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1. INTRODUCTION

Monetary economics provides one of the important tools, that is monetary policy, to deal with the macroeconomic problems of the economy. It is concerned with the supply of money and the demand for money. It is often assumed that the money supply is exogenously determined by the authorities and the demand for real money is determined by the market. The demand for money is of crucial importance in the conduct of monetary policy. It helps to understand macroeconomic activities and to prescribe appropriate policy instruments to deal with macroeconomic problems. The effectiveness of the monetary policy, however, depends on the shape and stability of the estimated demand for money function.

Empirical studies of the money demand in Pakistan concentrated on the estimation of aggregate money demand function by using conventional regression analysis. The main criticism against the aggregate models of the money demand is that these models lumped two different sectors of the economy, such as the household sector and the business sector. Further, it is argued that these two sectors have diversified behaviour. Their money demand behaviour is subject to different requirements. Sectoral money demand behaviour is thoroughly investigated in developed counties but a very thin literature on the estimation of money demand function by the business sector in developing countries is available, for example, Unger and Zilberfarb (1980) and Cameron and Qayyum (1994).

Econometric methodology of these studies is mainly concerned with the estimation of two types of money demand functions such as long-run static and short-run partial adjustment mechanism. However, the researchers employing the technique of cointegration in the empirical testing of money demand function have cast serious doubt on the results of these studies. This is because the underlying assumption in the conventional regression analysis is that the time series data are stationary whereas most macroeconomic series, such as money supply, prices and income etc., are nonstationary. Due to this property of data the conventional test

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statistics, that is, R^2, t, F and DW statistic, remain no longer standard [Phillips (1986)] and therefore cannot be used to make inference on the estimated parameters of interest. Cointegration analysis resolves these problems by providing consistent estimates of parameters, irrespective of the presence of conventional problems of serial correlation, multicolinearity and simultaneity [Stock (1987)].

Considering the importance of the business sector in the economy, nearly non existence of empirical studies on the demand for real money balances by the business sector and the role of cointegration technique in the time series analysis, it is decided to investigate the money demand behaviour of the business sector in Pakistan.

2. ECONOMETRIC MODEL OF THE MONEY DEMAND

Theories of the business money demand states that business sector reacts to different variables then the household sector (for example, Friedman's quantity theory and Baumol-Tobin's inventory theoretic model). At least the household money demand functions and the business money demand functions do not have same scale variable. In addition, it is argued, that sales are one of the most appropriate scale variable for the business sector. Further, the short-term rate of interest is most relevant opportunity cost variable for the business sector money demand. It is also proposed that the rate of interest on bank advances is important in determining the business money demand behaviour [Friedman (1987)]. Only the rate of inflation is common variable between the two sectors. The theories of money demand postulate that the scale variable has positive effect and opportunity cost variables have negative effect on the real money balances demand. In functional form the demand for real money balances can be written as;

$$RM1B_t = f(RS_t, r_t, \pi, D_t, \varepsilon_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where

$RMDB_t$ = Real money (M1) demand by the business sector.

RS_t = Real sales.

r_t = The vector of interest rates, for example, call money rate, yield on long-term government bonds and interest on bank advances.

π = Measured rate of inflation (i.e., percentage change in the log of consumer price index (1985=100).

D_t = Seasonal dummies.

ε_t = random error term assumed to be independent and identically distributed (iid).

Let us suppose that the individual time series data are non-stationary. Further assume that the variables of the real money demand and its determinants are cointegrated. If these conditions are held, the dynamic money demand model can be represented by the error correction mechanism.[1] Following Johansen (1988) and Johansen and Juselius (1990), the dynamic error correction money demand function is thus approached through the process of Autoregressive Distributed Lag (ADL). Therefore, from the above function (1) the following ADL formulation could be achieved.

$$X_t = \sum_{i=1}^{k} \Pi_i X_{t-1} + \mu_t + \Phi D_t + \varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

Where X_t is a vector of variables included in the model, μ_t is constant term, D_t is a vector of dummy variables and ε_t is *iid* (0, Λ) disturbance term. From this model, using $\Delta=1-L$, where L is the lag operator, we can deduce the following dynamic error correction model of the real money demand

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu_t + \Phi D_i + \varepsilon_t \qquad \ldots \qquad (3)$$

where

$$\Gamma_i = -I + \Pi_1 + \ldots\ldots + \Pi_i, \quad i = 1, 2, ... k \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

and

$$\Pi = -I + \Pi_1 + \ldots + \Pi_k \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

This model includes variables both in levels and in differences. If the individual series have unit root at frequency one, that is they are individually I(1), then first difference of the series are stationary. Moreover, if there is a cointegrating relationship between I(1) variables then the linear combination of these variables is I(0). It means that $\Pi_i X_t$ term is stationary. Thus all the variables in the model are stationary. Therefore, this equation can be estimated with the ordinary least square method[2] [Granger and Lee (1989)]. The error correction model captures the short-run dynamics of the demand for money. If the objective is to investigate the cointegrating vectors and the long-run relationship among the variables of real money demand and its determinants, then the analysis of the matrix Π of Equation (3) is crucial. It contains all the relevant information. For example, if matrix Π has full rank called p, then (X_t) is a stationary process. On the other hand, if the matrix of

[1]The relationship between the cointegration and the error correction mechanism is proved in the Granger representation theorem [Engle and Granger (1987)].

[2]Moreover, Banerjee *et al.* (1990) show that Instrumental Variable method and OLS yield same estimates. For similar results, see also Wickens and Bruesch (1988).

Π has zero rank, then (X_t) is first order autoregressive process. This implies that there is no long-run information in the data. Moreover, if rank $(\Pi) = r$, where $0 < r < p$, there exists r cointegrating relationships among the variables.[3] The other p-r linear combinations of the variables act as common stochastic trends. So in this case the long-run matrix can be factorised as $p \times r$ matrices of α and β of the form $\Pi = \alpha\beta'$. In the presence of the cointegration relationship, the vector β has the property that $\beta' X_t$ is stationary, though X_t itself is nonstationary. The vector α contains the loading vector, the elements of which weight each cointegrating relationship in each of the p equations of the system. The expected sing of the error correction parameter is negative. It gives the speed of adjustment towards the state of equilibrium.

The estimation of the error correction model (that is, Equation 3) and test of its stability are the main objectives of the study. To reach the final version of the dynamic model of the money demand, there are some questions that must be solved as a prerequisite. These relate to the unit root analysis and the multivariate cointegration relationship. The coexistence of unit roots in the series and cointegrating relationship among the set of variables give strong support to an error correction mechanism as a dynamic specification of money demand. Therefore, the term ΠX_{t-k} in Equation 3 needs some more elaboration. Suppose that

$$\Pi X_{t-k} = M_t - \beta_i Z_t = ECM_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

where M_t and Z_t are integrated series, I(1). If these series are cointegrated, then ECM_t is I(0). In this situation, the vector β_i are the parameters of the long-run cointegrating relationship between the real money demand and its determinants. The knowledge about the cointegrating vector is vital before estimating Equation 3, because if β is known, the error correction model (i.e., Equation 3) would be estimated by ordinary least squares. Fortunately, it is already proved by Engle and Granger (1987) that if the super consistent estimates of β such as $\hat{\beta}$ from the cointegrating regression is used, then the remaining coefficients will be estimated as efficiently asymptotically as if β were known *a priori*.

3. ECONOMETRIC METHODOLOGY

In the preceding section dynamic model of real money demand by the business sectors are also discussed. To estimate the final version of the error correction model we apply the following three step methodology is being adopted.

Step I: Univariate Analysis

[3]It, that is r, can be said: (1) the number of cointegrating vectors, (2) the rank of Π, (3) the number of columns of α, (4) the number of columns in β, and (5) the number of nonzero canonical correlations between the elements of ΔY_t and the elements of Y_{t-1} [Dickey and Rossana (1994)].

In this study, at first stage, we test whether a time series is a stationary, a random walk, a random walk with drift, or trend stationary. There are different techniques that are available to test the hypothesis of stationarity of the data. To test the presence of unit root in a univariate time series we applied the augmented Dickey and Fuller (1979, 1981) test. Consider the ADF regression equation

$$\Delta y_t = \alpha + \beta_t + \rho y_{t-1} + \sum_{t=1}^{n} \lambda_i \Delta y_t + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (6)$$

$$\text{for } i = 0, 1, 2, \ldots\ldots\ldots, n$$

where y_t is any time series to be tested for unit roots, t is time trend and ε_t is white noise error term. In the case $i = 0$, then it is simple Dickey and Fuller (1979, 1981) test.[4] First we test the hypothesis that $\rho = 0$ in equation 6 by precise critical t-values of MacKinnon (1991).

Step II: Multivariate Cointegration Analysis

The second and important step of the methodology deals with the theory of cointegration. This stage starts with the testing of hypothesis of no cointegration between the real money demand and its determinants. To analyse the prospects of the existence of cointegrating relationship between the variables of real money balances demand and its determinants by applying the Johansen (1988) maximum likelihood method.

The main hypothesis to be considered is that there exists 'r' cointegrating vector(s). The inference on the 'r' of the system can be conducted through the method of likelihood ratio (LR) test. The null hypothesis of

$$H_{0(r)} : rank\ (\prod) \leq r \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (7)$$

is tested against the unrestricted alternative of

$$H_{1(r)} : rank\ (\prod) = p \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (8)$$

by the trace statistic. Similarly, the validity of $H_{0(r)}$ against the alternative of $H_{0(r+1)}$ can be tested by looking at the maximal eigenvalue statistic.[5] The likelihood ratio (LR) test statistic for the hypothesis that there are at most 'r' cointegrating vector is:

$$-2lnQ = T \sum_{i=r+1}^{N} ln(1 - \hat{\lambda}_i) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (9)$$

[4]Banerjee *et al.* (1993) says that the lag structure in the ADF tests is *ad hoc*, it seems safest to over-specify the ADF regression.

[5]Johansen and Juselius (1990) suggests that the maximal eigenvalue test has greater power than the Trace test.

where $\hat{\lambda}_{r+1}.....\hat{\lambda}_N$ are $N–r$ smallest canonical correlations. It is proved by Johansen (1988) that these statistics are asymptotically distributed as χ^2 with $r(p–r)$ degrees of freedom. The precise relevant critical values calculated by Osterwald-Lenum (1992).

Likelihood Ratio (LR) test is used to test the significance of the estimated parameters is tested. The hypothesis of long-run money-income proportionality is also be tested by LR test.

Step III: Short-run Dynamic Money Demand Function

This step involves the estimation of the parsimonious, dynamic demand for real money balances function by employing the general to specific methodology. The results from the previous two steps are important in the estimation of this model. Step I indicates the variables that must be differenced to achieve stationarity. These integrated variables are subject to inclusion in the Step II, which provides the estimates of the long-run money demand function. It also dictates the variables that are placed in the error correction term, that is, $\Pi_i X_{t–k}$. If these variables are found to be cointegrated, then the combination of the integrated I(1) variables is stationary I(0). Therefore, the residual term, called error correction term, is stationary.

The estimation starts with the unrestricted general model. In which every variable enters with a lag length of four quarters. As all the variables in the model are stationary, this function can be estimated by OLS. The preferred money demand function would pass following diagnostic tests.

To test the hypothesis of no serial correlation in the residual term Brush and Godfrey (1981) version of Lagrange Multiplier (LM) test is applied. Functional form misspecification is tested through Ramsey (1969, 1970) RESET test. Jarque and Bera (1980) test of normality is used to test the normality of the residual term. To test the structural stability of the estimated model Chow's (1960) first test is used. The Chow's (1960) second test is used as predictive failure test. In order to check forecasting ability of the estimated functions we also compare the estimated values with the actual values. For good predictive performance these two series are expected to be fairly close to each other. The accuracy of predictions is also judged by using root mean square predictive errors (RMSE).[6]

4. DATA AND ITS LIMITATION

The published quarterly series of M1, seasonally adjusted, the call money rate (r_c) and the yield on government bonds (r_b) are taken from the different monthly issues of International Financial Statistics (IFS) for the period 1960:1 to 1991:2. The

[6]There are other measures of forecasting accuracy are available, such as mean square errors (MSE), mean absolute error (MAE), root mean square percentage error (RMSPE), etc.

quarterly series of the consumer price index (1985 = 100) and the wholesale price index (1985 =100) are also taken from IFS (various issues) and make consistent by splicing method. The data for the wholesale price index is not available before the fourth quarter of 1961. are also taken from IFS. The interest rate on saving deposits (r_s) and interest rate on the bank advances (r_a) are from the Bulletin-State Bank of Pakistan (various issues).

The time series of sales are not available quarterly. The annual series of sales are taken from annual reports of IFS (various issues) and the Economic Survey (various issues). Then the quarterly series are interpolated by the method used by Qayyum (1995).

5. TEST OF INTEGRATION

Data generation process of individual series is investigated by ADF test. The results are presented in Table 1. These results show that all variables are I(1) in their levels and I(0) in the first difference at the 5 percent level of significance. To confirm this finding of I(1) variables, the ADF test is also performed on the first difference of the data. The results are also reported in Table 1. The calculated *t*-statistics show that except for the consumer price index (1985 = 100) the estimated parameter ρ for all other variables are not significantly different from zero at the five percent level. The results lead us to conclude that the consumer price index is integrated of order two, I(2). All other series, however, are I(1).

Table 1

The ADF Test for Unit Roots: Quarterly Times Series of Monetary Aggregates

Name of Variables	Lag Length	τ_t-ratio	Name of Variables	Lag Length	τ_t-ratio
LM1	(0)	–2.62	ΔLM1	(0)	–13.02
RBM1	(4)	–2.46	ΔRBM1	(4)	–3.77
LSAL	(4)	–2.58	ΔLSAL	(7)	–4.22
RSAL	(3)	–2.72	ΔRSAL	(4)	–5.96
LCPI	(2)	–2.38	π	(3)	–3.19
π	(3)	–3.19	Δπ	(2)	–10.20
LWPI	(4)	–1.95	ΔLWPI	(3)	–4.04
r_c	(2)	–2.10	Δr_c	(1)	–11.70
r_s	(0)	–1.63	Δr_s	(0)	–10.85

r_a	(0)	–1.44	Δr_a	(0)	–9.54
r_b	(1)	–2.14	Δr_b	(1)	–11.10

Note: The 5 percent rejection region for the test is:
ADF τ_t < – 3.44 [Mackinnon (1991)].

The univariate analysis supports the hypothesis that macroeconomic time series in Pakistan are not stationary in their level. Most of the series require first differencing to become stationary. It implies that the implicit assumption about the stationarity of data maintained in the econometric investigation of different macroeconomic relationship in Pakistan was not true.

6. COINTEGRATION ANALYSIS OF DEMAND FOR REAL MONEY BALANCES

The cointegration relationship between the variables—real demand for M1, real sales, and the rate of inflation—is investigated and long run real money balances demand function is estimated. In the cointegration analysis the lag length of VAR at five quarters and three quarterly dummies are used. The hypothesis of no cointegration is tested between the real demand for M1 (RM1B), real sales (RSAL) and the rate of inflation (π). The χ^2 values from likelihood ratio test are reported in Table 2, leading to conclude that there is one cointegrating vector between the variables at the five percent level of significance.

Table 2

Johansen Maximum Likelihood Procedure: LR Tests of Cointegration between the Demand for Real M1 by the Business Sector and its Determinants

Null Hypothesis	Alternative Hypothesis	Maximal Eigenvalue Statistic	Trace Statistic
r = 0	R $\geq$ 1	40.99*	65.85*
r $\leq$ 1	R $\geq$ 2	16.84	24.86
r $\leq$ 2	R $\geq$ 3	7.75	8.02
r $\leq$ 3	R = 4	0.26	0.26

Note: *Shows significant at the 5 percent level .
The variables included in the analysis are: RM1B, RSAL and π.

The estimated long-run cointegrating relationship between the real money demand and its determinants is given in the following (the χ^2 values are presented in parentheses)

$$\widehat{RM1B} = \underset{(6.42)}{0.886}\ RSAL - \underset{(12.57)}{13.087}\ \pi \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

All the estimated parameters are significant at the 5 percent level. Further, the estimated coefficients have signs according to the theoretical expectations. We have tested the money-sales proportionality hypothesis. The calculated χ^2 (1) value is 3.81, which lead us not to reject this hypothesis at the 5 percent level. This implies that the business sector transactions elasticity of real M1 demand is equal to one. This result is not different from the result that is obtained from the aggregate demand for money (M1) function. Furthermore, the significance of the estimated coefficient of the rate of inflation reinforced its importance in determining the long-run demand for real money balances.

The long-run money demand function with unit sale elasticity restriction is estimated. This is given by

$$\widehat{RM1B} = RSAL - 18.60\,\pi \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (11)$$

This result indicates that the rate of inflation is an important determinant of the long run demand for real money balances by the business sector. The finding of this study when compared with aggregate money demand function estimated by Qayyum (1995) indicates the diversification of behaviour of two sectors. In the aggregate money demand function the rate of interest plays significant role while long run business sector's real money balances demand is not determined by the rate of interest. These results are also different from the money (M2) demand behaviour estimated by Cameron and Qayyum (1994). In their study the rate of interest on bank advances play a significant role in the determination of money demand behaviour by the business sector.

7. PREFERRED MODEL OF THE DEMAND FOR REAL MONEY BALANCES

The dynamic model of real money demand (M1) by the business sector is also estimated employing error correction mechanism. The model includes the residual from the long-run cointegrating relationship (Equation 1) as an error correction term (ECM). For the general specification the lag length of four quarters is chosen. This model tested down by deleting non significant variables from it. The estimated parsimonious dynamic error correction function that emerged is (t-ratios are in the parentheses)

$$\begin{aligned}\widehat{\Delta RM1B} = {} & \underset{(6.27)}{0.22} + \underset{(4.73)}{0.08}\,\Delta RSAL - \underset{(-1.87)}{0.10}\,\Delta r_s - \underset{(-3.37)}{0.49}\,\Delta\pi + \underset{(3.33)}{0.27}\,\Delta RM1B(-4) \\ & \underset{(-5.93)}{-0.07}\,ECM(-1) - \underset{(-1.99)}{0.02}\,S1 - \underset{(-4.05)}{0.12}\,S2 \quad \ldots \quad \ldots \quad \ldots \qquad (12)\end{aligned}$$

$R^2 = 0.45 \quad F(7, 104) = 12.33$

The residual passed a battery of diagnostic tests (LM version) at the five percent level. These test statistics lead to accept the hypotheses of no serial correlation [$\chi^2(4) = 2.42$], no functional form misspecification [$\chi^2(1) = 2.99$], normality [$\chi^2(2) = 0.91$], homoscedasticity [χ^2 (1) =3.68] and no ARCH [$\chi^2(1) = 0.59$] in the residual term. Further, the estimated parameters have expected signs.

The restricted version of the dynamic real balances demand function is also estimated. The long-run money-sales proportionality restriction, which is accepted in the previous subsection, is incorporated in the error correction term. (t-ratios are in the parentheses)

$$\widehat{\Delta RM1B} = \underset{(5.19)}{0.10} + \underset{(5.19)}{0.25}\,\Delta RSAL - \underset{(-1.82)}{0.10}\,\Delta r_s - \underset{(-3.43)}{0.47}\,\Delta\pi + \underset{(3.16)}{0.25}\,\Delta RM1B(-4)$$

$$-\underset{(-5.94)}{0.05}\,ECM(-1) + \underset{(4.47)}{0.12}\,S3 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (13)$$

$$R^2 = 0.45 \quad F(6, 106) = 14.62$$

The residual term passed the tests of no serial correlation [$\chi^2(4) = 1.52$], no functional form misspecification [$\chi^2(1) = 1.30$], normality [$\chi^2(2) = 5.34$], homoscedasticity [χ^2 (1) =3.48] and no ARCH [$\chi^2(1) = 0.32$] in the residual term at the predetermined significance level.

The short-run real money balances demand by the business sector is determined by the changes in real sales, the change in the rate of inflation, movement in the rate of interest on saving deposits and the change in the previous quarter's money holdings. It is interesting to note that in the short-run the business sector give importance to the rate of interest in the case of the demand of real M1 balances. The estimated coefficient of the error correction term indicates that the economic agent correct its 5 to 7 percent past errors in the first quarter. It shows that the business sector pays slow response and corrects some of its errors in the next quarter.

The hypothesis of parameter invariance in also tested. The tests of structural stability, such as the Chow (1960) test gives evidence of parameter invariance. As may be seen from Table 3, the tabulated F-values are insignificant at the predetermined five percent level. The evidence supports the hypothesis that the estimated error correction model remained stable throughout the estimation period.

The predictive performance of the estimated models is examined by using Chow (1960) test for the period 1985:3 to 1991:2. The calculated test statistics are $F(24, 80) = 0.38$ for the unrestricted Equation (12) and $F(24, 82) = 0.42$ for the restricted money demand function (13). These statistics indicate that our preferred models do not over or under predict systematically. This conclusion is reinforced when the actual and the estimated values are plotted. We presented the actual and the fitted values of money demand in Figures 1a and 2a, whilst the predicted values of money demand are compared with the actual values in the Figures 1b and 2b. The results are encouraging. No substantial difference is found between them. Moreover, forecasting accuracy is confirmed by RMSE. It is 0.024 and 0.025 for Equations (12) and (13), respectively.

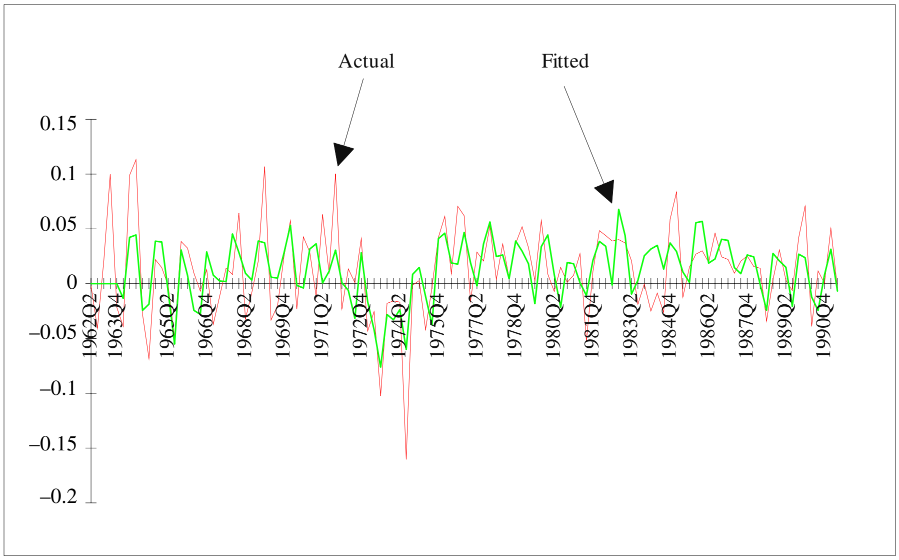

Fig. 1a. Actual and Fitted Values of the Real M1 Demand by the Business Sector (Equation 12).

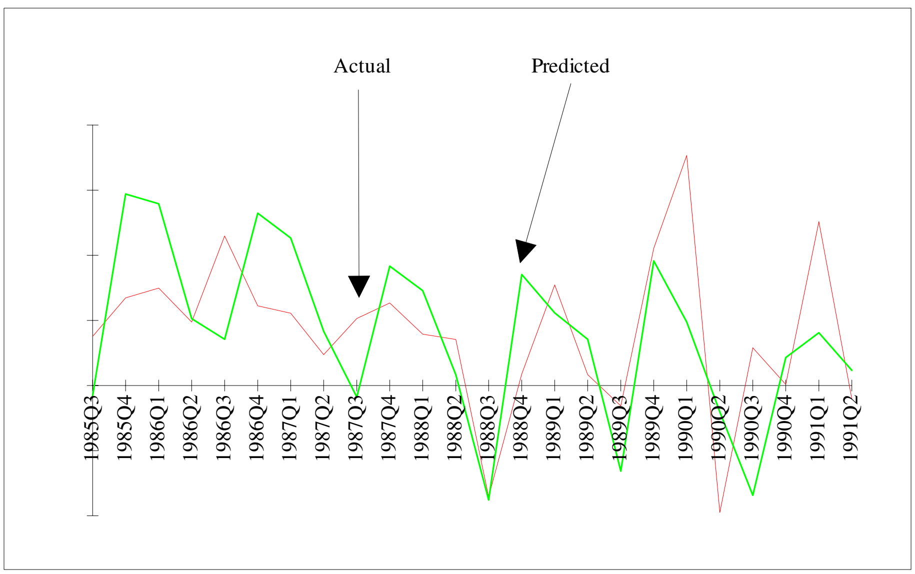

Fig. 1b. Actual and Predicted Values of the Real M1 Demand by the Business Sector (Equation 12).

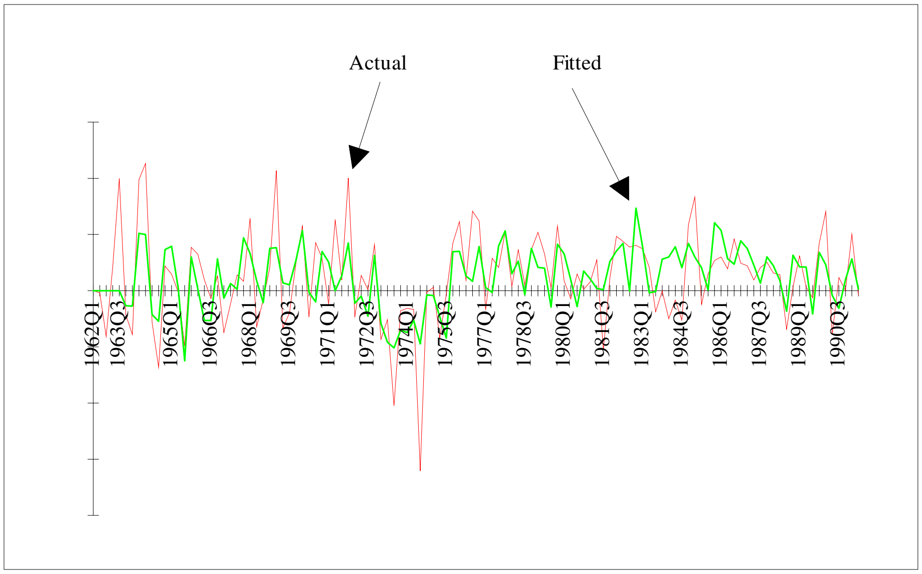

Fig. 2a. Actual and Fitted Values of the Real M1 Demand by the Business Sector (Equation 13).

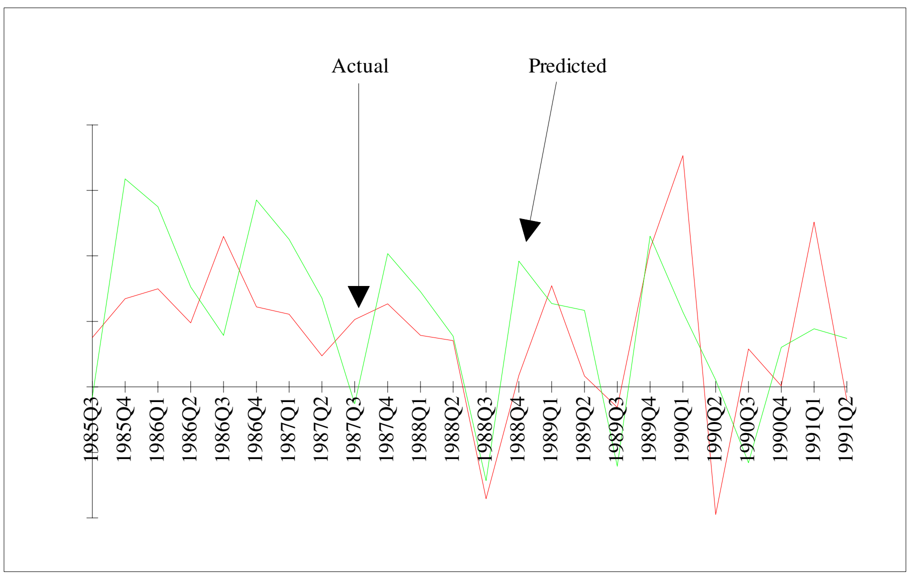

Fig. 2b. Actual and Predicted Values of the Real M2 Demand by the Business Sector (Equation 13).

Table 3

The Dynamic Demand for Real M1 by the Business Sector: Results from Chow's Test of Stability

Time of Break	Equation No. 3 F(8, 96)	Equation No. 4 F(7, 99)
1963:3-1971:4	1.02	1.39
1963:3- 1973:2	1.19	1.82
1963:3-1980:4	0.85	0.99
1963:3-1985:2	0.52	0.46

8. CONCLUSION

The objective of this paper has been to estimate dynamic demand for money function for the business sector in Pakistan. It is found that the individual time series of the variables included in the money demand function are not stationary. They are integrated of order one. Further it is concluded that the one cointegration relationship between money demand and its determinants. The rate of inflation emerged as important determinant of real money balances demand by the business sector. In the long run business sector give no importance to the rate of interest while holding money.

We have estimated dynamic stable money demand functions, which have remarkably good predictive power. In the short run rate of interest on saving deposit emerged an important determinant of money demand by the business sector. The previous money demand behaviour also plays an important role in the determination of current behaviour.

Though the meaning full comparison of our study is not available however our results are in contrast with those of Ungar and Zilberfrab (1980). They found no role for the rate of inflation in the determination of money demand behaviour and our result proved the importance of rate of inflation in the determination of money demand behaviour by the business sector in Pakistan.

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