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How Much Control Dose Central Bank of Iran over Money Supply?

Author: **Jafar HAGHIGHAT**, Department of Economics, University of Tabriz, Tabriz, Iran, haghighat@tabrizu.ac.ir, jafarhaghighat@yahoo.com

In discussions about the efficacy of monetary policy instruments, attention is often focused on analyzing the money supply process. Monetarists, in general, argue that the monetary authorities can exercise effective control over the stock of money; others, especially those who share the new view of monetary theory argue that the determination of the stock of money is part of the economy. In this view, the stock of money is the outgrowth of the behavior of the public, the financial sector (banks), the finance ministry, and the rest of the world as well as of the actions of the central bank. The paper investigated the co-integrating property and stability of the supply of money function in Iran. The paper employed the ARDL approach together with CUSUM and CUSUMSQ tests. The results show that M1 and M2 is co-integrated with net claims on the government, net foreign assets, and rate of profit on bank deposit (interest rate and a major implication of using interest rate elasticity estimates from M2 function is that money is endogenous.

Keywords: *money supply, monetary policy, money multiplier, central bank, ARDL, financial sector*

Introduction

The strategy of monetary targeting, as pursued by the Central Bank, relies on two basic assumptions. One, the targeted monetary aggregate has to be a stable function of a few indicators (GDP, interest rate, etc.). This condition is commonly referred to as the necessary stability of money demand. Two, the money supply has to be controllable by the monetary authorities. Otherwise unpredicted changes in the growth rate of the money multiplier can jeopardize the usefulness and success of monetary targeting. As far as the first condition is concerned, in recent years several studies confirmed the existence of a stable Iran money demand function with adequate statistical properties. With regard to controllability, far less studies have been presented, however, the Central Bank had documented difficulties in meeting its growth targets for the observed broad aggregate M2. In this study we focus on the problems of controlling the latter during the unstable monetary period of after revolution.

Having determined the most appropriate definition of money and its relation to the price level, monetary authority must understand how its behavior is determined in order, to control it (if possible) in a way consistent with price and other policy objectives. This is a non-trivial undertaking, as a central bank's activities influence but do not directly determine money's behavior. Therefore The purpose of this paper is to investigate the nature of the money supply process in light of the debate over the concept of exogenous and endogenous money supply to provide a detailed picture of the controllability of Iranian money supply under the reign of the Central Bank from the beginning of its monetary targeting period in 1968 until 2007.

This paper is organized as follows. In Section II we outline the conventional money multiplier model and permit the multiplier to depend upon some relevant macro-economic variables. Section III is a brief literature review. Section IV discusses the methodology used to test the nature of the relationship and develops a autoregressive distributed lag (ARDL) approach to examine the stability of the money and using Iranian monetary data for the period March 1968 to March 2008. Section V examines the analytical case for money instability and undertakes a ARDL empirically identify the determinants of factors affecting money supply and the multipliers so as to identify the determinants of alternative multipliers. Section VI concludes the paper.

Theoretical and formulation of supply for money in Iran

A simplified money-multiplier approach

The multiplier model of the money supply, originally developed by Karl Brunner (1961) and Brunner and Meltzer (1964), has become the standard paradigm in macroeconomics and money and banking textbooks to explain how the policy actions of the Federal Reserve influence the money stock. It also has been used in empirical analyses of money stock control and the impact of monetary policy actions on other economic variables (Garfunkel and Thornton ,1991).

The stock of money can be determined within the money-multiplier approach under two alternative assumptions. The first assumes stability of the money-multiplier (**M** = m. MB); the second, allows for variation in the money-multiplier and its component ratio, which we elaborate below (M = m ( ).MB). The implication of the first assumption is that variations in the stock of money are explained by the variations in monetary base. The latter assumption implies that both the money- multiplier and monetary base have a role to play in variations in the stock of money. "The modified equation implies that the money-multiplier (m) is a function of certain endogenous variables (which are to be specified in the empty parenthesize: after m). It has the merit of segregating policy variables affecting monetary base and determinants of money-multiplier. It incorporates a behavioral element in the theory of money supply (Mithani, D. M., 1993).

In the orthodox theories of money and monetary policy quantity of money is determined exogenously by the central bank. According to the portfolio approach of monetarists, money can appear as the result of the injection of some high-powered money by the central bank and the intention of economic units (usually households) to modify their asset portfolios.

Quantifying the relationship between movements in the monetary base and money supply requires first identifying each of the two variables.

The base money is then related to a broader money stock with the well-known credit multiplier:

$$\mathbf{M = MB \cdot 1/\ c + (1 - c) \cdot res} \qquad (1)$$

where **MB** is the monetary base, **res** is the reserve ratio, that is, the ratio of bank reserves (BR) to total demand plus time deposits, **c** is the cash to money ratio, and M is the monetary aggregate containing cash in circulation and bank loans. Monetarists proved that the credit multiplier shows historical stability: modifying high-powered money generates proportional changes in the money stock. This is the rationale for the assumption that the quantity of money can be and is determined exogenously by the central bank.

Two monetary aggregates for Iran, M1. and M2, are used, where M1 consists of currency held by the non-bank public (C) plus demand deposits kept with the banks (D), and M2 is M1 plus time deposits (T),

By definition the total money stock is equal to the monetary base times the money-multiplier. That is

$$\mathbf{M1 = kl.MB} \qquad (2)$$

$$\mathbf{M2 = k2.MB} \qquad (3)$$

$$\mathbf{or\ kl = M1/MB} \qquad (4)$$

$$\mathbf{k2 = M2/MB} \qquad (5)$$

We rewrite equation (4) and (5) as:

$$\mathbf{kl} = \frac{1}{\mathbf{cml - (rl.cml) + rl}} = \frac{1}{\mathbf{cml} + (1 - \mathbf{cml}) \cdot \mathbf{rl}} \qquad (6)$$

$$\mathbf{k2} = \frac{1}{\mathbf{cm2 - (r2.cm2) + r2}} = \frac{1}{\mathbf{cm2} + (1 - \mathbf{cm2}) \cdot \mathbf{r2}} \qquad (7)$$

where cml = C/M1, cm2 = C/M2, rl = BR/D , r2 = BR/(DD+T)

This gives us the money multiplier in terms of cml, rl for kl and in terms of cm2, r2 for K2. The monetarist argument is based on the postulates that the central banks control their monetary liabilities and that the changes in monetary base derived from these monetary liabilities induce predictable changes in money supply, given the money multiplier.

From equation (6) and (7) we can see that the money multiplier depends on the currency-money (cm = C/M) ratio and reserve requirement (r = RR/D). The assumed stability of the money multiplier implies that the **cm** ratio and the **r** ratio are stable. The **r** ratio is a policy variable subject to the central bank control, while the **cm** ratio is a behavioral variable. The application of the **r** ratio varies among different countries and, in some countries; it is not used as an active policy tool. It is reasonable to assume that the r ratio is stable and that it has no major impact on the observed changes in the money multiplier. Theoretically, therefore, the **cm** ratio would be the major behavioral determinant of the money multiplier.

The emphasis on the **cm** ratio in the money supply determination process, and its determinants can be seen for example, by Khatkhate, Galbis and Villanueva(1974), and Been stock(1989) works:

This ratio (currency-money ratio) is negatively related to the opportunity cost of holding currency as measured by the domestic Interest rate. It is also negatively related to income, since Individuals and corporations tend to become more efficient in their cash management as their income rises (Khatkhate, Galbis and Villanueva, 1974, pp.43, 44).

In this study the desired currency to money ratio(C/M) is assumed to a function of interest rate (rate of profit) on bank deposits and income (we will examine both of real and nominal income).

$$\mathbf{(C/M)_t = ao - al.Y_t - a2.RP_t} \qquad \mathbf{(8)}$$

Where Y can be Yr : real income or Yn: nominal income, and RP is rate of profit on bank deposit (interest rate).

Implicit in equation (8) are the assumptions that the public holds less currency in favor of saving and time deposits, C/M bring down the C/M ratio, as income increases, and that the interest rate on deposits influences the portfolio composition of total money (broadly defined).

Since it is assumed that it will take some time for the public to adjust the currency to money ratio to a desired level, it is postulated that a change in the ratio in a given period is a fraction of the gap between the “desired" ratio and the actual ratio in the previous period. As a result, with use of a partial adjustment framework we get the currency to money ratio equation as:

$$(C/M)_t - (C/M)_{t-1} = \delta [(C/M)_t - (C/M)_{t-1}] \quad (9)$$

$$(C/M)_t = \delta.a_0 - (\delta.a_1).Y_t - (\delta.a_2).RP_t + (1- \delta) (C/M)_{t-1} \quad (10)$$

Where $0 < \delta < 1$

The origin of any money supply process investigation is the relationship of the (adjusted) monetary base and the money multiplier. The (whole) monetary base or source base can be divided into two parts. One part is supposed to be exogenous, i.e. it is directly controllable by the monetary authorities. The other part is supposed to be partly or fully endogenous, i.e. the central bank cannot exert direct and/or full control over this part of the monetary base. Typically two types of reserves are recognized *i.e.*,

R = Required Reserves (RR) + Excess Reserves (ER) = kD + ER (11)

Where ER/D = ϕ (r mkt) (12)

Where ϕ is a decreasing function of the market rate of interest (r mkt) i.e., $d\phi / drmkt = \phi'(r\ mkt) < 0$. The rationale for this assumption is that banks may want to hold excess reserves beyond the required level so that unexpected demands on them for cash payments to other banks can be facilitated without allowing total reserves to fall below the required minimum. However, these excess reserves are costly to hold as they earn no interest, and by reducing such reserves, a bank would be able to increase the investment on which it earns interest. Consequently, the opportunity cost of holding excess reserves can be represented by interest rates (r mkt). The higher the rmkt, the less will be the excess reserves held. Equation (11) and (12) together yield;

R/D = k + ϕ (r mkt) (13)

Since $\phi_2'(r\ mkt)$ [illegible] 0, reserve deposit ratio will be smaller, for a given value of statutorily determined k, the higher the rate of interest (r mkt).

Over period of several years money's behavior is almost always overwhelmingly dominated by the monetary base. The supply of free high-powered money (monetary base), MB, is defined as the sum of the central banks claims on the commercial banks (BCC) its net claims on the government(NGBC), and net foreign assets(NFA); MB = BCC +NGBC + NFA. The monetary base, in turn, invariably dominated by the net foreign assets and/or the government's debts to central bank. Therefore we can examine relationship between MB, NGBC and NFA, MB=f (NGBC, NFA) with equation (14):

$$\mathbf{MB = f\,(NGBC, NFA, RP)} \qquad \mathbf{(14)}$$

Using the expression for money multiplier given in equations (6) and (7), the basic equation for the money-multiplier approach can be written for M1 and M2 as:

$$\mathbf{M1 = \frac{1}{cml + (1 - cml) \cdot rl}\,(MB)} \qquad \mathbf{(15)}$$

$$\mathbf{M2 = \frac{1}{Cm2 + (1 - cm2) \cdot r2}\,(MB)} \qquad \mathbf{(16)}$$

Finally, using the equations (10),(14) we shall estimate two model for money supply(M1 and M2), where the models are defined as follows: Model (1); consist of two behavioral equations, which are expressed in log linear form:

Model (1) for M1:

LM1 = f (LRP, NFA, NGBC) (17)

Model (1) for M2;

LM2= f (LRP, NFA, NGBC) (18)

Review of literature

Early theories of money supply developed a mechanistic approach that did not allow for the possibility of ratios being behavioral functions of economic variables (such as the studies by Friedman and Schwartz (1963), and Phillip Cagan (1956)). This stage of the theory's development is evocative of early quantity theory and Keynesian multiplier analysis. There is now considerable evidence showing that the supply of money can be expressed as a function of a few variables (Miegs (1962), Hendeshoot and Deleeuw (1970)). Basically, these functions are two types: Brunner(1961) and

Brunner and Meltzer (1963) consider money supply as a function of the monetary base, currency-deposit ratio, and reserve-deposit ratio. They contend that, with the monetary base given, the current rate of interest can have very little effect on the supply of money. In contrast, Teigen(1964), Goldefeld (1966), Smith(1967),Modigliani, Rasche, and Cooper(1970), and Bhattacharya(1974) attach importance to the interest rate. Baghestani and Mott (1997) have argued that the notion of an endogenous money multiplier leads to a better understanding of monetary impacts on the economy.

One of the first studies using time-series models to analyze the money multiplier was undertaken by Bomhoff (1977). He used the time-series technique for the United States and the Netherlands. Büttler et al. (1979) and Fratianni and Nabli (1979) also used this technique to forecast the money multiplier in Switzerland and in seven EEC countries respectively. Johannes and Rasche ((1971), (1981)) extended the time series approach to predict money multiplier by using a 'component' approach.

They claimed that the predictive performance of this disaggregated model was superior to the aggregate model. At the aggregated level Johannes and Rasche (1987) attempted to forecast the multiplier with the help of ARIMA modeling techniques at the aggregate level. When Hafer and Hein (1984) tested this claim, they found that the gain in terms of forecast accuracy from the component procedure was not significant, also Haffer and Hein (1998) find that the aggregate model yields quite accurate out of sample forecasts even when compared with a components approach, Siddique and Ahmad (1994) developed different models for the projection of the money multiplier and Gauger and Black (1991) identify multiplier movements as a major source of volatility of aggregates but do not analyze factors causing such multiplier movements.

The implications of the Post Keynesian position for both macroeconomic theory and policy are fundamental. At the theoretical level, the Post Keynesian position implies rejection of all models of macroeconomic activity new classical, neoclassical, Keynesian, as well as traditional monetarist-that assign major independent influence to the behavior of the money supply. In terms of policy analysis, it suggests that central bank interventions to control the growth rate of money and credit are not nearly as potent a tool as they are assumed to be in the mainstream literature.

The theoretical literature has convincingly put forward arguments in favor of money endogenity. To support this theoretical argument, the empirical literature on the endogenity of money has vehemently demonstrated that money supply is endogenously determined for various economies. However, all these studies exclusively encompass developed and middle-income economies. Lavoie (2005), Shanmugam et al. (2003), Nell (2001), Vera (2001), and Pollin (1991) have presented a time series analysis to test the money endogenity hypothesis for the case of Canada, and USA, Malaysia, South Africa, Spain, and US respectively. Marcelin W. Diagne(2010), Chor F. Tang (2009) and Tuck C(2007). Tang also empirically reinvestigates the long-run money demand function and its stability.

Methodology

Monetary and Credit Policies of Iran

Monetary policy in Iran, as in most developing countries, is not as effective and efficient as in developed economies because of the absence of a well-developed financial network and limited monetization of the economy. To clarify the exposition, monetary policy of Iran can be divided into two distinct periods:

- monetary policy during 1962-1973, when Iran faced a severe scarcity of foreign exchange
- monetary policy during 1973-1978, a period of relative abundance of foreign exchange;
- monetary policy after revolution and war, the Islamic Republic's monetary and credit policy since the revolution has been virtually dictated by the public sector's financial requirements.

The monetary authorities' obligation to finance annual budget deficits, and their statutory mandate to preserve the value of the Iranian rail, have overshadowed all other considerations. Bank Markazi has almost obsequiously lent money to the central government each year to meet its expenses, and has enjoined the banking system from unauthorized credit expansion. Faced with these constraints, the thrust of monetary policy in Iran has been to minimize the multiplier effect of growth in the monetary base. To this end, the Bank Markazi has relied on two key policy instruments:

- those that alter the cost of using funds, i.e., rediscount and interest rates
- those that directly regulate the supply of money , i.e., reserve requirements and credit ceilings

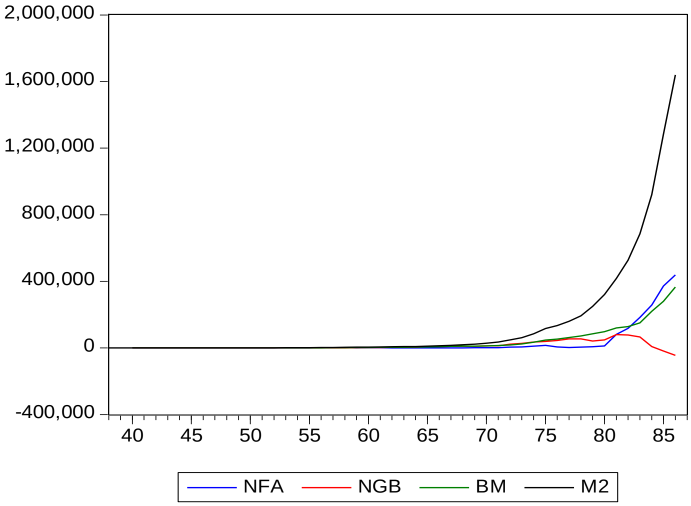
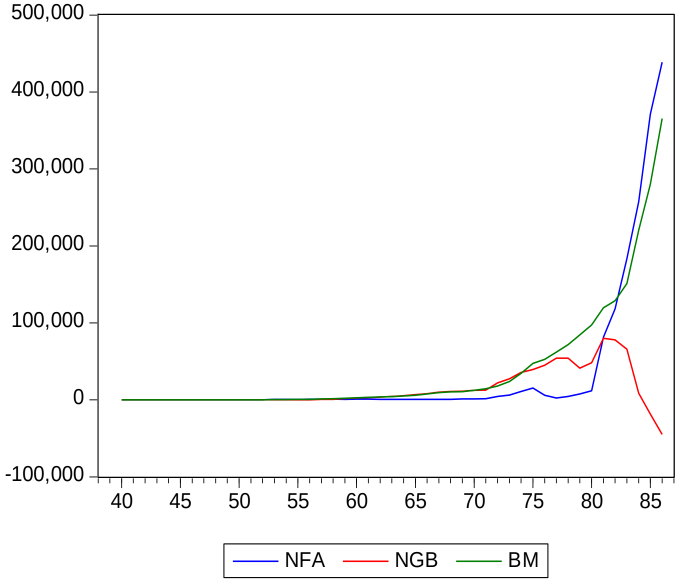


Figure 1: A graphical presentation of NFA, NGB, BM, M2 and k2 in Iran


500,000
400,000
300,000
200,000
100,000
0
-100,000
40
45
50
55
60
65
70
75
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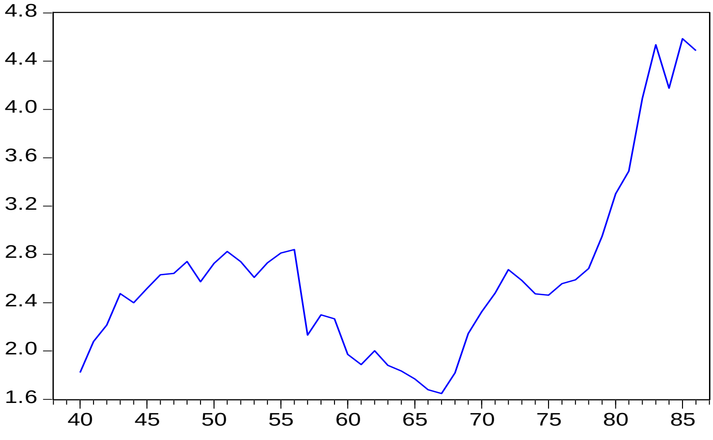
NFA
NGB
BM

K2


4.8
4.4
4.0
3.6
3.2
2.8
2.4
2.0
1.6
40
45
50
55
60
65
70
75
80
85

ARDL approach

Various factors are considered as determinants of the money supply function. The general agreement in the literature a money supply studies is assumed that the money supply function takes the following form:

$$\mathbf{LnM\ t = \alpha\ 0\ + \alpha 1\ 2RP\ t + \alpha\ 2\ log\ NFA\ t + \alpha\ 3\ log\ NGBC\ t + u\ t} \qquad (19)$$

Where NGBC is net claims on the government, NFA = net foreign asset, RP is rate of profit on bank deposit (interest rate).

In applying the co-integration technique, we need to determine the order of co-integration of each variable. However, as noted in the literature, depending on the power of the unit root tests, different tests yield different results. In view of this problem, Pesaran and Shin (1995) and Perasan et al. (2001) introduce a new method of testing for co-integration. The approach known as the autoregressive distributed lag (ARDL) approach. This method has the advantage of avoiding the classification of variables into I (1) or I (0) and unlike standard co-integration tests, there is no need for unit root pre-testing. However, the ARDL approach is very suitable to our formulation of the demand for money because we may have a stationary variable such as inflation rate along with non-stationary variables such as money or income.

The error correction version of ARDL model pertaining to the variables in Eq. (19) is as follows:

$$\mathbf{\Delta\ log\ M_{t} = \alpha\ 0 + \sum \alpha\ 1i\ \Delta\ log\ M_{t-i} + \sum \alpha\ 2_{i} \Delta\ RF_{t} + \sum \alpha\ 3_{i}\ \Delta\ NFA_{t} + \sum \alpha\ 4_{i}\ \Delta\ log\ NGBC_{t-i} + \gamma\ 1\ log\ M_{t-1} + \gamma\ 2RF_{t-1} + \gamma\ 3\ log\ NFA_{t-1} + \gamma\ 4\ log\ NGBC_{t}-1\ \ ut} \qquad (20)$$

The null of no co-integration defined by $H\ 0 : \gamma\ 1 = \gamma\ 2 = \gamma\ 3 = \gamma\ 4 = 0$ is tested against the alternative of $H\ 1 : \gamma\ 1 \neq 0 ,\gamma\ 2 \neq 0 ,\gamma\ 3 \neq 0 ,\gamma\ 4 \neq 0$, by means of familiar F-test. However, the asymptotic distribution of this F-statistic is non-standard irrespective of whether the variables are I (0) or I(1). Pesaran et al. (2001) have tabulated two sets of that they are all I (0). This provides a band covering all possible classifications of the variables into I(1) and I(0) or even fractionally integrated. If the calculated F-statistic lies above the upper level of the band, the null is rejected, indicating co-integration. If the calculated F-statistic falls below the lower level of the band, the null cannot be rejected, supporting lack of co-integration.

If, however, it falls within the band, the result is inconclusive.

Empirical results

The paper used data from CBI, Central Bank of Iran, over the period 1968–2007 to test the null of no co-integration against the alternative hypothesis. For this section, the Microfit (version 4) statistical software by Pesaran and Pesaran (2003) was used for all the computations of ARDL approach for co-integration (Pesaran et al., 2001) and error correction model estimates. We employ Akaike's information criterion (AIC) in selecting the lag length on each first differenced variable and Eq. 20 is estimated for M1 and M2 monetary aggregate and the results are reported in Tables 1, 2. In this stage, considering that monetary aggregates (M1 and M2), net claims on the government, net foreign assets, and rate of profit on bank deposit (interest rate) are co-integrated, the error correction model Eq. 20 is estimated. The main aim here is to capture the short-run dynamics. Table1, reports the coefficient estimates of all lagged first differenced variables in the ARDL model (short-run co-efficient estimates).

Not much interpretation could be attached to the short-run coefficients. All they show the dynamic adjustment of all variable.

Table 1: Short-run coefficient estimates

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Autoregressive Distributed Lag Estimates
Dependent variable is LM2

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Regressor	Coefficient	Standard Error	T-Ratio [Prob]
LM2(-1)	.96751	.011191	86.4552[.000]
NFA	.2173E-5	.8342E-6	2.6052[.014]
NFA(-1)	-.2583E-5	.1172E-5	-2.2040[.035]
NGB	-.1522E-5	.9221E-6	-1.6510[.109]
LRP	.35196	.10718	3.2838[.002]
C	-.28628	.21818	-1.3121[.199]
D4	.058375	.040032	1.4582[.155]

****

Diagnostic Tests

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*   Test Statistics  *      LM Version       *       F Version        *
*******************************************************************************
*                *                   *                    *
* A:Serial Correlation*CHSQ(   1)=   1.7373[.187]*F(   1,  31)=   1.4453[.238]*
*                *                   *                    *
* B:Functional Form   *CHSQ(   1)=   2.2587[.133]*F(   1,  31)=   1.9057[.177]*
*                *                   *                    *
* C:Normality        *CHSQ(   2)=   1.3071[.520]*      Not applicable       *
*                *                   *                    *
* D:Heteroscedasticity*CHSQ(   1)=   6.5088[.011]*F(   1,  37)=   7.4121[.010]*
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A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values

In Table 2, the long-run coefficients are reported. These are the coefficients of $\gamma 1 - \gamma 4$ from the ARDL model. Following the literature, we normalize these long-run elasticity on LM by dividing them by (γ 1). According to Table 2 the interest rate elasticity is 10.8323, which is highly significant as reflected by a t-statistic of 2.6150. The after war dummy variable elasticity is 1.7966 and significant supporting our theoretical expectation. The long-run model of the corresponding ARDL(1,1,0,0)for the supply of money can be written as follows:

LnM t = -8.8109 + 10.8323 log RPt + -.1262E-4 NFA t+ -.4686E-4 NGBC t

Table 2: Estimated Long Run Coefficients using the ARDL Approach
ARDL (1,1,0,0) selected based on Akaike Information Criterion

Dependent variable is LM2
39 observations used for estimation from 1348 to 1386

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
NFA	-.1262E-4	.1441E-4	-.87558[.388]
NGB	-.4686E-4	3602E-4	-1.3011[.203]
LRP	10.8323	4.1423	2.6150[.013]

C	-8.8109	7.5063	-1.1738[.249]
D4	1.7966	1.0338	1.7378[.092]

****

Table 3: Error Correction Representation for the Selected ARDL Model
ARDL (1,1,0,0) selected based on Akaike Information Criterion

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Dependent variable is dLM2
39observations used for estimation from 1348 to 1386

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob[
dNFA	.2173E-5	.8342E-6	2.6052[.014]
dNGB	-.1522E-5	.9221E-6	-1.6510[.108]
dLRP	.35196	.10718	3.2838[.002]
dC	-.28628	. 21818	-1.3121[.199]
dD4	.058375	.040032	1.4582[.154]
ecm(-1)	-.032491	.011191	-2.9034[.007]

****

Ecm = LM2 + .1262E-4*NFA + .4686E-4*NGB -10.8323*LRP + 8.8109*C - 1.7966* D4

****

Table 3 also reports some diagnostic statistics. Kremer et al. (1992) has shown that the significant lagged error correction term is a more efficient way of establishing co-integration. We use estimates of $\gamma_1 - \gamma_4$ to form a lagged error correction term,

$$EC_{t-1} = \gamma_1 \log M_{t-1} + \gamma RP_{t-1} - + \gamma \log NFA_{t-1} + \gamma \log NGBC_{t-1}.$$

After replacing the linear combination of the lagged level of variables in the ARDL model Eq.(19) by ECt-1, we re-estimate the model by imposing the same lag structure selected by the AIC criterion, and look for the significance of ECt-1. A negative and significant coefficient of ECt-1 will be an indication of co-integration. As can be seen from Table3, the ECt-1 carries an expected negative sign, which is highly significant, indicating that,M1 and M2, net claims on the government, net foreign assets, and rate of profit on bank deposit (interest rate) are co-integrated. We also report the Lagrange Multiplier (LM) statistic for serial correlation and

Ramsey's RESET test for functional specification. Since our calculated LM statistic is less than the critical value we conclude that the residuals of the estimated ARDL are free from serial correlation. and also, since our calculated RESET statistic is less than its critical value we conclude that the ARDL model is correctly specified.

Appendix tables reports the results for M1 monetary aggregate. As can be seen, there is co-integration relation as indicated by the significant coefficient attached to ECt-1 or by significant long-run coefficient estimates reported in Panel B.

The existence of a stable and predictable relationship between the supply of money and its determinants is considered a necessary condition for the formulation of monetary policy strategies based on intermediate monetary targeting. In the third stage the stability of the long-run coefficients are used to form the error-correction term in conjunction with the short run dynamics. As pointed by Laidler (1993) and noted by Bahmani-Oskooee (2001), some of the problems of instability could stem from inadequate modeling of the short-run dynamics characterizing departures from the long run relationship. Hence, it is expedient to incorporate the short run dynamics for constancy of long run parameters. In view of this we apply the CUSUM and CUSUMSQ tests proposed by Brown, Dublin and Evans (1975).

The CUSUM test is based on the cumulative sum of recursive residuals based on the first set of n observations. It is updated recursively and is plotted against the break points. If the plot of CUSUM statistic stays within 5% significance level, then estimated co-effects are said to be stable. Similar procedure is used to carry out the CUSUMSQ that is based on the squared recursive residuals.

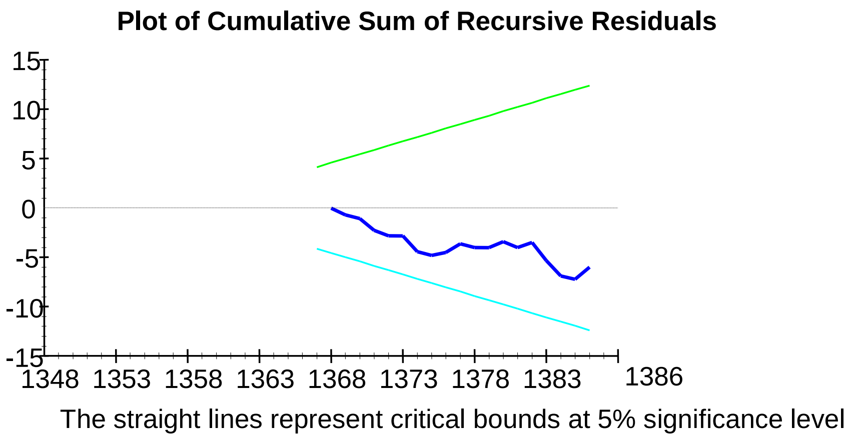
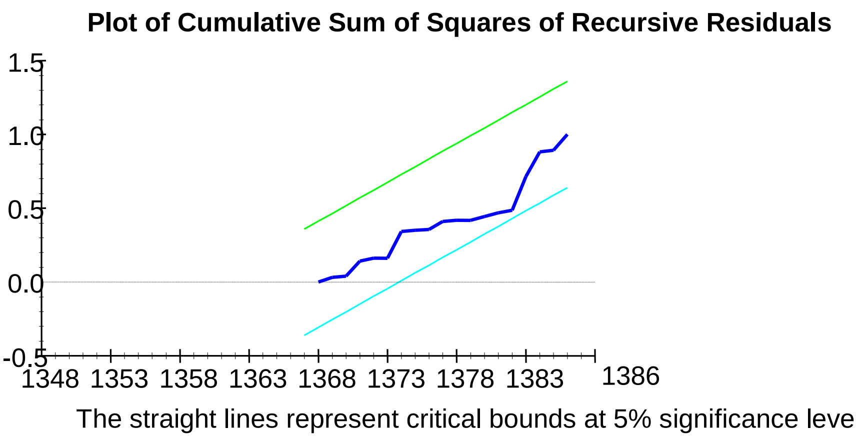


Figure 2: A graphical presentation of these two tests for M1



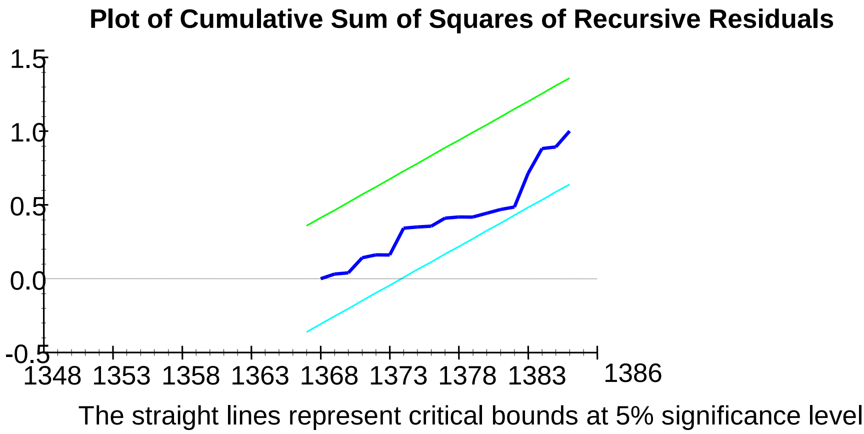
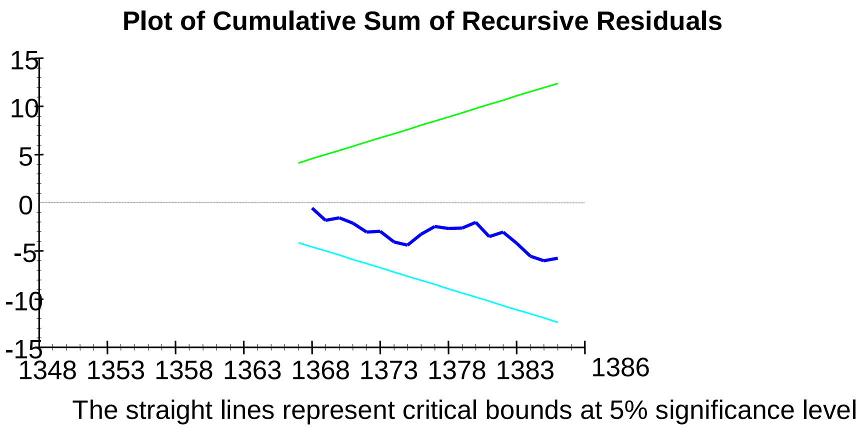


Figure 3: A graphical presentation of these two tests for M2



Since the plots of CUSUM and CUSUMSQ statistic for M1 and M2 do not cross the critical value lines, we are safe to conclude that M1, M2 and money supply is stable.

Conclusions

The paper investigated the co-integrating property and stability of the supply of money function in Iran. The paper employed the ARDL approach together with CUSU Mand CUSUMSQ tests. The results show that M1 and M2 is co-integrated with net claims on the government, net foreign assets, and rate of profit on bank deposit (interest rate) .With respect to stability, the results show that the estimated relation is somewhat stable most especially with CUSUM test. The question, then, is what are the implications of these findings on policy formulation in Iran?

One, the result shows that there is co-integration among M2,NFA, RP, NGB and a major implication of using interest rate elasticity estimates from M2 function is that money is endogenous and argues that endogenity of money matters for both short run comparative static macroeconomics and longer run macro dynamics. Second, the endogenity of money means that attempts to control the economy through monetarist styled money supply rules and targets are likely fail. This suggests that policy authorities should look to other means of control. The notion that the supply of money is, or could be, carefully controlled as in Friedman's famous money supply growth rate rule is also rejected.

Third, the money supply is a function of the currency-money ratio, the excess reserve ratio, the required reserve ratio and the monetary base . Therefore, monetary base is the main factor and main determinant of money supply. Among the three elements of monetary base, only the third part is under the control of central bank and the other two elements are fall out of the control limit of monetary authorities and therefore, considering the net foreign assets in the years before the revolution and share deficit of in the years before the revolution and share deficit of budget after revolution in the total monetary base, it become apparent that the money supply in Iran was affected by the rate of import and export , commercial policies and mainly under the influence of rate of sale of oil and annual budget and therefore, the Central Bank was only able to control once again the debt of banks by resorting to means i.e. authorized limitation of credit, rate of discount, determining the legal ratio, proportion of purchasing bonds. But considering that the share of debt of bank was little in the total monetary base and the share of money-multiplier was little in the growth of supply of money.

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APPENDEX (1)

Autoregressive Distributed Lag Estimates

ARDL(1,1,0,0) selected based on Akaike Information Criterion

****

Dependent variable is LM2

39 observations used for estimation from 1348 to 1386

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LM2(-1)	.96751	.011191	86.4552[.000]
NFA	.2173E-5	.8342E-6	2.6052[.014]
NFA(-1)	-.2583E-5	.1172E-5	-2.2040[.035]
NGB	-.1522E-5	.9221E-6	-1.6510[.109]
LRP	.35196	.10718	3.2838[.002]
C	-.28628	.21818	-1.3121[.199]
D4	.058375	.040032	1.4582[.155]

****

R-Squared	.99947	R-Bar-Squared	.99937
S.E. of Regression	.064376	F-stat. F(6, 32)	10092.1[.000]
Mean of Dependent Variable	9.8166	S.D. of Dependent Variable	2.5705
Residual Sum of Squares	.13262	Equation Log-likelihood	55.4966
Akaike Info. Criterion	48.4966	Schwarz Bayesian Criterion	42.6741
DW-statistic	1.4945	Durbin's h-statistic	1.5823[.114]

****

Diagnostic Tests

****

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1)= 1.7373[.187]	F(1, 31)= 1.4453[.238]
B:Functional Form	CHSQ(1)= 2.2587[.133]	F(1, 31)= 1.9057[.177]

* C:Normality *CHSQ(2)= 1.3071[.520]* Not applicable *
* * * *
* D:Heteroscedasticity*CHSQ(1)= 6.5088[.011]*F(1, 37)= 7.4121[.010]*
****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,1,0,0) selected based on Akaike Information Criterion
****
Dependent variable is LM2
39 observations used for estimation from 1348 to 1386
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
NFA	-.1262E-4	.1441E-4	-.87558[.388]
NGB	-.4686E-4	.3602E-4	-1.3011[.203]
LRP	10.8323	4.1423	2.6150[.013]
C	-8.8109	7.5063	-1.1738[.249]
D4	1.7966	1.0338	1.7378[.092]

****
Error Correction Representation for the Selected ARDL Model
ARDL(1,1,0,0) selected based on Akaike Information Criterion
****
Dependent variable is dLM2
39observations used for estimation from 1348 to 1386
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob[
dNFA	.2173E-5	.8342E-6	2.6052[.014]
dNGB	-.1522E-5	.9221E-6	-1.6510[.108]
dLRP	.35196	.10718	3.2838[.002]
dC	-.28628	.21818	-1.3121[.199]
dD4	.058375	.040032	1.4582[.154[

ecm(-1) -.032491 .011191 -2.9034[.007]
****

List of additional temporary variables created:
dLM2 = LM2-LM2(-1(
dNFA = NFA-NFA(-1(
dNGB = NGB-NGB(-1(
dLRP = LRP-LRP(-1(
dC = C-C(-1(
dD4 = D4-D4(-1(
ecm = LM2 + .1262E-4*NFA + .4686E-4*NGB -10.8323*LRP + 8.8109*C - 1.7966*D4
****

R-Squared .38815 R-Bar-Squared .27343
S.E. of Regression .064376 F-stat. F(5, 33) 4.0602[.006[
Mean of Dependent Variable .23447 S.D. of Dependent Variable .075524
Residual Sum of Squares .13262 Equation Log-likelihood 55.4966
Akaike Info. Criterion 48.4966 Schwarz Bayesian Criterion 42.6741
DW-statistic 1.4945
****

R-Squared and R-Bar-Squared measures refer to the dependent variable dLM2 and in cases where the error correction model is highly restricted, these measures could become negative.

APPENDEX (2)

Autoregressive Distributed Lag Estimates
ARDL(1,1,0,0) selected based on Akaike Information Criterion

```
*******************************************************************************
 Dependent variable is LM1
 39 observations used for estimation from 1348 to 1386
*******************************************************************************
 Regressor          Coefficient      Standard Error       T-Ratio[Prob]
 LM1(-1)              .98141          .013356             73.4824[.000]
 NFA                 .1923E-5         .1071E-5             1.7966[.082]
 NFA(-1)            -.2847E-5          .1507E-5           -1.8894[.068]
 NGB                -.3321E-5         .1187E-5            -2.7978[.009]
 LRP                  .53390          .13549               3.9406[.000]
 C                  -.78702          .28022               -2.8086[.008]
 D4                 -.0050882         .050943             -.099881[.921]
*******************************************************************************
 R-Squared                  .99912   R-Bar-Squared                 .99895
 S.E. of Regression         .082702   F-stat.    F(  6,  32)    6024.5[.000]
 Mean of Dependent Variable    9.0126   S.D. of Dependent Variable    2.5518
 Residual Sum of Squares      .21887   Equation Log-likelihood       45.7271
 Akaike Info. Criterion      38.7271   Schwarz Bayesian Criterion    32.9047
 DW-statistic               1.4009   Durbin's h-statistic      1.8773[.060]
*******************************************************************************
                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version         *         F Version         *
*******************************************************************************
*                    *                           *                           *
* A:Serial Correlation*CHSQ(   1)=   1.5290[.216]*F(   1,  31)=   1.2650[.269]*
*                    *                           *                           *
* B:Functional Form   *CHSQ(   1)=   5.5775[.018]*F(   1,  31)=   5.1733[.030]*
*                    *                           *                           *
* C:Normality         *CHSQ(   2)=   .89846[.638]*       Not applicable        *
*                    *                           *                           *
```

* D:Heteroscedasticity*CHSQ(1)= 5.8837[.015]*F(1, 37)= 6.5737[.015]*
****

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,1,0,0) selected based on Akaike Information Criterion
****

Dependent variable is LM1
39 observations used for estimation from 1348 to 1386
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
NFA	-.4970E-4	.5149E-4	-.96527[.342]
NGB	-.1787E-3	.1575E-3	-1.1341[.265]
LRP	28.7171	20.0244	1.4341[.161]
C	-42.3320	34.5429	-1.2255[.229]
D4	-.27368	2.8498	-.096036[.924]

****

Error Correction Representation for the Selected ARDL Model
ARDL(1,1,0,0) selected based on Akaike Information Criterion
****

Dependent variable is dLM1
39 observations used for estimation from 1348 to 1386
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dNFA	.1923E-5	.1071E-5	1.7966[.082]
dNGB	-.3321E-5	.1187E-5	-2.7978[.009]
dLRP	.53390	.13549	3.9406[.000]
dC	-.78702	.28022	-2.8086[.008]
dD4	-.0050882	.050943	-.099881[.921]
ecm(-1)	-.018592	.013356	-1.3920[.173]

****

List of additional temporary variables created:
dLM1 = LM1-LM1(-1)
dNFA = NFA-NFA(-1)
dNGB = NGB-NGB(-1)
dLRP = LRP-LRP(-1)
dC = C-C(-1)
dD4 = D4-D4(-1)
ecm = LM1 + .4970E-4*NFA + .1787E-3*NGB -28.7171*LRP + 42.3320*C + .27368*D4
****

R-Squared	.35069	R-Bar-Squared	.22894
S.E. of Regression	.082702	F-stat. F(5, 33)	3.4565[.013]
Mean of Dependent Variable	.22349	S.D. of Dependent Variable	.094182
Residual Sum of Squares	.21887	Equation Log-likelihood	45.7271
Akaike Info. Criterion	38.7271	Schwarz Bayesian Criterion	32.9047
DW-statistic	1.4009		

****

R-Squared and R-Bar-Squared measures refer to the dependent variable dLM1 and in cases where the error correction model is highly restricted, these measures could become negative.