6)	
	Σdi	.37		
9. Thailand				
	b1	.28	(2.6)	R^2 = .92 s = .07 DW = 1.1
	co	.48	(2.1)	$\chi^2(1)$ = 3.2 LM(1) = 2.9 ARCH(1) = 4.1
	c1	.31	(1.2)	Chow(3,18) = .19 F(3) = .21
	Σci	.79		
	do	.27	(2.8)	
10.Kenya				
	bo	.29	(2.0)	R^2 = .87 s = .06 DW = 1.4
	b1	.36	(2.9)	$\chi^2(1)$ = 1.8 LM(1) = 1.5 ARCH(1) = 1.8
	Σbi	.65		Chow(3,13) = 1.0 F(3) = 1.4
	co	.11	(1.1)	
	do	.12	(1.3)	
11.Malawi				
	bo	.28	(2.3)	R^2 = .78 s = .08 DW = 1.7
	b1	.46	(2.9)	χ^2 (1) = .13 LM(1) = 10
	Σbi	.74		ARCH(1) = .49 Chow(2,14) = .25
	c1	.11	(.98)	F(2) = .25
	d1	.03	(.24)	

Table 8.3 Total monetary and fiscal impacts on output by geographical regions [a]

	Total monetary impact	Total fiscal impact
(1) Latin America	.84	.02
(2) Asia	.58[b]	.26
(3) Africa	.70	.11

a simple average of individual country effects
b excludes the Republic of Korea.

It is also interesting to note that small but significant impacts have been obtained for the export variable in seven out of eleven countries. In four countries (Colombia, India, Kenya and Malawi), the export variable is not significantly different from zero. In the Latin American countries, the export impact is in fact negative.

We are now in a position to argue that money supply causes nominal income but the possibility of reverse causation, i.e., y -> m cannot be ruled out. It is, therefore, necessary to empirically determine the direction of causation before drawing any firm conclusions concerning the efficacy of fiscal and monetary policy. We employ the Granger[3] causality test which requires an OLS estimation of the following equation.[4]

$$\Delta y_t = \gamma + \Sigma_{j=1}\alpha_j \Delta y_{t-j} + \Sigma_{j=1}\beta_j \Delta m_{t-j} + u_t \quad (8.16)$$

The relative significance of the coefficients α_j and β_j are then used to make a judgement on the causal relationship between m and y. A test of the null hypothesis that Δm does not 'cause' Δy amounts to testing $\beta_j = 0$ for j = 1, 2,...., J. To test the reverse causation, i.e., Δy does not cause Δm, the variables in (8.16) are simply swapped around. A standard F- statistic is then calculated by estimating (8.16) both in its restricted and unrestricted form.[5] The results are given in table 8.4.

The Granger-Causality tests reported above reveal that change in output 'causes' change in money in four countries, namely, Mexico, Philippines, Korea, Kenya and Thailand. In one case (Malawi) the direction of causation is reversed while in Peru the two variables do not cause one another. On the other hand, causation runs in both directions in Brazil, India, Sri Lanka and Colombia. Given these mixed results, it is difficult to draw any meaningful conclusions in terms of which variable causes which. However, such evidence merely demonstrates that one variable leads another and does not prove causality, although it may be indicative of the latter. Evidence that nominal income leads the money supply or vice versa may not involve causality for at least two reasons. Firstly, both money and income may be influenced by a third factor with

Table 8.4 'Causality ' Test Results [6]

Country	Granger Test	Calculated F	Reject
1. Mexico	(a) $\Delta m \not\Rightarrow \Delta y$	1.3	(b)
	(b) $\Delta y \not\Rightarrow \Delta m$	4.7	
2. Brazil	(a) $\Delta m \not\Rightarrow \Delta y$	5.0	(a,b)
	(b) $\Delta y \not\Rightarrow \Delta m$	4.6	
3. Peru	(a) $\Delta m \not\Rightarrow \Delta y$	.69	
	(b) $\Delta y \not\Rightarrow \Delta m$	1.04	
4. Colom.	(a) $\Delta m \not\Rightarrow \Delta y$	2.4	(a,b)
	(b) $\Delta y \not\Rightarrow \Delta y$	3.5	
5. India	(a) $\Delta m \not\Rightarrow \Delta y$	2.3	(a, b)
	(b) $\Delta y \not\Rightarrow \Delta y$	3.5	
6.Sri Lanka	(a) $\Delta m \not\Rightarrow \Delta y$	2.4	(a,b)
	(b) $\Delta y \not\Rightarrow \Delta m$	3.9	
7. Phil.	(a) $\Delta m \not\Rightarrow \Delta y$	1.6	(b)
	(b) $\Delta y \not\Rightarrow \Delta m$	5.6	
8. Korea	(a) $\Delta m \not\Rightarrow \Delta y$	2.0	(b)
	(b) $\Delta y \not\Rightarrow \Delta m$	3.8	
9. Thailand	(a) $\Delta m \not\Rightarrow \Delta y$	2.0	(b)
	(b) $\Delta y \not\Rightarrow \Delta m$	3.8	
10.Kenya	(a) $\Delta m \not\Rightarrow \Delta y$	.16	(b)
	(b) $\Delta y \not\Rightarrow \Delta y$	4.7	
11.Malawi	(a) $\Delta m \not\Rightarrow \Delta y$	2.6	(a)
	(b) $\Delta y \not\Rightarrow \Delta m$	2.1	

money or income reacting more rapidly. Secondly, Kaldor (1970) used the now famous Christmas example to argue that the increase in the money supply that occur before a rise in expenditure (income) does not necessarily cause the latter. The fault with this example is that expenditure will rise at this time of the year anyway without a money supply increase.

It is also important to note that the term 'causality' in the above tests does not correspond to the intuitive notion of causality but simply means that one variable is useful in predicting another. For example, in terms of the Granger definition of 'causality'; Δm causes Δy if the past history of Δm can be used to predict Δy more accurately than simply using the past history of Δy. Jacobs, Leamer and Ward (1979) demonstrate that it is not possible to test for the intuitive notion of causality using the Granger approach.

The same conclusion applies if these tests are interpreted as test of exogeneity. Very few economists are truly committed to the proposition that the money supply is exogenous, i.e., it is completely independent of all variables which determine the demand for money. Even if one adheres to such notion of strict exogeneity, it does not preclude y's moving independent of m. For example, y may be determined in the goods market. On the other hand, very few people in the economics profession seriously believe that the money supply responds to variables which also determine the demand for money, i.e., strict endogeneity. Only under this definition of endogeneity is $m^s \rightarrow y$ ruled out. What then does exogeneity mean? There is a proliferation of terms but exogeneity, when it is used in this context means 'weak exogeneity' as explained in Engle, Hendry and Richard (1982).

8.6 Comparing Fiscal and Monetary Policies

Given the fact that the regressors in (8.16) have been interpreted as surrogates for monetary and fiscal policies, this equation has been utilized in the debate over the comparative effectiveness of fiscal and monetary policies. Unfortunately,this seems to be a misleading interpretation. On pure theoretical grounds, it reduces the issue to an evaluation of the simple minded Keynesian proposition that money does not matter and may result in the equally simple minded conclusion that fiscal policy does not matter. Such a conclusion is particularly misleading in the case of LDCs in view of the linkage between fiscal and monetary policy. This linkage has been discussed in section (8.2) with reference to the financing needs of government budget deficit. To crystalise the argument, we consider the following four variables which can be used as policy instruments: government expenditure (G), tax receipts (T), the money supply (m) and government securities (B). Then the following equations hold ex post.

$$G = T + \Delta B + \Delta m \qquad (8.17)$$

The relationship between fiscal and monetary policy is then readily illustrated by considering the various financing possibilities open to the government, i.e.

(i) $G - T = \Delta B$ (deficit financed by borrowing)
(ii) $G - T = \Delta m$ (deficit financed by money creation)
(iii) $-\Delta B = \Delta m$ (Open Market Operations)

Inspection of options (i) - (iii) reveals the difficulty of interpreting (8.16) as a test of monetary and fiscal policy measures in LDCs. Alternative (iii) is of little importance for LDCs as financial markets are not fully developed. Of the remaining two options, (i) would be classified as fiscal and (ii) as monetary policy by both monetarists and Keynesians.[7] But alternative (i) always has a potential monetary impact if government borrowing comes from abroad (which is quite substantial in LDCs) and domestic banks. The money supply tends to expand whenever the government increases its borrowing from abroad and banks increase their holdings of government papers. For this reason, it is not possible to distinguish between the separate implications of monetary and fiscal policy using equation (8.16). What is required in this regard is a more detailed analysis of the financing behaviour of the monetary authorities in LDCs. However, the version of the St.Louis equation does show the importance of change in the money supply (m2), however caused, to influence nominal income.

8.7 Conclusions

What has emerged most clearly from the foregoing discussion is that money plays an important role in the development process of LDCs. An expansionary monetary policy could increase output in the short-run if inflationary expectations adjust with lags. On the other hand, a restrictive monetary policy could bring down the rate of inflation in the long-run, but the short-run costs (e.g., decrease in output and employment) may be substantial. These costs could perhaps be avoided if authorities were to minimize the monetary shocks by adhering to a simple monetary growth rule. This would require a flexible exchange rate policy which is lacking in many developing countries. Under such circumstances, some alternatives, such as a foreign exchange rule might be substituted.

We have also estimated the traditional and export versions of the St. Louis equation. The results obtained from the two equations show that monetary policy is more potent in affecting economic activity than fiscal policy. It is important to point out that the effects of monetary expansion on output growth occur only in the short-run. In our studies, the largest estimated impact takes place during the first year, and growth starts to slow down soon thereafter. Generally, the total effect lasts for about two years in most of the countries we examined. The fact that these results were obtained despite all the difficulties of trying to effectively control the money supply may suggest that the question of exogeneity and causality do not appear to have any direct bearing on the ability to estimate a reduced form equation for a number of developing countries. However, the St.Louis equation may not be suitable for evaluating the relative effectiveness of monetary and fiscal policies given the close linkages between the two policies. An evaluation of the relative effectiveness of these policies would require a detailed analysis of the money supply process and government financing behaviour in the context of developing countries.

On the basis of our results, we argue that it is necessary for policy makers to identify the policy measures that exert the greatest impact on the economic activities of their respective countries. This is important to avoid undesirable changes in economic activity that are likely to result from the wrong choice of a policy instrument. However, although greater reliance and dependence should be placed on the policy instrument with the greater leverage, there may be a need for a mutual application of both policies (policy mix). This seems inevitable given the fact that LDCs have underdeveloped financial markets which limit the use of various stabilization instruments.

NOTES

1. In general, the larger the excess aggregate demand in the economy, the smaller are the effects on the economy.

2. No attempt was made to formally determine the optimum degree of the length of the lags. Various degrees of lag lengths were estimated and the best overall result was selected.

3. An alternative 'causality test' has been suggested by Sims (1972) but Guilkey & Salami(1982) claimed that the Granger test is superior to the Sims test and that shorter lags are superior to longer lags for sample sizes smaller than 200.

4.The inclusion of the lagged dependent variable (Δy_{t-j}) is designed to purge serial correlation from the residuals.

5. The relevant F-statistic is

$$F = \frac{(RSS_C - RSS_U)/J}{RSS_U /[(T - (2J + 2)]}$$

where RSS_U and RSS_C are the residual sums of squares from the unconstrained and constrained regressions respectively. J is the lag length and T the number of observations.

6. The arrow represents the hypothetical direction of causality. Thus, ≠> reads 'does not cause'. Critical values of F at the 5% level are $F_{4,23} = 2.2$, and $F_{4,17} = 2.3$ (Kenya and Malawi).

7. Chick (1983) pointed out that Keynesians tended to treat (i) and (ii) as fiscal policy and only (iii) as monetary policy, while monetarists treated (i) as fiscal policy and (ii) and (iii) as monetary policy. Any debate on the effectiveness of monetary vs fiscal policy will obviously run into difficulty if it is based on alternative (ii)! In fact, Keynes treated only (iii) as monetary policy and (ii) as 'fiscal policy' - what he called public works. furthermore (ii) was preferred to (iii) in the depression of the thirties because it was considered as the only effective way to increase the money supply.

CHAPTER 9

SUMMARY AND CONCLUSIONS

The objective of this thesis, as set out in chapter 1, has been the identification of a well-defined demand for money model that characterizes LDCs data. We begin this chapter by summarizing the main findings of the three alternative models we considered in this study. We then proceed to identify future areas of research in relation to developing countries and finally, we draw some tentative conclusions from our results.

9.1 Results from Partial Adjustment Models

This class of dynamic models are very popular in many LDCs demand for money studies. In chapter 5 we estimated a typical PA model for each of the eleven countries we considered. What has emerged from these models is that four of the estimated equations over-predicted and two equations under-predicted real money growth. In the remaining five equations, the derived long-run income and inflation elasticities were implausibly high. In general, the results obtained from the PA models are quite similar to those reported for developed countries, i.e. (i) the coefficient of the lagged dependent variable became very large, sometimes exceeding unity; (ii) the impact elasticity of real income declined markedly, and in some equations it was approaching zero; (iii) the implied long-run elasticities of income and inflation were not consistent with the underlying theory.

9.2 Results from Conventional EC Models

Instead of adding variables or parameters (e.g. autocorrelation parameter) to a poorly fitting equation to 'patch' the original theoretical model, we chose to apply the general to specific methodology due to Hendry and his associates. The tacit assumptions of this approach are that the money supply is exogenous and the coefficients of income and price are unity. We estimated the conventional error correction models using the same data set. Although EC specifications are marginally better than the pA models, they still leave a lot to be desired. The performance of three EC equations (Brazil, Kenya and Thailand) is disappointing and the stability of error correction models is doubtful, even when they are extracted from the data as velocity depends on the growth rate of income, price and the money stock. The relatively poor performance of the classic EC models in the context of the LDCs considered here is perhaps attributable to the restrictions imposed on the income and price coefficients.

9.3 Results from the Cointegration Equations

The third type of model we considered in this thesis was what is commonly known as the cointegration approach. This approach is similar to the conventional ECM, in the sense that it proceeds from a model which has a very 'general' specification to the one which is more parsimonious. However, the cointegration approach imposes the long-run solution on the model at the outset and whether this is optimal or not is debatable.

In chapter 7, we applied the cointegration techniques to demand for money in LDCs. By means of the reduction of a general model along lines suggested by theory and using common statistical criteria, a specific statistical model has been obtained for each of the countries under consideration. While incorporating reasonable explanatory power, the cointegration equations also displayed a high degree of robustness, i.e. theoretical consistency, predictive accuracy and absence of residual heteroscedasticity.

9.4 Comparing Conventional EC and Cointegration models

On the basis of the statistical criteria we have selected for evaluating a 'plausible' model, the conventional EC models might be discarded in favour of cointegration equations, but total reliance on these tests could be hazardous when the sample size is small. Hence, it is worth while considering some additional information that might help us in the choice of these alternative specifications. Table 9.1 summarizes the coefficients of determination (R^2) and the residual variances (σ) obtained from the two specifications.

Table 9.1 Coefficient of determination and Residual Variances of Error Correction and Cointegration Equations

	Error Correction		Cointegration	
Equation	σ	R^2	σ	R^2
1.	.12	.47	.11	.93
2.	.16	.75	.08	.98
3.	.09	.64	.06	.87
4.	.06	.61	.07	.87
5.	.05	.86	.06	.85
6.	.07	.63	.07	.85
7.	.07	.90	.04	.49
8.	.09	.84	.06	.96
9.	.10	.75	.08	.93
10.	.08	.59	.05	.64
11.	.10	.40	.08	.80

The main point to note from table 9.1 is that the cointegration equations display higher explanatory powers and lower residual variances compared to the classic error correction specifications. We may, therefore, conclude that the cointegration approach has yielded estimates which are efficient and fit the data better than either the pA or error correction models.

9.5 Results from the modified version of the St. Louis Model

Having identified a 'plausible' demand for money function, we have considered the efficacy of fiscal and monetary policies in LDCs. This was achieved by estimating the modified version of the typical St.Louis equation and the results are presented in chapter 8. As it happens, the monetary variables turn out to be statistically very significant in all cases. When countries were classified by region, the total monetary multipliers were .84 for Latin America, .58 for the Asia and .70 for Africa; while the total fiscal impacts were .02, .26 and .11 respectively. It is also important to note that the effects of monetary expansion on output growth occur only in the short-run. The largest estimated impact took place during the first year for most of the countries. Generally, the total effect lasts for about two years and dies out thereafter.

We also found a positive fiscal impact in four equations, but the cumulative impacts are much lower than the monetary impacts. However, it is difficult to determine the effects of fiscal expansion on output because of the linkage between fiscal and monetary policies, which are generally much tighter in developing countries than in developed countries. This link occurs because change in the money supply is by definition, equal to the sum of change in net credit to the government, net credit to the private sector and variations in international reserves. Given the fact that the government has to rely on bank credit for its financing requirements, there will be a closer correspondence between the fiscal deficit and changes in the supply of domestic credit, unless, of course, the authorities are prepared to allow the private sector to be squeezed out of the credit market. An understanding of this close linkage between fiscal deficit and money supply change is crucial to see the limitations of using fiscal and monetary variables as independent policy instruments. Consequently, models that include the growth of money (e.g. St Louis equation) tend to suggest that fiscal variables have only a relatively modest independent role. Given the under-development of financial markets and the interdependence of monetary and fiscal policies, there may be a need for the simultaneous application of both policies.

9.6 Future Area of Research

(i) Additional Variables. In chapter 1, we indicated the omission of some potentially useful but unobservable variables with respect to the limitations of this thesis. Some studies on the demand for money literature have already indicated the implications of the rate of monetization on the demand for money in developing countries. The role of monetization in monetary policy would seem far more important than has been recognized in conventional macroeconomic models. There is, therefore, a real need for detailed research on the structure and behaviour of the non-monetized sector as well as the nature and effects of monetization on demand for money. The program should aim, among other things, at an appropriate disaggregated system of national accounts.

Another aspect of demand for money which we ignored in this study is the openness of the countries under scrutiny. In an increasingly interdependent world, monetary developments in one country may affect both the supply and demand for money in other countries. A somewhat related issue is the extent of currency substitution in developing countries. The magnitudes involved are so large, particularly in Latin America, that some economist (Ramirez-Rojas, 1986) have indicated that authorities in LDCs do not have perfect control over credit and monetary aggregates. It seems reasonable to suggest that these factors should also be considered in future demand for money studies.

(ii) The Money Supply Process. In our analysis of demand for money, we heavily relied on a single equation approach without any reference to the determination of the money supply process. A proper analysis of the role of money in LDCs would require a structural model complete with a financial sector in the spirit of the Keynesian income/expenditure theory. However, the construction of structural models for policy and forecasting purposes is difficult in most LDCs, where knowledge of the structure of the economy and reliable data are limited. Thus, recognition of the structural approach should not imply other approaches are not helpful. On the contrary, in spite of their limitations, the reduced form equations are informative and serve useful purposes. They are in many ways complimentary to the structural approach. Vigorous efforts are thus required to develop and refine the structural models in LDCs, while at the same time the alternative approaches should be pursued.

(iii) Econometric Modelling. In chapter 5, we argued that the traditional econometric methodology is seriously flawed and proposed the use of the general to specific methodology. Although this approach resolves several problems associated with the traditional approach, there are a lot of issues to be clarified in future research and some of the crucial problems related to this approach are outlined below.

(1) One particularly worrying aspect is that the route to be followed in the reduction of an over-fitting model is very vague. It depends on the researcher's luck and craftsmanship. In this respect, the model design exercise becomes an art rather than a science.

(2) Critical values for the DF and ADF statistics have only been computed for up to 3 variables and a sample size of 100 observations. The literature on cointegration is silent

on how to proceed when there are a large number of regressors and the sample size is small.

(3) Given that the standard errors obtained from the static equation are biased, we cannot establish the statistical significance of the equilibrium elasticities.

(4) Error correction models in general have strong statistical foundations but their theoretical underpinnings are very weak. There have been some attempts recently to base EC models on expectations and adjustment cost functions but this efforts are ad hoc and unconvincing. The error correction term lacks economic interpretations and any future investigation in this area must concentrate on resolving this problem.

9.7 Overall Conclusions

The identification and evaluation of a 'good' demand for money function for developing countries have been the main objectives of this thesis. The single equation exercise, based on the Granger-Engle two-step estimation techniques, produced quite robust results which enabled us to conduct more sophisticated diagnostic tests than is usually the case in developing countries. The poor performance of previous demand for money equations could be attributable to a combination of the wide spread use of the traditional partial adjustment models, ignoring higher order lags without justification, and inappropriate and insufficient diagnostic tests. The following broad conclusions may be drawn from this study.

(1) The income elasticity of demand for money in many LDCs is greater than unity (closer to 2.0).

(2) Nominal money stock, m(2), real income, price and the discount rate are first difference stationary.

(3) The stock of money - whichever definition one might choose- is not under the direct control of the authorities and the monetary policy instruments are limited in scope, role, and effectiveness because of the under-developed financial system.

However, given the problems detailed in section 8.7 (i)-(iii), the above conclusions should be treated as indicative rather than conclusive. On the basis of the progress to date, it is fair to say that further research will resolve these difficulties. As for our preferred equations, their success depends on their strength to hold on outside the period of estimation.

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