A STABLE MONEY DEMAND FUNCTION FOR ZIMBABWE AS A PRE-REQUISITIE FOR EFFECTIVE MONETARY POLICY FORMULATION

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ABSTRACT

The analysis of monetary aggregates is one of the pillars of Zimbabwe’s monetary policy strategy since money growth is highly correlated with inflation. Consequently monetary authorities use money growth as one indicator for future risks to price stability. A stable money demand function is therefore a critical prerequisite for effective monetary policy formulation. This study using time series quarterly data for Zimbabwe over the sample period 1980:1 to 1990:4 investigated the rationale for including either foreign interest rates (three months (LIBOR) or expected exchange rate or both (proxying for international capital mobility) in Zimbabwe’s money demand function in order to achieve structural stability and hence an appropriately specified money demand function. A key innovation was the inclusion of foreign interest rates and expected exchange rate in Zimbabwe’s money demand function in order to capture the openness of the economy. The monetarist view, Keynesian view and the structuralist view of price stability formed the core of the literature review.

Utilizing the multivariate cointegration approach, the study applied the error correction model as the main tool of analysis. Selection of the suitable variables that entered the estimating equation used the Vector Auto Regression (VAR) procedure. The model was estimated by Ordinary Least Squares (OLS). The results showed that it was the expected exchange rate that entered the estimated equation for Zimbabwe’s money demand function more appropriately than the foreign interest rate. This approach yielded a predicted path of M1 velocity that closely matched the data. The results further indicated that there was cointegration among the variables in Zimbabwe’s money demand function. The applied tests supported the stability of the estimated model.

INTRODUCTION

Empirical evidence by researchers (Engle and Granger (1987), Hoffman and Rasche (1989), Johansen and Jesulius (1990), Dickey, D., D. W. Jansen, and D. L. Thornton (1991), Miller (1991), Hafer and Jansen (1191), Bab, Hendry, and Starr (1992), Ball (2001), and Choi (2003), as cited by Kasibhatle et al (2005)on money demand functions of both the developed and developing economies has demonstrated that coherent and robust models of the money demand function play a very important role in understanding the transmission mechanism of monetary policy. Broadly, the models are critical in macro-economic analysis. The Zimbabwean economy
however, has over the sample period (1980:1 to 1990:4), operated under a variety of policy constraints which include quantitative or restrictive trade practices, exchange control regulations, incomes and price controls, ceilings on certain selected interests rates.

Under these conditions, it is not unreasonable to deduce that the effectiveness of the transmission mechanism of monetary policy could accordingly be weakened. Despite the problems prevalent in developing economies, it was argued that monetary policy could still play a very important part in mobilizing savings for investment purposes as well as promoting to a great extent (Kasibhatla et al 2005) financial stability which in turn could serve as a sound basis for the development of reasonably efficient financial and capital markets.

Since the stability of money demand function is a pre-requisite (Bahmani-Oskooee et al 2005) for effective monetary policy, the researcher’s aim in this exercise was to investigate and establish whether the demand for money function for Zimbabwe was stable. The rationale for this assertion derives from the widely accepted conclusions of the empirically tested conventional theories (Sriram 2001) of money demand in developed economies which state that in order to predict meaningfully the impact of money supply changes on output and prices, the underlying money demand relationship must be temporarily stable. The investigation considered which of the two monetary aggregates used in Zimbabwe during the forecast period (MI which is narrow money comprising of notes and coin in circulation and demand deposits; M2 which is broad money comprising MI plus savings and fixed deposits) models a stable money demand function for policy purposes.

**HYPOTHESIS**

The researcher’s hypothesis was expressed as follows:

**HI: The Reserve Bank of Zimbabwe’s rigid monetary policy stance has been the major antidote against inflationary pressures over the ten-year period between 1980 – 1990.**

**Ho: The Reserve Bank of Zimbabwe’s rigid monetary policy stance has not been influential enough to stem creeping inflationary pressures over the ten-year period between 1980 – 1990.**

The two important test statistics that were applied to prove our hypothesis for cointegration were represented by the Cointegrating Regression Durbin Watson (CRDW) statistic and the Augmented Dickey-Fuller statistic (ADF). For CRDW we were testing the null hypothesis of Ho:DW = 0 against the null hypothesis of HI:CRDW>0. The null hypothesis of non-cointegration is Ho:p = 1. CRDW approaches zero if the cointegration residuals contain an autoregression unit root. On the other hand, the CRDW rejects the null hypothesis of non-cointegration if the CRDW statistic is significantly greater than zero.

The regression to test for cointegration in the series takes the form: $Y_t = \beta + BX_t + Z_t$, whereas the regression to test whether the cointegrating residuals are $I(0)$ takes the form: $Z_t = Y_t - \hat{\alpha} - X_t$.

**OBJECTIVES**

The objective of this study was to establish whether Zimbabwe’s Money Demand Function was correctly specified and therefore structurally stable. The transmission mechanism of monetary policy operates smoothly when this is the case since it yields spin-off results that positively impact upon the whole economy.
LITERATURE REVIEW

THEORETICAL CONTEXT

The monetarist view, Keynesian view (Leeson, R. (Ed.) (2003) and the structuralist view of price stability formed the core of literature review and therefore informed the whole research study.

FOUNDING THEORIES

This study borrows from three main founding theories viz:

1. Monetarist view from the monetarist School led by Friedman M. This school holds the view that inflation is wholly a monetary phenomenon. Friedman’s famous quote reads “Inflation is always and everywhere a monetary phenomenon”. Monetarists argue that if the Money Supply rises faster than the rate of growth of national income then there will be inflation. The following equation attributed to Fisher captures the above statement by M. Friedman:

\[
MV = PT
\]

\[M = \text{Money supply, } V = \text{Velocity of circulation, } P = \text{price level and } T = \text{Transactions}\]

\[T\] is difficult to measure so \(t\) is often substituted for \(Y = \text{National Income}\) therefore \(MV = PY\) where \(Y = \text{national output}\).

2. Keynesian view – Keynesians believe that the level of real GDP depends on aggregate demand (AD) expressed as \(C + I + G + X - M\) where \(C = \text{consumption; } I = \text{investment; } G = \text{Government; } X = \text{exports and } M = \text{Imports}\). Keynesians argue that inflationary pressures can be tamed through deliberate manipulation of government expenditures (Tuck Cheong Tang, 2004) to shore up consumption expenditure and hence government bodies and parastatals production units.

3. Structuralist view – Structuralists hold that the transmission mechanism of monetary policy is blunted by the existence of distortions /structural rigidities prevalent in most economies of the less developed countries. These bottlenecks prevent the smooth implementation of carefully conceived policies.

Surveyed literature suggested that the Reserve Bank of Zimbabwe macro model appeared to omit two of the most important interest rate transmission channels i.e:

(a) that via wealth effects , and hence domestic asset prices proxied by a fixed exchange rate regime

(b) That via expectations proxied by an ever changing basket of consumer goods (CPI). As a result it was difficult to settle for a well informed view of the size and dynamics of the effects of monetary policy in Zimbabwe. It also appeared that the models did not pay sufficient attention to the consequences of regime shifts e.g financial liberalisation . Such defects could lead to costly macroeconomic policy failures as was experienced in the UK in the late 1980s and early 1990s.

This paper estimated the stability of the money demand function for Zimbabwe.

MANAGING INFLATION EXPECTATIONS

Bernanke (2006) observed that the key to explaining why price stability promotes stability in both output and employment is the realisation that, when inflation itself is well – controlled, then the public’s expectations of inflation will be low and stable.

If people believe that inflation is low and that it will remain so, interest rates can also be kept low providing stimulus for both
economic growth and employment. This will yield an environment that promotes the modelling of a structurally stable Money Demand Function For Zimbabwe.

INSTRUMENTS OR TOOLS OF MONETARY POLICY THAT WERE IN USE DURING THE PERIOD (1980 -1990)

These were:-
1. Open Market Operations (OMO) – employed but not extensively
2. Bank Rate – Not used on a large scale as a technique - only changed twice, once in 1981 from 4.50 to 9.00 and in 1990 from 9.00 to 10.25 hence lacked information as a useful variable.
3. Rescue and liquid Asset Ratios – Most favoured instrument particularly the liquid asset ratios. - took the form of quantitative controls and they usually limited the bank’s ability to create credit.
4. Direct Lending Controls – seldom used
5. Moral Suasion – Has been effectively and successfully used especially as a substitute for direct quantitative controls.

MONETARY POLICY REGIMES BETWEEN 1980 - 1990

• During the period 1981 – 1991 the monetary authorities adopted Restrictive Monetary Policies which saw the Bank Rate being increased from 4.5 to 9.00 percentage points (Applied liquid asset ratios, with quantitative ceilings on interest rates and credit).
• From 1982 – 1983 there was monetary expansion containment through the minimum liquid asset ratio which was lowered from 35.5 to 30.%
• In 1984 – The RBZ focus centered around the acquisition of the external securities pool of funds which were regarded as savings. Once again monetary policy thrust was largely restrictive in order to reduce inflationary pressures.
• 1985 - 86 – The RBZ applied the policy of controlled monetary expansion utilising open market operations (OMO); changing hire purchase terms and moral suasion.
• 1987 – 1990 – The RBZ pursued contractionary monetary policy in order to counter inflationary pressures

CRITICISMS OF MONETARISM

• Not all measures of the Monetary Supply M0 M2 M4 move at the same rate . The money supply growth depends on which measure is used.
• Evidence in the 1980s showed that the money supply could grow much faster than the price level suggesting the link was not very close.
• The velocity of Circulation V is not stable, but can change due to factors such as increase in the use of credit cards.
• The increase in borrowing has led to an increase in M4 as more people can save money in time deposit accounts. More cash machines has meant that there has been an increase in M4.
• Monetarists say that income can vary in the short run, but the short run could be a long time and therefore make monetary policy ineffective .Keynesians Long-Run Aggregate Supply (LRAS) is not necessarily inelastic, they argue that the economy can be below full capacity for a long time.

METHODOLOGY

Utilizing the multivariate cointegration approach, (Kasibhatle et al 2005) the study applied the economic procedure called the Error Correction Model (ECM) as the main tool of analysis. This approach utilized the co-integration technique which involves a search for the existence of unit roots in the log of a variable, then determine stationarity in the residuals of the differenced variables of the dynamic form of the short-run
equation. The ECM specifies models in both levels and differences and is compatible with long-run information due to the utilization of differenced data only. This specification allows explicit division of effects into long-run influences and short-run adjustments. Selection of the suitable variables that enter the estimating equation used the Vector Auto Regression (VAR) procedure. The model was estimated by Ordinary Least Squares (OLS). The results showed that it was the expected exchange rate that entered the estimated equation for Zimbabwe’s money demand function more appropriately than the foreign interest rate which yielded perverse positive estimated coefficients and thus defy the widely held negative relationship between real money demand and interest rates.

RESEARCH DESIGN
The quasi-experimental design of the time series nature was chosen to approximate the causal influence of the selected independent variables against the dependent money supply variable. This design was preferred over the experimental designs mainly because it has been found to be less exacting in its requirements and yet achieving similar levels of scientific rigour (Claire Bless et al, 2007). The adoption of the time series design allowed the researcher to observe the effects of history through an analysis of the relationships between the selected variables.

SAMPLE
The study used secondary time series monetary based Quarterly data for Zimbabwe from the Reserve Bank of Zimbabwe (RBZ); the Central Statistical Office (CSO); foreign interest rates (RBZ) and the London Interbank Offered Rates (LIBOR) from the IFS over the period 1980:1 to 1990:4.

DATA COLLECTION PROCEDURE
Statistical data was extracted from various secondary sources published by the Reserve Bank of Zimbabwe (RBZ), Central Statistical Office (CSO) and the International Financial Statistics (IFS).

SELECTION OF THE ESTIMATING VARIABLES
Selection of the suitable variables that entered the estimating equation used the Vector Auto Regression (VAR) procedure. Specifically a selection was made of the most suitable among the three Gross Domestic Products compiled in Zimbabwe (GDPI = Gross Domestic Product at Factor Cost; GDP2 = Gross Domestic Product at Market Prices; and GDP3 = Gross Domestic Product at Constant Prices). GDP annual data series were transformed into Quarterly series. The price level was proxied by either Lower Income Price Index (CPI) or the Higher Income Price Index (CPI2).

For interest rates, the researcher employed both selected domestic interest rates and foreign interest rates (London Interbank Offered Rates = LIBOR). Domestic interest rates included three-months treasury bill rate (tbt), five-year interest on government stock (int5), ten-year interest on government stock (int20). The foreign interest rates included three months LIBOR rates (W1), six-months LIBOR (W2) and one-year LIBOR (W3). Interest rates proxied for the opportunity cost of holding either money balances or other assets.

The researcher also introduced into the estimating equations an exchange rate variable (exe) which took account of the openness of the economy and capital mobility as residents of Zimbabweans may choose to hold their wealth in foreign currency or foreign physical assets. Foreign exchange rates are middle rates (foreign currency units per Zimbabwe dollar for spot transactions) and in this case it was the U.S. dollar exchange rate vis-à-vis the Zimbabwe dollar quoted. Zimbabwe used a basket of currencies of its major trading partners with
the U.S. dollar serving as the intervention currency.

Both the monetary variables (MI and M2) and two income variables (GDP1, GDP2) were in nominal terms expressed in millions of Zimbabwe dollars and were deflated by the respective Consumer Price Index (CP1 and CP2). Domestic interest rates were expressed in nominal terms. The justification for inclusion of each representative variable into the estimating equation was based on recommendations by researchers who have empirically investigated the wisdom of employing one variable as opposed to other variables in the money demand functions of less developed economies.

ESTIMATING EQUATIONS

EMPIRICAL RESULTS

Empirical Results for Zimbabwe’s Money Demand Function using Quarterly Data for the Period 1980:1 to 1990:4

<table>
<thead>
<tr>
<th>Dependant Variable</th>
<th>Equation (1) log (M/Pt)</th>
<th>Equation (2) Δ log (M/Pt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.444</td>
<td>0.986</td>
</tr>
<tr>
<td>CRDW</td>
<td>1.405</td>
<td>2.348</td>
</tr>
<tr>
<td>ADF</td>
<td>-5.862</td>
<td>-7.201</td>
</tr>
<tr>
<td>LM:AR/MA1</td>
<td></td>
<td>2.544</td>
</tr>
<tr>
<td>LM:AR/MA2</td>
<td></td>
<td>2.007</td>
</tr>
<tr>
<td>LM:AR/MA3</td>
<td></td>
<td>7.229</td>
</tr>
<tr>
<td>LM:AR/MA4</td>
<td></td>
<td>9.351</td>
</tr>
<tr>
<td>Chow</td>
<td></td>
<td>0.847</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td>39.627</td>
</tr>
<tr>
<td>C</td>
<td>0.239</td>
<td>-0.350</td>
</tr>
<tr>
<td></td>
<td>(0.171)</td>
<td>(-1.785)</td>
</tr>
<tr>
<td>logEt</td>
<td>0.023</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(1.282)</td>
</tr>
<tr>
<td>logrt</td>
<td>-0.316</td>
<td>-0.200</td>
</tr>
<tr>
<td></td>
<td>(-2.473)</td>
<td>(-9.010)</td>
</tr>
<tr>
<td>logEt</td>
<td>0.022</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>(0.082)</td>
<td>(1.070)</td>
</tr>
<tr>
<td>Log (M/P)t-4</td>
<td></td>
<td>-0.930</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-35.669)</td>
</tr>
<tr>
<td>Residuals</td>
<td>-0.059</td>
<td>(-2.111)</td>
</tr>
</tbody>
</table>

The method of estimation involved the Ordinary Least Squares (OLS). The two estimating equations were laid out as follows:

\[(1) \log(M/P_t) = a_0 + a_1 \frac{Y}{P_t} + a_2 \log \pi_t + a_3 \log \eta_t + a_4 \log E_t + \varepsilon_t \]

The above is the long-run equation. The dynamic or short-run equation is expressed as follows:

\[(2) \Delta \log(M/P_t) = a_0 + a_1 \Delta \log(Y/P_t) + a_2 \Delta \log \pi_t + a_3 \Delta \log \eta_t + a_4 \Delta \log E_t + a_5 \Delta \log(M/P)_{t-1} + \varepsilon_t \]

Where:
- \( (M/P_t) \) = real money balances
- \( (Y/P_t) \) = real income
- \( \pi_t \) = price level
- \( \eta_t \) = interest rate
- \( E_t \) = exchange rate
- \( \varepsilon_t \) = error term (tending to white noise)
Critical values are in respect of Durbin Watson (CRDW), Augmented Dickey Fuller (ADF), Lagrange Multiplier (LM), Chow and the White tests. The t values are in parenthesis below the coefficients.

ANALYSIS OF RESULTS

Empirical results generated a CRDW statistic of 1.405. The CRDW is significantly greater than zero and therefore rejects the null hypothesis of non co-integration.

Examining the ADF statistic for the significance of the cointegrating residuals which ensures that the error term is a close approximation to white noise, we got a large critical value of -5.862 while the relevant t-statistics recorded the real income variable at 3.696 and interest rate at -2.473 (see Table) thus implying that the real income and interest rate variables are strongly cointegrated with the real money variable (M1 = narrow money). For real income this represented a 99% level of significance, while interest rate recorded also a 99% significance level. This indicated that both real income and interest rate had powerful explanatory influence on the level of real money balances that wealth holders might have preferred to hold. The result also confirmed cointegration of the estimated money demand function. The result suggested that the regression residuals were stationary and therefore were 1(0).

The price level and the expected exchange rate variable did not enter the long-run estimating equation significantly thus implying low influence of these variables on the real money demand variables. The respective t-values for the price level and the expected exchange rate were 0.086 and 0.082 (see Table). All the explanatory variables were, however, correctly signed. A clearer picture of the stationarity of the residuals in the error term, however, emerges from the results of the estimated ECM specification due to Engle and Granger (1987) as cited by Kasibhatle et al (2005), dynamic model and it is to these results that the researcher now turns for analysis.

The CRDW statistic for first order serial correlation was not applied since the dynamic model had a lagged dependent variable on the right hand side of the equation. Employing the CRDW statistic under these circumstances would result in biased results. The ADF test registers a large critical value of -7.201 thus indicating cointegration of the short-run dynamic model. The same variables estimated for the long-run model were retained in this dynamic model solely because they had been found to perform better. The respective coefficients of elasticity on the explanatory variables were 0.951, 0.047, -0.2 and 0.041 for real income, price, interest rate and the expected exchange rate respectively. Once more all the coefficients were correctly signed.

The important test statistics for stationarity were the t-ratios. The t-values for the explanatory variables were price level 1.282, interest rate -9.010 and expected exchange rate 1.07. Real income and interest rate were significant implying that these variables exerted a greater impact on real money demand than did prices and the exchange rate, both of which did not enter the estimating equation quite significantly.

A logical conclusion that could be drawn from the significance of the interest rate was that Zimbabwe had long-run interest rate effects, which suggested that this could be the correct variable to represent the opportunity cost of holding money balances. The high recorded value of R2 (0.986) suggested that the estimated model is the correct one since serial correlation in the errors had been eliminated from the dynamic model.

The DW statistic at 2.348 was high enough to show that there was no serial correlation in the errors. However, as already stated, this statistic could produce biased results due to the existence of a lagged dependent variable on the right hand side of the equation.
The Chow test was used to determine the structural stability of the money demand function for Zimbabwe. In applying the test, the researcher was well aware of a number of shortcomings associated with the Chow test which include the fact that the test tends to be quite sensitive to the presence of serial correlation and to a high degree of multicollinearity among the regressors. Secondly, the test, a priori, requires the regression error-variances of the two examined sub-samples to be equal (homoscedastic).

Thirdly, the test is questionable in the presence of even moderate heteroscedasticity.

In an attempt to improve the effectiveness of the Chow test, the researcher eliminated serial correlation and higher order autocorrelation up to the fourth differences. The researcher also ensured that the regression error variances of the two examined sub-samples were equal (homoscedastic). Procedurally, the researcher provided additional lags in the dependent and independent variables but without restricting the parameters of the equation. This procedure, although not without its weaknesses, was preferred because it did not imply a new long-run static equilibrium solution for the money demand function.

Since the researcher was working with quarterly data, the researcher had to ensure that higher order autoregressive process up to the fourth level was accounted for. The researcher applied the Lagrange Multiplier test (LM) which is a general test for mis-specification. The LM test has a clear advantage over the DW test in that the LM test is a robust test and tests against the general autoregressive and moving average serial correlation processes. The White (1980) test for general forms of heteroscedasticity was applied in order to supplement evidence of absence of heteroscedasticity.

**SUMMARY**

Researchers into LCDs money demand functions have argued that because of the under-developed nature of financial and capital markets in these economies, and the inadequacy or unavailability of attractive money substitutes, either foreign interest rates, expected inflation, expected exchange rate or both, could be used to proxy for the opportunity cost of holding money. Technological change should also be taken into account when specifying a money demand function in those countries where money substitutes were prevalent due to financial innovation. The suggestions have been borne out by the researcher’s findings in the Zimbabwean case study.

Quarterly data was used over the sample period 1980:1 to 1990:4 for Zimbabwe. Data on GDP was transformed from annual to quarterly series. The sources of data included the Reserve Bank of Zimbabwe (RBZ) Quarterly Economic and Statistical Review (various issues), the Central Statistical Office (CSO) Quarterly Digest of Statistics (various issues), and the International Financial Statistics (IFS). The cointegration approach and the Error Correction Mechanism or model (ECM) were used for analysis. The method of estimation involved the Ordinary Least Squares (OLS). The procedure involved vector autoregression (VAR). Cointegration testing for the long-run equation followed, then residuals were carried forward into the dynamic model for differencing in levels in order to achieve stationarity of these residuals in the error term.

The result was a correctly specified and hence structurally stable narrow money demand function for Zimbabwe. The Chow test for stability registered a level of significance between absence of this problem in the errors. The LM test confirmed correct specification by indicating absence of serial correlation and higher forms of autocorrelation (see Table). The augmented
Dickey-Fuller Statistic (ADF) at 7.201 indicated stationarity of residuals in the error term. Narrow Money (MI), Gross Domestic Product at Factor Cost (GDP1) Lower Income Consumer Price Index (CPI) and expected exchange rate were the cointegrated data series. The long-run, five-year interest on government stock was found more appropriate to proxy the opportunity cost of holding money than the foreign interest rates (LIBOR). Real income and interest rates have a greater influence on real money balances than prices and expected exchange rate although the latter were important variables that should also have entered the narrow money demand function for Zimbabwe. The results showed that real income, prices and the expected exchange rate exerted positive influences on real money holdings, while interest rate exerted negative influence on real money balances.

CONCLUSION

In this empirical study on the stability of Zimbabwe’s money demand function applying cointegration and ECM techniques, evidence of cointegration and stationarity in both the long-run and the short-run dynamic models has been fully established. This suggests correct specification of parameters and hence structural stability in Zimbabwe’s money demand function using selected variables already mentioned in the paper.

RECOMMENDATIONS

Moving to policy issues, in situations where monetary policy thrust is aimed at stabilizing the economy by counteracting the impact of external shocks upon the domestic economy, the monetary authorities must seriously consider the possible response of domestic money demand to these external pressures. From an individual point of view the result proved that although restricted by exchange control regulations the people of Zimbabwe did regard foreign exchange holdings as an attractive alternative to holding domestic money balances. This point has now been confirmed by the introduction of individual FCAs. The stability evidence obtained suggests that the Zimbabwe authorities can utilize this money demand function to design appropriate monetary policies. The error correction model and the cointegration technique could be utilized in estimating the Zimbabwe money demand function.

AREAS FOR FURTHER STUDIES

Areas for further studies could include carrying out further tests of stability to complement the Chow test. The Farley and Hinich test and Gupta test are examples of such tests. Out of sample forecasts and simulations could be carried out to see how variables behave in different conditions for effective policy determination. Future research could also utilize the cost of Production Index to proxy for the expected inflation rate instead of the Consumer Price Index. An in-depth investigation involving broad money (M3) and the other instrumental variables needs to be undertaken in order to determine the impact of inflation on Zimbabwe’s money demand function.

THE AREAS FOR FURTHER RESEARCH, IN BRIEF, INCLUDE:

- Trying out various definitions of monetary aggregates.
- Simulation of money demand equations in Zimbabwe using estimated parameters.
- Forecasting of money demand equation in Zimbabwe using estimated coefficients.
REFERENCES


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