1. **Introduction**

The most crucial issue for the transmission mechanism of monetary policy is to find a robust and coherent model. To have an effective monetary policy, an economy must have stability in its money demand function. Almost all studies in the literature on demand for money demonstrate the stability test of money demand e.g. Arize et al. (1990), Hoffman et al. (1995), Muscatelli and Spinelli (2000), Choi and Oh (2003), Pradham and Subradanian (2003), Sterken (2004), Akinlo (2005), Drama and Yao (2010), Chukwu et al. (2010), Lim et al. (2012), Wang (2011), Hossain (2013), Dreger and Wolters (2006) and (2014). The instability of money demand functions has been widely expressed as the main reason for reducing the role of monetary aggregates in the formulation of monetary policy (Ozdemir and Saygili, 2013). Furthermore, if money demand is found to be unstable, researchers have pointed out omitted variables from their specifications and shown that by including those omitted variables, stability could be achieved (Bahmani-Oskooee and Xi, 2011).

A brief review of the literature will shed light on the scope of our study. Choi and Oh (2003) showed that output uncertainty and monetary uncertainty, as well as output, interest rates and financial innovations, affect money demand in the US. The estimated long-run relationships were consistent with their postulated relationships. The model delivered high income elasticity consistent with cross-sectional evidence and helped to resolve M1[[1]](#footnote-1) demand puzzles. Their model, estimated in dynamic error-correction form, exhibited a good level of stability and forecastability. Atta-Mensah (2004) examined the impact of economic uncertainty on the demand for money in Canada. Using a general-equilibrium theory, he argued that in a world inhabited by risk-averse agents, who are constantly making portfolio decisions against a backdrop of macroeconomic uncertainty, the demand for money is a function of real income and interest rates, and an index of economic uncertainty. Atta-Mensah obtained empirical results that show that, in general, increased economic uncertainty leads, in the short run, to a rise in the desired M1 and M1++ balances that agents would like to hold. However, the impact of economic uncertainty on M2++ is observed to be negative.

Ozdemir and Saygili (2013) attempted to understand the causes of instabilities in the conventional money demand models for Turkey by accounting for the effects of macroeconomic uncertainty on money holdings. Their results suggest that money balances, income and interest spread are not cointegrated when the Vector Autoregressive, VAR, system is missing a measure of economic uncertainty. They found stable long-run relations and coefficients when the correct measures of uncertainty were introduced into the system. Bahmani-Oskooee and Xi (2011) included a measure of economic uncertainty and a measure of monetary uncertainty (both GARCH-based) in the long-run money demand for M3. By using the bounds testing approach to cointegration, under which variables could be stationary or non-stationary, they found strong evidence that the M3 money demand in Australia is stable. Both uncertainty measures have short- as well as long-run effects on the demand for M3. These factors were not considered by previous researchers.

Bahmani and Bahmani-Oskooee (2012) tried to find the impact of exchange rate volatility on Iran’s money demand by using data from post-revolutionary Iran and the bounds testing approach to cointegration. They argued that, in addition to Mundell’s theory that the exchange rate is an important determinant of the demand for money, exchange rate volatility also serves as an important variable that has an impact on demand for money, and should therefore be included in the money demand function. Their results revealed that during the post-revolutionary period of 1979–2007, exchange rate volatility had both short- and long-run effects on the demand for real M2 monetary aggregate in Iran, and is therefore a very important determinant when it comes to the demand for money.

Some numbers of studies have used cointegration and error-correction model approaches on the demand for money using South African data. A number of studies date from a period before the econometric literature developed these techniques. Hurn and Muscatelli (1992) use the cointegration approach to examine the long-run relationship between the money demand and its determinants, and the nature of the long-run elasticities of the model. All the variables except the alternative interest rate were found to be positively related to real money demand. Moll (2000) used the real variables to analyse the demand for money by employing the cointegration approach. He showed that the money demand function had stable parameters, and all other variables except the inflation rate had the expected signs. Similarly, Tlelima and Turner (2004) and Nell (2003) applied the cointegration approach and the error-correction model to estimate the demand for money and its stability in South Africa, respectively.

Zirammba (2007) in his study examines empirically the long-run relationship of money demand and its determinants in South Africa. He included final consumption expenditure, expenditure on investment goods and exports as the disaggregated components in the model. The other determinants were domestic interest rate, yield on government bonds and the exchange rate. He shows that the real income’s different components have different effects on the money demand in South Africa. Todani (2007) offers a system cointegration analysis of a long-run demand for money, M3, in South Africa. The paper computes a cointegrated VAR model, including real money, income and the opportunity cost of holding money. The model indicates that only income and real money are error-correcting to the money demand relation. The money demand relation is relatively stable over the sample period, when short-run fluctuations are corrected for. And, it is found that there is a weak long-run link between money and inflation. Mutsau (2013) analysed the broad and narrow money demand for South Africa using the autoregressive distributed lag (ARDL) approach. He found that M2 and M3 money aggregates are cointegrated and maintain a stable long-run relationship with their determinants. However, M0 and M1 monetary aggregates were found not to be cointegrated with their determinants.

Conventionally, it is held that real money demand depends mainly on income and interest rates, as income is positively related to money demand, and any rise in interest rates increases the opportunity cost of holding money. This specification of money demand is very restrictive. As an extension to the existing literature, we tried to investigate whether monetary uncertainty and output uncertainty impact the money demand in South Africa, this is the issue that has not been considered by previous studies. Due to business cycles the role of output uncertainty in every country, including South Africa, is very important. The South African economy was indeed influenced by Global Financial Crisis of 2008. It slowed down the economy, raised unemployment and reduced trade with major partners. Therefore, it is necessary to include output uncertainty in the money demand model for South Africa. Because of the expansion of the money supply during recessionary periods and its tightening during inflationary periods the inclusion of monetary uncertainty in the formulation of the money demand function is likely. We also employ Pesaran *et al*.’s (2001) bounds testing approach to cointegration and error-correction modeling, rather than other cointegration techniques. This is because within this approach the variables could be non-stationary, stationary, or both. This differentiates our study from previous ones. Section 2 presents the methodology, data and results, while Section 3 concludes the paper.

1. **Methodology, data and results**

Following previous studies on the demand for money, we assume that money demand depends on a scale variable like national income, personal consumption and wealth, plus the long-run interest rate which accounts for opportunity cost of holding money against the real and other financial assets. Nominal effective exchange rate (NEER) is also included as Mundell (1963) states that the demand for money is likely to depend upon the exchange rate in addition to the interest rate and the level of income. Furthermore, the exchange rate is included to account for currency substitution that may take place between domestic currency and foreign currencies (Bahmani-Oskooee and Xi, 2011). The long-run demand function for money will be:

 (1)

where is money supply measured by real M3; nominal M3 figures are deflated by the GDP deflator; is the real GDP; is the nominal effective exchange rate for South Africa; is the long-term interest rate measured by 10-year government bond yield; and is the error term. Quarterly data for the period 1980Q1–2014Q2 are used to carry out the estimations. All the data were obtained from the International Monetary Fund’s International Financial Statistics (IFS) CD-ROM.

In equation (1), according to Arize et al. (1999) due to the dictation of the usual budget conditions real money balances are assumed to be an increasing function of real income that is the money demand is positively related to scale variable (). As the rate of interest increases, the opportunity cost of holding money goes up and people will be less willing to hold money. So, is expected to be negative. When the value of domestic currency against foreign currencies decreases, the value of foreign securities held by domestic residents will increase. If this is measured as an increase in wealth, the demand for domestic money may rise, (Arango and Nadiri, 1981). On the other hand, Arize (1989) have discussed that, because of weak domestic currency, asset holders would shift their portfolios into foreign currencies as they expect further weakening. Therefore, can be either negative or positive.

In this study, in line with Bahmani-Oskooee and Xi (2011), we introduce macroeconomic uncertainty and monetary uncertainty measures to our model. The volatility measures are derived using moving-average standard deviation method suggested by Kenen and Rodrik (1986) and Koray and Lastrapes (1989).

where V is the measure of volatility, and m denotes the order of the moving average (m=4). For this purpose, we define them as the volatility of the nominal money supply (M3), UM, and the volatility of the real output, UY.

By entering these two variables into the equation (1), we will have

 (3)

Adding the volatility measures reduces the instability of the money demand. and could be negative or positive. Increased output or monetary uncertainty could generate a substitution effect away from cash and in favour of less volatile assets, implying a negative estimate for both and . On the other hand, an increase in both uncertainties could generate a precautionary effect to save more volatile assets by reducing their holding in favour of more cash, thus giving a positive estimate for both and (Bahmani-Oskooee and Xi, 2011).

Equation (3) gives us the long-run relationship between the variables. We need to incorporate the short-run dynamics into equation (3) to test the stability of the coefficients. To this end, we need to define equation (3) in an error-correction model format. We follow the ARDL approach of Pesaran *et al*.(2001), or the bounds testing approach to cointegration, and rewrite equation (3) as:

The ARDL cointegration approach has a number of advantages over the other methodologies. First, the long- and short-run parameters of the model are estimated at the same time. Second, it overcomes the endogeneity problems and the inability to test hypotheses on the estimated coefficients in the long run which we face when applying the Engle–Granger (1987) method. Third, to test for the existence of the long-run relationship among the variables in levels, we can employ the ARDL approach irrespective of whether the underlying regressors are purely *I*(0), purely *I*(1), or fractionally integrated. Last, the small sample properties of the bounds testing approach are far superior to those of multivariate cointegration (Narayan, 2005). In equation (4), the linear combination of lagged level variables as a proxy for the lagged error term is included.

Following Pesaran *et al*.(2001), we first carry out the *F*-test to justify the lagged level of variables. Pesaran *et al*.(2001) defined new critical values for this test. According to Bahmani-Oskooee and Harvey (2012), the values they tabulate account for the degree of integration of variables involved, and demonstrate that in this approach, variables could be stationary, non-stationary or a combination of the two. An upper bound critical value is provided by assuming all variables in a given model to be integrated of order one, or *I*(1). A lower bound critical value is provided by assuming all variables to be stationary, or *I*(0). Pesaran *et al*.(2001) demonstrate that the upper bound critical value could be used to justify cointegration even if some variables are *I*(1) and some *I*(0). Once cointegration is established, the long-run effects are judged by the estimates of to normalized on . The null hypothesis of (H0: β1= β2= β3= β4= β5= β6=0) is tested against the alternative hypothesis (H1: β1≠0, β2≠0, β3≠0, β4≠0, β5≠0, β6≠0). If the computed *F*-statistic exceeds the upper critical bounds value, then H0 is rejected and there is cointegration among the variables. Short-run effects are judged by the estimate of coefficients attached to first-differenced variables.

The error-correction model outlined by equation (4) is subject to an empirical analysis by drawing quarterly data for South Africa for the period 1980Q1–2014Q2. For the first step, to make sure that variables are either I(0) or I(1), using Augmented Dickey-Fuller (ADF) test we test for unit root. The test results presented in table (1) indicate that only output uncertainty measure is stationary at its level. The ADF statistics for other variables are all more than their critical values implying that they get stationary after first differentiation. Thus the ARDL approach to cointegration is the most suitable method to estimate the model.

**Table 1.** *Unit root test results*

|  |  |  |
| --- | --- | --- |
| Variables | ADF Statistics | 95% Critical Value |
| lnM | 0.0365(4) | -2.8832 |
| dlnM | -3.3240(4) |
| lnNEER | -1.4524(3) | -2.8830 |
| dlnNEER | -5.1314(3) |
| lny | 0.8408(9) | -2.8841 |
| dlny | -6.2989(9) |
| lnUM | -1.5974(10) | -2.8848 |
| dlnUM | -12.4925(10) |
| lnUY | -4.6671(12) | -2.8852 |
| r | -1.2133(3) | -2.8830 |
| dr | -9.8179(3) |

*Note: Numbers in parenthesis are the lag orders in the ADF test selected by the AIC criterion*

Then, we apply the *F*-test to joint significance of lagged level variables to see whether they are cointegrated. Then, in order to estimate equation (4), we impose a maximum of four lags on each first-differenced variable and rely upon the Akaike’s Information Criterion (AIC) in selecting the optimum lag length. Table (2) reports the results of the optimum model.

**Table 2.** *Estimation of equation (4) using the ARDL approach*

|  |
| --- |
| Short-run coefficient estimates |
| Lag order | 0 | 1 | 2 | 3 | 4 |  |  |
| ΔlnM |  | 0.7062(8.0236) | 0.0386(0.3552) | 0.1613\*\*(1.1979) |  |  |  |
| ΔlnY | 0.8813(3.8824) | -0.7212(-3.1343) |  |  |  |  |  |
| Δr | −0.0012(−0.5831) | -0.2144E-3(-0.0710) | -0.0042(-1.4546) | 0.0065(2.2467) | -0.0066(-3.2860) |  |  |
| ΔlnNEER | 0.0278(1.0615) | -0.0333(-1.3005) |  |  |  |  |  |
| ΔlnUM | -0.0059(-1.3702) | 0.0040(0.6922) | 0.0103\*\*(1.7611) | 0.0166(3.4952) |  |  |  |
| ΔlnUY | 0.0038(1.2599) | -0.0007(-0.1814) | -0.0016(-0.3969) | -0.0111(-3.3147) | 0.0025\*\*(1.8496) |  |  |
| Long-run coefficient estimates |
| Constant | lnY | r | lnNEER | lnUM | lnUY |  |  |
| -19.9733(-1.8833) | 1.7065(3.5177) | −0.0623(−2.2756) | -0.0584(-0.5120) | 0.2668\*(2.1661) | −0.0763\*\*(−1.7985) |  |  |
| Diagnostic statistics |
| *F* | ECM(−1) | LM | Adj. R2 | RESET | CUSUM | CUSUMSQ |
| 9.8883 | −0.0938(−2.7357) | 5.4223[0.247] | 0.5291 | 0.1259[0.723] | Stable | Stable |

\*Figures in parentheses are *t*-statistics; those in brackets are *p*-values. \* and \*\* stand for the 5% and 10% level of significance, respectively.

As shown in the first panel of Table 2, there at least one coefficient is obtained for each first-differenced variable that is significant at the 10% or 5% level, implying that all variables have short-run effects on money demand in South Africa, except the nominal effective exchange rate. These effects last in the long run too. All the long-run coefficients carry the expected signs and are statistically significant. The nominal effective exchange rate (NEER) has the expected sign, but does not have the statistically significant coefficient. The interest rate (*r*) coefficient is negative and significant, while income (*y*) has a significantly positive coefficient, which implies that in the long run a 1% growth in the economy requires an increase of 1.7% in money supply. This is similar to the findings of the Moll (2000) and Tavlas (1989). Furthermore, the nominal effective exchange rate coefficient is also insignificant, indicating that there is not much currency substitution in the long run. The coefficient for output uncertainty measure is statistically significant at 10% level and carries the expected sign. It implies that by increasing the output uncertainty a substitution effect away from cash and in favour of less volatile assets is generated in South African economy. Finally, monetary uncertainty (UM) carries a significantly positive coefficient at the 5% level, implying that increased monetary uncertainty could generate a precautionary effect to save more volatile assets i.e. cash (Bahmani-Oskooee and Xi, 2011). With respect to the main variables and monetary uncertainty, these findings are in line with the findings of Bahmani-Oskooee and Xi (2011) and Choi and Oh (2003) for Australia and the US, respectively. They found that output uncertainty has a negative effect on money demand, whereas monetary uncertainty has a positive effect.

The results of the *F*-test show that there is cointegration between the variables, as the *F*-statistic is greater than 3.76, *F*-critical, at 5% level. Following Bahmani-Oskooee and Tanku (2008), we use the long-run coefficient estimates and form an error-correction term, ECM. We then replace the linear combination of lagged level variables in equation (4) with ECM(−1) and re-estimate the model after imposing the optimum number of lags. As can be seen from Table 2, the significantly negative coefficient obtained for ECM(−1) supports adjustment towards long-run equilibrium.

Table 2 also reports some diagnostic statistics. The Lagrange multiplier (LM) statistic and Ramsey’s RESET test are used to test for serial correlation among the residuals of the optimum model and misspecification, respectively. The LM test is distributed as 𝜒2 with four degrees of freedom since data is quarterly, and the RESET test is distributed as 𝜒2 with one degree of freedom. The reported LM statistic is much lower than its critical value, 9.48, at the 5% level, supporting autocorrelation-free residuals. Ramsey’s RESET statistic is much lower than its critical value, 3.84, indicating a lack of misspecification.

Finally, to test the stability of the short-run as well as long-run coefficients, we use Brown *et al*.’s (1975) cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests on the residuals of the error-correction model. If the plot of CUSUM or CUSUMSQ stays within the 5% significance level, the coefficient estimates are said to be stable. As can be seen from Figure 1, the cumulative sum test and the cumulative sum of squares test prove the existence of stability.

**Figure 1:** Graphical presentation of the CUSUM and CUSUMSQ tests

|  |  |
| --- | --- |
|  |  |

**3. Conclusion**

This paper examines the impact of output uncertainty and monetary uncertainty on the money demand function in South Africa. As, different variables have different implications in the economy as a whole and affect the traditional monetary policy, the choice of uncertainty measures is an important issue. To this end, in order to have comparable estimation results, their estimation must be conducted in a consistent framework. In carrying out this task, we generate UM and UY using moving-average standard deviation technique as the monetary and output uncertainty measures, respectively. This is based on the belief that the conventional specification of money demand function as relationships between real money balances, a scale variable, and opportunity cost of holding money is very restrictive.

None of the previous studies that estimated the South African money demand function have included measures for output and monetary uncertainty. Most of them formulated the function employing income, interest rate, inflation rate and the exchange rate, and have provided mixed results as far as the stability issue was concerned. Our empirical results are different from the previous literature in some respects. First, the estimated coefficient of real income is larger. This reveals that long-run money demand function in South Africa might be more elastic in terms of real income than hitherto supposed. The findings show also that the measure of output uncertainty and monetary uncertainty have short- as well as long-run effects on demand for money in South Africa. Furthermore, including these two measures and incorporating short-run dynamics into the estimation procedure results in a stable money demand function in South Africa. Following Poole (1970), as there is no instability in money demand, we conclude that the money supply is the appropriate monetary policy instrument to be targeted by the South African Reserve Bank (SARB).

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1. A measure of the money supply that includes all physical money, such as coins and currency, as well as demand deposits, checking accounts and Negotiable Order of Withdrawal (NOW) accounts. [↑](#footnote-ref-1)