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# Measuring Money Demand Function In Saudi Arabia: : A Time Series Analysis

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**Abstract**

*This study aims to analyze money demand function in Saudi Arabia over the period 1990-2020 using annual time series data. ARDL bounds testing approach is used to investigate the cointegration between the selected variables of the model. The empirical findings indicate the existence of long-run co-integration[1] relationship between money demand and its determinants, namely real income, inflation and interest rate. Real income and inflation are positively related to money demand. Interest rate is negatively related to money demand. However, the estimated error correction model shows that most of the determinants do not have significant impact on the demand for money over the short run. The study recommends additional variables such oil prices and government spending need to be included in money demand function in Saudi Arabia.*

***Key words***. *cointegration, money demand, Saudi Arabia, monetary policy*

## Introduction

Money demand has been remained one of the most important topics in macroeconomic analysis. This is mainly due to the role of money in the economy. As a result, many theoretical and empirical studies have been made to investigate the determinants of money demand. According to Rosli(2013) money demand is considered as an important function of stabilization policies. The demand for money is a basic element in conducting monetary policy Abdulkheir (2013).

The demand for money has been discussed by many theories in different ways. For classical economists, people wish to hold to meet their daily transactions. The transactions version of the classical quantity theory of money is introduced by Fisher and is given by the following equation:

MV= PT

Where:

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M= money supply, V= velocity circulation of money, P = price level and T= total amount of goods and services exchanged for money.

PT represents money demand, MV represents money supply.

At equilibrium, money demand equals money supply

Thus, the equation becomes Md = PT where Md = money demand

An alternative version to equation of exchange is the Cambridge money demand equation and is given by the equation Md= kPY

where k is fraction of real income. This equation tells us that the demand for money is proportional to nominal income.

In his general theory , Keynes introduced three movies to hold money namely transaction demand, precautionary demand and speculative. Keynesian money demand can be represented by the equation.

M = M1 +M2 = L1(y) +L2 (r)

Where M is the demand for money, M1 is quantity of money demanded to meet transaction and precautionary motives, M2 is amount of money demanded for speculative motive, y in income, r is interest rate, L1 is liquidity function that determines M1 , L2 is liquidity function that determines M2 . Thus, total demand of money is a function of both income and interest rate. The demand of money is positively related to income and negatively related to interest rate. On the other way, Friedman improved Keynesian liquidity preference theory of money by treating money like another asset. Friedman's money demand function is look more stable than Keynes because it depends on permanent income. That means Friedman money is a function of wealth and expected returns of other assets relative to the expected returns of money. Friedman money demand can be represented by the equation.

Md = (r, p, di w, y, $\Delta p/P$ )

where: Md is money demand, P is price level (positive), r is interest rate (negative) y is income (positive) , w is wealth (positive) , di is deposit rate (negative ). Friedman’s money demand function emphasizes that wealth is a key indicator than current income.

**Literature Review**

Generally speaking, empirical study on money demand is not new across countries. Many theoretical and empirical work have analyzed money demand function due to its crucial role in conducting appropriate monetary policy. Study on money demand is mainly concerned with the factors that affect money. Although a large body of literature was conducted to study money demand function, few studies on money demand were conducted in Saudi Arabia. Al Rasasi (2016) examined money demand function in Saudi Arabia using quarterly data over the period of 2010-2018.His findings indicate a positive relationship between money demand and income and negative relationship between money demand and interest rate. Yannick(2021) studied money demand in Pakistan. The study found that the socio-economic factors play an important role in determining the money demand in Pakistan. The study by Abdulkheir,A.,(2013) on money demand in Saudi Arabia shows the existence of long run relationship between money demand M2 and its explanatory variables namely real gross domestic product , interest rate and inflation. Inoue and Hamori (2008) empirically analyzed India’s money demand function over the period of 1980 - 2007 using monthly data and over period of 1976 - 2007 using annual data. Their findings indicate that there is no long run equilibrium relationship in money demand function in India if money supply is presented by M3. They concluded that it is appropriate to focus on M1 or M2, rather than M3, in managing monetary policy in India.

**Data and Methodology**

In determining the variables, the study was based on economic theory and previous studies. The dependent variable is money demand(M3). M3 is known as broad money. The independent variables are the real income, inflation rate and interest rate .The influence of income is expected to be positive .As income increases , people demand more money .Inflation can have positive or negative effect on money demand .Inflation may cause money to lose its purchasing power .As inflation rises, more money is demanded to buy the same amount of goods and services .On the other hand, inflation may reduce money demand because high inflation force people to keep their wealth in form of assets rather than money. Interest rate is expected to vary negatively with money demand. Data on money demand and interest rate were obtained from Saudi Arabian Monetary Authority. Data on real income and inflation rate were obtained from the Saudi Central Bureau of Statistics. The study adopted error correction model to establish short run and long run relationship after conducting cointegration and units' roots tests

The econometric model for the determinants of money demand can be formulated in the Saudi economy according to the following equation.

$M3t = \beta O + \beta 1 RGDPt + \beta 2 INFt + \beta 3 IRt + ui$……. (1)

BO, B1> 0, B2>0 , B3<0

Where:

M3: money demand

RGDP: real gross domestic product (proxy for income)

INF: inflation rate

IR: interest rate

B0: constant term in the model, B1, B2, B3: regression coefficients, ui: random error term, the subscript (t) indexes time.

**Data analysis and discussion**

To apply the integration, time series must be tested for stationary. A time series said be stationary if the statistical properties of time series such as mean, variance and covariance remain constant over time. This is a fundamental assumption of modeling. Table (1) shows the descriptive statistics includes the mean, median, maximum, minimum, standard deviation, Jarque-Bera, and probability of each variable. The average amount of money supply M3 is 957282.8 SAR million. The maximum amount of money supply is 2495372 SAR million in 2022 and the minimum amount is 188438.4 SAR million in 1990.Real gross domestic product averaged 1898633 SAR million during the period 1990-2022. Inflation averaged 2.4 percent and reaching peak of 6.2 percent in 2008 and record a low of -1.1percent in 2000. The average interest rate is 3,4 percent. The maximum rate of interest rate is 8.2% in 1990 and the minimum rate is 0.69% percent in 2011.

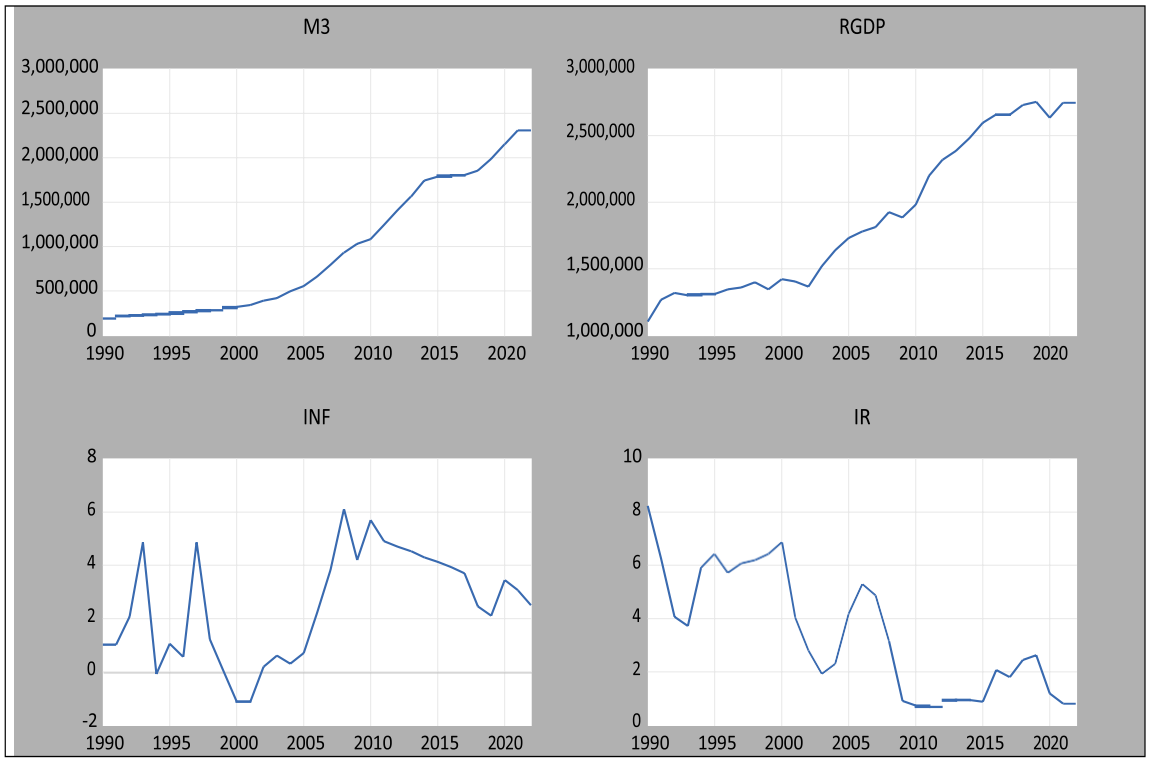
**Table 1. Descriptive statistics**

| Statistical Indicators | **M3** | **RGDP** | **INF** | **IR** |
|---|---|---|---|---|
| **Mean** | 957282.8 | 1898633 | 2.487130 | **3.475455** |
| **Median** | 660268.1 | 1779274 | 2.458142 | **3.130000** |
| **Maximum** | 2495372. | 2984636. | 6.100000 | **8.230000** |
| **Minimum** | 188438.4 | 1102228 | -1.110000 | **0.690000** |
| **Std. Dev.** | 746786.3 | 584382.8 | 2.031438 | **2.252173** |
| **Skewness** | 0.574519 | 0.388908 | -0.047760 | **0.340365** |
| **Kurtosis** | 1.859652 | 1.631769 | 1.829329 | **1.832977** |
| **Jarque-Bera** | 3.603434 | 3.405949 | 1.896942 | **2.509834** |

| | | | | |
|---|---|---|---|---|
| **Probability** | 0.165015 | 0.182141 | 0.387333 | **0.285100** |
| **Observations** | **33** | **33** | **33** | **33** |

**Source**: Authors' Calculations (E-views 12)

Figure 1; time series plots of the variables




Source: Authors' Calculations (E-views 12)

**Unit Root Tests.**

In empirical macroeconomic research, it is important to asses time series properties in order to avoid spurious regression result. To test the stationary, we used the Extended Dickey-Fuller (ADF) test and the Phelps- Perron (P.P.). The (ADF) test can be expressed by the following simple equation:

**Yt = PYt-1 + μt (2)**

Where :

P is the coefficient that defines unit roots, μ is error term

By subtracting Yt-1 from both sides

**oYt = (P-1)Yt-1 + μt (3)**

If P =1 then units root is present and the series is not stationary

The null hypothesis is generally indicating the presence of a unit roots and the alternative hypothesis means stationary of time series. In other words, if null hypothesis H0: B=0, we say series is unstable. If the alternative hypothesis H1: B<0, we say series is stable.

Table (2) shows the result of the Dickey-Fuller test (ADF). The result indicates that all the variables of the study are not stationary. when taking the first difference, the variables became stationary and they integrated of the first order I(1) To confirm these results, the (P.P) test known

as the (Phillips-Perron) test was used. Table (3) shows that all the variables are unstable at the level and stabilized when converting all variables to the first difference.

**Table 2. ADF unit root test**

| Variable | Intercept | | | Trend and Intercept | | |
|---|---|---|---|---|---|---|
| | **ADF statistics** | **p-value** | **Stationary order** | **ADF statistics** | **p-value** | Stationary order |
| **M3** | **-5.357** | **0.001** | **I(1)** | **-5.284** | **0.009** | **I(1)** |
| **RGDP** | **-4.051** | **0.0039** | **I(1)** | **-4.431** | **0.0073** | **I(1)** |
| **INF** | **-7.576** | **0.0000** | **I(1)** | **-7.467** | **0.0000** | **I(1)** |
| **IR** | **-3.653** | **0.0102** | **I(1)** | **-3.892** | **0.026** | **I(1)** |

Source: Authors' Calculations (E-views 12)

**Table 3. P.P unit root test**

| Variable | Intercept | | | Trend and Intercept | | |
|---|---|---|---|---|---|---|
| | **ADF statistics** | **p-value** | **Stationary order** | **ADF statistics** | **p-value** | Stationary order |
| **M3** | **-5.451** | **0.001** | **I(1)** | **-5.361** | **0.008** | **I(1)** |
| **RGDP** | **-4.272** | **0.0021** | **I(1)** | **-4.405** | **0.0075** | **I(1)** |
| **INF** | **-12.711** | **0.0000** | **I(1)** | **-13.009** | **0.0000** | **I(1)** |
| **IR** | **-3.180** | **0.0309** | **I(1)** | **-5.629** | **0.0004** | **I(1)** |

Source: Authors' Calculations (E-views 12)

**Co-integration Tests.**

In order to empirically analyze the long-run co-integration and dynamic interactions among the variables under consideration, we employ the most recently introduced, the autoregressive distributed lag (ARDL) approach to co-integration developed by Pesaran and shin. (1999), and Pesaran et al. (2001). This approach is superior to other cointegration tests as it is suitable even in the presence of a mix order of order.

Accordingly, the determinants of demand for money in the short and long terms can be measured according to the ARDL model as follows:

$$\Delta \mathbf{M3_t} = \mathbf{a_0} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{1i}}\, \Delta \mathbf{M3_{t-1}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{2i}}\, \Delta \mathbf{Rgdp_{t-i}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{3i}}\, \Delta \mathbf{INF_{t-i}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{4i}}\, \Delta \mathbf{IR_{t-i}} + \lambda \mathbf{1M3t-1} + \lambda \mathbf{2RGDPt-1} + \lambda \mathbf{3INFt-1} + \lambda \mathbf{4IRt-1} + \varepsilon \mathbf{t} \ldots (4)..$$

Where (Δ) is the first difference operator, and ($a_0$) the drift component and (εt) the white noise residuals. The coefficients ($\gamma_1, \gamma_2 \gamma_{,3} \gamma_{4,}$) represent the long –run relationship, ($\mathbf{a_{1i}}, \mathbf{a_{2i}}, \mathbf{a_{3i}}, \mathbf{a_{4i}}$) represent the short –run dynamics of the model.

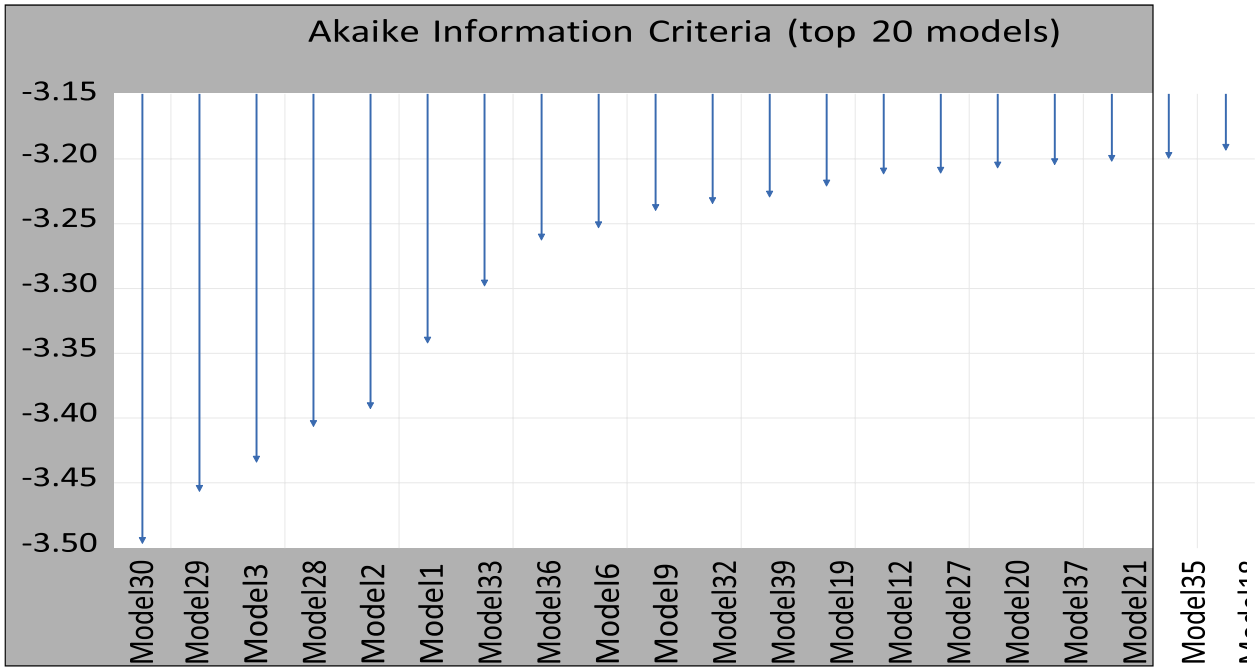
After confirming the existence of cointegration, we need to correct imbalance that might arise by estimating the error correction model according to the following equation;

$$\Delta \mathbf{M3_t} = \mathbf{a_0} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{1i}}\, \Delta \mathbf{M3_{t-i}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{2i}}\, \Delta \mathbf{Rgdp_{t-i}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{3i}}\, \Delta \mathbf{INF_{t-i}} + \sum_{\mathbf{i=0}}^{\mathbf{r}} \mathbf{a_{4i}}\, \Delta \mathbf{IR_{t-i}} + \lambda \mathbf{ECM_{t-1}} u_t \ldots (\mathbf{5})$$

Where $\lambda$ : standard for error correction term which denotes the speed of adjustment.
The error correction model (ECM) shows how much of the disequilibrium is being corrected, that is, the extent to which any disequilibrium in the previous period is being adjusted in depended variable. In other word, the ECM allows model to capture short -term fluctuations and the speed at which the variables return to equilibrium.

Before using Bound Test of Co-integration, we need to determine the optimum degree of delay for the variables by minimizing the criterion (AIC). figure (2) shows the optimal degree of delay for the demand for money (M3) , the real gross domestic product (RGDP), the inflation rate (INF), and the interest rate (IR) correspond to the values (2, 1, 0, 0) which correspond to the lowest value of the criterion (AIC).

Figure (2). Optimal degree




Source: Authors' Calculations (E-views 12)

**Bound Test of Co-integration**

After determining the optimal degree of lag for the study variables, the existence of long-run co-integration was tested using a bounds test. The results of the co-integration test are shown in Table (4). The F- score of (13.617) is above upper bound of ( 3.67) at 5 percent level of statistical and therefore we have sufficient reasons to reject the null hypothesis or accept the alternative hypothesis of the existence of co-integration among the variables in the model. In other word, money demand, inflation rate, and interest rate have a long run relationship over the period under study.

**Table 4. Bound Test of Co-integration**

| Variables | F-Statistics | Decision |
|---|---|---|
| **M3=F(RGD,INF,IR)** | **13.617** | **Co-integration exist** |
| **Critical Value Bounds (significance)** | **Lower Bound I (0)** | **Upper Bound I (I)** |
| **10%** | 2.37 | **3.2** |
| **5%** | 2.79 | **3.67** |
| **2.5%** | 3.15 | **4.08** |
| **1%** | **3.65** | **4.66** |

**Source**: Authors' Calculations (E-views 12)

**Long-Run results**

The results of the long-run ARDL model is depicted in table (5). The long run regression result indicates all the variables are statistically significant on demand for money. Real income is positively related to money demand. Higher income would encourage consumer to demand more money to meet their daily selling of goods. Al Rasasi (2020) reached the same result. Similarly, estimated coefficient of inflation reveals positive relationship between inflation and money demand. Inflation is also positively related to money demand. Thus, a 1% increase in inflation rate would cause 0.05 percent increase in money demand. This result is consistent with the findings of Abdulkheir (2013) and Rosli (2013). High inflation rates lead to an increase in demand for money. The coefficient of interest rate is (-0.043730) which indicates negative effect on money demand. This suggests that a 1% increase in real interest rate would cause 0.04 percent decline in money demand.

**Table 5. Long-run estimation results for the ARDL model**

| Dependent Variable: M3 | | | | |
|---|---|---|---|---|
| Variables | **Coefficients** | **Std .Error** | **t-stat** | P-value |
| RGDP | 1.31E-06 | 7.06E-08 | 18.56821 | 0.0000 |
| INF | 0.050328 | 0.019979 | 2.519012 | 0.0195 |
| IR | -0.043730 | 0.019163 | -2.282010 | 0.0325 |
| C * | 10.69502 | 0.199705 | 53.55414 | 0.0000 |

**Source**: Authors' Calculations (E-views 12)

**3.2 short-Run results**

Table (6) reports the empirical result of short run analysis. Short run coefficient of inflation is statistically insignificant at 5% level. This means that money demand is high inelastic for short run fluctuations in inflation rate. The results of estimating short-term model indicate that there is a direct relationship between the real income in the previous year and the demand for money (M3). The coefficient of error correction model is negative, as expected, and statistically significant. The coefficient of error correction model is around 0.267340- which indicates that around 27 % of the disequilibrium in the money demand in the short-term is corrected annually. More precisely, it takes three years and seven months to correct short term disequilibrium and restore long run. The adjusted coefficient of determination indicates 55% of variations in demand for money have been explained by variations in real income, interest rate and inflation.

**Table 6. Short run Coefficients (Error Correction Model)**

| Dependent Variable : M3 | | | | |
|---|---|---|---|---|
| Variables | **Coefficients** | **Std .Error** | **t-stat** | P-value |
| D(RGDP) | -1.56E-07 | 9.56E-08 | -1.628315 | 0.1177 |
| D(RGDP(-1)) | 3.01E-07 | 8.16E-08 | 3.696757 | 0.0013 |
| D(INF) | 0.001506 | 0.003912 | 0.384909 | 0.7040 |
| D(INF(-1)) | 0.012213 | 0.003882 | 3.146429 | 0.0047 |
| CointEq(-1)* | -0.267340 | 0.029802 | -8.970504 | 0.0000 |

**Source**: Authors' Calculations (E-views 12).

R-squared=0.61. Adjusted-squared=0.55.

**Diagnostic Tests and stability**

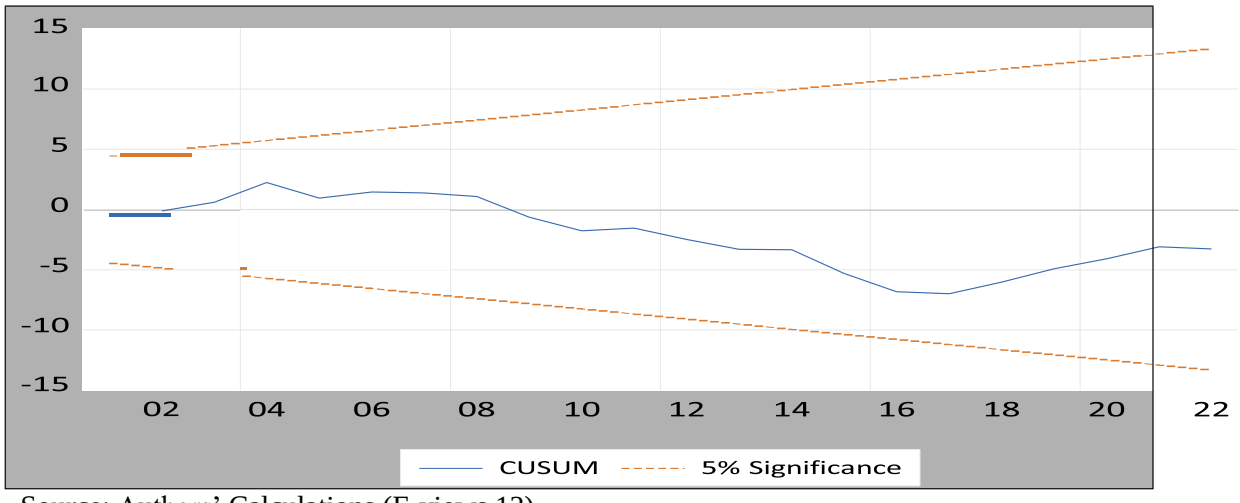
The result of test of autocorrelation and heteroscedasticity are shown in table (7). Test of autocorrelation indicates that the residuals are not correlated as the P- Value (0.980) is greater than 5% level of significance. Likewise, findings of heteroscedasticity test declared that data series are homoscedastic. was used. The result of Ramsey (1969) test indicates that the functional form of the estimated model is correct. This indicates that the selected variables of money demand in Saudi Arabia are correctly specified. Figure (3) indicates that the Cumulative Sum of Residuals (CUSUM) test falls within the critical limits at a significance level (5%), which means stability and consistency of the model. In other word, the plot of the CUSUM or line do not break the limits which imply that the coefficients are stable.

**Table 7. Diagnostic Tests Results**

| **Test** | **F-statistics** | **P-value** |
|---|---|---|
| Breusch – Godfrey | 0.020246 | 0.980 |
| Breusch-Pagan-Godfrey | 0.7061 | 0.683 |
| Ramsey | 0.6085 | 0.444 |

**Source**: Authors' Calculations (E-views 12).

Figure 3. CUSUM Test




Source: Authors' Calculations (E-views 12).

## Conclusion and Recommendation

Money demand has been remained one of the most important topics in macroeconomic analysis. This study aimed to analyze money demand function in Saudi Arabia over the period 1990-2020 using annual time series data. ADF and PP unit root tests are used for checking the stationarity of the variables. ARDL bounds testing approach is used to investigate the cointegration between the selected variables of the model. The empirical findings indicate the presence of long run relationship between money demand and its determinants. The result shows that real income is positively related to money demand. Higher income would encourage consumer to demand more money to meet their daily transactions. Estimated coefficient of inflation reveals positive relationship between inflation and money demand. Thus, a 1% increase in inflation rate would likely to cause a %5 increase in money demand. The coefficient of interest rate is (-0.043730) which indicates negative effect on money demand. This suggests that a 1% increase in real interest rate would cause 0.04 percent decline in money demand. Short run coefficient of inflation is statistically insignificant at 5% level. This means that money demand is high inelastic for short run fluctuations in previous inflation rate. The results of estimating short-term model indicate that there is a direct relationship between the real income in the previous year and the demand for money (M3). The coefficient of error correction model is around 0.267340- which indicates that around 27 % of the disequilibrium in the money demand in the short-term is corrected annually. More precisely, it takes three years and seven months to correct short term disequilibrium and restore long run. The adjusted coefficient of determination indicates 55% of variations in demand for money have been explained by variations in real income, interest rate and inflation. The findings of this study are crucial for monetary authorities to design appropriate monetary policy The study recommends additional variables such oil prices and government spending need to be included in money demand function in Saudi Arabia.

**Conflicts of Interest**:
The author declares no conflicts of interest regarding the publication of this paper.

Data availability statement
https://database.stats.gov.sa/home/landing
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