Exchange Rate Volatility and Demand for Money in Iran

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ABSTRACT

In 1963, Nobel Laureate, Robert Mundell (1963) proposed the idea that the demand for money could depend on the exchange rate, in addition to income and the interest rate. In this paper, by using data from post revolutionary Iran and the bounds testing approach to cointegration, we attempt to discover another determinant of the demand for money. We argue that, in addition to Mundell's theory on exchange rate being an important determinant of the demand for money, exchange rate volatility also serves as another important variable than impacts demand for money and should therefore be included in the money demand function. Our results reveal that indeed, exchange rate volatility has both short-run as well as long-run effects on the demand for real M2 monetary aggregate in Iran, during the post revolutionary period of 1979 to 2007, and is therefore a very important determinant when it comes to the demand for money.

Key words: Money Demand, Exchange Rate Volatility, Bounds Testing, Iran.

JEL Classification: E41, F30

I. Introduction

In 1963, Nobel Laureate, Robert Mundell (1963) was the first to propose the idea that the exchange rate is another important determinant of the demand for money because it plays a critical role and should therefore be included in the money demand function. He asserted that, "The demand for money could depend on the exchange rate in addition to income and the interest rate," (p. 175). Though Mundell was the first to introduce this proposition, he did not have any empirical proof that justified his theory. Subsequent studies, especially those during the current float, tried to justify the link between exchange rate changes and the demand for money empirically since Mundell had not taken this important step. For example, Arango and Nadiri (1981) argued and empirically demonstrated that a depreciation of domestic currency, or an appreciation of foreign currency, raises the domestic currency value of foreign assets held by domestic residents, which could be perceived by people as an increase in wealth, hence an increase in the demand for money. However, Bahmani-Oskooee (1996) argued that if a depreciation of domestic currency results in an increase in expectations of further depreciation, the public may decide to hold more foreign currency and less domestic money. Thus, rather than raising the demand for money, a depreciation could result in a decrease in the demand for domestic currency. The final end result is completely dependent on the magnitude and the strength of the wealth effect compared to that of the expectation effect.[1]

The main contribution of this paper is to demonstrate that since exchange rate volatility could make the wealth effect or expectation effect uncertain, it could have a direct impact on money demand, and should, therefore, be considered as another determinant to be included in the money demand function due to the vital role it plays. To this end, a money demand function that includes a measure of exchange rate volatility is specified in Section II. The estimation method is also

[1] Other examples of studies that have included the exchange rate in the money demand function include Marquez (1987), McNown and Wallace (1992), and Bahmani (2008).

explained in that section. Section III provides the empirical support to justify that indeed, exchange rate volatility has both short-run and long-run effects on the demand for M2 monetary aggregate and should therefore be included as an important determinant of the demand for money function. Section IV provides a summary of the major findings as well as concluding remarks, while data sources and the definitions of variables appear in the Appendix.

II. The Model and the Method[2]

Any money demand function in the literature includes a scale variable measured by income, an opportunity cost variable measured by interest rate or the rate of inflation, and the exchange rate, which accounts for currency substitution. The specification here follows that of Bahmani-Oskooee (1996), who estimated a money demand function for the high-inflation country of Iran, by including real GDP, denoted by Y, inflation rate, which is measured by Log (P_t/P_{t-1}) where P denotes the Consumer Price Index, and the nominal exchange rate, denoted by EX. Using data from the Iranian economy, it was proven that in countries where there is a black market for foreign exchange, the black market exchange rate and not the official exchange rate should be included in the money demand function. Furthermore, the study argued that due to the lack of well-developed financial markets in Iran, the inflation rate should be used as an alternative measure for the opportunity cost of holding money. Most Iranians do speculate in the market for housing and land rather than in financial markets.[3] Additionally, interest rates are not market determined and they are fixed by the government for extended time periods, which justifies why, in the case of Iran, the inflation rate is used as a proxy for the opportunity cost of holding money. Therefore, with the usual money demand

[2] The methodology here closely follows Bahmani-Oskooee and Tanku (2008).
[3] Just like the United States, the housing bubble in Iran has burst and prices have fallen almost 30% from their peak.

specification we now add a volatility measure of the real exchange rate and we use the following long-run demand for money function in Iran:

$$LnM_t = a + bLnY_t + cLn(P_t / P_{t-1}) + dLnEX_t + eLnVEX_t + \varepsilon_t \qquad (1)$$

Based on the vast monetary theory literature, we expect an estimate of b to be positive, while we expect an estimate of c to be negative. However, as mentioned in our discussion earlier in the previous section, the estimates of both d and e could be positive or negative. In addition to estimating equation (1) and testing the significance of the exchange rate volatility measure, *VEX*, an important issue is whether including exchange rate volatility results in a stable money demand or not. Laidler (1993, p. 175) had discovered that inadequate modeling of the short-run dynamics can lead to problems with instability in the money demand function. We follow Laidler in order to test for stability of equation (1) and we also incorporate the short-run adjustment mechanism to avoid the dynamics issue when estimating the long-run money demand (1) by specifying it in an error-correction format. We follow Pesaran *et al.*'s (2001) bounds testing approach and rewrite equation (1) as equation (2):

$$\Delta LnM_t = \alpha + \sum_{i=1}^{n1} \beta_i \Delta LnM_{t-i} + \sum_{i=0}^{n2} \delta_i \Delta LnY_{t-i} + \sum_{i=0}^{n3} \gamma_i Ln(P_t / P_{t-1})_{t-i} + \sum_{i=0}^{n4} \eta_i \Delta LnEX_{t-i} + \sum_{i=0}^{n5} \lambda_i \Delta LnVEX_{t-i} + \rho_0 LnM_{t-1} + \rho_1 LnY_{t-1} + \rho_2 Ln(P_t / P_{t-1})_{t-1} + \rho_3 LnEX_{t-1} + \rho_4 LnVEX_{t-1} + \varepsilon_t \qquad (2)$$

By specifying the long-run money demand (1) in an error-correction model in equation (2), the short-run as well as the long-run effects of all the right-hand side variables in equation (1) are estimated in one step, which is a major advantage that error-correction modeling has in comparison to other specifications. We use a set criterion and we also select the optimum lags when estimating equation (2), following Bahmani-Oskooee and Tanku (2008). The coefficient estimates of all the first-differenced variables explain the short-run effects while the long-run effects are explained by the estimates of ρ_1- ρ_4 that are normalized on ρ_0.[4] We must justify the joint significance of lagged level variables as a sign of cointegration in order for the long-run coefficients to be of meaning and value. Pesaran *et al*. (2001) highly recommends the standard F test with new critical values that they tabulate. They provide an upper bound critical value when assuming all variables are I(1) and they provide a lower bound critical value when assuming all variables are I(0). In the case that some variables are I(1) and other variables are I(0), the authors show that the upper bound critical value is still valid, which is a major advantage because it eliminates all pre-unit root testing. The bounds testing approach is highly appropriate in the case of our money demand model, portrayed in equation (1), because of the fact that money and income are I(1) while the inflation rate and the measure of exchange rate volatility are most likely I(0). In the next section we estimate (2).

III. The Results

Using annual data from Iran's post revolutionary period of 1979 to 2007, we estimate the error-correction model, depicted in equation (2). We concentrate on the post revolutionary period because before the Islamic Revolution of 1979, the official exchange rate and the black market exchange rate did not deviate too much and were not volatile at all. Furthermore, as a result of the availability of Iranian real GDP on an annual basis, we are limited to only annual data. We impose a maximum of three lags on each first-differenced variable because of the limited number of observations. By using Schwarz Bayesian Criterion, we are able to select optimum lags and we report the results of the optimum model in Table 1.

[4]For more details of normalization, see Bahmani-Oskooee and Tanku (2008).

Table 1 goes about here

In Table1, Panel A reports the short-run coefficient estimates. As can be seen, for each first-differenced variable, there is at least one coefficient estimate that is highly significant. This clearly indicates that all four of these variables: income, inflation rate, the exchange rate and exchange rate volatility do in fact have short-run effects on the demand for money in Iran. The major issue that needs to now be looked into is whether or not these short-run effects translate into the long run. In Table 1, Panel B reports the long-run results and these findings indicate that the short-run effects do in fact translate into the long run. The long-run income elasticity is 1.0086 and highly significant, implying that in Iran, a one percent economic growth rate requires a nearly one percent increase in the nation's money supply. Inflation rate carries its expected negative and highly significant coefficient as does the exchange rate. The exchange rate is defined as the number of Iranian rial per U.S. dollar, as the appendix indicates. Thus, an increase in the exchange rate reflects depreciation of the rial. It appears that in Iran, depreciation of the rial from 165 rials per dollar in 1979 to 9357 rials per dollar in 2007 has induced the expectation of further depreciation and resulted in less holding of rials and more holding of the reserve currency, the dollar.[5] Finally, exchange rate volatility carries a significantly negative coefficient, implying that exchange rate uncertainty in Iran results in less holding of rials and more holding of foreign exchange. Therefore, our newly introduced variable seems to have short-run as well as long-run effects.[6]

The long-run results would only be meaningful if we establish cointegration or the joint significance of lagged level variables in equation (2) first. The F test results as well as other diagnostics are reported in Panel C. As can be seen, our calculated F statistic of 9.81 is much higher

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[5]It should be mentioned that even though there is neither political nor strong trade relations between Iran and the U.S., the dollar still is the most desired foreign exchange.

[6] Our finding supplements Choi and Oh (2003) who demonstrated that output volatility and money volatility has short-run and long-run effects on the demand for money in the U.S. We now add exchange rate volatility to that list.

than the critical value of 3.79, providing strong support for cointegration. Next, using long-run coefficient estimates from Panel B we form an error-correction term, *ECM*.[7] After replacing the lagged level variables with ECM_{t-1}, we re-estimate the model one more time at the same optimum lags. From Panel C, it is evident that the significantly negative coefficient obtained for the lagged error-correction term supports adjustment toward equilibrium. The speed of adjustment itself, which is sixteen percent, seems somewhat low and is mostly due to rigidities in the Iranian economy. Also reported in the table are the results of the three other diagnostic tests that were conducted. The Lagrange Multiplier (LM) test statistic helps to test for the presence of autocorrelation, while the Ramsey's RESET statistic tests for functional misspecification, and a statistic to test for the normality of the residuals is also included. While the first two are distributed as χ^2 with only one degree of freedom, the last diagnostic statistic is distributed as χ^2 with two degrees of freedom. All three statistics are much less than their critical values reported at the bottom of Table 1. This means that we have a correctly specified model that is autocorrelation free and has normally distributed residuals. Furthermore, the estimated error-correction model enjoys a very high goodness of fit, as reflected by 93% adjusted R^2. Lastly, when we apply the CUSUM and CUSUMSQ tests to the residuals of the estimated error-correction model, because these two tests are well known for testing the stability of both the short-run and long-run coefficient estimates, a graphical presentation of these two tests reveals that the estimated coefficients are in fact stable because neither statistic crosses the critical values represented by the two straight lines, as demonstrated in Panel C of the table.

[7] For details of this step, again, see Bahmani-Oskooee and Tanku (2008).

IV. Summary and Conclusion

In 1963, the Nobel Laureate, Robert Mundell (1963) was the first to propose the idea that the demand for money could depend on the exchange rate in addition to two other critical variables, income and the interest rate. The main reason behind his conjecture is that an appreciation of foreign currency, or a depreciation of domestic currency, raises the domestic currency value of foreign assets that are held by domestic residents. If this is perceived by people as an increase in wealth, the demand for domestic currency could rise. However, if the depreciation of domestic currency induces the expectation of further depreciation, the opposite effect would take place with the public deciding to hold more foreign currency and less domestic currency. In this paper, we argue that since exchange rate volatility introduces uncertainty into the wealth or expectation effect, it could have a direct impact on the demand for money. Therefore, we conclude that exchange rate volatility should be included as another determinant of the money demand function.

By using annual data from post revolutionary Iran, over the period of 1979-2007, we are able to successfully demonstrate our main hypothesis. We conclude that a stable demand for money function in post revolutionary Iran needs to include income, the inflation rate, the exchange rate and a volatility measure of the real exchange rate. These four determinants of money demand are shown in this paper to all have short-run as well as long-run effects on the M2 monetary aggregate in Iran. Future research should concentrate on justifying our findings for other countries.

Appendix

All data are annual over the period 1979-2007 and collected from:
a. International Financial Statistics of the IMF (on line).
b. Bahmani-Oskooee (2005).

Variables:

Real Money (M2): Nominal monetary aggregate (M1) is added to quasi money to get nominal M2. Nominal M2 is then deflated by CPI (the only available price index in Iran) to obtain real money. All data come from source a.

Real Income (Y): In the absence of GDP deflator, nominal GDP is deflated by CPI to get real GDP. All data come from source a.

Ln (P_t/P_{t-1}): CPI-based rate of inflation**.** CPI data come from source a.

EX: The exchange rate defined as number of rials per U.S. dollar. In line with Bahmani-Oskooee (1996), the black market exchange rate is used here. Of course, since 2001 the official and the black market rates have been unified. Thus the data from 1979 till 2001 come from source b and after 2003, from source a.

VOL: Volatility measure of the rial-dollar rate. Following previous research, e.g., De Vita and Abbott (2004) and Bahmani-Oskooee and Mitra (2008), for each year, it is defined as standard deviation of the 12 monthly real bilateral rates (*REX*) within that year. The REX, in turn is constructed as (U.S. CPI x EX / Iranian CPI). Monthly CPI data for both countries come from source a and monthly nominal exchange rate data come from source a & b. It should be mentioned that prior to the introduction of cointegration analysis, the volatility measure was based on the standard deviation of *percentage changes* in the real exchange rate. Since cointegration and error-correction techniques do not require detrending the variables, rather than using the standard deviation of *percentage change* in the exchange rate, researchers now rely upon the standard deviation of the real exchange rate itself (Bahmani-Oskooee and Mitra, 2008).

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Table 1: Full-Information Estimate of Equation (3).

Panel A: Short-Run Coefficient Estimates

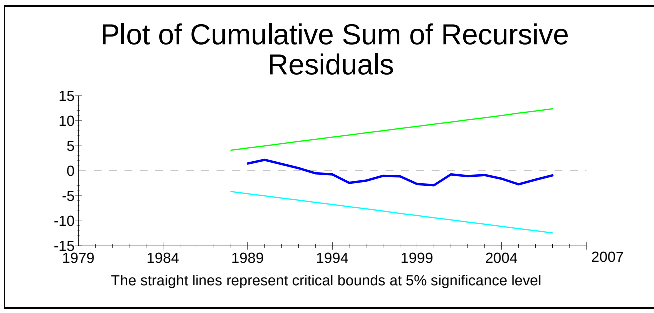
	Lag Order 0	1	2	3	4
Δ Ln M	-	-0.0626 (0.83)	-0.1961 (2.76)		
Δ Ln Y	0.30575 (5.78)				
ΔLn (P_t/P_{t-1})	-0.56696 (7.54)				
Δ Ln EX	-0.02588 (3.41)				
Δ Ln VEX	0.00152 (0.16)	0.03546 (4.98)			

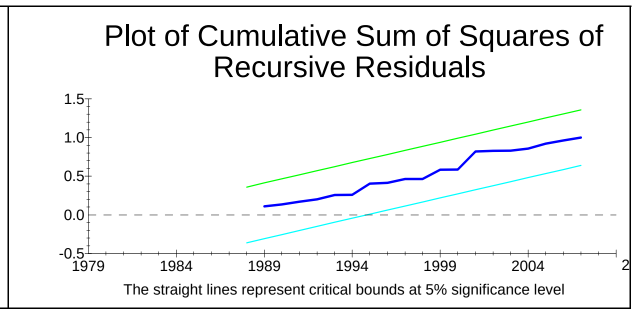
Panel B: Long-Run Coefficient Estimates

Constant	*Ln Y*	*Ln* (P_t/P_{t-1})	*Ln EX*	*Ln VEX*
2.1640 (1.33)	1.0086 (4.75)	-3.1864 (3.53)	-0.1455 (2.89)	-0.1725 (2.07)

Panel C: Diagnostic Statistics

F	ECM_{t-1}	*LM*	*RESET*	*Normality*	*Adj.* R^2
9.81	-0.1671 (7.78)	0.052	0.060	0.1676	0.93





Notes: a. Number inside parentheses are absolute value of t-ratios.

b. The upper bound critical value of the F statistic at the usual 5% level of significance is 3.79. This comes from Pesaran *et al.* (2001, Table CI-Case III, p. 300).

c. LM is the Lagrange multiplier test for serial correlation. It has a χ^2 distribution with one degrees of freedom. The critical value at the 5% level of significance is 3.84.

d. RESET is Ramsey's specification test. It has a χ^2 distribution with only one degree of freedom. The critical value at the 5% level of significance is 3.84.

e. The normality test is based on test of skewness and kurtosis of residuals. It has a χ^2 distribution with only two degrees of freedom. The critical value at the 5% level of significance is 5.99.