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Article

The Monetary Model of Exchange Rate Determination for South Africa

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Abstract: The disconnect between the exchange rate and its macroeconomic fundamentals has been extensively discussed in the literature. It nonetheless continues to pose theoretical and empirical challenges in the literature. This study examines the relationship between the exchange rate and its fundamentals. This study used the monetary model of exchange rate determination developed in the 1970s. The study used the TAR to estimate the exchange change rate behaviour in response to variations in monetary variables. We found that the exchange rates respond to the interest rate differential, consistent with the predictions of the monetary model of exchange rate determination. Furthermore, in all the regimes, the sizes of coefficients are different, which shows that the exchange rate behaviour is non-linear (asymmetric). While the impact of the interest rate differential in regime 1 and 2 leads to exchange rates appreciating although in regime 2 the results are insignificant, this occurs when the exchange rates fluctuate below 0.87 percentage points. In regime 3, on average, a marginal increase in interest rate differential leads to an exchange rate depreciation. In some instances, the exchange rates respond to the monetary variables' changes in line with the predictions of the monetary theory of exchange rate determination. An increase in interest rates in some instances leads to an improvement in the value of the exchange rate. However, the conditions are not constant—they vary depending on the state of exchange rate fluctuation.

Keywords: monetary model; exchange rates; interest rate differential; bonds; economic policy uncertainty



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1. Introduction

Since the 1970s, there has been great interest in investigating the monetary model of exchange rate determination. However, exchange rate movement remains one of the unresolved research issues, despite extensive research on the subject matter. The theory argues that in the long run, a number of macroeconomic fundamentals, such as inflation rates, money supply, interest rates, and output, determine exchange rate behaviour. However, empirically, it has been demonstrated that the assumptions of this theory do not hold. For example, [Chinn \(1999\)](#) found that the monetary model is not valid for explaining the exchange rates (South African rand/United States dollar (ZAR/USD)) in both the short run and the long run. Furthermore, the study used the monthly data starting from 1980 to 1998, while [Brink and Koekemoer \(2000\)](#) used the data from 1979 to 2000 and found that the ZAR/USD behaviour is explained by the monetary model. [Cushman \(2000\)](#), on the other hand, found that the monetary model for exchange rate determination cannot explain the exchange rate behaviour of the Canadian dollar vs. the USD.

[Nell \(2003\)](#) examined the money demand function using South African (SA) data and found that it is stable. Then he further argued that the money demand can be used to estimate the behaviour of exchange rates in the long run. [Sichei et al. \(2005\)](#) estimated the monetary model and shocked the exchange rates (ZAR/USD) with interest rates. Their study found that the exchange rates respond with depreciation when the interest rates

increase using data from 1994 to 2004. These findings are contrary to what is expected. This may suggest that the relationship between the monetary variables and the exchange rates is different in SA. The theory assumes that when the interest rates increase, the exchange rates will appreciate. Even [Engel and West \(2005\)](#) were not able to find evidence to show that the monetary model can explain the exchange rate behaviour in the long run. [Ziramba \(2007\)](#) used South African data from 1970 to 1993 and assumed the 1976 monetary model with flexible prices. The study found that the exchange rates respond to changes in income inconsistently with the theory assumptions. However, [Dube \(2008\)](#) was able to provide empirical support for the monetary model being able to show the long-run relationship of macroeconomic fundamentals and the exchange rates for ZAR/USD. [Hassan and Simione \(2013\)](#) assessed panel data from three countries, South Africa (SA), Mozambique, and the United States of America (USA), and determined that in the long run, the monetary model determines the exchange rate behaviour. [de Bruyn et al. \(2015\)](#) made the same conclusion about the ZAR/USD. However, they used data that span over 100 years (1910–2010), which is an issue because the long-run data suffer structural problems.

[de Bruyn et al. \(2015\)](#) do not account for structural issues that have arisen in the past 100 years when estimating. The period between 1910 and 1914 saw the rise of the classical gold standard, followed by World War 1 (WWI) from 1914 to 1918. WWI disrupted the gold standard, which led to more currencies claiming the role that was previously held without contestation by the British pound sterling. For more discussion on the evolution of exchange rates throughout history, see ([Officer 2007](#)). There are many events that could have caused structural breaks domestically which are not accounted for as well. For more discussion of the SA history, see ([Ludi and Ground 2006](#)). [de Bruyn et al.'s \(2015\)](#) data have too many structural issues that are not accounted for, which makes their findings unreliable. The researchers who reported that there is a relationship between the monetary variables and the exchange rates managed to find the link by including a trend in their estimation. [de Bruyn et al. \(2015\)](#) argue that including a trend produces a weak form of the link.

If the monetary model of exchange rate determination does not hold, it becomes a problem for institutions like the South African Reserve Bank (SARB). The SARB is the monetary policy authority of SA with a constitutional responsibility to maintain the value of the rand. The SARB uses the interest rates as its main tool for maintaining the inflation rates between 3% and 6% ([Msomi and Ngalawa 2024](#)). The theory of the monetary model for exchange rate determination assumes that the variation in interest rate has effects on the exchange rate in the long run ([de Bruyn et al. 2015](#); [Itskhoki and Mukhin 2021](#); [Tawadros 2017](#)). However, in the literature, there is no consensus about the effects of monetary variables on the exchange rates.

The literature associates the rise in the inflation rate with depreciating exchange rates ([Ha et al. 2020](#)). Thus, exchange rate depreciation is a macroeconomic effect that has implications for the SARB objective. The constant depreciation of exchange rates makes the job of the SARB unachievable. The ZAR/USD in the period between 2000 and 2023 has a long depreciation swing. This shows the extent the domestic currency has lost strength over time against the USD. Initially, the exchange rates appreciated rapidly with moderated fluctuations. Thereafter, in the third quarter of 2003, the exchange rate depreciation became rapid. Although the exchange rate began to appreciate after a period of sharp depreciation, the fluctuations increased. Thereafter, the exchange rate resumed another period of sharp depreciation until 2004. Then the exchange rates became stable between 2004 and 2012, compared to the entire period between 2000 and 2023. However, the exchange rates became very volatile during this period, especially before the first quarter of 2004. At the beginning of the third quarter of 2009, the exchange rates depreciated again. From 2012, the exchange rates began depreciating rapidly until 2016. This continuous depreciation of the exchange rates makes the job of the SARB difficult. The debate in the literature does not point clearly to the effects of monetary variables on the exchange rates.

The depreciation of the rand makes SA-produced goods relatively cheaper to the rest of the world, which incentivises foreigners to increase demand for goods produced in SA.

The higher demand for domestic goods puts pressure on the domestic price level to increase. The pressure on the domestic price level increases the risk for the SARB to not achieve its objective. Then the SARB responds by increasing the interest rates, and its effect in the short/long run on the exchange rates is still subject to debate in the literature. The empirical literature shows that the relationship between exchange rates and monetary variables is not clear, which makes policy making have unclear consequences for the economy. The SARB needs to know the relationship between the exchange rates and the monetary variables to make its job effective.

The study provides insight into the debate in the literature concerning the effects of monetary variables on the exchange rates both in the short run and the long run. The findings of the study can be applied to many emerging economies with similar characteristics as SA to guide monetary policy making. This study is different because we use a non-linear regime-switching model, which assumes that the exchange rate behaviour varies. The monetary model estimated in the study does not assume constant parameters as have previous studies on the ZAR/USD. The data used span the years 2000 to 2023. In this period, SA monetary policy is transparent and clear. The data would provide meaningful insights into the monetary model and the exchange rate determination.

2. Literature Review

Chahrouh et al. (2021) explain that exchange rates are central to the international transmission mechanism of open economies. However, modelling the exchange rates' movement remains a challenging exercise in the macroeconomics literature (Bacchetta and van Wincoop 2013). Tawadros (2017) adds that whether monetary models assume sticky prices, flexible prices, or are based on the present value method, when estimated, they are unsuccessfully modelled. This claim is confirmed by Xie and Chen (2019). Mallick et al. (2024) believe that the exchange rate model should be able to accommodate its long swings for it to succeed. Soon and Baharumshah (2021) support Mallick et al. (2024) by emphasizing that exchange rates' large fluctuations often exhibit extreme movements that introduce challenges to the literature, hence the necessity to study exchange rate movement.

There has been a great attempt in the literature to link floating exchange rates to macroeconomic fundamentals, which are monetary variables such as interest rates, outputs, and money supply (Hacker Scott et al. 2012). The monetary policy framework of models follows the models of Dornbusch (1976), Frenkel (1976), and Bilson (1978), which analysed the floating exchange rates' behaviour over the long run. Frenkel (1976) combined the monetary models of Bilson (1978) and Frenkel (1976), which assume flexible prices, with the model of Dornbusch (1976), which assumes sticky prices. Frenkel's (1976) model can be used to consider the validity of the theoretical model of exchange rate determination.

The way to deal with exchange rate determination is, firstly, by relying on some theories such as Purchasing Power Parity (PPP) (Majumder and Ray 2020), and secondly, by making additional theoretical assumptions that show a positive relationship between prices and nominal interest rates for exchange rate determination to be true (Benigno et al. 2012). Consequently, monetary models tend to show the interest rate differential as positively related to the domestic exchange rates (Frenkel 1976).

Kim and Lim (2018) found that tight monetary policy results in significant exchange rate appreciation for the domestic currency. Furthermore, the delay in overshooting becomes relatively short. However, if the monetary policy tightening is not expected, the domestic exchange rates respond to it by depreciating (Gürkaynak et al. 2021). Other researchers in the past found the same results, affirming that monetary policy tightening led to the depreciation of the domestic exchange rates (Clarida and Gali 1994; Eichenbaum and Evans 1995; Faust and Rogers 2003). There is empirical evidence showing that the exchange rate fluctuations are monetary policy shocks such as tightening via the interest rate differential (Corsetti et al. 2018).

Bjørnland (2009) argues that following a monetary policy shock (a rise in domestic interest rate), the domestic exchange rates initially depreciate and then appreciate. However,

Engel (2016) shows that the impact of the interest rates on the exchange rates is unclear, which leads to uncertainty about the impact of the interest differential. The interest rate change in the short run leads to domestic exchange rate appreciation (Farhi and Gabaix 2016). Engel (2016) adds that a country with high interest rates tends to have stronger exchange rates.

When the domestic exchange rates appreciate because of high interest rates, the domestic currency appreciates because it is less risky and has higher returns (Heider et al. 2021). In this sense, the latter element about the link between the interest rates and the domestic exchange rates means they are risky. Therefore, if the interest rates are high, the exchange rates can be expected to appreciate. However, higher interest rates today mean in the future they can be expected to fall (Özmen and Yılmaz 2017). Accordingly, the exchange rates can be expected to depreciate in the future. Consequently, higher interest rates increase the risk of exchange rate depreciation in the future (Dimitriou and Kenourgios 2013). As a result, the implication of high interest rates is that they are less risky. In this situation, this introduces the impact of the interest rates on the exchange rates and, therefore, interest differential.

Rastogi et al. (2023) considered that the interest rate differential and the exchange rate have interdependence. However, Armah et al. (2023) showed that the relationship between the exchange rates and the interest rate differential is weak. Özmen and Yılmaz (2017) found that the relationship between the exchange rates and the interest rate differential differs across countries. However, Chahrour et al. (2021) state that the relationship between the exchange rates and the interest rate differential changes depending on the horizon.

Engel (2016) argues that currencies do not depreciate sufficiently to offset the interest rate differentials, which leads to the failure of uncovered interest rate parity (UIP). When the interest rate differential is not offset, the studies tend to find that the exchange rate behaviour follows a random walk (Ellwanger and Snudden 2023). Chahrour et al. (2021) add that high domestic interest rates do not cause the exchange rates to depreciate sufficiently. However, Armah et al. (2023) show that the interest rate differential does lead to sufficient exchange rate depreciation; that is, there is expected exchange rate depreciation.

Ellwanger and Snudden (2023) show that money supply shock does not cause the exchange rates to follow a random walk. Instead, the exchange rates undershoot their long-run value. The results are contrary to what Bjørnland (2009) argues, that the exchange rates overshoot.

The effects of monetary policy shocks have heterogeneity over time on the domestic exchange rate behaviour. Furthermore, the impact of the policy shock depends on the economic agents' expectations (Inoue and Rossi 2019).

The statement by Chahrour et al. (2021) that "exchange rates live a life of their own" can be interpreted as little is known about exchange rate behaviour and its relation to macro-fundamentals. This demonstrates the exchange rates' basic disconnect from macroeconomic fundamentals. However, recently, a growing number of studies claimed some degree of success in modelling exchange rate behaviour (see, for example, Beckmann et al. 2012, among others). Xie and Chen (2019) challenge these findings on the basis that the differences in the findings are due to the sophistication of the estimating methods. In addition, Chahrour et al. (2021) allege that the literature has largely focused on the co-movement of the exchange rate and fundamentals rather than the disconnect or the behaviour. There are pertinent questions that remain unresolved in the literature, such as, what are the determinants of exchange rates? And how is the exchange rate equilibrium determined? The disconnect between the exchange rate and the macro-fundamentals in estimating and forecasting adds an experimental and theoretical problem (Ghosh and Bhadury 2018).

Modelling exchange rate movements remains a challenging exercise in the macroeconomics literature. Changes in exchange rates have substantial effects on employment, prices, interest rates, and productivity. Meese and Rogoff (1983) ignited a huge interest in studying the behaviour of the exchange rate when they indirectly found that there is no link between the exchange rate and fundamentals. The need to study the movement of the exchange rates in detail exists. The function of the exchange rate in the world economy is a vital factor in the determination of prices (Klein and Shambaugh 2015). Auboin and Ruta

(2013) state that the exchange rate is used daily to conduct international transactions and settlements of international bills. Furthermore, it indicates the strength of the domestic economy's external sector participation in international trade (Hadebe and Msomi 2023).

When a country's central bank puts in place strict foreign exchange control policies, the domestic currency appreciates in the long run (Devereux et al. 2023). Pham (2019) confirms these findings. When the central bank decides to tighten the interest rate, the exchange rates appreciate and subsequently depreciate. Bjørnland (2008) and Zettelmeyer (2004) added that soon after a contractionary monetary policy shock, the real exchange rate tends to appreciate, followed by a gradual depreciation. Bjørnland (2009) found that contractionary monetary policy leads to depreciation of the domestic currency. Furthermore, when the exchange rates appreciate, it is prolonged for a lengthy period, which violates the interest rate parity theory. However, in the long run, Cover and Mallick (2012) found that monetary policy shocks tend to exhibit monetary neutrality.

An increase in domestic interest rates requires the money supply to decrease, which increases the value of the domestic currency (Raza and Afshan 2017). This is confirmed by Ismailov and Rossi (2018) and Chen et al. (2020), among others, who also discussed the impact of money demand on the behaviour of exchange rates through interest rate variation. When a country's interest rate is higher, it attracts investors to move capital into the country, which increases demand for the domestic currency, thereby leading to an appreciation of the domestic currency (Magud et al. 2014).

Hina and Qayyum (2015) maintain that being able to predict and model the exchange rate is vital for macroeconomic policy making. Bahmani-Oskooee and Bahmani (2015) established that there is an asymmetric relationship between exchange rates and money demand. Bouraoui and Phisuthtiwatcharavong (2015) argued that the monetary base and the exchange rate do not have a significant relationship. Instead, they suggest that international reserves determine the behaviour of exchange rates. Mahmood and Alkhateeb (2018) found that the exchange rate and money demand are negatively related. However, other studies revealed that when the currency is in a floating exchange rate regime, an increase in the quantity of money leads to a depreciation in the short run. Furthermore, in the long run, an increasing money supply results in the exchange rate appreciating. However, the results are mixed in the case of a non-floating exchange rate regime in the long run (Ibhagui 2019).

3. Theoretical Discussion

This study follows Tari and Gözen's (2018) model, which was developed from Frenkel's (1976) monetary model. We also applied the assumptions in Cushman (2008), supposing foreigners do not hold the currency of another country. In addition, demand for assets depends on the interest rate. Now we define the demand for assets and wealth constraints as

$$H = \sigma(i)Y \quad (1)$$

$$F = \sigma^*(i^*)Y^* \quad (2)$$

where H denotes the assets of SA residents in rands (ZAR); F represents the assets of US citizens in USD. Then i, i^*, Y , and Y^* represent the domestic interest rate, the foreign interest rate, domestic nominal income, and the foreign country's nominal income, respectively. Equation (1) means that SA citizens hold assets dominated in rands, and therefore, Equation (2) shows that US domestic residents hold assets dominated in USD. The SA and US citizens can choose to hold assets in both countries. The equations are shown below for both domestic and foreign countries:

$$Z_H = \delta_H(i - i^* - E\Delta e)(W_H - H_H) \quad (3)$$

$$Z_F = \delta_F(i - i^* - E\Delta e)(W_F - F_F) \quad (4)$$

where Z_H and Z_F denote SA assets held by domestic residents and SA assets in the hands of US citizens, respectively. Moreover, W_H and W_F represent home country wealth and foreign citizens' wealth, respectively. S represents the domestic currency price for a foreign currency (e denotes the logarithm of the exchange rates); $S = \frac{Z^{AR}}{USD}$. Moreover, E represents expectation. In Equations (3) and (4), the interest differential is an increasing function of the exchange rates. Moreover, the δ_H and δ_F have the value between 0 and 1 in Equations (3) and (4). $\delta_H > \delta_F$, an assumption is imposed for deterministic asset preference. The SA citizens' demand for US assets is shown by

$$SJ_H = [1 - \delta_H(i - i^* - E\Delta e)](W_H - H_H) \tag{5}$$

$$SJ_F = [1 - \delta_F(i - i^* - E\Delta e)](W_F - F_F) \tag{6}$$

where J_H and J_F represent US assets held by SA citizens and US assets held by its residents, respectively. Then assume that citizens demand assets equivalent to their level of wealth such that

$$W_H = SJ_H + Z_H + H_H \tag{7}$$

$$W_F = SJ_F + Z_F + F_F \tag{8}$$

We can determine the endogenous variable by rearranging equations. Equations (5) and (7), similarly for (6) and (8), can be solved simultaneously to make S the subject of the formula:

$$S = \left(\frac{Z_H}{SJ_H} \right) \frac{[1 - \delta_H(i - i^* - E\Delta e)]}{[\delta_H(i - i^* - E\Delta e)]} \tag{9}$$

and

$$S = \left(\frac{Z_F}{SJ_F} \right) \frac{[1 - \delta_F(i - i^* - E\Delta e)]}{[\delta_F(i - i^* - E\Delta e)]} \tag{10}$$

Equations (9) and (10) are linearised following [Frenkel \(1976\)](#), as shown below:

$$e = \rho_H - \theta_H(i - i^* - E\Delta e) + z_H - \varepsilon_H \tag{11}$$

and

$$e = \rho_F - \theta_F(i - i^* - E\Delta e) + z_F - \varepsilon_F \tag{12}$$

All variables are expressed as logs with the exception of the interest rates. The $E\Delta e$ is ignored in the estimation of the long-run relationship because it is $I(0)$. Equation (11) represents domestic investors, while Equation (12) represents foreign investors. The demand for a country's assets is also dependent on the country's international liability. There is a section of non-monetary wealth held as a net foreign liability. Thus, asset demand in Equations (3)–(6) is not unit elastic regarding wealth, if it is assumed that elasticities are positive. See below.

$$S = S\left([i - i^{*(-)} - E\Delta s], Z_H^{(+)}, J_H^{(-)}, Z_F^{(\pm)}\right) \tag{13}$$

$$S = S\left([i - i^{*(-)} - E\Delta s], J_H^{(\pm)}, Z_F^{(+)}, J_F^{(-)}\right) \tag{14}$$

If the demand for assets in both countries is larger than 1, then variable Z_H in Equation (13) is positive and J_H is negative. When the elasticity is less than 1, both these signs are positive. When considering the case of elasticities for Equation (14), an increase in Z_F decreases domestic net wealth, reducing the relative domestic demand for assets, leading to the depreciation of the domestic currency, and thus, S increases. In Equation (14), a rise in variable J_H results in a fall in foreign net wealth, which leads to a depreciation in the foreign currency.

For this study, we followed [Frenkel \(1976\)](#) and [Cushman \(2008\)](#) to define the assets of each country in the hands of its citizens (Z_H and J_F). Following [Tari and Gözen \(2018\)](#),

the study uses bilateral data assets to make the differential variables. A simple Threshold Autoregressive (TAR) model was initially introduced by Tong (1983), which is an autoregressive analysis of the variable of interest. The TAR models are non-linear. Chinn (1991) also showed evidence of non-linear models performing better in modelling the exchange rate. Rapach and Wohar (2006) confirm that non-linear models perform better in modelling the exchange rates.

3.1. Estimation

Consider a linear and symmetry estimation:

$$\Delta\mu_t = \theta\mu_{t-1} + \gamma_t \quad (15)$$

where $\{\mu_t\}$ is a vector of random variables and integrated of order 1; if the null hypothesis is $\theta = 0$, it would be rejected, and then $\{\mu_t\}$ series follows a stationary process. Therefore, in the long run, PPP holds, and exchange rates revert to equilibrium. Furthermore, γ_t is independently identified ('iid'). Following Enders and Siklos (2001), μ_t is estimated and it can be modified by including lags. If symmetry is assumed, then the changes in μ_t and μ_{t-1} are the same. However, when prices are sticky downwards, then assuming symmetry and linearity leads to misspecification. The study adopts Chen et al.'s (2005) specification, which permits asymmetric adjustment in the long run following a TAR process:

$$\mu_t = I_t\theta_1\mu_{t-1} + (1 - I_t)\theta_2\mu_{t-1} + \gamma_t \quad (16)$$

where I_t is the indicator function, as follows:

$$I_t = \begin{cases} 1 & \text{if } \mu_{t-1} \geq \delta \\ 0 & \text{if } \mu_{t-1} < \delta \end{cases} \quad (17)$$

where δ is the value of the threshold, and a condition for $\{\mu_t\}$ to be stationary is given by $-2 < (\mu_1, \mu_2) < 0$ for all values of δ . When these conditions are met, $\{\mu_t\} = 0$ can be taken as the long-run equilibrium value, such that $\mu_{1t} = \beta_0 + \beta_2\mu_{2t} + \beta_3\mu_{3t} + \dots + \beta_k\mu_t$. If the value of μ_t becomes bigger, the system moves into convergence. The threshold variable is $\mu_{t-1} = \varphi_{t-d}$, for some integer $d \in [1, \bar{d}]$. Basically, the threshold is a change point that allows estimators to differ between regimes. The integer d is referred to as a delayed lag in which its value is unknown and must be estimated. In Equation (16), coefficients (μ_1, μ_2) represent the speed of adjustment to long-run equilibrium. If $\mu_{t-1} \geq \delta$, then $I_t = 1$, and the speed of adjustment becomes μ_1 . Alternatively, if $\mu_{t-1} < \delta$, then $I_t = 0$, and the speed with which the deviation adjusts back to equilibrium becomes μ_2 . Therefore, in the situation where $|\mu_1| > |\mu_2|$, the adjustment back to equilibrium is faster for $\mu_{t-1} \geq \delta$.

Equation (17) indicates that the degree of autoregressive decay depends on the state of the equilibrium error. The key feature of the TAR model is that transmission from one regime to the other occurs endogenously. The TAR models allow for the distinguishing of historical events that lead to unusual pressure on the exchange rate.

3.2. Data and Variables

The sample is from the first quarter of 1994 to the fourth quarter of 2023. The data used in the study were collected from the Federal Reserve Bank of St. Louis. The study examines the exchange rate behaviour of the South African rand (ZAR) against the United States dollar (USD) (ZAR/USD) and its relationship to macroeconomic variables. It augments Saeed et al.'s (2012) specification of the model. Here, (*) relates to the foreign variables representing the US. The i denotes the domestic interest rates, while i^* is the parameter representing US interest rates. f is the domestic debt for SA, denotes the US debt, and is the economic policy uncertainty. The economic policy uncertainty is a differential given by Pol . The estimating equation is shown below:

$$e_t = \beta_1 + \beta_2(i - i^*) + \beta_3(f - f^*) + \beta_4 Pol + \mu$$

3.3. Interest Rates

The inclusion of interest rates in the monetary model of exchange rate determination is a common practice emerging from theory, regardless of whether the assumption is flexible prices (see [Frenkel 1976](#)) or fixed prices (see [Dornbusch 1976](#)). There is extensive literature following the specification of the 1970s work mentioned in [Tawadros \(2017\)](#) and [Ismailov and Rossi \(2018\)](#). The higher the interest rates are relative to the rest of the world, the more exchange rates are expected to appreciate, according to [Bahmani-Oskooee and Bahmani \(2015\)](#). If the opportunity cost of holding money is low, the exchange rate will depreciate. [Bahmani-Oskooee and Arize \(2020\)](#) explain that when the domestic interest rates increase, the interest rate differential changes. [Hacker Scott et al. \(2012\)](#) shows that the interest rate differential has a positive relationship with the exchange rate. Figure 1 shows the interest rate differential.

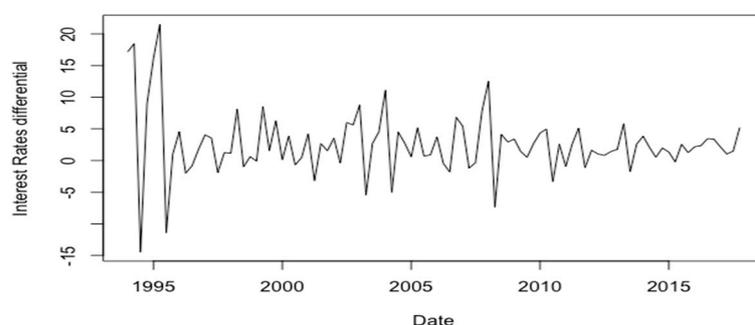


Figure 1. Interest rate differential for SA and USA. Source: Author's compilation.

The interest rate differential was very wide in the mid-1990s until 1995 (see Figure 1). The large spikes in the interest rate differential might have been caused by the high interest rates SA experienced throughout the 1990s. The spikes became smaller in the second quarter of 1995, which shows that the interest rates were not changing excessively in relation to each other whenever they were adjusted. However, in 2003–2004, the interest rate differentials had larger spikes compared to the period between the third quarters of 1996 and 2004 (see Figure 1). In the period between 2005 and 2006, the interest rate differential did not have large spikes. However, from 2007 to the end of 2008, the interest rate differential had relatively bigger spikes compared to the former period. Thereafter, the interest rate differential did not have much volatility.

3.4. Exchange Rates

The theory assumes that monetary variables have effects on the exchange rate behaviour (see, among others, [Klein and Shambaugh \(2015\)](#); [Chahrour et al. \(2021\)](#); [Xie and Chen \(2019\)](#)). The theory assumes that the exchange rate depends positively on monetary variables. When the interest rates increase relative to the rest of the world, the exchange rates appreciate. As discussed above, the empirical evidence does not conform to the predictions of the theory. The following figure shows the exchange rate.

The exchange rates show that the ZAR depreciated rapidly against the USD between 1994 and 2003 (see Figure 2). Thereafter, the ZAR gained strength until 2005. However, in the period between 2005 and 2008, the rand was stable against the USD (see Figure 2). While there was a spike in 2009 where the ZAR depreciated rapidly against the USD, it quickly gained strength until 2011. Thereafter, the ZAR depreciated rapidly until 2017, then temporarily gained strength against the USD (see Figure 2).

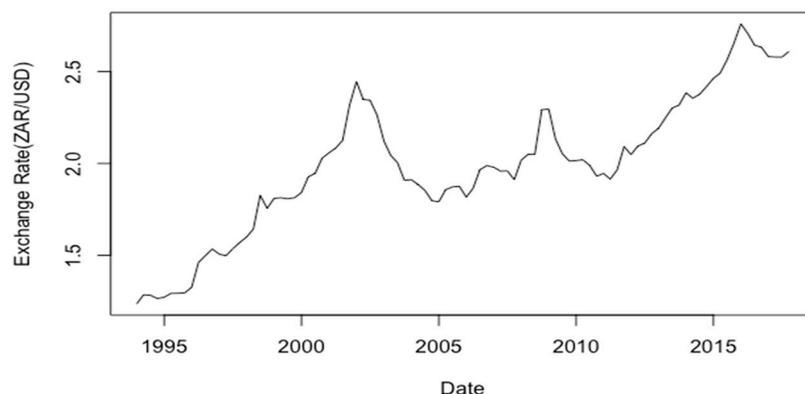


Figure 2. The exchange rates (ZAR/USA). Source: Author's compilation.

3.5. Domestic Debt

Domestic debt is important for a small economy like South Africa, especially since a sizable part of its debt is dominated in foreign currency. [Barbosa-Filho \(2014\)](#) explains that emerging economies accumulate foreign exchange rate reserves to reduce exchange rate volatility, which might increase the debt burden on them. The domestic debt is measured as the public debt, which are loans the government takes from the rest of the world. When the government acquires a loan from the rest of the world, the public debt tends to increase, which leads to an exchange rate depreciation if the loan is indexed in foreign currency. In the event that the loan is dominated in domestic currency when the home country receives the money, it would lead to an appreciation of the domestic currency. We show the domestic debt differential next.

The domestic debt differential declined from the mid-1990s to 2002 (see [Figure 3](#)). Thereafter, the debt differential increased rapidly until 2014. The domestic debt differential does not show any volatility, which indicates that government projects between the two nations are correlated. The behaviour of the domestic debt differential shows that there might be strong government involvement in both countries' economies.

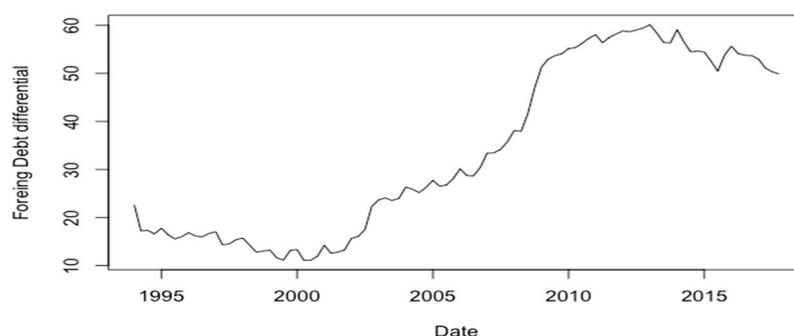


Figure 3. The domestic debt differential between SA and USA. Source: Author's compilation.

4. Economic Policy Uncertainty

The use of traditional macroeconomic fundamentals in the determination of exchange rates is common in the literature (see, for example, [Dornbusch 1976](#); [Frenkel 1976](#)), although it has been criticised by [Meese and Rogoff \(1983\)](#) as not providing a link to the exchange rate. Many studies develop new models of exchange rates based on macroeconomic variables (see [Almeida et al. 1998](#); [Almeida et al. 1998](#)). Since the mid-1980s, the literature has identified the effects of macroeconomic news on the exchange rate as important ([Cheung et al. 2019](#)). Focusing on the influence of economic and political statements has allowed researchers to detect how the market responds to perceived news, and how the information is included in the behaviour of the exchange rates ([Neely and Dey 2010](#)). The literature has extensively discussed the impact of news on exchange rates. [Jabeen](#)

and Rashid (2022) argue that macroeconomic news has a significant impact on the fluctuations of the exchange rate. Moreover, the foreign exchange rates tend to move nearly instantaneously upon an announcement of macroeconomic news. There are considerable studies examining exchange rate responses to news or announcements (see, for example, Caporale et al. 2018; Gau and Wu 2017; Ben-Omrane et al. 2020). Boudt et al. (2019) affirm that the literature shows a significant relationship between announcements and exchange rates in developing economies. According to Lilley et al. (2022), political and public news play a dominant role in determining the economy's direction. Karahan (2020) adds that favourable political information attracts investors. Rehman et al. (2021) mention that political information has the ability to move or maintain the stability of macroeconomic variables. Figure 4 depicts economic policy uncertainty.

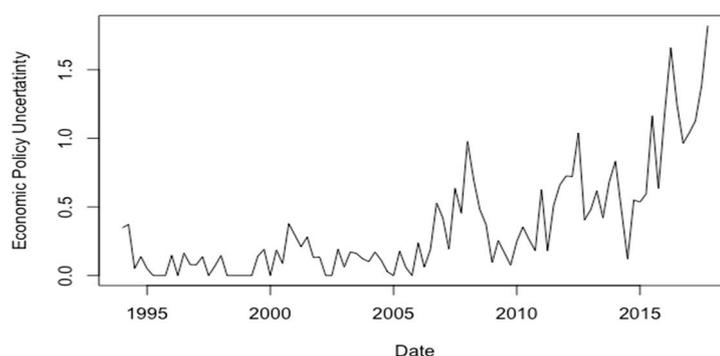


Figure 4. Economic policy uncertainty (political risk for SA). Source: Author's compilation.

In the period between 1994 and 2000, economic policy uncertainty in SA was low (see Figure 4). However, from 2000 to 2002, economic policy uncertainty increased and then declined to its previous levels. After 2002, the economic policy uncertainty increased and then decreased in 2005 (see Figure 4). In the period after 2005, uncertainty about economic policy began to increase, reaching the highest level in 2008. Then it declined until 2009, and thereafter, economic policy uncertainty has been increasing.

5. Results

Then, we used the Threshold Autoregressive (TAR) model to determine the impact of the monetary variables on the exchange rate behaviour. The model uses thresholds to estimate the separate effects of exchange rates. The figure below shows how the TAR model selected the thresholds on the threshold variable.

The vertical axis measures the exchange rates, and on the horizontal axis, time is measured (see Figure 5). Therefore, there are two estimated threshold values for the exchange rate behaviour, and three regimes. The threshold values are 0.6827 and 0.8655, which are the lower limit (indicated by the red line) and upper limit (represented by the green line), respectively (see Figure 5). The first regimes occur when the exchange rate behaviour is below 0.6827 ($\delta < 0.6827$) (see Figure 5). Furthermore, regime two occurs when the exchange rate behaviour is between 0.6827 and 0.8655 ($0.6827 \leq \delta \leq 0.8655$). Finally, the third regime occurs when the exchange rate behaviour is strictly above 0.8655 ($\delta > 0.8655$) (see Figure 5).

We estimate the TAR model to evaluate the impact of the monetary variables on the exchange rate behaviour.

In regime 1, the debt differential indicates a positive relationship between itself and exchange rates (Table 1). Therefore, if everything remains the same, an increase in the debt results in a depreciation of the exchange rate. This phenomenon is expected because as the debt increases, it attracts higher interest rate payments. Therefore, more foreign currency is required to pay off interest payments on debt, hence the depreciation of the domestic currency. With an increase in economic policy uncertainty, if everything remains the same, the exchange rate tends to appreciate. These results are significant at a 10% level

of significance. The increase in economic policy uncertainty also serves as a signal that in the future, the economy will improve (Table 1). Therefore, these expectations lead economic agents to demand the domestic currency. Hence, the exchange rate appreciates. According to Msomi and Ngalawa (2024), this behaviour of the exchange rate is characterised as the bandwagon effect. On the other hand, on average, a marginal increase in the interest rate, all else remaining the same, leads to an exchange rate appreciation (Table 1). The exchange rate adjusts in response to interest rate deviation from equilibrium to bring the interest rate of both countries to parity.

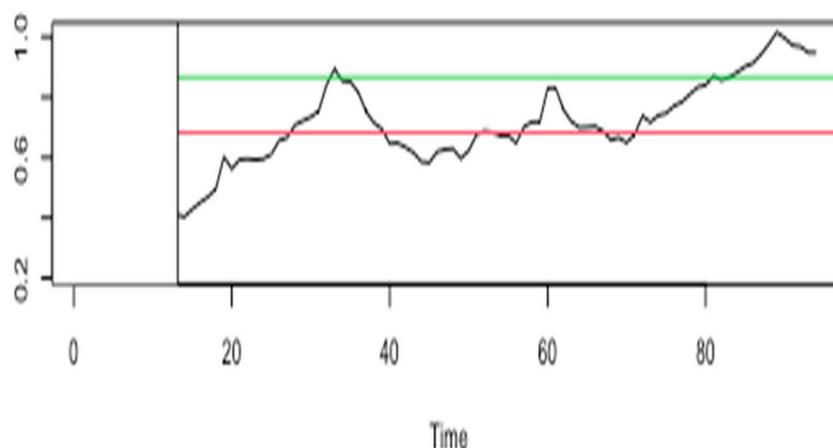


Figure 5. Threshold variable (exchange rates). Source: Author’s compilation.

Table 1. Threshold autoregressive model.

Variable	Coefficient
Debt differential	2.421309 ***
Economic policy uncertainty	−0.259494 *
Interest rate differential	−0.029141 *
Lower threshold value 0.6827	
Debt differential	0.297169
Economic policy uncertainty	−4.259460 ***
Interest rate differential	−0.065262
Upper threshold value = 0.8655	
Debt differential	0.473598 ***
Economic policy uncertainty	0.541118 **
Interest rate differential	0.133507 *

***, **, and * represent 1%, 5%, and 10% levels of significance, respectively.

In regime 2, the relationship between the debt differential and the exchange rate is insignificant (Table 1). There are a lot of varying conclusions in the literature about the debt differential and exchange rate (Valchev 2020; Lilley et al. 2022). There is no consensus about the relationship; however, these results show that the relationship is not clear when the exchange rate fluctuation is more stable. Further, a rise in economic policy leads to exchange rate appreciation. These results are similar to the ones in regime 1. Then, the interest differential has an inverse relationship with the exchange rates. These results are expected and are similar to the ones in regime 1.

In regime 3, a marginal change in debt differential, economic policy uncertainty, or interest rate differential leads to a depreciation of the exchange rate (Table 1). These results are not expected, and their justification can be found in Msomi and Ngalawa (2024), who argue that the exchange rate is also influenced by unknown factors. So, when there is a force such as an increase in interest rate differential, there is another force that acts against the direction of the exchange rate predicted by theory, which leads to the exchange

rate moving in an unexpected direction. The results of the debt differential marginal increase and the relationship with the exchange rates make economic sense (Table 1). When the debt increases, there is a need for foreign currency to pay the interest on the debt. Hence, this leads to a depreciation of the domestic currency. Furthermore, an increase in economic policy uncertainty is expected to lead to an increase in exchange rate depreciation (Smales 2022). When there is high economic policy uncertainty, it is followed by a decline in economic activity, which leads to a fall in demand for domestic goods (Table 1). Hence, the exchange rate depreciates.

We then performed a grid search using the sum of squares by contraction of the objective function. Given that the threshold is estimated through the maximum likelihood, the minimisation problem can be reduced through the estimated threshold $\hat{\beta}(\hat{\delta})$. Therefore, the objective function is given by

$$\hat{\delta} = \min_{\delta} SSR(\delta)$$

This allows us to determine the optimal exchange rate behaviour and where the variables are having the most effect on its movement. The following figure presents the results of the grid search.

The monetary variables have an optimal effect on the behaviour of the exchange rate when it is in regime 2 (see Figure 6). The monetary variables are more likely to drive the exchange rate movement when fluctuations are moderate.

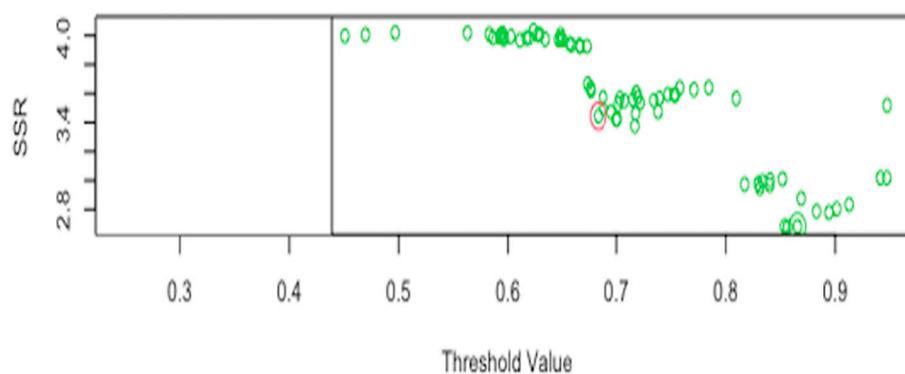


Figure 6. Grid search for the optimal behaviour of the exchange rate. The red dot represents the threshold value. Source: Author's compilation.

This means that exchange rate behaviour can be assessed to determine how it responds to monetary variables. Figure 6 confirms that the threshold value is estimated appropriately. The red dot in Figure 6 shows the position where the values measuring the exchange rate change the sequence of their movement.

6. Conclusions

In this study, the model used for estimation accounted for structural breaks, which is what most estimating techniques used in previous studies cited above omitted. This allows for making an inference on the data without a risk of biased results. The TAR model estimated two thresholds that separate the exchange rate behaviour into three regimes. In all the regimes, the sizes of coefficients are different, which shows that the exchange rate behaviour is non-linear (asymmetric). While the impact of the interest rate differential in regimes 1 and 2 leads to an exchange rate appreciation, this occurs when the exchange rates fluctuate below 0.87 percentage points. In regime 3, the increase in interest rate differential leads to an exchange rate depreciation. The impact of economic policy uncertainty and domestic debt on the exchange rates is the same in regimes 1 and 2. In regime 2, the exchange rate response to the monetary variables changes is mostly insignificant.

The SARB should aim to create economic conditions that keep the exchange rates fluctuating below 0.68 percentage points because the effect of a change in the monetary variables is consistent with the theory. However, when the exchange rate behaviour is above 0.87, the change in the interest rate differential also leads to an exchange rate depreciation. If the SARB wants to improve the value of the exchange rate, it should increase the interest rates in regimes 1 and 2.

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