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Real Money Demand, Income, and Interest Rates in Iran: Is there a Long-Run Stable Relation?

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The demand for money plays a critical role in macroeconomic analysis, especially in the formulation and implementation of appropriate monetary policy and Demand for money and its stability have received vast attention in the country specific time series studies. Developments in the unit roots and cointegration techniques and financial reforms have stimulated further empirical work on this already well researched relationship. It is now an almost stylized fact that the demand for broad money has become temporally unstable in Iran after the continuing changes to the financial sector due to financial reforms.Then the main objective of this paper is to empirically reinvestigate the long-run Iranian money demand function and its stability. The Johansen-Juselius cointegration test is employed over the period 1968- 2009 to examine the long-run equilibrium relationship between money demand and its determinants, such as real income, inflation rate and exchange rate. Apart from this, the rolling regression procedure is also used to examine the stability of money demand function. Our results show that money demand function has been stable and financial reforms are yet to have any significant effects. Furthermore, the negative sign of inflation supports our theoretical expectation which indicates that people prefer to substitute physical assets for money balances. Finally, the positive sign of the exchange rate variable implies that as Iran rial depreciates, the demand for M2 increases, possibly supporting the wealth argument in the literature. Therefore, macro policies in Iran must focus not only at stabilizing the economy but also at achieving equilibrium exchange rate of the domestic currency.

JEL Classification: E4, E41, F31, C22

1. Introduction

A stable demand function for money is a necessary condition for money to exert a predictable influence on the economy so that control of the money supply can be a useful instrument of economic policy. As such, the notion of a stable money demand function appears to require that money holdings, as observed in the real world, should be pre- dictably related to a small set of variables representing significant links to spending and economic activity in the real sector of the economy.

Most of the research up until the 1980s was carried out by the so-called partial adjustment models in which demand for money is thought to be a function of scale variable and a vector of opportunity cost variables. Furthermore, it was determined that due to adjustment costs, there was a lag involved for the "desired" level of holdings to match the "actual" level. Models built under this framework for the United States using post World War II data indicated that the demand for money, especially narrow money, revealed instability in the 1970s which is commonly known as "the missing money episode." Other industrial countries experienced similar problem as well. The results on developing countries, however, are mixed.

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Two sets of explanations were provided for this observed instability. The first one considered the ongoing financial innovation being responsible for this issue, while the second focused on the inadequacy of the partial adjustment modeling framework as an empirical apparatus to analyze the demand for money. In order to find a solution, research on the first group attempted a variety of scale variables and modeled the financial innovation process in various ways. These refinements improved the explanatory power of the model when the past data were used but could not predict the future well. The second strand of research identified a number of theoretical and econometric problems associated with the partial adjustment framework. On the theoretical basis, buffer-stock models were put forward, but they ran into empirical difficulties as well. The econometric problems associated with the partial adjustment models led to error-correction models. The important feature of these models is that they provide significant emphasis on the time series characteristics of data. While the economic theory is allowed to define the long-run equilibrium, the short-term dynamics is determined from the data. Because of their success, they have become the primary tool to analyze the demand for money in the 1990s.

The main objective of this study is to reinvestigate the nature of the Iranian money demand function by studying the long-run relationship among M2 aggregate, various macroeconomic components of real income (real Gross Domestic Product, GDP), exchange rate, and opportunity cost of holding money (inflation rate) over the period 1968- 2007. A second aim is to employ the Johansen and Juselius (1990) cointegration test associated with a modified version of the Pantula's principle (Hjelm and Johansson, 2005) to re-examine the long-run equilibrium relationship between M2 money demand and its determinants.The paper is organized as follows: Section II is devoted to the theoretical debate and some relevant previous empirical works regarding the concepts of money demand theories. Section III discusses the methodology used and presents the empirical results as well. Then this section justifies the implementation of the selected econometric methodology along with a brief discussion on the Error Correction Model. In section V, the empirical findings are reported, and finally conclusions are offered.

2. Literature Review

During the late 1970s, studies on money demand in both developed and developing countries coincided in reporting a systematic over prediction of monetary aggregates and the tendency of estimated parameters to be non-robust. These "missing money" episodes have been extensively documented for the US by Goldfeld (1973, 1976) and for most other developed countries by Fair (1987). Likewise, episodes of systematic under prediction are not unusual (Goldfeld and Sichel, 1990).

Many studies are available in the literature which estimate money demand behaviour, in particular, using various time series econometrics techniques. It is impossible to review all in this paper, and to conserve space, only selected (perhaps those related to the present theme) are reviewed. Judd and Scadding (1982) have provided a brief survey on the issue of stable money demand function. The studies selected are Darrat (1984), Fielding (1994), Arize et al. (1999), Dekle and Pradhan (1999), Civcir (2003), and Bahmani-Oskooee and

Rehman (2005). A common feature of these studies is that they have employed conventional money demand function relating quantity of money demanded to a scale variable, and a set of interest rate variables to represent opportunity costs.

In the earlier stage, the studies employed the Ordinary Least Squares (OLS) technique to estimate the money demand function as well as the Chow test to ascertain the stability of money demand in Malaysia (e.g., Yahya, 1984a and 1984b; and Yusuff, 1987); however, these studies do not take into account the time series properties and Chow test is low powered when the break point is unknown. For these reasons, the studies in the earlier stage may have suffered from the spurious regression problem and are, thus, unreliable (Granger and Newbold, 1974; and Phillips, 1986). Since the introduction of cointegration test, several studies (Tan, 1997; Chaisrisawatsuk et al., 2004; and Karim and Tang, 2004) have employed this test to determine the presence of stable long-run money demand function. The rationale is that if money demand and its determinants are cointegrated, this implies that the money demand function is stable as the cointegrated variables will never move too far apart, and will be attracted to their long-run equilibrium relationship. Nevertheless, Bahmani-Oskooee and Bohl (2000) demonstrated that although M3 money demand and its determinants (i.e., income and interest rate) were cointegrated, the CUSUM of Squares test showed that M3 money demand function in Germany was not stable. In line to this, Bahmani-Oskooee and Barry (2000) in the case of Russia, and Bahmani-Oskooee and Economidou (2005) in the case of Greece, also discovered similar outcomes with regard to the M2 monetary aggregate. Therefore, they argued that the presence of cointegration may not imply stable relationship among the set of variables.

Sriram (1999a, 1999b,2009), Cziraky and Gillman (2006), and Mishkin (2007) argue that the stability of money demand helps predict the effect of monetary policy on interest rates, output and inflation, and therefore reduces the possibility of an inflation bias. Central banks increasingly regard stable money demand as an important condition for conducting monetary policy, and more researchers have devoted their efforts to examining this issue. One prevailing argument is that stable money demand exists if the demand for money has a longrun cointegrating relationship with its determinants (Granger, 1986). Following Granger, the error correction model (ECM) has proven to be the most useful method for estimating the real demand for money, because the cointegration in ECMs means that whenever the demand for money diverges from its steady-state, a short-run adjustment pushes it toward equilibrium.

Then some studies conclude that money demand is stable after finding a long-run relationship in their estimated ECMs (see Lee and Chung, 1995; Watanabe and Pham, 2005; and Yu and Gan, 2009). Others search further and examine statistical tests for the constancy of parameters, in order to give a robust conclusion about the stability of long-run money demand (e.g., Huang, 1994; Anglingkusumo, 2005; Cziraky and Gillman, 2006; Baharumshah, Mohd and Yol, 2007; and Wu, 2009). Bahmani-Oskooee and Shin (2002) argue that cointegration is not sufficient for stability, rather it is also important to test whether the long-run and short-run estimated elasticities are stable over time. Useful tests for this include the CUSUM and CUSUMSQ tests.

Owing to this argument, another group of researchers (Tang, 2002; Baharumshah, 2004; Bahamani-Oskooee and Rehman, 2005; Hussain and Liew, 2006; and Tang, 2007a) carried out cointegration, CUSUM and CUSUM of Squares tests to reinvestigate the stability of money demand function in Malaysia.

3. Methodology and Model

Next, the Joha There is a diverse spectrum of money demand theories emphasizing the transactions, speculative, precautionary or utility considerations. Essentially, these theories tend to address a broad range of hypotheses. However, one thing about these diverse theories is that they share common important variables in their analysis. In general, they examine the relationship between the quantity of money demand and a set of few important economic variables linking money to real sector of the economy. The general specification takes the following functional relationship for the long-term demand for money.

$$M/P = (Y, i) \qquad (1)$$

where the demand for real balances M/P is a function of the chosen scale variable (Y) to represent economic activity and the opportunity cost of holding money (i). M stands for selected monetary aggregates in nominal term and P for the price level.

In the literature, there is consensus that the money demand function is estimated in log-linear form. The monetary aggregates and the scale variables are in logarithms; the interest rate rates in levels. Owing to the absence of a well-developed financial market in many developing countries, the inflation rate has been widely used as a proxy for the opportunity cost of holding money (Wong, 1977; Yusuff, 1987; and Sriram, 2002). In addition, when interest rates are subject to regulation by policy makers, then it is no longer a good proxy for the actual costs of holding money but, rather, tend to indicate the restrictiveness of monetary policy. For these reasons, the inflation rate will use as a proxy for the opportunity cost of holding money.

Apart from that, the exchange rate was also included in the equation due to the effect of currency substitution on money demand (Tang, 2002). Thus, this study used the model specification suggested by Bahmani-Oskooee (1996) and Bahmani-Oskooee and Rehman (2005). The M2 money demand function is expressed as Equation (2).

$$\ln M2t = \alpha 0 + \alpha 1 \ln Yt + \alpha 2 \Pi t + \alpha 3 \ln EXt + \varepsilon t \qquad (2)$$

where 'ln' denotes the natural logarithm, M2 is the M2 monetary aggregates in real term. It is true that several studies on developing countries indicated that the models on narrow money worked better reflecting the weak banking systems and levels of financial sector development. All the same, as the boundaries of narrow money shift over time to accommodate the new financial instruments, arguments have been raised in favour of adopting broad money in the empirical estimation. The measure was hypothesized to yield a stable demand function and was considered a preferable measure with which to evaluate the long run impact of the change in monetary policy (Hafer & Jansen, 1991; Laidler, 1993). Y is the real income , Π denotes the inflation rate and EX is the nominal exchange rate and ε, an error term. According to macroeconomic theory, an estimate of $\alpha 1$ is expected to be positive and an estimate of $\alpha 2$ is expected to be negative. Finally, an estimate of $\alpha 3$ can be either positive or negative.

In order to analyze the short-run dynamics and long-run relationships among monetary aggregates in real term(M2), the real income(Y) , the inflation rate(Π) and the nominal exchange rate(EX), we employ the Cointegration Test in the following VAR model form: U (VAR) = (M2,Y, Π, EX). Its advantage is that it allows the interpretation of any variable as a possible endogen one and that it explains the variation through previous personal values and those of the model.

As known, the short-run dynamics and long-run relationships requires the applications of three steps. First, the time series properties are analyzed in order to test their stationarity and to determine the order of integration. Second, the long run relationship between the variables is investigated using Cointegration technique. Finally, the short run, as well as, the long run relationship are investigated using the Vector Error Correction Model (VECM).

Johansen and Juselius (1990) maximum-likelihood cointegration method is used to examine the presence of a long-run equilibrium relationship in the system of money demand. The advantage of using this method lies in the fact that the Johansen-Juselius approach performs better than other conventional cointegration methods even when error terms are not normally distributed (Gonzalo, 1994). Furthermore, Hargreaves (1994) stated that Johansen's method is the best, if the sample size is reasonably large (e.g., 100 observations or more) and the model is well-specified without highly autocorrelated cointegrating errors.

According to Granger and Newbold (1974), cointegration is a test of long run equilibrium of non stationary series that do not have equilibrium in the short run. Cointegration implies that there is some adjustment process that does not allow the errors in the long run relationship to expand (Charemza and Deadman, 1992). The basic idea behind cointegration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989).

Here, we briefly describe the estimation procedure for Johansen-Juselius cointegration test. Cheung and Hung (1998) and Motinga (2001) noted that Johansen-Juselius cointegration test is nothing more than a multivariate generalization of the Augmented Dickey-Fuller (ADF) unit roots test. Therefore, as long as the cointegrating vector(s) is present, the estimated variables are I(1) and non-stationary at level (Holden and Perman, 1994, p. 89). In addition, Enders (1994, p. 396) noted that Johansen's test can handle variables with different orders of integration, I(d). This is evidence that Johansen's cointegration test is valid even if the order of integration is not consistent. To implement the Johansen-Juselius procedure, the following Vector Error Correction Model (VECM) is estimated:

$$\Delta Zt=\Phi Dt +\Pi\ Zt-1+\sum \Gamma i\ \Delta Zt-1+\mu t \qquad (3)$$

where Δ is the first difference operator, ($Zt - Zt{-}1$). Zt is a vector of endogenous variables (ln M2t, lnYt, Πt and ln EXt). Dt is the deterministic vector (constant, trend, etc.) and Φ is a matrix of parameters Dt. The matrix Π contains information about the long-run relationship between the variables in Zt vector. If all the variables in Zt are integrated of order one, the cointegrating rank, r, is given by the rank of $\Pi = \alpha \beta'$ where α is the matrix of parameters denoting the speed of convergence to the long-run equilibrium and β is the matrix of the cointegrating vector. To determine the number of cointegrating rank, Johansen- Juselius proposed two Likelihood Ratio (LR) tests statistics as follows:
The trace test statistic is given as:

$$LR(\lambda\ trace) = -T \sum_{i=r+1}^{\kappa} \ln(1-\lambda_i) \qquad (4)$$

The maximum eigenvalue test statistic is given as:

$$LR(\lambda\ max) = -T \ln(1 - \lambda_{i+1}) \qquad (5)$$

where λ_i are the eigenvalues ($\lambda_1 > \lambda_2 \ldots > \lambda_k$) and T denotes the number of observations. It should be noted that the Johansen-Juselius approach is sensitive to deterministic components (i.e., constant and trend) specified into the model because different specifications of deterministic components may yield different cointegration results. In practice, Johansen (1992b) proposed to use the Pantula's (1989) principle to select a proper model for cointegration test. Although Ahking (2002) observed that Model 2 (restricted intercept and no trend) and Model 3(unrestricted linear intercept and no trend) are the most plausible models to be used in empirical analysis, the author opts to use the Pantula's principle to select an appropriate model. In contrast, Hjelm and Johansson (2005) found that the standard Pantula's principle is heavily biased towards choosing Model 3 (i.e., an unrestricted constant) when the model with a restricted trend (i.e., Model 4) is the true one. To avoid this estimation bias arising from the use of the standard Pantula's principle, we decided to use a modified version of the Pantula's principle as proposed by Hjelm and Johansson (2005). This modified procedure stipulates that if the standard Pantula's principle' chooses Models 2, 4 or 5, the cointegration result is accepted. On the other hand, if Model 3 is chosen, the VECM is estimated with the inclusion of a restricted deterministic trend model (i.e., Model 4). Then, the LR test is computed to determine the significance of the parameter on the restricted deterministic trend. If the null hypothesis of no deterministic trend is rejected after the said computation, Model 4 is selected, otherwise Model 3 is preferred.

Using annual available series from 1968 to 2009, we estimate the error-correction model, depicted in equation (2). The data source is from the Central Bank of Iran statistical bulletin and site which includes monetary aggregates in real term(M2), the real income(Y) , the inflation rate(Π) and the nominal exchange rate(EX). Furthermore, as a result of the availability data in that period on an annual basis, we are limited to only annual data. The Consumer Price Index, CPI (year 1997 = 100) is used to derive the real term and compute the inflation rate.

4. Results/Analysis

As known, the short-run dynamics and long-run relationships requires the applications of three steps. First, the time series properties are analyzed in order to test their stationarity and to determine the order of integration. Second, the long run relationship between the variables is investigated using Cointegration technique. Finally, the short run, as well as, the long run relationship are investigated using the Vector Error Correction Model (VECM).

4.1 Unit Root Test

This involves testing the order of integration of the individual series under consideration. Several procedures for the test of order of integration have been developed. The most popular ones are Augmented Dickey-Fuller (ADF) test due to Dickey and Fuller (1979, 1981), and the Phillip-Perron (PP) due to Phillips (1987) and Phillips and Perron (1988). Augmented Dickey-Fuller test relies on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypotheses of stationarity. The tests are conducted with and without a deterministic trend (t) for each of the series.

The analysis of the time series based on ADF and PP unit root tests indicates that the null hypothesis of the presence of a unit root cannot be rejected for the levels of the time series of money demand , real income, inflation rate and exchange rate variables since their computed values are less than the critical values at the 1 % level of significance. However, the results indicate that the null hypothesis is rejected for the first differences since their computed values exceed the critical values at the 1% level of significance. Therefore, the four time series are integrated of order one (I (1)). The results of ADF and PP unit root tests are presented in tables (1 and 2) respectively:

Table (3.2): ADF Unit Root Test

Variable	Level With intercept	Level With intercept and rend	First difference with intercept	First difference With intercept and Trend
Lm2	0.461974	-2.024659	-3.662837	-3.610392
Lexg	-0.382606	-2.360895	-5.756374	-5.721358
Inf76	-3.401195	-3.328302	-5.962911	-6.179195
Ly	-0.563771	-1.226201	-6.190266	-6.500572

Critical values:	Intercept	Intercept and Trend
At (1%) level of Significance	-3.66	-4.29
At (5%) level of significance	-2.96	-3.57
At (10%) level of significance	-2.62	-3.22

Table (3.3): PP Unit Root Test

Variable	Level With intercept	Level With intercept and rend	First difference with intercept	First difference With intercept and Trend
Lm2	-0.474564	-2.257339	-3.645077	-3.610392
Lexg	-0.359383	-2.402174	-5.760387	-5.725265
Inf76	-3.281387	-3.200084	-9.846132	-14.10672
ly	-0.897391	-1.507254	-6.231499	-7.832138

Critical values:	Intercept	Intercept and Trend
At (1%) level of Significance	-3.66	-4.29
At (5%) level of significance	-2.96	-3.57
At (10%) level of significance	-2.62	-3.22

4.2 Cointegration Test

Since the time series of money demand , real income, inflation rate and exchange rate are integrated of order one i.e. I (1), they would be tested for the existence of a long run relationship. The non-stationary time series that have the same order of integration may be cointegrated if there exist some linear combination of the series that can be tested for stationarity i.e. (I (0)). According to Granger and Newbold (1974), cointegration is a test of long run equilibrium of non stationary series that do not have equilibrium in the short run. Cointegration implies that there is some adjustment process that does not allow the errors in the long run relationship to expand (Charemza and Deadman, 1992).

Johansen (1988,1991,1992a, 1992b), and Johansen and Juselius (1990) proposed a test for cointegration based on likelihood ratio (LR) test to determine the number of cointegration vectors in the regression. Johansen and Juselius' procedure is considered better than the two steps procedure proposed by Engle-Granger (1987), especially, in relationships including more than two time series since it allows feedback effects among the variables under investigation. Johansen and Juselius' technique allows testing for the existence of nonunique cointegration relationships.

Two tests statistics are suggested to determine the number of cointegration vectors based on the likelihood ratio test (LR): the trace test (λ trace) and maximum eigenvalue test (λ trace) statistics.

Table (3) presents the result of the vector autoregressive model (VAR) which includes the results of the trace test (λ trace) and the maximum eignvalue test (λ trace) statistics for the existence of long run equilibrium between money demand , real income, inflation rate and exchange rate.

Table (3.4): Cointegration with unrestricted intercept and no trend in the VAR(model 2)

Null Hypothesis	*(λ max)*	*(λtrace)*	*95% critical value for maximum eigenvalues test*	*95% critical value for trace test*
r = 0	43.18894	73.38325	32.11832	63.87610
r ≤ 1	12.69206	30.19431	25.82321	42.91525

Table (3.5): Cointegration with unrestricted linear intercept and no trend in the VAR(model 3)

Null Hypothesis	*(λ max)*	*(λtrace)*	*95% critical value for maximum eigenvalues test*	*95% critical value for trace test*
r = 0	41.95233	63.21808	27.58434	47.85613
r ≤ 1	1 .13894	21.26575	21.13162	29.79707

Table (3.6): Cointegration with unrestricted linear intercept and trend in the VAR(model 4)

Null Hypothesis	(λ max)	(λtrace)	95% critical value for maximum eigenvalues test	95% critical value for trace test
r = 0	25.546 4	33.92999	19.38704	25.87211
r ≤ 1	8.383549	8.3 5 9	12.51798	12.51798

The null hypothesis of no cointegration based on both the maximum eigenvalue and the trace tests between money demand , real income, inflation rate and exchange rate is rejected at a (5%) level of significance. However, the alterative of the existence of at least one cointegrating equation could not be rejected. According to Granger (1988), the existence of cointegration between the time series under consideration suggests that there is a long run relationship between money demand , real income, inflation rate and exchange rate, and that there exists causality in at least one direction between the variables.

$$\ln M2t = -16.7762 + 2.0958 \ln Yt - .048164\, \Pi t + .018627 \ln EXt \qquad (6)$$

t -1.585 2.317 -2.588 .218

4.3 The Error Correction Model

If cointegration is proven to exist, then the third step requires the construction of error correction mechanism to model dynamic relationship. The purpose of the error correction model is to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium state. The greater the co-efficient of the parameter, the higher the speed of adjustment of the model from the short-run to the long-run. We represent equation (2) with an error correction form that allows for inclusion of long-run information thus, the error correction model (ECM) can be formulated as follows:

$$\Delta \ln M2t = \underset{-2.473}{-1.82} + \underset{3.983}{.2278}\Delta \ln Yt - \underset{-4.459}{.0052}\Delta \Pi t + \underset{.209}{.0020}\Delta \ln EXt + \underset{-2.776}{-.109}ECTt{-1} \quad (7)$$

t

Where

Δ is the first difference operator

the error correction coefficient is λ and the remaining variables are as defined above.

Equation (7) presents the estimators of the vector error correction model. The lagged error term coefficient (ect−1) is negative and statistically significant, The value of (e t−1) indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium. 10% of the disequilibrium in money demand is corrected each year. In addition, the significant error term in the money demand equation supports the existence of a long run equilibrium relationship between money demand , real income, inflation rate and exchange rate.

5. Conclusion

The main objective of this study is to empirically reinvestigate the long-run Iranian M2 money demand function and its stability for the period from 1968 to 2007. This study utilizes the Johansen-Juselius multivariate cointegration test in association with a modified version of the Pantula’s principle (Hjelm and Johansson, 2005) to examine the presence of long-run equilibrium relationship between M2 money demand and its determinants, such as real income, inflation rate and exchange rate. The results of Johansen-Juselius cointegration test reveal that the estimated variables are cointegrated. This implies that real income, inflation rate and exchange rate are coalescing with real M2 money demand to achieve their steady-state equilibrium in the long run, although deviations may occur in the short run.

Unlike the earlier studies, this study estimated the error correction model for M2 with the rolling regression procedure to gain some insight on the stability of money demand by analyzing the behavior of the ECTt– 1 coefficient. The results suggest that M2 money demand did not remain stable throughout the period analyzed, attributed to a series of changes in the Iranian monetary policy environment. These findings support our prior expectation that the money demand function in Iran is not stable in short –run.

The signs of these normalized coefficients (In equation (6)) are consistent with the tenets of macroeconomic theory, which postulate that real income and exchange rate are positively related to M2 money demand, while inflation negatively is related to M2 money demand. Furthermore, the negative sign of inflation supports our theoretical expectation which indicates that people prefer to substitute physical assets for money balances.Finally, the positive sign of the exchange rate variable implies that as Iran rial depreciates, the demand for M2 increases, possibly supporting the wealth argument in the literature. Therefore, macro policies in Iran must focus not only at stabilizing the economy but also at achieving equilibrium exchange rate of the domestic currency.

Using annual available series from 1968 to 2009, we estimate the error-correction model, depicted in equation (2). Furthermore, as a result of the availability data in that period on an annual basis, we are limited to only annual data.

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