

# **The Stability of Broad Money Demand (M3) in South Africa: Evidence from a Shopping-Time Technology and an ARDL Model**

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## **Abstract**

The paper examines the relationship of South African broad money (M3) and a set of variables such as income, opportunity cost of holding money (domestic and foreign interest rates), inflation, and stock market prices using a shopping-time technology model from [1] and [49]. The empirical evidence employs an ARDL model to test for a stable long-run relationship between M3 and its determinants. With cointegration established, we estimate an error-correction model that reveals how short-run dynamics adjust towards a long-run equilibrium. There are four important results for broad money in South Africa. First, there is cointegration between M3 and its determinants – income, foreign interest rates, inflation, and real stock market prices. Second, stock prices are an important determinant since cointegration fails if real stock prices are left out. Third, contrary to some of the received literature, the inclusion of an exchange rate in addition to stock prices causes most coefficients to be insignificant. More importantly, demand for M3 becomes unstable. Finally, a dummy variable that captures the introduction of inflation targeting introduced in 2000Q2 is insignificant. This irrelevance of inflation targeting in a money demand function remains whether we employ real stock prices or stock returns as one of the determinants of money demand.

**JEL classification numbers:** E41, E44, E4, M3

**Keywords:** Cointegration, ARDL, shopping-time technology, inflation targeting.

## **1 Introduction**

The paper examines the relationship of South African broad money (M3) and determinants such as income, opportunity cost of holding money (domestic and foreign interest rates), inflation, and stock market prices with relationships based on a shopping-

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time technology model. The empirical evidence is drawn from an ARDL or bounds test model to test for a stable long-run relationship between M3 and its determinants.

A growing number of countries have abandoned monetary targeting for inflation targeting, inducing less interest in modeling money demand and questioning whether a stable money demand is necessary. According to [1], this view is related to the conventional wisdom that ‘an inflation targeting policy that in effect is close to a Taylor rule [2] does not require knowledge of the underlying money demand, or its stability. [3] defends studies on money demand for inflation targeting countries provided such studies are considered from a general equilibrium perspectives such as the shopping-time exchange models. He found that when money supply rules (that examine money demand stability) are compared to the Taylor rules, they often perform better in monitoring inflation.

Our paper reports five noteworthy results. First, we find that stock prices have a significant positive effect on the demand for money in South Africa for the period examined. Second, an omission of the real stock prices from a money demand equation fails to produce cointegration and the use of an alternative variable such stock returns is inferior to real stock prices. Third, a dummy variable that captures the effects of inflation targeting on money demand is insignificant. Fourth, unlike a few existing studies, we find that the coefficient of the exchange rate is insignificant if a foreign interest rate (U.S. bank prime rate) is included in the model. Finally, both income and price elasticities are confirmed to be unitary. The adoption of inflation targeting in February 2000 followed by an inflation target range of 3% -6% in 2005-06 questioned the relevance of targeting M3 growth rates. The breakdown in the relationship between the growth rates of M3 and inflation and the adoption of inflation targeting by the South African Reserve Bank (SARB) might lead many researchers to conclude that the stability of broad money demand (M3) is no longer a useful avenue for research. For the most part, there is agreement on the unitary income elasticity of money demand in most general equilibrium models and other aggregate demand studies.<sup>2</sup> The major problem that remains is to relate interest elasticity to a wide variety of issues in monetary economics.

Beyond [3]’s defense of money demand studies and stability of the money demand function, there are at least five additional motivations for continuing to examine money demand. First, the stability of broad money is critical in the money transmission process since any changes brought by changing a policy rate (the repo rate in South Africa) assumes a stable money demand curve. Without such an assumption, it is difficult, if not impossible, to determine the final market rate that has impact on aggregate demand, and hence inflation. Second, related to the first, if a stable relationship between broad money and its suggested determinants exists, changes in money supply can still provide useful information about medium and long term inflation. According to [4] and [5], money demand stability is one indicator that lies at the heart of the framework employed by the European Central Bank. Third, the interest elasticity of money is fundamental to four concerns of monetary economics: hyperinflation, the costs of a suboptimal inflation rate policy, and growth rates. Fourth, the relationships between money supply growth and ultimate policy objectives in South Africa (e.g. reducing inflation) were highly unstable

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<sup>2</sup>For the U.S., [7] provide further evidence that a stable long-run money demand with unitary elasticity and no trend is obtained if the monetary aggregate is defined as a Money Zero Maturity (MZM) to reflect changes in regulations, innovations in electronic payments and widespread use of NOW accounts and credit cards.

and [6] observed that no “close and reliable relationship between broad money and real and nominal variables can be uncovered.” However, the question of stability of broad money is sensitive to the choice of information set (data) and estimation techniques which usually lead to mixed empirical results. Finally, with money demand instability, the transmission mechanism of monetary policy is further complicated even if the central bank has inflation targeting in place. This paper tests whether inflation targeting is relevant in the money demand function.

According to [5] in 2005-06, M3 growth rates in South Africa ranged from 15%-20% and yet the inflation rate remained within the 3% -6% target range. In other words, growth rates of M3 did not translate into higher inflation as envisaged when the M3 growth rate was adopted in 1985. According to [5] the rise in M3 demand or decline in income velocity could be due to a rise in real wealth in South Africa. The problem with this observation is that there exists no wealth data to replace the income variable that is often used as a scale variable in most money demand studies in the context of the portfolio-balance framework ([8] and [9]).<sup>3</sup> [11] advocated for the inclusion of both income and wealth in the demand for money without necessarily adopting the portfolio-balance framework.

The choice of monetary aggregate M3 reflects the broadest ‘moneyness’ - the ability to buy and sell a financial asset at short notice at or close to its full market. According to [12], South Africa’s M3 = M2 + *long-term deposits* held by the domestic private sector with monetary institutions. They note that there are two ways to characterize the relationship between the SARB and the banking sector. The standard procedure to expand credit is on the basis of deposit liabilities (part of which has to be kept as non-interest earning cash reserves). The expansion of credit is limited by the cash reserve requirement and the multiplier effect. The second part is closer to the reasons for the choice of examining money demand (M3) and its stability in this paper. [12] state that within SARB’s current refinancing framework banks extend credit based on demand, affordability by clients, and their own risk tolerance. These loans turn into deposits (*long-term deposits*) within the banking system and provide new funds which increase money supply. Although a certain amount of cash reserves is held against these deposits, any shortfall for banks is funded by the SARB at the repo rate. By maintaining liquidity management liabilities in excess of total assets, the SARB uses this shortage-driven policy in the money market to accommodate or refinance through the repo rate any shortfalls in the banking sector. In that way, the SARB has control over short-term rates that eventually feed into the economy and financial markets.<sup>4</sup> The main point here is this. M3 as broad money reflects a larger degree of moneyness than in previous periods in South Africa. The high degree of moneyness reflects technological innovations and

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<sup>3</sup>Although [10a and 10b] have made published a balance-sheet measure of household wealth for South Africa, we are unable to use in the paper because the series ends in 2006Q4. In addition, this wealth measure does not include corporate wealth, a substantial portion in a well-developed economy such as South Africa.

<sup>4</sup>According to [12], in the consolidated balance sheet of the monetary sector, M3 = claims on the private sector (CPS) + claims on the government sector (NCG) + net foreign assets + net other assets and liabilities. Given that Total domestic credit (TDCE) = CPS+NCG where CPS = investment + Bills + Total Loans and Advances; Total loans and Advances = Asset-backed Credit + Other Loans and Advances; Asset-backed credit = installment sale credit + leasing Finance + Mortgages; other loans and Advances = Overdrafts + Credit Card Advances + General Advances; and NCG = gross claims on the government (GCG) – Government Deposits (GD).

changes in the regulatory practices during the past two decades which have made M3 as almost liquid as M1.

The use of M3 reflects changes in regulations, innovations in electronic payments and widespread use of NOW accounts and credit cards.<sup>5</sup> Once we adjust the measure of money to be M3, it is possible to find the stability of money demand in South Africa despite the presence of inflation targeting. For the U.S., [7] adopted a measure of money termed the Money Zero Maturity (MZM) and found that it preserved the long-run relationship between money and its opportunity cost which had ceased to be so by the mid-1980s. They estimate the interest elasticity to be 0.24, so that a 1% increase in the opportunity cost of holding money results in a 0.24 percent drop in real balances.

The paper is organized as follows. Section 2 reviews the literature on money demand, particularly studies on South African money demand. Section 3 outlines the shopping-time technology model that is the basis of ARDL model or bounds test model to test for a stable long-run relationship between M3 and its determinants such as income, the opportunity cost of holding money (domestic and foreign interest rates), inflation, and stock market prices. Section 4 explains the data sources, the dependent and independent variables. Section 5 presents regression results and Section 6 contains a brief summary and conclusion.

## 2 The Literature on South African Money Demand

The literature on money demand is extensive, reflecting decades of experiments with targeting monetary aggregates as intermediate targets in monetary policy. Policy makers often assumed a stable money demand as one of the key elements of monetary policy since monetary aggregates were assumed to influence output, interest rates, and ultimately the price level or inflation. A majority of studies related to the stability of a money demand function focused on industrialized countries since data was readily available.<sup>6</sup> However, recent years have seen an increase in money demand focusing on developing countries, including South Africa.

With specific reference to South Africa, money demand studies encompass the whole spectrum of monetary aggregates from M1 through M3 from the early 1970s to the present day. We limit the scope of the review to the period 1980-2010. [14], [15], [16], [17], [18], [19], [20], [21], [22], and [23] estimate the money demand function in South Africa, using many different specifications, different time periods, different data frequencies (monthly, quarterly, and annual data), and different econometric techniques, and different monetary aggregates (M1, M2, and M3). Most of these studies show that there is a long-run relationship between the dependent and independent variables in the models. However, some of these studies indicate otherwise.<sup>7</sup> For example, [23] discovered that “recursive estimates of the steady-state elasticities with respect to income and the interest and inflation rate indicate that these important parameters are not stable throughout the period. It has been observed that the income elasticity of money demand

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<sup>5</sup>The reforms that have been implemented in South Africa trace their way back to [13].

<sup>6</sup>See [24], [25], [26] and [27] [U.S.], [28], [29] and [30] [Japan], [31] [U.K.], [32] [Canada], [33] [Australia], and [34] [New Zealand]. A comprehensive review of money demand is found in [35].

<sup>7</sup>[36] provides a comprehensive review of the literature on money demand in other countries in addition to South Africa.

has increased significantly through the period as has the sensitivity of money demand to the opportunity cost of holding money balances.”

Others found signs of misspecification. However, none of these studies explicitly include real stock market prices despite the central role of the Johannesburg Stock Market following financial liberalization. [17] employed an autoregressive distributed lag approach, using the 1965-80 quarterly data. Unlike other studies, this study used M0 (M1) and M2 and found that the opportunity cost variable to be correctly signed and significant in addition to price and income. His estimated model is a test of [37]’s model. The empirical results fail to uphold Friedman’s theory. Like [15] and [16] include price levels in the estimated model instead of an interest rate. From these earlier studies, one could conclude that money demand is determined by income and the price level as the interest rate effect is weak. In fact, these studies point to the following fundamental problem in all money demand studies: there is no clear microeconomic foundation for most of the studies on money demand. Furthermore, all these studies suffer from the “Barnett Critique”—that is, it is meaningless to estimate money demand functions using simple sum aggregates such as M1, M2, and M3 instead of Divisia monetary service indexes.<sup>8</sup> This paper explores the possibility that broad money might be cointegrated with real stock prices or stock returns in addition to the standard variables such as income, the opportunity cost of holding balances (inflation, domestic and foreign interest rates) and real stock prices.

Like China, India, and Brazil, South Africa has undergone financial liberalization and some economic reforms that lead to concerns about the stability of broad money demand. Furthermore, the Johannesburg Stock Exchange (JSE) has broadened its coverage. In 2001 it entered into an agreement with the London Stock Exchange (LSE) which enabled cross-dealing between the two, and replaced the JSE’s trading system with that of the LSE. By 2006, the JSE listed more than 400 companies and had market capitalization of over \$182 billion, making it the largest exchange in Africa and among the top ten largest in the world. Although many studies on money demand ignore the role of stock prices, this paper considers stock prices as a possible determinant of money demand common in a portfolio framework. Studies in developed countries indicate that real stock prices have significant effects on the long-run demand for money. In developing countries with a particular focus on China, [40] and [41a and 41b) have shown that stock prices do

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<sup>8</sup>See [38]. Incidentally, there are no Divisia monetary service data for South Africa. Even the Federal Reserve System stopped producing these indexes in 2006. The approach [39] to estimating money demand is to change the definition of the monetary aggregate so that it only has the *non-interest bearing* features of all monetary components by a “Divisia” application of index and aggregation theories to monetary aggregates. For example, during a period of financial innovations and other banking reforms, the Divisia index would increase the weight of interest-bearing components in M3 while reducing the weight given to currency. By capturing the all non-interest parts of M3, the aggregate only responds to the nominal interest rate, the *price* of money. In other words, it avoids shifts in the demand of money during changes in the *substitute prices* due to changes in the cost of interest bearing instruments. It focuses on shifting the weights that define M3 [1]. Thus, a stable money demand function per Barnett is based on solid microeconomics. Instead of using Divisia index for M3, our paper derives the demand for money from a shopping-time technology model and recognizing the credit creation by the monetary sector has created an extensive moneyiness in M3.

influence monetary aggregates.<sup>9</sup> The paper seeks to test for cointegration of income, interest rates (or inflation), and stock prices from a shopping-time technology model using the ARDL model or bounds test.

[43] and [44] studied M3 money demand using quarterly data for the period 1980-2003. He controlled for the elimination of banking competition restrictions in 1984 and for emerging market crises in 1998Q1-1998Q2 by including dummies. He found income and interest elasticities to be 3.2 and 6.30 respectively. The income elasticity is higher than 1.8 found by [45]. There is a suggestion that the omission of wealth (a more relevant variable in money demand) tends to induce upward bias in the income elasticity of demand. [23] estimated a money demand model using an error-correction model. Their study used GDP and consumption as alternative scale variables. In fact, the error-correction term in their study is -0.20 which indicates that the money market takes about 3 months to adjust following disequilibrium. [18] and [46] used a buffer stock model to estimate a money demand function and found a stable demand for broad money (M3). [47] used the Johansen-Juselius (JJ) approach to obtain a stable money demand with income, prices, and interest rates as determinants. The income elasticity of 1.11 is similar to the result in [46]. The interest rate elasticities for the deposit and loan rates are 0.032 and -0.038 respectively. [21] points to the importance of controlling for inflation targeting after February 2000. He found the period 1970-96 to exhibit a stable money demand function. However, he found an unstable money demand function after political and economic changes in the 1990s.

[6] estimated a money demand function over the 1965-97 period. He split the sample into before and after liberalization in the 1980s. He found no cointegration and suggested the omission of inflation as a determinant might have contributed to this result. [20]'s M3 demand has as arguments, prices, GDP, interest rates, and the inflation rate. Unlike other papers, interest rates are in logarithmic form and hence they are not easily compared to other studies. He used the Johansen-Juselius approach, Henry's general-to-specific approach, and the two-step approach of Engle and Granger. He found cointegration of M3 with prices, interest rates, and inflation. Similarly, [22] estimated a money demand function for broad money and found cointegration and stability of the function. The variables included nominal M3, the price level, 10-year government yield, and the own interest rate represented by a fixed deposit rate of 12 months. He has argued that the stability of a demand function (M3) and the implementation of inflation targeting strategy by the SARB improve the efficiency of monetary policy. The error-correction term of -0.59 indicates that the money market adjusts to a long-run equilibrium occurs by 59% in the quarter.

[48] used annual data, 1970-2005, to estimate a money demand function with components of GDP as determinants rather than GDP as a singular variable. [45] and [48] confirm the presence of a stable long-run relationship between M2 and its determinants. [19] estimated an error-correction model with arguments as price, real disposable income, the Treasury bill rate and inflation, all in logs. He found high short-run income and inflation elasticities. The study could not reject the null hypothesis of unitary long-run income and price elasticities. The inclusion of inflation as a determinant seems to be justified on the grounds that it is a return on goods – an alternative to money within a portfolio balance approach.

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<sup>9</sup>According to [42], the equity premium affects money demand although economic theory does not shed light on the sign of the coefficient on real stock prices.

As indicated above, all money demand studies suffer from the Barnett Critique. Specifically, [38] labels all these studies as occupying the ‘low road’ as opposed to the ‘high road’ that insists on ‘internal coherence among data, theory, and econometrics.’ Given the paucity of data on Divisia monetary service data for most countries including South Africa, we accept the ‘low road’ label with a little bit of push back by using a different model that partially responds to the Barnett Critique. In this paper, we employ an empirical model from a shopping-time model developed by [49].

### 3 A Shopping-Time Technology Model and the ARDL Model or Bounds Test

#### 3.1 A Shopping-Time Technology Model

In a shopping time model, there is a transactions technology relating the volume of transactions to time and money used in performing such transactions. The simple transaction technology monetary model shows an equilibrium relationship between real money demand and its determinants such as the opportunity cost of money, output of GDP. This paper adds real stock prices as an additional variable.

In the theoretical model, a representative household makes labor supply decisions, consumption and portfolio decisions in two separate steps. The first stage is the labor supply decision which determines labor income. With labor income decided, the second decision involves consumption and portfolio decisions. While modeling both stages is ideal, we assume that the first stage is given or obtained from endowment so that we focus only on the second stage. The simple economy has one good and two assets (money and a bond). The representative consumer derives direct utility from current period real consumption and leisure plus indirect utility from transaction services from real money balances. Thus, the consumer seeks to maximize total discounted utility given as

$$\sum_0^{\infty} \delta^t U(c_t, l_t) \tag{1}$$

where  $c_t$  and  $l_t$  are real consumption of the good and leisure at time  $t$  respectively. Both are normal goods with decreasing marginal utility in both goods,  $mu_c < 0$ , and  $mu_l < 0$  and  $\delta$  is the discount factor where  $0 < \delta < 1$ . As the household maximizes their utility, they face the following budget constraint.

$$\underbrace{PY_t + B_{t-1}(1 + R_{t-1}) + M_{t-1}}_{\text{Sources of funds available to the household from Income in the current period, money balances from previous period, and bonds bought in the previous period}} = \underbrace{PC_t + M_t + B_t}_{\text{Total expenses in consumption and bonds, and money balances at the end of the current period}} \tag{2}$$

*Sources of funds available to the household from Income in the current period, money balances from previous period, and bonds bought in the previous period*

*Total expenses in consumption and bonds, and money balances at the end of the current period*

where  $R$  is nominal interest rate,  $Y$  is nominal income,  $B$  is the nominal stock of bonds,  $M$  is nominal money balances,  $P$  is the price level (proxied by the CPI), and  $C$  represents nominal consumption. In this shopping model, money is held as a medium of exchange and enables the household to acquire consumption goods. The *shopping-time*

nature of the model arises from the fact that acquiring consumption goods requires that the consumer spend time and energy in this endeavor with the following *time* technology.

$$l_t = l(c_t, m_t) \quad (3)$$

where the time devoted to shopping is positively related to real consumption and negatively on real money balances ( $m_t = M / P$ ). Accordingly,  $l_t$  is negatively related to consumption (labor supply) and positively to real money balances. As in [3], a specific form of the utility function is given by

$$U(c_t, l_t) = c_t^{1-\alpha} l_t^\alpha, \quad 0 < \alpha < 1 \quad (4)$$

A specific functional form (3)

$$l(c_t, m_t) = c_t^{-\beta} l_t^\beta, \quad 0 < \beta < 1 \quad (5)$$

The problem to be solved is set out as follows.

$$\begin{aligned} & \text{Max } \sum_0^{\infty} \delta_t U(c_t, l_t) \\ & \text{subject to} \\ & (i) \ l_t = l(c_t, m_t) \\ & (ii) \ P_t Y_t + B_{t-1}(1 + R_{t-1}) + M_{t-1} = P_t C_t + M_t + B_t \end{aligned} \quad (6)$$

Putting the leisure function in the utility function puts money balances directly into the utility function model. We transform the nominal budget constraint into real terms by dividing all terms by  $P_t$ . We then set up the Lagrangian and obtain first-order conditions which are used to obtain a general conventional money demand (see the **Appendix** for details that derive (7) from (6)).

$$m_t = \frac{\alpha\beta}{1-\alpha-\beta} \left( 1 + \frac{1}{R_t} \right) c_t \quad (7)$$

By taking logs of both sides, we obtain

$$\ln m_t = \ln \alpha\beta - \ln(1-\alpha-\beta) + \ln\left(1 + \frac{1}{R_t}\right) + \ln c_t \quad (8)$$

If we assume that at equilibrium, real consumption ( $c_t$ ) equals real income ( $y_t$ ), we obtain the standard money demand function which can be written as



$$\ln m_t = \lambda_0 + \lambda_1 \ln y_t - \lambda_2 \ln R_t, \quad (9)$$

with  $\lambda_0 = \ln \alpha\beta - \ln(1 - \alpha - \alpha\beta)$  and  $\ln(1 + \frac{1}{R_t}) \approx -\ln R_t$

In the model,  $\lambda_1 > 0$ , and  $\lambda_2 < 0$ . Real stock prices are added to augment (9) equation without the need to derive them explicitly.

$$\ln m_t = \omega_0 + \omega_1 \ln y_t + \omega_2 \ln R_t + \omega_3 \ln sp + \varepsilon_t \quad (10)$$

where  $\omega_1 > 0$ ,  $\omega_2 < 0$ , and  $\omega_3 = (+/-)$ ?

### 3.2 ARDL Model of Money Demand

The money demand specification here is from [41a] where asset demand depends on wealth (proxied by real GDP), the expected return on other assets relative to money (domestic and foreign interest rates, and the exchange rate) and real stock prices. The inclusion of equity or stock market prices follows from [42], [50], [51], and [41a, 41b]. The money demand function takes the following form.

$$\ln m_t = \beta_0 + \beta_1 \ln y_t + \beta_2 r_t + \beta_3 r_t^* + \beta_4 \ln sp + \varepsilon_t \quad (11)$$

where  $m$ ,  $y$ ,  $r$ ,  $r^*$  and  $sp$  represents logs of real stock of M3, log of real GGP, domestic interest rate, foreign interest rates, and the log of real stock prices respectively. The  $\varepsilon$  represents white noise assumed to have a zero mean. In the empirical part of the model, the foreign interest rate ( $r^*$ ) is represented by various rates from the U.S., U.K., and Japan (see Figure 1 for all interest rates used in the paper). Similarly, the domestic interest rate ( $r$ ) is represented by four different rates. In equation (11),  $\beta_1 > 0$ ,  $\beta_2 < 0$ ,  $\beta_3 < 0$ ,  $\beta_4 \leq 0$  or  $\beta_4 \geq 0$ . The real stock price elasticity can be either positive or negative depending on the net effect of a combination of substitution and income effects. If  $\beta_4 = 0$ , it means that the stock market has no role in the demand for broad money. If the income elasticity of money demand ( $\beta_1 = 1$ ), this would support the validity of the quantity theory of money, whereas if  $\beta_1 = 0.5$ , then money demand function can be modeled within the Baumol-Tobin approach. However, if  $\beta_1 > 1$ , it might represent the neglect of wealth effects that are inadequately captured by the proxy variable, real GDP.

In a liberalized economy such as South Africa with no restrictions on holding foreign currencies, there is a large degree of currency substitution within a household portfolio. The inclusion of foreign interest rates in (11) reflects capital mobility and exchange rate effects. That is, changes in interest rate differential captures exchange rate effects ( $\Delta r^* - \Delta r \approx \Delta E$  where  $\Delta E$  is the domestic price of foreign currency (an increase in  $E$  is a depreciation of the home currency)). Given this, an increase in  $r^*$  relative to  $r$  induces

households to substitute domestic currency for foreign currency and invests in foreign bonds and other assets. Thus, we expect  $\beta_3$  to be negative [41a and 41b] and [52].

To establish whether broad money demand is cointegrated with real GDP, domestic interest rates, foreign interest rates, and real stock prices, we employ the ARDL model from [53], and [54]. The advantage of the approach is that it is applicable whether variables are both I(0) and I(1). For example, the inflation rate (used as an alternative measure of opportunity cost of holding money balances) is I(0) while other variables are I(1). Since the sample size is over 100 observations, we introduce sufficient lags to remove endogeneity and serial correlation. If there is cointegration it is possible to estimate both short-run and long-run estimates of the money demand function. The resulting error-correction model from (11) is given by

$$\Delta \ln m_t = \alpha_0 + \sum_{i=0}^q b_i \Delta \ln m_{t-i} + \sum_{i=0}^q c_i \Delta \ln y_{t-i} + \sum_{i=0}^q d_i \Delta r_{t-i} + \sum_{i=0}^q e_i \Delta r_{t-i}^* + \sum_{i=0}^q f_i \Delta \ln sp_{t-i} + \lambda_1 \ln m_{t-1} + \lambda_2 \ln y_{t-1} + \lambda_3 r_{t-1} + \lambda_4 r_{t-1}^* + \lambda_5 \ln sp_{t-1} + u_t \quad (12)$$

The variables in (12) are as defined before. Equation (12) shows a VAR with a linear combination of lagged variables which represent lagged error-terms which measure how far the dependent variable strays from independent variables.

#### 4 Methodology and Data

The 1980Q1- 2010Q3 quarterly data come from the IMF's International Financial Statistics disk supplemented by data from Bank of Japan, Bank of England, and FRED for foreign interest rates.<sup>10</sup> Stock prices are the *All Shares* from the Johannesburg Stock Exchange. The opportunity costs of holding money are domestic and foreign interest rates. Domestic interest rates are the money market rate, the Treasury bill rate, and the loan and deposit rates. For the U.S. we used bank prime loan rate, the 3-month secondary market rate, and the Treasury bill rate while for the UK, we have the deposit rate, lending rate, and the overnight interbank rate. For Japan, we used the lending rate, the certificate of deposit rate and the call money rate.<sup>11</sup> Figure 1 shows that South African rates are the highest and Japanese rates being the lowest. All variables except interest rates were converted to real values by dividing GDP and stock prices by the CPI which was also used to construct the inflation rate.<sup>12</sup>

<sup>10</sup>The data is available from the St. Louis Federal Reserve website.

<sup>11</sup>In a global economy and within it a liberalized financial sector, the opportunity cost of holding money balances is not as simple as it used to be. The variable (s) chosen to represent opportunity cost has to take into account that real balance holders can substitute real balances with other financial and real assets, including foreign counterparts. A few empirical studies also consider exchange rate changes as one of the variables that affect the behavior of money demand ([55] and [56]).

<sup>12</sup>All domestic interest rates proved insignificant save the deposit rate. As a result domestic rates were replaced by the inflation rate.

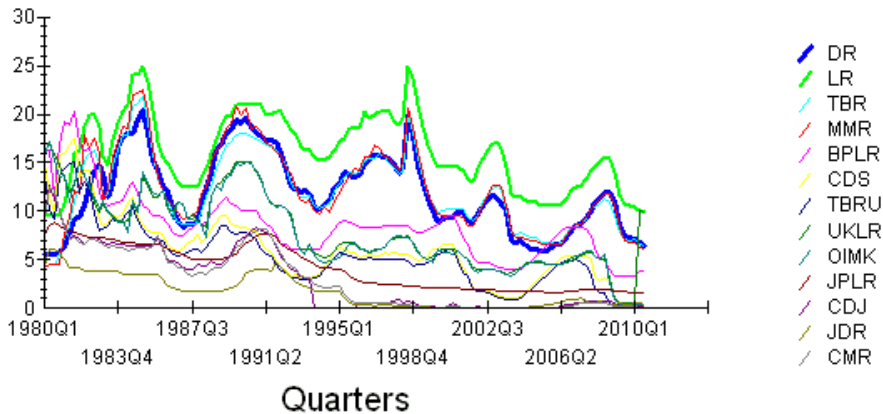


Figure 1: South African interest rates and foreign rates (USA, UK, Japan)

Legend

**South Africa** [DR=South African deposit rate; LR = South African lending rate; TBR = South African Treasury bill rate; MMR = South African money market rate]

**U.S.** [BPLR= US bank prime loan rate; CDS =secondary 3-monh rate; TBRU = US Treasury bill rate]

**UK.** [UKLR = UK lending rate; OIMK= UK overnight interbank rate]

**Japan** [JPLR = Japanese lending rate; CDJ = Japanese certificate of deposit rate; JDR= Japanese deposit rate, CMR = Japanese call money rate]

We begin by testing for the existence of a long-run money demand using the F-tests (bounds test) with the null that there is no such relationship. The computed F-statistics are compared to the critical bounds reported in [53]. The tables have critical values for both I(0) and I(1), hence the term *bounds test*. The null hypothesis of no long-run relationship in (12) is denoted as  $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$  against the alternative that  $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0$ . For example, Table 1 has five tests with of various lags  $q$  chosen by the Schwartz-Bayesian Criterion (SBC). To test whether the dependent variable, M3 is cointegrated with chosen variables, we state this as  $F_{M_3}(m_3 | y, \text{inf}, r^*, sp)$  and find that the calculated F-statistic is 7.19. If the calculated F-statistic is greater that the upper bound of critical values at a chosen level of significance, we reject the null and accept that there is a long-run relationship. In Table 1 for a 5% level of significance, 7.19 is higher than 3.80. Thus, we can conclude that there is indeed a cointegrating relationship when money demand (M3) is the dependent variable with a lag of 8. Table 1 shows F-statistics when other variables are dependent variables. It is clear that other than  $F_{\text{inf}}(\text{inf} | y, m_3, \text{inf}, r^*, sp)$ , all calculated F-statistics are below the lower bound and hence we can reject any cointegrating relationship. If the calculated F-statistic lies between the lower and upper bounds, any decision on cointegration requires additional information about the order of integration of variables but the decision is often deemed inconclusive. From Table 1, we conclude that there is indeed a unique cointegration between money demand and all variables.

Initially, we estimated (11) by OLS and found that domestic rates (except the deposit rate) were insignificant and thus it was omitted from cointegration tests in Table 1. To ensure that we just didn't drop domestic rates as measures of opportunity cost, results in Table 4

confirm the fact that none of the domestic rates (except the deposit rate) ever make it into any long-run money demand. Thus, we drop the domestic interest rate in (12) and tests in Table 1 and replace it by the inflation rate.<sup>13</sup>

## 5 Empirical Results and the Stability of the Demand for Broad Money Function

### 5.1 Empirical Results

Using the ARDL approach we estimate the model in (12) in *levels* and the long-run and short-run estimates are presented in Tables 2 and 3 respectively. In Table 2, the lower part of the table also presents various results from testing standard restrictions. The long-run estimates show that results conform to economic theory. In Table 2, the income elasticity of money demand ( $b_y$ ) is 1.51, the inflation elasticity demand for money ( $b_{inf}$ ) is -0.13 and inelastic, the foreign interest elasticity ( $b_{r^*}$ ) is -0.039, and the real stock price elasticity ( $b_{sp}$ ) is 0.286. The income elasticity of money demand reported here is much lower than that from [43 and 44] (3.2) and [45] (1.8). There is a suggestion that the omission of wealth (a more relevant variable in money demand) tends to induce upward bias in the income elasticity of demand.

The inflation elasticity of the demand for money shows that a one percent increase in inflation induces holders of money avoid inflation tax by holding less money by 0.13 percent. A plausible explanation of inelasticity might be related to a large percentage of the population (mainly Africans and Coloureds) that remains largely unbanked (that is, this population has no bank accounts). This population has to hold money for every day transaction purposes. The income elasticity of demand is 1.51, higher than 1. We tested the hypothesis that the income elasticity is 1 and failed to reject this hypothesis. The lower portion of Table 2 shows a  $\chi^2$  of 2.65 with  $p=0.11$  at the 5% level of significance. Thus, the result is in line with the quantity theory of money. The value of the income elasticity does point to financial depth in the South African financial market to allow for alternative assets in a household portfolio. The earlier discussion of increasing liquidity in most components of M3 has come with an increasing African middle class (until the financial crisis in 2007) with wealth that they could shift from more liquid M3 to less liquid portions of the same aggregate (see a discussion on Divisia monetary service indexes).

The real stock price or equity elasticity of money demand is positive, inelastic and yet significant. This means that a one percent increase in equity prices leads to a 0.29 percent increase in the demand for broad money. Since prices have a negative (substitution) and positive (income) effect, the fact that the coefficient is net positive means that the income effect dominates the substitution effect. The noteworthy result here is that the inclusion of

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<sup>13</sup>[57], [58], [52], [59], and [41a and 41b) drop the domestic interest in their models in favor of the inflation rate as an alternative measure of the opportunity cost of holding money. [60] found that including both the domestic and foreign rates in (12) as in (11) resulted in severe multicollinearity. In the light of evidence from these studies, the results in Table 2 and 3 report estimates of the coefficient on inflation rather than that on domestic interest rates.

real stock prices improves the specification of the money demand function and contributes to its stability as well (see Model 4 in Table 5).<sup>14</sup> [41a and 41b] suggest that unstable money demand functions evidenced in the literature could arise from the omission of important variables. To the best of my knowledge, none of studies of money demand in South Africa incorporate real stock prices. This is indeed surprising given that equity prices are a crucial determinant in the demand for alternatives to money holdings. With the increasing ‘moneyness’ of components of M3, the exclusion of stock prices or equity prices from money demand studies may lead to misspecification and instability of money demand. Table 3 presents error-correction estimates for the money demand model. The short-run income elasticity (0.11) is positive and significant and so is the stock price elasticity (0.02). The latter result is justified by [42]’s argument that if it is positive, then the income effect dominates the substitution effect.

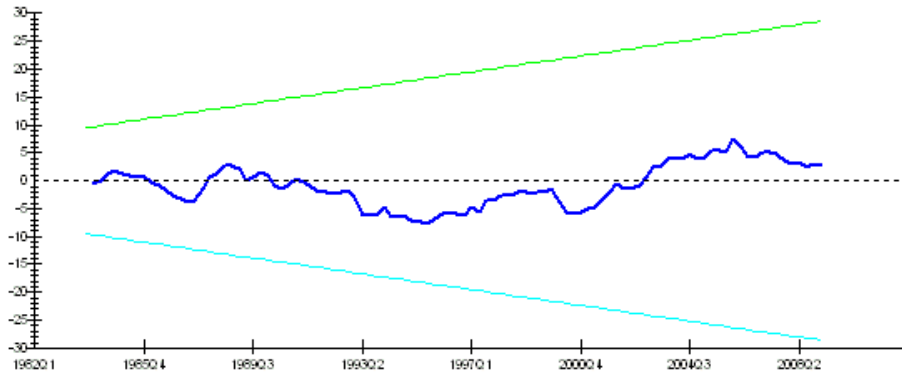
The short-run inflation elasticity (-0.01) is negative and significant. It shows that even in the short-run, changes in inflation induce households to reduce their balances held as M3. The foreign interest rate elasticity is 0.003 is negative and significant. Even in the short-run, the monetary influence of U.S. on domestic money holdings in South Africa is not zero. Although the effect is very small, it represents the influence of a global economy within a substantial liberalized South African monetary sector. The error-correction term (ECM) in the Table is negative and significant at the 5% level of significance. According to [61], a significant error-correction term is indicative of causality running from stock prices, foreign interest rates, inflation and income. The ECM coefficient of -0.074 shows that about 7.4% of the previous quarter disequilibrium between actual and equilibrium values of M3 are corrected each quarter. Although the adjustment is small, it is similar to the number found by other studies on money demand in South Africa. The error-correction coefficient reported in this paper is much smaller than -0.20 in [23], -0.59 in [22], and 1.11 in [46] and [47].

## 5.2 Stability of the Demand for Money

Within the ARDL framework, the stability (constancy) of the long-run relationship between money demand and the set of variables in (12) is conducted using the CUSUM and CUSUMSQ tests (applied to residuals) from [62]. The CUSUM test is based on the cumulative sum of recursive residuals on say,  $m$  observations. The cumulative sum test is updated recursively and plotted against break points. If the plot of residual statistics lies within a 5% significance band, then the ARDL-based estimates of the money demand function are deemed stable. The CUSUM results are presented in Figure 2 lie within the critical bounds.

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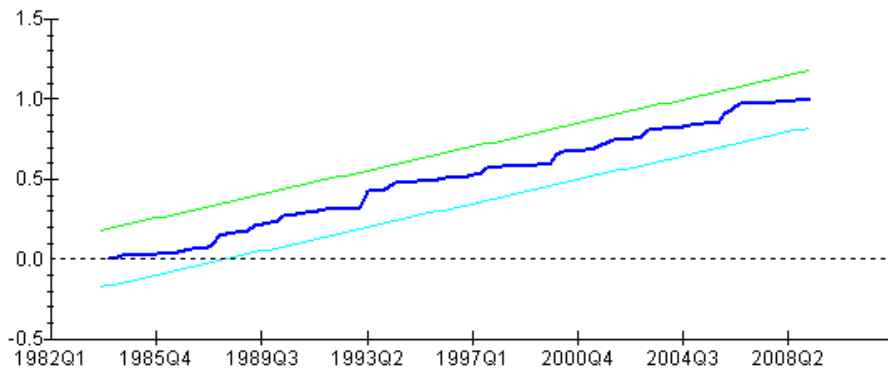
<sup>14</sup>However, if we use stock market returns (RSP) as in Table 5 (Model 5), all variables become insignificant and the model becomes unstable.



The straight lines represent critical bounds at 5% significance level

Figure 2: Plot of cumulative sum of recursive residuals

The CUSUMSQ test is based on squared residuals and the result is presented in Figure 3. Figure 2 and 3 show residuals from (12) with real stock prices as an additional variable. Given that M3 is cointegrated with real GDP, inflation, foreign interest rates (specifically, the U.S. bank prime loan rate), and stock prices the results in Figures 2 and 3 point to the importance of including stock market prices in the demand for money.



The straight lines represent critical bounds at 5% significance level

Figure 3: Plot of cumulative sum of squares of recursive residuals

[41a], [56], [55], and others suggest the inclusion of an exchange rate in a money demand function. Model 1 in Table 5 includes a nominal effective exchange (*er*) in a long-run money demand function. Other than the income elasticity of demand (1.32) the rest of the variables including the exchange rate are now insignificant even at 10% level of significance. Furthermore the model fails the CUSUM stability test. The failure of the exchange rate as a variable in a money demand function may simply reflect the fact that the differential between the foreign and domestic interest rates adequately captures exchange rate effects via the Fisher effect. Thus, the  $r^*$  term picks up most of the exchange rate effects in Model 1. Another experiment is in Model 3 where we define SPRE as the spread between the loan and deposit rate. It turns out to be insignificant as well even when we enter these as separate variables in Model 2 (the loan rate is significant). In Model 4 we put a dummy variable (D) to test whether the adoption of

inflation targeting in February 2000 had an impact on money demand in an equation with real stock prices. The dummy coefficient is  $-0.18$  ( $t=-1.74$ ) but insignificant. In Model 5, we replace real stock prices by their rate of return and test whether the adoption of inflation targeting has an impact on money demand. Again the D coefficient is negative and insignificant. However, Model 5 is CUSUM unstable whereas Model 4 is stable.

Table 4 reports results that impose different domestic and foreign interest rates and estimate a long-run money demand function despite earlier results in Table 1. For the most part, the domestic interest rate coefficients are insignificant regardless of the domestic rate used (deposit, loan, Treasury bill, money market). On the other hand, foreign interest rate coefficients are a mixed; with positive and negative signs, and a mixture of significance and non-significance. The last entry in Table 4 is probably more significant for this paper. By excluding domestic interest rates and real stock prices but allowing for inflation yields an unstable model as determined by both CUSUM and CUSUMSQ tests. The foreign interest rate (the U.S. bank prime loan rate) coefficient of  $-0.05$  has the correct sign and significant at the 5% level of significance whereas the inflation coefficient value of  $-0.13$  is barely significant at the 10% level.

## 6 Summary and Conclusion

The summary of information from Tables 2 to 5 tells an interesting story about the demand for broad money (M3) in South Africa. From Table 2, it is clear that M3 is cointegrated with the set of variables therein. The model passes all the diagnostic tests as shown in Table 2. In Table 3 the error-correction term is negative and highly significant, pointing to the ability of the money market to adjust by 7.4% each quarter in response to disequilibrium. Table 4 shows that various domestic rates are not adequate measures of opportunity cost of holding money balances in M3. However, Table 4 shows the importance of including some foreign interest rates in the money demand function. Furthermore, Table 4 shows that the exclusion of real stock prices, given the irrelevance of domestic rates results in an unstable money demand function. Table 5 (Model 1) shows that the inclusion of the effective exchange variable induces most coefficients to be insignificant and the model becomes unstable as it fails the CUSUM test. Finally, inflation targeting does not seem to affect M3 money demand since the dummy coefficient is insignificant when the real stock price variable is included. If the stock market return variable is included instead, the insignificance holds in addition to instability as the model (Model 5) fails the CUSUM test.

Overall, we find a stable money demand function if real stock prices are included. This result confirms other studies of money demand elsewhere ([63], [41a and 41b], [40], and [50]). With an income elasticity of 1.51, we could not reject the hypothesis that it unity. Having noted that M3 components have become more liquid with a global economy and a liberalized South African financial sector, domestic interest rates have no effect on demand as one would expect with the use of Divisia monetary aggregate advanced by [38] and [39]. From a policy perspective, it is important to take into account foreign interest rates and the stock prices when formulating monetary policy even in the presence of inflation targeting.

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## Appendix

The nominal budget constraint is  $P_t Y_t + B_{t-1}(1 + R_{t-1}) + M_{t-1} = P_t C_t + M_t + B_t$  as in (2) and (6).

Divide through by  $P_t$

$$P_t Y_t + B_{t-1}(1 + R_{t-1}) + M_{t-1} = P_t C_t + M_t + B_t$$

$$Y_t + \frac{B_{t-1}}{P_t}(1 + R_{t-1}) + \frac{M_{t-1}}{P_t} = c_t + \frac{M_t}{P_t} + \frac{B_t}{P_t}$$

$$\text{Let } b_t = \frac{B_t}{P_t}, m_t = \frac{M_t}{P_t} \text{ so that } \frac{B_{t-1}}{P_t} * \frac{P_{t-1}}{P_t}(1 + R_{t-1}) + \frac{M_{t-1}}{P_t} * \frac{P_{t-1}}{P_t} = c_t + m_t + b_t \Rightarrow$$

$$Y_t + b_{t-1}(1 - \tau_t)(1 + R_{t-1}) + m_{t-1}(1 - \tau_t) = c_t + m_t + b_t$$

$$\text{where } \tau_t = \frac{P_t - P_{t-1}}{P_t}$$

With all variables now stated in real values, set the Lagrangian as

$$L = \sum_0^{\infty} \delta_t U(c_t, m_t) + \sum_0^{\infty} v_t [Y_t + b_{t-1}(1 - \tau_t)(1 + R_{t-1}) + m_{t-1}(1 - \tau_t) - c_t - m_t - b_t] \quad \text{and}$$

obtain the following first order conditions (FOCs) as follows.

$$\frac{\partial L}{\partial c_t} = \delta_t U_c - v_t = 0; \quad (\text{A1})$$

$$\frac{\partial L}{\partial m_t} = \delta_t U_m - v_t + v_{t-1}(1 - \tau_{t+1}) = 0; \quad (\text{A2})$$

$$\frac{\partial L}{\partial \delta_t} = v_t = v_{t-1}(1 - \tau_{t+1})(1 + R_t) \quad (\text{A3})$$

From (A3), solve for  $v_{t+1} = \frac{v_t}{(1 + R_t)(1 - \tau_{t+1})}$  and substitute into (A2) to obtain

$$\delta_t U_m + \frac{v_t(1 - \tau_{t+1})}{(1 + R_t)(1 - \tau_{t+1})} - v_t = 0$$

$$\Rightarrow \delta_t U_m = v_t \frac{R_t}{(1 + R_t)}$$

We use (A1) to derive

$$\delta_t U_m = \delta_t U_c \frac{R_t}{(1 + R_t)} \Rightarrow U_m = U_c \frac{R_t}{(1 + R_t)} \quad (\text{A4})$$

Combine the partial derivatives of the utility function,  $U(c_t, m_t) = c_t^{1-\alpha-\alpha\beta} m_t^{\alpha\beta}$  from (4) and (5) as given as

$$U_c = (1 - \alpha - \alpha\beta) c_t^{-\alpha-\alpha\beta} \quad (\text{A5})$$

$$U_m = \alpha\beta c_t^{1-\alpha-\alpha\beta} m_t^{\alpha\beta-1}$$

Substitute (A5) into (A4) which yields (7) in the text.

Table 1: The Bounds Test for the Existence of a level relationship

Model	Calculated F-statistic	Lag	Significance Level	Critical Bounds Values	
				F-Statistic (Pesaran et al., 2001)	
				I(0)	
				I(1)	
$F_{sp}(sp y,inf,r^*,m_3)$	2.41[0.043]	3	1%	3.52	
$F_{inf}(inf y,sp,r^*,m_3)$	3.78[0.661]	4	5%	4.78	
$F_{r^*}(r^* y,inf,sp,m_3)$	1.02[0.411]	6	10%	2.65	
$F_{m_3}(m_3 y,inf,r^*,sp)$	7.19[0.00]	8		3.80	
$F_Y(y inf,r^*,sp,m_3)$	2.72[0.003]	5		2.26	
				3.37	

The estimation period is 1983Q2-2009Q1, preserving 2009Q2 – 201Q3 for out-of-sample testing.  $m_3$  is the log of real M3,  $y$  is the log of real GDP,  $inf$  is the inflation rate (based on the CPI),  $r^*$  is the U.S. bank prime rate, and  $sp$  is the real stock prices (Johannesburg Stock Exchange). F-statistic is the statistic for testing zero-restrictions on the coefficients of lagged variables in a particular model. The critical bounds values are drawn from [53].

Table 2: The Long-Run Demand for M3

**Normalized Equation**

m3	Y	inf	r*	sp	c
-1.00	1.51	-0.13	-0.039	0.286	-5.11
	(7.78) <sup>b</sup>	(-2.10) <sup>b</sup>	(-2.08) <sup>b</sup>	(2.71) <sup>a</sup>	(-2.65) <sup>b</sup>

The figures in () are t-statistics. The restriction test is the normal Wald test imposed on the parameters of the estimated model. The superscripts *a* represents significance at 10% level while *b* represents statistical significance at 5% level.  $M_3$  is the log of real M3,  $inf$  is the inflation rate measured by the CPI,  $r^*$  represents the US bank prime rate,  $sp$  is the log of real stock prices, and  $c$  is the constant term. **Note:** The foreign interest rate used in Tables 2 and 3 is the U.S. bank prime loan rate since it is the only foreign interest rate that is significant out of all foreign rates.

Hypotheses	Restrictions	$\chi^2$	p-value
A1=-1;A2=0	$b_y=0$	48565.3	0.000
A1=-1;A3=0	$b_{inf}=0$	6474.2	0.000
A1=-1;A4=0	$b_{r^*}=0$	5833.1	0.000
A1=-1;A5=0	$b_{sp}=0$	12630.8	0.000
A1=-1;A2=1	$b_y=1$	2.6547.1	0.117
<b>Diagnostic Tests</b>			
	LM(4)	Reset	JB[2]
			HET( $\chi^2$ )
$\chi^2$	9.63	1.63	1.94
p-value	0.57	0.202	0.380
			0.421
			0.516

The LM represents a Lagrange multiplier test of residual correlation, JB is the Jarque-Bera test for normality (checking skewness and kurtosis of residuals). Reset is a Ramsey’s

test for functional misspecification, and HET is White’s test for heteroskedasticity. The model passes all the diagnostic tests.

Table 3: Error-Correction Representation for the Selected ARDL Model

Estimated Coefficients (t-statistics in parentheses)											
$\Delta m_3$	= -0.38	+	0.11 $\Delta y_{t-1}$	-	0.01 $\Delta \text{inf}_{t-1}$	-	0.003 $\Delta r_{t-1}^*$	+	0.021 $\Delta \text{sp}_{t-1}$	-	0.074 $\Delta \text{ECM}_{t-1}$
	(-1.94) <sup>a</sup>		(2.74) <sup>b</sup>		(-4.77) <sup>b</sup>		(2.56) <sup>b</sup>		(1.99) <sup>a</sup>		(-2.87) <sup>b</sup>
$R^2=0.87$											

The letters *a*, *b* represents statistical significance at 10% and 5% levels respectively. The ECM term represents the error-correction term.

Table 4: Long-run demand for M3 using different domestic and foreign interest rates

Variable Selection	Y	inf	r	r*	sp	c	F-test	ECM <sub>t-1</sub>	CUSUM	CUSMSQ
r=DR r*=BPLR (U.S.)	1.45 (12.59)	-	-0.02 (-2.35)	-0.003 (-0.32)	0.091 (1.02)	-4.44 (-3.85)	11.36	-0.11[0.000] (-2.76)	Stable	Stable
r=LR r*=BPLR	1.77 (9.23)	-	-0.005 (-0.63)	-0.030 (-2.08)	0.072 (0.55)	-7.78 (-4.25)	13.25	-0.085[-3.12] (-3.12)	Stable	Stable
r=MMR r*=BPLR	1.74 (9.85)	-	0.003 (0.36)	-0.023 (-1.68)	0.124 (1.04)	-7.51 (-4.42)	13.14	-0.091[0.002] (-3.18)	Stable	Stable
r=TBR r*=BPLR	1.77 (9.15)	-	-0.004 (-0.43)	0.029 (1.94)	0.086 (0.67)	-7.78 (-4.20)	13.17	-0.085[0.003] (-3.06)	Stable	Stable
r=TBR r*=CDS	1.78 (10.18)	-	-0.003 (-0.40)	-0.028 (-2.27)	0.054 (0.45)	-7.87 (-4.75)	13.38	-0.095[0.001] (-3.34)	Stable	Stable
r=TBR r*=TBRU	1.822 (9.08)	-	-0.004 (-0.43)	-0.032 (-2.09)	0.054 (0.42)	-8.20 (-4.33)	13.09	-0.089[0.002] (-3.18)	Stable	Stable
r=MMR r*=UKLR	1.63 (10.24)	-	0.01 (1.03)	0.005 (0.42)	0.22 (1.83)	-6.39 (-4.20)	12.10	-0.089[0.004] (-2.92)	Stable	Stable
r=MMR r*=OIMK	1.63 (10.58)	-	0.007 (1.01)	0.005 (0.49)	0.22 (1.82)	-6.40 (-4.35)	12.11	-0.090[0.004] (-2.92)	Stable	Stable
r=MMR r*=JPLR	1.55 (7.30)	-	0.010 (1.28)	-0.010 (-0.32)	0.27 (1.70)	-5.56 (-2.68)	12.09	-0.076[0.043] (-2.63)	Stable	Stable
r=MMR r*=CDJ	1.63 (13.82)	-	0.01 (1.10)	0.012 (1.10)	0.18 (1.84)	-6.45 (-5.75)	12.28	-0.12[0.010] (-2.63)	stable	stable

Table 4 continues

r=MMR r*=CMR	1.61 (10.05)	-	0.01 (1.24)	-0.001 (-0.072)	0.24 (1.78)	-6.14 (-4.04)	12.05	-0.087[0.023] (-2.30)	stable	stable
r*=CMR INF	1.31 (7.35)	-0.12 (-2.40)	-	0.02 (1.94)	0.41 (2.50)	-2.97 (-1.64)	19.30	-0.089[0.006] (-2.84)	Stable	Stable
r*=UKLR INF	1.38 (8.86)	-0.14 (-2.56)	-	0.03 (2.65)	0.419 (2.64)	-3.75 (-2.41)	18.57	-0.083[0.002] (-3.15)	Stable	Stable
r*=BPLR Inf	1.83 (9.95)	-0.14 (-1.90)	-	-0.05 (-2.29)	-	-8.22 (-4.84)	19.54	-0.062[0.018] (-2.40)	<b>UNSTABLE</b>	<b>UNSTABLE</b>

The foreign interest rates ( $r^*$ ) are drawn from three countries, United Kingdom (UK), U.S.A, and Japan. For the UK, UKLR and OIMK represent the lending rate and the overnight sourced from the Bank of England website. For Japan, JPLR, CDJ, and CMR represent the Japanese lending rate, the certificate of deposit, and the call money rate respectively. For the U.S., BPLR, CDS, and TBRU represent the bank prime loan rate, the secondary 3-month rate, and U.S. Treasury Bill rate respectively. For domestic interest rates (South Africa), MMR, DR, LR, and TBR represent the money market rate, deposit rate, lending rate, and the South African Treasury Bill rate respectively.

Table 5: Long-run demand for M3 (testing for the interest rates, the exchange rate, inflation targeting, and stock returns)

Model Variables											
Model 1	Y 1.32 (4.88)	Inf -0.16 (-1.89)	$r^*$ -0.04 (-1.92)	sp 0.42 (1.84)	er -0.01 (-0.42)	C -2.74 (-0.78)	F-test 14.8	ECM <sub>t-1</sub> [p-value] -0.066 (-2.50)	CUSUM Unstable	CUSUMSQ stable	
Model 2 $i_b=LR$ $i_d=DR$	Y 1.24 (7.40)	Inf -0.16 (-1.96)	$i_b=LR$ -0.09 (-2.32)	$i_d=DR$ 0.04 (1.68)	-	C -1.27 (-0.61)	F-test 13.5	ECM <sub>t-1</sub> [p-value] -0.062 (-2.55)	CUSUM Stable	CUSUMSQ stable	
Model 3 SPRE=LR-DR	Y 1.63 (9.73)	Inf -0.20 (-1.61)	SPRE -0.10 (-1.79)	-	-	C -5.38 (-3.76)	F-test 19.06	ECM <sub>t-1</sub> [p-value] -0.049 (-1.96)	CUSUM stable	CUSUMSQ stable	
Model 4 D ; SP	Y 1.17 (4.85)	Inf -0.13 (-2.34)	$r^*$ 0.036 (2.53)	SP 0.33 (2.13)	D -0.18 (-1.74)	C -1.97 (-0.84)	F-test 17.08	ECM <sub>t-1</sub> [p-value] -0.80[0.002] (-3.20)	CUSUM stable	CUSUMSQ stable	
Model 5 D; RSP	Y 1.65 (7.58)	Inf -0.13 (-1.84)	$r^*$ 0.05 (2.46)	RSP 0.001 (1.61)	D -0.160 (-1.26)	C -6.58 (-3.29)	F-test 16.67	ECM <sub>t-1</sub> [p-value] - 0.064[0.015] (-2.47)	CUSUM Unstable	CUSUMSQ stable	

$SPRE = (LR-DR)$ , the spread between the domestic lending and deposit rates where  $LR$  is the lending rate and  $DR$  is the deposit rate – all South African rates;  $RSP$  is the return of returns on stocks,  $y$  is the log of real income,  $inf$  is the inflation rate based on the CPI,  $SP$  is the log of real stock prices,  $ER$  is the nominal effective exchange rate,  $D$  is the dummy variable that takes the value 0 for the period 1980Q1-2000Q1 and 1 for the period 2000Q2 -2010Q3.  $D$  measures whether inflation-targeting (IT) adopted by the South African Reserve Bank in February 2000 had an impact on M3 money demand. We experimented with  $dinf$  ( $inf$  interacted with IT dummy,  $D$ ). The  $dinf$  term was=0.0005 ( $t=0.156$ ) which is insignificant. It points to the absence of IT influence on money demand in South Africa. The same results are reflected in models 4 and 5 for the  $D$  term. The results are not reported here but are available from the authors.