General or Specific - An Invesitgation into Demand for Money Functions in LDC's

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NUMBER 263

July 1985

This paper is circulated for discussion purposes only and contents should be considered preliminary.

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1/ This paper is an extract from a University of Warwick thesis submitted in September 1983. Thanks are due to my supervisors and examiners for various comments, and to Mandy Broom for typing. Responsibility for remaining shortcomings is entirely my own.

2/ Estimated parameter values are available on request.

General or Specific - An Investigation into Demand for Money Functions in LDC's

I. Introduction*

Empirical work on money demand in developed economies pertains to be based on sound microeconomic principles. If this is truly the case, estimated models should be unaffected by country boundaries, given that as economists we believe the majority of people to be motivated by the same basic forces. In the development literature, however, it is usually maintained that the problems of LDC's must be taken specifically into account, which would appear to contradict the above argument.

Surprisingly little attempt has been made to investigate whether functions specific to the LDC's really are better at explaining money demand than the more general functions estimated for the U.K. or U.S.A.; whether there is, in fact, little difference in explanatory powers or whether limitations imposed by the data problems that are notoriously endemic to LDC's allow any meaningful conclusions to be made. These are the questions that I hope to address in this paper.

In order to give some indication of the importance of the data, I employ the "general" misspecification test devised by Hausman (1978), as well as the standard test statistics ($\bar{R}^2$, dw etc.) Using these to choose the "best" function from each author's different formulation, I then apply the nonnested test procedures devised by Pesaran/Deaton (CPD) and Davidson/Mackinnon (J). These allow comparison to be made between

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* This paper is based upon research undertaken between June and September 1983 for the M.A. in Economics at Warwick University.

competing functions, by indicating whether the model assumed to be true can explain the results obtained from estimating a credible alternative.

The exercise was carried out for four LDC's, chosen to give as wide a range of country types as possible given the availability of data : Jamaica - Small, ex-colony

Venezuela - Oil exporter

Korea - Newly Industrialising Country (NIC)

Pakistan - Asian sub-continent

and for two developed countries (U.S.A. and France) as a control. The usefulness of the LDC-specific functions can be identified by observing their relative performances over the two groups.

The purpose of this study is not to find the "best" money demand function for each country, therefore, but to compare the relative performances of the functions themselves and the theories underlying them.

II. Demand for Money : Theory and Practice

The three sections of this chapter comprise a brief summary of money demand, and overviews of some of the empirical work undertaken on developed and developing countries.

Notes : Upper case indicates nominal, lower case real variables or percentages throughout. Stochastic terms omitted unless necessary to the imposition.

a) Basic Theory

The two major strains of money demand theory, on which most later work offers embellishment rather than alternatives, are those derived by Fisher (the Quantity Theory) and Keynes.

The Fisher "Equation of Exchange":

$$M\bar{V} = P\bar{T}$$

(M = nominal money stock, V = velocity of circulation, P = price level, T = volume of transactions)
Assuming that T is given and M, V are determined independently results in the function:

$$M^d = kPY \qquad [Y = \text{income}]$$

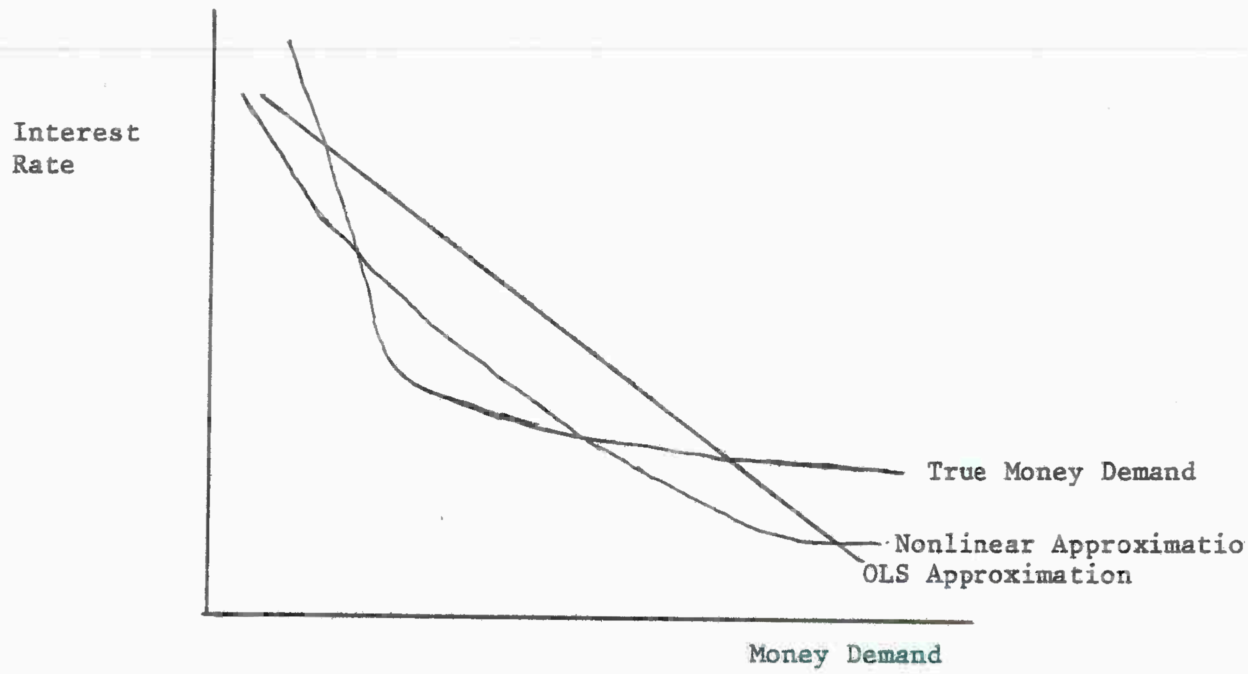
as long as money demand arises solely from its use in transactions, which have a stable relation to income. Financial market clearing and stability of velocity implies.

$$\bar{V} = 1/k$$

This money demand function has no real theoretical base and is unduly restrictive. Friedman argued that money can be treated in the same way as any other consumer good, involving standard utility maximisation techniques. He therefore applied the concept of Permanent Income to money demand, which implies that transitory changes in current income will have no effect on current demand for money, only changes in Permanent Income.

The Keynesian Liquidity Preference theory analyses the underlying reasons for people holding cash balances. As money is perfectly liquid, it will be held in order to make regular payments and as an insurance against unexpected or irregular payments such as illness, accident or an unexpected funeral. This implicit treatment of uncertainty is even today all too rare in macroeconomics, although microeconomic theory has shown it to play an important role in the individual's decision-making process. The transaction and precautionary demands for money are normally assumed to depend on income, interest rates (V) and the cost of maintaining the desired level of money balances. The interest and transaction costs, however, are generally ignored or assumed to be dominated by the Speculative Effect. In this case the motive for holding money balances is uncertainty about future interest rates rather than personal expenditure. For each individual, an interest rate above their "normal" or expected rate leads them to anticipate a drop in the bond rate and therefore capital gains from rising bond prices, so they will hold all their wealth in bonds. The opposite holds true with interest rates below "normal". Individuals, therefore, have discontinuous money demand functions and in order to get a smooth, negatively sloped aggregate function it must be assumed that "normal" rates vary over the population. It could be argued that with Rational Expectations, the range of speculator's expected interest rates will be low given competitive financial markets, therefore the aggregate function will establish discontinuity so that standard estimation techniques would give a poor approximation (fig II.1)

Fig II.1 - Approximation errors with nonlinear aggregate demand for money function



In practice, the problem of Liquidity Trap, an interest rate so low that everybody expects it to rise so that demand for money becomes infinitely interest elastic, is unlikely to occur given the ranges over which interest rates actually vary, and empirical evidence supports this argument. In LDC's, where interest rates are kept artificially low (Financial Repression) while inflation is often high, the Liquidity Trap could be relevant. Developed financial markets and opportunities for large scale speculation are rare in these situations, however.

Assuming that speculative demand depends upon wealth (w) and interest rates, the Keynesian money demand function has the form:

$$M^d = [ky + f(v).\ W].P$$

The recent Quantity Theory approach has been to model $\bar{V}$ using the opportunity costs of holding money. With low inflation, the next best strategy to holding money is holding a portfolio of financial assets with a range of interest rates and associated risks, and real assets. Arbitrage in financial markets results in a close alignment of interest rates, so a single rate is a good enough proxy for the whole range. This is less likely to be true for LDC's which have fewer well developed alternatives to money and although financial repression keeps official rates in line, the relation between the official and unofficial rates, which depend upon risk and collateral as well as demand and supply, is more complex. In a period of high inflation, the real value of money balances is eroded relative to real assets and the inflation rate becomes a relevant opportunity cost (Cagan (1956) and others).

The Modern Quantity Theorist's typical demand for money function therefore comprises a scale variable (usually current or permanent income) and a measure of the opportunity cost of holding money (usually some interest rate). I would argue that these functions are observationally equivalent to the Keynesian function outlined above. The difference between the two schools is that Keynes derived a direct explanation for money demand while the Quantity Theory version addresses the problem indirectly via velocity.

Modern Keynesians no longer believe in the inherent instability of money demand, having been convinced otherwise by the evidence. One possible discriminatory factor, however, could be the nonlinearity of the Liquidity Preference function, in which case empirical estimates using a log-linear form may better approximate the Keynesian version. This requires the assumption of a linear relation between velocity and the opportunity cost of holding money, which is a strong one to make a priori.

b) Empirical Work - The Developed Economies

One of the earliest comprehensive studies was Friedman's (1959) using annual U.S. data, 1870-1954. He argued that interest rate fluctuations merely reflected the business cycle, and by abstracting from these cycles, demand for money could be explained solely using permanent income. Laidler (1966), however, showed that money demand had not been independent of interest over the period, which had exhibited a downward trend even after the business cycle had been accounted for.

Cagan (1956) allowed for inflation expectations by including a partial adjustment term for inflation. Using data for 16 European countries that had experienced hyperinflation, this term dominated all other effects as agents substituted real assets for money. Later work has corroborated this evidence to a great extent.

More recently, Arango and Nadiri (1950) have entered what seems to be a little explored area, by trying to model the effect of the open economy. In international monetary theory it has long been accepted that changes in overseas financial factors, namely interest and inflation rates, affect domestic money supply (see, for example, the work of Mundell and Fleming in the early 1960's). Arango and Nadiri argue that the extreme policy multipliers predicted by theory will be modified when both demand and supply in the money market is taken into account. The strong assumptions necessary to make empirical analysis possible, however, result in a function that is really only applicable to a small group of developed countries over a fixed period, so that the generality of the theory is sacrificed for econometric pliability

c) Empirical Work - The LDC's

Studies on the LDC's can be loosely divided into two categories. Firstly, those studies that mimic one of the general functions outlined above, with perhaps some small additions to improve the fit, and secondly those that are implicitly based around the special circumstances in the developing world. Unfortunately, it seems that the former category by far outweighs the latter and although I feel this to be unsatisfactory, I realise that the practice could be an argument for the generality of the functions used. However, it seems all too often that empirical papers contain some sort of "escape clause", apportioning the blame for unexpected results on the data, e.g.:

"The estimated form of the equation is incomplete because of the unavailability of interest rate series . . . For this reason, the estimates in this paper may be somewhat biased". (Galbis)

"Some care has, therefore, been taken to avoid the use of less reliable data. This has been at considerable cost in terms of the number of observations. For none of the ten countries used in the analysis were "satisfactory" and/or consistent statistics available for more than a twelve year period". (Fry)

Although I can well understand the problems encountered in this area, it seems to me that not enough consideration is given to finding out whether it is the functional form rather than the data that is to blame.

Bhattacharya (1974) based his study on India, using a two stage least squares (2SLS) approach. He simultaneously modelled money demand and supply rather than the usual method of assuming market clearing, where the observable money supply can be used in place of unobservable money demand (see Brunner/Metzer (1963). He argues that in LDC's, nonmonetary transaction such as barter and consumption of home produced goods make up a sizeable proportion of income. This proportion diminishes with development, making monetised rather than total income the relevant variable, although the exact derivation of this series is unclear. Bhattacharya also argues that money supply changes and Keynesian Liquidity Preference are irrelevent within the unorganised money markets that develop to satisfy the excess demand for financial services that results from financial repression and an underdeveloped banking system. Interest rates in these markets are related to risk and returns to real assets such as land, rather than the financial market conditions that apply in the organised markets. I would argue that the official and unofficial markets are linked, however. For instance, a Government credit squeeze that reduces resources available to the Development Banks, Agricultural Banks etc., would force borrowers into the relatively free unofficial markets, driving up interest rates there.

On estimation, he finds the main difference between his favoured version and formulations incorporating total income and bazaar interest rates, to be in the significance of the interest term.

A major fault in the methodology used, however, was the use of nominal rather than real values. The implication that the Indians suffer from money illusion just does not hold water, particularly given their propensity for gold hoarding that indicates a sensitivity to the effects of inflation on real wealth. There is also a mass of empirical evidence to support the use of real variables in economic decision making.

Many studies have followed Cagan by allowing for inflation. The LDC's, particularly those of Central and South America, have had much greater experience of long run inflation than the developed countries, and this is often reflected in their institutional and economic frameworks, widespread wage indexation being one instance of adaptation to long term inflationary conditions. In Meiselman (1970) there are comprehensive studies on Chile, (Deaver 1931-6) and Argentina (Diz 1935-62). Both place heavy emphasis on long, carefully researched data sets and follow Cagan's basic functional form, incorporating adaptive expectations for inflation:

$$\log m = a_o + a_1 \dot{p}^e + a_2 \log y$$

($\dot{p}^e$ = expected inflation)

Both studies omit interest rates, Deaver because no reliable measure was available while Diz argues that as real interest is the important variable, the price element dominates in cases of high inflation.

Deaver also argues that for LDC's, current rather than permanent income is more nearly proportional to wealth, as transitory changes can affect the demand for money when there are poor outlets for saving. I believe that this is not the case, given the amount of empirical evidence that points to the superiority of permanent income, and the relatively high stage of development of Chile where transitory income may be spent on financial assets, gambling or transitory consumption, as compared with the African Subcontinent, where to the majority of subsistence farmers transitory income is likely to be negligible.

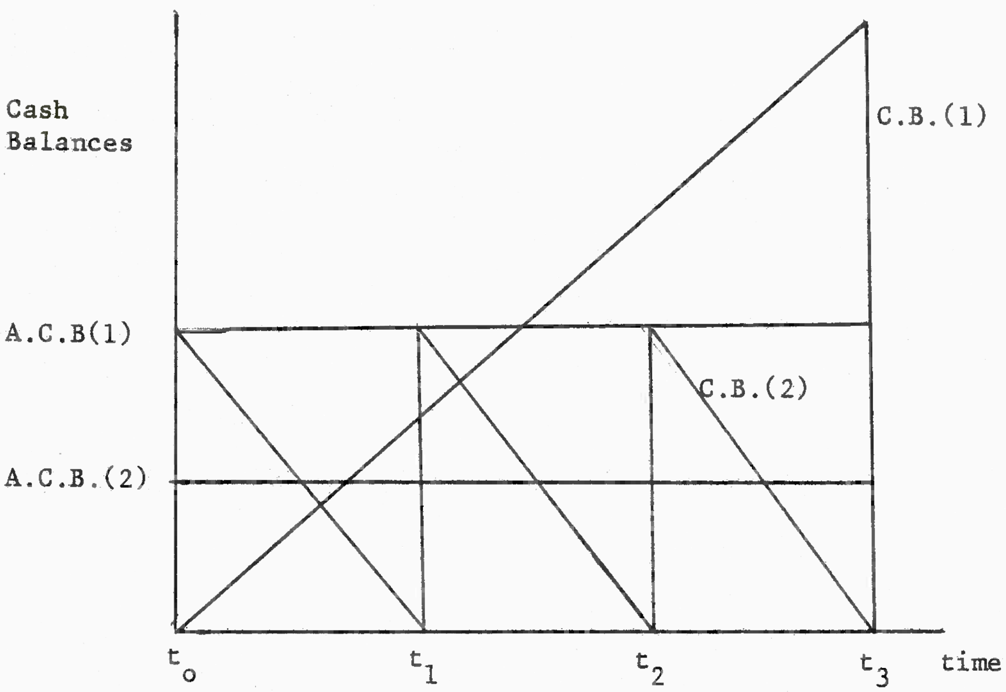
The incorporation of a partial adjustment term in this case resulted in unidentified coefficients. Although the necessary iterative solution techniques and accompanying computer software are currently standard, at the time of the Deaver study they were unavailable. Instead he used a grid search technique, running a number of regressions and varying the inflation adjustment parameter between zero and unity, choosing the value that optimises some summary statistic. Although this method forces undue restrictions on the parameters and there is a chance of obtaining a local rather than a global optimum through setting the grid too wide, this method can be effective if used with care and became popular for a time in similar work.

Corbo (1981) using quarterly Chilean data, 1960-70, argued against this restriction and using maximum likelihood techniques found a much shorter lag in expected inflation adjustment than previous studies. Khan (1977), believed that the adaptive expectations assumption that only the gap between actual and expected inflation and not the level of inflation itself affects expectations was invalid. Allowing the adjustment coefficient to be a linear function of inflation he found (using quarterly data for Chile, Brazil and Argentina over a similar period to Corbo that the lag length falls as inflation rises. Using a technique for solving stochastic differential equations developed by Sargan (1974) he was able to estimate his function in continuous rather than distinct time, to give a much more accurate picture of the true lag length.

d) Substitution and Complementarity

The McKinnon (1973) Complementarity Hypothesis and the Shaw (1973) Financial Repression argument merits close attention, as they were specifically formulated to deal with money demand in LDC's.

Fig II.2 - Illustration of McKinnon's "Lumpy Investment"



C.B. = Cash Balances

A.C.B. = Average Cash Balances

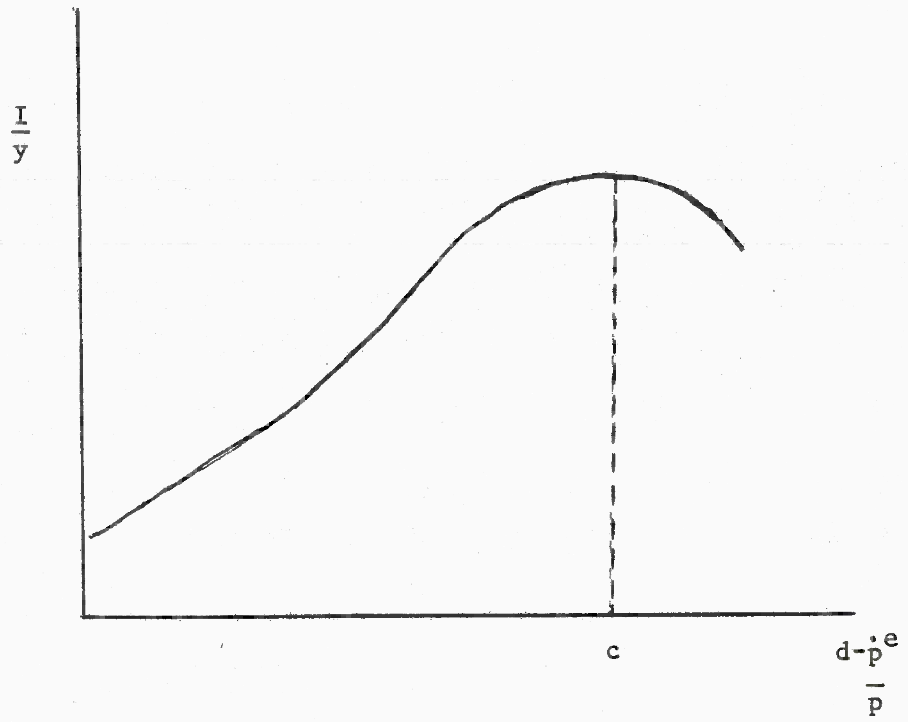
The traditional arguments hold that as wealth consists of both real assets and money balances, an increase in money given constant wealth must reduce investment in real assets. McKinnon argued that money and investment were complementary, based upon two assumptions. Firstly that there are no sources of credit so that all investment is financed from savings. This may be credible for small farmers who cannot pay the high interest rates of the village moneylender or obtain official credit, but not for larger farmers with more collateral and influence on Development Banks and Co-operatives. Secondly, investments can only be made in large, indivisible lumps. Fig II.2 shows that the large investment farmer requires higher average cash balances than the one who spends his income over each period. Many Green Revolution techniques are easily divisible, however, such as new seeds and different ploughing methods. McKinnon also ignores the possibility of aid and Government construction for bigger projects, and the existence of agricultural extension workers who disseminate skills and information at little or no cost to the farmer. Again it seems that it is to the small farmer, for whom just changing seed varieties is a major investment relative to total wealth, that this theory bears the most relevance. It is questionable whether this group is adequately represented in the National Accounts data normally used in empirical studies of the Complementarity Hypothesis, and this may explain the unfavourable results that have hitherto arisen.

The money demand function has the form:-

$$m^d = f\left(y,\ d - \frac{\dot{p}^e}{p},\ \frac{I}{y}\right)$$

(I = investment, d = return to holding money)

Fig II.3 - The Competing Asset Effect



d = return of holding money

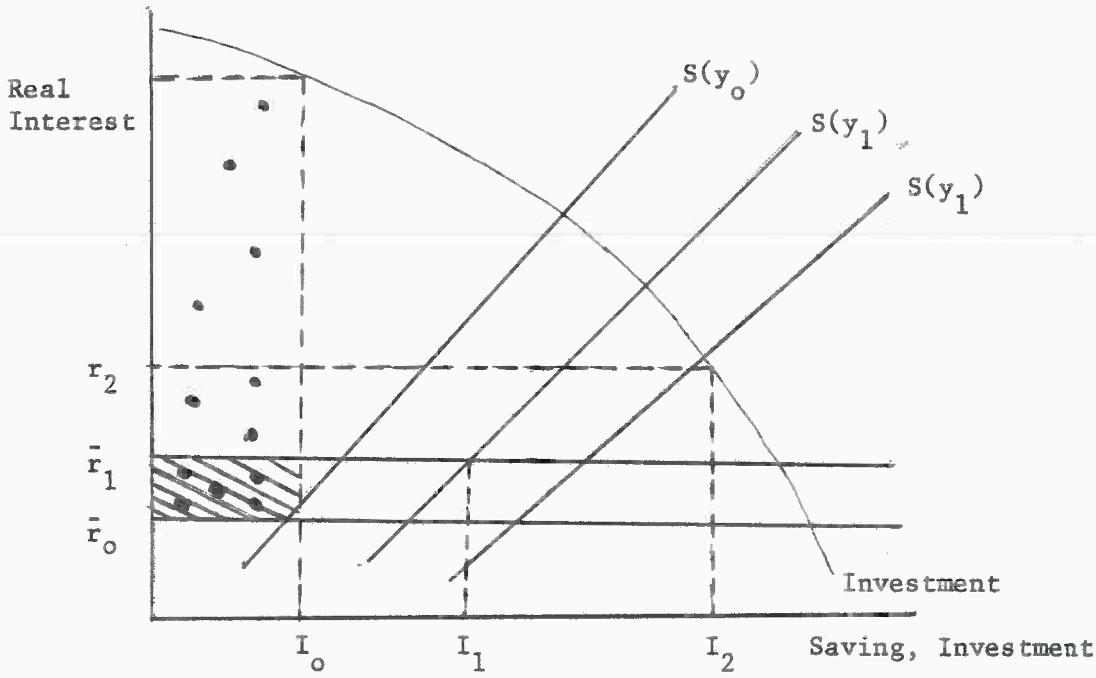
$\dot{p}^e/p$ = expected inflation

I = Investment

y = Output/Income

A priori, it is expected that $f_1 > o$, $f_2 > o$, $f_3 > o$, however in the latter case the Competing Asset Effect poses a problem (see Fig II.3). Above $\bar{c}$ the real return to holding money exceeds that on investment and substitution occurs.

Fig II.4 - Credit Rationing



S(y) = Savings function

$\bar{r}$ = Restricted interest rates

• = Investment Projects

Shaw argues that the money part of wealth cancels out as one man's savings are another's debt, ignoring the well-known arguments about the differing marginal propensities to invest of savers and borrowers. He believes debt intermediation to be the main use for money, output of the financial sector being an input into the production sector. Financial Repression, restricting banks' practices and especially the interest rates they can offer on deposits, results in credit rationing as savings fall below their equilibrium value. Those with the most influence or the least risky projects (as no risk premium can be charged) are more likely to obtain finance. As interest restrictions are relaxed ($\bar{r}_1 > \bar{r}_o$ in Fig II.4), low return, inefficient projects are weeded out, while increased savings allow total investment to rise.

The resulting function has the form:-

$$m^d = f\left(y,\ v,\ d - \frac{\dot{p}^e}{p}\right)$$

(v = Opportunity cost of holding money)

It is espected that $f_1 > o$, $f_2 < o$, $f_3 > o$. Like McKinnon, Shaw himself undertook little empirical work. Given the prevalence of Government maintained interest rates in LDC's, Shaw's idea is appealing however I would not dismiss Complementarity outright as the small farmers, for whom I believe the theory to be most relevant, are usually one of the most important groups in LDC's, in terms of employment and development potential even if not of output.

III. The Chosen Models

a) The Developed Economies

The model used by Laidler/Parkin (1970) will be described in Chapter IV, Part a. Using quarterly U.K. data 1955-67, their general model was estimated via a nonlinear least squares technique. Three other forms, derived by imposing various parameter restrictions, were also estimated, so that comparison with the general model could indicate the validity of the restrictions:

a) $m = a_o\theta + a_1\theta y + a_2\theta r + (1 - \theta)\, m_{-1}$ (set $\lambda = 1$)

b) $m = a_o\lambda + a_1\lambda y + a_2 r + a_2(1 - \lambda)r_{-1} + (1 - \lambda)\, m_{-1}$ (set $\theta = 1$)

c) $m = a_o + a_1 y + a_2 r$ (set $\lambda,\ \theta = 1$)

(θ = Adjustment parameter on desired real money balances, λ = adjustment parameter on desired income).

In these models the parameters are identified and can be calculated from the OLS coefficients. Townend (1970) pointed out the main flaw in this study. The use of the Koyck transformation to eradicate unobservable terms (see Ch. IV) induces autocorrelation in the model which Laidler/Parkin ignored by assuming autoregressive errors, i.e.:-

Assume: $u_t = \lambda u_{t-1} + e_t$

After transformation: $u_t - \lambda u_{t-1} = \lambda u_{t-1} + e_t = e_t$

(u_t = actual error, e_t = random error term)

If this is not the case, the error term will exhibit autocorrelation. Under normal circumstances, inefficiency would be the main result, due to over-large standard errors and biased sampling variances. The real problem arises in the presence of a lagged dependent variable, in which case, not only is the Durbin-Watson statistic biased towards two (2), reducing its power to detect autocorrelation, but the coefficients are inconsistent, so bias need not disappear with repeated samples. Laidler/Parkin did not publish their values for d_w.

Townend's function, similar to model (b) above, but explicitly allowing for serially correlated errors, resulted in a rejection of the Adaptive Expectations hypothesis in favour of Partial Adjustment. Later work has reversed this conclusion, however.

Meyer and Neri (1975) using U.S. annual data 1897-1960, confront the problem of differentiating between the Keynesian and Quantity Theory functions by asking whether the transactions or asset holding motives for holding money are more important. They argue that long run expected income, modeled by Friedman's Permanent Income, is relevant to the latter, while the short run income expectation, approximated by a modified, exponentially weighted moving average, applies to the former. In the construction of the "Keynes - Friedman demand for money function", they note that Keynes had described a further motive for holding money balances. The "Finance" motive, referring to balances held for planned activity, which was:-

> "The copingstone of the liquidity theory of the rate of interest". (Keynes' Reply to his Critics)

Thus expected income becomes a valid argument of Keynesian demand for money functions. Short run expected income is assumed to equal its actual value. Meyer/Neri then assume that agents first estimate permanent income, then form short run expectations adaptively about this value. A Rational Expectations criticism of this would be that agents are unlikely to make consistent errors even in the short run, so long as the costs of doing so exceed the costs of getting better forecasts. Using the above arguments, Meyer/Neri derived a modified moving average process for expected income:

$$y^e = (1 - \lambda\alpha)\ y + \lambda\alpha\ (1 - \alpha) \sum_{i=o}^{\infty} \alpha^i\ y_{t-1-i}$$

(α = long run adjustment, λ = short run adjustment)

If $\lambda = o$, expected = current income, supporting the transactions approach. If $\lambda = 1$, expected = permanent income, supporting Friedman. Within these bands, demand for money depends upon expected income or transactions rather than permanent income. Two functions are estimated using a grid search technique (see Deaver (1970):-

1) $(m - \alpha m_{-1}) = (1 - \alpha)a_o + a_1 (1 - \lambda\alpha)y + a_1\alpha (\lambda - 1) y_{-1} + a_2 (r - \alpha r_{-1})$

2) $(m - \alpha m_{-1}) = \theta(1 - \alpha) a_o + a_1\theta (1 - \lambda\alpha y) + a_1\theta\alpha (\lambda - 1)y_{-1} + a_2\theta(r - \alpha r_{-1})$
$+ (1 - \theta) (m_{-1} - m_{-2})$

The differences are due to two different assumptions on the adjustment of actual to expected money balances. (1) assumes perfect foresight, (2) partial adjustment.

These three functions provide the general functions with which to compare the specific functions to be outlined in the next section.

b) The LDC's

Nath (1982) based his study on the Laidler/Parkin model using annual Indian data 1953-1979. Using a similar scenario to that of Bhattacharya (1974), he argues that the state of development of financial institutions in LDC's is continually changing and attempts to measure the effects of this via various proxies. Understandably, the most successful measure was the number of bank branches, however as this information is not readily available for the countries used in this study, two other proxies, a time trend and the product of this trend with output, which may lead to a multicollinearity problem were utilised:-

1) $m = a_o + a_1y + a_2r + a_3t$

2) $m = a_o + a_1 y + a_2 r + a_3 ty$

Nath omits the inflation rate as an explanatory variable, arguing that transactions finance is the main motive for holding money, although this will be more relevant to India than, say, South America, which has had more experience with inflation.

The assumption implicit in the above equation is that all adjustment of actual to desired money balances occurs within a year. This may be reasonable when using annual data, but with quarterly data I do not believe that it would do the model justice, and a partial adjustment term was included, with the resulting estimating equation:-

1) $m = \theta a_o + \theta a_1 y + \theta a_2 r + \theta a_3 t + (1 - \theta)\, m_{-1}$

2) $m = \theta a_o + \theta a_1 y + \theta a_2 r + \theta a_3 ty + (1 - \theta)\, m_{-1}$

Khan (1977) developed the Cagan (1956) work on inflation. In the long run, it is an economic truism based on the Quantity Theory that with constant output, growth in money balances must equal the inflation rate. In the short run however, changes in inflation lag changes in monetary growth. Khan argues that empirical work based on partial adjustment, which assumed instantaneous price adjustment, ignores this factor and is therefore only applicable to money demand changes that do not arise from changes in money supply. Following Rational Expectation work he differentiates between the effects of anticipated and unanticipated shocks, a delayed response to the latter resulting from sticky short run prices. This additional source of short run disequilibrium is modeled by the addition of a nominal balance term. With few financial markets in LDC's, adjustment to monetary stocks is accomplished via changes in real balances, initially responding to money supply changes, then reaching their long run equilibrium position via price changes. Khan makes the strong assumption that there is no contemperaneous feedback between inflation and monetary growth, implying that the Government is not indulging in deficit financing by generating an inflation tax (see McKinnon (1982)).

Allowing expectations to be "consistent" with the model rather than strictly Rational avoids complication, so the expected money growth rate is set equal to nominal money demand growth. The following model was estimated for a selection of LDC's (quarterly data 1962-76) using the Deaver (1970) grid search method:-

$$(1 - (1 - \beta)L)m = \theta a_o + (1 - (1 - \beta)L)\theta a_1 y + \beta(\theta a_2 + (1 - \gamma))L\Delta P$$
$$+ (1 - (1 - \beta)L)(1 - \theta)m_{-1} + (1 - (1 - \beta)L)(1 - \gamma)\Delta M$$

(β = expectations adjustment parameter, γ = nominal money balance adjustment parameter, L = lag operator, Δ = difference operator).

Fry (1976) compares the McKinnon and Shaw hypotheses using pooled, annual data for several Asian LDC's over various periods since 1960.

1) McKinnon : $m = \theta a_o + \theta a_1 \, {}^s/_y + \theta a_2 y^e + \theta a_3 (r^t - \dot{p}^e) + (1 - \theta) m_{-1}$

2) Shaw : $m = \theta a_o + \theta a_1 y^c + \theta a_2(r^t - p^e) + \theta a_3\ (r^s - \dot{p}^e) + (1 - \theta)\ m_{-1}$

(p^e = expected inflation, r^s = short rate, r^t = long rate)

There are major problems with the econometrics, however. To make the best use of the information of his limited data set, Fry used a time series/cross-section technique, combining the data and adding a dummy variable for each country. This implicitly assumes that the slope of the function is universally identical, only the constant changing between countries. Even in the unlikely case that this were are credible assumption for the original model, the speed of adjustment to desired money balances will not be the same for different countries at different stages of economic and financial development. The data set is also unnecessarily restricted by dropping points that seem unreliable, although the criteria for them are never specified. There is a trade off between the loss in degrees of freedom resulting from a reduced sample size and the gain in accuracy from more reliable data, however I am wary of deciding a priori that certain values of the endogenous variable cannot be explained by the right hand side.

Fry argued that if Complementarity holds, demand for real balances is jointly determined with the savings ratio, estimating (1) simultaneously with a savings function, although as it turned out, the OLS estimates were "virtually identical" to the 2SLS results.

Galbis (1979) investigated Complementarity using Annual Latin American data 1961-73. He includes the inflation rate separately rather than as part of a composite real interest rate, arguing that although the real interest effect is negative, for broad money which contains deposits, for the narrower definition the full effect depends on the relative interest elasticities of the demand for real money, savings and deposits. Furthermore, a differential response may occur because interest rates are set in advance while inflation must be forecast and is therefore subject to error.

Interest rates were omitted from the estimated function due to unavailability of data, which may result in omitted variable bias, particularly given the small sample size. As is implicit in the Fry study, investment is approximated by assuming an ex-post equality with savings, although this may not be a good proxy given the large Government and aid projects that do not come within the scope of McKinnon's theory.

As in the case of Nath a partial adjustment term was included, and estimation was carried out both with and without an interest rate term in order to investigate the likelihood of serious omitted variable bias:-

1) $m = \theta a_o + \theta a_1 y + \theta a_2 (\frac{\Delta P}{P_{-1}})_{-1} + \theta a_3\ {}^{s}/_{y} + (1 - \theta)\ m_{-1}$

2) $m = \theta a_o + \theta a_1 y + \theta a_2 (\frac{\Delta P}{P_{-1}})_{-1} + \theta a_3\ {}^{s}/_{y} + \theta a_4 r + (1 - \theta)\ m_{-1}$

The final study adopted was Wong (1977) work using annual data for a group of LDC's. He argues that transactions are the main motive for holding money balances due to financial repression and a lack of alternative financial assets, so that the Quantity Theory applies and current rather than permanent income is the appropriate scale value. As well as including inflation as an opportunity cost for holding money, Wong argues that some proxy for interest rates is also important. He derives various measures of credit rationing in order to indirectly take into account the effects of unofficial financial markets. The present study utilises the five that were most easily calculable and approximated one of the others. The estimated function, including partial adjustment, is therefore:-

$$m = \theta a_o + \theta a_1 y + \theta a_2 (CR_i + \theta a_3) \frac{\Delta P}{P_{-1}} + (1 - \theta)\, m_{-1}$$

(i = 1.....6, CRi = credit rationing - see Appendix a)

The original study was guilty of ignoring the "pre-test problem". After making the first run without the inflation variable,

"The most desirable equation for each country is then selected and additional variables are introduced at the second stage".

This movement from specific to general is frowned upon, as each succeeding test depends upon the significance levels of the preceding stage. Earlier stages are also likely to suffer from omitted variable bias, leading to overlarge standard errors and more chance of terminating the sequence of steps before the "true" formulation is reached. This study seems to be a useful attempt to adapt traditional theory to financial conditions in the LDC's, although the number of proxies considered and the scant theoretical justification provided for them may indicate ad hocery.

IV. An Econometric Digression

This section contains brief descriptions of some of the econometric problems faced when estimating demand for money functions and the derivation of the two tests that were emphasised in this study.

a) Permanent Income, Distributed Lags and the Partial Adjustment Controversy

The empirical treatment of Permanent Income, expected values and Partial Adjustment beset the econometrication with difficulties.

Friedman's Permanent Income hypothesis is theoretically appealing but like expected values, empirically unobservable, and a similar problem arises when economists drop the assumption of instantaneous financial market clearing for the more credible hypothesis that the adjustment of real money balances to their desired values takes more than one period, owing to costs, inertia, lack of full information etc.

The method adopted to deal with the former is to postulate an adaptive framework, followed by back substitution and a Koyck Transformation, in order to eradicate the unobservable expectation term and bring the resulting infinite distributed lag down to a more manageable form. A typical example is provided by Laidler/Parkin (1970):-

1) $m^* = a_o + a_1 y^P + a_2 r$ - actual relation

2) $y^P = \lambda y + (1 - \lambda) y^P_{-1}$ $(o \leq \lambda \leq 1)$ - adjustment of permanent income

3) $m = \theta m^* + (1 - \theta) m_{-1}$ $(o \leq \theta \leq 1)$ - partial adjustment

Substitute:-

4) $m = \theta a_o + \theta a_1 \lambda y + \theta a_1 \ (1 - \lambda) \ y^p_{-1} + \theta a_2 r + (1 - \theta) \ m_{-1}$

lag (1) and (3):-

$$m^*_{-1} = a_o + a_1 y^p_{-1} + a_2 r_{-1}, \ m_{-1} = \theta m^*_{-1} + (1 - \theta) \ m_{-2}$$

((1) into (3)) x (1 - λ):-

5) $(1 - \lambda)_{m-1} = (1 - \lambda) \ \theta a_o + (1 - \lambda) \ \theta a_1 y^p_{-1} + (1 - \lambda) \ \theta a_2 r_{-1}$

(4 - 5):-

6) $m = \lambda \theta a_o + \theta a_1 \lambda y + \theta a_2 r - (1 - \lambda) \ \theta a_2 r_{-1} + (2 - \theta - \lambda) \ m_{-1}$

$$- (1 - \lambda) \ (1 - \theta) m_{-2}$$

$$= b_o + b_1 y + b_2 r + b_3 r_{-1} + b_4 \ m_{-1} + b_5 \ m_{-2}$$

(m^* 1 desired money balances)

In the case of Partial Adjustment, the process (3) is directly substituted into (1). The argument that this is an ad hoc method has been countered by assuming a quatratic cost function, balancing the cost of being off target against that of adjustment and minimising; however the form of the function is still an arbitrary choice.

The Adaptive Expectations approach has also been used as an explanation, and was the process by which Friedman assumed agents calculated their permanent incomes. This assumes that the change in expectation is a function of past expectation errors.

There are two major differences between Partial Adjustment and Adaptive Expectations. Firstly, the latter requires certain parameter restrictions, which depend upon the particular functional form used and the expectation lag length. Secondly, use of the Koyck Transformation affects the error term, including serial, correlation, which does not occur when using direct substitution, as in the Partial Adjustment case (See IIa)). Unfortunately, the two explanations are observationally equivalent:-

"Thus if we find that a regression equation of this form provides a satisfactory explanation of m, it is open to argument whether lags in adjustment or expectation variables are at work. Regression analysis cannot distinguish the two hypotheses". (Stewart/Wallis (1981)).

The prevalence of the adaptive expectations approach before the 1970's was in no small measure due to Muth's (1961) original work on Rational Expectations. The particular form required for the adaptive to be the same as the Rational solution and the fact that this would not be true for more complex models, was not implicitly recognised until the later work of the Chicago School.

I would argue that the pure Partial Adjustment explanation, which is better applied to physical constraints on adjustment, is a more realistic assumption for LDC's with their bad communications and under-developed financial system, than Adaptive Expectations which allows agents to make consistent errors. Bliss and Stern (1982) site a case where farmers in a small Indian village, when questioned as to the expected marginal product of certain agricultural innovations, come up with the values close to those calculated by the researchers themselves using standard economic methodology, which indicates that economic theory is justified in assuming that agents will not consistently make the same errors.

b) Nonlinear Coefficients and Standard Errors

The example on the previous page illustrates that an important result of both the partial adjustment and the adaptive expectations/ permanent income hypotheses is that the estimated coefficients are nonlinear combinations of the true parameter with the adjustment factor. In the less complicated examples, the true parameters are identified and can be calculated from estimated coefficients, however we remain with the problem of calculation of standard errors. Many empirical studies are guilty of ignoring this complicating factor, merely publishing estimated coefficients and standard errors. This can lead to false conclusions. Wong, Fry, Khan and the Bank of England in particular, are guilty of this practice.

A Taylor approximation can be used to calculate the standard error of a nonlinear parameter. Consider a simple partial adjustment model:-

i) $m^* = a_o + a_1 y$ true model

ii) $m - m_{-1} = \theta\ (m^* - m_{-1})$ partial adjustment

iii) $m = a_o\theta + a_1\theta y + (1 - \theta)\ m_{-1}$ actual coefficients

iv) $m = b_o + b_1 y + b_2\ m_{-1}$ estimated coefficients

The actual coefficients can be identified thus:-

$$a_o = \frac{b_o}{1-b_2} \qquad a_o = \frac{b_1}{1-b_2} \qquad \theta = 1 - b_2$$

After estimation, the Taylor approximation to a_1 is:-

$$(\hat{a}_1 - a_1) \simeq (\hat{b}_1 - b_1)\frac{\partial a_1}{\partial \hat{b}_1} + (\hat{b}_2 - b_2)\frac{\partial a_1}{\partial \hat{b}_2}$$

$$= (\hat{b}_1 - b_1)\frac{1}{1-\hat{b}_2} + (\hat{b}_2 - b_2)\frac{\hat{b}_1}{(1-\hat{b}_2)^2}$$

Thus,

$$\text{VAR}\ (\hat{a}_o - a_1) = \text{VAR}\ (\hat{b}_1 - b_1)\frac{\partial a_1}{\partial \hat{b}_1} + \text{VAR}\ (\hat{b}_2 - b_2)\frac{\partial a_1}{\partial \hat{b}_2}$$

$$+ 2\ \text{COV}\ [(\hat{b}_1 - b_1), (\hat{b}_2 - b_2)].\ \frac{a_1}{\partial \hat{b}_1}\ .\ \frac{a_1}{\partial \hat{b}_2}$$

$$= \text{VAR}\ (\hat{b}_1 - b_1)\frac{1}{1-\hat{b}_2} + \text{VAR}\ (\hat{b}_2 - b_2)\frac{\hat{b}_1}{(1-\hat{b}_2)^2}$$

$$+ 2\ \text{COV}\ [(\hat{b}_1 - b_1), (\hat{b}_2 - b_2)]\ \frac{\hat{b}_1}{(1-\hat{b}_2)^3}$$

As the true values for a_1, b_1 and b_2 are unavailable, we further approximate by inserting the estimated values, and the final formula becomes:-

$$VAR(\hat{a}_1) = V\hat{A}R(\hat{b}_1)\frac{1}{1-\hat{b}_2} + V\hat{A}R(\hat{b}_2)\frac{\hat{b}_1}{(1-\hat{b}_2)^2} + 2\,COV(\hat{b}_1, \hat{b}_2)\frac{\hat{b}_1}{(1-\hat{b}_2)^2}$$

and similarly for $VAR(\hat{a}_o)$. The t-test on θ is much simpler, using the estimated standard error in the formula:-

$$\frac{\hat{b}_2 - 1}{SE(\hat{b}_2)} \sim t_{n-k}$$

The same procedure can be carried out where the nonlinearities are more complex.

As an illustration of the effect of this calculation, Table 1 below shows two formulations chosen at random:-

1) Venezuela, Laidler/Parkin equation (2), M1, logs

	Const	y	r	λ	m_{-1}	θ
a) Original Parameters	0.073	0.13	-0.01	1*	0.97	-
(t-statistic)	(0.55)	(2.36)	(-3.35)	-	(30.32)	-
b) True Parameters	2.43	4.33	-0.33	1*	-	0.03
(t-statistic)	(-0.54)	(1.15)	(-0.86)	-	-	(0.94)

2) Pakistan, Nath equation (1), M1, lags

	Const	y	r	λ	m_{-1}	θ
a) Original Parameters	0.61	0.0079	-0.012	0.051	0.90	-
(t-statistic)	(2.30)	(0.12)	(-2.21)	(2.36)	(16.75)	-
b) True Parameters	6.1	0.079	-0.12	0.51	-	0.10
(t-statistic)	(1.51)	(0.53)	(-1.76)	(1.98)	-	(1.85)

Although the majority of these examples show a reduction in the t-values, this was not always true, it often being the case that the coefficient on m_{-1} was not significant while that on θ was.

It is likely that studies which ignore this important issue are guilty of econometric negligence or of concealing unfavourable results.

c) Nonnested Tests*

Econometricians often have to discriminate between different models that are designed to explain the same behaviour. Traditional summary statistics are model specific and should not be used to compare different fomulations. The significance level for R^2, for example, has been shown to be as low as 50%, which can clash with the t-tests. Addition of a variable that is not significantly different from zero at 95% can therefore still increase R^2. Measures such as $\bar{R}^2$, the Akaike Information Criterion and the Deaton measure have been designed, based on higher implicit significance levels, but these have a consistent ordering and are therefore of little use in choosing between competing models.

The usual General to Specific techniques apply when one model is nested within the other. The Likelihood Ratio Test is the most commonly used:-

$$\ell = \frac{L^*_R}{L^*_U} \qquad -2 \log \ell \sim \chi^2_k$$

(L^*_U) = Unrestricted likelihood, L^*_R = restricted likelihood,
k = degrees of freedom = number of restrictions).

This works because the best that the restricted version can do is to equal the unrestricted, when the restriction is valid, i.e. $L^*_u \geq L^*_R$ so $0 \leq \ell \leq 1$. With nonnested models 1 and 2, however, $L^*_1 \gtrless L^*_2$, so ℓ need not lie within the required range. From this starting point, Cox devised the Modified Likelihood Ratio that initiated recent work in this area.

The basic premise of nonnested testing is the "encompasing principle". This states that the model that is closer to the true Data Generating Process should not only explain the data better than any alternative but should also explain the results arising from the estimation of that alternative. The Cox statistic, the first to be explicitly based on this principle, is derived as follows:-

$$\text{Assume Model 0} \quad m = X\beta + u \rightarrow \text{log likelihood } L(\hat{\theta}_o)$$
$$= f(\beta) + u$$
$$\text{Model 1} \quad m = Z\gamma + v \rightarrow \text{log likelihood } L(\hat{\theta}_1)$$
$$= g(\gamma) + v$$

$$\text{Then} \quad To = L(\hat{\theta}_o) - L(\hat{\theta}_1) - n\left[\text{plim}_o 1/n\, (L(\hat{\theta}_o) - L(\hat{\theta}_1))\right]_{\theta_o = \hat{\theta}_o}$$

$$\overset{asy}{\sim} N(0, Vo)$$

$$\text{so: } To/\sqrt{Vo} \overset{asy}{\sim} N(0, 1)$$

---

* Much of the following discussion is based on Davidson/McKinnon (1980)

(n = sample size, $plim_o$ = probability limit given that Model 0 is true)

Thus the modified likelihood ratio is equal to the ratio of the conventional test to the expected likelihood ratio given that Model 0 is correct. The calculation difficulties of this latter term inspired the derivation of the CPD or Cox-Pesaran-Deaton statistic.

The term $N[plim_o 1/n\ L(\hat{\theta}_o)]_{\theta_o = \hat{\theta}_o}$ can be replaced by $L(\hat{\theta}_o)$ as the best approximation to the estimated likelihood of model o, assuming it to be the true model, is itself.

The Cox statistic becomes:-

$$T = -L(\hat{\theta}_1) + N[plim_o 1/n\ L(\hat{\theta}_1)]_{\theta_o = \hat{\theta}_o}$$

Now, $L(\hat{\theta}_1) = {}^{-n}/_2 \log \hat{\sigma}_1^2$, $\hat{\sigma}_1^2 = 1/n\ (m-\hat{m})'\ (m-\hat{m})$ so we require estimates of $\hat{\sigma}_1^2$ and the probability limit term.

We know that:-

$$\hat{m} = g(\hat{\gamma})$$

Set: $\hat{\gamma} = plim_o \hat{\gamma}$

Thus: $\hat{\sigma}_1^2 = 1/n\ (m - g\ (\bar{\gamma}))'(m - g(\bar{\gamma}))$

$$= 1/n\ (m - g\ (\bar{\gamma}) + f(\beta)-f(\beta))'\ (m - g(\bar{\gamma}) + f(\beta) - f(\beta))$$

$$= 1/n\ [(m - f)'\ (m - f) + (f - g)'\ (f - g) + 2(m - f)'\ (f - g)]$$

The third product term is asymptotically zero if model 0 is the true one, thus:-

$$\hat{\sigma}_{10}^{2} = \hat{\sigma}_{o}^{2} + 1/n \left[(f(\hat{\beta}) - g(\bar{\gamma}))' (f(\hat{\beta}) - g(\bar{\gamma}))\right]$$ when we estimate

for β. $\bar{\gamma}$ is estimated asymptotically by $\hat{\gamma}$ from the regression:-

$$\hat{y} = z\gamma + u$$

where $\hat{y} = X\hat{\beta}$

This variance is therefore the sum of the estimated variance under model 0 and a factor arising from the difference between the two models. The CPD statistic is given by:-

$$To = n/2 \log \left[\frac{\hat{\sigma}_1^2}{\hat{\sigma}_{10}^2}\right] \overset{asy}{\sim} N(0,1)$$

($\hat{\sigma}_1^2$ = estimated variance of model 1, $\hat{\sigma}_{10}^2$ = estimated variance of model 1 given that model 0 is correct).

If model 1 fits better than expected, $\hat{\sigma}_1^2 < \hat{\sigma}_{10}^2$, To is negative, and vice versa, so important information as to the direction of misspecification is given by the sign of To. The only difference between these two estimated variances is the term $(m - f(\beta))' (f(\hat{\beta}) - g(\bar{\gamma}))$ which is asymptotically zero if model 0 is correct. This merely states that there should be no correlation between the residuals from the true model and the difference between the fitted values of both models.

The Davidson/McKinnon J-test investigates this more directly.

being based on a "linear embedding" procedure rather than one of variance estimation. The method of embedding (containing competing hypotheses within a general formulation in order to test the validity of restrictions) used, does not suffer from the drawbacks arising with standard procedures. In the model:-

$$m = (1 - \alpha)\ f(\beta) + \alpha g(\gamma)$$

Under the null hypothesis that model 0 is correct, we can replace γ with $\hat{\gamma}$ which allows us to use the single variable $g(\hat{\gamma})$, the predicted value of m under model 1 that converges to a nonstochastic probability limit, instead of the matrix $g(\gamma)$. We first estimate $g(\hat{\gamma})$, include it as a variable in model 0 and jointly estimate $\hat{\beta}$ and $\hat{\alpha}$, testing whether $\hat{\alpha} = 0$. If model 0 is correct, the argument runs that additional variables should be unable to increase its explanatory power. The t-test becomes asymptotically normal.

The CPD and J-tests are only asymptotically equal, so they are likely to differ in small samples.

d) <u>Nonnested Tests and Serial Correlation</u>

The implications of serial correlation for the CPD and J-tests are important, and I would argue that in the case of positive autocorrelation, the standard textbook assumption, the effects will be more marked on the CPD test.

In the case of the J-test, parameter bias arising from serial correlation is the most important factor. Assume that model 0 is so biased, consistently over or underpredicting the dependant variable, while model 1 is not. The effect of this is to introduce a systematic factor into the error term that model 1 will be able to explain if it is specified well enough, leading to rejection of model 0. This may also occur if both models are biased, although in this case it is likely that the reciprocal test on model 1 will also result in rejection. If only model 1 is biased, I would argue that there is little difference from the ideal situation, as a biased alternative that probably arises as a result of dynamic misspecification, need not be any better or worse at explaining the residuals from the null.

The CPD test, however, is based upon the OLS variances which are known to be underestimated under positive correlation. When the problem arises solely in model 0, $\hat{\sigma}_{10}^2$ would tend to be smaller than its true value, giving a positive bias to the estimated statistic, and rejection of model 0 would be in a direction away from the possibly dynamically better specified model 1. It is therefore possible to accept a badly specified model 0 if the autocorrelation bias outweighs the better explanation of the data by model 1.

With autocorrelation in both functions, $\hat{\sigma}_1^2$ and $\hat{\sigma}_{10}^2$ are underestimated, and the net result depends upon the relative effects. It could be argued that for similar models, the effect would be the same for both variances, which would give greater weight to the second term of $\hat{\sigma}_{10}^2$, although other factors may also be involved. If only model 1 is autocorrelated, $\hat{\sigma}_1^2$ will be less than expected resulting in a negative bias towards the misspecified formulation, again opposite to the desired results.

The J-test therefore seems more powerful in this situation. The effects of serial correlation are superimposed upon the normal results, and the inconsistency that arises with a lagged dependant variable means that the two tests are no longer asympototically equal.

e) <u>Misspecification Tests</u>

Classical test statistics such as dw, t, CPD and J are formulated against a specific alternative hypothesis. In a new range of so called "general" misspecification tests, the alternative is merely that the formulation is incorrectly specified. Misspecification can lead to the failure of one or both of the assumptions on the stochastic error terms that give OLS its desirable properties:-

i) $E(U|X) = 0$ - orthogonality. The error term is unrelated to the explanatory variables. Failure of this assumption leads to both biased and inconsistent estimates and can be caused by errors in variables, wrong functional form and omitted variables,

ii) $VAR(U|X) = \sigma^2 I$ - sphericality or constant error variance (I is the identity matrix). Failure of this assumption (heteroscedasticity) merely results in loss of efficiency, but not inconsistency and can be caused by wrong functional form.

Hausman (1978) argued that failure of (i) had the more important consequences. The Hausman test compares β_1, the efficient estimate that is inconsistent under the alternative, with β_2, another, less efficient, estimator that is consistent under both H_o : no misspecification and H_1 : misspecification. Thus, under H_o :-

$$1/n \text{ plim } \hat{q} = 0 \quad \text{where } \hat{q} = \hat{\beta}_2 - \hat{\beta}_1$$

Given the lemma that the efficient estimators are uncorrelated with $\hat{q}$, Hansman shows that under H_o:-

$$\text{VAR } (\hat{q}) = \text{VAR } (\hat{\beta}_2) - \text{VAR } (\hat{\beta}_1) \geq 0$$

$$\Rightarrow H = \hat{q}' \, M(\hat{q})^{-1} \, \hat{q} \overset{asy}{\sim} \chi^2_K \qquad M(\hat{q}) = 1/n \text{ VAR } (\hat{q})$$

(K = Number of variables excluding the constant)

The most useful version of this test is aimed specifically at detecting errors in variables, such as those arising from bad data, where OLS is the efficient estimator and the consistent estimator is given by instrumental variables (IV):-

$$\hat{\beta}_{OLS} = (X^1X)^{-1} X'M \qquad \hat{\beta}_{IV} = (Z'X)^{-1} Z'M \qquad (Z = \text{instruments})$$

$$\sqrt{n}\, \hat{q} = \sqrt{n}\, (\hat{\beta}_{IV} - \hat{\beta}_{OLS}) \overset{asy}{\sim} N(0, D)$$

$$D = \text{VAR } (\hat{q}) = \sigma^2 \left[\text{plim } (\frac{\hat{X}'\hat{X}}{n})^{-1} - \text{plim } (\frac{X'X}{n}^{-1}\right]$$

$$\hat{X} = Z(Z'Z)^{-1}Z'X$$

$$\Rightarrow n\,\hat{q}'\,D\,\hat{q} \overset{asy}{\sim} \chi^2_K \text{ under } H_o.$$

In practice, I use the formulation:-

$$H = \hat{q}'\,\hat{V}^{-1}\,\hat{q} \overset{asy}{\sim} \chi^2_K, \quad \hat{V} = V/n \quad V = \hat{\sigma}^2_{IV}\,[(\hat{X}'\hat{X})^{-1} - (X'X)^{-1}]$$

As might be expected given the basically simple idea upon which these tests (see also Plosser/Schwert/White (1980), White (1980)) are founded, major problems exist.

The results obtained from the Hausman test depend to a great extent upon the instruments used. The closer they are to the original $X's$, the closer $(\hat{X}'\hat{X})$ will be to $(X'X)$ and the power of the test to detect misspecification will fall as $\hat{q}$ tends to zero. Instruments that are close to the original $X's$ will also suffer from the same specification problems, so both $\hat{\beta}_{OLS}$ and $\hat{\beta}_{IV}$ will be inconsistent. If the chosen variables are not good instruments, $(\hat{X}'\hat{X})$ will be much larger than $(X'X)$ and the test will tend to be rejected whether the model is correctly specified or not.

In general there will be a severe information loss, as these tests attempt to condense two variance-convariance matrices into a single value. Hausman's statistic is really designed to pick up the effects of a violation of orthogonality and may not be powerful against other forms of misspecification even though pertaining to be "general".

The most dâmning criticism of this class of tests, however, is their low power. The nonspecific alternative of the Hausman test results in a high probability of accepting a false hypothesis, i.e. of making a type II error.

I believe that this test can still be a useful addition to the econometricians array of descriptive statistics as long as it is used in conjunction with, rather than instead of, the classical methods. Although the low power of such tests casts doubt upon the conclusion that can be drawn from accepting a null hypothesis, rejection gives a strong indication that some form of misspecification exists, although unlike the CPD test for instance, gives no indication of the direction to pursue in eliminating the problem.

V. Estimation and Results

a) Notes on Estimation

In this section I discuss the form of the variable used and choice of model for the nonnested test procedure. Appendix (a) contains more specific points.

During estimation I attempted, wherever possible, to duplicate the methods used in the original studies. This resulted in, for instance, use of a grid search method for the Khan and Meyer/Neri function, where a more accurate picture could have been gained from using the Laidler/Parkin iterative procedure. Some changes were necessary for standardisation purposes, as the nonnested test procedures require competing models to explain the same independant variable. The studies chosen presented a bewildering array of adjustments and often used differing definitions and subdivisions of the dependant variable:-

Laidler/Parkin	- levels, real, per capita
Bank of England	- logs, i) nominal, per capita
	ii) real, per capita
Meyer/Neri	- logs, real
Nath	- logs, real, per capita
Khan	- logs, real
Fry	- logs, real
Galbis	- levels, real
Wong	- i) levels, real
	ii) logs, real

To avoid a priori assumptions on the linearity of the functions I estimated each model in both levels and log-linear form, for both M_1 and M_2 in real, per capita terms. The latter imposes the restriction that aggregate demand for money adjusts to changes in population and prices within a single period, which has been supported by empirical work (see Laidler (1977)). The complexity of the Khan formulation illustrates the problems that can arise otherwise.

After estimation, the "best" formulation from each author was chosen using a two-step procedure. First, the optimum form for the dependant variable was chosen using $\bar{R}^2$ as a criterion. Although well aware of the problems with this approach, I would argue that they are outweighed by the gains in speed and simplicity and also that the number of regressions carried out for each country was large enough to clearly indicate the preferred formulation.

In the majority of cases levels were chosen and where the evidence was more well balanced there seemed little to lose from sticking with them. The differences arose with the different definitions of the dependant variable. In half the sample, U.S.A., Korea and Venezuela, M_1 was preferred to M_2.

For the second stage, the optimal function for each author, given stage I,was chosen using standard procedures. To save time I utilised the estimated rather than the "untangled" parameter. Although I have previously argued against their use for explaning the situation in a given economy, I believe there to be no conflict with the procedure outlined above, which is of a comparative rather than an absolute nature. In most cases the results would not have been altered much had the "true" standard errors been available at the time. Between nested models, e.g. Galbis (1) and (2), the more general model was chosen, based on the argument that the addition of an insignificant variable should not affect the explanatory power of the basic model. The main choices, therefore, lay within the Nath and Wong formulations, where a clear leader invariably emerged.

One of the major decisions necessary when estimating the original regressions was the treatment of serial correlation. Given the inconsistency problem arising in the presence of a lagged dependant variable, it would seem obvious that a re-estimation, using one of the available filtering techniques such as Cochrane-Orcutt, should be carried out. I did not do this, however. Although I realise that under normal circumstances this may appear to be "econometrically unsound", the problem that I faced was that NEWSTAB, the nonnested test package that was available for my use, did not allow for autocorrelation when calculating the necessary test statistic.

It is often argued that serial correlation can indicate dynamic misspecification, as omitted lag variables are forced into the error term. In this study the basic theory behind most of the models used is similar, so that the dynamic specification is one of the important aspects in which they differ. May main aim was to compare the actual models, and given the two-stage process outlined above I justify my action (or lack of it) by agruing that had I compared models after allowing for autocorrelation, this would have been unfair to those where the dynamics were better specified. By not allowing for autocorrelation, therefore, I have compared the original form of each model rather than some "convenient simplification" of a more general model with an unknown lag structure. It may be that the error were genuinely correlated, in which case the functions are still placed on the same footing.

Time constraints precluded the calculation of Durbin's 'h' for every regression, however, mindful of the likely bias of the dw statistic towards two, I used the dw upper bound as a rule of thumb, assuming any values below this to indicate the presence of serial correlation.

b) The Results

The discussion will concentrate on cross-country effects, with some attention being paid to individual results when necessary.

The fit for all countries is surprisingly high, with most functions explaining more than 90% of the movement in the dependant variable (For Venezuela 98%, Jamaica 80%). This could be partly explained by serial correlation bias, however, in those formulations where dw exceeded its upper bound the fit was not markedly different.

There is strong evidence of serial correlation arising in all cases, with less than 50% of the regressions for each country passing the dw test (see Table 1)

Table 1: Country:	Jamaica	Korea	Pakistan	Venezuela	France	U.S.A.
% of regressions where dw > du	40	36	5	42	36	24

As the functions were identical for each country, this gives a rough indication of the degree of autocorrelation present in the data, with Pakistan faring markedly worse than elsewhere. It should be noted that 28% of the regression estimated on U.S.A. data exhibited negative correlation, dw > (4 - du), and if we can discount this for time series data that proportion can be added to the above figure. The best results were given by the Wong functions and to a lesser extent Fry and Meyer/Neri. The common factor in the first two is the inclusion of an inflation term, while in the latter case a more complex dynamic structure may be responsible, although it may simply be that these functions have a greater positive bias than the others.

The Hausman statistics painted a most disappointing picture, with a clear rejection for each function in every country. This must implicate the data to a certain extent, being the main common factor. Korea was the best performer with almost twice the number of statistics accepting the null hypothesis as its nearest rival, France. The developed countries as a whole did not show a markedly better performance in this respect.

As for parameter values, most of these had the expected signs, although there seems little evidence of any cross country relationship to explain the pattern of significance. In most cases the interest rate parameter had a negative sign and there was no evidence to support the Liquidity Trap hypothesis. Direct comparisons of parameter values are not possible given that each country utilises a different currency, so within the limits of this study it is not possible to say whether the Fry time series/ cross section technique is valid or not.

The three variables of most general interest are inflation, the adjustment parameter on anticipated money balances and savings. In all countries, the coefficient on inflation was either negative, relatively large and highly significant, or positive but not significant. The effect is particularly noticeable in Venezuela where the experience of inflation has arguably been greater than for the rest of the sample, resulting in a greater awareness of the affects on real balances and well established channels of adjustment.

The estimated value of θ, the adjustment parameter, was less than 0.5 in almost every country. This implies that less than 50% of the discrepancy between actual and desired money balances is made up in the first quarter. The exception is Korea where in a significant number of cases θ exceeds 0.9. This is to be expected in a Newly Industrialising country where high demand for investment funds and relatively unrestricted financial markets allow faster savings mobilisation in the form of nonmonetary assets with a high return.

The sign on the savings coefficient is important for assessing the relevance of the complementarity hypothesis. As table 2 (see below) shows, the results were highly ambiguous.

Table 2 Sign on the Savings Coefficient (in the majority of cases) for the Galbis and Fry Functions.

Country:	Jamaica	Korea	Pakistan	Venezuela	France	U.S.A.
Galbis	-	+	+	-	+	+
Fry	+	+	+	+*	+	±**

* = Not significant

** = + for M1, - for M2

At first glance, this would appear to support complementarity, however the implication that it is also relevant to developed economies is worrying. Instead, I would argue that either the functions themselves do not adequately represent the hypothesis or, more likely, that the use of savings as a proxy for investment and the method used to derive that variable render it a bad measure of the true value and call into question the reliability of these results.

Assuming that savings are equal to investment is not valid for LDC's where much investment is financed, both directly and indirectly, from development aid. As the complementarity hypothesis is more relevant to investment that has been generated from domestic sources, an accurate, disaggregated figure is necessary to properly estimate these functions. Unfortunately this is the kind of data that is almost never available in LDC's.

In the area of functional specification, two points clearly suggest themselves. In all cases of the Laidler/Parkin study, the worst performance was that of the most restricted equation (1), yet it is on this that the original Nath study was based (I used the less restricted equation (2)). Some of the estimations of the unrestricted form (4) also gave results that were not credible, however, in particular, positive signs on the interest term. Owing to the iterative technique used, this may be an example of the iteration settling on a local rather than global optimum set of parameters. This occurred in the original study, where two solutions were estimated which depended upon the initial parameter values, however in this case a preliminary search for further solutions proved fruitless.

There is also evidence, for the studies using the grid search methods, that the grid may have been set too wide, with incongruous results.

For instance, in the Meyer/Neri study on U.S.A. data, the optimum value of α exceeded 0.9 in all cases bar one in which it was 0.05, and there were significant differences in goodness of fit and parameter values.

There appears to have been a multicollinearity problem with Nath (2). Significant changes in the income coefficient and sometimes those on the interest and other variables between versions (1) and (2) occurred for all countries.

There were also, in the majority of cases, significant differences between Galbis (1) and (2), with the better statistics exhibited by the latter. This indicates that Galbis' omission of an interest rate term may have seriously affected his results and therefore the conclusions arising from them.

The overall impression to be gained from using the standard criteria must be that few firm statements can be made concerning the relative performances of these functions, although the Wong formulation was indicated to be a superior explanation of the data in some cases.

Before discussing the results of the nonnested tests, I wish to stress that rejection of model 0 does not have any implication for model 1 as the tests are based on the expected performance of the alternative <u>assuming that model 0 is true</u>.

The results of the two tests indicated clear winners and losers for each country:-

Table 3 - Nonnested Tests - Winners and Losers

Country	Jamaica	Korea	Pakistan	Venezuela	France	U.S.A.
J-test:-						
Winners	Wong (4)	Wong (5)	Nath (3)	Wong (5)	Wong (4)	Wong (3)
		Laidler/ Parkin (5)	Boe (3)			Nath (3)
Losers	Fry (0)	Fry (0)	Galbis (0)	Fry (0)	Galbis (0)	Fry (0)
CPD-Test:-						
Winners	Wong (0)	Galbis (5)	Nath (3)	Wong (5)	Wong (4)	Wong (3)
			Boe (3)			Boe (2)
Losers	Galbis (0)	Fry (0)	Galbis (0)	Galbis (0)	Galbis (0)	Fry (0)
	Laidler/ Parkin (0)	Nath (0)	Fry (0)	Fry (0)	Nath (0)	Galbis (0)
			Wong (0)			
	Nath (0)					

The value in brackets indicates the number of times H_o "model 0 is the true one" was not rejected at 95%.

The obvious conclusion is that the Wong formulation is preferred, although it must be borne in mind that different measures of Credit Rationing were used for each country. This supports the argument that for each country, although the basic theory behind money demand may be sound, there is a substantial benefit to be had from adapting to its idiosyncracies.

Both tests of the McKinnon hypothesis are soundly rejected overall, reversing the conclusions that could have been drawn merely from straight estimation, with the single exception of Korea where complementarity is given partial support.

The inconclusive results for Pakistan reflect the implication of the original estimation, that the data was of questionable quality.

It is also notable that the LDC-specific equation, devised by Wong was superior in both of the Developed countries for both tests. In both countries, the measure of Credit Rationing chosen was CR2, ($\frac{\Delta D}{D_{-1}}$. D = total bank deposits which is equivalent to M2 less cash in circulation). It may be that this measure would adjust more rapidly to inflation than interest rates, although this does not seem very likely unless a Rational Expectations argument could be brought in to play, the implication being that deposits adjust in anticipation of a change in interest rates. In both countries, the coefficient on $\frac{\Delta P}{P_{-1}}$ was markedly different from its value when the other Credit Rationing measures were used. With French data it was large and positive in this case, and negative elsewhere, while for the U.S.A. the coefficient was smaller and other variables become significant when CR2 was used, although the effect here was not much different to that of CR1, (the interest rate, r).

This result has the implication that the so-called general formulations are not so general after all and the current theories used to explain demand for money do not give a very accurate picture of the true process.

The rejection of the Complementarity Hypothesis, both for the developed countries and for the LDC's, confirms the indication of the standard tests discussed previously.

VI. Comparisons, Conclusions and the Future

a) Comparisons

This section comprises a brief comparison, where feasible, of my results with those of the original studies. With few exceptions, the high values of $\bar{R}^2$ reported here were not out of line with past work. As I found with Jamaica, individual countries can deviate markedly from the average. In the Galbis study for example, the value was 0.5 for Uruguay, while the mean $\bar{R}^2$ for the other 18 Latin American countries in the sample was around 0.9. As each study tested only a single formulation for differing sets of countries, little more can be said in this area.

Similarly, for those papers that published values of the Durbin-Watson statistic, the range was not dissimilar to that discussed in the previous section, although Nath reports values of 1.3 and 1.4 for his equation (1) and (2) even after taking serial correlation into account in his estimation.

In most cases, the calculated values for θ were low, implying slow adjustment of money balances. Nath found values around 0.95 for his replication of Laidler/Parkin (4), but given that this was for annual data there is no substantial disagreement. The main exception arose with the original Laidler/Parkin (4) where nonlinear estimation produced two solution values for θ, 0.203 and 0.794, with the former being rejected by the authors on the grounds that it seemed too small. Values reported by the Bank of England for a similar data set lay between 0.1 and 0.2 and

I would argue that the Laidler/Parkin result may have arisen due to the estimation technique. In the present study the value of θ in all countries was noticeably higher when the nonlinear option was utilised, which used the Laidler/Parkin parameter values as starting points.

As for the Complementarity Hypothesis, the single Fry equation based on grouped data produced a negative sign on the savings coefficient. In the Galbis study the sign was positive in only seven of the nineteen countries investigated and he concluded that the data did not support McKinnon's hypothesis.

The general conclusion that can be drawn from these comparisons is that my results are by no means unusual and cannot be blamed upon idiosyncracies of the data set or estimation techniques.

b) Conclusions

This paper began by asking whether the general money demand functions estimated for the developed economies were as good at explaining the situation in the LDC's as function devised specifically for that purpose. In my opinion the results indicate that although the general functions can do no worse, and in some cases markedly better than many specific formulations, the results can be improved by paying attention to the situation in each individual country. The Wong strategy of estimating a variety of regressions based on the same underlying theory but differing slightly in its application clearly has advantages in this respect, although it is open to the criticism that some of the measures for credit rationing appear to be ad-hoc rather than generated by any particular theory.

The benefits to be gained from this approach depend on what is required. If the purpose is to find the best possible explanation of demand for money in a certain country at a particular point in time, then I would recommend the Wong method. If, however, a more long term use is to be made of the estimated function, for instance as part of a large scale macroeconomic model for a developing country to be used in Development Planning, the above approach is less advantageous. Almost by definition, the developing countries are continually changing in the customs, attitudes, economic and financial institutions from which the underlying basis of money demand is derived. It is likely, therefore, that the function that was tailor made to give a fit of over 98% for a particular country in 1979 will not perform as well in 1984. More important, there will be uncertainty as to how much the fit will have changed. Thus, for example, the projections used as the basis for a Five Year Plan become increasingly unreliable. In this situation, it may be that one of the more general formulations, where the fit may be marginally worse but to a certain extent predictable, will be more appropriate. For this type of application, the search for a more specific function is akin to the search for the provential "better mousetrap"; if the present model does the job efficiently, a different and necessarily more complex and expensive version seems irrelevant.

On a more specific point, the high prevalence of serial correlation and the results of Hausman's "errors in variables" misspecification test, imply that bad data is a major but not insurmountable problem for LDC's and the current attempts by the international aid agencies to improve their statistical base must be welcomed, although there is still a great deal of room for improvement. Personal experience of the statistics generation and collection in small developing country has indicated that significant irregularities are likely to be the rule rather than the exception and published data on any but the most basic indicators (prices, interest rates etc.) are likely to be only a pale reflection of the true situation, so that any conclusions based upon an analysis of such data can only really be tentative in the extreme.

c) The Future

Apart from repeating the same tests for a wider range of countries, I would suggest two possible avenues for future work in this area. Firstly, a re-estimation, taking serial correlation into account, with the development of a nonnested test option that can allow for this. Secondly, given the argument that merely allowing for autocorrelation without further investigations of lag structures can conceal the true dynamics of the system, a more thorough investigation of its effects on the nonnested test statistics, including development of an unbiased version of the CPD test that will give a truer indication of the direction of rejection.

I also reiterate Wong's closing statement:-

"Further studies on the question of which proxy variable for the degree of credit restraint should be used and how to treat the lags in the demand for money may be worthwhile".

Finally, the surprising and fairly strong rejection of McKinnon's Complementarity Hypothesis, notwithstanding its theoretical appeal, leads me to suggest two ways in which specification of the model could be improved. As I have previously stated, I believe the main relevance of the hypothesis to be for the small farmer. One way of dealing with this would be to use highly disaggregated data, such as the intensive village-level studies advocated by Liebenstein (1981) and carried out by Bliss/Stern (1982) in a different context. This is an expensive practice, however, and by its very nature the data collected is highly area specific. An alternative possibility would be to model the duality between small and large farmers, perhaps in a similar way to Galbis'(1977) model of a fragmented economy.

This should at least allow us to predict whether more aggregate data would support or reject complementarity given the overall ratio of small to large farmers. Hopefully, we would then be able to avoid the situation that arose in this study where the favourable, rather than the unfavourable results were viewed with suspicion.

The second possibility would be a partial movement towards Shaw's position by explicitly allowing for the informal financial sector as the main alternative for investment funds to holding money balances. The true cost of unofficial credit, which has a lower default rate than the official variety, depends to a great extent on the availability of the latter (see Bottomley (1975), Wai (1977), Adams (1978)). Financial Repression and in particular credit rationing, not only has a direct effect on the demand for money, therefore, but also an indirect effect, as a cut in the official funds available for investment will also push up rates in unofficial markets, forcing more farmers to rely upon their own savings for investment purposes. The competing asset effect would be unlikely to operate in the unofficial markets, which are comprised of individual moneylenders, co-operatives and similar organisations that pay little or no interest on deposits. Higher interest rates will squeeze out the least efficient investments, however, and may cause some farmers to save for current consumption items such as weddings or videos instead. To empirically test for these complex interactions would require a more disaggregated data set than is currently available for most countries, however.

Appendix A - Notation and Specific Estimation Points

M - money demand

Y - income

S - savings

DC - domestic credit

M^* - desired money balances

r - interest rate

D - total bank credits

t - time trend

Superscript 'e' denotes expected value.

Superscript 'p' denotes permanent value.

θ - adjustment parameter on desired real money balances.

λ - adjustment parameter on desired income (short run).

α - adjustment parameter on desired income (long run).

β - adjustment parameter on inflation.

γ - adjustment parameter on desired nominal money balances.

(all adjustment parameters lie between zero and unity).

a_i - actual coefficients

Δ - difference operator ($\Delta x = x - x_{-1}$)

E - expectations operator

b_i - nonlinear combinations of coefficients

L - lag operator ($Lx = x_{-1}$)

Wong measures of credit rationing:-

$CR1 = r$

$CR2 = \frac{\Delta D}{D_{-1}}$

$CR3 = \frac{DC}{y}$

$CR4 = 1 - CR3$

$CR5 = \frac{-DC}{DC_{-1}}$

$CR6 = 1 - CR5$

In the case of logs, only CR1 and CR4 do not become negative at some point.

Specific Points

i) M3: measures were unavailable for the LDC's, and as it includes interest bearing deposits the results from estimating functions where the interest rate is an explanatory variable may be ambiguous.

ii) GNP: It is often argued that GDP is more closely related to domestic transactions than GNP. In LDC's, however, transfers from overseas, e.g. from migrant workers, are often significant, and these would affect the demand for domestic currency.

iii) Instruments: Those used in the Hausman test were lagged values of the explanatory variables, excluding trends, seasonal dummies and previously lagged values which are predetermined at time t.

iv) Laidler/Parkin (4): Estimation was carried out using both nonlinear least squares with the L/P coefficients as initial values, and OLS. $\bar{R}^2$ is not given by TSP in the former case so that from the latter was used which may be misleading given the possibility of multiple solutions.

v) Fry: To avoid complication, expected inflation was approximated by current inflation rather than an Almon lag. The function was estimated using Almon polynomials for expected output, of orders 3, 2 and 1 as well as OLS. In general there was little difference between the results, and the OLS form was used for the nonnested tests.

vi) Meyer/Neri, Khan: These could not be included in the nonnested tests as the dependant variable differs from the other formulation. For estimation, the grid search method was used to increase β or α in steps of 0.05 between 0 and 1.00, minimising the standard error of the regression.

vii) J, CPD Tests: √ => accept Ho: model 0 is correct at 95% (statistic lies within (-1.96, 1.96)). For the CPD test, X(-) => reject Ho, negative sign on statistic.

viii) All data series were derived from varous issues of International Financial Statistics.

Appendix B - Results of Nonvested Tests

Jamaica M2, levels

J - Test / Alternative

Assumed True	BOE	La/Pa	Nath(2)	Fry	Galbis	Wong(CR4)
BOE	-	√	√	X	X	X
La/Pa	X	-	√	X	√	X
Nath	X	√	-	X	X	X
Fry	X	X	X	-	X	X
Galbis	X	X	X	X	-	X
Wong	X	√	√	√	√	-

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	X	√	√	X(-)	X	X(-)
La/Pa	X(-)	-	X(-)	X(-)	X	X(-)
Nath	X(-)	X(-)	-	X(-)	X	X(-)
Fry	X(-)	X(-)	X(-)	-	√	X(-)
Galbis	X(-)	X(-)	X(-)	X(-)	-	X(-)
Wong	√	√	√	√	X	-

Korea M1, levels

J - Test / Alternative

Assumed / True	BOE	La/Pa	Nath(1)	Fry	Galbis	Wong(CR1)
BOE	–	√	√	X	X	X
La/Pa	√	–	√	√	√	√
Nath	√	√	–	X	X	X
Fry	X	X	X	–	X	X
Galbis	√	√	√	√	–	√
Wong	√	√	√	√	√	–

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	–	X(–)	√	X(–)	X(–)	X(–)
La/Pa	√	–	√	√	X(–)	X(–)
Nath	X(–)	X(–)	–	X(–)	X(–)	X(–)
Fry	X(–)	X(–)	X(–)	–	X(–)	X(–)
Galbis	√	√	√	√	–	√
Wong	√	√	√	X	X(–)	–

Pakistan M2, levels

J - Test / Alternative

Assumed / True	BOE	La/Pa	Nath(2)	Fry	Galbis	Wong(CR4)
BOE	–	√	√	X	√	X
La/Pa	X	–	√	X	√	X
Nath	√	√	–	X	√	X
Fry	X	X	X	–	√	X
Galbis	X	X	X	X	–	X
Wong	X	√	X	X	√	–

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	-	√	√	X(-)	√	X
La/Pa	X(-)	-	X(-)	X	√	X(-)
Nath	√	√	-	X(-)	√	X(-)
Fry	X(-)	X	X(-)	-	X	X(-)
Galbis	X(-)	X(-)	X(-)	X(-)	-	X(-)
Wong	X	X	X	X	X	-

Venezuela M1, levels

J - Test

	BOE	La/Pa	Nath(2)	Fry	Galbis	Wong(CR2)
Assumed BOE	-	√	√	√	X	X
True La/Pa	√	-	√	√	X	X
Nath	√	√	-	√	X	X
Fry	X	X	X	-	X	X
Galbis	X	X	X	X	-	X
Wong	√	√	√	√	√	-

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	-	X(-)	√	√	X(-)	X(-)
La/Pa	√	-	√	√	√	X(-)
Nath	√	X(-)	-	√	√	X(-)
Fry	X(-)	X(-)	X(-)	-	X(-)	X(-)
Galbis	X(-)	X(-)	X(-)	X(-)	-	X(-)
Wong	√	√	√	√	√	-

France — M2, levels

J - Test — Alternative

Assumed / True	BOE	La/Pa	Nath(2)	Fry	Galbis	Wong(CR2)
BOE	-	√	√	X	X	X
La/Pa	X	-	√	X	√	X
Nath	X	X	-	X	√	X
Fry	X	√	X	-	X	X
Galbis	X	X	X	X	-	X
Wong	X	√	√	√	√	-

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	-	√	√	X(-)	X(-)	X(-)
La/Pa	X(-)	-	√	X(-)	X	X(-)
Nath	X(-)	X(-)	-	X(-)	X	X(-)
Fry	X(-)	√	√	-	X	X(-)
Galbis	X(-)	X(-)	X(-)	X(-)	-	X(-)
Wong	X(-)	√	√	√	X	-

U.S.A. — M1, levels

J - Test — Alternative

Assumed / True	BOE	La/Pa	Nath(2)	Fry	Galbis	Wong(CR2)
BOE	-	X	X	X	√	X
La/Pa	X	-	X	X	√	X
Nath	X	√	-	√	√	X
Fry	X	X	X	-	X	X
Galbis	X	X	X	X	-	X
Wong	X	√	X	√	√	-

CPD Test

	BOE	La/Pa	Nath	Fry	Galbis	Wong
BOE	-	X	X(-)	✓	✓	X(-)
La/Pa	X(-)	-	X(-)	✓	X	X(-)
Nath	X	X	-	✓	X	X(-)
Fry	X(-)	X(-)	X(-)	-	X	X(-)
Galbis	X(-)	X(-)	X(-)	X(-)	-	X(-)
Wong	X(-)	✓	X(-)	✓	X	-

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