# An Estimation of Iran Money Demand Function Considering Asymmetric Effects of Exchange Rate and Household Religious Costs

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## ABSTRACT

There are many studies about demand for money in Iran, varying in variables and methods. But in this research, first, we used real amount of money, real M1, as dependent variable. Real GDP, real interest rate, real exchange rate, and real household religious costs are explanatory variables. Second, we included household religious costs (urban and rural) as a religious measure of Iran Islamic-based economy. And third, we employed NARDL framework to determine asymmetric effects of exchange rate and household religious costs on M1, simultaneously.

By employing NARDL method and using bounds testing approach and, results demonstrate that there is a cointegration relationship between variables. Both GDP and interest rate show positive long run effects on M1. Furthermore, employing Wald test to check asymmetric effects revealed that negative and positive movements of exchange rate and household religious costs have asymmetric effects on M1, both in short and long run.

## Keywords:

Money Demand, Household Religious Cost, Nonlinear ARDL

## 1. Introduction

Money demand is an important issue in monetary and banking economics. There are a lot of studies about Iran money demand, but there are some new aspects here. First, we used amount of money, M1, as dependent variable. Second, household religious costs is included in money demand function as a religious determinant, because of Islamic-based economy of Iran. Third, we applied NARDL framework to study asymmetric effects of exchange rate and household religious costs, simultaneously.

In section 2, a brief review of literature and previous studies has been provided. Econometrics methodology is in section 3. Results are in section 4 and a conclusion is in section 5.

## 2. Literature Review

There is a full background for money demand literature and studies. Therefore, we only represent a summary where meets our goals. Theoretically, concepts of money demand is based on Fisher (1930), Keynes (1930, 1936), Baumol (1952), Friedman (1953), and Tobin (1958) studies. Their studies suggest main ideas about concepts of demand for money. However, there are a lot of empirical studies, such as Blejer (1978), Arango and Nadiri (1981), Bahmani-Oskooee and Rhee (1994), Bahmani-Oskooee (1996), Arize and Shwiff (1998), Bahmani-Oskooee, Martin, and Niroomand (1998), Arize, Malindretos, and Shwiff (1999), Hueng (2000), Bahmani-Oskooee and Chomsisengphet (2002), Bahmani-Oskooee and Ng (2002), Nezhad and Askari (2006), Bahmani-Oskooee and Bahmani (2015), Bahmani-Oskooee et al. (2019), and Eidi et al. (2019).

Bahmani-Oskooee and Bahmani (2015), demonstrate that failure of insignificant relationship between exchange rate and demand for money in Iran is due to a linear assumption of variables. So they introduced nonlinearity into the model and they found that the impact of exchange rate in short and long run is in an asymmetric way.

Bahmani-Oskooee et al. (2019) perform both ARDL and NARDL frameworks to determine nonlinearity of exchange rate for selected emerging economies. They demonstrate that linear models are not successful to explain impact of exchange rate movements on money demand. In contrast, nonlinear models mostly show an asymmetric effect of exchange rate on demand for money, both in short and long run.

Eidi et al. (2019) using a NARDL framework for Iran money demand function including real M2 as dependent variable and real GDP, real interest rate, real exchange rate, and negative and positive changes of real household religious costs as explanatory variables, demonstrate that all variables have significant effect on M2. Also, asymmetric effects of household religious costs is established.

## 3 Methodology

The methodology of the study is mainly based on Pesaran and Shin (1998), Pesaran, Shin, and Smith (2001), and Shin, Yu, and Greenwood-Nimmo (2014). Empirical studies can referred to Bahmani-Oskooee and Bahmani (2015), Bahmani-Oskooee and Mohammadian (2016), Bahmani-Oskooee et al. (2019), and Eidi et al. (2019).

### 3.1 NARDL Model

We consider Iran money demand function as below:

$$LnM1_t = \alpha_1 + \alpha_2 LnY_t + \alpha_3 R_t + \alpha_4 LnEX_t + \alpha_5 LnRC_t + \varepsilon_t$$

Where M1 is real amount of money, Y is real GDP as a measure of income, R is real interest rate, EX is real exchange rate, and RC is real household religious costs (urban and rural). As we want to study asymmetric effects of exchange rate and household religious costs on Iran money demand, we have to define their nonlinearity into the equation 1. Consider X as a known variable, according to Shin et al. (2014), we can divide it into negative and positive movements:

$$LnX_t = LnX_0 + LnX_t^- + LnX_t^+ \quad (2)$$

$$LnX_t^- = \sum_{s=1}^{t} \Delta LnX_s^- = \sum_{s=1}^{t} \min(\Delta LnX_s, 0) \quad (3)$$

$$LnX_t^+ = \sum_{s=1}^{t} \Delta LnX_s^+ = \sum_{s=1}^{t} \max(\Delta LnX_s^+, 0) \quad (4)$$

Where $LnX_t^-$ and $LnX_t^+$ are partial sum processes of negative and positive changes in variable X. According to equations 2, 3, and 4, we can insert nonlinearity of EX and RC into the equation 1. Thereby, we can rewrite equation 1 as below:

(5)

Equation 5 is a long run model considering asymmetric effects of EX and RC. We can represent equation 5 in a conditional error correction (EC) form:

$$\begin{aligned}\Delta LnM1_t &= \theta_1 + \sum_{i=1}^{n1}\theta_2 \Delta LnM1_{t-i} + \sum_{i=0}^{n2}\theta_3 \Delta LnY_{t-i} + \sum_{i=0}^{n3}\theta_4 \Delta R_{t-i} \\ &+ \sum_{i=0}^{n4}\theta_5 \Delta LnEX^{-}_{t-i} + \sum_{i=0}^{n5}\theta_6 \Delta LnEX^{+}_{t-i} + \sum_{i=0}^{n6}\theta_7 \Delta LnRC^{-}_{t-i} + \sum_{i=0}^{n7}\theta_8 \Delta LnRC^{+}_{t-i} \\ &+ \lambda_1 LnM1_{t-1} + \lambda_2 LnY_{t-1} + \lambda_3 R_{t-1} \\ &+ \lambda_4 LnEX^{-}_{t-1} + \lambda_5 LnEX^{+}_{t-1} + \lambda_6 LnRC^{-}_{t-1} + \lambda_7 LnRC^{+}_{t-1} + \varepsilon_t \end{aligned} \quad (6)$$

In this form, we have all the short run and long run coefficients, simultaneously. First we have to estimate equation 6, to estimate all the coefficients. Then we have to check diagnostic tests to ensure about quality of the estimated model. Then we will perform a bound testing, based on Pesaran et al. (2001), to test existence of cointegration between variables. That means a F-test will applied to test a null hypothesis of $H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0$.

If we reject the null hypothesis, then a cointegration relationship is established. The F-statistic used in bound testing approach is not a standard F-test, so critical values are provided by Pesaran et al. (2001). Null hypothesis will be reject, if calculated F-statistic is higher than upper critical bound. A F-statistic less than lower critical bound, leads to the claim that there is no cointegration relationship between variables. And finally, if calculated F-statistic lies between upper and lower bounds, then bound testing approach is inconclusive. At the end, a Wald test will employed to test for asymmetric effects of EX and RC, both in short and long run.

## 3.3 Data

We used quarterly data between 1376 and 1396. The source of current GDP and current household religious costs (urban and rural) is Statistical Centre of Iran, and nominal M1, nominal interest rate, and nominal exchange rate are from Central Bank of Iran. All variables, except interest rate, are changed to real ones by using their nominal data and CPI[1] (Base year=1395). For real interest rate, we calculated real interest rate by Fisher equation, using nominal interest rate and inflation rate.

# 4 Results

Generally, a unit root test is a primary step for estimating a time series model, but in ARDL method it is not necessary to perform a pre-test because we are free to use a combination of I(0) and I(1) variables. Even so, we performed an Augmented Dickey-Fuller (ADF) test for logarithm of all the variables to make sure that none of them are I(2). The results shows that logarithm of all the variables are I(0) or I(1).

For estimating equation 6, we have to select the best orders of lags. Hence, we applied a maximum 6 lags to all variables to select a combination of lag orders according to Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan–Quinn information criterion (HQ). Comparing the outputs of these three selection criteria show that the model selected by Hannan–Quinn criterion is the best one, so we used it as our estimation. The estimated short run coefficients of the selected output is provided in table 1.

[Table 1 near hear]

Considering the estimated model, we have to check diagnostic tests to make sure of no problem. Diagnostic tests results are provided in table 2. Therefore, residuals are normally distributed, there is no serial correlation and no heteroskedasticity, and finally, no model misspecification.

[Table 2 near hear]

In addition, CUSUM[2] and CUSUMSQ[3] tests results are shown in figure 1, which reveal stability of the estimated model.

[Figure 1 near hear]

Afterwards, we can use bound testing F-statistic to test for cointegration. Calculated F-statistic and bounds values related to different significance levels are provided in table 3. Calculated F-statistic, 10.31, is more than critical upper bounds in all significance levels, so we can strongly reject the null hypothesis of no cointegration. In presence of cointegration relationship between variables, we are allowed to interpret long run coefficients in equation 5.

[Table 3 near hear]

Estimated long run coefficients are shown in table 4. Actually, long run coefficients are calculated by dividing $\lambda_2$ to $\lambda_7$ by $\lambda_1$. The results show that all the

[1] Consumer Price Index

[2] Cumulative sum

[3] Cumulative sum of the squares

long run coefficients are statistically significant. Estimated long run coefficients for GDP, interest rate, negative and positive changes in exchange rate, and negative and positive changes in household religious costs are 0.95, 0.01, 0.71, -0.18, 0.60, and -0.33, respectively.

[Table 4 near hear]

To test asymmetric effects of exchange rate and household religious costs both in short and long run, we employed Wald test with a null hypothesis of no asymmetric effect. Wald tests results establish asymmetric effect for exchange rate and household religious costs both in short and long run.

**5 Discussion**

In this research we tried to estimate a money demand function for Iran. We used real amount of money, named M1, as dependent variable and real GDP, real interest rate, real exchange rate, and real household religious costs as explanatory variables. Household religious costs is included in money demand function, because of Islamic bases of Iran economy. We applied NARDL framework to determine asymmetric effects of exchange rate and household religious costs on demand for money, using quarterly data between 1376 and 1396.

Using bound testing approach to find out if there is a cointegration relationship between variables, calculated F-statistic strongly leads us to presence of a cointegration. Hence, we could interpret the estimated long run model. Both GDP and interest rate have positive effect on amount of money, M1. Estimated coefficients of partial negative and positive elements of exchange rate are statistically significant also checked by Wald test, reveal asymmetric effects of exchange rate on M1. As well, estimated coefficients of partial negative and positive elements of household religious costs are statistically significant, checked by Wald test, establish asymmetric effects of household religious costs on M1.

Totally, our research demonstrates that effects of exchange rate and household religious costs on amount of money, M1, are nonlinear or asymmetry, both in short and long run.

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## Tables

Table 1 Estimated short run coefficients

| Variable | Lag 0 | Lag 1 | Lag 2 | Lag 3 | Lag 4 | Lag 5 |
|---|---|---|---|---|---|---|
| ΔLnM1 | - | 0.354 (2.399)** | 0.322 (2.425)** | -0.011 (-0.093) | 0.549 (5.548)* | - |
| ΔLnY | 0.197 (1.860)*** | -0.559 (-4.047)* | -0.347 (-2.950)* | -0.217 (-2.010)** | -0.230 (-2.132)** | -0.289 (-2.763)* |
| ΔR | 0.003 (1.265)** | -0.004 (-1.733)*** | -0.005 (-2.229)** | 0.002 (-0.912) | -0.007 (-2.899)* | - |
| $\Delta EX^-$ | 0.563 (3.986)* | - | - | - | - | - |
| $\Delta EX^+$ | -0.178 (-1.767)*** | -0.009 (-0.084) | -0.261 (-2.344)** | - | - | - |
| $\Delta RC^-$ | 0.473 (5.503)* | - | - | - | - | - |
| $\Delta RC^+$ | -0.258 (-3.248)* | - | - | - | - | - |

Note: The first number is estimated coefficient and the second one is t-statistic.
One, two or three asterisks notations show 1%, 5%, and 10% significance levels, respectively.
Source: Research findings.

Table 2 Diagnostics tests results

| R-squared | Adj. R-squared | JB[4] | BG[5] | BPG[6] | RR[7] |
|---|---|---|---|---|---|
| 0.9877 | 0.9815 | 1.0203<br>(0.600) | 0.5043<br>(0.607) | 0.7497<br>(0.785) | 1.1105<br>(0.272) |

Note: The first number is estimated statistic and the second one is related probability.

Source: Research findings.

Table 3 Bounds testing results

| F-statistic | 10.131 | |
|---|---|---|
| Significance Level | Lower Bound | Upper Bound |
| 10% | 2.53 | 3.59 |
| 5% | 2.87 | 4 |
| 1% | 3.6 | 4.9 |

Source: Research findings

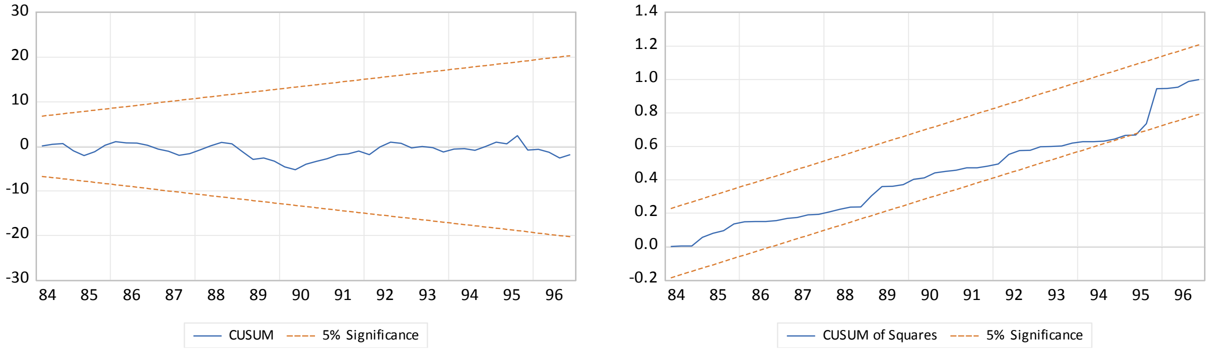
Table 4 Estimated long run coefficients

| Variable | Coefficient | Std. Error | t-Statistic | Probability |
|---|---|---|---|---|
| LnY | 0.951 | 0.085 | 11.110 | 0.000 |
| R | 0.005 | 0.002 | 2.138 | 0.037 |
| $LnEX^-$ | 0.713 | 0.208 | 3.429 | 0.001 |
| $LnEX^+$ | -0.182 | 0.042 | -4.303 | 0.000 |
| $LnRC^-$ | 0.599 | 0.097 | 6.171 | 0.000 |
| $LnRC^+$ | -0.328 | 0.098 | -3.351 | 0.001 |

Source: Research findings

**Figures**

Figure 1 CUSUM and CUSUMSQ




[4] Jarque-Bera statistic
[5] Breusch-Godfrey Serial Correlation LM test
[6] Breusch-Pagan-Godfrey Heteroskedasticity test
[7] Ramsey RESET test