



# Money Demand Determinants and Stability in Yemen: An ARDL Approach to Cointegration

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*Received 1 February 2016, Revised 10 March 2016, Accepted 20 March 2016, Published 1 July 2016*

**Abstract:** This paper investigates the determinants and stability of narrow and broad real money demand functions in Yemen. The ARDL bounds testing approach to cointegration and error correction modeling were applied to quarterly data covering the period from 2001Q1 to 2013Q4. The empirical results suggest the existence of long-run relationships between real money balances (M1 and M2), and their determinants including real income, inflation rate, and exchange rate. The elasticity coefficients of the real income and inflation rate bear the predicted positive and negative signs respectively and found to be statistically significant. The dominance of the currency substitution effect is reflected in the negative sign of the elasticity coefficient of exchange rate. In addition, CUSUM and CUSUMSQ tests support the stability of both M1 and M2 models during the estimation period.

**Keywords:** Money demand, cointegration, bounds testing, Yemen.

## 1. INTRODUCTION

The importance of a well-specified and stable money demand function in designing and conducting monetary policy is widely recognized in theoretical and applied macroeconomics. Accordingly, the determinants and stability of money demand, have been receiving intensive attention via country-specific and cross-country studies. The selection of monetary policy targets and the effectiveness of such targeting depend on the identification of factors affecting money demand and the test of its stability. A stable relationship between money demand and its determinants indicates that money supply targeting is the appropriate choice for monetary policy to achieve its goals (Rutaysire, 2010). In contrast, if money demand appears to be instable, monetary authority should consider other intermediate targets. However, it is often suggested that even with monetary policy frameworks that apply other targets, such as inflation targeting, money aggregates still have a role to play. On the one hand, they can be used as supplementary target variables (Laidler, 1999). On the other hand, they are considered as sources of information in the prediction of inflation rates and as intervention indicators for monetary policy (Hayo, 1999).

Yemen is one of the least developed countries, with GDP per capita 1412 US\$ and a population of 24.88

million in 2013, about 46.6% of Yemen population has been estimated to live below the poverty line of 2 US\$ / day<sup>1</sup>. Yemen economy faced with several structural constraints which are reflected in a weak and inflexible productive capacity for different sectors. In 2013 and as a share of GDP, agriculture, manufacturing, and oil and gas extraction contributed by 15%, 8 %, and 23% respectively<sup>2</sup>. As a result, the country imports most of its needs starting from food to machinery and equipments on the one hand and has a limited and concentrated base of export on the other<sup>3</sup>.

The financial system is underdeveloped and thus limited financial intermediation and monetary policy transmission are available. A rudimentary, informal, and discretionary framework of monetary policy is implemented. It is only after several programs of economic and financial adjustment, during the second half of the 1990's, the central bank of Yemen (CBY) started targeting broad money supply via treasury bills and changing reserve requirements. Interest rate is subject to administrative control through the benchmark deposit rate set by the CBY, and as a result, this

<sup>1</sup> Poverty line percentage is that of 2005.

<sup>2</sup> Depending on Central Statistical Organization, statistical Year Book 2013. (Sana'a: CSO, 2014).

<sup>3</sup> Oil export represent more than 90% of total goods export and the rest dominated by other primary products.



instrument is considered as relatively rigid. In addition, the employment of interest rate instrument in a country like Yemen, is often suggested to be of limited impact due mostly to the lack of a well-developed financial market, as well as the role of the religious factor, which forbids interest-based transactions. Starting from 1997, the liberalization of the external sector, both current and capital accounts, coincided with the introduction of a managed float exchange rate regime instead of previous fixed rate regime. Chami et al. (2007) examine the exchange rate pass-through to domestic inflation in Yemen and found it to be significant. Accordingly, they conclude that exchange rate management must be considered in the formulation of monetary policy framework to keep inflation within the targeted rates in Yemen.

To the best of my knowledge, until today the study of Chami et al. (2007), is the only published econometrical investigation to the money demand function in Yemen. Applying OLS method on quarterly data for the period 2001Q1 - 2005Q2, they estimated a broad money demand function, using oil exports to represent real activity, and inflation rate and nominal exchange rate changes as variables of opportunity cost for holding money. The study confirms the significant impact of both inflation rate and lagged exchange rate changes on broad money demand. The real activity variable shows insignificant impact and carries the positive sign with very low value, which may reflect the use of inappropriate estimation method and the shortness of the time series used. The study also examines the stability of money demand function using Chow test and arrives at the conclusion that broad real money demand in Yemen appears to be instable.

The aim of this paper is to investigate the determinants and stability of real money demand in Yemen using quarterly data for the period from 2001Q1 to 2013Q4. The distinguished aspects of this study from Chami et al. (2007), lies in its coverage and use of robust and most recent econometrical tools. The current study covers the time period after 2005, and makes use of the new and robust cointegration technique namely, Autoregressive Distributed Lag (ARDL) bounds testing approach and error correction models. Moreover, the current study analyzes both narrow and broad definitions of real money balances (M1 and M2). From the perspective of the empirical literature of money demand in developing countries, this study may add some evidence to them as they are still looked upon as inconclusive. The rest of the paper is organized as follows. Section 2 reviews the recent empirical literature of money demand, particularly those of developing countries, whereas section 3 discusses model specification and econometrical techniques to be used.

Empirical analysis will be conducted in section 4. Section 5 is the last one where conclusions and policy recommendations of the study.

## 2. LITERATURE REVIEW

A vast amount of empirical literature has been devoted to money demand and its stability since the 1950's. Until the late 1970's, these literature mostly centered on industrial countries and used traditional modeling and econometrical tools. The problem of spurious regression and thus unreliability of statistical inference threw doubt on the results of these studies (see Philips, 1986). The 1980's and 1990's witnessed the introduction and development of cointegration techniques such as those of Engle-Granger (1987), Johansen (1988), Philips and Hansen (1990), and Johansen and Juselius (1990), as well as error correction models. The employment of these techniques and models addressed the stationarity issue and enhanced the reliability of statistical inference about the long-run equilibrium and short-run dynamics. Accordingly, during the 1990's numerous studies on money demand in developed and developing countries have been conducted using cointegration and error correction modeling<sup>4</sup>. However, these traditional cointegration techniques require the variables of the regression to be integrated of the same order and data samples to be of large size (Mah, 2000; Kremers et al. 1992). The ARDL bounds test developed by Pesaran and Shin (1996) and Pesaran et al. (2001) can be applied irrespective of whether the regressors are integrated of zero order, one, or mutually integrated. Furthermore, the bounds test is considered valid and suitable for small size samples (Narayan, 2004).

Our empirical literature review will focus on recent country-specific studies which mostly utilize cointegration techniques and error correction models. Real broad money demand proved to be cointegrated with real GDP, domestic and foreign interest rates, and exchange rate in Hong Kong in the study of Bahamani-Oskooee and Ng (2002) via adopting ARDL bounds testing and error correction models on quarterly data for the period 1985Q1-1999Q4. Besides, they arrive at the conclusion that broad real money balances are stable during the study period. Pradhan and Subramanian (2003) studied both narrow and broad money demand in India, employing Johansen cointegration procedure on monthly data for the period from 1970(04) to 2000(03). Both narrow and broad money demand found to have long-run relationships with their determinants, whereas their stability hypothesis could not be supported. Sriram (2009) employed Johansen-Juselius cointegration approach to study broad money demand in Gambia for

<sup>1</sup> See for detailed survey Sriram (1999).



the period of January 1988 – June 2007. It is found that money demand has a long-run relationship with real GDP, expected inflation, interest rate on short term deposits, and domestic treasury bills rate. The study finds instable relationship for broad money demand. Dagher and Kovanen (2011) test the stability of broad money demand in Ghana, applying ARDL bounds test and error correction models on quarterly data covering the period from 1990Q1 to 2009Q4. Their results provide strong evidence for the presence of a stable and well-identified money demand function during the study period, despite the fact that substantial changes in the financial markets occurred during this period. To examine both narrow and broad money demand functions and their stability in Nepal, Budha (2012) utilizes ARDL bounds test and error correction models on annual data covering 1975-2011. A long-run relationship is found between both definitions of money demand and real GDP, interest rate, and inflation rate. However, only narrow money demand function shows stability. Narrow and broad money demand of Pakistan studied by Anwar and Asghar (2012) depending on the ARDL bounds test and error correction models for the period from 1975 to 2009. Both narrow and broad money proved to be cointegrated with real GDP, inflation rate, and nominal exchange rate but, only broad money demand appeared to be stable.

**3. MODEL, METHODOLOGY, AND DATA**

In literature of money demand specification, usually two types of independent variables are included: scale variable representing economic activity and opportunity cost variables for holding money balances. Most empirical literature employ real GDP as a measure of real income as a scale variable whereas several variables can be included as measures of opportunity cost such as interest rates, inflation rate, exchange rate changes.

In this study real GDP will be used as a proxy for real income, whereas inflation rate and nominal exchange rate represent opportunity cost variables. In developing countries with high inflation pressures, controlled interest rates and less developed financial sector, the expected inflation rate is used as the rate of return on alternative financial assets (Sriram, 2009: 12). Accordingly, following Domowitz and Elbadawi (1987) and Bahmani-Oskooee (1996), the specification of real money demand function for Yemen is given by the following equation:

$$LM_t = \beta_0 + \beta_1 LY_t + \beta_2 INF_t + \beta_3 LEX_t + u_t, \quad (1)$$

where  $M_t$  is the desired real money balances,  $Y_t$  is real income,  $INF_t$  is inflation rate,  $EX_t$  is nominal exchange rate, and  $U_t$  is stochastic disturbance term.  $L$  denotes natural logarithm. The exclusion of interest rates reflects

the fact that deposit interest rate is still controlled by the CBY and thus anchors all other interest rates. On the other hand, the yield on treasury bills or certificates of deposit are not included as their buyers are the banks and other financial institutions.

The expected sign of income variable is positive ( $\beta_1 > 0$ ) as the increase in income raise the demand for money balances for transaction purpose, and the expected sign of inflation rate is negative ( $\beta_2 < 0$ ) as people desire less money balances and shift to real assets when inflation rate rise (Arestis, 1988). The dominance of either the substitution or wealth effect will determine exchange rate sign. If the sign of exchange rate is negative ( $\beta_3 < 0$ ), this means that an initial increase of exchange rate (depreciation of domestic currency) is expected to continue and thus holding domestic money imply high opportunity cost which lead to domestic money substitution by other foreign currencies, i.e. money demand decrease (Bahmani-Oskooee and Pourheydarian, 1990). When wealth effect of Arango and Nadiri (1981) dominates ( $\beta_3 > 0$ ), this means that an increase of exchange rate (depreciation of domestic currency), increases the domestic money value of foreign assets, and if considered as an increase in wealth, the demand for domestic money should increase.

The ARDL bounds testing to cointegration and error correction modeling proceed in stages. In the first stage, the existence of a cointegration relationship between real money demand and its determinants is tested by estimating a conditional ARDL representation of equation (1) as follows:

$$dLM_t = \beta_0 + \sum_{i=1}^n \beta_1 dLM_{t-i} + \sum_{i=0}^n \beta_2 dLY_{t-i} + \sum_{i=0}^n \beta_3 dINF_{t-i} + \sum_{i=0}^n \beta_4 dLEX_{t-i} + \beta_5 LM_{t-1} + \beta_6 LY_{t-1} + \beta_7 INF_{t-1} + \beta_8 LEX_{t-1} + e_t, \quad (2)$$

where  $d$  denotes the first difference operator and  $n$  is the maximum lag length. The parameters  $\beta_1$ - $\beta_4$  stand for the short-run dynamics whereas  $\beta_5$ - $\beta_8$  present the long-run relationship. Following the estimation of equation (2), a joint significance test of no cointegration relationship between the variables is implemented with the null hypothesis ( $H_0: \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$ ) as against the alternative hypothesis ( $H_1: \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8 \neq 0$ ).

The bounds test procedure of Pesaran et al. (2001) depends on the Wald test (F statistics) with an asymptotic non standard distribution. Pesaran et al. (1996) provide two bounds of critical values for different model



specifications. If the computed F statistic, at a chosen significance level, exceeds the upper critical bound value, the null hypothesis of no cointegration is rejected. Similarly, if the lower computed F statistics falls below the lower critical bound value, the null hypothesis of no cointegration is not rejected. When the computed F statistics falls between the two critical bound values, the result is considered inconclusive.

Once a long-run relationship is confirmed, the long-run elasticities are calculated from equation (2), or estimated using the following long-run model:

$$\begin{aligned} \text{LM}_t = & \mu + \sum_{i=0}^n \delta_1 \text{LY}_{t-i} + \sum_{i=0}^n \delta_2 \text{INF}_{t-i} \\ & + \sum_{i=0}^n \delta_3 \text{LEX}_{t-i} + \sum_{i=1}^n \delta_4 \text{LM}_{t-i} + \varepsilon_t \quad (3). \end{aligned}$$

The appropriate optimal lag length for each variable of model (3) can be selected, via applying different criteria such as AIC (Akaike Information Criterion), SBC (Schwarz Bayesian Criterion), HQ (Hanann-Quinn Criterion), and R (R Bar Squared Criterion). Microfit software estimates (regressions and selects the appropriate specification according to the chosen criterion, where  $\rho$  is the maximum lag length to be used and  $k$  is the number of variables included in the equation.

Estimating the ARDL short-run dynamics is the second step of ARDL bounds test, by formulating the error correction representation associated with the above long-run equation (3). It estimates the short-run coefficients and the speed of adjustment of real money demanded to changes in the explanatory variables before converging to its equilibrium level. The error correction model can be formulated as follows:

$$\begin{aligned} d\text{LM}_t = & \theta + \sum_{i=0}^n \alpha_1 d\text{LY}_{t-i} + \sum_{i=0}^n \alpha_2 d\text{INF}_{t-i} \\ & + \sum_{i=0}^n \alpha_3 d\text{LEX}_{t-i} + \sum_{i=1}^n \alpha_4 d\text{LM}_{t-i} \\ & + \Theta \text{ect}_{t-1} + \phi_t, \quad (4) \end{aligned}$$

where  $\Theta$  is the speed of adjustment parameter and  $\text{ect}$  is the residuals that are obtained from the estimation of equation (3). The structural stability of the parameters of money demand is tested using the CUSUM (cumulated sum of recursive residuals) and CUSUMSQ (cumulated sum of squares of recursive residuals) tests, suggested by Brown et al. (1975).

In this study, quarterly time series data for the period 2001Q1 – 2013Q4 are used. The variables used in this study are defined as follows:  $M_t$  is the nominal aggregate

money divided by consumer prices (2005=100) as a proxy to the desired real money balances. Both narrow definition of money  $M1$  and broad money  $M2$ , which issued by the CBY, will be investigated.  $M1$  is defined as the currency outside banks and the demand deposits.  $M2$  adds saving deposits, time deposits, and foreign currency deposits to  $M1$ .  $Y_t$  is the real GDP (2005=100) which, due to unavailability of quarterly series, obtained via the cubic spline interpolation of the annual data for real GDP.  $\text{INF}_t$  is inflation rate calculated based on consumer price index percentage change (2005=100).  $\text{EX}_t$  is the nominal exchange rate defined as the number of Yemeni Rial units per unit of U.S dollar. The data of  $M1$ ,  $M2$ ,  $\text{INF}_t$ , and  $\text{EX}_t$  were taken from International Financial Statistics CDROOM 2014. Microfit 4.1 software is used in different stages of the ARDL approach.

#### 4. EMPIRICAL RESULTS

##### A. Unit Root Test

Before the implementation of the ARDL bounds test, it is important to identify the degree to which the model variables are integrated to make sure they are not  $I(2)$  or higher. The augmented Dickey-Fuller (ADF) and Phillips-Perron tests are conducted and the results of both tests, reported in Table.1, show that  $\text{LM}1$ ,  $\text{LM}2$ ,  $\text{LEX}$  are  $I(1)$ , whereas  $\text{INF}$  is  $I(0)$ . This result lends support to the implementation of bounds test procedure.

TABLE 1. UNIT ROOT TEST

Variable	ADF Test		Phillips-Perron Test	
	Intercept	Intercept & trend	Intercept	Intercept & trend
LM1	-1.64	-2.88	-1.64	-2.96
dLM1	-8.35*	-8.33*	-8.41	-8.43*
LM2	-1.5	-1.28	-1.48	-1.5
dLM2	-6.64*	-6.69*	-6.63*	-6.69*
LY	-2.17	3.26	-2.05	-1.087
dLY	-3.64**	-2.47**	-4.23**	3.36**
INF	-7.18*	-7.19*	-7.76*	-9.11*
dINF	-8.4*	-8.33*	-26.3*	-27.19*
LEX	-3.72	-2.52	-3.15	-1.97
dLEX	-5.02*	-5.93*	-5.02*	-5.17*

Note: \*, \*\*, \*\*\* indicate 1%, 5%, and 10% significance level, Respectively.

##### B. Narrow Real Money Demand M1

Our empirical ARDL bounds test begins with testing the existence of a cointegration among the narrow money demand  $M1$ , real GDP, inflation rate, and exchange rate via performing F test to equation (2) as explained above. Table.2 shows that the computed F statistic (4.55) is higher than the upper bound critical value (3.78) and consequently, the null hypothesis of no cointegration between  $M1$  and its determinants can be rejected at the 5% significance level.





TABLE 2. BOUNDS TEST ANALYSIS FOR M1

Computed F statistic	4.55
Critical bound values at 5%	Lower = 2.86 upper = 3.78
K (number of regressors)	3
intercept and no trend in the model	

Note: critical values are from Pesaran et al.(2001: 300).

As the relationship between narrow real money demand and its determinants is found, we now estimate the elasticities via the estimation of equation (3). But we need first to determine the optimal lag length of the four variables LM1, LY, INF, and LEX, using SBI, AIC, HQ, and R Bar Squared criteria, with eight as a maximum lags length<sup>2</sup>. Table.3 shows the long-run elasticities of the selected narrow real money demand M1 model according to R Bar Squared criterion ARDL(4,3,8,3), which constitutes the best model, based on the explanatory power and the absence of major regression problems, among four models selected according to the four criteria (SBI(1,0,0,2), AIC(4,3,8,2), HQ(1,0,0,2), R(4,3,8,3)). Both LY, and INF bear the expected signs and are significant at 5% level. The income elasticity of less than one (0.63) is consistent with Baumol-Tobin framework. Despite the fact that the effect of exchange rate upon real money demand is insignificant, the resulted negative sign of LEX supports the argument of Bahmani- Oskaoee and Pourhedrian (1990) regarding the existence of substitution effect between domestic currency and foreign ones. When the exchange rate increase (Yemeni Rial depreciates), the demand for real domestic money decrease.

TABLE 3. M1 LONG RUN ELASTICITIES FOR ARDL(4,3,8,3)

Regressor	Coefficient	t-ratio [Probability]
LY	0.63	3.40(0.002)
INF	-.033	-2.32(0.027)
LEX	-.091	-.28(0.780)
INPT	4.02	3.21(0.003)

The estimated short-run elasticities, via the error correction representation of the above ARDL(4,3,8,3) model is displayed in Table.4. The sign of the lagged error correction term ect(-1) is negative and significant which confirms the long-run relationship between narrow real money demand and its determinants. The value of the coefficient of ect(-1) reveals a moderate speed (57% per quarter) of adjustment to changes in the explanatory variables before converging to its equilibrium value. The short-run elasticity of LY is significant at the 5% level only after one period lag and greater than that of the long-run(1.3). The short-run elasticity of the inflation rate

is negative and highly significant without any lag, despite its value is lower than that of the long-run. The elasticity of LEX is negative as predicted, but significant only after one period lag.

The explanatory power of the model is high and the diagnostic tests related to major regression problems are performed on the ARDL model upon which error correction models representation is established, and the results suggest the absence of these problems (see Table.4.

TABLE 4. M1 ERROR CORRECTION MODEL FOR ARDL(4,3,8,3)

Dependent variable dLM1		
Regressor	Coefficient	t-ratio probability]
dLy	0.16	0.026[0.79]
dLY1	1.3	2.06[0.046]
dLY2	-1.83	-3.19[0.003]
dINF	-0.0072	-4.6[0.000]
dINF1	0.01	1.37[0.178]
dINF2	0.0093	1.33[0.19]
dINF3	0.0071	1.20[0.24]
dINF4	0.0083	1.76[0.086]
dINF5	0.0030	0.86[0.396]
dINF6	0.0047	1.79[0.082]
dINF7	0.0033	1.86[0.071]
dLEX	0.011	0.031[0.975]
dLEX1	-1.01	-2.69[0.011]
dLEX2	-0.356	-1.06[0.295]
dINPT	2.3	2.52[0.016]
ect(-1)	-0.57	-4.32[0.000]
R-Squared 0.76 R-Bar Squared 0.61		
S.E of Regression 0.025 F(18, 37) 5.90[0.000]		
DW – Statistic 2.06		
Diagnostic test	LM version	F version
A:Serial Correlation	3.35[.501]	F(4, 30)= 0.48[.72]
B:Functional Form	1.58[.209]	F(1,33)= 0.96[.33]
C:Normality	0.6189[.734]	Not applicable
D:Heteroscedasticity	0.143[.706]	F(1,54)= 0.137[.712]

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.

To test the stability of the parameters of M1 function, we apply the CUSUM and CUSUMSQ to the error correction model. fig.1 and fig.2 reveal that the model of narrow money demand appears to be stable, as the plots of the CUSUM and CUSUMSQ remain within the critical bounds.

<sup>2</sup> The empirical studies usually use either 4 or 8 as lag length for quarterly data depending on the availability of dat.

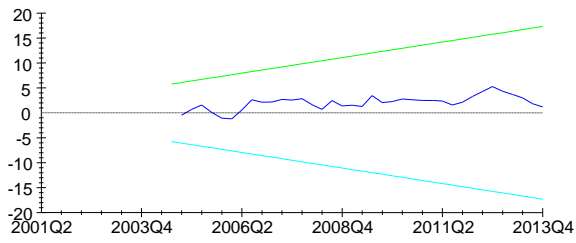


Figure 1. Plot of CUSUM for M1

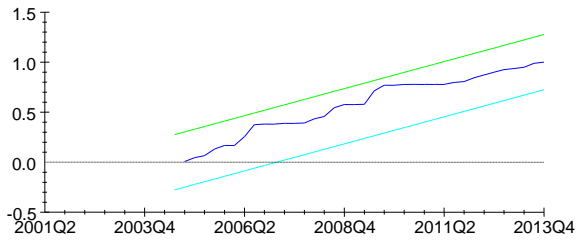


Figure 2. Plot of CUSUMSQ for M1

### C. Broad Real Money Demand M2

We begin by testing the existence of a cointegration between M2 and its determinants depending on F test as done before. Table.5 shows that the computed F statistic (5.38) is higher than the upper bound critical value (3.78) and consequently the null hypothesis of no cointegration between M2 and its determinants can be rejected at the 5% significance level.

TABLE 5. BOUNDS TEST ANALYSIS FOR M2

Computed F statistic	5.38
Critical bound values at 5%	Lower = 2.86 upper = 3.78
K (number of regressors)	3
intercept and no trend	

Note: critical values are from Pesaran et al.(2001, 300).

To estimate the elasticities of broad money M2 function, we first determine the optimal lag length of the four variables LM2, LY, INF, and LEX, using the already mentioned four criteria with a maximum lag length to be eight. Table.6 shows the elasticities of M2 model according to SBI criterion ARDL(1,3,1,0), which constitutes the best model, based on the explanatory power and the absence of major regression problems, among two ARDL models resulted according to the four criteria (SBI(1,3,1,0), AIC(1,3,4,4), HQ(1,3,4,4), R(1,3,4,4)). LY shows a positive significant effect on M2. The value of income elasticity (1.43) is in line with most empirical results of developing and least developed countries, as a result of the underdeveloped financial sector and high degree of monetization. The elasticity of the inflation rate is negative and significant but little bit

lower than that of M1 (-0.03). Similar to that of M1, the exchange rate effect on M2 is insignificant, and its negative sign reflects the dominance of the substitution effect.

TABLE 6. M2 LONG RUN ELASTICITIES FOR ARDL(1,3,1,0)

Regressor	Coefficient	t-ratio [Probability]
LY	1.43	4.27(0.000)
INF	-0.028	-2.20(0.033)
LEX	-0.55	-0.99(0.328)
INPT	-4.85	-2(0.051)

Table.7 shows the estimated error correction model of the selected ARDL(1,3,1,0) of M2 and the short-run elasticities. The error correction term  $ect(-1)$  is significant with the expected negative sign, which confirms the long-run relationship between M2 and its determinants. The value of  $ect(-1)$  is -0.29 which indicates a short-lived deviations from equilibrium. The sign of the short-run elasticity of income is the expected one and its value (1.13) is smaller compared with that of the long-run (1.43). The elasticities of both inflation and exchange rates in the short-run are negative, whereas only inflation rate effect appears to be significant. As is the case with the elasticity of LY, elasticities of both inflation and exchange rates are smaller than those of the long-run.

The diagnostic tests of the ARDL model upon which error correction representation is established, suggest that the model is free of the regression key problems (see Table.7).

TABLE 7. M2 ERROR CORRECTION MODEL FOR ARDL(1,3,1,0)

Dependent variable dLM2		
Regressor	Coefficient	t-ratio [Probability]
dLY	1.13	2.10[0.04]
dLY1	1.08	2.02[0.049]
dLY2	-1.32	-2.97[0.005]
dINF	-0.0055	-3.99[0.000]
dLEX	-0.016	-0.96[0.34]
dINPT	-1.42	-1.46[0.15]
ect(-1)	-0.29	-2.66[0.011]
R-Squared 0.5 R-Bar Squared 0.51 S.E of Regression 0.025 F(6, 49) 10.97[0.0] DW - Statistic 2.21		
<i>Diagnostic tests</i>	LM version	F version
<i>A:Serial Correlation</i>	1.8718[.759]	F( 4, 43)= 0.37[.83]
<i>B:Functional Form</i>	1.3141[.252]	F( 1, 46)= 1.11[.30]
<i>C:Normality</i>	1.1192[.571]	Not applicable
<i>D:Heteroscedasticity</i>	1.5557[.212]	F( 1, 54)= 1.54[.22]

With regard to the stability of the error correction model coefficients, fig.3 and fig.4 show that M2 appears to be stable, as the plots of both CUSUM and CUSUMSQ remain within the straight lines (critical bounds). It has to be mentioned here that despite the fact that M2 is stable, the CUSUMSQ is about to touch the upper line during 2006Q3 – 2009Q2 whereas CUSUMSQ of M1 maintains a middle position between the two critical lines along the estimation period<sup>6</sup>.

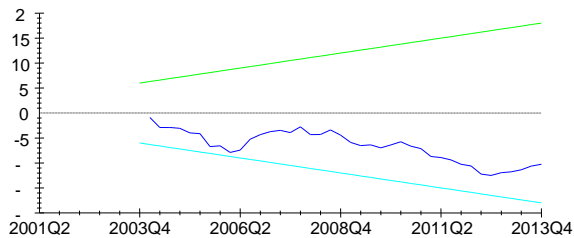


Figure 3. Plot of CUSUM for M2

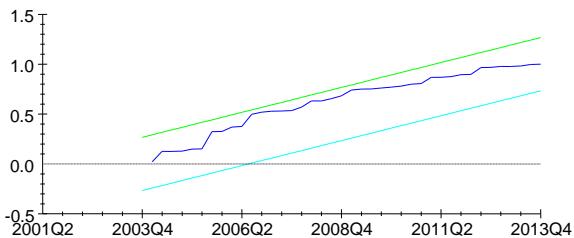


Figure 4. Plot of CUSUMSQ for M2

## 5. SUMMARY AND CONCLUDING REMARKS

The importance of examining the determinants of money demand function and its stability in formulating monetary policy constitutes the motivation of this study. The relationship between real money balances (both M1 and M2) and real income, inflation rate, and exchange rate is investigated using ARDL bounds approach to cointegration and error correction modeling on data over the period 2001Q1-2013Q4. The results of the bounds test indicate that both M1 and M2 are cointegrated with real income, inflation rate, and exchange rate. The real income and inflation rate bear their expected signs and are significant at the 5% level in both models of narrow and broad real money balances. The elasticity estimate with regard to real income is equal to 0.63 for M1 and 1.43 for M2, whereas the real income short-run elasticity for M1 and M2 are 1.3 and 1.13 respectively. The long-run impact of exchange rate on both M1 and M2 is statically insignificant but its coefficient sign is negative

supporting the substitution effect hypothesis between Yemeni Rial and foreign currencies. Error correction models of both M1 and M2 assure the relationship between both M1 and M2 and their determinants via the significance and negative sign of the error correction term. The application of CUSUM and CUSUMSQ tests provide evidence of stable models of M1 and M2. This result imply that both M1 and M2 can be used as monetary aggregates in conducting the monetary policy. Nevertheless, M1 might be the better choice in this regard as it proved to be more stable and shows a better fit compared to M2. In addition, several empirical investigations departs from the assumption that M1 is more amenable to control by monetary authorities (Sriram, 1999, 19).

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<sup>6</sup> This result is similar to the results reached with several empirical studies on developing countries. See for example Moosa (1992) and Hossain (1994) for the cases of India and Pakistan respectively



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