

# The Monetary Model of Exchange Rate Behaviour: The case of South Africa

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Submitted to University of KwaZulu Natal in fulfilment of the requirement of Doctor of  
Philosophy in Economics

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## **Declaration**

I, Simiso Msomi, declare that

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Signature...SimisoMsomi Date 05 January 2024.

**Dedication**

To my Mom and Late Dad.

## **Acknowledgements**

I would like to thank the Almighty God, through whom everything is possible. And then, I would like to thank my mother whom constantly keeps me in her prayers. Thanks to Luyand'uthando Myeni, whom when I said, "the period leading the completion of this project is challenging", she said, "I'll pray for you until the date of submission." Then a special thank you to my PhD advisor Prof. H Ngalawa, this project would not have been completed without his guidance. My gratitude also extends to the school of economics for all the support it offered.

Thanks to Prof. M Sibanda for the support and words of encouragement. I would also like to give thanks to the Macroeconomics Research Unit (MRU), for their help and support. Thanks to TATA for awarding me scholarship in the first year of my PhD project. This project would not have been completed without the support of my loving family's support and their understanding, especially Khanya Msomi and Nyezi Msomi, who scarified the most. Further, I would like to thank Nompumelelo Mdletshe for support throughout my academic journey.

I would like to acknowledge Sandile, Zolani, Njabulo and Simo, for their constant encouragement. There are many people who contributed to this project such as Ntokozo Nzimande who debated me all the time and made sure I improved this project all the time. Malibongwe Nyathi, Sanele Gumede, Ayanda Meyiwa, Christian Tipoy, Nezeka Damoyi and Sakhile Mpungose. Thanks for being available in all the adhoc presentations I organised. I would like to acknowledge Nomfundo Nzama, Nhlanhleni Mdunge, Mzwandile Mdunge, Zodwa Xulu, Cebolenkosi Ngwenya, Mthokozisi Ngcobo, Nduduzo Ngcobo, Sthembele Myeza, Bonginkosi Mbatha, Phila Mbatha, Itumeleng Phosisi, Ayabulela Pinzie, Ntandoyenkosi Ngubane, Puleng Rutiri, Nkosana Mathe, Lindani Buthelezi, Nomfundo Buthelezi, Itumeleng Phosisi, Lethani Ndwandwe and Fani Jojozi for the unending support.

Lastly, I would like to acknowledge the University of KwaZulu Natal, Howard college library staff including the security guards and cleaners.

Psalm 91:2. I will say of the Lord, "He is my refuge and my fortress, my God, in whom I trust."

## **Abstract**

The exchange rates behaviour has been a topic of interest in the macroeconomics literature. Despite the extensive body of the literature on the subject, the exchange rates movement remains controversial. In the previous 40 years, economists developed theories that intended to explain the behaviour of the floating exchange rates. However, the empirical results have not been consistent with the predictions of the theories.

South Africa has also had challenges with its exchange rate behaviour since the beginning of World War I. Over the years, the monetary authorities tried various methods of managing the factors believed to influence the behaviour of the domestic exchange rates. The main problem of the domestic exchange rates has been constant depreciation. The domestic exchange rates continue to depreciate even to this day despite the efforts.

This study focuses on the relationship of some monetary variables that are believed have effect on the behaviour of the exchange rates. The economic theory supports the link between monetary variables and the exchange rates behaviour. However, the relationship between domestic exchange rates fundamentals seems to diverge from what is expected. As noted, the literature fails to link the exchange rates with its fundamentals.

In this study we use non-linear estimations to model the interaction between the macroeconomic fundamentals and the domestic exchange rates which are Markov Switching model, Bayesian VAR and Threshold Autoregressive model.

Firstly, the study found that private information which is not observed might have more effect on the exchange rates behaviour than expectations of exchange rates. Secondly, we found that expectations of income have an impact on the domestic exchange rates in some occasions. While in other situations, the domestic exchange rates behaviour cannot be linked with the fundamentals. Lastly, the domestic exchange rates behaviour responds to interest rates differential, domestic debt and political uncertainty when the exchange rate fluctuation is relatively stable. When the domestic exchange rates are appreciating, only the interest rate differential can explain the domestic exchange rates behaviour. Furthermore, the domestic exchange

rates response is asymmetric to effects of expectations.

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# CHAPTER ONE- INTRODUCTION

## 1.1 Background

The monetary model of exchange rate determination indicates that there is strong connection between floating exchange rates and monetary fundamentals. In the monetary model, the price level of a country is determined by its supply and demand for money. Hence, the inflation rate should be similar in different countries when expressed in the same currency. This provides an interesting theoretical approach, which is useful for understanding floating exchange rate behaviour over time.

However, the exchange rate disconnect puzzle is one of the longest standing problems in the macroeconomic literature. There are many approaches that have been tried with an aim to explain the disconnect of the floating exchange rates to its fundamentals. The most common in the literature are the Balassa-Samuelson model, purchasing power parity, uncovered interest parity, and the monetary model. According to Cheung et al. (2005), there is no model or specification combination that has been very successful in explaining the exchange rate behaviour. Furthermore, some models are only able to explain the exchange rate behaviour in a certain horizon with some strict and specific criteria.

Meese and Rogoff (1983) were the first to identify the difficulty in trying to link the floating exchange rates to monetary fundamentals such as the interest rates, output, and money supply. The Frankel's (1976) monetary model argues that the exchange rates is determined by such macroeconomic fundamentals. However, it is observed in the literature that the floating exchange rate behaviour between countries is well explained by random walk behavior instead of fundamentals. This renders the fundamentals not useful for explaining the behaviour of the exchange rates. In contrast, there is a large number of empirical works claiming to find success for various version of fundamental based models (Engle and West, 2005).

The standard exchange rates model (see, Frankel 1976) argues that a variation on the monetary policy variables, such as interest rates, money supply and output, will have long run effect on the exchange rates (see, Jang and Ogaki, 2004). This makes the assumptions of the theory not obvious, which means it holds only under specific

conditions. Therefore, it becomes necessary to assess how the changes in the monetary policy variables affect the exchange rates behaviour.

In South Africa, the South African Reserve Bank (SARB) is the monetary policy authority. This gives it the responsibility to change monetary variable to achieve its objectives. The operations of the SARB should have an impact on the ZAR as predicted by Frankel's (1976) exchange rates model. This should be possible because the ZAR is a floating currency; therefore, varying monetary variables should reflect a corresponding exchange rate behaviour.

Since the 1960s, the domestic exchange rates management has been an objective for the South African monetary policy. The South African Reserve Bank has historically put effort to correcting the imbalances of the domestic exchange rates in the foreign exchange market. Previously, the central bank used monetary policy based on pre-commitment to exchange rate parity, which involved intervention into foreign exchange rates market to defend the value of the Rand.

Pre-year 2000, the SARB invested a lot of effort to the management of the domestic exchange rates, but nothing worked effectively. The domestic exchange rates continued to behave in an unpredictable manner with high volatility. According to Mtonga (2011), adopting new monetary policy in the year 2000 was expected to anchor market expectations to currency pricing based on economic fundamentals. Because the new monetary policy works through interest rates in which they increase domestic exchange rates predictability when stabilized, the central bank believed.

The current monetary policy stabilizes the interest rates, which reduces volatility of important nominal variables. In this case, this should increase information (therefore, improve the quality of expectations formed) processing by economic agents. Thereby, anchors market expectations to pricing of the domestic exchange rates which are linked to economic fundamentals.

However, the domestic exchange rates continue to exhibit a long swing of depreciation. The depreciation swing of the domestic exchange rates has always been considered to have dire consequences to the economy. In the past, the domestic exchange rates depreciation led to the establishment of the Myburgh Commission 2002, to investigate the causes of the rapid depreciation. However, the commission

failed to identify factors leading to the continued depreciation of the domestic exchange rate.

The domestic exchange rates are important for international trade, investment, and therefore economic growth. If monetary authorities and other stakeholders do not understand the relationship between the domestic exchange rates and its economic fundamentals, it may lead to policy challenges with unintended outcomes. Furthermore, the South African governments' macroeconomic policies (previous and current) cite the domestic exchange rate behaviour as an important component for economic prosperity of the country.

The domestic exchange rate behaviour has been stated to be of concern in the Accelerated and Shared Growth Initiative for South Africa (ASGISA), and National Development Plan (NDP). Moreover, both ASGISA and NDP place the domestic exchange rate as one of the leading factors that limit economic prosperity. Therefore, understanding how the domestic exchange rates relate to macroeconomic fundamentals could provide useful insight to policy makers. Accordingly, this shows that the domestic exchange rate behaviour is important for economic prosperity of South Africa. Therefore, it is important for monetary authorities and other stakeholders to have an understanding about the impact of macroeconomic fundamentals on the behaviour of the domestic exchange rates.

### **1.1.1 Problem Statement**

The monetary model of exchange rate behaviour assumes that the monetary fundamentals have effect on the exchange rates. The theory refers to a range of monetary fundamentals such as money supply, money demand, output, interest rate and expectations (MacDonald and Taylor, 1993). As noted, the monetary authorities have control over these monetary fundamentals. The South African Reserve Bank uses the interest rates therefore, expectations as its primary instruments. In this case, the assumption of the monetary model is that monetary variables have effect on the behaviour of the domestic exchange rate. Therefore, the effect of the interest rates and expectations should be reflected in the domestic exchange rate behaviour.

Furthermore, since the South African Reserve Bank stabilizes market expectations by

providing information, this should translate to stable domestic exchange rate behaviour. However, the domestic exchange rate exhibit a long depreciation swing. This can be associated with a continuous deviation from equilibrium. In the first quarter of 2001 and 2002, the Rand depreciated by, respectively, 25 percent and 45 percent (see Myburgh Commission, 2002). The level of depreciation seen on the Rand against other currencies raises a question such as 'what level of depreciation can be considered a deviation form equilibrium'.

The depreciation of the domestic exchange rate is concerning such that in 2002 the government organized the Myburgh Commission 2002, to investigate the factors causing the depreciation. The commission failed to point out the factors responsible for the continuous domestic exchange rate depreciation. This creates a challenge for the work of the South African Reserve Bank when it is not clear what leads to the domestic exchange rate's continuous depreciation.

The monetary authorities need to have a clear understanding of how the central bank's instruments (monetary variables which are interest rates and expectations, mainly) impact the domestic exchange rate behaviour over time. Moreover, the pursuit of stable exchange rate behaviour is, and has been, the South African government's strategic objective that is stated in its macroeconomic policies. These policies are the National Development Plan and Accelerated Sustainable Growth Initiative in South Africa.

The theory of monetary model provides factors which affect the exchange rate behaviour. These factors are managed by the South African Reserve Bank in this case. However, the relationship between the exchange rates and interest rates, expectations, and income, is not obvious in the literature. While the results are mixed about the effects of the monetary fundamentals, the domestic exchange rates show a concerning depreciation swing.

The swing might be interpreted as suggesting that the market expectations do not reflect what the central bank intends, hence, the long depreciation swing of domestic exchange rates. Moreover, the swing could mean the relationship between the interest differential and the exchange rate does not hold, as predicted by Frankel (1976). In general, the continuous depreciation of the Rand exchange rates might be interpreted as suggesting that the relationship between monetary variables and the exchange

rates is different in South Africa. However, this has not been determined, which is a challenge for policy makers.

Following the 2008 financial crisis, the literature began analysing the market characteristics. Hence, there are many studies, including Yartey (2008), that began looking at what makes SA financial markets different. The literature shows that SA is different to other economies because of gross domestic investment, banking sector development, private capital flow, stock market liquidity, and political risk (see Hoque, 2023; Le et al., 2023). Andrianaivo and Yartey (2010) argue that SA markets are different to those of other African countries because of the banking sector development, credit repression, and domestic savings. These factors distinguish SA, even among other emerging economies, which makes studying South African exchange rate behaviour interesting. These differences may cause the transmission links in South Africa to differ from those of other emerging economies. Furthermore, Petry (2023) argues that the exchange rate behaviour and formation of expectations of emerging economies, including South Africa, are different from those of developed countries.

If policy makers and other stakeholders do not understand the relationship between the exchange rates and monetary variables, the work of policy makers (monetary policy authorities in particular) becomes difficult. This is because they will not know how to make effective policies. Moreover, this is a problem for the literature because the relationship between the exchange rates and macroeconomic variables might be different for South Africa. Hence, the relationship between the domestic exchange rates and monetary variables needs to be understood in order to determine how varying monetary variables impact the domestic exchange rates. This would help in understanding the reason for the continued depreciation of the domestic exchange rates despite deliberate interventions that are designed to make it behave stable.

### **1.1.2 The history of exchange rates**

Making a decision on the exchange rate regime to choose was a simple task a 100 years ago. There were two choices, which were the gold standard and floating exchange rates. At the time, the exchange rate regime that dominated was the gold

standard. As a result, this ensured stable price level and guaranteed that policies can be predicted (Officer, 2010). Before World War 1 (WWI), almost all countries were using the gold standard. The adoption of floating exchange rates was thought of as a radical idea that deviated from monetary and fiscal policy stability (Bordo, 2003). The idea of floating exchange rates was only thought as something that is relevant in a time of crisis, such as war time (see Martino, 2022). The floating exchange rates require money to be without any intrinsic value (fiat money) associated with it. There were two countries that followed the floating exchange rate regime during the era of the gold standard dominance, which were Spain and Austria-Hungary (Bordo, 2001). These countries were viewed with disfavour.

During the WWI period, the economies of the world abandoned the gold standard. After the interwar period, the gold standard did not survive for long because the Great Depression followed. During the Great Depression period and after, many economies started adopting the floating exchange rates (Bordo, 2003). However, the experience of the floating exchange rates during the interwar period associated them with destabilizing speculation. Hence, this gave birth to the creation of the Bretton Woods adjustable peg in 1944 (Igwe, 2018).

The Bretton Woods system was a currency management method in which many countries agreed on pursuing. The Bretton Woods system combined pegged exchange rates with parities fixed to the United States of American Dollar (USD). Thus, the USD was pegged to the gold, with a narrow band of  $2\frac{1}{2}\%$  around parity (Bordo, 2003). The economies were given the right to change parity in the situation of misalignment of fundamentals. The aim of the Bretton Woods system was to provide a mechanism that combines the advantage of the gold standard with the benefit of floating exchange rates (such as flexibility).

The economies discovered it was challenging to find parity that is consistent with the balance of payments equilibrium. As such, the economies that experienced currency crises realized realignment of parity was unachievable at times (see Jocelyne et al., 2020). This led to the beginning of the debate between fixed and flexible exchange rates. According to Friedman (1958), floating exchange rates provides the advantage



of monetary policy inference, less disruptive adjustment mechanism, and insulation from real shocks.

In 1963, the argument made by Friedman (1953) was extended by Mundell (1963) by adding the flow of international capital in the discussion. The argument pointed out that choosing between fixed and floating exchange rates depended on the sources of shocks, if they are real or nominal, and the extent of capital mobility. The argument was advanced by Mundell (1963), and also expressed by Fleming (1962).

The Mundell-Fleming model gave rise to an important theory of exchange rate regime choice. The possibility of choosing an exchange rate regime that offers the trinity, which is open capital market, monetary independence and pegging, was proven to be unattainable. However, economies can choose a system that provides two of any of the three. In this case, the gold standard offered open capital markets and fixed exchange rate because monetary independence was not of much significance. The gold standard collapsed during the interwar period because monetary policy was important since it drove economies to full employment.

The Bretton Woods system consisted of monetary independence and pegged exchange rates regime, but prevented capital movement. Therefore, it collapsed when capital movement became hard to prevent. In recent time, the automatic choice is capital mobility between the hard-pegs (currency union or dollarization) and floating. As a result, developed economies today are either pursuing floating exchange rates or are an economic and monetary union.

A suitable condition for a functioning monetary system must conform conditions of an optimal currency area (OCA). A OCA is defined as “a region for which it is optimal to have a single currency and a single monetary policy” (Bordo, 2003). This idea has been used as a criterion for forming a monetary union with near perfectly rigid exchange rates between member states with a common monetary policy. In simple terms, the fixed exchange rates regime has more advantage in the case of increased integration.

### **1.1.3 The history of exchange rates in South Africa**

Since the World War II period, SA started implementing exchange rates controls. They

were ushered in as an Emergency Finance Regulation of the United Kingdom and member states of the Sterling Area (see Henshaw, 1996). The aim was to prevent hard currency from moving out of these countries. Moreover, to maintain free movement of capital within the member states. Then after the war, the Sterling Area exchange rate controls were slowly dismantled. In March 1960, following the Sharpeville Massacre, there was an overwhelming capital outflow from SA, which led to exchange rate controls being intensified (Baumann and Gallagher, 2013; Khumalo and Kapingura, 2014). The exchange rate controls were instituted to prevent non-residents from selling their investments to local residents or foreigners.

In 1961, South African Pound was replaced by the Rand when SA left the Sterling Area. After the collapse of the Bretton Woods arrangement, the Rand was pegged to the USD. Following the peg, the Rand was devalued by 12.28% after the realignment (Abramitzky and Boustan, 2007). Then the Rand was linked to the British Pound in June 1972, thereafter, it was pegged again to the USD in October of 1972. In 1973, the USD was devalued by 10%, however, the South African authorities did not follow suit (see Odhiambo, 2015). The Rand remained pegged to the USD until June of 1974. The South African Reserve Bank then began implementing the policy of managed floating with a fixed Rand-Dollar rate shifting. So, between 1974 and 1975, there were eleven adjustments made on the foreign exchange rate market to defend the value of the Rand (see Aron et al., 1997). As a result of extensive speculative pressure on the Rand during this period, the South African Reserve Bank stopped the policy and went back to pegging the Rand to the USD until 1979 (see Kahn, 1992). Despite pegging the Rand to the USD, the pressure continued on the balance of payments. This led to the devaluation of the Rand against the USD, of 17,9 percent (Niyitengaka, et al., 2013).

In 1979, the South African Reserve Bank implemented a dual exchange rate regime for the first time (Abramitzky and Boustan, 2007). The financial Rand replaced the securities Rand. The principal reform was that foreigners were now free to use the financial Rand to acquire quoted and non-quoted, equities of South Africa (Garner, 1994). The objectives of the functionality of Rand were to cut the direct connection between the foreign and domestic interest rates (Gustafsson et al., 2010), and to cushion the capital account against shocks of some categories of the capital flow.

When there was outflow of capital of a non-resident, it had to be matched by an inflow. The South African Reserve Bank was able to achieve this balance through the adjustment of the financial Rand rate. In this period of dual exchange rates regime, the financial rate was left to float freely with limited government intervention (Bordo, 2003).

The commercial Rand rate was announced officially by the SARB on daily basis in line with the market forces (MacDonald et al., 2004). The process of announcing the commercial Rand rate ended in 1983. The commercial Rand rate was applicable to foreign trade, and other current account (interest, dividends, repatriation of profits, trade credits and foreign loans) items were pegged to the USD, but the commercial Rand rate was subject to government intervention (see Aron et al., 1997). However, in the early 1990s, the South African Reserve Bank did not intervene in the commercial market (Khumalo and Kapingura, 2014).

In 1983, South Africa abandoned the financial Rand and removed the single exchange rate system (Iizetzki et al., 2010). The change in the foreign exchange rates policy was partly a consequence of the findings of the De Kock Commission (1984), and it was partly as a result of the gains South Africa had made in domestic economic conditions. The financial Rand was defined as the interim stage in the De Kock Commission. The main long-term objective intended was the unitary exchange rate regime. Soon after the abandonment of the dual exchange rate system, the Rand depreciated because of the sharp fall of the price of gold. The other cause of the sharp fall in the Rand was the increase in the rate of disinvestment in South Africa (De Kock Commission, 1979).

In 1985, after the declaration of the UN sanctions on South Africa, the government implemented the debt standstill (see Balcilar et al., 2014). South Africa declared that it would only pay half of its international debt (see Cross, 2003). Following this event, the government re-established the financial Rand mechanism in order to try to resolve the economic crisis (Bordo, 2001; Aron et al., 1997; Van der Mewer, 2004; Van de Mewer, 1997). Although both the commercial and the financial rate were now floating (see Hirsch, 1989), the financial rate was still under limited control from the government.

In 1990, both the commercial rate and financial rate stabilized, however, the political

uncertainty continued (Cross, 2003). In 1992, the South African Reserve Bank allowed foreigners to access the Rand freely so that they can invest locally (Gustafsson et al., 2010). This meant that the supply of the Rand increased, leading to a depreciation of the financial rate. In an attempt to stop the depreciation crisis, the government reversed the liberalisation of the regime by the South African Reserve Bank (Aron et al., 1997). In 1994, the Rand began appreciating and the financial Rand discount narrowed (Balcilar et al., 2014), which was followed by the termination of the dual exchange rate regime in 1995 (MacDonald et al., 2004; Abramitzky and Boustan, 2007).

In the period between 1984 – 1994, South Africa did not have an explicit policy to stabilize the real exchange rates. Aron et al. (1997) states that the monetary policy was only directed to assure that the economy ran a current account surplus. The objective was to use the surplus to finance the capital outflows emerging from the debt rescheduling agreements.

The period between 1994 to 1995 was the period of normalizing and expanding the economy's international financial relations. The economy acquired credit ratings from three international rating agencies. Thereafter, the government issued a government bond of 750 million USD (Gustafsson et al., 2010). And then, the government pursued financial liberalisation, which led to an abolishment of the financial Rand in 1995 (Aron et al., 1997; Gustafsson et al., 2010; Bordo, 2001; Bordo 2003).

#### **1.1.4 The exchange rates in South Africa between 1995 to 1990**

In 1995, South Africa began using the exchange rates system where market forces basically determined the spot exchange rate (Mhaka and Jeke, 2018). Although some exchange rates controls remained, respect to capital movement by domestic residents was maintained. The Rand spot exchange rates were determined by supply and demand in the competitive market (MacDonald and Ricci, 2004). Accordingly, the South African Reserve Bank stopped determining the fixed buying and selling rate for the Dollar, which was quoted by banks in their transactions with the public (see Ricci, 2005).

In the late 1990s, the forward market of quoting spot exchange rates had not

developed well enough to operate without the active participation of South African Reserve Bank (Henshaw, 1996). Hence, special arrangements such as determination of the interest rate differential and the spot exchange rate between relevant foreign currency remained (Arezki, et al., 2014).

During this period, the central bank intervened in the foreign exchange rates market (Ricci, 2005). The aim was to influence the demand and supply. The South African Reserve Bank appeared to prefer smoothing out the short-run fluctuations in both the forward market and the spot exchange rate market (Ferroaro et al., 2002). The forward market is simulated, hence it is likely to be perfectly inconsistent with the expected spot exchange rates (see Spronk et al., 2013). The central bank did not pursue the announced exchange rates or predetermined target (Arezki, 2014). The bank operated within the framework of existing exchange rate controls while being guided by market forces (Mpofu, 2016). If the central bank used artificial and discretion to fix the exchange rates, it would have disrupted the market forces (Sanchez, 2008). Therefore, it would have had implications on the interest rates and money supply (Engel, 2016; Alvarez et al., 2002).

The South African Reserve Bank's monetary policy was heavily based on foreign exchange rate market operations (Aron et al., 1997). The South African Reserve Bank had an overriding objective of protecting the value of the Rand internally and externally (see Bordo, 2003). This makes the behaviour of the domestic exchange rates an integral part of the monetary policy. The South African Reserve Bank used short run interest rates as its key monetary policy tools to signal the lowest rate that the central bank can use to transfer money to struggling banks (De Jager, 2010). This guided the short-term lending rates such that it did not create inflationary pressure. In this case, the central bank took the domestic exchange rates as determined by demand and supply in the foreign exchange rates market (Spronk et al., 2013).

The South African Reserve Bank did not intervene in the foreign exchange rate markets to defend any industry, as it did in the before (Bordo, 2001). Hence, Bank's broad macroeconomic objectives, domestic exchange rates, interest rates and other macroeconomic variables, were not manipulated (Mminele, 2013). The central bank's foreign currency holding was of a small quantity, so the bank could not afford to defend the domestic exchange rates from depreciation (Van der Merwe, 2004; Schanz, 2019).

Van der Merwe (1997) states that the central bank understands that intervention into the foreign exchange rates market is justifiable on the grounds of smoothing out unneeded temporally, random and reversible deviations of the domestic exchange rates. So, as a short run solution, the South African Reserve Bank counteracted unduly downward or upward pressure on the domestic exchange rates (Van der Merwe, 2004). The intervention only occurs if the domestic exchange rates deviate temporally from the level determined by market forces. However, the intervention is limited by the availability of the reserves (see Aron et al., 1997).

The operations of the central bank in the foreign exchange rate market also affected the money market (Van der Merwe, 1997). The SARB sometimes entered as the purchaser of foreign exchange because for every Dollar spent, there was a counterpart Rand. This increased the liquidity available in the domestic money market (see Mminele, 2013). The central bank was aware of the connection between the money market and the foreign exchange rate markets. Hence, the intervention could sometimes be designed to simultaneously affect both markets, or to cancel the developments in the money markets that are not desirable.

## **1.2 The exchange rates expectations and the exchange rates behaviour**

As noted, Chueng et al. (2019) states that monetary policy is mostly used to shape perceptions and expectations that have an impact on the exchange rate behaviour. The literature shows a link between the exchange rates and central bank announced information (Stann and Grigoriadis, 2020).

The South African Reserve Bank pursues monetary stability through the use of the interest rates. Mtonga (2011) explains that it is believed that stable interest rates lead to the formation of stable expectations and other macroeconomic variables.

As the South African Reserve Bank stabilizes the inflation rate, which is a key nominal variable, it is supposed to assist in information processing that relates to behavioural variations in exchange rate expectations (see Vermeulen, 2020). The central bank's inflation targeting policy should anchor economic agents' exchange rate expectations to exchange rates on the basis of how macroeconomic fundamentals are perceived (Dikau and Volz, 2021).

However, the domestic exchange rates continue to be unstable. In this case, this raises the question about how expectations affect exchange rates. The behaviour exchange rates remain an unresolved problem in South Africa. In 2001, a big (40%) depreciation of the rand over a six-month period between June and December (referred to as the rand crisis) prompted the government to establish the Myburgh Commission of Inquiry in January 2002, to investigate the factors driving the rapid depreciation of the local currency. However, the commission was not able to identify the factors responsible for the rapid collapse of the Rand exchange rate (Myburgh Commission, 2002).

As previously stated, expectations play a significant role in driving the direction of a currency. Thus, understanding how exchange rate expectations are formed may assist efforts by policy makers to stabilize exchange rate movements. In chapter 2, therefore, an understanding of how expectations of exchange relate to exchange rate behaviour is sought.

We analyse the impact of the exchange rate expectations on the exchange rates movement for South Africa, using high frequency data and assuming asymmetric impact of exchange rate expectations. The analysis is estimated using the Markov Switching Model.

The study uses the microstructure theory, which allows economic agents to form expectations by incorporating private information and noise into the asset market. There are two types of economic agents in the market, which are the risk averse and price-takers in the market. We assume that the assets are risky and there's only one trading period. The results and analysis are shown in chapter 2.

### **1.3 The movement of exchange rate and expected income**

In South Africa (SA), the authorities have undertaken reforms to promote economic growth. Among these reforms are economic and political changes that have implications for the expected level of future income. The reforms allowed the economy to be free to engage in international trade with various markets. The economic reform offered an opportunity to international investors to do business with SA. These reforms meant the economy could potentially experience higher levels of productivity and,

hence, income. Reforming the economy also meant that the government could give investors mining rights and mineral resource exploration rights. The reform aimed to reduce uncertainty about investing in SA. The reforms involved trade agreements with other countries and trading blocs.

Hayat and Tang (2013) demonstrated that signing production agreements, economic cooperation deals, and being a member of economic blocs, fuels expectations of future income. In addition, it leads to a significant appreciation of the real exchange rate. Fluckiger and Ludwig (2018) argue that economies that are members of the trade bloc tend to seek economic prosperity from exporting, which can be expected to lead to the domestic exchange rate appreciation. Moreover, economies can expect to have higher levels of income in future because of signed export agreement.

The SA minister of Trade and industry stated that China's requirements are aligned with SA economic interests (Patel, 2019). He further cited the comprehensive Strategic Partnership Agreement between SA and China, stating that it is a gesture of deep economic ties. These developments created expectations for future higher income, which Hayat and Tang (2013) argue that it should lead to exchange rate appreciation.

However, the domestic exchange rate (SA Rand, ZAR and the United States of America, USD) has a long continuous depreciation swing. This is concerning because it suggests that the relationship between the exchange rates and expected higher income is different for ZAR/USD, or is not understood.

The model is informed by the monetarist economic framework for supply and demand of countries' (in the case South Africa and the United States of America) currencies. It emphasizes that the exchange rate determination is dependent on asset prices that respond to expectations. The expectations are particularly influenced by monetary policy, and they reflect available information about currencies. Thus, the exchange rate changes in response to new information and the prevailing situation.

The Bayesian Vector Autoregressive (BVAR) estimating technique is applied on this theoretical framework. The BVAR is chosen because its results are produced by sampling from the posterior distribution of variables. The analysis of the results is contained in chapter 3.



#### **1.4 The Interest Rates differential and Exchange Rates behaviour: the case of South Africa.**

Since the 1970s, there has been great interest in investigating the monetary model of exchange rate determination. However, the 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 the exchange rate behaviour. However, empirically it is demonstrated that the assumptions of the 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 State of American Dollar (ZAR/USD)) in both the short-run and the long-run. Furthermore, the study used monthly data starting from 1980 to 1998, while Brink and Koekemoer (2000) used data from 1979 to 2000 and found that the ZAR/USD behaviour is explained by the monetary model.

If the monetary model of exchange rate determination does not hold, it becomes a problem for 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 of maintaining the inflation rates between 3% and 6% (SARB, 2020). The theory of 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., 2013, Bahman-Oskooe et al., 2015, Iskhoki and Mukhin, 2021, Tawadros, 2017). However, in the literature there is no consensus about the effects of the monetary variables on the exchange rates.

This study follows Tari and Gözen's (2018) model, which was developed from Frenkel's (1973) monetary model. We also applied the assumptions in Cushman (2007), supposing that foreigners do not hold a currency of another country. Chapter 4's estimation of results permits asymmetric adjustment from the long run following a TAR process.

#### **1.5 Significance of the Study**

This study uses non-linear estimation of the exchange rates monetary models. This

will give an insight on the nature of the exchange rates response. Furthermore, the study will determine whether the response is asymmetric to different (for positive and negative) shocks of the same variable.

This study is important because it will help in understanding the relationship between monetary fundamentals and the exchange rate behaviour. Moreover, the study will contribute to the literature by providing an analysis of effect of monetary fundamentals on the exchange rates of an emerging economy. Moreover, the study will be beneficial to other economies with the same characteristics as South Africa (SA). The models used in this study can be applied to a wide range of emerging economies. This is a significant contribution into the literature.

## **1.6 The objective of the Study**

### **1.6.1 The main Objective**

The main objective of the study is to investigate the relationship between the exchange rates and monetary fundamentals. The study assess this relationship in relation to the predictions of the monetary model of exchange rate determination. The study aims to determine if the relationship in SA is different or is consistent with what is argued by Frankel (1979). To achieve this objective, the study will investigate the following.

### **1.6.2 Secondary Objective**

- a. The exchange rates expectations and Exchange rate behaviour in South Africa.
- b. The movement of exchange rates and expected income in South Africa.
- c. The Interest Rates differential and Exchange Rates behaviour: the case of South Africa.

### **1.6.3 Research Questions**

- a. What are the effects of expectations of exchange rates on exchange behaviour?
- b. How do exchange rates respond to expectations of future income?
- c. What impact do variations in monetary variables have on the exchange rates

behaviour?

#### **1.6.4 Structure of the thesis**

The remainder of the study is organised as follows: Firstly, chapter 2 contains the background of the study, a brief discussion on exchange rate fundamentals, theoretical framework, estimation, analysis, and then the conclusion of the chapter. Secondly, Chapter 3 consists of the background, discussion on exchange rate fundamentals, the analysis of results, and the conclusion. Thirdly, Chapter 4 incorporates the background, a brief discussion on exchange rates empirical facts, an analysis of results, and the conclusion. Fourthly, Chapter 5 is the conclusion, which is then followed by references.

#### **1.7 Contribution of the Study**

The Study found that the responses of the exchange rates is asymmetric to the shock of expectation. Furthermore, in some instances, the exchange rates do not respond to expectations as prescribed by the economic theory. This points to an unobserved pressure that acts on exchange rates, which leads to a behaviour that may not be consistent with the expectations. It depends on the prevailing situation,. For example, in some instances, the exchange rate is expected to appreciate, but the unobserved pressure pushes the exchange rate's behaviour to depreciate. The same occurs in some situations when it is expected to depreciate. However, in the period when the exchange rate is stable, expectations of the exchange rates can drive the it. This is contrary to Frenkel and Rose (1995) who argued that monetary variables only explain the behaviour of exchange rates during the times of economic turmoil.

Furthermore, upon examining the effects on the interest rate differential, the study found that the interest rate differential effectiveness depends on the timing of the shock. The interest rate differential is only effective when the exchange rate is already appreciating or depreciating. When the exchange rate is appreciating, and then the interest rate differential increases, the Rand exchange rate appreciates. Conversely, when the rand is depreciating against the dollar, then the interest rate differential

decreases, the rand depreciates against the dollar. Furthermore, the study shows that economic policy uncertainty does not always have an effect on the exchange rates behaviour.

## **CHAPTER TWO: EXCHANGE RATE EXPECTATIONS AND EXCHANGE RATE BEHAVIOUR**

### **2.1 Introduction**

Many studies have observed that information on socioeconomic events in a country is central in the determination of exchange rates (Frenkel, 1982; Frankel and Rose, 1995; Ibhagui, 2018; Karoui and Karoui, 2021;). Soe and Kakinaka (2020) have argued that if the central bank provides accurate information to the public, economic agents will form correct expectations, which should indirectly result in stable exchange rate behaviour. Underscoring the role of expectations, Rehaman (2013) has maintained that exchange rate movements are largely dependent on expectations formed by economic agents.

In the literature, monetary policy announcements are broadly used to study perceptions and expectations in relation to the behaviour of exchange rates (see Chueng et al., 2019; Kearns et al., 2018). Korus and Celebi (2019), for instance, examined the effect of Brexit news on the British currency and found that changes in the exchange rate were linked to the announced information. There are numerous other studies that provide evidence demonstrating that exchange rates react to expectations of monetary policy announcements (see, for example, Zettelmeyer, 2004; Bjørnland, 2008; Gürkaynak et al, 2021; Stann and Grigoriadis, 2020).

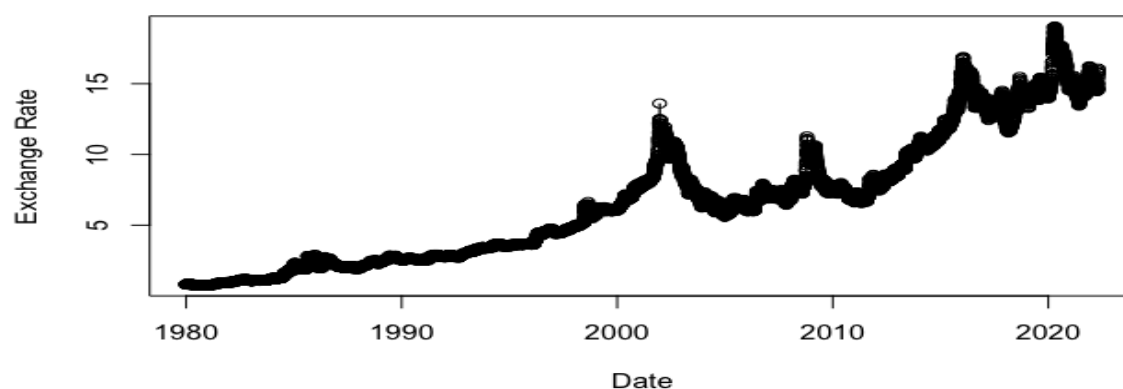
In South Africa, the South African Reserve Bank (SARB) uses interest rates as its main policy instrument in pursuance of its primary objectives of monetary stability and balanced economic growth, as outlined in the South African Reserve Bank Act of 1989 (see SARB, 1989). In the late 1990s, the SARB believed that if it could reduce and

stabilize interest rates, it would consider allowing the market to form stable expectations about exchange rates, among other macroeconomic variables (Mtonga, 2011).

In the late 1990s, the SARB abandoned the pre-commitment to any exchange rate parity by using any form of exchange rate intervention, essentially allowing the exchange rate to fluctuate freely (Mtonga, 2011; Barguelli et al., 2018; Rohit and Sash, 2019). Since the SARB set to stabilize inflation rates, which is a key nominal macroeconomic variable, it should aid in processing information relating to exchange rates, consequently contributing to behavioural changes in exchange rate expectations (Vermeulen, 2020). The SARB's inflation targeting policy should anchor economic agents' exchange rate expectations to exchange rate pricing based on macroeconomic fundamentals (Dikau and Volz, 2021).

However, the South African Rand/ United States dollar exchange rate continues to be unstable. Figure 2.1 below shows a sustained exchange rate depreciation since the mid-1980s, which is reversed between 2000 to 2006. Thereafter, the Rand continues depreciating until 2009 when it briefly gains value before starting to lose value again in 2012. The value of the Rand vis-à-vis the United States dollar (USD) improved again for a short while from 2016 to 2020. The Rand/USD exchange rate movement has been stable in some periods, but short-run fluctuations have become increasingly volatile and evidently displaying unexpected movements.

Figure 2.1: Exchange Rate in South Africa (1980-2021)



*Source: Author compilation*

The change to inflation targeting with an aim to stabilize macroeconomic fundamentals has seen a rise in volatility of the Rand/USD exchange rate. Furthermore, the continued depreciation of the South African rand against the United States dollar was unexpected. In this case, these situations cause concerns about the formation of expectations about exchange rates. The formation of exchange rate expectations remains an unresolved problem in South Africa. In 2001, a large (40%) depreciation of the rand over a six-month period between June and December (referred to as the rand crisis) prompted the government to establish the Myburgh Commission of Inquiry in January 2002, to investigate the factors driving the rapid depreciation of the local currency. However, the commission was not able to identify the factors responsible for a rapid collapse of the Rand exchange rate (Myburgh Commission, 2002).

Excessive depreciation of a currency is detrimental to the economy (see Conrad and Jagessar, 2018; Kreko and Oblath, 2020; Bhatti et al., 2018), so is an excessive appreciation of a currency. As indicated in the foregoing discussion, expectations play a key role in driving the direction of a currency. Thus, understanding how exchange rate expectations are formed may assist efforts by policy makers to stabilize exchange rate movements. This study, therefore, seeks to understand how expectations of exchange rates relate to exchange rate behaviour. The paper attempts to determine whether exchange rates expectations matter for pricing of the South African Rand. This is important because understanding about the Rand exchange rate behaviour requires consideration of the exchange rate expectations, which is one of the factors assumed to be a central driver of the exchange rate movement.

There are two studies that have analysed the impact of exchange rate expectations on exchange rate movements in South Africa. Mtonga (2011) examined exchange rate dynamics resulting from monetary policy changes. The study compared exchange rate behaviour pre- and during inflation targeting. Consequently, the study established that fundamentals explaining exchange rates change when the monetary policy regime changes. In the current monetary policy era, perceptions about the future direction of macroeconomic variables are important for their influence in the market. However, the

study does not analyse the effect of exchange rate expectations, which the study indicates is among factors conditioning exchange rate movements. In the second study, May et al., (2018) examine exchange rate responses to monetary policy shocks using high frequency data. The study shows that after a monetary policy shock, participants revise expectations. However, they did not analyse how exchange rate expectations impact on the exchange rate movement. The authors focused on the repo rate surprise and the response of the exchange rate.

Following an extensive review of literature, it can be argued that this is the first study to analyze the impact of exchange rate expectations on the exchange rate movement for South Africa, using high frequency data and assuming asymmetric impact of exchange rate expectations. This study will be the first work to estimate a Markov Switching Model in this context. This is an important contribution to the literature since this method can be applied to a range of economies with similar characteristics as South Africa.

## **2.2 Exchange rates fundamentals**

The literature shows that expectations affect the foreign exchange rates market, leading to fluctuations of exchange rates (see Taylor, 1995; Mussa, 2019; Frenkel, 2019). However, Itskhoki and Mukhin (2021) argue that exchange rates have been found to be disconnected to the fundamentals including expectations. Indeed, the literature has largely failed to link macroeconomic fundamentals with exchange rate movements (see Lilley, 2022; Demir and Razmi, 2022; Engel and Zhu, 2019; Frenkel and Rose, 1995). Recently, Mueller et al. (2017) found that exchange rate dynamics respond to macroeconomic fundamentals, and their impact is large in the case of an announcement.

Since Meese and Rogoff's (1983) work, concerns about fundamentals and exchange rates behaviour have intensified. This shows that economic agents do not have complete knowledge about the factors influencing the exchange rate behaviour. On the other hand, the literature does attempt to address unexplainable exchange rate movements. In the literature, the unexplainable exchange rate movements are associated with unobserved factors (Lyones, 2001). In some instances, the literature

points out that some of the unobserved factors can be captured in expectations (see Palamalia, 2019; Kabundi et al., 2019). Abid (2020) explains that the unobserved component of macroeconomic fundamentals captured by expectations play an important role in shaping macroeconomic variables. Tawadros (2017) argues that many variables, some of which may be unobserved, have a large impact on exchange rate behaviour, which makes the relationship between exchange rates and its determinants unclear in the short-run. Bacchetta and Van Winscoop (2013) argue the same point, adding that the exchange rate depends more on unobserved effects than observed factors. Kalemli-Ozcan and Barela (2019) established that in short-run, a mismatch in expectations is a large driver of exchange rates behaviour. However, Itskhoki and Mukhin (2021) point out that the exchange rate remains disconnected to its fundamentals, including expectations.

As noted, there is a large body of literature focusing on exchange rate behaviour, but studies fail to link exchange rates to its fundamentals. Some studies found that exchange rates respond to announced changes of the fundamentals, such as interest rates and money supply (Stavrakeva and Tang, 2015; Hutchison and Wu, 2012; Rossi, 2005). Ho et al., (2017) add that the announcement of fundamentals has a greater impact on shaping the exchange rate behaviour.

Goergiadis and Grabs (2016) point out that exchange rates in emerging economies respond to announcements made by monetary authorities. This explains economic agents' understanding of the impact of the central bank's announcements on the behaviour of exchange rates. Exchange rates are very responsive to expected changes in the real economy that are channeled through announcements (Egert, 2014). Omrane et al., (2019) add that announcements create stable exchange rate expectations in the long-run. On the contrary, Maserumele and Algidede (2017) state that macroeconomic announcements in South Africa alter expectations so much so that they increase unexpected swings of the exchange rate.

Expectations formed from favourable announcements that are associated with the domestic country tend to have more impact on the exchange rate, while negative announcements exhibit less impact on the exchange rate movement (Tamagac,



2021). This asymmetric impact of expectations on exchange rates is also reported in the literature in various studies (Boudt et al., 2019, Ekincia et al., 2019). Wu and Gau (2020) argue that after an announcement, information asymmetry among economic agents declines. Moreover, this reduces contradictions about the future course of the economy, leading to the exchange rate adjusting towards a new equilibrium.

The literature identifies changes in expectations of macroeconomic fundamentals that could lead to a swing on the exchange rate when an announcement is made (see Gbadebo et al., 2021). The changes in exchange rates results form announced changes in decisions, not changes in monetary policy of the central bank. Kearns and Manners (2018) explain that economic agents' expectations incorporate the impact of macroeconomic fundamentals on the exchange rates. There are more studies confirming the impact of the expectations on the exchange rates following a central bank's announcement (Lyocsa et al., 2019).

Despite Meese and Rogoff's (1983) findings that random walk model outperforms monetary models in exchange rate determination, more work emerged when larger data became available, and the results could not produce evidence to support the theory of exchange rates determination (West, 2005; Cushman, 2000). Recent studies have used sophisticated procedures to model the exchange rate behaviour and the results are mixed (Tawadros, 2017; Westerlund, 2015; Beckmann et al., 2011; Dabrowski et al., 2014). Cheung et al. (2005) argue that no single model dominates exchange rate determination. This can be interpreted as meaning that estimated results of exchange rate models may be influenced by estimation techniques. As Xie and Chen (2019) noted, the monetary models of exchange rate behaviour determination are not useful.

Meese and Rose (1990) reveal that exchange rates are nonlinear and unstable for economies with low inflation rates, while some studies indicate that current exchange rates are defined by expected future values of exogenous variables that are not known (Meese and Singleton, 1983). The changes in exchange rates are driven by swings of fundamentals, which represent a dynamic evolution of market expectations (Sarno and Valente, 2009). Devereux and Engel (2002) affirm that there may be more factors

involved in shaping the behaviour of exchange rates which are captured by expectations. This is supported by Xie and Chen (2019), who explain that variations on expectations in the short-run drive movements of the exchange rates. Furthermore, considerable literature indicates that monetary policy announcements are an important factor that drives expectations of exchange rates (see Fatum and Scholnick, 2008)

There are several studies that use financial market indices to proxy near-term expectations of Central Banks' interest rates around the days of the announcement to measure monetary policy shocks (see Ricci 2015; Wang and Mayes 2012; Vithessonthi and Techarongrojwong 2013; Wongswan 2009; Lee et al., 2016; Chao et al., 2011; Stotz 2019; Angerer et al., 2021). Gurkaynak et al (2006) remarked that monetary policy shocks can be analyzed using stock market-based instruments to measure the impact of expectations. According to Barro and Gordon (1981), economic agents form rational expectations and central bank authorities optimize each period based on the expectations of economic agents (Rudebush (1995). Expectations are important because without them, economic behaviour would not make sense in the period before, during and after the implementation of monetary policy. Economic agents form expectations about central bank actions conditional to available information (Foerster, 2015).

Announcements reduce the amount of uncertainty (Beber, 2006). This has been confirmed by Beckmann and Czudaj (2016), who found that expectations are affected by announcements. Bacchet (2004) established that exchange rates are affected by different fundamentals at different occasions. Variations in exchange rates may result from expectations of monetary policy, which may induce variations on prevailing economic fundamentals (Chan and Chow, 2012). Exchange rates are important for two reasons in this study: they determine relative prices of goods in the international market, and they serve as an asset price that establishes relative prices of two currencies. Devereu and Engel (2008) expressed that asset prices move in response to news that modify expectations of the future. In addition, exchange rate movements occurring in the short-run result from changes in expectations of future monetary policy or real conditions.

## **2.3 Theoretical Foundation**

### **2.3.1 Background of the microstructure theory**

The literature on exchange rate behaviour in economics and finance has developed independently of each other. In both disciplines, there is larger literature showing various successes and challenges. In economics, studies carried out in the 1960s have assumed the demand for currencies primarily comes from purchases of goods (Dornbusch, 2019). This simply implies that countries with trade surpluses would experience exchange rate appreciation. However, even though this reasoning sounds intuitive, it fails miserably when tested against data to evaluate. It has been demonstrated extensively that trade balance is not correlated with the behaviour of the exchange rate (Itskhoki, 2020). This may be suggesting that pricing of goods and services might be accounting for a small fraction in the exchange rate behaviour.

The failure of the goods market approach gave rise to the asset market method in the 1970s. Its construction was based on the realization that demand for currency may not only be determined by the desire for trade. The asset approach included the sale and purchases of assets in the construction of factors that could explain the behaviour of the exchange rate. For example, if South African residents want to purchase a Zimbabwean government bond, South African investors will need to initially buy Zimbabwean Dollars. The return on the South African Rand will depend on the movement of the Zimbabwean Dollar, which makes the investors demand for the bond to depend partially on their appetite to speculate on the behaviour of both currencies.

The change in modelling exchange rates led to the consideration of efficiency, which incorporates all publicly available information. This also means publicly available information cannot be used to generate additional returns. The goods market approach of the 1960s used in the modelling of exchange rate behaviour did not have

this feature.

While the asset approach is more intuitive than the goods market approach, its empirical work fails to capture exchange rate behaviour. Meese and Rogoff (1983) were the first to show that exchange rates cannot be explained by fundamentals using the asset approach. Lyones (2001) explains that exchange rates behaviour is too complex, and it consists of large trading volumes which are problematic for the asset approach. This is because explaining exchange rate behaviour would require mapping macroeconomics variable changes.

The changes in macroeconomic news are available in the public domain. In the event that an announcement is made, it is reasonable to assume exchange rates will shift to a new level that all economic agents accept. The resulting expectations leading to a change in the value of the exchange rates do not need any trading to occur. In the asset approach, there is no need to consider that an existence of differences in beliefs will lead to a trade, since an announcement creates homogenous expectations. This explanation shows that the asset approach appears to be lacking some central features, which can help explain the movement of the exchange rate.

This study will piece together the developments in finance and macroeconomics. The study integrates the asset approach with microstructure models. The microstructure models are used in finance. The reason we chose to employ a microstructure model is because it recognises that some information useful for exchange rate behaviour may not be available in the public domain. Furthermore, economic agents have complete understanding of differences exhibited by the market participants, and the effect they have on prices. In addition, microstructure models of international trading are assumed to differ in the manner that they might relate to prices.

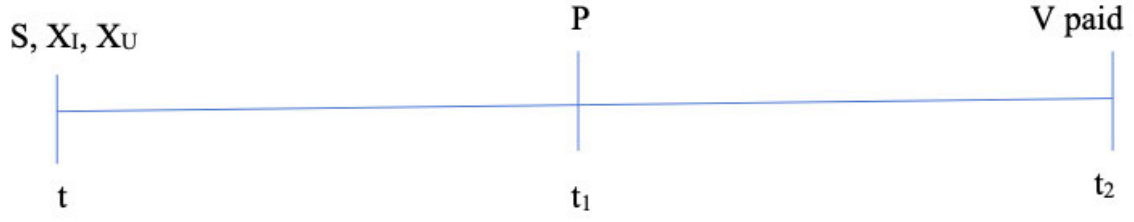
The term 'market microstructure' is defined in finance as "a process and outcomes of exchanging assets under an explicit trading rule" (Menkhoff et al., 2016). This study assumes rational expectations, as conceptualized by Muth (1961), in which the behaviour of endogenous variables depends on the economic agents' expectations on the values of those variables (Fieremans et al., 2017). The study assumes the foreign exchange rate market (FX) has a partially revealing equilibrium. The reason the study uses microstructure is because it allows adding other sources of noise that might have an impact on the exchange rate behaviour. For example, when the exchange rate

appreciates in the FX market, economic agents cannot tell if it is a result of a decline in supply of assets or positive private information. Both events can lead to an exchange rate appreciation.

In the microstructure, the price of the exchange rate has two roles: it provides information to economic agents, and it clears the market. While equilibrium price plays a role of market clearing, any changes in equilibrium price tends to eliminate excess demand/supply. This is because financial equilibrium is based on the role of prices being a central source of information. Here we add that at equilibrium, individual economic agents disregard the price information role. This means that individual economic agents do not consider price information. Accordingly, prices do not affect expectations, which makes individuals' demand for foreign currency a function of their own information. Therefore, the equilibrium price is an aggregate bit of information of each economic agent. This makes the equilibrium price a reflection of all economic agents operating in the FX market. However, individuals neglect the equilibrium price and act as though it is uninformative. Because economic agents are rational, they view the equilibrium price as an information aggregator. This point eliminates arguments that may lead one to consider ignoring the market clearing price as irrational.

### **2.3.2 Theoretical Framework**

The microstructure allows economic agents to form expectations by incorporating private information and noise in the asset market. This market has different types of economic agents: risk averse and nonstrategic (price-takers) agents. Assume we have a risky asset and a single trading period. Now let us consider the illustration below. It consists of three scenarios, where  $V_2$  denotes the value of an asset at the end of the period. It is normally distributed with a mean zero and variance  $\sigma_V^2$ . Trade of an asset occurs at price  $P_1$ . Suppose one of the two traders is "informed" about assets before trading takes place at  $P_1$ , which means the informed trader has private information relating to  $V_2$ . The private information is received in the form of a signal  $S_0$ .  $S_0$  is normally distributed, and both traders know this. However, only the informed trader observes  $S_0$ .



Therefore,  $S_0$  is defined by:

$$S_0 = V_2 + \mu_0 \quad (1)$$

White noise innovation about signal  $S_0$ , is denoted by  $\mu_0$ , with a mean zero and a variance  $\sigma_{S_0}^2$ . The trader who does not observe  $S_0$  is not informed, which makes him/her lack the motive for trading. However, the trader who does not observe  $S_0$ , trades with the motive to hedge. Note that in general, both traders have a motive to hedge. Assume that both traders are endowed with random unites of risky assets (shares or United States of American Dollars). Let  $X_i$  and  $X_u$ , respectively represent the informed and uninformed traders. Furthermore, assume each endowment of risky assets is  $N \sim (0, \sigma_{X_{i,u}}^2)$ . The combined supply of risky assets is defined by:

$$X = X_i + X_u \quad (2)$$

Suppose  $X_i > X_u$ . If trades are purely driven by motives to hedge, then the expectation is that the uninformed trader purchases risky assets from the informed trader. We assume  $X_i$  and  $X_u$ , are independent of  $S_0$ , each other and  $V_2$ .

The demand for a risky asset does not depend on wealth. The study uses an exponential utility function following Ronaldo and Somogyi (2021) to define wealth( $W$ ) at the end of the period as:

$$U(W) = -\exp(-W) \quad (3)$$

Equation (3) states that reallocation of wealth through the trading process has no effect

on the equilibrium. Individual gains or losses do not affect the equilibrium price, but the return of the risky assets is normally distributed. In addition, all traders know the mechanism of the pricing rule. The trading rule meets two conditions: firstly, the equilibrium price rule is consistent with the expectations of  $V_2$ , and secondly, the market always clears.

When the  $X_u$  purchases from the  $X_i$ , they use the pricing rule together with the market price to verify  $S_0$ . The pricing rule satisfies two conditions: rational expectations, and equilibrium. The equilibrium condition is defined as

$$P_1 = \alpha S_0 - \beta X \quad (4)$$

where  $X$  denotes the supply of risky assets.  $S_0$  and  $X$  are key and random components, in which demand for risky assets relies on, while  $V_2$  is neglected because it is not observable during the time trading takes place. Since the informed trader learns only from her own signal,  $X_i$  is aware that her counterpart is uninformed. The informed trader's posterior belief in relation to  $V_2$  is conditional to her  $S_0$ . Given by:

$$E[V_2|S] = \left( \frac{\sigma_{S_0}^{-2}}{\sigma_{S_0}^{-2} + \sigma_{V_2}^{-2}} \right) S \quad (5)$$

with a variance:

$$Var[V_2|S_0] = \left( \frac{1}{\sigma_{S_0}^{-2} + \sigma_{V_2}^{-2}} \right) S_0 \quad (6)$$

The weaker version of the signal given by equations (5) and (6) give insights into  $S_0$  variance ( $\sigma_{S_0}^2$ ). The signal ( $S_0$ ), is weak when the variance gets larger, i.e.,  $E[V_2|S_0]$  tends towards the unconditional expectation of  $V_2$  when  $E[V_2] = 0$ , and  $Var[V_2|S_0]$  approaches the unconditional variance  $V_2(\sigma_{V_2}^2)$ . The stronger version of a signal is achieved when, as  $\sigma_{S_0}^2$  approaches zero,  $E[V_2|S_0]$  goes to  $S_0$ , whereas  $Var[V_2|S_0]$  approaches zero.

The uninformed trader's expectations are not based on private information, but extract information from the equilibrium price because they include information about the informed trader's trades. Furthermore, the uninformed trader tries to obtain additional information observed by the informed trader, from the equilibrium price and relate it to

$S_0$  using the pricing rule. So, the uninformed trader observes  $P_1$  from equation (4).

In equation (7) we find variable  $\frac{P_1}{\alpha}$ , which is distributed around the mean of  $S_0$ . This is the information the uninformed trader wants to learn. At this point, it is important to note that neither the informed nor uninformed trader knows the quantity of  $X$ .

$$\frac{P_1}{\alpha} = S_0 - \left(\frac{\beta}{\alpha}\right)X \quad (7)$$

Now let's fit demand in the model, given that both traders' posteriors are normally distributed. The exponential utility specification, and demand for the informed trader and the uninformed traders, respectively are denoted by  $D_i$  and  $D_u$ ,

$$D_i = \frac{E[V_2|S_0] - P_1}{Var[V_2|S_0]} \quad (8)$$

and

$$D_u = \frac{E[V_2|P_1, \alpha, \beta] - P_1}{Var[V_2|P_1, \alpha, \beta]} \quad (9)$$

Substituting the price functions as a source of information in the demand of the uninformed trader, including  $E[V_2|S_0]$  and  $Var[V_2|S_0]$  into  $D_i$  and  $D_u$  gives:

$$D_i = (\sigma_{S_0}^{-2})S_0 - (\sigma_{S_0}^{-2} + \sigma_{V_2}^{-2})P_1 \quad (10)$$

$$D_i = (\sigma_{S_0}^{-2})A_0 - (\sigma_{A_0}^{-2} + \sigma_{V_2}^{-2})P_1 \quad (11)$$

In equation (11),  $A_0$  represents the uninformed trader's estimation of the informed trader's signal by using a price rule. The uninformed trader may not have the exact information that the informed trader has. To determine the equilibrium price, we equate demand and supply. Recall that

$$D_i + D_u = X \quad (12)$$



So, the condition for market clearing is:

$$P_1 = \alpha S_0 - \beta X \quad (13)$$

where  $\alpha$  and  $\beta$  ensure that excess demand is equal to zero.

## 2.4 Data

The literature has always considered the issue of asymmetric adjustment to the equilibrium of economic variables. Ball and Mankiw (1992) remark that shocks that tend to make prices adjust upwards trigger firms' desire to increase prices to their preferred price, while a shock that lowers prices has a relatively lower impact on firms' desire to lower prices. The adjustment to equilibrium has always been considered to be asymmetric for a long time. Chang and Rajput (2018) show that macroeconomic variables respond asymmetrically to shocks. Moreover, it does appear in the literature that exchange rate behaviour is not symmetric at different regimes. Soon and Baharumshah (2021) theorise that it is difficult to explain the behaviour of the exchange rate without incorporating fluctuations at various regimes. This chapter assumes asymmetric behaviour of the exchange rate, and investigates whether exchange rates are affected asymmetrically by their expectations or not. The depreciation or appreciation is in terms of the South African Rand (ZAR) against the United State of American Dollar (USD).

The study uses high frequency data, which is collected every minute from 3 days before the monetary policy committee announcement to the day of the announcement. The collection of data corresponds to the time when the Johannesburg stock market is open. High frequency data is used because it captures the movement of the stock market equity index, which is used in this chapter to proxy exchange rates expectations. The data used in this chapter is collected from Bloomberg from 2015 to 2016. It was not possible to use a larger amount of data because the software used could not hold a larger amount of data (I used a basic version of STATA for analysis).

## 2.4 Estimation

Following Nzimande and Msomi (2016), the variable is decomposed into two components, expected appreciation (positive) and expected depreciation(negative). The exchange rate is quoted using the direct method  $ZAR/USD$ . Suppose a time series

of  $\{x_t\}_{t=0}^T$  is decomposed to values of the initial process.

$$x_t = x_0 + x_t^+ + x_t^- \quad (14)$$

where  $x_t$  is a scalar  $I(1)$  variable,  $x_0$  represents the values occurring in the beginning and  $x_t^+$  and  $x_t^-$  are decomposed variables. The partial sum process of the appreciation and depreciation is given by:

$$x_t^+ = \sum_{i=0}^{t-1} 1\{\Delta x_{t-1} \geq 0\} \Delta x_{t-1} \quad (15)$$

and

$$x_t^- = \sum_{i=0}^{t-1} 1\{\Delta x_{t-1} < 0\} \Delta x_{t-1} \quad (16)$$

where  $\{x_t^+\}_{t=0}^T$  and  $\{x_t^-\}_{t=0}^T$  denote the expected appreciation and expected depreciation cumulative shocks, and both represent the initial time  $t$ . When the event in the parenthesis occurs, it is represented by the indicator 1, otherwise 0. Let's consider two integrated time series  $x_{1t}$  and  $x_{2t}$ , both define  $x_{jt}^+$  and  $x_{jt}^-$  for values of  $j = 1, 2$ , according to (15). Now assume these series  $x_{jt}^+$  and  $x_{jt}^-$  are both not linearly cointegrated, but within them there is a linear relationship represented by  $q_t$  such that

$$q_t = \sigma_0 x_{1t}^+ + \sigma_1 x_{1t}^- + \sigma_2 x_{2t}^+ + \sigma_3 x_{2t}^- \quad (17)$$

Schorderet (2004) argues that  $x_{1t}$  and  $x_{2t}$  are asymmetrically cointegrated if there exist a vector  $\sigma' = (\sigma_0, \sigma_1, \sigma_2, \sigma_3)$  with  $\sigma_0 \neq \sigma_1$  or  $\sigma_2 \neq \sigma_3$  (and  $\sigma_0$  or  $\sigma_1 \neq 0$  and  $\sigma_2$  or  $\sigma_3 \neq 0$ ) such that  $q_t$  in (D) is a stationary process. To simplify without losing generality, let us assume only one component of each partial process is in the cointegrating relationship (17), given by:

$$q_t = x_{1t}^+ - \sigma^+ x_{2t}^+ \quad (18)$$

and

$$q_t = x_{1t}^- - \sigma^- x_{2t}^- \quad (19)$$

Equations (18) and (19) are nonlinear. Schorderet (2003) argues that if a cointegrating

relationship occurs in each series in (17), it means there is a single direction cointegrating relationship. So, equations (18) and (19) can be rearranged

$$x_{1t}^+ = \sigma^+ x_{2t}^+ + q_t \quad (20)$$

$$x_{1t}^- = \sigma^- x_{2t}^- + q_t \quad (21)$$

According to Alvarez-Plata and Schrooten (2003), the model accounts for smooth shift in expectations, especially when they are unobserved. The switching model is described by unobserved state variables following a first-order Markov process. Therefore, the probability that regime  $S_t$  is number  $i$  is not conditional on the prior  $S_{t-1}$ , for extended details on this (see Hamilton, 1996).

$$P\{S_t = i | S_{t+1} = j, S_{t-2} = k, \dots\} = P\{S_t = i | S_{t-1} = j\} = p_{ji} \quad (22)$$

Let  $S_t$ ,  $n \in \mathbb{Z} \geq 0$  be a stochastic innovation, following values  $i_1, i_2 \dots i_n$  such that if  $S_t = i_n$ , it is maintained that the process is in state  $i_n$ , where  $p_{ji}$  in general denotes the probability transition from the current state  $j$  to the next state  $i$ . At any random period, the structure described above may appear and will be changed to a different structure when a regime switch occurs. The switch probability will satisfy.

$$p_{j0} + p_{j1} = 1 \quad (23)$$

Alvarez-Plata and Schrooten (2003) state that the transmission probability can take a vector dimension  $M \times M$ , with matrix  $P$  forming a switch matrix

$$P = \begin{Bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{Bmatrix} \quad (24)$$

Given that the exchange rate is depreciating, the probability of the exchange rate depreciating in the next period is  $(p_{00})$ . This is regime 1, while  $p_{01}$  represents regime 2. Given that the exchange rate is depreciating in the current period, the probability of it appreciating in the next period is  $p_{01}$ . The example given above is simplified. The study assumes 3 regimes which are consistent with exchange rate behaviour and

these are appreciation, depreciation and stability (where the exchange rate tends to remain flat). Furthermore, the study uses the direct method to measure the exchange rate. In addition, exchange rates are measured as real exchange rates. The negative values imply the exchange rate is expected to depreciate, and positive values mean the exchange rate is expected to appreciate. The value of zero will mean the exchange rate is neither depreciating nor appreciating.

A three-regime Markov-Switching model is estimated because it can account for the disjointed data. To measure expectations, this study follows Wongswan's (2005) concept of using the market index. This method is supported in the literature by Gurkaynak et al., (2006), who detail their support for estimating expectations of exchange rates by linking them to the central bank's announcement. There is extensive literature on the effects of monetary policy announcements and the response of exchange rates (Wright, 2021, Kuttner, 2001 Altavilla and Giannone, 2017, Inoua and Rossi, 2019).

The central bank and expectations of exchange rates are linked through the announcement of the monetary policy committee (MPC). For the same reason, the announcement has a special link to the financial and the money markets through the interest rates. If the interest rate is expected to increase, market participants will withdraw money from the stock market in order to invest in the money market (Papadamou et al., 2020). Conversely, if interest rates are expected to fall, rational households are expected to act in a manner that ensures higher returns by taking money off their money market to buy financial instruments, which would lead to a stock consistent with a stock market index (Lamla and Vinogradov, 2019).

The expectations data for exchange rate behaviour can be broadly classified into macroeconomic models, survey based and financial market-based models. The innovative feature of this study is in using the stock market data as opposed to employing the conventional measures. In this chapter, we assume the return on stock can be explained by the model of stock returns. The portfolio of assets or a single asset is believed to respond to news relating to exchange rates (see Becker et al., 2002). Therefore, changes in the stock market portfolio return can be associated with

the current changes in the exchange rates, since the stock market prices have a forward-looking nature. Thus, expectations about the future path of exchange rates are implied in the variations occurring in prices. This means that variations in stock prices/index react to both unforeseen and actual events, resulting in the expectations of exchange rates. Acikalin et al. (2008) note that changes in the stock market prices are sensitive to expectations of exchange rates behaviour.

The study uses the Johannesburg Stock Exchange (JSE) all share index as a variable representing expectations of exchange rates. As noted in Evans (2010), models of high frequency identification generated by dealings between traders in the stock markets possess more information concerning the current state of the macroeconomy and the movement of exchange rates. This assertion is also emphasized by Xie and Chen (2019), who suggest that high frequency data captures the slowly changing structure of the macroeconomy, where stock market traders convey this information through dealings.

The data used in the study starts from the first day of the MPC meeting, to one day after the MPC announcement was made. The MPC meeting usually takes place over three days. The data is collected daily in minute intervals, from 9am to 5pm. Gürkaynak et al., (2007) mention that high frequency data can be used to measure expectations of monetary policy. The data is available from Bloomberg. This idea is similar to the one presented by Backmann and Czudaj (2016), where the variable measuring expectations captures the current path of the realized fundamentals. The expected shock, which is the MPC announcement in this case, is a mirror version of unobserved systematic and unsystematic movements of the fundamentals explained (Rime et al., 2010, Engle and West, 2005). This is a well-established approach in the literature.

A recent study that employs this method was conducted by Kremens and Martin (2019). However, our approach differs because we decompose the variable measuring expectations in order to capture the asymmetric effects of the exchange rate. The MS model also allows for asymmetric behaviour of the exchange rate. This will allow us to analyse an alternative dimension linked to a shift of the entire system triggered by unexpected changes as a result of the announcement. The expectations are

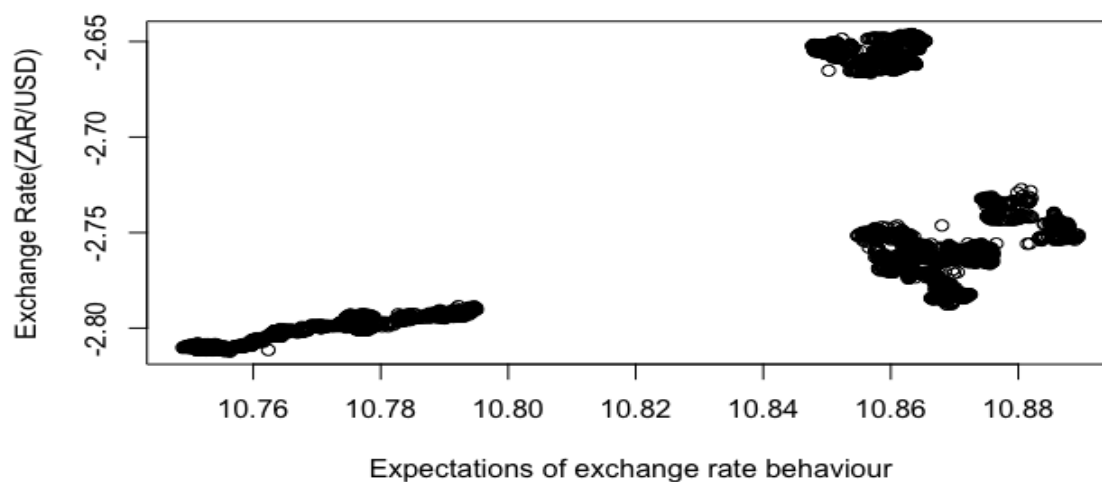
decomposed into positive shocks and negative shocks. This is because market participants have access to reliable information, which informs the decisions they make. This allows us to apply the microstructure theory. Hatemi-J (2012) supports the method of decomposing a variable into negative (and positive) combinations in order to investigate its effect on the exchange rates.

This study allows viewing the effects of expectations on the exchange rates by allowing the asymmetric effect. The idea for assuming asymmetry is also supported by Inoue and Rossi (2019), where they note that expansionary monetary policy may be contractionary if it is not expected. Soon and Baharumshah (2021) believe that when an economy is either in a state of expansionary or contractionary policy, the impact on exchange rates is asymmetric. Introducing asymmetry in the analysis of exchange rate determination may reveal interesting insights into the behaviour of exchange rates. For example, Narayan (2007) found that when exchange rates adjustment is asymmetric, Purchasing Power Parity (PPP) does not hold in the long-run.

### **2.5.1 Results**

The graphs in Figures 2-4 show the relationship between the exchange rate of South African Rand (ZAR) vis-a-vis the United States of American Dollar (USD) against expectations of exchange rates. The figures are used to investigate if there are patterns indicating unusual behaviour. The first diagram shows undecomposed expectations of exchange rates, while the subsequent diagrams consist of decomposed expectations of the exchange rate.

Figure 2.2: Exchange Rate of the South African rand per US Dollar (2015-2016)



*Source: Author compilation*

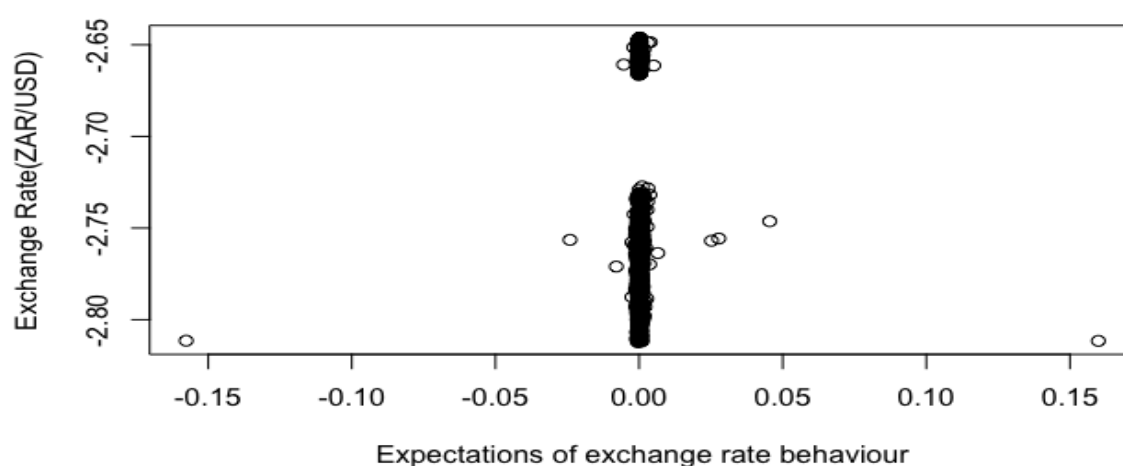
Figure 2.2 indicates the relationship between expectations of exchange rate before and after decomposing expectations. The vertical axis measures ZAR/USD movements, and the horizontal axis measures expectations of exchange rates. In Figure 2.2, initially the ZAR/USD exchange rate exhibits the same behaviour in relation to expectations of exchange rates. The ZAR/USD spreads around the same region and its movement appears constant. After the inflection point, the slope becomes steeper. The inflection point suggests that the ZAR/USD exchange rate is sensitive to variations of expectations of exchange rates, which may imply asymmetric impact of expectations of exchange rates on the ZAR/USD movement. This is also discussed extensively in the literature (see Arghyrou and Pourpourides, 2016; Bhat and Bhat, 2021), which tells us that the exchange rate behaviour may be asymmetric itself.

Towards the right of Figure 2.2, there is a huge shift on the ZAR/USD exchange rate behaviour. The ZAR/USD exchange rate appreciated in between the first two MPC meetings. Devereux and Engel (2006) mention that a shift in expectations may lead to a shift in the exchange rate behaviour. Frömmel et al., (2008) perceive a shift of expectations as an affirmation that new information has emerged. So, it can be put forward that observed changes in Figure 2.2 may be a result of changes in expectations of exchange rates. The ZAR/USD exchange rate is clustered in the same region. This ZAR/USD exchange rate behaviour strengthens the argument of

asymmetric impact and asymmetric behaviour of the exchange rate. It seems that the relationship between the ZAR/USD exchange rate behaviour and expectations of exchange rates clutter in the same region.

Figure 3 shows the relationship between the ZAR/USD exchange rate behaviour and expectations of exchange rates. The expectations of exchange rates are decomposed to allow asymmetric effects on the exchange rate behaviour. The component of expectations of the exchange rate shown in the following figure are associated with an appreciation of the exchange rate.

Figure 2.3: Exchange Rate in of the South African rand against the US Dollar (2015-2016)



Source: Author compilation

In figure 2.3, the vertical axis measures the ZAR/USD exchange rate. The movement from down-upwards on the vertical axis represents an improvement of the value of ZAR against the USD. However, negative values indicate a depreciation. The horizontal axis measures expectations of exchange rates. A value of zero on the horizontal axis means stable expectations. At zero, expectations are anchored. Stable expectations of exchange rates imply that the information provided by monetary authorities is believed. There are few points laying away from the zero mark. The interaction between expectations and the ZAR/USD exchange rate is always



characterized by a depreciation. The closest value to a zero ZAR/USD exchange rate reaches it at -2.65 percentage points. Even though the ZAR/USD may improve at times, the depreciation occurring overtime outweighs any gains.

The Figure below measures the ZAR/USD exchange rate behaviour and expectations of exchange rates. The expectations are decomposed to allow asymmetric effects on the exchange rate behaviour. The component of expectations measured in the following figure is associated with an expected depreciation of the exchange rate. The expectation of exchange rate behaviour corresponds to the period preceding the monetary policy announcement of the exchange rate.

Figure 2.4: Exchange Rate of the South African rand against the US Dollar (2015-2016)



*Author compilation*

Figure 2.4 presents the relationship between the ZAR/USD and the exchange rate expectations. In Figure 2.4, the vertical axis measures ZAR/USD exchange rates, and the horizontal axis measures expectations of exchange rates. The decomposed expectations measure the expected depreciations of the ZAR/USD exchange rates. Expectations are not changing. They are anchored. This is represented by dots being clustered at zero.

The following table shows stationarity test results of the variables. A unit root test is conducted to determine whether the series contains unit root or not. The unit root test is run prior and after decomposition of the variables. The study uses Phillip Perron (PP) and Augmented Dicky Fuller (ADF). The PP test is chosen for various reasons.

The PP assumes data is generated by an autoregressive model with a known order. In addition, the PP test is robust even when there are structural breaks (Amsler and Lee, 1995, Khan, 2021, Maijama'a, 2020). The data used in this study is also disjointed, collected in different quarters, then added together to make a continuous series. The ADF uses the Ordinary Least Squares (OLS) estimator to determine if the data generating mechanism has unit roots.

The literature argues that the presence of unit roots in the data generating process leads to biased results (Patterson, 2011). The first step of correcting for the presence of unit roots is to make a monotonic transformation of the data by converting it into a natural log. In the event the data continues to contain unit roots even after logging, then it is next differenced. The following table shows the unit roots results.

Table 2.1: Unit root test

Variables	Phillip Perron (PP)		Augmented Dicky Fuller (ADF)	
	Intercept	Intercept+ Trend	Intercept	Intercept+ Trend
Exchange rate	- 1.839059	-1.975541	-1.837687	-1.975505
Expectations of exchange rate	- 1.594549	-1.897701	-1.587599	-1.890053
Logged				
Log of exchange rate	-1.8605	-1.988788	-1.859176	-1.988937
Log of expectations of exchange rate	- 1.598985	-1.90129	-1.590925	-1.89259
Differenced				
Log of exchange rate	-48.05***	-48.0401***	-48.05***	-48.0401***

Log of expectations of exchange rate	-47.91***	-47.9056***	-47.92***	-47.90558***
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*Author compilation*

In Table 2.1, we use the PP test to examine the unit roots. The test reveals a test statistic of -1.839, which is insignificant at all conventional levels. Furthermore, a re-run of the test, which includes an intercept and trend, leads to the same results. The variable contains a unit root, and the test statistic is -1.9755. It is noticeable that the value of the test statistic changes slightly, but it remains insignificant. Then the variable 'exchange rate' is tested using the ADF unit root test. We allowed for an intercept only and found that it is insignificant with the test statistic -1.8377. When the intercept with a trend is tested, the exchange rate has a unit root, and the test statistic value is -1.9755. The values of the test statistics produced by both methods on the variable are slightly different from each other but insignificant.

We conduct a stationarity test on expectations of exchange rates using the PP unit root test with an intercept only. The results are insignificant at all conventional levels. The test statistic value is -1.5946. When a trend with an intercept is included, the test statistic changes to 1.8977. However, the variable contains a unit root. When using the ADF test including an intercept only, we find the test statistic of 1.5876. The results indicate the series contains a unit root, and it is insignificant at all conventional levels. We repeat the ADF test, but now including an intercept with trend, the results are insignificant with a test statistic of 1.890.

Both the PP and ADF tests indicate that variables are insignificant at level. This requires logging variables, then conducting unit root tests to determine if it is not resolved. Using the PP test on the log of exchange rates, including the intercept only, the results are insignificant at all conventional levels. The test statistic value is -1.8605. Then the log of exchange rate is tested including an intercept with trend, with the series also containing unit roots. The test statistic changes to -1.9888. The ADF Test including the intercept shows the same results as the PP test. The log of exchange rate is insignificant, with a test statistic value 1.8592. When considering the intercept

with trend, the results do not change, the series contains unit root. The test statistic value estimated is -1.9889. The series is insignificant at all conventional levels.

Next, the PP test is used on log of expectations of exchange rates. We begin by including the intercept only. The results show that the series is insignificant with a statistic of -1.5990. Furthermore, including the intercept with a trend, the test finds the series does not change from being non-stationary. The test statistic value of 1.9013 is insignificant at all conventional levels. It is worth noticing that the test statistic value changes when the intercept with trend is included, although the statistic remains insignificant. Then we run an ADF unit root test on the log of expectations of exchange rate. Initially, only the intercept is included, then we included the intercept and trend. The results obtained show that the test statistic is insignificant. The test statistic values respectively are of -1.5909 and -1.8926.

Then we difference both logged variables because we still find unit roots. Using the PP test on the differenced log of exchange rates, when we include an intercept only, we find a test statistic of -48.05. The log of exchange rates is significant at all conventional levels of significance. In addition, when the differenced log of exchange rates is tested with the inclusion of an intercept and a trend, we find that it is significant at all conventional levels. The estimated test statistic of the difference of the log of exchange rates is -48.04. When we run the ADF test on the differenced log of exchange rates, by firstly including the intercept only and then including the intercept with a trend, the results do not change from the ones found when the PP test was used. Moreover, the differenced log of expectations of exchange rate is also tested using PP and ADF tests. The results found are the same. The results are significant at all conventional levels, with a test statistic of -47.91. These results do not change whether a PP or ADF test is used. The same two tests were done on the differenced log of expectations of exchange rate. The results are significant at all levels of significance with a test statistic value of -47.92. These results do not change whether an intercept only is used or an intercept with trend is included in the test.

It is important to choose an optimal number of lags to use in the analysis to prevent running out of degrees of freedom. The selection of the optimal number of lags ensures that the estimated results are not biased. The lag selection results are shown below.

Table 2.2: Optimal lag selection

variable	number of lags
Expectations of Exchange Rate Appreciation	8
Expectations of Exchange Rate Depreciation	1
Exchange Rate	1

*Source: Author compilation*

In Table 2.2, we use Akaike Information Criteria (AIC) to select the optimal lag length. The AIC shows that the optimal lags for the variable measuring expectations of the exchange rate appreciation is 8, while the optimal lag for expectations of the exchange rate depreciation is 1. Lastly, the optimal lag length of the variable measuring exchange rates is 1.

The following two tables show an estimate of the Markov Switch (MS) model. The dependent variable is the log of exchange rates, while dependent variables are the change in the component of expected depreciation (appreciation) and the expectation of exchange rate appreciation (depreciation). The variable measuring a change in the component of expected depreciation (appreciation) ensures that the model measures a complete variable. Moreover, the variable allows the model to capture asymmetric effects. Furthermore, the component measuring change in the component of exchange rate depreciation or appreciation is assumed to be constant within regimes. This component is associated with the private information of the informed trader (economic agent). The informed economic agent only alters his/her behaviour when (s)he observes change in the signal. The presence of new information available in the public domain affects his/her decisions. The other dependent variable is the

expectation of exchange rates, expectations of exchange rate depreciation, and expectations of exchange rate appreciation. In the following tables, the MS model consists of 3 regimes, where the exchange rate depreciates, remains stable and appreciates.

The following table shows the results of an MS model when the exchange rate is expected to appreciate.

Table 2.3: Markov Switch Model

dependent variable	Independent Variable	Coefficient
Log of exchange rate	Regime 1	
	Expectations of Exchange Rate	
	Appreciation	-0.295231
	Constant	-2.755729
	Regime 2	
	Expectations of Exchange Rate	
	Appreciation	0.075423
	Constant	-2.654992
	Regime 3	
	Expectations of Exchange Rate	
	Appreciation	0.035857
	Constant	-2.793621
non-switching variable		
	Change in the expected (Depreciation)	
	component	0.948462
	LOG(SIGMA)	-4.759260

letters A and D in the parenthesis, respectively means appreciation and depreciation. This

estimation assumed that the exchange rate is expected to appreciate.

*Source: Author compilation*

Table 2.3 estimates the exchange rate behaviour when expected to appreciate. The coefficients of expectations of exchange rate appreciation are different in all 3 regimes. This shows the asymmetric impact of expectations on the exchange rate given that in regime 1 the exchange rate is depreciating. The expected exchange rate appreciation reduces the probability of staying in regime 1. However, the exchange rate continues to depreciate. In regime 2, the exchange rate is more likely to switch to regime 3, when the exchange rate is expected to appreciate. The expectations of exchange rate appreciation have some impact, but not enough to change the position of the market to act in accordance with the information. These expectations are not changing the signal used by informed traders. Hence, there seems to be a sluggish movement towards acting on the information. The private information effects dominate the impact of expectations of exchange rate appreciation. In regime 2, the exchange rate is neither appreciating nor depreciating. The expectations of exchange rate appreciation are effective in inducing the exchange rate to appreciate. The private information and expectations are aligned when the exchange rate is stable. When the exchange rate is relatively more stable, it is more likely to appreciate if the expectation is pointing to an appreciation. While in regime 3, the exchange rate is already appreciating. An expectation of an appreciation is more likely to trap the exchange rate on the higher value.

The following table shows the results of the MS model when the expectations of exchange rates indicate that the exchange rate is likely to depreciate.

Table 2.4: Markov Switch Model

Dependent Variable	Independent Variable	Coefficient
Log of exchange rate	Regime 1	

Expectations of Exchange Rate (D)	-0.352500
Constant	-2.655232

Regime 2

Expectations of Exchange Rate (D)	-0.884629
Constant	-2.796375

Regime 3

Expectations of Exchange Rate (D)	0.054256
Constant	-2.757782

Non-switching variable

Change in the expected (A) component	0.621969
LOG(SIGMA)	-4.757610

letters A and D in the parenthesis, respectively means appreciation and depreciation. This estimation assumed that the exchange rate is expected to appreciate

*Source: Author compilation*

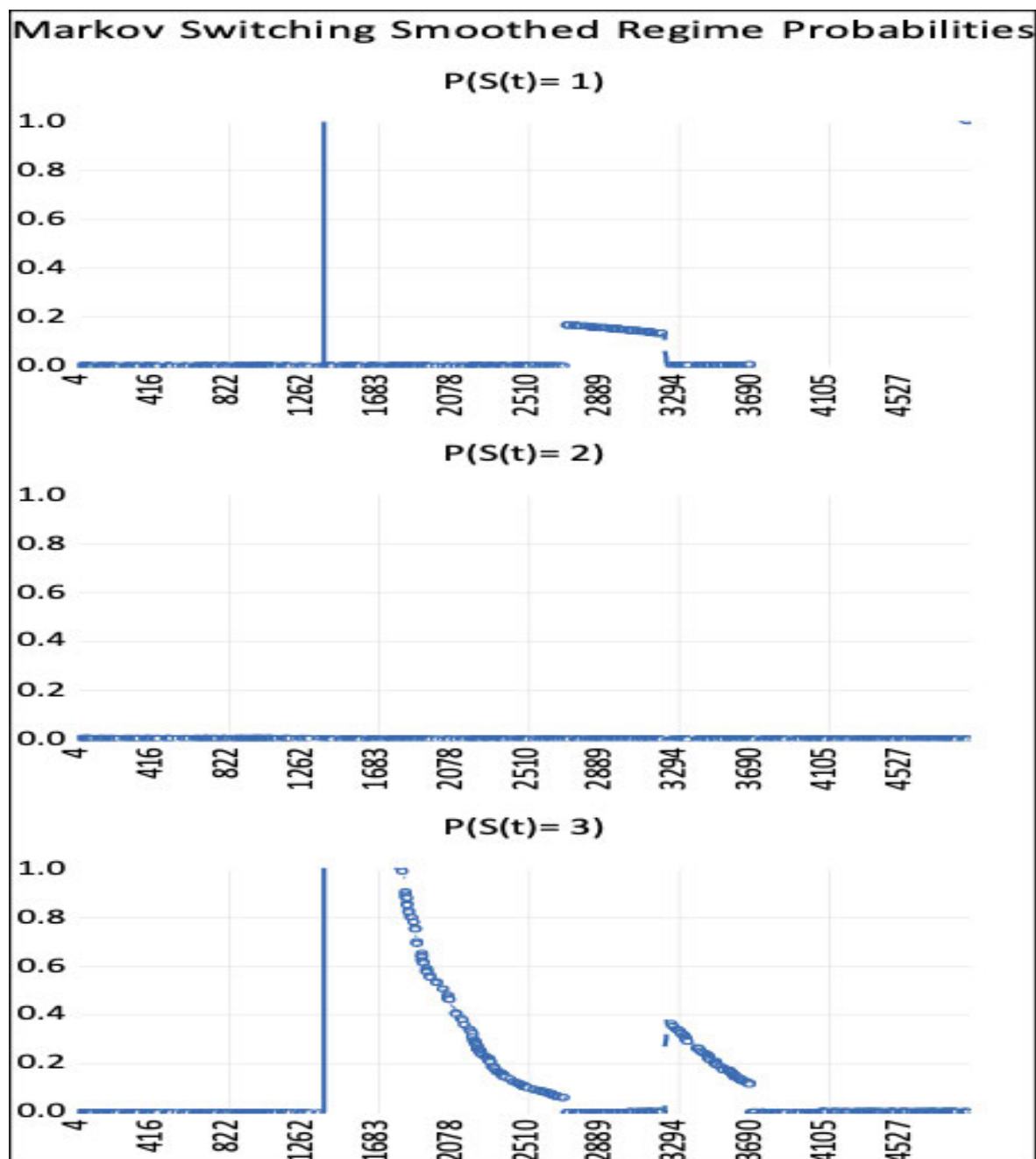
Table 2.4 shows results of the MS model for exchange rate behaviour when the exchange rate is expected to depreciate. The coefficients of the expectations of an exchange rate depreciation are different in all regimes. This is an indication for asymmetric exchange rate behaviour. The movement of the exchange rate depends on the type of the regime. In table 5, the exchange rate depreciates in all regimes. The exchange rate behaviour reveals that expectations of exchange rate depreciation have more effect on the exchange rate behaviour. This suggests that private information of economic agents is more likely to be aligned with expectations of exchange rate depreciation. Given regime 1, when the exchange rate is expected to depreciate, the probability of remaining in regime 1 decreases. Given the exchange rate is in regime 2, if it is expected that the exchange rate will depreciate in the next period, the probability of the exchange rate remaining in regime 2 in the future period decreases.



While, when it is given that the exchange rate is in regime 3 in the current period, the probability of the exchange rate being in regime 2 while the exchange rate is expected to depreciate increases.

The MS model is also estimated using a smooth regime transition combined with abrupt changes. The reason behind combining the two and showing them is because exchange rates also serve as asset prices. The exchange rate can either change suddenly, or return of asset may change as a result of a major economic crisis. While some economic news may be processed sluggishly by economic agents, this makes their impact reveal slower in the market. This effect would need to be examined because these changes would be gradual than abrupt. The horizontal axis of the following Figure measures time. The frequency of the data is in minutes. The horizontal axis is measured from left to right, and it is cumulative. The vertical axis measures probabilities, where  $P(S(t)=1)$ ,  $P(S(t)=2)$  and  $P(S(t)=3)$  respectively represents regime 1, regime 2 and regime 3.

Figure 2.5: Markov Switching Smoothed Regime Probabilities (exchange rate is expected to appreciate)



Source: Author compilation

In Figure 2.5, given regime 1, the exchange rate depreciates throughout the period. The new information relating to the exchange rate is processed instantaneously by the market. However, when the exchange rate remains in regime 1 for some time, new information tends to be digested slowly by the market. The longer the exchange rate depreciates given regime 1, expectations of appreciation of the exchange rate tend to be absorbed slowly, then a sudden abrupt shift follows. The exchange rate seems to push against the force of exchange rate appreciation. This seems to suggest that

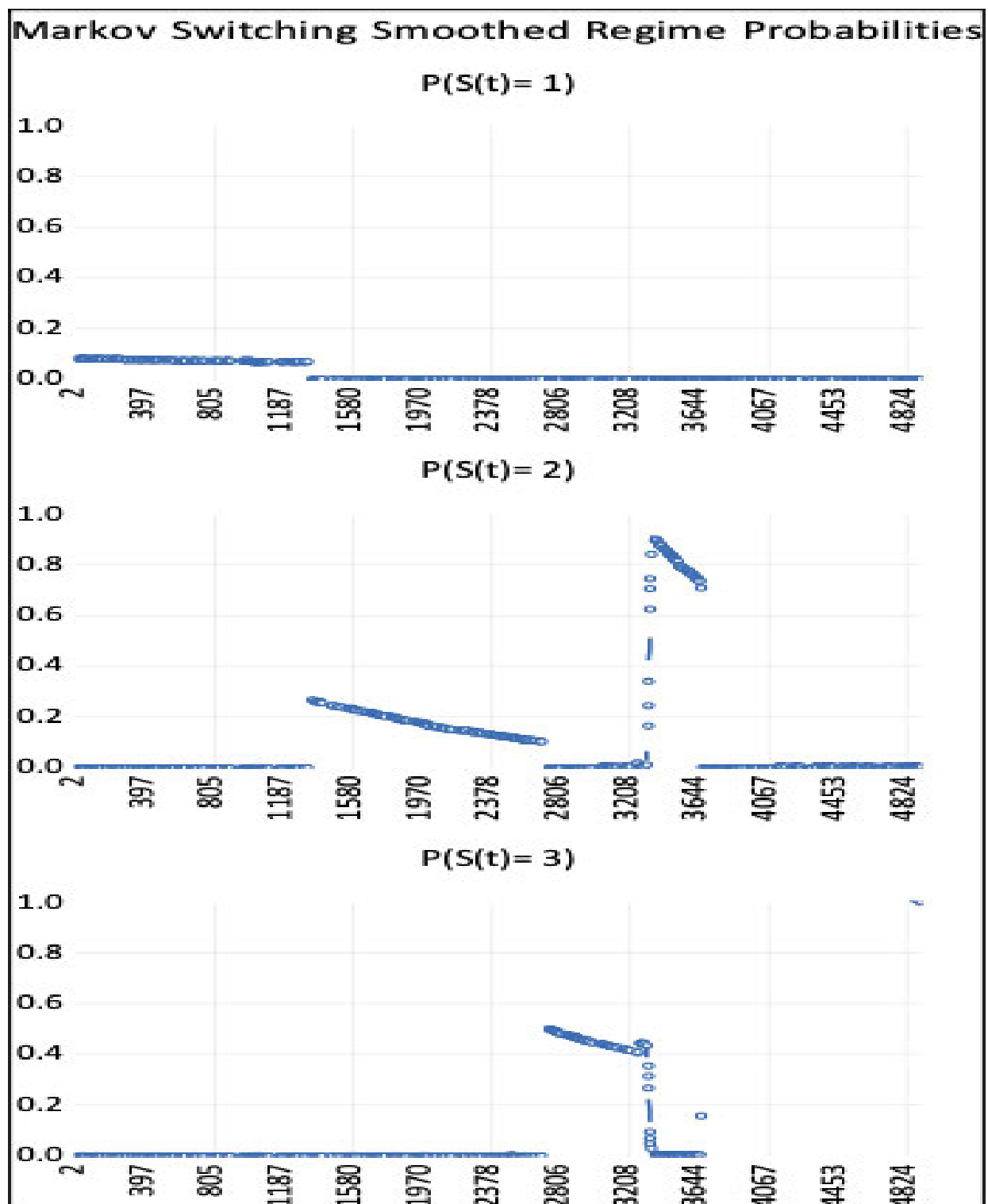
information emerging in the public domain does not have much of an impact on the exchange rate. The exchange rate is driven by private information.

In regime 2 the exchange rate remains stable throughout the period. This seems to suggest that economic agents are not likely to change or to be influenced by new information emerging. The expectation that the exchange rate will appreciate does not seem to impact the exchange rate. The probability that the exchange rate switches to another regime is 0, even though it is expected to appreciate. The exchange rate does not seem to be affected by expectations of an appreciation of the exchange rate.

In regime 3, the exchange rate adjusts gradually after a deviation caused by expectations of an appreciation of the exchange rate. Given the exchange rate is appreciating, the exchange rate gradually responds to information, which leads to an exchange rate appreciation.

The exchange rate behaves differently across the 3 regimes. This is a signal of a nonlinear relationship between the exchange rate and its expectations. Furthermore, the exchange rate impact is asymmetric, and its behaviour appears to be responding more to private information, compared to expectations. The smooth transition estimation results indicate that the market differs in how it processes information, given regime 3. The exchange rate in some instances shows abrupt changes. The longer the exchange rate remains in regime 3, the more it tends to process information relating to expectations gradually.

Figure 2.6: Markov Switching Smoothed Regime Probabilities (exchange rate is expected to depreciate)



Source: Author compilation

In Figure 2.6, given regime 1, the information of an expected exchange rate depreciation is absorbed instantaneously. The expectations of exchange rate

depreciation are consistent with regime 1. Hence, it does not appear that there is a force pushing against the expected exchange rate depreciation. This is an indication of private information being consistent with expectations of exchange rate depreciation. These results are not unexpected. In regime 1, the exchange rate depreciates. Accordingly, expectations of the exchange rate depreciation reinforce the current state. When the exchange rate is depreciating, while expected to depreciate in the next period, the transition of information is instant. In addition, private information of economic agents aligns with exchange rate expectations of a depreciation, when the exchange rate is already in the state of depreciation.

Given regime 2, the exchange rate adjustment to expectations of a depreciation is asymmetric. The same information relating to exchange rate depreciation is processed differently at different periods. Given regime 2, the market digests information of exchange rate expectations gradually. The rate of processing information on exchange rate depreciation differs throughout the period. The more the exchange rate remains stable when expectations of exchange rate depreciation emerge, the more the exchange rate tends to adjust rapidly. The expectations of a depreciation are incorporated instantaneously in the market, as the exchange rate remains stable for a longer period. Given regime 3 the exchange rate adjusts smoothly.

The exchange rate transition from regime to regime provides more insight on the probability of the exchange rate changing its state. The following table shows exchange rate transition probabilities for all three regimes. Transition probabilities permit viewing of regimes jointly instead of viewing probabilities of a state exclusively. This is important because there is some information about the current regime that could possibly have an impact on the future behaviour of the exchange rate.

Table 2.5: Markov Switch Model Transition Probabilities

	regime 1	regime 2	regime 3
regime 1	0.999036	0.000000	0.000964
regime 2	1.21E-11	0.999626	0.000374
regime 3	0.004646	0.001646	0.993708

The table shows transition probabilities from one regime to the next when the exchange rate is expected to appreciate. Regime 1, regime 2 and regime 3 represent a depreciation, stability and appreciation.

*Source: Author compilation*

In table 2.5, the probability of being in regime 1 in the next period, when it is already regime 1, is high and close to 1. This reveals that the exchange rate's tendency to depreciate is not likely to be changed by what is believed about the future. This is consistent with the theory. The information dominating the exchange rate behaviour is not the one available on the public domain. The actions of economic agents are driven by what their signals predict. The expected appreciation of the exchange rate does not have any effect on the exchange rate behaviour when it is already depreciating. Given regime 1, the probability of the exchange rate being in regime 2 next period is zero. The exchange rate is likely to respond to expected exchange rate appreciation and become more stable. The difference in probabilities shows an asymmetric exchange rate behaviour.

Given regime 2, the probability of being in regime 1 in the following period is 1.21E-11. The exchange rate is more likely to be depreciating next period, if it is stable in the current period. There is less force required to make the ZAR/USD depreciate, if it is relatively stable in the current period. These results are not aligned with the expected appreciation of the exchange rate. This means private information suggests something opposite to what is in the public domain. Given regime 2, the probability of the exchange rate being in regime 2 in the following period is 0.99. This means the exchange rate requires a stronger pressure to change its trajectory. The expected appreciation does not have effects on the exchange rate when it is stable. Given the

exchange rate is in regime 2, the probability of the exchange rate being in regime 3 is 0.000374. The exchange rate is more likely to remain stable than to be appreciating. The expected appreciation does not have much impact on the exchange rate behaviour. If the exchange rate has been stable, to shift it so that it appreciates requires a greater force. The probabilities are different across regime 1. This indicates asymmetric exchange rate behaviour.

Given the exchange rate is in regime 3, the probability of the exchange rate transitioning to regime 1 in the next period is 0.004646. The expected appreciation seems to have more effect on the exchange rate behaviour. Private information of economic agents aligns with expectations of the exchange rate if it is appreciating. While the exchange rate starting point is regime 3, the probability of being in regime 2 in the following period is 0.0001646. The expected appreciation leads to the exchange rate gaining value continuously. Given regime 3, the probability that the exchange rate will remain in regime 3 in the following period is 0.99. A stronger force would be required to prevent the exchange rate from appreciating. Table 6 shows transition probabilities for exchange rate regimes. In Table 6, the exchange rate is expected to depreciate.

Table 2.6: Markov Switch Model Transition Probabilities

	Regime 1	Regime 2	Regime 3
Regime 1	0.999728	0.000249	2.29E-05
Regime 2	0.000368	0.998550	0.001081
Regime 3	5.48E-08	0.000736	0.999264

The table shows transition probabilities from one regime to the next when the exchange rate is expected to depreciate. Regime 1, regime 2 and regime 3 represent a depreciation, stable and appreciation.

*Source: Author compilation*



Given that the exchange rate is in regime 1, the probability of remaining in regime 1 for the next period is 0.999728. The exchange rate is not likely to change from depreciating. The expected depreciation reinforces the exchange rate trajectory, if its starting point is regime 1. Once the exchange rate starts losing value, expectations of an exchange rate depreciation lead to continuous depreciation. Given regime 1, the probability of transitioning to regime 2 in the next period is 0.000249. The exchange rate behaviour is consistent with expected depreciation. The exchange rate behaviour is reinforced by the expected depreciation. Given the exchange rate is in regime 1, the probability of being in regime 3 in the next period is  $2.29\text{E-}05$ . The exchange rate continues to depreciate. This is consistent with expectations about the exchange rate. Once the Rand exchange rate starts losing value, with expectations of a further depreciation, it is not likely to change.

Given regime 2, the probability of the exchange rate transitioning to regime 1 is 0.000368. When the exchange rate starts from a position of stability, an expected depreciation is not likely to affect it. The exchange rate is influenced more by private information rather than expectations of an exchange rate depreciation. Given the exchange rate is in regime 2, the probability of being in regime 2 in the next period is 0.998550. The exchange rate is likely to remain stable regardless of the expected depreciation. Given regime 2, the probability of being in regime 3 in future is 0.001081. The exchange rate is more likely to remain stable, even though it is expected to depreciate. The starting regime is important for the behaviour of the exchange rate. The exchange rate tends to remain in the same trajectory regardless of the expected depreciation.

Given regime 3, the probability of being in regime 1 is  $5.48\text{E-}08$ . When the exchange rate is depreciating, an expected depreciation does not have any effect on the exchange rate behaviour. The force keeping the exchange rate in the state of appreciation is stronger than the pressure exerted by expectations. Given regime 3, the probability of transitioning to regime 2 in the following period is 0.000736. The exchange rate's tendency to keep appreciating when the starting point is regime 3 outweighs the pressure of expected depreciation. Given regime 3, the probability of being in regime 3 is close to 1. The exchange rate is not likely to depreciate if the

starting point is regime 3. This means the exchange rate responds more to private information, rather than expectations of a depreciation.

## **2.6 Discussion**

Lags are not necessary when estimating the MS model because it considers the current period and the likelihood of transitioning to another state next period. The estimated transition probabilities are different across regimes. This means that the exchange rate behaves differently across the regimes. This is evidence of asymmetric behaviour of the exchange rate. The impact of exchange rate expectations on exchange rate behaviour varies across regimes. The difference of impact of expectations within and across the regimes is evidence of asymmetric effect on the exchange rate behaviour.

The exchange rate behaviour shows that there are forces acting on it, even if it does not move in the expected direction. The asymmetric behaviour shows that there is a deliberate force acting on the exchange rate with an opposing pressure. The force opposing the exchange rate from moving in accordance with its expectations varies. This is revealed by the difference of probabilities for transitioning to another state.

The study finds that factors making the exchange rate transition from regime-to-regime are, in most instances, not expectations of either depreciation or appreciation. The theory suggests that private information has more effects on the exchange rate behaviour, compared to expectations of either a depreciation or an appreciation. Lyones (2001) remarks that expectations only influence the exchange rate when there is economic turmoil, including high inflation, recession or financial crisis. This might be the case in this study; expectations are only able to explain exchange rate behaviour during periods of large economic activities.

Since Meese and Rogoff (1983), it has been widely accepted that exchange rates follow a random walk. However, the results of this study reveal that the exchange rate does not behave randomly.

The exchange rate movement is aligned with its expectations in some instances. When the exchange rate is not responding to expectations, it is because the information determining its behaviour is not in the public domain. Hence, the modeled behaviour does not align with what is observed. The factors driving the exchange rate's behaviour depend on the state of the economy. When economic conditions are dire, it is easy to read an informed economic agent's signal. Therefore, the exchange rate behaviour aligns with expectations of an appreciation/depreciation. However, during stable economic conditions, attempting to read the informed economic agent's signal is not easy. Hence, wrong deductions about the informed economic agent signal are often obtained, which lead to modeling incorrect exchange rate behaviour.

The exchange rate is consistent with expectations of the exchange rate when the starting regime is either a depreciation or an appreciation. The probability of the exchange rate staying in the same state is high at these regimes, but different. This means expectations of exchange rates matter when current conditions are expected in the following period. Then when expectations of exchange rates do not match the current regime, the exchange rate deviates from the expected movement. However, there is a slight difference when the exchange rate is stable. It slightly adjusts to the expected direction. This gives an indication that the exchange rate is dependent on expectations, but other factors have an impact that may outweigh them at times. The information that results from the trade or transfer of exchange rates in the foreign exchange rate market may be leading to what we observe in the results.

## **2.7 Conclusion**

In this study, data is collected during the time when the major focus of economic news is on economic indicators, in anticipation of what monetary authorities may decide on the interest rate. This is in line with what Lyones (2001) favours when working with exchange rates. The timing of exchange rate data collection is important and is likely to give better analysis of the characteristics of the behaviour that cannot be easily observed. The fact is that we are not able to measure all factors that affect the exchange rate under normal economic environment. Early studies in fluctuation exchange rates indicate this phenomenon (Meese and Roggof, 1983, Frankel and

Rose 1995). In this study, the exchange rate is captured during a major economic event.

The exchange rate expectations appear to be scattered in one region, which shows a period of stability. Figure 2 shows a steady gradual extension of expectations of exchange rates at first. When it jumps to another region, it clutters within the same region. The behaviour of exchange rate expectations gives confidence on the market being stable. This means that we can relate the behaviour of the exchange rate to the expectations. To achieve this, we had to decompose exchange rate expectations. Both expectations of an exchange rate depreciation and appreciation are cluttered in a single region, which shows stability.

The exchange rate behaviour depends largely on private information. The mismatch between expectations of exchange rate movement and private information results in an unexpected behaviour of the exchange rate. Although it is not easy to know what is contained in an informed economic agent's private information that relates to the exchange rate behaviour, the information relating to an informed economic agent's signal is obtainable. This allows for the possibility of learning about the informed economic agent's signal and its implications on the exchange rate behaviour. The emphasis of Bacchetta and Ban Winscoop (2013) is also on the exchange rate being more responsive to unobserved factors than observed effects.

The expected appreciation/depreciation does not dominate exchange rate behaviour determination. Egerl (2014) is of a different view, as he argues in favour of expectations being at the center of exchange rate behaviour. This study findings show that exchange rate expectations are more dominant when they are in line with a present trajectory (appreciation/depreciation) of the exchange rate. This study also differs with Maserumele and Alagidede (2017), who found that new information changes the direction of the exchange rate. The study shows that publicly available information does not affect exchange rate behaviour. The factors that lead to formation of exchange rate expectations are largely wrong in instances where they are not consistent with the current exchange rate behaviour. There is a slight response of the exchange rate behaviour to an expected appreciation only when the exchange rate is stable, while the exchange rate deviates from an expected depreciation.

The recommendation is that if the government seeks to improve the value of the Rand, it would be easy to achieve this when the exchange rate shows some improvement in value. The exchange rate tends to appreciate more if, while it is in the trajectory, expectations of an appreciation emerge. The government will have to create conditions indicating that the exchange rate is expected to appreciate in the future.

## **CHAPTER THREE: THE MOVEMENT OF EXCHANGE RATE AND EXPECTED INCOME**

### **3.1 Introduction**

One of the main drivers of exchange rates is expectations, which are determined differently in the developing and emerging economies (Kaltenbrunner, 2015). Barbosa et al (2018) observed that in developing countries, exchange rates are not driven by expectations that are linked to macroeconomic fundamentals only; and that the exchange rates also depend on institutional characteristics linked to international liquidity, which in turn are driven by expectations. In the short-run, expectations about capital flows assume an autonomous function of determining exchange rates (Harvey, 1991). Accordingly, exchange rates largely depend on lenders and foreign investors' portfolio decisions, which are driven by expectations (Andrade and Prates, 2013).

Akiba (2004) maintains that exchange rate behaviour depends on the combination of expectations formed in the short-run and the medium term. However, expectations cannot be observed, which means that knowledge about expectations is incomplete (Juselius, 2017). It has been extensively demonstrated in the literature that economic agents form expectations rationally (De Grauwe and Grimaldi 2018). This is consistent with the rational expectations hypothesis, which assumes that economic agents use available information efficiently to construct expectations. This is in accordance with Muth (1961), who argues that expectations depend on the current state of the economy.

In South Africa (SA) the authorities have undertaken reforms to promote economic growth. Among these reforms are economic and political changes that constitute implications for the expected level of future income. The reforms allowed the economy to be free to engage in international trade with various markets. The economic reform offered an opportunity to international investors to do business in SA. These reforms meant the economy could potentially experience higher levels of productivity and, hence, income. Reforming the economy also meant that the government could give investors mining rights and mineral resource exploration rights. The reform aimed to

reduce uncertainty about investing in SA. The reforms involved trade agreements with other countries and trading blocs.

Hayat and Tang (2013) demonstrated that signing production agreements, economic cooperation deals, and being a member of economic blocs, fuels expectations of future income. In addition, it leads to a significant appreciation of the real exchange rate. Fluckiger and Ludwig (2018) argue that economies who are members of the trade bloc tend to seek economic prosperity from exporting, which can be expected to lead to the domestic exchange rate appreciation. Moreover, economies can expect to have higher levels of income in future because of signed export agreement.

Since 1994, the South African government has taken part in numerous trade agreements to promote SA's economic interest, which include: the European Union-South Africa Trade and Development Cooperation Agreement (EUSATDCA), Europe Free Trade Association (EFTD), Southern African Customs Union (SACU) and Southern African Development Community (SADC). In some trade agreements, SA enters automatically because of its regional bloc membership. By virtue of being a member of SADC, it affords SA an opportunity to participate in regional trade.

The SADC has agreements with the European Union (EU), India, China, and United States of America (USA), which are economies with large demand for raw materials (EC, 2018, USGS, 2018). The trade agreements include exchange of raw materials, some of which these economies define as rare earth elements (REE) (Andersson, 2020). The REE are of high national interest to these economies because they are essential for the development of their industries or nations security (Mancheri, 2015, EC, 2018, USGS, 2018). Hence, they are part of trade agreements with SADC and other mineral exporting countries in other parts of the world.

In addition, SA has bilateral trade agreements with these countries and others. Some of the raw material found in SA are considered rare by EU, China, and USA, as indicated, hence, are required for survival of some of their manufacturing industries (Andersson, 2020, Jin et al., 2020, Moore et al., 2020). These economies have big manufacturing sectors that require the supply of raw materials from the rest of the

world. In their respective economies, domestic supply of raw material is not able to meet manufacturing demand, which drives them to secure supply elsewhere (Andersson, 2020). This places SA in an advantageous position in terms of supplying raw materials to their manufacturing industries. SA has, for a protracted period, remained the largest economy in Africa with an advanced infrastructure. This advantageous position afforded attracting business from rapidly growing countries that require raw materials.

India and China have been among the fastest growing economies in the world, who are SA's trade partners, with growth rates above 6% a year (Dixit and Ghosh, 2013, Wang, 2019, Hubacek et al., 2007). A substantial amount of their growth is derived from manufacturing, which means more raw materials are required to sustain their economic growth (Ericsson, 2011, Andersson, 2020). However, domestic supply cannot meet the demand requirements to maintain the high level of economic growth. Therefore, to maintain production, they require additional supply.

The literature also acknowledges that China's development and growth of its manufacturing sector requires foreign supply of raw materials (Jones et al., 2020). Furthermore, the demand for raw materials is expected to double by 2030, not only in China but in EU, India, Brazil, and USA. All these economies are SA trading partners, with whom it has trade agreements at various levels of economic cooperation, either bilaterally, SADC, or through the African Continental Free Trade Area (AfCTA).

The United States of America and European Union have been criticizing China for its mining investments in Africa (Machecek, 2017). However, China's demand for raw materials is significant for SA's economic interest. This is true because SA is the biggest trading partners of China in Africa (Monyamane and Adney, 2020). China's increasing demand for raw materials, which are available in SA, could result in a mutual beneficial arrangement between the two countries. This could result into higher future income which is argued to have an impact on the exchange rates behaviour.

There is large demand for cobalt, chromium, and Petroleum Group Metals (PGM), which are used in the production of batteries for laptops, cellphones, and electric



vehicles (EV). These raw materials are concentrated in SA, Zambia, and Democratic Republic of Congo (Ericsson, 2011). The demand for these products is increasing throughout the globe. Which is argued to have an impact on the level of future income, therefore, the behaviour of the domestic exchange rates.

The world is moving toward reducing carbon emissions, which is expected to result in an increased production of EV in the future. Hence, the demand for raw materials which are available in SA is expected to increase. According to Hayat and Tang (2013) the demand for these products should lead to higher future income and hence, the domestic exchange rates should appreciate. Since China, EU, and USA are among the largest countries manufacturing these products, and they need additional supply of the raw materials, to sustain or increase production. All these countries are SA trading partners. Accordingly, higher demand for some of these raw materials will involve SA if its trading partners are involved. The income in the future can be expected to be higher.

The Chinese Ministry of land and natural resources acknowledges domestic supply of some raw materials is not enough to meet manufacturing demand (Ericsson, 2011, Plumer, 2014, Mancheri et al., 2019). Hence, China is investing in mining and other business opportunities exploration in other countries (Park et al., 2010, Mancheri et al., 2019, Raman, 2013). This is similar to what USA and EU businesses are doing in foreign countries, to ensure that they have enough stock of raw materials to support their manufacturing demand (McLellan et al., 2013).

After the BRICS summit, the SA minister of Trade and industry stated that China's requirements are aligned with SA economic interests (Patel, 2019). He further cited the comprehensive Strategic Partnership Agreement between SA and China, stating that it is a gesture of deep economic ties. These developments created expectations for future higher income, which Hayat et al. (2013) argue that it should lead to exchange rate appreciation. However, the exchange rate (SA Rand. ZAR and the United States of America, USD) has a long continuous depreciation swing. This is concerning because it suggests that the relationship between the exchange rates and expected higher income is different for ZAR/USD or is not understood. The challenge

facing the literature and policy making is that it has not yet been established if the relationship is different in South Africa. If the characteristics of the relationship are not understood, it could lead to implementation of wrong policies, and hence unintended consequences.

Achieving stable exchange rate fluctuations has been part of the SA macroeconomic objectives since the 1960s (Mtonga, 2011). The SA macroeconomic policies, the ASGISA, and NDP cite the exchange rate stability as the necessary precondition for achieving macroeconomic goals. The exchange rate behaviour is an integral part of the macroeconomic policy in SA. The literature on exchange rates has mostly focused on commodity prices and exchange rate volatility effects (Bahmani-Oskooee and Gelan, 2018, Balcilar et al., 2019, Kabundi and Mbelu, 2018, Jooste and Jhaveri, 2014, Miyajima 2020, Liu et al., 2020, Salisu and Gupta, 2022, Shiferaw, 2019, Belasen and Demirel, 2019, Salisu et al., 2021, Tiwari et al., 2018, Usman and Musa, 2018, Balcilar 2019).

However, Frankel (2007) looked at the determinants of exchange rates, which included expectations of inflations. The issue with what we've learned from Frankel (2007) is that it does not address the concerns between exchange rates and expectations of higher income. In addition, the results are based on limited data and a linear estimation of the exchange rates relationship, while Cheung et al. (2005) states that it is impossible to explain exchange rates behaviour without including a non-linear model.

This study is different because it examines the effects of expectations of future income on the exchange rate behaviour. It assumes the exchange rate is impacted asymmetrically by its fundamentals. Furthermore, the study uses a non-linear model to estimate the exchange rate behaviour. The data used in this study is detailed enough to provide unbiased results. The findings of this study are useful because they can be applied to other emerging economics with similar market characteristics as SA.

In addition, this study will fill the gap in the literature regarding an emerging economy's exchange rates response to expectations of future higher income. The South African

Reserve Bank (SARB), which is the authority of monetary policy in SA and other stakeholders, are interested in knowing what the key factors that drive the SA exchange rate are. Furthermore, how exchange rates drivers can be managed effectively to achieve sustainable economic growth for SA. This study provides direction to these concerns.

### **3.2 Empirical Facts about the exchange rates movement**

Whelan (2015) explains that prior to the collapse of the Bretton Woods System, many economists thought that exchange rates would be stable if countries adopted flexible exchange rates (Dunn,1970; Lanyi,1969; Stoll, 1968, Britton 1970). However, empirical evidence demonstrated volatile and unpredictable behaviour of floating exchange rates. Meese and Rogoff (1983) showed that there is no link between the exchange rates and its fundamentals. Further to that, Pfahler (2021) proved that random walk models performed better than any other model in predicting the behaviour of exchange rates. While Chang and Matsuki (2022) using recent data challenges this proposition, they state that the Taylor rule model of monetary policy outperformed random walk models.

Xie and Chen (2019) do not believe that monetary models of exchange rate determination are able to provide useful insight. Earlier Tawadros (2017) had found that the exchange rate behaviour is explained better by using monetary models. The accuracy of determining the behaviour of exchange rates has varied overtime when using the random walk (Ribeiro, 2017). The link between the exchange rate and its fundamentals remains challenging, hence, the debate is yet to be settled. Moosa and Burns (2014) confirm that the random walk performs better compared to any other model, but the success has only been determining the direction of exchange rates. The point noted by Cheung et al. (2005), and Rossi (2013), is that there is no consensus among economists about the exchange rate behaviour in response to its fundamentals.

Voss and Willard (2009) attributed reasons for the dismal results to overlooking asymmetric effects on monetary models. There are many other reasons provided in the literature for poor performance of various models (Meese, 1990; Bacchetta and

Wincoop, 2006; Evens and Lyons, 2004, Eichenbaum et al., 2018, and Kohlscheen, 2016). However, the literature indicates that there is a link between monetary variables and exchange rates (Baharumshah et al., 2017). Engel and West (2005) were not able to find evidence that the exchange rate and its fundamentals are correlated. Rossi (2013) mentions that the literature indicates that out-of-sample estimations perform better compared to traditional fundamentals. However, Beckmann et al. (2011) confirm that some macro fundamentals show exchange rates predictability in the short run. The dismal performance for macro fundamentals in predicting exchange rates has been discussed by many researchers (such as Engel and West, 2005; Molodtsova and Papell, 2009; Taylor and Peel, 2000; Ghosh et al. 2016; Ahmed et al. 2017; and Amat, et al. 2018).

Beckmann et al. (2011) declare that fundamentals are central in determining exchange rates, although their effects are significantly different in each period. However, the literature indicates that studies are not able to link floating exchange rates to their theoretical determinants (Itskhoki and Mukhin, 2021). This forms the basis of fundamental uncertainty, according to the Post Keynesian framework. While modelling the behaviour of exchange rates differs, Harvey (2003) argues that expectations of exchange rates are central in determining the exchange rates both in the short-run and the long-run. The expectations of the exchange rates are formed differently in various countries. This point is supported by Lavioe and Daiggle (2011), who argue that while there might be capital mobility, there are domestic conditions which impact on the free flow of capital. Furthermore, domestic limitations of free flow of capital are associated with each home country's regulations of the capital market.

It is common in the literature to use uncovered interest parity hypothesis to formulate expectations of exchange rates (Ismailov and Rossi, 2018; Engel, 2016), but it is contended that uncovered interest parity depends on arbitrary assumptions (Taylor, 2003). The failure to model the behaviour of exchange rates implies that models used in the area of macroeconomic research are invalid or are largely incomplete. Furthermore, this erodes the policy suitability of these models and creates uncertainty about the impact of the fundamentals.

The literature recognizes the importance of examining the components related to higher future income, however, giving a considerable attention to the relationship between exchange rate behaviour and stock of prices of oil. Mensi et al. (2017) evaluated asset prices and established that available fundamental information is a driver for a prevailing price of assets. Ngoma (2022) states that real exchange rates respond asymmetrically to an oil shock. Moreover, the shock triggering an increase in the oil price tends to be followed by a rapid exchange rate appreciation. The literature points out that the export of manufactured goods and natural resources affect the exchange rate behaviour (McLeod and Mileva, 2011). These observations are confirmed by Bekun et al. (2019), who found that the Rand exchange rate depends on natural resources.

Deveruex and Yu (2019) reveal that the exchange rate has a time changing relationship with its fundamentals. While Engel et al. (2007) argue that current economic information about exchange rate fundamentals has little weight in determining exchange rates, the expectation about the fundamentals weighs more. This is supported by Beckmann and Czudaj (2017), who emphasize that the exchange rate responds to its expectations. Furthermore, the exchange rate behaviour reflects available information. This is different from what the random walk predicts, which is that the exchange rate should not be affected by expectations of future income (Chakrabarti and Scholnick, 2002). Expectations of lower future output increase expectations of a lower interest rate in the future. So, if the exchange rate appreciates today, the likelihood of it depreciating in the future increases (Taylor, 2001).

### **3.3 Methodology**

#### **3.3.1 Economic Theory**

The model is informed by the monetarist economic framework for supply and demand of countries' currencies. It emphasizes that the exchange rate determination is dependent on asset prices that respond to expectations. The expectations are particularly influenced by monetary policy, and they reflect available information about currencies. Thus, the exchange rate changes in response to new information and the prevailing situation. The monetarist framework consists of six components. The quantity theory of money (QTM) is given by the formula: Where M is the nominal

money,  $V$  is the number of times by which money changes hands (velocity of money),  $P$  denotes the price level and  $Y$  in the level of income

$$MV = PY \quad (1)$$

Equation (1) can be rewritten as. Let  $\frac{1}{V}$  be the proportion of annual income held as money. Now the QTM states that the general price level places pressure on nominal money supply to bring about equilibrium on real money balances and nominal money balances.

$$\frac{M}{P} = \frac{1}{V}Y \quad (2)$$

Secondly, the Purchasing Power Parity (PPP) is constructed using the law of one price. The law states that when the price of good  $i$  is converted into the same currency in either country, the price of good  $i$  is the same in both countries.

$$P_i = EP_i^* \quad (3)$$

where  $P_i$  is the domestic price of good  $i$ ,  $P_i^*$  denotes foreign price of good  $i$ , and  $E$  is the exchange rate.

The theory of interest rate parity (IRP) assumes that the profits on the assets are independent of the value of currency of any country and are equal. Third, the fisher relationship maintains that the nominal interest rate is a function of an expected fall of the purchasing power of currency and nominal interest rates. Considering both the PPP and Irvin Fisher's relationship, it can be inferred that nominal interest rate differentials carry information that can be used to predict future inflation rate.

The public's belief about the likely future direction of monetary policy is a driving component in the formulation of inflation expectations in a monetarist framework. The fourth component is concerned with efficient market hypothesis, which maintains that the asset market information is fully and correctly reflected on the asset prices. In addition, the foreign exchange rate contains all available information. Moreover, the exchange rate moves immediately to accommodate new information. Following Humphrey (1977), inflation rate in the home country and in the foreign country, is the function of the ratio of money supply and money demand.

$$\pi_1 = \frac{M_s}{M_d}; \text{ and } \pi_2^* = \frac{M_s^*}{M_d^*} \quad (4)$$

here  $\pi_1$  denotes price level in the home country, while  $\pi_2^*$  is price level in the foreign country.  $M_s$  denotes domestic nominal money supply, whereas  $M_s^*$  is foreign nominal money supply. The letter  $M_d$  is the domestic money demand and  $M_d^*$  represents the foreign demand for money. Rearranging the equation (4), shows that the price level brings nominal money balances and real money balances to equilibrium. This implies that the price level adjusts instantaneously to bring nominal money stock into equilibrium with the real demand for money;

$$M_d = \frac{M_s}{\pi_1} \quad (5)$$

Assuming that money demand is given by income and interest rate. Therefore, we show description for money demand as;

$$M_d = Y i^{-z} \quad \text{and} \quad M_d^* = Y^* i^{*-z} \quad (6)$$

here domestic output is denoted by  $Y$ , whereas  $Y^*$  represents foreign income,  $i$  is nominal interest rate in the domestic economy and  $i^*$  denotes foreign nominal interest rate. Then  $z$  is the interest elasticity of demand for money. Furthermore, it appears as the exponent for interest rates. The parameter  $z$ , captures the sensitivity of the money demand to interest rate dynamics. Moreover, it shows that nominal interest rates are inversely related to real balances. Hence, the negative sign and the size of the coefficient is assumed to be similar in either country. Equation (6) is the money demand function which is the products of output and nominal interest rate.

The domestic and foreign prices are connected to each other through the exchange rate, then assuming PPP holds, it ensures that currencies of both countries are expressed in the same currency unit.

$$\pi_1 = e \pi_2^* \quad (7)$$

where  $e$  is the exchange rate, and equation (7) is the PPP. The domestic exchange rate is the ratio of the prices of domestic goods to the prices of foreign goods.

$$e = \frac{\pi_1}{\pi_2^*} \quad (8)$$

The nominal interest rate is a function of expected price level and real interest rate. The nominal interest rate is defined as;

$$i = r + \varphi \quad \text{and} \quad i^* = r^* + \varphi^* \quad (9)$$

where expectations of inflation are denoted by  $\varphi$ , and the domestic real interest rate is same as the foreign real interest rate. This assumption allows for yield on assets to be the same everywhere in the world. The following equation show the interest rate parity.

$$r = r^* = r_w \quad (10)$$

Equation (10) is the condition for interest rate parity (IRP) which ensures that the yield is independent of the specific currencies. Assume there is international capital mobility. Equation (9) shows how the interest rates are determined which enables international capital mobility. The following step is to show how the inflation expectations are formed using the money demand function. While the nominal interest rate is the money demand function it is also central in determining the exchange rate. Inflation expectations are based on perception about the future growth of money supply. So, expectations of inflation are given by;

$$\varphi = \varphi(M_s^e) \quad \text{and} \quad \varphi^* = \varphi^*(M_s^{e*}) \quad (11)$$

where expected money growth is represented by  $M_s^e$ . The public is assumed to formulate expectations about money growth rationally. All relevant and new information available in the public domain is incorporated in expectations. The information considered includes, among others, political information, data on previous



events, policy announcements, and previous actions of policymakers when the economy changes. Then, the expected money supply can be expressed as;

$$M_S^e = M_S^e(M_S, \vartheta) \text{ and } M_S^{e*} = M_S^{e*}(M_S^{e*}, \vartheta^*) \quad (12)$$

where domestic information is denoted by  $\vartheta$  and foreign information  $\vartheta^*$ . Equation (12) shows that expected money growth is a function of money supply and other information. Equation (12) depicts that almost all components that affect money growth are covered.

Following Hayat et al. (2013) we assume a small economy consisting of a large number of identical households. Further, let's assume the size of households in this economy does not change overtime. In addition, households are normalized to 1. The economy has a large number of mineral reserves. However, the precise amount of mineral reserves is not easily determinable. Furthermore, the government does not have the technology to extract or quantify the number of minerals underground. Therefore, the extraction and quantification of the quantity of minerals remaining underground can only be supplied by foreign firms. Assume that households are informed about the terms of the mining deal. The information is available to the public through web publications of the Ministry of the Trade, Industry and Competition and Mineral Resources and Energy Ministry. Furthermore, SA has the mining charter, which details the types of resources mined and the manner in which the mining communities and labour benefit.

The deal between the government and the foreign firms provides for the quantity to be mined and the share government collects from profits. The South African mining charter contains these details, although, it is not easy for households or government to predict the exact amount of income to be derived in future from the deposits. This is due to uncertainties about domestic production, world price of minerals, and the uncertainty about the quantity of minerals remaining underground. Instead, households use the available information (Trade agreements) about their future minerals income to form expectations. The households use the information such as

the amount of minerals to be mined and the share collected by the government of profits (The government's Budget Speech).

The more minerals are extracted, the more income the households expect to receive in the future. This means that if a new technology which enhances production, or new deposit, is discovered, the expected future income increases. The information about new discoveries is managed by the department of mineral resources and energy. The department of mineral resources and energy has the sole authority to issue mining licences.

Following Van der Ploeg (2011), assume households consume tradable goods that are non-minerals,  $C_t^T$ , imported from the rest of the world, and tradable good  $C_t^N$ . Households' supply of labour is inelastic to domestic firms producing non-tradable goods. Assume the tradable good is dominated in the domestic currency. The price of the tradable good is exogenous, and it is determined by international demand  $C_{wt}$ , which is

$$P_T = g(C_{wt},) \quad (13)$$

while domestic demand for the non-tradable good determines the price  $P_N$ , which is defined by

$$P_N = f(C_t) \quad (14)$$

Households maximize their utility by consuming both tradable and non-tradable goods. Following Cashin et al. (2004), each household's optimal level of consumption is given by

$$C_t = C_t^N + C_t^T \quad (15)$$

$C_t$ , is equal to the sum of income from minerals,  $W_t$  and labour income  $H_t$ .

$$C_t = k_t(W_t + H_t) \quad (16)$$

here  $k_t$  captures preferences, other factors, and income, where as  $W_t$  and  $H_t$  includes current and expected present values of future income.

$$W_t + H_t = E_t \left[ \sum_{i=t}^{\bar{T}} \frac{Y_i^W + Y_i^H}{(1+R)^{i-t}} \right] \quad (17)$$

here  $\bar{T}$  is the life expectancy and  $R$  denotes the interest rate, while  $Y_i^H$  and  $Y_i^W$  both denote current income. We can define  $Y_i^H$  and  $Y_i^W$  as,

$$Y_{i+1}^H = \beta_H(Z_{i+1}^H, Y_i^H, \mu_i^H) \quad (18)$$

and

$$Y_{i+1}^W = \beta_W(Z_{i+1}^W, Y_i^W, \mu_i^W) \quad (19)$$

where  $Z_{i+1}^W$  denotes foreign firms' productivity,  $Z_{i+1}^H$  is Foreign Direct Investment (FDI) and  $\mu_i^W(\mu_i^H)$  represents the shocks to income such as a mineral resource boom or a strengthening of economic ties between two trading countries.

The real exchange rate ( $e_t$ ) is the ratio of prices of non-tradable good  $P_N$ , to tradable good  $P_T$ . Therefore, real exchange rate can be expressed as a function of the expected future income and international demand,

$$e_t = \frac{P_N}{P_T} \quad (20)$$

$$e_t = R \left( E_t \left[ \sum_{i=t}^{\bar{T}} \frac{Y_i^W + Y_i^H}{(1+R)^{i-t}} \right], C_{wt} \right) \quad (21)$$

Equation (21) shows that the exchange rate depends on current and expected future mineral and labour income,  $E_t(\cdot)$ , and demand of imported tradable goods. It is important to note that  $E_t(\cdot)$  depends on FDI, government expenditure, productivity, or trade agreements.

### 3.4 Estimation

A Bayesian Vector Autoregressive (BVAR) estimating technique is applied on this theoretical framework. The BVAR is chosen because its results are produced by sampling from the posterior distribution of variables. The Bayesian estimation framework allows for the reduction of the variance of unrestricted least squares estimators. Furthermore, it allows inclusions of various information about VAR model parameters which are impossible at times to facilitate when using the frequentist analysis.

The frequentist analysis techniques rely on the existence of a parameter vector describing the data collected, which is obtained from the sample. Then inferences are made on the basis of the value of the parameter. These common methods of analyzing data assume parameters are non-stochastic, irrespective of them being stochastic in nature. This is where the Bayesian analysis differs from the common frequentist estimation technics.

In the Bayesian framework, the vector parameter is assumed to take a stochastic nature. The Bayesian analysis allows modeling perceptions about the parameter. The perceptions are weighed in probabilities distributions. There is no repeated sampling required, and the nature of data is not important for drawing inferences on the parameter. The observed data determines the inference in the Bayesian framework. The data is taken as given, while the parameter of interest is treated as unknown. This

holds because the prior information on the variable of interest given is in a density form. Let's consider a VAR model

$$y_t = \sum_{s=1}^k y_{t-s} \beta_s + z_t \vartheta + \varepsilon_t \quad (22)$$

here  $\beta_s$  and  $\vartheta$  are vector parameters of  $n \times n$  and  $j \times n$  dimensions respectively. The posterior probability distribution function (pdf) is the quadratic loss function  $y_{t+b}$ , conditional on the observed data  $y_t, y_{t-1}$  and the independent variables  $z_{t+b}$ . Equation (22) is a partial system such that  $z_t$  may contain a deterministic time trend. The first difference of (22)  $y_t^* = y_{t-1}^* \beta + z_t Q + \varepsilon_t^*$ , where  $y_t^* = \{y_t, \dots, y_{t-k+1}\}$ ,  $Q = \{\vartheta, 0, \dots, \}$ ,  $\varepsilon_t^* = \{\varepsilon_t, 0, \dots, \}$  and

$$\beta = \begin{pmatrix} \beta_1 & I & 0 & \dots & 0 \\ \beta_2 & 0 & I & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & I \\ \beta_k & \dots & 0 & \dots & 0 \end{pmatrix} \quad (23)$$

To examine how the results are generated, consider the following

$$y_t(h) = \int F(\beta, Q, y_t^*, Z, h) v(\varnothing|y) d\varnothing \quad (24)$$

where  $v(\varnothing|y) d\varnothing$  is the marginal posterior which is established from estimated parameters  $\beta$  and  $Q$ , and where  $F(\cdot)$  denotes the function of the forecast. We take the VAR system and express the posterior distribution with a Bayesian framework as show in the following equation.

$$F(\beta, Q, y_t^*, Z, h) = y_t^* \beta^h + \sum_{s=1}^{h-1} z_{t+h-s} Q \beta^s \quad (25)$$

The stochastic variables in the future are assumed to be independent of  $\varepsilon_t$ ,  $E(\varepsilon_{t+s} | z_{t+s}) = 0, s, w > 0$ . This allows the posterior to be conditional to the observed situation. Equation (25) is a VAR linear function of parameters. However, the model becomes none-linear when the density distributions are estimated for a longer period.

We use the Minnesota Prior, which is characterized by a variance covariance matrix that is diagonal and fixed. Let us consider the prior for an  $i$ th period

$$\delta_i = N\left(\bar{\delta}_i, \bar{\Sigma}_i\right) \quad (26)$$

Applying Bayesian framework, the posterior pdf is described by

$$\delta_i/y = N\left(\bar{\delta}_i, \bar{\Sigma}_i\right) \quad (27)$$

where

$$\bar{\Sigma}_i = \left( \sum_i^{-1} + \tau_{ii} U'U \right)^{-1} \quad (28)$$

Through rearranging:

$$\bar{\delta}_i = \bar{\Sigma}_i \left( \sum_i^{-1} \tilde{\delta}_i + \tau_{ii}^{-1} U' y_i \right) \quad (29)$$

The fixed diagonal components  $\tau_{ii}$  are found in the Data Generation Process (DGP), since the covariance matrix of the residual is assumed to be diagonal. This is similar to stating the belief that the single element follows random walk behaviour . The Menesota prior assumes that the information contained in the most recent lags consists of more relevant and reliable information. When the number of lags keeps increasing the coefficient matrix of  $\beta_s$  in equation (25), the posterior distribution converges and approach zero. The covariance matrix works to reduce the number of parameters to be estimated. A belief about each coefficient decay over its own lags is given by  $\beta_s/k$ . The parameter  $k$  denotes the number of lags, and it uses another variable  $\phi$  to determine lags containing coefficients with relevant information (relative importance of its own lags).

$$Var[\beta_s] = \frac{\beta^2}{k} \begin{pmatrix} 1 & \phi\sigma_2^2/\sigma_1^2 & \dots\phi\sigma_1^2/\sigma_n^2 \\ \phi\sigma_2^2/\sigma_1^2 & 1 & \dots\phi\sigma_2^2/\sigma_n^2 \\ \vdots & \vdots & \ddots & \vdots \\ \phi\sigma_n^2/\sigma_1^2 & \phi\sigma_n^2/\sigma_1^2 & \dots & 1 \end{pmatrix} \quad (30)$$

In this study, we also test the long-run relationship between expectations of income and the exchange rate behaviour . This is conducted using the Johansen Cointegration test. So, we first determine if all the variables are integrated of order 1 or not.

### 3.4.1 Unit Root Test

#### 3.4.1.1 Augmented Dicky Fuller (ADF) Test

The ADF test is derived from the Dickey and Fuller test because it assumes there is a chance for the error term not to be random. The ADF is extended through adding more lags to remove serial correlation. The following model is considered

$$A_t = \rho_1 + \rho_2 A_t + \gamma_t \quad (31)$$

$$A_t = \rho_1 + \rho_2 A_t + \rho_3 A_{t-1} + \gamma_t \quad (32)$$

$$A_t = \rho_1 + \rho_2 A_t + \rho_3 A_{t-1} + \rho_4 A_{t-2} + \gamma_t \quad (33)$$

where  $A$  represents the variable obtained from the data,  $s$  denotes time and  $\gamma$  is the white noise innovation, where  $\gamma_s \sim N(0, \sigma^2)$ . The following step is to difference equation (33)

$$\Delta A_t = \omega A_{t-1} + \rho_1 \Delta A_{t-1} + \gamma_t \quad (34)$$

$$\Delta A_t = \omega A_{t-1} + \rho_1 \Delta A_{t-1} + \rho_2 \Delta A_{t-2} + \dots + \rho_s \Delta A_{t-s} + \gamma_t \quad (35)$$

this process occurs until serial correlation is eliminated.

$$\Delta A_t = \omega A_{t-1} + \sum_{j=1}^s \rho_j \Delta A_{t-j} + \gamma_t \quad (36)$$

$$\Delta A_t = \vartheta + \omega A_{t-1} + \sum_{j=1}^s \rho_j \Delta A_{t-j} + \gamma_t \quad (37)$$

$$\Delta A_t = \vartheta + \theta_t + \omega A_{t-1} + \sum_{j=1}^s \rho_j \Delta A_{t-j} + \gamma_t \quad (38)$$

Then testing for unit roots at first differences

$$\Delta^2 A_t = \omega A_{t-1} + \sum_{j=1}^s \rho_j \Delta A_{t-j} + \gamma_t \quad (39)$$

$$\Delta 2A_t = \vartheta + \omega A_{t-1} + \sum_{j=i}^s \rho_1 \Delta A_{t-1} + \gamma_t \quad (40)$$

$$\Delta 2A_t = \vartheta + \theta_t + \omega A_{t-1} + \sum_{j=i}^s \rho_1 \Delta A_{t-1} + \gamma_t \quad (41)$$

### 3.5 Variables and Data

The data is sourced from the SARB and the Federal Reserve Bank of St Louis. The sample stretches from 1994q1-2017q4. This chapter borrows from Hayat et al. (2013), who investigated expectations of higher future income resulting from the sale of oil. In this chapter we examine the expectations of income as a direct consequence of mineral resources. The behaviour of the exchange rate is a function of the terms of trade  $tot_t$ , which relate positively to the real exchange rates, the foreign direct investment  $FDI_t$ , which is capital coming from the rest of the world. Furthermore, the higher the FDI, the more the exchange rate is expected to appreciate. The study also includes investment  $I_t$ , excluding FDI, as the exchange rates depend positively on the Investment. Then the interest rate  $i_t$  is included, which relates to the exchange rates through the flow of capital. When the interest rate increases relative to the rest of the world, the exchange rate is expected to appreciate. The degree of openness  $open_t$ , is positively related to the exchange rates. The expected income  $Y_{t+1}^e$ , is measured using mineral resources reserves. The model is the relationship being analysed in this study;

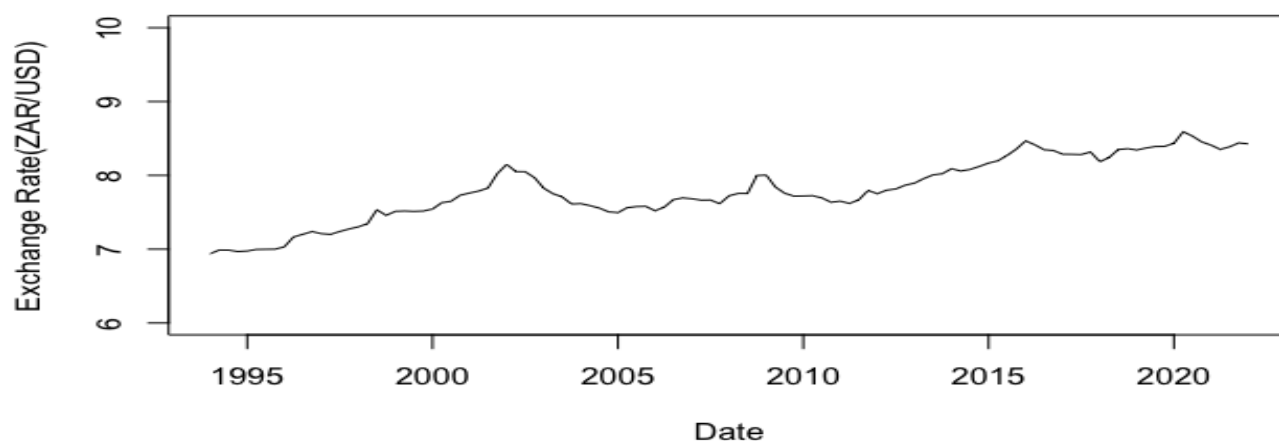
$$e_t = \beta_1 + \beta_2 Y_{t+1}^e + \beta_3 tot_t + \beta_4 I_t + \beta_5 FDI_t + \beta_6 i_t + \beta_7 Open_t + \beta_8 MP_t + \varepsilon_t$$

#### 3.5.1 Real Exchange Rate

Firstly, an explanation of the causes of the exchange rates shift is provided. Edward (1989) defines real exchange rates as the ratio of non-tradable prices to tradable prices of goods, which ensures simultaneous internal and external equilibrium. When the non-tradable goods market clears in the current period, the internal equilibrium occurs and the same is expected to repeat in future. While external equilibrium occurs when the current account balance is zero intertemporally, the real exchange rates are expected to be at equilibrium. Therefore, real exchange rate behaviour should reflect dynamics exhibited by fundamentals in the economy.



Figure 3.1: Exchange Rate (ZAR/USD) (1994 - 2021)



Source: Author compilation

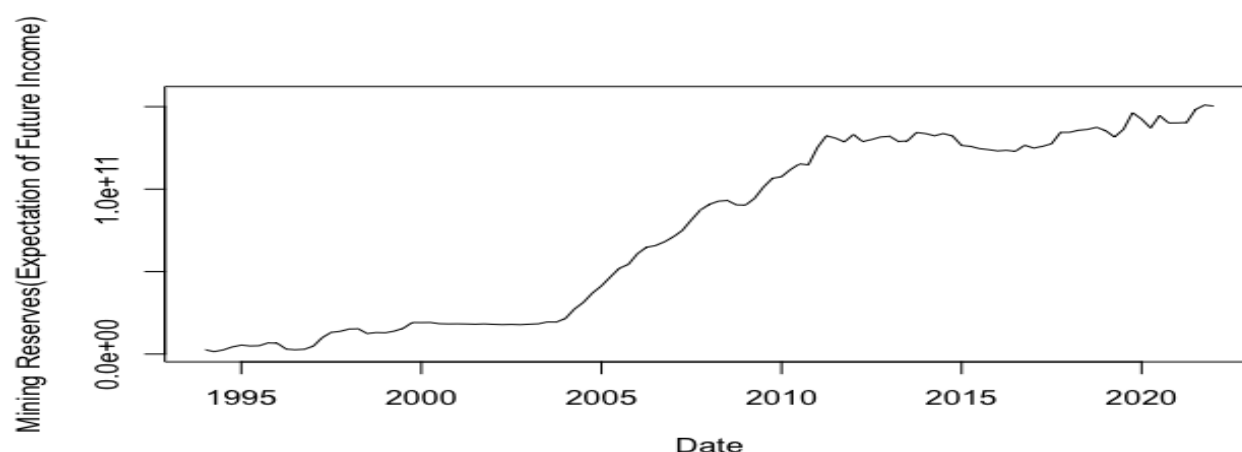
In figure 3.1, the exchange rate of the South African Rand against the United States Dollar(USD) has a sustained long depreciation swing (see Figure 1). From 1994 to the end of 1996 the domestic exchange rate was stable. Thereafter, the Rand began depreciating rapidly against the USD. Then the rate of depreciation slowed down at the beginning of 1998 until 1999. The depreciation rate picked up in 1999, before slowing down from just before the year 2000 to the end of 2001. In the year 2002, the Rand reached the highest-level of depreciation against the USD since 1994. The depreciation seen in 2002 caused the government to institute the Mayberg Commission 2002, which investigated the cause of the Rand exchange rate depreciation. However, soon after, the Rand gained strength against the USD until 2007. Then the exchange rate depreciation lasted until the last quarter of 2009. Thereafter, the Rand gained strength against the USD until 2012. In the years after 2012, the Rand experienced a sharp depreciation against the USD until 2016. In 2016, there was a pick, which characterised the highest depreciation seen in the history of the Rand. Then in the following years the Rand became stable against the USD. In the subsequent years, the exchange rate experienced a slight appreciation. However, the Rand exchange rate has not appreciated enough to go back to 1994 and 1995

levels. The exchange rate does gain strength in some instances, but not enough to reverse the losses.

### 3.5.2 Expectations of Income

Following Masedua et al. (2018), we use mining reserves to measure expectations of future income. The date of mineral deposits is obtained from the Federal Reserve Bank of St Louis. The quantity of the reserves depends on new discoveries or revision of previous estimates. The invention of new technology also enhances the available quantity in terms of how it is used. The exploration can also provide new knowledge about the deposits that are still underground, which might have been overestimated or underestimated. The following diagram presents the expectations of income.

Figure 3.2: Expectation of Future income/Mining Reserves (MR) in South Africa (1994 - 2021)



*Source: Author compilation*

The mining reserves (MR) changed between 1994 to 2021 (see Figure 3.2). The quantity of MR increased from 1994 to 1996, thereafter, declined until the end of 1998. The late 1990s can be seen with higher reserves, and it is a period characterized by a sharp increase in the quantity of deposits. This could be due to foreign firms coming to SA to do business, hence, more exploration leading to new discoveries of mineral resources. The period between 2003 to 2011 saw the quantity of mineral resources increase sharply. Then from 2011 to 2014, the quantity of mineral deposits was relatively stable. In the beginning of 2015 first quarter, there was a decline in the

number of deposits. The end of the second quarter of 2015 marked the beginning of a period where the MR were stable until 2017. In the end of the second quarter of 2017 the MR increased, and from there, it increased slightly until 2019 first quarter. Since then, the quantity of reserves fluctuates with a slight upward swing.

The mining reserves are used as the measure of expectations of future income. In this chapter, the level of income is allowed to vary in the entire period of the sample, starting from 1994 to 2021. Following Beek (2021), we assume the impact of natural resources on the exchange rate is asymmetric. Therefore, following Kassi (2019), we assume fundamentals have asymmetric impact on the exchange rates. We use the Schorderet (2003) method to decompose the expectation of income to allow for asymmetric impact on the exchange rates. The variable is decomposed into two components, which are: expected higher future income (positive) and expected lower future income (negative). The equation below shows a decomposed series into positive and negative components.

$$\phi_t = \phi_0 + \phi_t^+ + \phi_t^- \quad (48)$$

where  $\phi_t$  is a scalar I (1) variable,  $\phi_0$  represents the values occurring in the beginning and  $\phi_t^+$  and  $\phi_t^-$  are decomposed variables. The partial sum process of the of higher income and lower income is

$$\phi_t^+ = \sum_{i=0}^{t-1} 1\{\Delta\phi_{t-1} \geq 0\} \Delta\phi_{t-1} \quad (49)$$

and

$$\phi_t^- = \sum_{i=0}^{t-1} 1\{\Delta\phi_{t-1} < 0\} \Delta\phi_{t-1} \quad (50)$$

where  $\{\phi_t^+\}_{t=0}^T$  and  $\{\phi_t^-\}_{t=0}^T$  denotes the expected appreciation and expected

depreciation cumulative shock, and both represent the initial time  $t$ ; and 1 is the indicator function. When the event in the parathesis occurs, it is represented by 1, otherwise 0. For a moment, consider two integrated time series  $\phi_{1t}$  and  $\phi_{2t}$ , both of which define  $\phi_{jt}^+$  and  $\phi_{jt}^-$  for values of  $j = 1, 2$ , as show in (49). Now assume these series  $\phi_{jt}^+$  and  $\phi_{jt}^-$  are both not linearly cointegrated, but within them there is a linear relationship represented by  $s_t$  such that

$$s_t = \alpha_0 \phi_{1t}^+ + \alpha_1 \phi_{1t}^- + \alpha_2 \phi_{2t}^+ + \alpha_3 \phi_{2t}^- \quad (51)$$

Schorderet (2004) argues that  $x_{1t}$  and  $x_{2t}$  are asymmetrically counteragent if there exist a vector  $\alpha' = (\alpha_0, \alpha_1, \alpha_2, \alpha_3)$  with  $\alpha_0 \neq \alpha_1$  or  $\alpha_2 \neq \alpha_3$  (and  $\alpha_0$  or  $\alpha_1 \neq 0$  and  $\alpha_2$  or  $\alpha_3 \neq 0$ ) such that  $s_t$  in (51) is a stationary process. To simplify without losing generality, let's assume only one component of each partial process is in the cointegrating relationship (51), as show in the following equations below;

$$s_t = \phi_{1t}^+ - \sigma^+ \phi_{2t}^+ \quad (52)$$

and

$$s_t = \phi_{1t}^- - \sigma^- \phi_{2t}^- \quad (53)$$

Equations (52) and (53) are nonlinear. Schorderet (2003) argues that if cointegrating relationships occur in each series in Equation (51), this means that there is a single direction cointegrating relationship. So, equations (52) and (53) can be rearranged as:

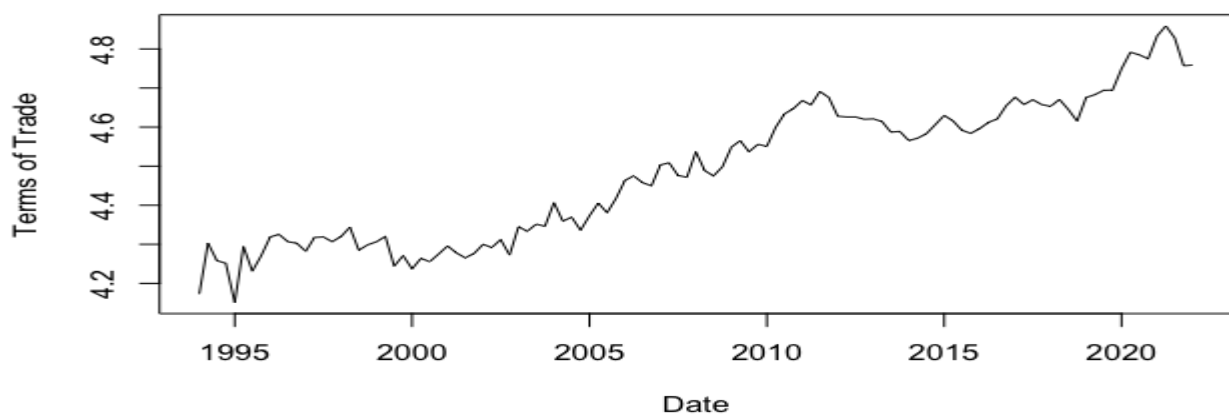
$$\phi_{1t}^+ = \sigma^+ \phi_{2t}^+ + s_t \quad (54)$$

$$\phi_{1t}^- = \sigma^- \phi_{2t}^- + s_t \quad (55)$$

### 3.5.3 Other Variables

Arendse and Smith (2018) notes that the production of some minerals grew by 8% between 1994 and 2011. This is something expected because the government was opening up the economy for business to the rest of the world. Prior to 1994, doing business in SA involved a high and complex tariff system and extensive import and export controls.

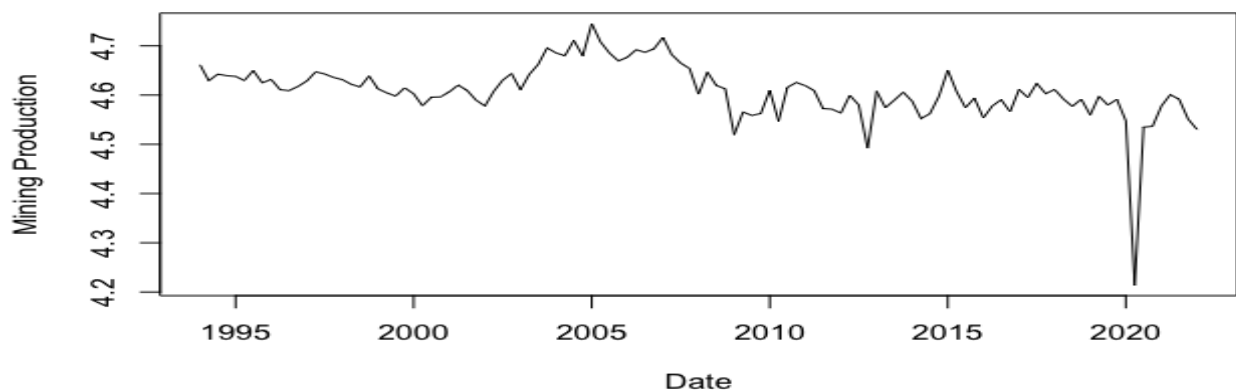
Figure 3.3: Terms of Trade in South Africa (1994 - 2021)



*Source: Author compilation*

The country's ratio of exports to imports has been improving since 1994 (see Figure 3.3). However, the period between 1994 – 1995 was very volatile compared to any period in the sample. There is a sharp increase after the first quarter of 1995, then it becomes stable. In this period, SA was making gradual changes in the economy (IMF, 2021). In the year 2001, the Terms of trade improved significantly until the second quarter of 2010. Thereafter, the increase becomes gradual until the last quarter of 2021.

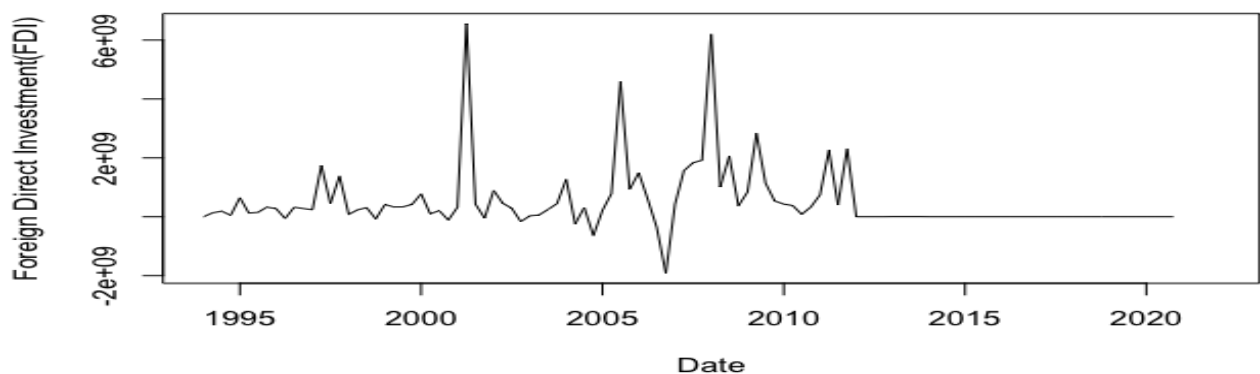
Figure 3.4: Mining Production in South Africa (1994-2021)



Source: Author compilation

The mining production was stable but declining slightly until 2004 (See Figure 3.4). Mining does not have a trend showing either a rise or a fall of production, but it fluctuates within the same band. However, just before 2005, there was a substantial increase in mining production compared to the previous period. The increase in production seen before 2005 halts in 2009. Thereafter, mining becomes stable with only one spike in 2020, which might be related to COVID-19 effects.

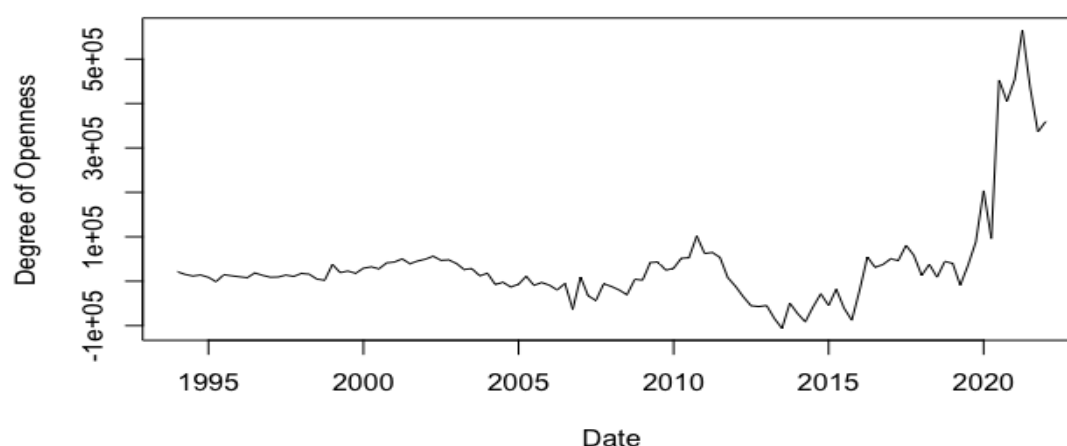
Figure 5.5: Foreign Direct Investment into South Africa (1994-2021)



Source: Author compilation

FDI is very volatile (see Figure 3.5). Since 1994, FDI has had moderate fluctuations, which remained until the second quarter of year 2000. Thereafter, there was a spike, which was followed by moderate fluctuations that lasted until 2005. FDI exhibited large fluctuations between 2005 and 2011. SA has not experienced growth in FDI since 1994, but its fluctuations became larger after 2005, then stabilized.

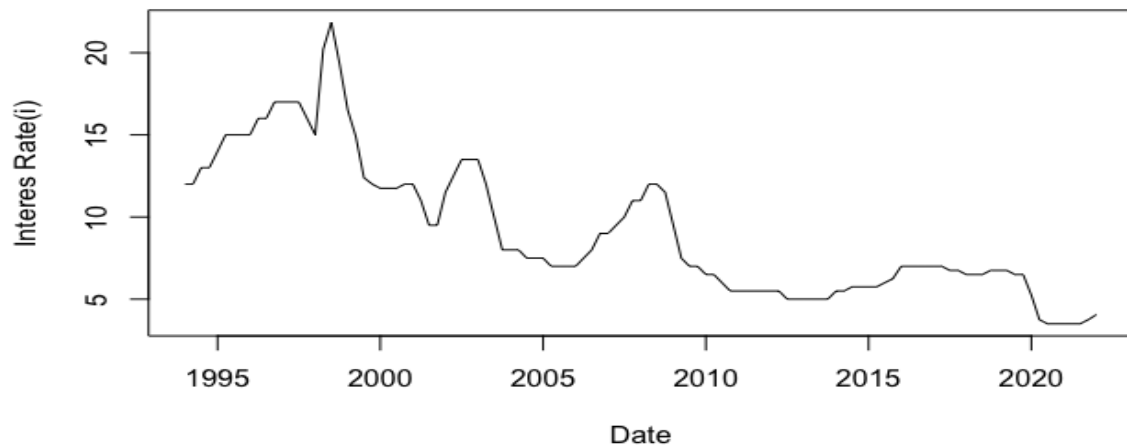
Figure 3.6: Degree of Openness in South Africa (1994-2021)



*Source: Author compilation*

The degree of openness remained the same from 1994 until it worsened in 2004 (see Figure 3.6). In 2006, it started fluctuating more than the period prior. Thereafter, from 2008, the economy became more open until the year 2011. In the period between 2011 and 2014, the degree of openness declined. Thereafter, openness became stable until the beginning of the second quarter of 2015. In the period between 2015 second quarter and the end of 2019, the degree of openness was moderate compared to the previous period. Then in 2020, the of openness increased to larger levels.

Figure 3.7: Interest Rates in South Africa (1994-2021)

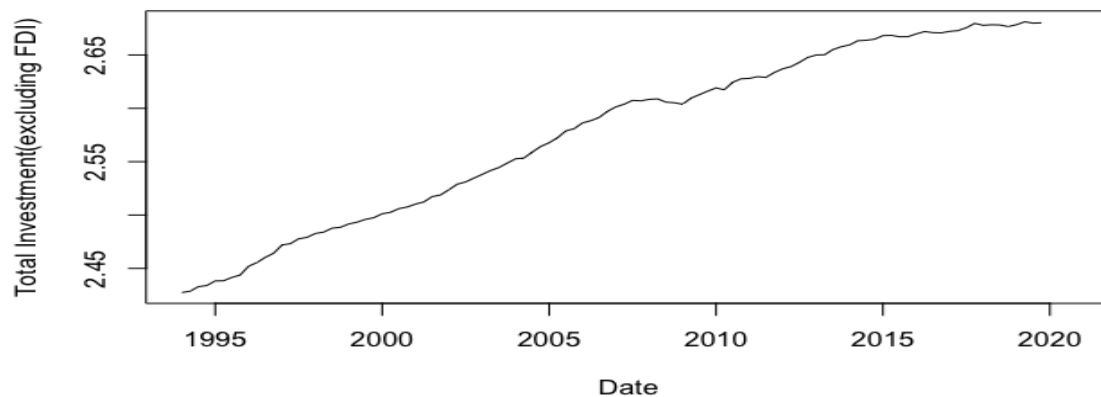


*Source: Author compilation*

Interest rates were on an increasing trajectory between 1994 and 1997(see Figure 3.7). Subsequently, the interest rates became constant until the end of 1998, where they fell. In 1999 the interest rates increased to reach the highest level they have ever been between 1994 and 2021(see Figure 3.7). Thereafter, the interest rates began their downward trend in the second quarter of 1999 to 2000 (see Figure 3.7). In the first quarter of 2002, the interest rates fell, then increased and became constant in 2003. In 2004 the interest rates began decreasing until 2006. Thereafter, they started rising again until 2008. In the period between 2008 and 2013, the interest rates first decreased rapidly, then gradually reduced between 2011 and 2013. The period between 2013 and 2016 was characterized by an increase in the interest rates. Thereafter, from 2016 to 2020, the interest rate was stable but falling(see Figure 3.7).



Figure 3.8: Investment in South Africa (1994-2021)



Source: Author compilation

Investment by government and domestic residents in the economy has grown throughout the period (see Figure 3.8). The period between 1994 and 2008 saw a growth in investment at a rapid rate. Then at the end of 2008 to the third quarter of 2009, investment flattened. At the beginning of the last quarter of 2009, the domestic growth of investment increased at a rapid rate. However, towards the end of the last quarter of 2019, investment slowed down. The diagram shows the investment curve flattening (see Figure 3.8).

### 3.6 Results

We first conduct a stationarity test to determine if the series contains unit roots. In the following table we conduct the unit root test. The results of the test are shown below.

Table 3.1: Stationarity test results

Variables	ADF	
	intercept	intercept and trend
Expectations of future income	-2,0303	-3.508443
Mining Production	0.213309	-2.629480
Investment	-1.388682	-1.507804
Terms of Trade	0.232157	-2.309469
Degree of Openness	-2.394937	-2.195880
Foreign Direct Investment	1.130845	0.185505
Exchange rates	-0.966462	-2.440444

*Source: Author compilation*

In table 3.1, The null hypothesis for unit root test  $H_0$ : the series does not contain serial correlation, and the alternative hypothesis,  $H_1$ : the series does contain serial correlation. Variables are tested at levels before they are logged. The null hypothesis is rejected for all variables, and we conclude that the variables contain unit roots. The variables lack Gaussian characteristics, therefore, estimation using the data in its raw form will yield biased results. In the subsequent table all variables are transformed into logarithms in order to determine if they still have unit roots. However, the interest rate is not converted into a natural log because it is a rate. The interest rates test results are not shown in this table, but we show it in the following table.

Table 3.2: Stationarity test results

	ADF	
	intercept	intercept and trend
log of mining reserves	-0.593361	-1.988276
Log of investment	-1.446624	-1.132509
Log of Terms of trade	0.139210	-2.429866
Log of degree of openness	-2.407552	-2.232210
Log of Foreign Direct Investment	0.184491	-1.915519
Log of expectation of future income	-1.654835	-1.991398
Interest rates	0.25548***	0..55557***
Log of exchange rates	-1.357423	-2.097863

\*\*\*, \*\* & \* respectively refer to 1%, 5% and 10%

*Source: Author compilation*

The null and alternative hypotheses are given by:

$H_0$ : the series does not contain serial correlation; and

$H_1$ : the series does contain serial correlation.

The results show the presence of unit roots in the data even after we have converted the data into natural logs (see Table 2). The data in its current form cannot produce reliable results because the series is not Gaussian. In the next step we difference the data then test for unit roots. The stationarity test results for this data are presented in the following table.

Table 3.3: Stationarity test results

	ADF	
	intercept	intercept and trend
Interest Rates	-7.164991***	-7.154138***
Log of mining production	-7.164991***	-7.154138***
Log of investment	-11.18154***	-11.30798***
Log of terms of trade	-5.524103***	-5.68187***
Log of degree of openness	-11.71939***	-11.73366***
Log of foreign Direct Investment	-3.74248***	-3.767699***
Expectations of future income	-6.185393***	-6.158649***
Log of exchange rates	-8.505723***	-8.490956***

\*\*\*, \*\* & \* respectively refer to 1%, 5% and 10%

*Source: Author compilation*

Table 3.3 shows that the data contains unit roots. The variables are first differenced, and the results show that the data no longer has unit roots. This makes the series valid for estimations with a significantly reduced probability for spurious results. However, this data changes after logging and first differencing, as shown in Table 3.3. The values of the coefficients in table 3.3 are different to those in other tables. This may mean the differenced data has different information to the raw data. The process of transforming the series to be Gaussian changes the original characteristics.

Then we run a BVAR to test the impact of expectations of income on the exchange rate. The results of the BVAR are shown in the subsequent table which considers the

positive component of expectations associated with higher income. The negative value on the coefficient means the domestic exchange rates are appreciating. While the positive sign of the coefficient means a depreciation of the domestic exchange rates. The results of the BVAR are shown below;

Table 3.4: Bayesian VAR estimation results with higher expectations of income

-	EX
Exchange Rates(-1)	0.652493
Exchange Rates(-2)	0.084701
Expectations of Income(-1)	-0.029899
Expectations of Income(-2)	0.008680
Interest Rates(-1)	0.000921
Interest Rates(-2)	-0.002944
Foreign Direct Investment(-1)	0.093743
Foreign Direct Investment(-2)	0.033457
Investment(-1)	0.163656
Investment(-2)	-0.026206
Degree of openness(-1)	0.022363
Degree of Openness(-2)	-0.016792
Mining Production(-1)	-0.224776
Mining Production(-2)	0.067339
Terms of Trade(-1)	-0.358636
Terms of Trade(-2)	-0.139438
C	0.379430

*Source: Author compilation*

In period  $t-1$ , given that the economic agents expect future income to be higher than in the previous period, the exchange rate is likely to appreciate (see Table 3.4). This is consistent with what is demonstrated in the theory. In period  $t-2$ , given that income is expected to increase in the future, the exchange rate is more likely to depreciate. This is not expected, but it might mean previous expectations about mineral resources have unexpected effects on the exchange rate behaviour. This is similar to what Singhal et al. (2019) observed for the Mexican peso.

Investment produces unexpected results in time  $t-1$ . Given the investment increased, the exchange rate is likely to depreciate. These results are contra to predictions of theory. However, time  $t-2$  produces results that are consistent with theory, given that investment increases, the exchange rate is more likely to appreciate. These results are expected and comparing the probability to period  $t-1$ , it is larger.

Given that the economy is open to international trade in time  $t-1$ , the exchange rate is likely to depreciate. These results are not expected. The theory assumes the more open the economy becomes the higher is the number of skilled labor. The economy will be efficient in production, hence, export more, resulting to an increase in demand for domestic money. High demand for domestic money leads to an appreciation of the home currency.

Given that mining production increased in period  $t-1$ , the exchange rate is likely to appreciate in the current period, which is consistent with the theory. However, given that mining production increased in period  $t-2$ , the exchange rate is likely to depreciate in the current period. These results are consistent with what is expected. This is expected because having increased output in the previous periods means a fall of the level of output can be expected in the future. This means that some economic agents may expect the exchange rate to fall as a result of a low production, hence, low exports.

The following table displays the result of the BVAR. The test is run to determine what is the impact of the expectations of income on the behaviour of the exchange rates.

The difference of the result shown in the table below is that we use the component of expectations that capture the expected fall of income.

The negative value on the coefficient means the domestic exchange rates is appreciating. While the positive sign of the coefficient means a depreciation of the domestic exchange rates. The results of the BVAR are shown below;

Table 3.5: The table: Bayesian VAR estimation of lower expectations of income

	EX
Exchange Rate(-1)	0.637800
Exchange Rate(-2)	0.088941
Expectations of Income(-1)	-0.028334
Expectations of Income(-2)	-0.001733
Interest Rate(-1)	0.000670
Interest Rate(-2)	-0.002700
Investment(-1)	0.147780
Investment(-2)	-0.015046
Foreign Direct Investment(-1)	0.094562
Foreign Direct Investment(-2)	0.035148
Degree of Openness(-1)	0.021653
Degree of Openness(-2)	-0.013712
Mining Production(-1)	-0.205413
Mining Production(-2)	0.051909
Terms of Trade(-1)	-0.360941
Terms of Trade(-2)	-0.138045
C	0.391813

*Source: Author compilation*



Given that in period  $t - 1$  future income is expected to fall in time  $t$ , the exchange rate is likely to appreciate (see Table 3.5). The results are inconsistent with economic theory. When there are less deposits available, the supply falls, which leads to higher prices of minerals. The increase in prices of commodities leads to higher demand for domestic currency, which is used in exchange for minerals. Given that in  $t - 2$  the future income is expected to fall in time  $t$ , the exchange rate depreciates (see Table 3.5).

Suppose investment in  $t - 1$  increases, the exchange rate is likely to depreciate. This effect of investment on the exchange rate is not expected. While it is given that investment increased in  $t - 2$ , the exchange rate appreciates in the current period (see Table 3.5). This is consistent with the theoretical prediction. Given the interest rate increased in  $t - 1$ , the probability that the exchange rate will depreciate in period  $t$ , increases. The increase of the interest rate in  $t - 1$  leads economic agents to expect a decline in period  $t$  or  $t + 1$ , hence, the exchange rate to depreciate, which might be putting pressure on exchange rate behaviour (see Table 3.5). Given that interest rates rose in  $t - 2$ , the probability that the exchange rate will appreciate increases. These results are consistent with the predictions of the theory.

Given that in  $t - 1$  FDI increased, the exchange rate is likely to depreciate. The exchange rate does not respond to FDI as expected. There might be unobserved factors working against FDI's impact on the exchange rates. The same results are obtained in  $t - 2$ . Given that openness increased in  $t - 1$ , the exchange rate is likely to depreciate. It is possible that there is an unobserved factor putting pressure on the exchange rate to depreciate. The degree of openness is not responding as expected. Whereas, given that the degree of openness increased in  $t - 2$ , the probability that the exchange rate appreciates increases. Given that mining production increased in  $t - 1$ , the probability that the exchange rate will appreciate increases. While at time  $t - 2$  given mining production increased, the exchange rate is likely to depreciate (see Table 3.5). This is not consistent with the expected response of the exchange rates to variations of mining production. There might be some unobserved factors putting pressure on the exchange rate to depreciate. However, it might be that the effects of the increase in mining production took place long ago. So, in period  $t$  mining production might no

longer have impact on the behaviour of the exchange rates. The terms of trade in both time periods  $t - 1$  and  $t - 2$ , given they increased, the probability that the exchange rate will appreciate increases.

The following table shows the results of the BVAR with expectations of future income not decomposed into positive and negative components.

Table 3.6: Results for undecomposed expectations of future income and the response of the exchange rate.

	EX
Exchange Rate(-1)	0.638470
Exchange Rate(-2)	0.089406
Expectations of Income(-1)	-0.009700
Expectations of Income(-2)	0.013061
Interest Rate(-1)	0.000803
Interest Rate(-2)	-0.002847
Foreign Direct Investment(-1)	0.094592
Foreign Direct Investment(-2)	0.035725
Investment(-1)	0.148154
Investment(-2)	-0.016628
Degree of openness(-1)	0.020420
Degree of Openness(-2)	-0.013319
Mining Production(-1)	-0.205390
Mining Production(-2)	0.032913
Terms of Trade(-1)	-0.359173
Terms of Trade (-2)	-0.136363
C	0.436901

*Source: Author compilation*

Table 3.6 shows that given that in period  $t - 1$ , the expected future income increased, the exchange rate is likely to appreciate. While in period  $t - 2$  given that future income

is expected to increase, the exchange rate is likely to depreciate (see Table 3.6). The expectation of the future income does not affect the exchange rate behaviour. The exchange rate movement is probably responding to some unobserved factors which are believed to be putting pressure on it to depreciate. The probabilities are different, and the results are mixed, which shows asymmetric effects on the exchange rates.

Given that the interest rate increased in  $t - 1$ , the exchange rate is likely to depreciate. This is not consistent with the expected response of the exchange rate behaviour (see Table 3.6). The increase of the interest rate in the previous period may be perceived as an expectation that it will increase in future time. So, the economic agents expect the exchange rate to depreciate in the current or future periods. Hence, the economic agents' beliefs drive the exchange rate in the opposite direction. In both periods,  $t - 1$  and  $t - 2$ , given the FDI increased, the exchange rate is likely to depreciate (see Table 3.6). There are unobserved factors pushing against the force exerted by the FDI, which ends up leading the exchange rate to depreciate. The probabilities are different, which is the indication of asymmetric behaviour of the exchange rate.

Given investment increased in  $t - 1$ , the exchange rate is likely to depreciate. This increases suspicion of other factors acting on the exchange rate. The exchange rate responds in an unexpected manner, which contradicts the theory. Given that in  $t - 2$  investments increased, the probability that the exchange rate appreciates increases (see Table 3.6). The exchange rate exhibits different behaviour in response to the same variable in separate periods. This shows an asymmetric behaviour of the exchange rate.

Given that the degree of openness increased in  $t - 1$ , the exchange rate is likely to depreciate. This is not an expected response of the exchange rate behaviour (see Table 3.6). The effect of unobserved factors on the exchange rate dominates, which override the impact of an increase in openness. However, given that the degree of openness increases in  $t - 2$ , the probability of the exchange rate appreciating increases (see Table 3.6). The more time passes, the more the effect of the degree of openness is likely to influence the exchange rate behaviour. The exchange rate

behaves asymmetrically, and its movement varies depending on the period that has passed.

Given mining production increases in time  $t - 1$ , the probability that the exchange rate will appreciate increases in period  $t$ . Considering period  $t - 2$ , given the mining production increased, the exchange rate behaviour is more likely to result in a depreciation (see Table 3.6). The effect of the increased mining production on the exchange rate behaviour varies depending on the period that has passed. The probabilities are different for both impacts, which signals asymmetric response of the exchange rate behaviour. Given the terms of trade improved in  $t - 1$  and  $t - 2$ , the probability of the exchange rate appreciating increases in period  $t$  (see Table 3.6). However, the probabilities are different in the separate periods, which shows asymmetric behaviour of the exchange rate.

The variables used in estimating the BVAR model are not able to estimate the common tests at the same time. The models would be unstable because the degrees of freedom run out. Therefore, we use the following table to choose the variables we can use to test for cointegration. Since Bayesian estimation uses prior known/unknown information to estimate the posterior, this study uses the Minnesota prior for reasons provided earlier. The variables chosen for estimation of a long-run relationship are based on their relevance to the theory and what this study aims to understand. The criteria used is, firstly, whether the probability of each of the variables is large, which means it is more likely to affect the exchange rate behaviour. Secondly, the variables estimated shows results consistent with theoretical predictions. Lastly, the results must be consistent with theoretical expectations in the first lag because the BVAR estimated using the Minnesota prior. The variables we use to estimate the long-run relationship are the exchange rate, expectations of income, mining production and terms of trade.

In this chapter, we do not test for weak exogeneity following the cointegration test for the following reason. The requirement for testing for weak exogeneity requires the assumption of loss of information. To achieve this condition, the parameter of interest must be transformed into a joint distribution of conditional and marginal distributions. Urbain et al. (1993) argue that the test of exogeneity is based on limited information or instrumental variables. Furthermore, Vinod et al. (2018) points out that the

instrumental variables used in exogeneity testing produce estimates with systematic errors, moreover, many do not have finite moments. Further, the estimates may be inefficient which leads to changing the original specification.

We need to determine the optimal number of lags in order to be able to proceed to test for the existence of a long-run relationship. The optimal number of lags is necessary because it ensures that the required number of lags are used. A model with more than the optimal number of lags produces biased results, while if lags are fewer than the optimal number of lags, the model will lack the necessary information required to make a correct inference.

Liew (2004) recommends the use of Akaike Information Criteria (AIC) and Final Prediction Error (FPE) because they are both superior in minimizing the chances of underestimation, while maximising the chance of recovering the optimal length. This chapter uses the Akaike Information Criteria (AIC). The AIC is extensively used in the literature. So, using it here allows us to compare the results with what is available in the literature. However, other tests are included in the lag selection criteria including the Schwarz Information Criteria (SIC), Hannan-Quinn Criterion, and Final Prediction Error (FPE).

Table 3.7: Lag selection criteria

Criteria	1	2	3	4
AIC	-2.626544e+01	-2.663247e+01	-2.664368e+01	-2.650835e+01
HQ	-2.610063e+01	-2.630283e+01	-2.614922e+01	-2.584908e+01
SC	-2.585862e+01	-2.581881e+01	-2.542319e+01	-2.488104e+01
FPE	3.918575e-12	12 2.717668e-12	2.695200e-12	3.103460e-12

Source: *Author's compilation*

The study uses the AIC to choose the optimum number of lags. The rule states that the lowest value indicates the optimal number of lags. The lowest number indicated

by the AIC is at 3 lags (see Table 3.7). Therefore, the number of lags to be used in this section is 3. The FPE also shows the lowest value at 3 lags, which is consistent with the AIC (see Table 3.7). However, both the HO and SC show the optimal number of lags to be 1. The HO and SC cannot be used for this study because the estimation of the cointegration requires a minimum of 2 lags. If the lag length is 1, the test cannot be conducted because the rule requires subtracting 1, which then leaves nothing.

The cointegrating relationship is shown below. The tested relationship is specified as follows: exchange rates ( $e_t$ ), expectations of income ( $Y_{t+1}^e$ ), mining production ( $tt_t$ ) and  $\gamma_t$  is the error term. The estimated equation is;

$$e_t = -0,0197Y_{t+1}^e - 0,1740mr_t - 0,1709tt_t + \gamma_t$$

The cointegrating relationship shows that the variables have a negative relationship with the exchange rate. The negative sign in this study means an appreciation. So, the long-run variations in  $Y_{t+1}^e$  and  $tt_t$  lead the exchange rates to appreciate. These results are expected, and these results are similar to Li et al. (2021).

Then we determine whether the long-run relationship exists for specified variables. The Johansen Cointegration test is conducted to determine the number of cointegration models. The cointegration test is estimated using 2 lags. In this chapter, cointegration is tested at 5% level of significance. The 5% level of significance is chosen for consistence with other studies in the literature. The chosen statistic for the Johansen Cointegration test is the Trace statistic. If the test statistic is above the critical value, then the null hypothesis is rejected. However, if the test statistic is less than the critical value, then we cannot reject the null hypothesis. The null hypothesis  $H_0$ , states that there is a cointegrating relationship, while the alternative hypothesis  $H_1$ , states that there is no cointegrating relationship. The following table shows the result to the Johansen Cointegration Test Results.

Table 8: Johansen Cointegration Test Results

	Statistic	10%	5%	1%
$r \leq 3$	3.99	10.49	12.25	16.26
$r \leq 2$	19.52	22.76	25.32	30.45
$r \leq 1$	39.34	39.06	42.44	48.45
$r = 0$	73.46	59.14	62.99	70.05

Source: Author's compilation

The trace test statistic is 73.46, while the critical value is 62.99 (see Table 3.8). Therefore, the null hypothesis is rejected, and we can conclude that there are more than zero cointegrating relationships when  $r = 0$ . In the subsequent tests at  $r \leq 1$ , the test statistic is 39.34, while the critical value is 4.44, thus the null hypothesis cannot be rejected. At  $r \leq 2$ , the test statistic is 19.52, and the critical value is 25.32. We then fail to reject the null hypothesis. And at  $r \leq 3$ , the Trace test statistic is estimated to be 3.99, whereas the corresponding critical value is 12.25. The null hypothesis cannot be rejected. Therefore, we can conclude that there are 3 or less cointegration relationships. The long-run relationship exists between Exchange rates, expectations of income, mining production, and terms of trade.

We estimate a Vector Error Correction Model (VECM) from the cointegrating relationship. This is procedure is programming using R. We programme this transition to allow a revers approach to obtain a VECM. This approach makes it possible to do a reverse estimation. Further, the reverse estimation minimizes mistakes.

Then (VECM) is estimated to determine the speed of adjustment to equilibrium in a case of a deviation. In addition, the VECM can be used to determine if the variables specified are related to each other in the short-run or long-run. The VECM is estimated with the error correction term corresponding to each variable, which allows determination of whether a long-run relationship with each variable exists. The variables used in the estimations of the VECM are Exchange Rates (ex), Expectations of Income (mr), Mining production (mp) and terms of trade (tt). The table below presents the results of the VECM.



Table 3.9: Vector Error Correction Model

	Error Correction Term	Intercept
Exchange Rates	-0.0477*	0.0020*
Expectations of higher income	-0.0188	0.0285*
Mining Production	0.1490	-0.0019
Terms of Trade	0.0460	0.0088*
	ex-1	mr-1
Exchange Rates	0.2199*	-0.0042
Expectations of higher income	0.4088	0.5936***
Mining Production	-0.8007	-0.4909
Terms of Trade	-0.7650	-0.0231
	mp-1	t.t-1
Exchange Rates	0.0119	-0.0184
Expectations of higher income	-0.0270	-0.4909
Mining Production	-0.6483***	-0.0240
Terms of Trade	-0.0470	-0.3826***
	ex-2	mr-2
Exchange Rates	0.0131	0.0021
Expectations of higher income	-1.1211	-0.3268***
Mining Production	-0.3431	-0.0125
Terms of Trade	0.0124	0.0186
	mp -2	tt- 2
Exchange Rates	0.0216	-0.0479
Expectations of higher income	0.2509	0.1765

Mining Production	-0.4642***	0.0407
Terms of Trade	0.0024	-0.0665

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\*\*\*, \*\* & \* , respectively mean 10%, 5% & 1%.

Source: Author's compilation

The error correction term of the exchange rate is negative and significant, which indicates that it reverts to equilibrium (see Table 3.9). With lag 1, the exchange rate has a long-run relationship with itself. Furthermore, the short-run relationship is significant at 10% (see Table 3.9). Now let's consider the relationship between the exchange rates and the expectations of higher income. The expectation of higher income has a negative error correction term, although it is insignificant. These findings are not unusual. The literature does demonstrate that there is a weak link between the exchange rates and expectation of commodity income (Chen and Rogoff, 2003, Cashin et al., 2004).

The negative sign is an indication that the exchange rate does revert to equilibrium in the case of a shock. However, this is insignificant. The rest of the variables included in the model have positive error correction terms and are insignificant. These results are not expected because they suggest that the exchange rate does not revert to equilibrium when shocked by mining production and terms of trade. The error correction terms of variables are different, but insignificant different from zero. Furthermore, the study finds that the selected variables do not have a relationship with the exchange rates or with each other in the short run.

We now need to test if the VECM in table 3.9 is stable or not. This is done by estimation of the VAR model from the VECM. We work backwards using VECM, this process is programmable in R.

It is possible to have a long run relationship which variable stationary at different levels. Using the R coding we able to estimate the cointegration with the Error correction term without first estimating the VECM. Thereafter, it is possible to estimate the VECM from the long run relationship. This is an uncommon approach because usually researcher do not programme their estimation. In most case, the method available to estimate the

long run relationship requires to start from a VAR estimation.

There is no stability test on the VECM available, this is the reason that is making use estimate a VAR. We use VEC2VAR r command to convert the VECM to a VAR model. The estimated VAR model can be used to test for appropriateness of the model used above (see Table 3.9).

The results of the VAR modes are shown in the following table.

Table 3.10: Vector Autoregressive Model

	ex-1	mr-1	mp-1	tt-1
Exchange Rate	1,1869689	0,00177229	-0,0026304	-0,0049742
Expectations of Income	0,5322727	1,22966948	0,44179092	0,50914544
Mining Production	-0,8356282	0,01714099	0,42445003	-0,0999452
Terms of Trade	-0,8549186	-0,0057335	-0,1185448	0,29056517
Lag 2				
	ex-2	mr-2	pp-2	tt-2
Exchange Rate	-0,2102622	0,0004435	-0,0149494	-0,0116085
Expectations of Income	1,0976196	-0,3226482	0,78830925	0,65118648
Mining Production	0,5015222	0,00191839	0,32339596	-0,0999452
Terms of Trade	0,670415	0,01625867	-0,0207023	0,29056517

*Source: Author's compilation*

The only purpose of Table 3.10 is to run the serial correlation test and the Arch effects

test. The table is also useful because it will allow us to determine the policy implications.

Table 3.11: Serial Correlation Test

df	52
Chi-squared	60,022
p-value	0,2078
Portmanteau Test (asymptotic) for residuals of VAR object model.	

*Source: Author's compilation*

$H_0$ : there is no autocorrelation in the model; and

$H_1$ : the model has autocorrelation.

The p-value is 0.2078, which means the null hypothesis cannot be rejected. The model does not have autocorrelation. The following step is to test if the model has arch effects.

The test results for Arch effects are shown in the following table.

Table 3.12: Arch test

df	1500
Chi-squared	910
p-value	1
Testing residuals of VAR object model for ARCH (multivariate)	

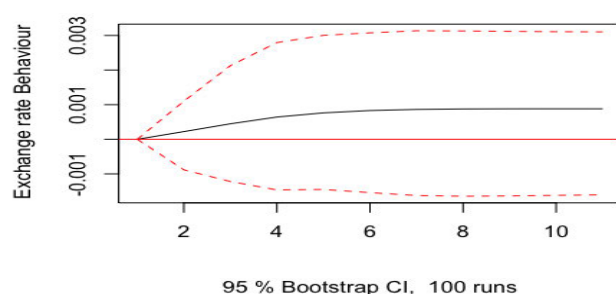
*Source: Author's compilation*

The Arch effects test returns the p-value of 1, which means the model does not have the volatility. This absence of Arch effects and serial correlation means estimated show that the model is stable (see Table 3.11; Table 3.12). This means that the VAR model can be used to determine policy implications (see Table 10).

The chapter uses the Impulse Response functions to analyse the behaviour of the exchange rate. Then we examine how the exchange rate responds to shocks. This gives a visual perspective to how the variables are related to each other. The focus of the impulse response is on the effects of expectations of income, mining production, and terms of trade on the exchange rate. The impulse responses are computed at 95% level of significance. The impulse responses are produced through bootstrapping by resampling 100 times.

The figures showing impulse responses are shown below. The impulse response for the exchange rates to expectations of income (mining reserve) is shown below;

Figure 3.9: Exchange Rate Impulse Response to Mining Reserves Shock

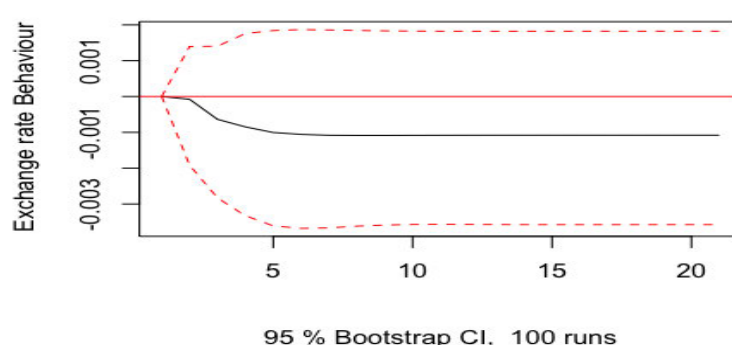


Source: *Author's compilation*

The shock of expectations of higher income on the exchange rate is not significant throughout the period under the analysis (see Figure 3.9). When income is expected to increase, the exchange rate responds by depreciating. The exchange rate responds gradually to a shock of expected higher income. When the shock hits, the exchange rate response takes off slowly, and the slope of the graph is smooth. Then after 5 quarters, the exchange rate flattens and remains constant. The exchange rate depreciation in response to an expected increase of income is not expected, but it is significant. The exchange rates response to the shock produces equality between the domestic and the foreign expectations of future income endogenously. Thereby, the expectations of income shock cause the exchange rate to shift to a different equilibrium. This occurs because the information about the future income is credible, hence, the shift.

This is not an unusual finding about the exchange rate behaviour (see Benigno et al., 2007). The exchange rate seems to have multiple equilibria. Soon after the shock, the exchange rates move towards a new equilibrium path. Following this, the exchange rates settle on the explosion path. Accordingly, the exchange rate does not go back to the previous steady state. Thus, credible information concerning expected income might be leading to an exchange rate equilibrium shift.

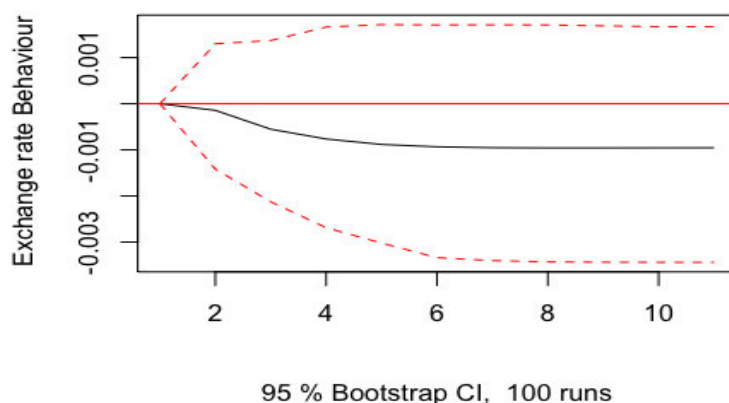
Figure 3.10: Exchange Rate Impulse Response to Mining Production Shock



Source: *Author's compilation*

The shock of the mining productions and the exchange rate response is insignificant in the entire period (see Figure 10). The exchange rate responds to a shock of the mining production with a lag. When mining increases, the exchange rate only responds in the third quarter. The increase in production leads to the appreciation of the exchange rate. The response of the exchange rate between the 2<sup>nd</sup> to the 3<sup>rd</sup> quarter is very rapid. The exchange rate movement between the 3<sup>rd</sup> quarter to the 5<sup>th</sup> quarter, the rate of appreciation becomes slower. What's more, the exchange rate response shows an explosive behaviour. As I have noted, this is not uncommon exchange rate behaviour. Taylor (2006) shows that the exchange rate behaviour can be explosive even in neighbourhood of its equilibrium. This is in line with the exchange rate behaviour exhibiting multiple equilibria. As a result, the exchange rates are not going back to equilibrium after the shock.

Figure 3.11: Exchange Rates Impulse Response to Terms of Trade Shock

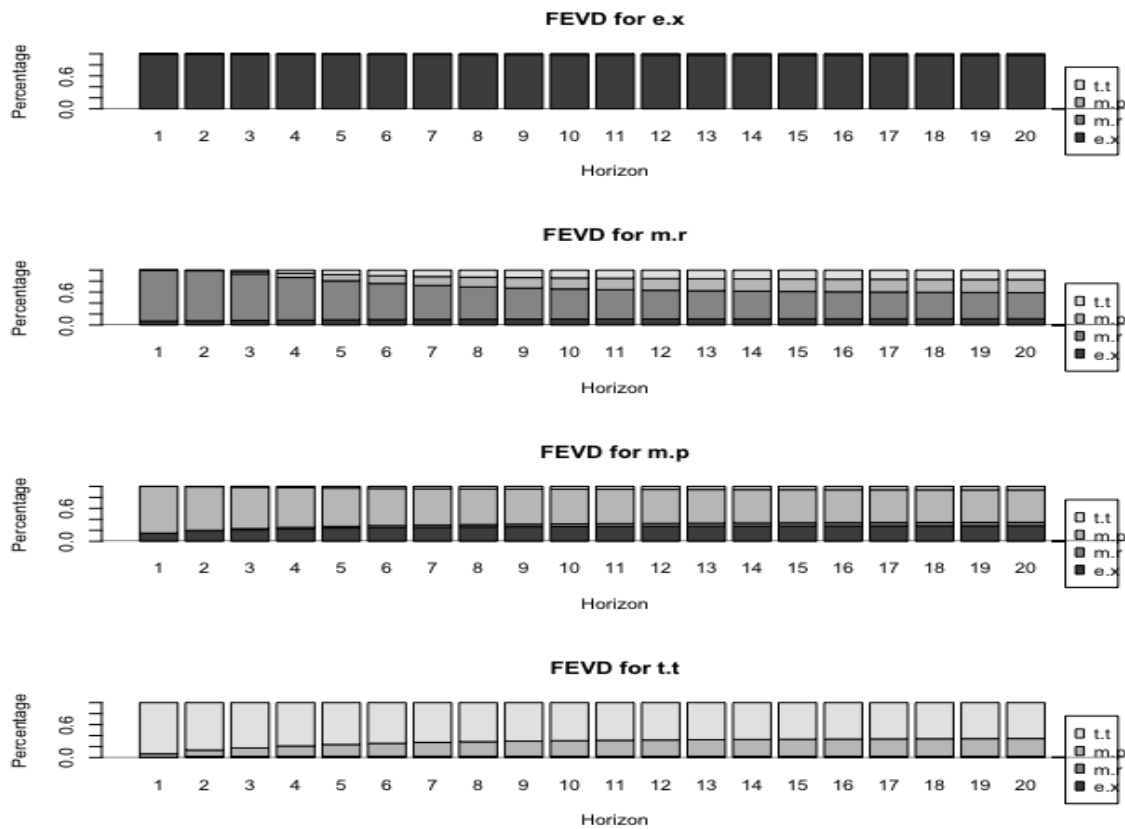


Source: *Author's compilation*

The exchange rate impulse response to the terms of trade shock is insignificant (see Figure 11). The exchange rate responds with a lag. The exchange rate appreciates asymptotically until after the 3<sup>rd</sup> quarter. From the 3<sup>rd</sup> quarter, the exchange rate appreciates rapidly then flattens as it approaches the 4<sup>th</sup> quarter. However, the exchange rate remains appreciating slightly throughout. In brief, the exchange rates show that does not revert back to the previous steady state after the shock. Thus, it settles at a new steady state.

Then we conduct a forecast error variance decomposition (FEVD) to determine the drivers of all these variables. The same specification used to estimate the VAR model above is used to estimate the FEDV. The t.t denotes terms of trade, m.p is mining production, e.x is the exchange rates and m.r is the mining reserve.

Figure 3.12: Forecast Error Variance Decomposition



Source: *Author's compilation*

Figure 3.11 shows the exchange rate explains itself more than any variable provided in this specification, while the expectations of higher future income have some effect on the exchange rate (see Figure 3.11). The other variables t.t, and m.p do not have an impact on the exchange rate.

### 3.7 Discussion

The estimated probabilities of the same variable vary in different periods, which shows that the impact of expectations of future income is asymmetric, depending on the period. This makes the response of the exchange rate to vary depending on the time when the impact occurred. Therefore, we argue that the exchange rate behaviour is asymmetric to expectations of future income.



The exchange rate behaviour tends to appreciate if the expectations of higher income were made in a shorter period. If expectations of higher income are formed over a relatively longer period, the exchange rate tends to depreciate. Thus, expectations of higher income formed in a far longer previous period do not have effect on the exchange rate behaviour. For instance, the expected higher income in  $t - 2$  is too far long ago. To demonstrate, the economic agents might be thinking that in time  $t$ , the income was expected to be higher than in  $t - 2$ , but now the conditions have changed. This perception dominates, hence, it results in the exchange rate depreciation. There may be unobserved factors pushing the exchange rate against the expected movement. The literature discusses the unobserved factors that act on the exchange rate, thereby leading the exchange rate to exhibit unexpected behaviour. Frazscher et al. (2015) found evidence supporting that individual perceptions drive unobserved factors influencing the exchange rate behaviour.

The expectations of low income in the future result in exchange rate appreciation. This was not expected. This gives the impression that there is pressure pushing against the exchange rate depreciation. The other observation is that probabilities of expectations of lower income are different in  $t - 1$  and  $t - 2$ . The difference in probability values is an indication of asymmetric impact of the exchange rate. The probability of the exchange rate appreciating is small in both periods. This indicates that the expectations of lower income are applying some force on the exchange rate to depreciate. However, the pressure of expectation of lower income is outweighed by the force of unobserved factors.

The expectation of lower income is associated with a fall in the supply of mineral resources. When the news of an expected lower income in the future emerges, the price of minerals rises in response to a fall in supply. While mining production remains the same, the demand for domestic currency increases in the foreign exchange market. This could be the force leading the exchange rate to appreciate. The changes are not observed; hence, they may be the forces outweighing the pressure being exerted by the expectations of the fall income.

The cointegration test shows that there are at least 3 cointegrating relationships. The relations shown in the cointegrating model reveal that the specified variable has a negative relationship with the exchange rate. However, their error correction terms are insignificant. The error correction term of the exchange rate is significant, while that of the expectation of higher income is insignificant. The insignificance of the error correction term is a sign of unobserved factors pushing against the force of expectations of higher income.

The shocks of all variables on the exchange rate are significant. However, the exchange rate responded by depreciating in response to a shock on expectations of higher income. This is not what is expected, but it may be explained by the fact that there are unobserved factors affecting the exchange rate. These factors may be the information we are not measuring in this study. There might be a chance that economic agents act on private information instead of the public domain has. However, this is beyond the scope of this study.

### **3.8 Conclusion**

This chapter has shown theoretically and empirically that expectations of income affect the behaviour of the exchange rate. Firstly, the exchange rate movement is asymmetric to the shock of expectations of income. Secondly, the expectations of higher income have an impact on the exchange rate behaviour if they are made in the recent past. Finally, the expectations of higher income formed in a distant past result in the exchange rate depreciation.

This chapter also discovered that the expectations of a fall in income lead to an appreciation of the exchange rate. However, there are signs that the exchange rates might be influenced by unobservable factors. But the investigation of the unobserved factors is beyond the scope of this study.

We recommend that the SARB or government should use expectations of higher income to manage or to influence the behaviour of the exchange rates. The timing of forming expectations must be considered because recent expectations of higher income lead to an exchange rate appreciation. The expectations of higher income

formed in a distant past longer than  $t-1$  cause the exchange rate to respond by depreciating. Accordingly, for expectations to have an impact on the exchange rate, the lag between forming expectations and period  $t$  must not be too long.

The expectations of lower income cannot be relied on since there are signs of that they are being influenced by unobserved factors. As has been noted, the impulse responses give results that have no significance. However, the results show that the exchange rates do not go back to equilibrium.

# **CHAPTER FOUR: INTEREST RATE DIFFERENTIAL AND EXCHANGE RATE: THE CASE OF SOUTH AFRICA**

## **4.1 Introduction**

Since the 1970s, there has been great interest in investigating the monetary model of exchange rate determination. However, the 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 the exchange rate behaviour. However, empirically it is demonstrated that the assumptions of the 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 State of American Dollar (ZAR/USD)) 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 rates 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 the exchange rates in the long-run. Sichei et al. (2004) estimated the monetary model and shocked the exchange rates (ZAR/USD) with interest rates. Their study found that the exchange rates respond with a depreciation when the interest rates increase using data from 1994 to 2004. These findings are contra to what is expected. This may be suggesting 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 the South African data from 1970 to 1993 and assumed the 1976 monetary model with flexible

prices. The study found that the exchange rates responds to changes of 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 of 3 countries, South Africa (SA), Mozambique and United States of America (USA) and determined that in the long run, the monetary model determines the exchange rate behaviour. de Bruyn et al. (2013) made the same conclusion about the ZAR/USD. However, they used data that spans over 100 years (1910 - 2010), which is an issue because the long data suffer structural problems.

de Bruyn et al. (2013) do not account for structural issues which have risen in the past 100 years when estimating. The period between 1910 to 1914 saw the rise of the classical gold standard, followed by World War 1 (WWI) from 1914 to 1918. The 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 the 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's et al. (2013) data has 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's et al. (2013) argues 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 the institutions like the South African Reserve Bank (SARB). The SARB is the monetary policy authority of SA with a constitution responsibility to maintaining the value of the Rand. The SARB uses the interest rates as its main tool of maintaining the inflation rates between 3% and 6% (SARB, 2020). The theory of 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., 2013, Bahman-Oskooe et al., 2015, Iskhoki and Mukhin, 2021, Tawadros, 2017). However, in the literature there is no consensus about the effects of the monetary variables on the exchange rates.

The literature associates the rise of the inflation rate with the depreciating exchange rates (Ha et al., 2020). Thus, exchange rates depreciation is a macroeconomic effect which has implications for the SARB objective. The constant depreciation of the exchange rates makes the job of the SARB unachievable. The ZAR/USD viewed just in the period between 2000 to 2021 shows a long depreciation swing. This shows the extent the exchange rates have lost strength overtime. Initially, the exchange rates appreciate rapidly with moderated fluctuations. Thereafter, in the third quarter of 2003, the exchange rates depreciation becomes rapid. Although, the exchange rate begins to appreciate after a period of sharp depreciation, the fluctuations increase. Thereafter, the exchange rate resumes another period of sharp depreciation until 2004. Then the exchange rates become stable between 2004-2012, compared to the entire period between 2000 to 2021. However, the exchange rates become very volatile during this period, especially before the first quarter of 2004. In the beginning of the third quarter of 2009, the exchange rates depreciate again. From 2012, the exchange rates begin 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 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 incentivize 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, which 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 the exchange rates with monetary variables is not clear, which makes policy making have unclear consequences to 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 to 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 nonlinear regime switching model which assumes the exchange rate behaviour varies. The monetary model estimated in study does not assume constant parameters as previous studies on the ZAR/USD have done. The data used starts from year 2000 to 2020. In this period, SA monetary policy is transparent and clear. The data would provide meaningful insight about the monetary model and the exchange rates determination.

## **4.2 Fundamentals of exchange rates**

Chahrour et al. (2021) explain that the exchange rates are central to the international transmission mechanism of open economies. However, modeling the exchange rates movement remains a challenging exercise in the macroeconomics literature (Bacchetta and van Wincoop, 2011). Tawadros (2019) adds that whether monetary models assume sticky prices, flexible prices or are based on the present value method, when estimated, they are unsuccessfully modeled. This claim is confirmed by Xie and Chen (2019). Klassen (2005) believes that the exchange rates model should be able to accommodate its long swings for it to succeed. Soon and Baharumshah (2021) support Klassen (2005) by emphasizing that exchange rates' large fluctuations often exhibit extreme movements that introduce challenges to the literature, hence the necessity to study exchange rates movement.

There has been 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 (Scott Hacker, 2012). The monetary policy framework of models follows Dornbusch (1976), Frankel (1976) and Bilson (1978) models which analysed the floating exchange rates behaviour over the long-run. Frankel (1979) combined the monetary models of floating exchange rates which assume flexible prices of Bilson (1978) and Frankel (1976), with Dornbusch (1976), components of sticky prices. The work done by Frankel (1976), model can be used to consider the validity of 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). Secondly, by making additional theoretical assumption which show a positive

relationship between prices and nominal interest rate for exchange rate determination to be true (Benigno et al., 2007). Consequently, monetary models tend to show that the interest rate differential is positively related to the domestic exchange rates (Frankel, 1976).

Kim and Lim (2018) found that tight monetary policy results into significant exchange rate appreciation for the domestic currency. Furthermore, the delay in overshooting becomes short relatively. However, if the monetary policy tightening is not expected, the domestic exchange rates respond to it by depreciating (Gurkaynak et al., 2021). Other researchers in the past found the same results which affirm that monetary policy tightening led to the depreciation of the domestic exchange rates (Clarida and Gali, 1994, Eichenbaum and Evans, 1996, Faust and Rogers, 2003). There is empirical evidence showing that the exchange rate fluctuations are monetary policy shocks such as tightening via the interest rates differential (Leduc, 2005).

Bjornland (2008) argues that following a monetary policy shock (a rise in domestic interest rate), the domestic exchange rates initially depreciate and thereafter, it appreciates. However, Engel (2016) shows that the impact of the interest rates on the exchange rates is not clear, therefore, the interest differential. The interest rates change in the short-run leads to the domestic exchange rates appreciation (Farhi and Gabaix, 2016). While Engel (2014) 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., 2015). In this sense, the later 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, the higher interest rates today mean in the future they can be expected to fall (Ozmen, 2017). Accordingly, the exchange rates can be expected to depreciate in the future. Consequently, higher interest rates increase the risk of the exchange rate depreciation in the future (Dimitriou et al., 2013). As a result, the implication of high interest rates is that they are less risky, which means they are not risky. In this situation, this introduces the impact of the interest rates on the exchange rates, therefore, interest



differential.

Lian (2014) considered a relationship between the interest rates differential, and the exchange rates have interdependence. However, Hoffmann and MacDonalda (2003) showed that the relationship between the exchange rates and the interest rates differential is weak. While Ozmen and Yilmaz (2017), found that the relationship between the exchange rates and the interest rates differential differs across countries. However, Valchev (2015), states that the relationship between the exchange rates and the interest rates differential changes depending on the horizon.

Engel (2013) argues that currencies do not depreciate sufficiently to offset the interest rates 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 random walk (backman, 2013). Varlchev (2015) adds that high domestic interest rates do not cause the exchange rates to depreciate sufficiently. Whereas, Hoffmann and MacDonald (2009), shows that the interest rate differential does lead to sufficient exchange rate depreciation. That is, when there is expected exchange rates depreciation.

Tervala (2010) shows that money supply shock does not cause the exchange rates to follow random walk. Instead, the exchange rates undershoot their long-run value. The results are contrary to what Bjornland (2009), who argues that the exchange rates overshoot.

There effects of monetary policy shocks have heterogeneity overtime 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 their relation to macro-fundamentals. This demonstrates the exchange rates’ basic disconnect to macroeconomic fundamentals. However, recently a growing number of studies claimed some degree of success in modelling the exchange rate behaviour (see, for example, Beckmann et al 2012; Dabrowski et al. 2014, among others). Xie and Chen (2019) challenge these findings on the basis that the differences in the findings are due to 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).

Modeling exchange rate movements remain a challenging exercise in the macroeconomics literature. Changes in exchange rates have substantial effects on employment, prices, interest rates and productivity. Roggof and Meesa's (1983) ignited huge interest to study 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 (Keiln and Shambaugh, 2012). Oleka et al. (2014) 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 (Mohammaed and Abdulmuahymin 2016).

When the central bank puts in place strict foreign exchange control polices, the domestic currency appreciates in the long run (Isola et al., 2016). Pham (2019) confirms these findings. When the central bank decides to tighten the interest rate, the exchange rates appreciate and subsequently depreciates. 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 of domestic interest rates requires 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 Du et al. (2018), among others, who also discussed the impact of money demand on the behaviour of exchange rates through interest rates variation. When the interest rate is higher, it attracts investors to move capital into the domestic country, which increases demand for the home 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 Phisutthiwatcharavong (2015) argued that monetary base and the exchange rate do not have a significant relationship. Instead, they suggest that international reserves determine behaviour of exchange rate. 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 into the exchange rate appreciating. However, the results are mixed for the case of a non-floating exchange rate regime in the long-run (Ibhagui, 2019).

### 4.3 Theoretical Discussion

This study follows Tari and Gözen's (2018) model, which is developed from Frenkel's (1973) monetary model. We also applied the assumptions in Cushman (2007), supposing foreigners do not hold a currency of another country. In addition, demand for assets depend on the interest rate. Now we define the demand for assets and wealth constraints as

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

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

here  $H$ , denotes assets of SA residents dominated in Rand(ZAR),  $F$  is the assets of USA citizens dominated in the USD. Then  $i, i^*, Y$  and  $Y^*$  respectively, represent the

domestic interest rate, foreign interest rate, domestic nominal income, and foreign country's nominal income. Equation (1) means that SA citizens hold assets dominated in Rands, and therefore, equations (2) shows that USA domestic residents hold asset dominated in USD. The SA and USA citizens can choose to hold asset in both countries. The is 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  $Z_F$  , respectively denotes SA assets held by domestic residents, and SA assets in the hands of USA citizens respectively. Moreover,  $W_H$  and  $W_F$  respectively represent home country wealth and foreign citizens' wealth. Where  $S$  represents the domestic currency price for a foreign currency(  $e$  denotes the logarithm of the exchange rates)  $S = \frac{ZAR}{USD}$ . Moreover,  $E$  represents expectation. In equation (3) and (4), the interest differential is an increasing function of the exchange rates Moreover, the  $\delta_H$  and  $\delta_F$  have the value between 0 and 1 in equation (3) and (4).  $\delta_H > \delta_F$  assumption is imposed for deterministic asset preference. The SA citizens demand for USA asset is shown by

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

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

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

$$W_H = SJ_H + Z_H + H_H \quad (7)$$

$$W_F = SJ_F + Z_F + F_F \quad (8)$$

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

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

and

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

The (9) and (10) are linearized following Frenkel (1983), as shown below

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

and

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

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  $I(0)$ . The equation (11) represents domestic investors, while (12) represents foreign investors. The demand for a country's asset is also dependent on the country's international liability. There is a section of non-monetary wealth held as net foreign liability. Thus, asset demand in (3), (4), (5) and (6) is not unit elastic regarding wealth, if it is assumed that elasticities are positive. See below.

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

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

If 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 one, 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 (1973) and Cushman (2007) 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 asset to make the differential variables. A simple Threshold Autoregression (TAR) model initially introduced by Tong (1983), which is an autoregressive analysis of the variable of interest. The TAR models are non-linear. Boero and Marroucu (2002) also showed evidence of nonlinear models performing better in modelling the exchange rate. Wang (2019) confirms that non-linear models perform better in modeling the exchange rates.

#### 4.5 Estimating Technic

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,  $\theta$  is such that if the null hypothesis is  $\theta = 0$  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,  $\gamma_t$  is independently identified (iid). Following Enders and Siklos (2001),  $\mu_t$  is estimated and it can be modified by including lags. If symmetry is assumed, then the changes in  $\mu_t$  and  $\mu_{t-1}$  are same. However, when prices are sticky downwards, then assuming symmetry and linearity leads to misspecification. The chapter adopts Chen, et al. (2005) specification, which permits asymmetric adjustment from the long run following a TAR process such that

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

where  $I_t$  is the indicator function such that

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

and  $\delta$  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  $\delta$ . 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  $\mu_t$  gets 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 (16) coefficients  $(\mu_1, \mu_2)$  represent speed of adjustment to long run equilibrium. If  $\mu_{t-1} \geq \delta$  then  $I_t = 1$  and the speed of adjustment becomes  $\mu_1$ . Alternatively, if  $\mu_{t-1} < \delta$  then  $I_t = 0$  the speed with which the deviation adjusts back to equilibrium becomes  $\mu_2$ . Therefore, in the situation where  $|\mu_1| > |\mu_2|$  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 making 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 to the exchange rate.

#### 4.6 Data and Variables

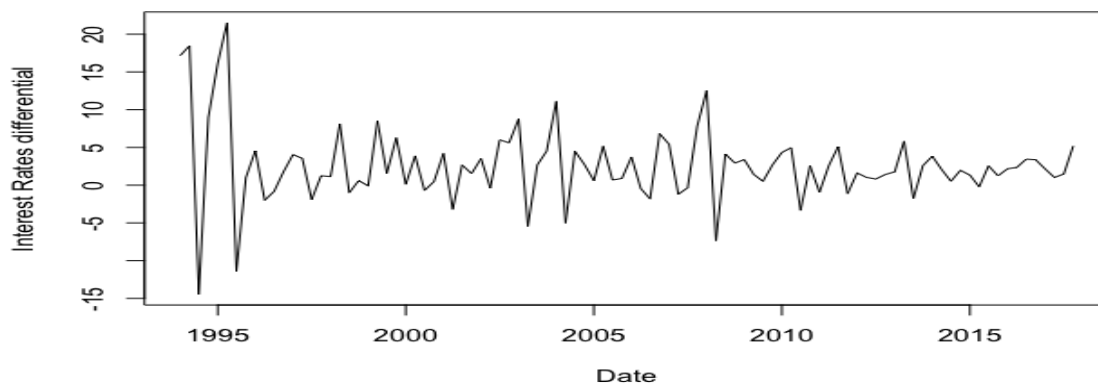
The sample is from 1994 quarter 1 to 2018 fourth quarter (The data on economic policy uncertainty was discontinued in 2018, so we could not collect data to the close date). The data used in the study is collected from the Federal Reserve Bank of St' Louis. The study examines the exchange rate behaviour of the South African Rand (ZAR) against the United States of American Dollar (USD), (ZAR/UDS) 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 USA interest rates. Where  $f$  is the domestic debt for SA, denotes the USA debt, and is the economic policy uncertainty. The economic policy uncertainty is a differential is given by  $Pol$ . The estimating equation is show below;

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

#### 4.6.1 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 70's work mentioned in Towadros (2018), Ismailov and Rossi (2018), Du et al. (2018), and Mohammed and Abdulmuahymin (2016). The higher interest rates relative to the rest of the world, the more exchange rates are expected to appreciate Bahamani-Oskooee and Bahmani (2015). If the opportunity cost of holding money is low, the exchange rate will depreciate. Bahamani-Oskooee et al. (2020) explains that when the domestic interest rates increased, the interest rates differential changes. Velchev (2015) shows the interest rate differential has a positive relationship with the exchange rate. The following figure shows the interest rate differential.

Figure 4.1: Interest Rate differential for SA and USA (1994q1 – 2018q4)



*Source: Author compilation*

The interest rates differential was very wide in the mid-1990s until 1995(see Figure 4.1). The large spikes in the interest rates differential might have been caused by the high interest rates SA experienced throughout the 1990s. The spikes became smaller

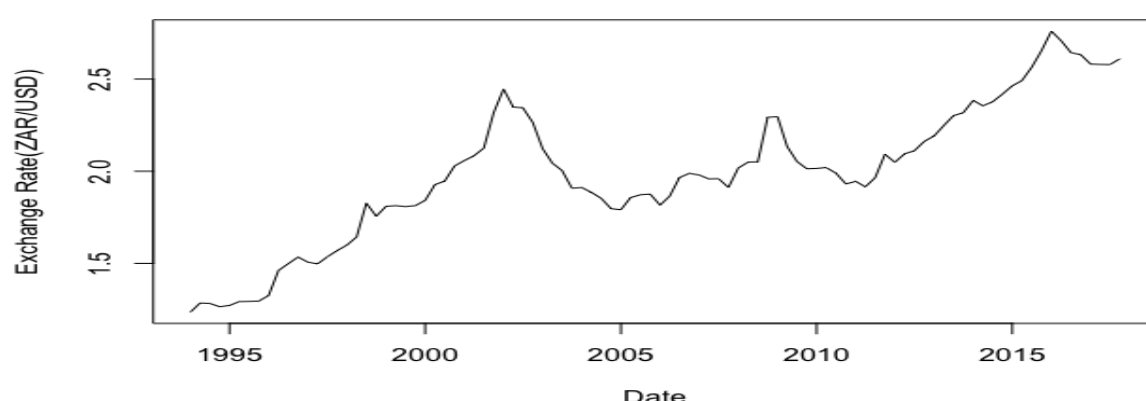


from 1995 second quarter, which shows the interest rates were not changing excessively in relation to each other whenever they were adjusted. However, in 2003-2004, the interest rate differentials had larger spikes compared to the period between 1996 – 2004 third quarter (see Figure 4.1). In the period between 2005 to 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 rates differential did not have much volatility.

#### 4.6.2 Exchange Rates

The theory assumes that monetary variables have effect on the exchange rate behaviour, see among others, Keiln and Shambaugh (2012), Oleka et al. (2014), 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 show the exchange rate.

Figure 4.2: The Exchange Rates (ZAR/USA)(1994q1 – 2018q4)



Source: Author compilation

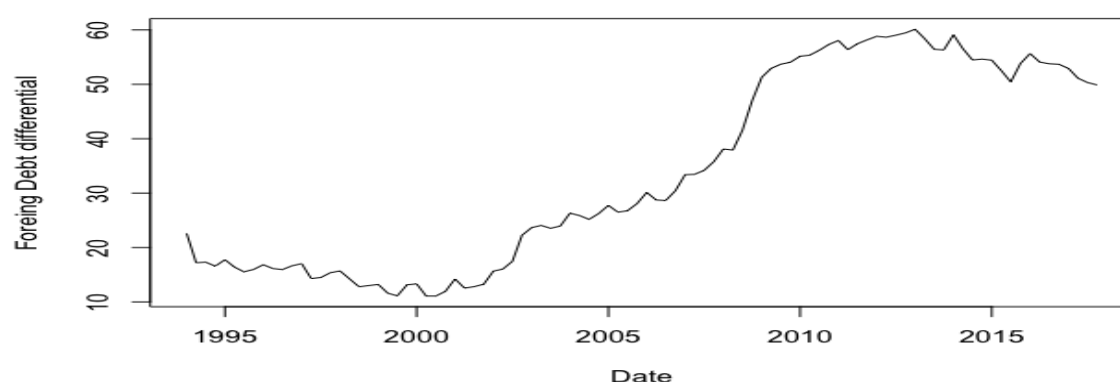
The exchange rates show the ZAR depreciated rapidly against the USD between 1994 2003 (see Figure 4.2). Thereafter, the ZAR gained strength until 2005. However, in

the period between 2005 – 2008, the Rand was stable against the USD (see Figure 4.2). 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 4.2).

#### 4.6.3 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 that might increase the debt burden on them. The domestic debt is measured as the public debt, which are loans government take 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;

Figure 4.3: The Domestic debt differential between SA and USA (1994q1 – 2018q4)



Source: Author compilation

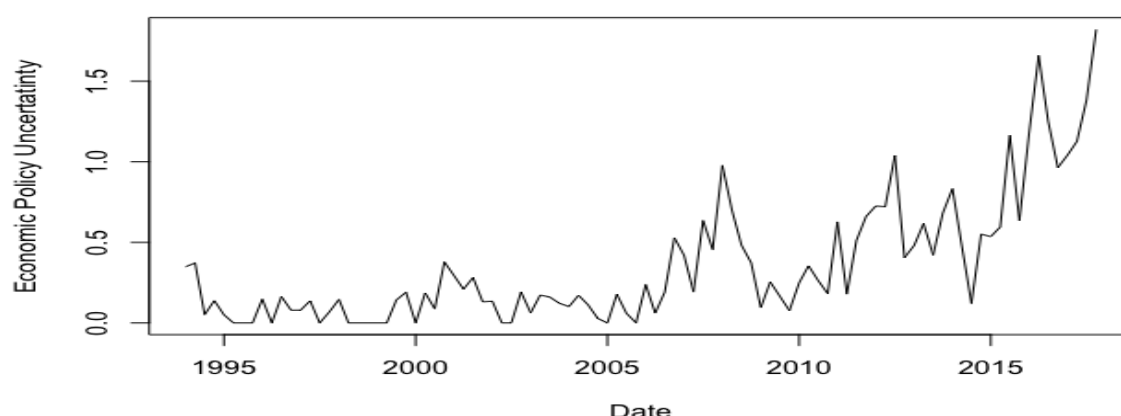
The domestic debt differential declined from the mid-1990s – 2002(see Figure 4.3). Thereafter, the debt differential increased rapidly until 2014. The domestic debt differential does not show any volatility, which indicates government projects between

the two nations are correlated. The behaviour of the domestic debt differential shows that there might be strong government involvement in both countries' economies.

#### **6.6.4 Political Uncertainty (economic policy uncertainty) (1994q1 – 2018q4)**

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 criticized 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 Henry and Pesaran, 1993; Almeida et al., 1998; Almeida et al., 2003). Since the mid 1980's, 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 discussed the impact of news on exchange rates extensively. Jabeen et al. (2020) argue that macroeconomic news have a significant impact of and on the fluctuations of the exchange rate. Moreover, the foreign exchange rates tends to move nearly instantaneously upon an announcement of macroeconomic news. There are considerable studies examining exchange rates responses to news or announcements (see, for example, Caporale et al., 2018; Gau and Wu 2017; Fatum et al., 2012, 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 Wei et al. (2015) and Lu and Wei (2013), political and public news play a dominant role in determining the direction of the economy. Kose (2017) adds that announced favourable political information attracts investors. Rehman et al. (2021) mention that political information has the ability to move or maintain stability of macroeconomic variables. The following figure depicts economic policy uncertainty;

Figure 3.4: Economic Policy Uncertainty(political risk for SA) (1994q1 – 2018q4)



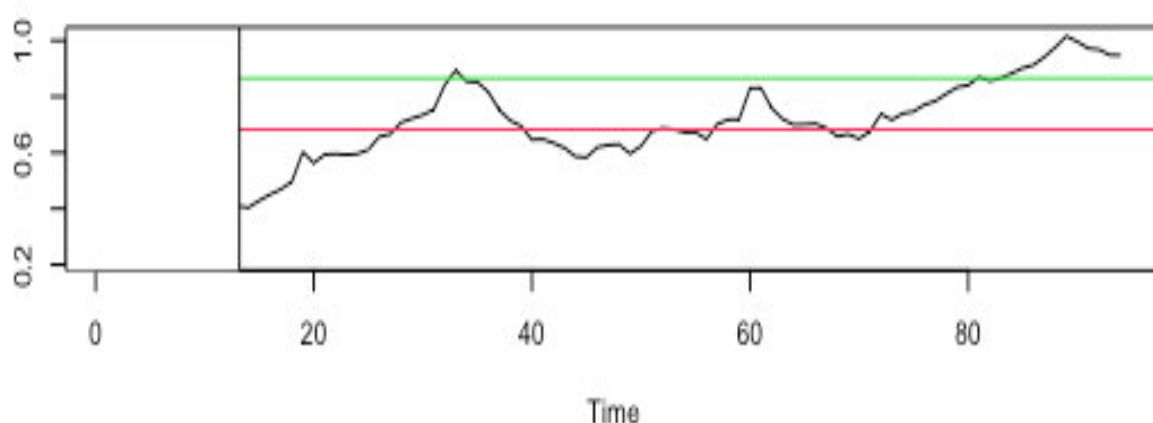
*Source: Author compilation*

In the period between 1994 – 2000, economic policy uncertainty in SA was low (see Figure 4.4). However, from year 2000 – 2002, economic policy uncertainty increased then declined to its previous levels. After 2002, the economic policy uncertainty increased then decreased in 2005(see Figure 4.4). The period after 2005 uncertainty about economic policy began to increase to the highest level in 2008. Then it declined until 2009, and thereafter, economic policy uncertainty has been increasing.

#### **4.7 Results**

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

Figure 4.5: Threshold Variable (Exchange rates) (1994 – 2018)



*Source: Author compilation*

The vertical axis measures the exchange rates, and in the horizontal axis, date (time) is measured (see Figure 4.5). There are two estimated threshold values for the exchange rates behaviour, therefore, three regimes. The threshold values are 0,7169 and 0,8655, respectively the lower limit (indicated by the red line) and upper limit (represented by the green line) (see Figure 4.5). The first regimes occur when the exchange rate behaviour is strictly below 0,7169 ( $\delta < 0,7169$ ) (see Figure 4.5). Furthermore, regime two occurs when the exchange rate behaviour is between 0,7169 and 0,8655 ( $0,7169 \leq \delta \leq 0,8655$ ). Finally, the 3<sup>rd</sup> regime occurs when the exchange rate behaviour is strictly above the 0,8655 ( $\delta > 0,8655$ ) (see Figure 4.5).

We estimate the TAR model to evaluate the impact of the monetary variables on the exchange rate behaviour. The results of the TAR model are shown in the following table.

Table 4.1: Threshold Autoregressive Model

Variables	exchange rates	Interest rates	economic policy	domestic debt
			uncertainty	
exchange rates (-1)	1,0229	0,0561	-0,0148	0,2547
exchange rates (-2)	-0,0444	-0,0879	0,0379	-0,3436
lower Threshold value = 0,6827				
exchange rates (-1)	1,2225	-0,0252	0,0391	1,5291
exchange rates (-2)	-0,3317	-0,4269	0,0217	1,3486
upper Threshold value = 0,8655				
exchange rates (-1)	1,1273	-0,4738	-0,0222	0,1217
exchange rates (-2)	-0,4051	-1,1136	0,0413	-0,1352

The numbers in the  
parenthesis represents the  
lags

*Source: Author compilation*

In regime 1 (lag 1), If the exchange rates depreciate, the likelihood that they will continue to depreciate is higher (see Table 4.1). The likelihood that the exchange rates depreciate increases if the interest rates differential increases. This could be resulting from capital flow as the interest rates change, and the investors might be seeing the USA capital market as more profitable. The increase in economic uncertainty rises the likelihood of the exchange rates appreciating. These results are not expected because they are counter intuitive. This can only make sense if the economic policy is not

compatible with the market operations and requirements. Hence, its failure would result in a favorable condition for the economy in general.

If in lag 2 the exchange rates depreciate, the likelihood that the exchange rates appreciate increases (see Table 4.1). This is expected because, for example, if the exchange rates depreciate in  $t-2$ , economic agents expect it to appreciate in the future. The future exchange rate appreciation is expected because exchange rates revert to equilibrium. So, the exchange rate depreciation in  $t-2$  leads economic agents to expect an appreciation in the future period (see Table 4.1). In lag 2, an increase in the interest rate differential increases the likelihood that the exchange rate appreciates, while the increase in economic policy uncertainty rises the likelihood of an exchange rates depreciation. If domestic debt increases, the likelihood that the exchange rate will appreciate increases. This is expected because if the domestic debt increased in  $t-2$ , then in period  $t$  it would be expected that some of it is paid. Therefore, if the economy is able to service interest on its debt, it becomes a signal for it being a well-managed economy. This means that more capital is likely to flow into the country, thereby leading to an exchange rates appreciation.

In regime 2, when the exchange rate has been stable in  $t-1$ , the likelihood that the exchange rates will depreciate increases (see Table 4.1). This shows that there might be some unobserved factors acting on the exchange rate. An increase in the interest rate differential increases the likelihood that the exchange rates will appreciate. On the other hand, an increase in economic policy uncertainty raises the likelihood that the exchange rates will depreciate. This is not surprising since an increase of the debt might lead to increase in speculation about the exchange rate behaviour.

In  $t-2$  when the exchange rates are stable, the likelihood of an appreciation increases. This is expected. Furthermore, an increase in interest rate differential rises the likelihood of an exchange rates appreciation (see Table 4.1). However, the increase in economic uncertainty policy and domestic debt raises the likelihood of an exchange rates depreciation.

In regime 3 at lag 1, the likelihood of the exchange rate depreciation increases. However, the rise in interest rates differential increases the likelihood of the exchange rates appreciation (see Table 4.1). Furthermore, the increase in the economic policy uncertainty by 1 unit raises the likelihood of an exchange rate appreciation. This might mean that economic policy is counterproductive. Hence, either a change or failure of the economic policy is believed may result in a favorable economic environment, while an increase of the domestic debt by one unit increases the likelihood of the exchange rates depreciation.

At lag 2, if the exchange rates were depreciating, the likelihood that it appreciates in the current period would increase (see Table 4.1). These results are expected because an exchange rates depreciation in  $t - 2$  means that in the future, an appreciation is expected (see Table 4.1). The exchange rates deviation from equilibrium cancels out in the long run. Moreover, if the interest rates differential increases marginally, the likelihood that the exchange rates will appreciate increases. However, an increase in the economic policy uncertainty increases the likelihood that the exchange rates will depreciate, while an increase in domestic debt increases the likelihood of an exchange rates appreciation. This might mean that after some time, if the economy is able to service interest on its debt, a favourable image of the economy emerges. This positive view of the economy leads to more capital inflow into the economy.

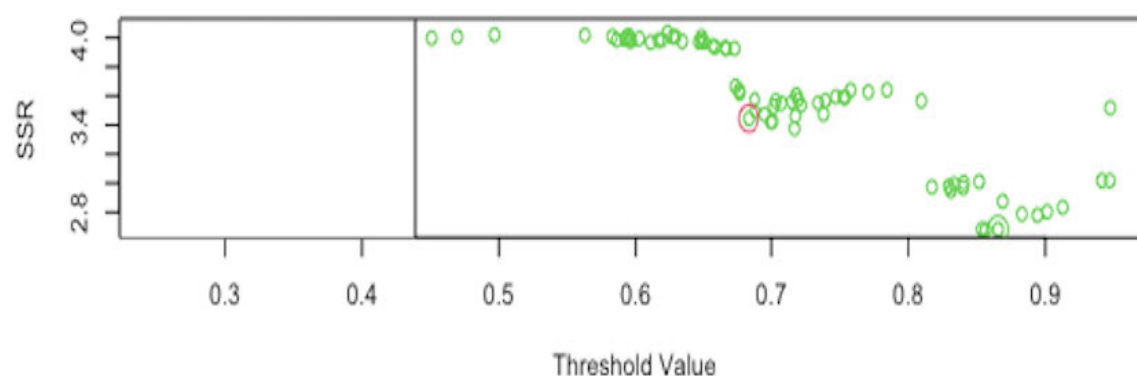
We then perform a grid search using the sum of squares by contraction of the objective function. Given the threshold is estimated through the maximum likelihood, the minimization problem can be reduced through the estimated threshold  $\beta(\hat{\delta})$ . Therefore, the objective function is given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

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

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



Figure 4.6: Grid search for the optimal behaviour of the exchange rate (1994 – 2018)



Source: Author compilation

The monetary variables have optimal effect on the behaviour of the exchange rate when it is in regime 2 (see Figure 4.6). The monetary variables are more likely to drive the exchange rate movement when fluctuations are moderate.

This means that exchange rate behaviour can be assessed to determine how it responds to the shock of each monetary variable. The table below shows the estimated impulse response function (irf) of the exchange rates. The monetary variables are used to shock the exchange rates. The negative and positive sign next to the coefficient, respectively, are appreciation and depreciation. The first table shown below corresponds with regime 1, which is the exchange rate behaviour below 0,7169 percentage points.

The following three tables present results for the impulse response functions.

Table 4.2: Impulse Response Function Coefficients of the Exchange Rates in Regime 1

period	exchange rates	interest rates differential	economic policy uncertainty	domestic debt differential
[1,]	0,0204	0,0000	0,0000	0,0000
[2,]	0,0111	-0,0052	-0,0093	-0,0091
[3,]	0,0105	-0,0100	-0,0049	-0,0068
[4,]	0,0088	-0,0058	-0,0076	-0,0089
[5,]	0,0046	-0,0058	-0,0072	-0,0079
[6,]	0,0047	-0,0075	-0,0083	-0,0079
[7,]	0,0035	-0,0071	-0,0072	-0,0078
[8,]	0,0027	-0,0067	-0,0086	-0,0084
[9,]	0,0025	-0,0072	-0,0078	-0,0093
[10,]	0,0014	-0,0072	-0,0095	-0,0100
[11,]	0,0021	-0,0081	-0,0118	-0,0110

Impulse response function coefficients of the exchange rates of regime 1, The negative and positive signs respectively mean appreciation and depreciation,

*Source: Author compilation*

In regime 1, the exchange rates is always more likely to respond by depreciating if its values are below 0,6827 percentage points(see Table 4.2). This gives the impression that the exchange rate behaviour below 0,6827 percentage points result to a further depreciation. Furthermore, a marginal increase in the interest rates deferential leads to the exchange rate depreciation in all periods. However, the exchange rates do not respond instantaneously to changes in the interest rates differential. The exchange

rates respond with a lag to a change of the interest rates differential. In addition, the exchange rates respond with a lag to the shock of economic policy uncertainty. The lagged response might be indicating that economic agents take time and evaluate how economic policy influences the economy. In the event where the outcome is favourable, it leads to an exchange rate appreciation. Moreover, domestic debt differential causes a lagged exchange rates response. The exchange rates respond by appreciating. This could mean that the market initially waits to observe if the economy is able to service its interest on debt or not. If the observations reveal that the economy manages its debt efficiently, then the exchange rates result by appreciating.

The following table shows the irf coefficients of the exchange rates in regime 2. In regime 2, the exchange rates fluctuate between 0,6827 and 0,8655 percentage points. The exchange rates were more stable in this regime as shown in figure 5. In addition, in figure 6 we were able to see that the exchange rates are optimal at this regime.

Table 4.3: Impulse Response Function Coefficients of the Exchange Rates in Regime 2

period	exchange rates	interest rates differential	economic policy uncertainty	domestic debt differential
[1,]	0,0299	0,0000	0,0000	0,0000
[2,]	0,0299	0,0025	-0,0024	0,0017
[3,]	0,0295	-0,0017	0,0036	0,0015
[4,]	0,0308	-0,0019	0,0044	-0,0001
[5,]	0,0310	-0,0002	0,0071	-0,0004
[6,]	0,0310	-0,0005	0,0086	-0,0002
[7,]	0,0316	-0,0010	0,0114	-0,0007
[8,]	0,0323	-0,0008	0,0130	-0,0010
[9,]	0,0329	-0,0007	0,0152	-0,0012
[10,]	0,0337	-0,0008	0,0171	-0,0014
[11,]	0,0347	-0,0008	0,0193	-0,0016

Impulse response function coefficients of the exchange rates of regime 2. The negative and positive signs respectively mean appreciation and depreciation.

*Source: Author compilation*

The exchange rates shock on itself is likely to lead to a higher depreciation in all periods, while interest differential shock to the exchange rates produces lagged response(see Table 4.3). However, in the second period, the exchange rates depreciate when responding to an interest rate deferential. This might be caused by the strong attractiveness of the USA capital market to the SA one. Thereafter, in the remainder of the periods, the exchange rates respond by appreciating to an interest rates differential shock in all periods. While economic policy uncertainty shock on the exchange rates is lagged, in the second period the exchange rates respond by

appreciation. In the subsequent periods, the exchange rates depreciate when there is a shock of economic policy uncertainty. The exchange rates respond with a lag on the shock of domestic debt differential. In the second and third period, the exchange rates depreciate if there is an economic policy shock. However, in the subsequent periods, the shock of domestic debt differential leads to an appreciation of the exchange rates. This may be explained by the sense of confidence on the economy. The confidence is produced by the ability of the economy to meet its interest payment on previously acquired domestic debts.

The following table shows the irf coefficients in regime 3. This is when the exchange rates fluctuate above 0,8655 percentage points. Figure 5 shows that the exchange rates in this regime have the highest values of fluctuation. In the following table, we show the response of the exchange rates to the shock of the monetary variables.

Table 4.4: Impulse Response Function Coefficients of the Exchange Rates in Regime 3

period	exchange rates	interest rates differential	economic policy uncertainty	domestic debt differential
[1,]	0,0304	0,0000	0,0000	0,0000
[2,]	0,0332	0,0067	0,0043	0,0079
[3,]	0,0331	0,0044	0,0100	0,0077
[4,]	0,0373	0,0026	0,0129	0,0076
[5,]	0,0377	0,0034	0,0168	0,0090
[6,]	0,0391	0,0040	0,0179	0,0088
[7,]	0,0399	0,0032	0,0218	0,0087
[8,]	0,0420	0,0039	0,0248	0,0081
[9,]	0,0443	0,0055	0,0283	0,0099
[10,]	0,0476	0,0061	0,0316	0,0095
[11,]	0,0506	0,0047	0,0337	0,0101

Impulse response function coefficients of the exchange rates of regime 3. The negative and positive signs respectively mean appreciation and depreciation.

The shock to the exchange rates to itself leads to a depreciation(see Table 4.4). This response might be driven by the bandwagon effect of the exchange rates depreciation. The depreciation of the exchange rates leads economic agents to continue expecting it to depreciate further. The literature does discuss the exchange rates bandwagon effects, see among others (Frenkel et al. (2012), Rötheli, (2002)). The shock of the interest rate differential is lagged but leads the exchange rates to depreciate in all periods. At higher levels of exchange rates depreciation, the bandwagon effects or the unobserved factors might be dominant. If the pressure of bandwagon effect or

unobserved factors outweighs the interest differential, this leads the exchange rates to exhibit an unexpected behaviour. While the economic policy uncertainty shock produces a lagged exchange rates impulse response, the exchange rates depreciate in response to economic policy uncertainty, which is expected. Moreover, the domestic debt differential's shock to the exchange rates has lagged impulse response. In addition, the exchange rates depreciate in all the periods when shocked by the domestic debt differential.

## **4.8 Conclusion**

In this chapter, the model used in estimation accounts for structural breaks, which is what most estimating techniques used in previous studies cited above omitted. This allows making an inference on the data without a risk of bias results. The TAR model estimated two thresholds which separate the exchange rates 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 lag 1 leads to an exchange rates depreciation, this only occurs when the exchange rates fluctuate below 0,68 percentage points. In all other regimes, the increase in interest rate differential leads to an exchange rate appreciation. The impact of economic policy uncertainty and domestic debt on the exchange rates vary depending on the lag length both in regime 1 and 3. In regime 2, the exchange rates respond to the monetary variables changes in line with the predictions of the monetary theory of exchange rates determination.

SARB should aim to keep the exchange rates fluctuating between 0,68 and 0,87 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 appreciation. If the SARB wants to improve the value of the exchange rate, they should increase the interest rates in regime 2 and 3. Furthermore, the shock of the interest rates is lagged, so the effect will only be realized in the following period.

# CHAPTER FIVE: CONCLUSION

## 5.1. Conclusion

Historically, South Africa has always struggled with the behaviour of the exchange rates. Being part of the currency union came with challenges that were not easy to deal with. And switching between pegging and having a dual exchange rates system still presented challenges of the exchange rates behaviour. The major difficulty has been on the management of the factors that influence the behaviour of the exchange rates. The South African Reserve Bank and the government, over the past, invested a lot of efforts in controlling monetary variables.

In some instances, the study shows that monetary variables have effect on the behaviour of the exchange rates. In this case, the exchange rates tend to exhibit expected behaviour when the monetary variables change. Equally, the study reveals that there are occasions where the exchange rates do not respond as expected when the monetary variables are varied. As noted, the exchange rates have been found to be disconnected from their fundamentals (see Leigh et al., 2017; Messe and Rogoff, 1983).

In this situation, the unobserved factors have been associated with the exchange rates' disconnect to their macroeconomic fundamentals. In chapter 2, the effect of the private information is acknowledged, some of which may be associated with unobserved factors. With that said, the exchange rates behaviour gives the impression that there is an unknown factor pushing to an opposite direction than the one expected. In brief, the exchange rates tend to exhibit unexpected behaviour, which is not in line with the monetary determination of exchange rates. Consequently, this makes the relationship between the exchange rates and monetary variables not clear.

In Chapter 2, we set to evaluate the effect of exchange rates expectations on the exchange rates behaviour. We used the short run dynamics of expectations of the exchange rates to evaluate if they will have an impact on the exchange rates. Since expectations of exchange rates are hard to observe, they are not easy to control for the effect of the expectations of exchange rates on the exchange rate itself.



However, the microstructure approach makes it possible to evaluate the effect of expectations of exchange rates. Further, the microstructure approach makes use of detailed data of transactions of traders in the asset market. Using this approach, we use the imbalances of information between the two traders to determine the behaviour of the exchange rates.

The results show that expectations of exchange rates appreciation during regime 1 lead to exchange rates appreciation. To illustrate, this means the publicly available information is able to drive the exchange rate when it is regime 1. The signal, in this case, the available information used to form expectations of exchange rates is consistent with private information that drives the exchange rate behaviour. For instance, in regime 1, the exploratory power of expectations can be associated with a channel of transmission which is due to available information. The literature also supports this finding. Taylor (1995) states that the behaviour of the exchange rates represents the change of expectations.

However, in regime 2, the exchange rates respond with a depreciation when it is expected that the Rand will appreciate against the USD. In spite of expecting the domestic exchange rates to appreciate, the Rand depreciates against the USD. Interestingly, these results suggest that the information in the public domain used to form expectations does not matter in regime 2. As has been noted, this may indicate that there is an unknown factor acting on the exchange rates. Lastly, in regime 3, the exchange rates do not behave consistently with the exchange rates expectations.

Now let's consider expectations of exchange rates depreciation. The exchange rates appreciate in both regime 1 and regime 2. These results show that the exchange rates do not respond in accordance with expectations of exchange rate depreciation. As noted, the exchange rate behaviour suggests that there is an unknown factor influencing the exchange rates. It appears that the unknown factors have more influence on the exchange rates behaviour than expectations of exchange rates depreciation in both regime 1 and 2. In regime 3, expectations of exchange rates depreciation seem to have an influence on the exchange rates behaviour.

In chapter 2, we find that the expectations of exchange rate have an impact on the exchange rate behaviour in some situations. However, the impact of exchange rates expectation on the exchange rates depends on the regime. This indicates that the impact of exchange rates expectations on the exchange rates behaviour is limited. In fact, in most cases the exchange rates do not respond to expectations of exchange rates.

The microstructure approach tells us that the information available in the public domain used to form expectations of exchange rates is not always relevant. Therefore, the expectations of exchange rates are not the main driver of the exchange rate behaviour. The information used to form expectations of exchange rates relies on signals. The signal sometime is not read correctly, which leads to the formation of incorrect expectation of exchange rates. Thus, private information seems to be the one that determines the exchange rates behaviour in many cases.

Furthermore, the results also reveal that the exchange rates behaviour is asymmetric to the expectations of exchange rates. The asymmetric effect of the exchange rate behaviour is in two dimensions. Firstly, within the positive/negative shock, that is expectations of exchange rates depreciation/appreciation. For instance, in all three regimes, the coefficients of the same variable are not similar. This is a sign that the exchange rates impact is different, depending on the exchange rates regime. Secondly, if we compare both the expectations of exchange rates depreciation and appreciation, the coefficients are different. Moreover, even the responses of the exchange rates to both shocks are different. This shows that the exchange rate response is asymmetric to expectations of exchange rates.

In chapter 3, we discussed the developments made by authorities to open up the economy to international trade. The more open to trade a small economy like SA becomes, the more the level of income can be expected to increase. Therefore, being more open and having higher income can be associated with higher foreign investment, hence, higher local production and exports. In this case, becoming more open to international trade should create expectations of higher income.

Furthermore, in chapter 3, we showed through discussion that the literature concedes to exchange rates being driven by expectations of macroeconomic fundamentals. This allowed us to investigate the connection between the exchange rates and the

expectations of future higher/lower income. The expectations of income are measured using mineral reserves.

The foreign investors engage in mineral reserve exploration, as well as other research and development activities. The exploration is done to determine the remaining number of minerals underground. And then, the research and development are conducted to find new deposits, and to determine the means of not depleting the remaining mineral reserves rapidly. Evidently, when new discoveries of mineral reserves are made, higher income can be expected in the future. Similarly, if there is a breakthrough technology that prolong the consumption/use of existing minerals, the level of income can be expected to be higher in the future. Conversely, when the opposite happens, the level of income can be expected to be lower in the future.

The expectations of higher income are tested to value if they influence the behaviour of the exchange rates. The expectations of income are decomposed into positive and negative components, respectively, expectations of higher income and expectations of lower income. The results reveal that, firstly, if expectations of income were formed in  $t-1$ , they lead to an exchange rates appreciation. Evidently, these results are consistent with what we showed theoretically. Furthermore, they are consistent with what Hayat et al. (2013) proposed. Secondly, when expectations of higher income are formed in  $t-2$ , the domestic exchange rates respond by depreciating.

In this instance, the exchange rate behaviour is not expected. These results are not in line with Frankel (2007), who found that the SA Rand is influenced by commodities, hence, these results are not affirming the conclusion. However, as previously noted, the literature shows that the exchange rates sometimes cannot be linked to their fundamentals. Thus, this behaviour can be perceived as showing that there are other unknown factors affecting the exchange rates.

The impact of the expectations of higher income in  $t-1$  and  $t-2$  produces different exchange rate behaviour, and the probabilities are different. This shows that the exchange rate behaviour is asymmetric to expectations of income.

While the expectations of lower income in both periods  $t-1$  and  $t-2$  lead the exchange rates into an appreciation, these findings are not expected, but as noted, this behaviour of the exchange rates shows signs that it is subject to unknown factors.

The expectations of lower income should lead to a depreciation of the domestic exchange rates. On the other hand, this shows that the exchange rates and the expectations of lower income have an inverse relationship, which is that expectations of lower income lead to an appreciation of the exchange rates. Lastly, the probabilities indicating the exchange rates response to expectation of lower income are different. The different probabilities are an indication of asymmetric response to expectations.

The cointegration shows that the domestic exchange rates have a relationship with the expectations of income in the long run. Yet, when there is a shock on the expectations of income, the domestic exchange rates deviate from the long-run and never revert back. Moreover, the error correction term does not have significant results, however, it has a correct sign that shows the exchange rates can adjust back to the long-run level.

If the exchange rates do not revert to long run, this means that the domestic exchange rates have multiple equilibria. However, the impulse response functions could not confirm this because the results were not significant. Nevertheless, insignificant results are still results. Therefore, we can say that there is a chance that the exchange rates are explosive, but this is based on results that are not significant.

In chapter 4, we set out to evaluate if the variations in monetary variables have effect on the exchange rates behaviour. Despite the great interest in investigating the monetary model of exchange rate determination, the exchange rates behaviour remains challenging in the macroeconomic literature.

In chapter 4, we used the TAR model to estimate the number of thresholds that can be used to analyse the exchange rate behaviour. We found two thresholds, and the two thresholds give 3 regimes. In regime 1, at  $t - 1$ , we found that an increase on interest rate differential leads to a domestic exchange rate depreciation. This finding shows that the exchange rates tend to move in an unexpected manner. Even with the economic policy uncertainty and the domestic debt, the exchange rate shows an unexpected behaviour. In this situation, the exchange rate behaviour can be thought as having a mind of its own.

At  $t - 2$ , but still in regime 1, the results are the opposite of what is obtained in  $t - 1$ . The shock on the interest rate differential increased the probability of the exchange

rate appreciation. Furthermore, the shock on the economic policy uncertainty led to a higher probability of exchange rate depreciation. While the shock of domestic debt increased, the probability of the exchange rate appreciated.

If we take the case of the interest differential, the difference in the two-shocks discussed is time, it means that the timing of the shock on the interest rates differential has an important effect on the behaviour of the exchange rates. The increase in the interest rate differential does not have one effect on the exchange rate behaviour. The higher interest rate may result in an increase in business bankruptcies and capital outflows, which may lead to the exchange rates depreciation. On the contrary, the increase in the interest rates is expected to lead to a domestic exchange rates appreciation. These two effects may be affecting the behaviour of the exchange rates, hence the difference in exchange rates response in the two periods.

In regime 2, at both  $t - 1$  and  $t - 2$ , a change in an increase in the interest rates differential increases the probability of exchange rate appreciation. Additionally, in the same time frame, the economic policy uncertainty and domestic debt resulted in the exchange rates depreciation. In regime 2, the exchange rate behaviour conforms with the predictions of the monetary model of exchange rate determination.

While in regime 3, in  $t - 1$  and  $t - 2$ , the interest rates differential led to the exchange rates appreciation, whereas the results for the economic policy uncertainty and domestic debt are mixed. These results show that the monetary model of the exchange rates determination holds. However, the monetary model only holds under specific conditions. As noted previously, the interest rates differential has more chances to influence the behaviour of the exchange rates, in cases where the exchange rates are stable, or when the exchange rates are already in an appreciation trajectory.

The limitation of the study is that we did not investigate the content of the unobserved factors that may be influencing the exchange rates behaviour. Clearly, there are factors putting pressure against the expected exchange rates behaviour. These factors in most cases have the effects that dominate on the exchange rates than fundamentals.

The results are robust. We used the CUSAM test to verify the robustness of the models

used. Moreover, the models were tested for stability. We found that all the models used in estimation were stable.

In the future, it would be interesting to investigate the formation of unobserved factors influencing the exchange rates. Furthermore, the investigation of the unknown factors should go further to investigate the reasons for their dominance in some cases and not in others. In addition, the exchange rate itself should be used to determine the extent in which it is able to explain itself.

## Reference :

Abid, A., 2020. Economic policy uncertainty and exchange rates in emerging markets: Short and long runs evidence. *Finance Research Letters*, 37, p.101378.

Abramitzky, R. and Boustan, L., 2017. Immigration in American economic history. *Journal of economic literature*, 55(4), pp.1311-45.

Ahmed, H., 2009. Capital flows and real exchange rate overvaluation-a chronic ailment: Evidence from Pakistan. *The Lahore Journal of Economics*, 14, p.51.

Ahmed, R., 2021. Monetary policy spillovers under intermediate exchange rate regimes. *Journal of International Money and Finance*, 112, p.102342.

Alam, M., Uddin, G. and Taufique, K., 2017. The Relationships between exchange rates and stock prices: empirical investigation from Johannesburg stock exchange. *Alam, MM, Uddin, MGS, and Taufique*.

Almeida, A., Goodhart, C. and Payne, R., 1998. The effects of macroeconomic news on high frequency exchange rate behaviour . *Journal of Financial and Quantitative Analysis*, 33(3), pp.383-408.

Almeida, A., Goodhart, C. and Payne, R., 1998. The effects of macroeconomic news on high frequency exchange rate behaviour . *Journal of Financial and Quantitative Analysis*, 33(03), pp.383-408.

Almeida, A., Goodhart, C. and Payne, R., 1998. The effects of macroeconomic news on high frequency exchange rate behaviour . *Journal of Financial and Quantitative Analysis*, 33(3), pp.383-408.

Alvarez, F., Atkeson, A. and Kehoe, P.J., 2002. Money, interest rates, and exchange rates with endogenously segmented markets. *Journal of political Economy*, 110(1), pp.73-112.

Alvarez-Plata, P. and Schrooten, M., 2003. The argentinean currency crisis: A markov-switching model estimation (No. 348). DIW-Diskussionspapiere.

Ames, M., Bagnarosa, G. and Peters, G.W., 2017. Violations of uncovered interest rate parity and international exchange rate dependences. *Journal of International Money and Finance*, 73, pp.162-187.

Andersen, T.G., Bollerslev, T., Diebold, F.X. and Vega, C., 2003. Micro effects of macro announcements: Real-time price discovery in foreign exchange. *American economic review*, 93(1), pp.38-62.

Angerer, S., Bolvashenkova, J., Glätzle-Rützler, D., Lergetporer, P. and Sutter, M., 2021. *Monetary Policy Announcements, Information Shocks, and Exchange Rate Dynamics...*(No. 2021-17).

Angerer, S., Bolvashenkova, J., Glätzle-Rützler, D., Lergetporer, P. and Sutter, M., 2021. Monetary Policy Announcements, Information Shocks, and Exchange Rate Dynamics .(No. 2021-17).

Arendse, A. and Smith, J., 2018. Economic Transformation and Emancipation through Active Citizenship Education. *Education in Modern Society*, p.45.

Arezki, R., Dumitrescu, E., Freytag, A. and Quintyn, M., 2014. Commodity prices and exchange rate volatility: Lessons from South Africa's capital account liberalization. *Emerging Markets Review*, 19, pp.96-105

Arghyrou, M.G. and Pourpourides, P., 2016. Inflation announcements and asymmetric exchange rate responses. *Journal of International Financial Markets, Institutions and Money*, 40, pp.80-84.

Arize, A.C., Malindretos, J. and Igwe, E.U., 2017. Do exchange rate changes improve the trade balance: An asymmetric nonlinear cointegration approach. *International Review of Economics & Finance*, 49, pp.313-326.

Aron, J., Elbadawi, I. and Kahn, B., 1997. *Determinants of the real exchange rate in South Africa*. Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.

Aron, J., Elbadawi, I. and Kahn, B., 1997. *Determinants of the real exchange rate in South Africa*. Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.

Bacchetta, P. and Van Wincoop, E., 2004. A scapegoat model of exchange rate fluctuations (No. w10245). National Bureau of Economic Research.

Bacchetta, P. and Van Wincoop, E., 2013. On the unstable relationship between exchange rates and macroeconomic fundamentals. *Journal of International Economics*, 91(1), pp.18-26.



- Baek, J., 2021. A new look at the oil price-exchange rate nexus: Asymmetric evidence from selected OPEC member countries. *Economic Analysis and Policy*, 70, pp.172-181.
- Bahmani-Oskooee, M., Miteza, I. and Tanku, A., 2020. Exchange rate changes and money demand in Albania: a nonlinear ARDL analysis. *Economic Change and Restructuring*, 53(4), pp.619-633.
- Balcilar, M., Gupta, R. and Jooste, C., 2016. The dynamic response of the rand real exchange rate to fundamental shocks. *Journal of Economic Studies*, 43(1), pp.108-121.
- Balcilar, M., Van Eyden, R., Inglesi-Lotz, R. and Gupta, R., 2014. Time-varying linkages between tourism receipts and economic growth in South Africa. *Applied Economics*, 46(36), pp.4381-4398.
- Barbosa-Filho, N., 2006, November. Exchange rates, growth and inflation. In *Conferencia Annual sobre Desarrollo y Cambio Estructural, Campos do Jordao, Brazil, del* (Vol. 18).
- Barbosa-Filho, N., 2006, November. Exchange rates, growth and inflation. In *Conferencia Annual sobre Desarrollo y Cambio Estructural, Campos do Jordao, Brazil, del* (Vol. 18).
- Barguelli, A., Ben-Salha, O. and Zmami, M., 2018. Exchange rate volatility and economic growth. *Journal of Economic Integration*, 33(2), pp.1302-1336.
- Barro, R.J. and Gordon, D.B., 1981. A positive theory of monetary policy in a natural-rate model.
- Baumann, B.A. and Gallagher, K.P., 2013. Post-crisis capital account regulation in South
- Beber, A. and Brandt, M.W., 2006. The effect of macroeconomic news on beliefs and preferences: Evidence from the options market. *Journal of Monetary Economics*, 53(8), pp.1997-2039.
- Beckmann, J. and Czudaj, R., 2016. Exchange rate expectations and economic policy uncertainty. *European Journal of Political Economy*.
- Beckmann, J., 2013. Nonlinear adjustment, purchasing power parity and the role of nominal exchange rates and prices. *The North American Journal of Economics and Finance*, 24, pp.176-190.

Beckmann, J., Belke, A. and Dobnik, F., 2012. Cross-section dependence and the monetary exchange rate model—A panel analysis. *The North American Journal of Economics and Finance*, 23(1), pp.38-53.

BEKAR, S.A., TÜRKİYE'DE HARBERGER-LAURSEN-METZLER YAKLAŞIMININ VARLIĞI. *Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (26), pp.156-170.

Bekun, F.V., Emir, F. and Sarkodie, S.A., 2019. Another look at the relationship between energy consumption, carbon dioxide emissions, and economic growth in South Africa. *Science of the Total Environment*, 655, pp.759-765.

Ben Omrane, W., Welch, R., & Zhou, X.(2020). The dynamic effect of macroeconomic news on the euro/US dollar exchange rate. *Journal of Forecasting*, **39**(1), 84–103.

Ben Omrane, W., Savaser, T., Welch, R., & Zhou, X.(2019). Time-varying effects of macroeconomic news on euro-dollar returns. *The North American Journal of Economics and Finance*, 50(C), 130–143. <https://doi.org/10.1016/j.najef.2019.101001> [Google Scholar]

Benlialper, A. and Cömert, H., 2016. Implicit asymmetric exchange rate peg under inflation targeting regimes: the case of Turkey. *Cambridge Journal of Economics*, 40(6), pp.1553-1580.

Bhat, J.A. and Bhat, S.A., 2021. On the dynamics of exchange rate pass-through: asymmetric evidence from India. *International Journal of Emerging Markets*.

Bhatti AA, Ahmed T, Hussain B. Growth effects of real exchange rate misalignment: evidence from Pakistan. *The Pakistan Journal of Social Issues*, (Special Issue). 2018 Jun 29:70-88.

Bjørnland, H.C., 2008. Monetary policy and exchange rate interactions in a small open economy. *Scandinavian Journal of Economics*, 110(1), pp.197-221.

Bjørnland, H.C., 2008. Monetary policy and exchange rate interactions in a small open economy. *Scandinavian Journal of Economics*, 110(1), pp.197-221.

Bjørnland, H.C., 2009. Monetary policy and exchange rate overshooting: Dornbusch was right after all. *Journal of International Economics*, 79(1), pp.64-77.

Boero, G. and Marrocu, E., 2002. The performance of non-linear exchange rate models: a forecasting comparison. *Journal of Forecasting*, 21(7), pp.513-542.

Bordo, M.D. and Flandreau, M., 2001. Core, periphery, exchange rate regimes, and globalization.

Bordo, M.D., 2003. Exchange rate regime choice in historical perspective.

Bordo, M.D., 2003. Exchange rate regime choice in historical perspective.

Boshoff, W.H., 2008. Rethinking ASGISA and the rand exchange rate. *South African Journal of Economic and Management Sciences*, 11(1), pp.112-120.

Botev, J., Égert, B. and Jawadi, F., 2019. The nonlinear relationship between economic growth and financial development: Evidence from developing, emerging and advanced economies. *International Economics*, 160, pp.3-13.

Boudt, K., Neely, C.J., Sercu, P. and Wauters, M., 2019. The response of multinationals' foreign exchange rate exposure to macroeconomic news. *Journal of International Money and Finance*, 94, pp.32-47.

Buchholz, P. and Brandenburg, T., 2018. Demand, supply, and price trends for mineral raw materials relevant to the renewable energy transition wind energy, solar photovoltaic energy, and energy storage. *Chemie Ingenieur Technik*, 90(1-2), pp.141-153.

Bulligan, G. and Delle Monache, D., 2018. Financial markets effects of ECB unconventional monetary policy announcements. Bank of Italy Occasional Paper, (424).

Byrne, J.P., Korobilis, D. and Ribeiro, P.J., 2016. Exchange rate predictability in a changing world. *Journal of International Money and Finance*, 62, pp.1-24.

Canals, C. (2016) available at: <https://www.caixabankresearch.com/en/economics-markets/activity-growth/india-and-china-so-close-yet-so-far>: 03 March 2016.

Canals, C. available at: <https://www.caixabankresearch.com/en/economics-markets/activity-growth/india-and-china-so-close-yet-so-far>: 03 March 2016.

Caporale, G.M., Spagnolo, F. and Spagnolo, N., 2018. Exchange rates and macro news in emerging markets. *Research in International Business and Finance*, 46, pp.516-527.

Centre for the Study of the South African Economy and International Finance, London School of Economics.

Centre for the Study of the South African Economy and International Finance, London School of Economics.

Chang, R., 2018. *Foreign exchange intervention redux* (No. w24463). National Bureau of Economic Research.

Chao, C.C., Hu, S.W., Tai, M.Y. and Wang, V., 2011. Monetary policy announcements and stock price dynamics in a small open economy. *International Review of Economics & Finance*, 20(4), pp.520-531.

Chao, C.C., Hu, S.W., Tai, M.Y. and Wang, V., 2011. Monetary policy announcements and stock price dynamics in a small open economy. *International Review of Economics & Finance*, 20(4), pp.520-531.

Chen, F., Diebold, F.X. and Schorfheide, F., 2013. A Markov-switching multifractal inter-trade duration model, with application to US equities. *Journal of Econometrics*, 177(2), pp.320-342.

Chen, N., Chung, W. and Novy, D., 2022. Vehicle currency pricing and exchange rate pass-through. *Journal of the European Economic Association*, 20(1), pp.312-351.

Chen, S.S. and Chou, Y.H., 2012. Rational expectations, changing monetary policy rules, and real exchange rate dynamics. *Journal of Banking & Finance*, 36(10), pp.2824-2836.

Cheung, Y.W., Chinn, M.D. and Pascual, A.G., 2005. Empirical exchange rate models of the nineties: Are any fit to survive?. *Journal of international money and finance*, 24(7), pp.1150-1175.

Cheung, Y.W., Fatum, R. and Yamamoto, Y., 2019. The exchange rate effects of macro news after the global financial crisis. *Journal of International Money and Finance*, 95, pp.424-443.

Cheung, Y.W., Fatum, R. and Yamamoto, Y., 2019. The exchange rate effects of macro news after the global financial crisis. *Journal of International Money and Finance*, 95, pp.424-443.

Cheung, Y., Fatum, R., & Yamamoto, Y. (2019). The exchange rate effects of macro news after the global financial crisis. *Journal of International Money and Finance*, 95(C), 424–443.

Clarida, R. and Gali, J., 1994, December. Sources of real exchange-rate fluctuations:

How important are nominal shocks?. In *Carnegie-Rochester conference series on public policy* (Vol. 41, pp. 1-56). North-Holland.

Conrad D, Jagessar J. Real exchange rate misalignment and economic growth: The case of Trinidad and Tobago. *Economies*. 2018 Dec;6(4):52.

Coricelli, F. and Jazbec, B., 2004. Real exchange rate dynamics in transition economies. *Structural Change and Economic Dynamics*, 15(1), pp.83-100.

Corlu, C.G. and Corlu, A., 2015. Modelling exchange rate returns: which flexible distribution to use?. *Quantitative Finance*, 15(11), pp.1851-1864.

Corsetti, G., Kuester, K., and Müller, G.J., 2017. Fixed on flexible: Rethinking exchange rate regimes after the great recession. *IMF Economic Review*, 65(3), pp.586-632.

Cover, J.P. and Mallick, S.K., 2012. Identifying sources of macroeconomic and exchange rate fluctuations in the UK. *Journal of International Money and Finance*, 31(6), pp.1627-1648.

Crosland, C.A.R., 2021. The Transition from Capitalism<sup>1</sup>. In *Democratic Socialism in Britain* (pp. 33-68). Routledge.

Cross, J.H., 2003. Global integration and capital account liberalisation in South Africa. *Press & Communications CH-4002 Basel, Switzerland E-mail: publications@bis.org Fax:+ 41 61 280 9100 and+ 41 61 280 8100 This publication is available on the BIS website (www.bis.org).*, p.104

Dąbrowski, M.A., Papież, M. and Śmiech, S., 2014. Exchange rates and monetary fundamentals in CEE countries: Evidence from a panel approach. *Journal of Macroeconomics*, 41, pp.148-159.

Dao, M.C., Minoiu, M.C. and Ostry, M.J.D., 2017. *Corporate investment and the real exchange rate*. International Monetary Fund.

De Jager, J.J., 2010. Central Bank, Lender of Last Resort Assistance: An Elusive Concept. *De Jure*, 43, p.228.

Demir, F. and Razmi, A., 2022. The real exchange rate and development theory, evidence, issues and challenges. *Journal of Economic Surveys*, 36(2), pp.386-428.

Department of Trade and Industry, accessed [2017 June  
<http://www.thedtic.gov.za/sectors-and-services-2/1-4-2-trade-and-export/market->

[access/trade-agreements/](#)

Devereux M., Shi S., (2013) Vehicle currency, *International Economic Review*, 54,97-133

Devereux, J., & Connolly, M. 1995. Growth and the Real Exchange Rate. *Journal of Economic Integration*, 10(2), 206-218.

Devereux, M.B. and Engel, C., 2002. Exchange rate pass-through, exchange rate volatility, and exchange rate disconnect. *Journal of Monetary economics*, 49(5), pp.913-940.

Devereux, M.B. and Engel, C., 2006. Expectations and exchange rate policy.

Dewachter, H., Erdemlioglu, D., Gnabo, J.Y. and Lecourt, C., 2014. The intra-day impact of communication on euro-dollar volatility and jumps. *Journal of International Money and Finance*, 43, pp.131-154.

Di Martino, P., 2022. Central banks' interventions in exchange rate markets during the international gold standard: Italy 1880–1913. *Financial History Review*, pp.1-23.

Dikau, S. and Volz, U., 2021. Central bank mandates, sustainability objectives and the promotion of green finance. *Ecological Economics*, 184, p.107022.

Dimitriou, D., Kenourgios, D. and Simos, T., 2017. Financial crises, exchange rate linkages and uncovered interest parity: Evidence from G7 markets. *Economic Modelling*, 66, pp.112-120.

Dixit, R. and Ghosh, M., 2013. Financial inclusion for inclusive growth of India-A study of Indian states. *International Journal of Business Management & Research*, 3(1), pp.147-156.

Dornbusch, R., 2019. The theory of flexible exchange rate regimes and macroeconomic policy. In *Flexible Exchange Rates and Stabilization Policy* (pp. 123-143). Routledge.

D'Souza, E., 1999. Fiscal deficits, expectations, and exchange rates. *Economic and Political Weekly*, pp.963-968.

Du, W., Tepper, A. and Verdelhan, A., 2018. Deviations from covered interest rate parity. *The Journal of Finance*, 73(3), pp.915-957.

Durčáková, J. and Mandel, M., 2002. Exchange rate, inflation, and real economic growth in transitive economies. *Prague Economic Papers*, 2002(2).

Econ. Lett., 168 (2018), pp. 10-14

Economics and Finance in South Africa. Research Paper No 9.

Eichenbaum, M. and Evans, C.L., 1995. Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *The Quarterly Journal of Economics*, 110(4), pp.975-1009.

Eichenbaum, M.S. and Evans, C., 1993. Some empirical evidence on the effects of monetary policy shocks on exchange rates.

Eichengreen, B., 2007. The real exchange rate and economic growth. *Social and Economic Studies*, pp.7-20.

Eichengreen, B., Mehl, A. and Chițu, L., 2019. Mars or Mercury? The geopolitics of international currency choice. *Economic Policy*, 34(98), pp.315-363.

Eichengreen, B., Mehl, A. and Chițu, L., 2019. Mars or Mercury? The geopolitics of international currency choice. *Economic Policy*, 34(98), pp.315-363.

Eichler, S. and Littke, H.C., 2018. Central bank transparency and the volatility of exchange rates. *Journal of International Money and Finance*, 89, pp.23-49.

Engel, C. 2014. Exchange Rates and Interest Parity. *Handbook of International Economics*, vol. 4, 453-522.

Engel, C., 2016. Exchange rates, interest rates, and the risk premium. *American Economic Review*, 106(2), pp.436-474.

Engel, C.M. and Zhu, F., 2019. Exchange rate puzzles: evidence from rigidly fixed nominal exchange rate systems.

Evans, K. and Speight, A., 2010. International macroeconomic announcements and intraday euro exchange rate volatility. *Journal of the Japanese and international economies*, 24(4), pp.552-568.

Evans, M.D., 2010. Order flows and the exchange rate disconnect puzzle. *Journal of International Economics*, 80(1), pp.58-71.

Evans, M.D., 2018. FX Trading and the Exchange Rate Disconnect Puzzle. *Available at SSRN 3278950*.

Farhi, E. and Gabaix, X., 2016. Rare disasters and exchange rates. *The Quarterly Journal of Economics*, 131(1), pp.1-52.

Fatum, R. and Scholnick, B., 2008. Monetary policy news and exchange rate responses: Do only surprises matter?. *Journal of Banking & Finance*, 32(6), pp.1076-1086.

Fatum, R. and Scholnick, B., 2008. Monetary policy news and exchange rate responses: Do only surprises matter?. *Journal of Banking & Finance*, 32(6), pp.1076-1086.

Fatum, R., Hutchison, M., & Wu, T.(2012). Asymmetries and state dependence: The impact of macro surprises on intraday exchange rates. *Journal of the Japanese and International Economies*, 26(4), 542–560.

Faust, J. and Rogers, J.H., 2003. Monetary policy's role in exchange rate behaviour . *Journal of Monetary Economics*, 50(7), pp.1403-1424.

Fedderke, J.W. and Wollnik, A., 2007. The Spatial Distribution of Manufacturing in South Africa 1970-1996, its Determinants and Policy Implications. *Available at SSRN 1812143*.

Ferraro, D., Rogoff, K. and Rossi, B., 2015. Can oil prices forecast exchange rates? An empirical analysis of the relationship between commodity prices and exchange rates. *Journal of International Money and Finance*, 54, pp.116-141.

Fieremans, E., Lemberskiy, G., Veraart, J., Sigmund, E.E., Gyftopoulos, S. and Novikov, D.S., 2017. In vivo measurement of membrane permeability and myofiber size in human muscle using time-dependent diffusion tensor imaging and the random permeable barrier model. *NMR in Biomedicine*, 30(3), p.e3612.

Fischer, A.M. and Yeşin, P., 2021. Foreign currency loan conversions and currency mismatches. *Journal of International Money and Finance*, p.102499.

Foerster, A.T., 2015. Financial crises, unconventional monetary policy exit strategies, and agents' expectations. *Journal of Monetary Economics*, 76, pp.191-207.

Fourie, J., Pretorius, T., Harvey, R., Henrico, V.N. and Phiri, A., 2016. Nonlinear relationship between exchange rate volatility and economic growth: A South African perspective.

Frankel, J. and Saiki, A., 2002. A proposal to anchor monetary policy by the price of the export commodity. *Journal of Economic Integration*, pp.417-448.



Frankel, J., 2007. On the rand: Determinants of the South African exchange rate. *South African Journal of Economics*, 75(3), pp.425-441.

Fratzscher, M., Rime, D., Sarno, L. and Zinna, G., 2015. The scapegoat theory of exchange rates: the first tests. *Journal of Monetary Economics*, 70, pp.1-21.

Frenkel, J.A., 2019. A monetary approach to the exchange rate: doctrinal aspects and empirical evidence. In *Flexible Exchange Rates and Stabilization Policy* (pp. 68-92). Routledge.

Frenkel, M., Rülke, J.C. and Stadtmann, G., 2012. Twisting the dollar? On the consistency of short-run and long-run exchange rate expectations. *Journal of Forecasting*, 31(7), pp.596-616.

Frenkel, R. and Taylor, L., 2009. Real exchange rate, monetary policy, and employment: Economic development in a garden of forking paths. *Beyond Inflation Targeting: Assessing the Impacts and Policy Alternatives*, Cheltenham, E. Elgar, pp.28-43.

Frömmel, M., Mende, A. and Menkhoff, L., 2008. Order flows, news, and exchange rate volatility. *Journal of International Money and Finance*, 27(6), pp.994-1012.

Gala, P., 2007. Real exchange rate levels and economic development: theoretical analysis and econometric evidence. *Cambridge Journal of economics*, 32(2), pp.273-288.

Garner, J. 1994, 'An Analysis of the Financial Rand Mechanism', Centre for Research into Economics and Finance in South Africa. Research Paper No 9.

Garner, J. 1994, 'An Analysis of the Financial Rand Mechanism', Centre for Research into

Gau, Y.F. and Wu, Z.X., 2017. Macroeconomic announcements and price discovery in the foreign exchange market. *Journal of International Money and Finance*, 79, pp.232-254.

Ghosh, T. and Bhadury, S.S., 2018. Has Money Lost Its Relevance? Resolving the Exchange Rate Disconnect Puzzle.

Goldstein, M., Mathieson, D.J., Bayoumi, T., Mussa, M. and Clark, P.B., 2017. II The Current Exchange Rate Regime. In *Improving the International Monetary System*. International Monetary Fund.

Goodwin, T.H., 1993. Business-cycle analysis with a Markov-switching model. *Journal of Business & Economic Statistics*, 11(3), pp.331-339.

Gossel, S.J. and Biekpe, N., 2012. The nominal rand/dollar exchange rate: Before and after 1995. *Studies in Economics and Finance*, 29(2), pp.105-117.

Gourinchas, P.O. and Rabanal, P., 2017. Exchange Rates and External Adjustment.

Gumede, D. (2010). Available at: <https://pmg.org.za/committee-meeting/11659/>(Accessed: 18 August 2018).

Gumede, W., 2014. The BRICS Alliance: challenges and opportunities for South Africa and Africa. *Shifting Power Critical Perspectives on Emerging Economies, TNI Working Papers*.

Gürkaynak, R.S., Kara, A.H., Kısacıkoglu, B. and Lee, S.S., 2021. Monetary policy surprises and exchange rate behaviour . *Journal of International Economics*, 130, p.103443.

Gürkaynak, R.S., Kara, A.H., Kısacıkoglu, B. and Lee, S.S., 2021. Monetary policy surprises and exchange rate behaviour . *Journal of International Economics*, p.103443.

Gürkaynak, R.S., Sack, B.P. and Swanson, E.T., 2007. Market-based measures of monetary policy expectations. *Journal of Business & Economic Statistics*, 25(2), pp.201-212.

Gürkaynak, R.S., Sack, B.P. and Swanson, E.T., 2012. Market-based measures of monetary policy expectations. *Journal of Business & Economic Statistics*.

Gustafsson, H., Hassmén, P. and Podlog, L., 2010. Exploring the relationship between hope and burnout in competitive sport. *Journal of Sports Sciences*, 28(14), pp.1495-1504.

Hagen, J.V. and Zhou, J., 2005. The choice of exchange rate regime: an empirical analysis for transition economies. *Economics of Transition*, 13(4), pp.679-703.

Hale, D., 2004. China's growing appetites. *The National Interest*, (76), pp.137-147.

Hamilton, J.D., 1996. Specification testing in Markov-switching time-series models. *Journal of Econometrics*, 70(1), pp.127-157.

Han, Y.W., 2004. *Quantitative analysis of macroeconomic shocks and the Euro currency in high frequency perspective*. Working paper, Hallym University, October 2004.

Hansen, B. E. (1992). The likelihood ratio test under nonstandard conditions: testing the Markov switching model of GNP. *Journal of applied Econometrics*, 7(S1), S61-S82.

Hariharan, N., 2020. Available at :  
[https://www.academia.edu/43479426/A\\_STUDY\\_ON\\_THE\\_EVOLUTION\\_OF\\_EXCHANGE\\_RATE\\_MECHANISM\\_AND\\_ITS\\_REGIME?auto=citations&from=cover\\_page](https://www.academia.edu/43479426/A_STUDY_ON_THE_EVOLUTION_OF_EXCHANGE_RATE_MECHANISM_AND_ITS_REGIME?auto=citations&from=cover_page):  
22 November 2021

Hatemi-j, A., 2012. Asymmetric causality tests with an application. *Empirical economics*, 43(1), pp.447-456.

Hayat, A., Ganiev, B. and Tang, X., 2013. Expectations of future income and real exchange rate movements. *Journal of Banking & Finance*, 37(4), pp.1274-1285.

Heider, F., Hoerova, M. and Holthausen, C., 2015. Liquidity hoarding and interbank market rates: The role of counterparty risk. *Journal of Financial Economics*, 118(2), pp.336-354.

Henshaw, P.J., 1996. Britain, South Africa and the sterling area: gold production, capital investment and agricultural markets 1931–1961. *The Historical Journal*, 39(1), pp.197-223.

Hicham, A., 2019. The effect of terms of trade on current account balance: Harberger-Laursen-Metzler effect in Arabic countries. *Journal of Smart Economic Growth*, 4(1), pp.17-30.

Hina, H. and Qayyum, A., 2015. Exchange rate determination and out of sample forecasting: cointegration analysis.

Hirsch, A., 1989. The origins and implications of South Africa's continuing financial crisis. *Transformation*, (9).

Hoffmann, M. and MacDonald, R., 2003. A re-examination of the link between real exchange rates and real interest rate differentials. *Available at SSRN 388622*.

Hubacek, K., Guan, D. and Barua, A., 2007. Changing lifestyles and consumption patterns in developing countries: A scenario analysis for China and India. *Futures*, 39(9), pp.1084-1096.

Humphrey, T.M., 1977. A monetarist model of exchange rate determination.

Ibhagui, O.W., 2018. Monetary model of exchange rate determination under floating

and non-floating regimes. *China Finance Review International*.

Ibhagui, O.W., 2019. Monetary model of exchange rate determination under floating and non-floating regimes. *China Finance Review International*.

Igwe, I.O., 2018. History of the international economy: The Bretton Woods system and its impact on the economic development of developing countries. *Athens JL*, 4, p.105.

Ilzetzi, E., Reinhart, C.M. and Rogoff, K.S., 2017. *The Country Chronologies to Exchange Rate Arrangements into the 21st Century: will the anchor currency hold?* (No. w23135). National Bureau of Economic Research.

Inoue, A. and Rossi, B., 2018. The effects of conventional and unconventional monetary policy: A new approach.

Ismailov, A. and Rossi, B., 2018. Uncertainty and deviations from uncovered interest rate parity. *Journal of International Money and Finance*, 88, pp.242-259.

Ismailov, A. and Rossi, B., 2018. Uncertainty and deviations from uncovered interest rate parity. *Journal of International Money and Finance*, 88, pp.242-259.

Isola, L.A., Oluwafunke, A.I., Victor, A. and Asaleye, A., 2016. Exchange rate fluctuation and the Nigeria economic growth. *EuroEconomica*, 35(2), pp.127-142.

Ito, T., Isard, P. and Symansky, S., 1999. Economic growth and real exchange rate: an overview of the Balassa-Samuelson hypothesis in Asia. In *Changes in exchange rates in rapidly developing countries: Theory, practice, and policy issues (NBER-EASE volume 7)* (pp. 109-132). University of Chicago Press.

Itskhoki, O. and Mukhin, D., 2021. Exchange rate disconnect in general equilibrium. *Journal of Political Economy*, 129(8), pp.2183-2232.

Itskhoki, O., 2020. *The story of the real exchange rate* (No. w28225). National Bureau of Economic Research.

Iyke, B.N. and Ho, S.Y., 2018. Real exchange rate volatility and domestic consumption in Ghana. *The Journal of Risk Finance*.

Jocelyne, F.C.B., Budnikova, A.S. and Jocelyne, F.C., 2020. The stages of development of the international monetary system. In *МИРОВОЙ ОПЫТ И ЭКОНОМИКА РЕГИОНОВ РОССИИ* (pp. 13-14)

Kabundi, A. and Mlachila, M., 2019. The role of monetary policy credibility in explaining the decline in exchange rate pass-through in South Africa. *Economic Modelling*, 79, pp.173-185.

Kabundi, A., Schaling, E. and Some, M., 2019. Estimating a Phillips curve for South Africa: A bounded random-walk approach. *58th issue (June 2019) of the International Journal of Central Banking*.

Kahn, B., 1992, 'South African Exchange Rate Policy, 1979–1991', Research Paper No. 7,

Kahn, B., 1992, 'South African Exchange Rate Policy, 1979–1991', Research Paper No. 7,

Kalemli-Ozcan, S. and Varela, L., 2019, April. Exchange rate and interest rate disconnect: The role of capital flows, currency risk and default risk. In Society for Economic Dynamic Meeting Papers (Vol. 351).

Karoui, A.T. and Kammoun, A., 2021. Exchange Rate Determination: Mixed Microstructural and Macroeconomic Approach. *International Journal of Economics and Financial Issues*, 11(3), pp.89-106.

Khan, M.F.H., 2021. Impact of exchange rate on economic growth of Bangladesh. *European Journal of Business and Management Research*, 6(3), pp.173-175.

Khumalo, S.A. and Kapingura, F.M., 2014. Impact of capital account liberalization on economic growth in Africa: A case study of South Africa. *Mediterranean Journal of Social Sciences*, 5(20), p.2753.

Kiliçarslan, Z., 2018. The Relationship between Exchange Rate Volatility and Foreign Direct Investment in Turkey: Toda and Yamamoto Causality Analysis. *International Journal of Economics and Financial Issues*, 8(4), pp.61-67.

Kim, S. and Lim, K., 2018. Effects of monetary policy shocks on exchange rate in small open Economies. *Journal of Macroeconomics*, 56, pp.324-339.

Kim, S. and Lim, K., 2018. Effects of monetary policy shocks on exchange rate in small open Economies. *Journal of Macroeconomics*, 56, pp.324-339.

Kim, S.J., McKenzie, M.D. and Faff, R.W., 2004. Macroeconomic news announcements and the role of expectations: evidence for US bond, stock and foreign exchange markets. *Journal of Multinational Financial Management*, 14(3), pp.217-232.

Klein, M.W. and Shambaugh, J.C., 2012. *Exchange rate regimes in the modern era*. MIT press.

Korea and South Africa. *Political Economy Research Institute Working Paper. University of Massachusetts, Amherst.*

Krekó, J. and Oblath, G., 2020. Economic growth and real exchange rate misalignments in the European Union. *Acta Oeconomica*, 70(3), pp.297-332.

Kremens, L. and Martin, I., 2019. The quanto theory of exchange rates. *American Economic Review*, 109(3), pp.810-43.

Kumar, D., 2018. Market efficiency in Indian exchange rates: Adaptive market hypothesis. *Theoretical Economics Letters*, 8(9), pp.1582-1598.

Kuttner, K.N., 2001. Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. *Journal of monetary economics*, 47(3), pp.523-544.

Laakkonen, H. and Lanne, M., 2009. Asymmetric news effects on exchange rate volatility: Good vs. bad news in good vs. bad times. *Studies in Nonlinear Dynamics & Econometrics*, 14(1), pp.1-38.

Lee, C., and Law, C.H., 2013. The Effects of Trade Openness on Malaysian Exchange Rate.

Lee, J., Ryu, D. and Kutan, A.M., 2016. Monetary policy announcements, communication, and stock market liquidity. *Australian Economic Papers*, 55(3), pp.227-250.

Lee, J., Ryu, D. and Kutan, A.M., 2016. Monetary policy announcements, communication, and stock market liquidity. *Australian Economic Papers*, 55(3), pp.227-250.

Levy-Yeyati, E. and Sturzenegger, F., 2005. Classifying exchange rate regimes: Deeds vs. words. *European economic review*, 49(6), pp.1603-1635.

Lewis, J.D., Robinson, S. and Thierfelder, K., 2003. Free trade agreements and the SADC economies. *Journal of African Economies*, 12(2), pp.156-206.

Lewis, J.D., Robinson, S. and Thierfelder, K., 2003. Free trade agreements and the SADC economies. *Journal of African Economies*, 12(2), pp.156-206.

Li, C., Su, Z.W., Yaqoob, T. and Sajid, Y., 2022. COVID-19 and currency market: a comparative analysis of exchange rate movement in China and USA during pandemic. *Economic Research-Ekonomska Istraživanja*, 35(1), pp.2477-2492.

Li, L., 2018. China's manufacturing locus in 2025: With a comparison of "Made-in-

China 2025” and “Industry 4.0”. *Technological Forecasting and Social Change*, 135, pp.66-74.

Lian, F. (2014). The linkage effect of exchange rate and interest rate in China and US under the condition of open economy. *Inquiry into Economic Issues*, 4, 127–132.

Liew, V.K.S., 2004. Which lag length selection criteria should we employ?. *Economics bulletin*, 3(33), pp.1-9.

Lilley, A., Maggiori, M., Neiman, B. and Schreger, J., 2022. Exchange rate reconnect. *Review of Economics and Statistics*, 104(4), pp.845-855.

Liu, X., Schwaag Serger, S., Tagscherer, U. and Chang, A.Y., 2017. Beyond catch-up—can a new innovation policy help China overcome the middle-income trap?. *Science and Public Policy*, 44(5), pp.656-669.

Lomonosov, D.A., Polbin, A.V. and Fokin, N.D., 2020. Demand, supply, monetary policy, and oil price shocks in the Russian economy (Analysis based on the BVAR model with sign restrictions). *Voprosy Ekonomiki*, (10), pp.83-104.

Luna, V.M.I., 2017. Trade Balance, Capital Flow, and Real Interest Rate in Mexico from 1950 to 2014. COMPENDIUM: Cuadernos de Economía y Administración, 4(8), pp.66-83.

M. Flückiger, M. Ludwig Maia, J., 2013. The interface between mining and manufacturing sectors in South Africa. *Industrial Development Corporation. Department of Research and Information*.

MacDonald, R. and Ricci, L.A., 2004. Estimation of the equilibrium real exchange rate for South Africa 1. *South African Journal of Economics*, 72(2), pp.282-304.

Magud, N.E., Reinhart, C.M. and Vesperoni, E.R., 2014. Capital inflows, exchange rate flexibility and credit booms. *Review of Development Economics*, 18(3), pp.415-430.

Mahmood, H. and Alkhateeb, T.T.Y., 2018. Asymmetrical effects of real exchange rate on the money demand in Saudi Arabia: A non-linear ARDL approach. *PloS one*, 13(11), p.e0207598.

Maican, F.G. and Sweeney, R.J., 2013. Real exchange rate adjustment in European transition countries. *Journal of Banking & Finance*, 37(3), pp.907-926.

Maican, F.G. and Sweeney, R.J., 2013. Real exchange rate adjustment in European transition countries. *Journal of Banking & Finance*, 37(3), pp.907-926.

Maijama'a, R., Musa, K.S., Garba, A. and Baba, U.M., 2020. Corona virus outbreak and the global energy demand: A case of people's republic of china. *American Journal of Environmental and Resource Economics*, 5(1), pp.10-13.

Majumder, A. and Ray, R., 2020. National and subnational purchasing power parity: a review. *Decision*, 47(2), pp.103-124.

Maserumule, T., & Alagidede, P. (2017). Impact of macroeconomic announcements on foreign exchange volatility: Evidence from South Africa, *Economic Research Southern Africa*.

Mashhadizadeh, F., Piraei, K., Akbari Moghaddam, B. and Zare, H., 2019. Monetary policy rules and commodity terms of trade shocks in an oil exporting country. *Quarterly Journal of Quantitative Economics*.

May, C., Farrell, G. and Rossouw, J., 2018. Do monetary policy announcements affect exchange rate returns and volatility of returns? some evidence from high-frequency intra-day south african data. *South African Journal of Economics*, 86(3), pp.308-338.

Meese, R.A. and Rose, A.K., 1990. Nonlinear, nonparametric, nonessential exchange rate estimation. *The American Economic Review*, 80(2), pp.192-196.

Meese, R.A. and Singleton, K.J., 1983. Rational expectations and the volatility of floating exchange rates. *International Economic Review*, pp.721-733.

Meniago, C. and Eita, J.H., 2017. Does Exchange Rate Volatility Deter Trade in Sub-Saharan Africa?. *International Journal of Economics and Financial Issues*, 7(4).

Mhaka, S. and Jeke, L., 2018. An evaluation of the trade relationships between South Africa and China: An empirical review 1995–2014. *South African Journal of Economic and Management Sciences*, 21(1), pp.1-15.

Miah, F., Khalifa, A.A. and Hammoudeh, S., 2016. Further evidence on the rationality of interest rate expectations: A comprehensive study of developed and emerging economies. *Economic Modelling*, 54, pp.574-590.

Mirchandani, A., 2013. Analysis of macroeconomic determinants of exchange rate volatility in India. *International Journal of Economics and Financial Issues*, 3(1), p.172.

Mminele, D., 2013. Note on the foreign exchange market operations of the South African Reserve Bank. *BIS Paper*, (73x).



- Mpofu, T.R., 2016. The determinants of exchange rate volatility in South Africa. *Economic Research Southern Africa, Working Paper*, 604.
- Mueller, P., Tahbaz-Salehi, A., & Vedolin, A. (2017). Exchange rates and monetary policy uncertainty. *The Journal of Finance*, 72(3), 3.
- Muhammed, M.B. and Abdulmuahymin, S.A., 2016. Modelling the Exchange Ability of Nigerian currency (Naira) with respect to US Dollar. *International Journal of Scientific and Engineering Research*, 7(7), pp.86-104.
- Mupu, E., 2020. Termes de l'échange, balance commerciale et performances économiques: examen de l'effet Harberger-Laursen-Metzler en République Démocratique du Congo. *ECONOMIK*.
- Murshed, M., 2018. The Harberger-Laursen-Metzler Effect and Dutch Disease Problem: Evidence from South and Southeast Asia. *Journal of Accounting, Finance and Economics*, 8(1), pp.134-166.
- Mussa, M., 2019. The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating. In *Flexible Exchange Rates and Stabilization Policy* (pp. 97-116). Routledge.
- Muth, J.F., 1961. Rational expectations and the theory of price movements. *Econometrica: Journal of the Econometric Society*, pp.315-335.
- Nawaz, K., Lahiani, A. and Roubaud, D., 2019. Natural resources as blessings and finance-growth nexus: A bootstrap ARDL approach in an emerging economy. *Resources Policy*, 60, pp.277-287.
- Neely, C.J. and Dey, S.R., 2010. A survey of announcement effects on foreign exchange returns. *Federal Reserve Bank of St. Louis Review*, 92(5), pp.417-463.
- Niyitegeka, O., Asmal, R., Naidoo, N. and Karodia, A.M., 2013. Fleeting Moments in the Exchange Rate Regimes of South Africa: Tracking the Yo-Yo Effect Since 1961. *International Journal of Afro-Asian Studies*, 4(2).
- Odhiambo, N.M., 2015. Exchange rate dynamics in South Africa: A review of past and present regimes. *Economics, Management, and Financial Markets*, 10(2), pp.77-95.
- Officer, L.H., 2007. *Between the Dollar-Sterling Gold Points: Exchange Rates, Parity and Market Behaviour*. Cambridge University Press.
- Officer, L.H., 2010. Gold standard. *Monetary Economics*, pp.96-107.

- Oleka, C.D., Eyisi, A.S. and Mgbodile, C.C.I., 2014. Empirical analysis of the relationship between foreign exchange rate and economic growth in a developing economy: Nigerian experience. *World Journal of Management and Behaviour al Studies*, 2(2), pp.28-36.
- Oliveira, L.V. and Curi, A., 2016. Disagreement in expectations and the credibility of monetary authorities in the Brazilian inflation targeting regime. *Economia*, 17(1), pp.56-76.
- Oropeza García, A., 2014. The role of China and the BRICS project. *Mexican law review*, 7(1), pp.109-136.
- Özmen, M.U. and Yilmaz, E., 2017. Co-movement of exchange rates with interest rate differential, risk premium and FED policy in “fragile economies”. *Emerging Markets Review*, 33, pp.173-188.
- Palamalai, S., Kumar, K.K. and Maity, B., 2021. Testing the random walk hypothesis for leading cryptocurrencies. *Borsa Istanbul Review*, 21(3), pp.256-268.
- Pan, L. and Mishra, V., 2018. Stock market development and economic growth: Empirical evidence from China. *Economic Modelling*, 68, pp.661-673.
- Papanikos, G.T., 2015. The real exchange rate of euro and Greek economic growth. *The Journal of Economic Asymmetries*, 12(2), pp.100-109.
- Parker, G. and Van Alstyne, M., 2018. Innovation, openness, and platform control. *Management Science*, 64(7), pp.3015-3032.
- Patterson, K., 2011. *Unit root tests in time series volume 1: key concepts and problems*. Springer.
- Payne, R., Almeida, A. and Goodhart, C., 1998. The Effects of Macroeconomic'News' on High Frequency Exchange Rate Behaviour . *Journal of Financial and Quantitative Analysis*.
- Pham, V.A., 2019. Impacts of the monetary policy on the exchange rate: case study of Vietnam. *Journal of Asian Business and Economic Studies*.
- Pinder, D., 2021. “The Bahamas’ Fixed Exchange Rate Regime: Can the Currency Peg Survive?” Determining the Sustainability of the Fixed Exchange Rate.

Rapach, D.E. and Wohar, M.E., 2004. Testing the monetary model of exchange rate determination: a closer look at panels. *Journal of international Money and Finance*, 23(6), pp.867-895.

Raza, S.A. and Afshan, S., 2017. Determinants of exchange rate in Pakistan: Revisited with structural break testing. *Global Business Review*, 18(4), pp.825-848.

Redford, S., 2008. *The effect of exchange rate volatility on the volume of South African exports* (Master's thesis, University of Cape Town).

Rehman, M.A., Shah, S.G.M., Cioca, L.I. and Artene, A., 2021. Accentuating the Impacts of Political News on the Stock Price, Working Capital and Performance: An Empirical Review of Emerging Economy. *J. Econ. Forecast*, 24, p.55.

Ribeiro, R.S.M., McCombie, J.S. and Lima, G.T., 2017. *Does real exchange rate undervaluation really promote economic growth?* (No. 2017\_11). University of São Paulo (FEA-USP).

Ricci, L.A., 2005. South Africa's Real Exchange Rate Performance'. *Post Apartheid South Africa: The First Ten Years*, pp.142-55.

Ricci, O., 2015. The impact of monetary policy announcements on the stock price of large European banks during the financial crisis. *Journal of Banking & Finance*, 52, pp.245-255.

Rodrik, D., 2008. The real exchange rate and economic growth. *Brookings papers on economic activity*, 2008(2), pp.365-412.

Rogers, J.H., Scotti, C. and Wright, J.H., 2018. Unconventional monetary policy and international risk premia. *Journal of Money, Credit and Banking*, 50(8), pp.1827-1850.

Rogoff, K., 1992. Traded goods consumption smoothing and the random walk behaviour of the real exchange rate. *NBER Working paper*, (w4119).

Rohit, A.K. and Dash, P., 2019. Dynamics of monetary policy spillover: The role of exchange rate regimes. *Economic Modelling*, 77, pp.276-288.

Rosa, C., 2011. The high-frequency response of exchange rates to monetary policy actions and statements. *Journal of Banking & Finance*, 35(2), pp.478-489.

Rötheli, T.F., 2002. Bandwagon effects and run patterns in exchange rates. *Journal of International Financial Markets, Institutions and Money*, 12(2), pp.157-166.

Rudebusch, G.D., 1995. Federal Reserve interest rate targeting, rational expectations, and the term structure. *Journal of monetary Economics*, 35(2), pp.245-274.

Sajedianfard, N. and Akbarian, R., 2018. Terms of Trade Effect on Economic Growth in Iran: Markov Switching Model. *Quarterly Journal of Quantitative Economics*, 15(1), pp.109-145.

Sanchez, M., 2008. The link between interest rates and exchange rates: do contractionary depreciations make a difference?. *International Economic Journal*, 22(1), pp.43-61.

Sarno, L. and Valente, G., 2009. Exchange rates and fundamentals: Footloose or evolving relationship?. *Journal of the European Economic Association*, 7(4), pp.786-830.

Schanz, J.F., 2019. Foreign exchange reserves in Africa: benefits, costs and political economy considerations. *BIS Paper*, (105).

Schmidt, S., 2018. Time-consistent monetary policy, terms of trade manipulation and welfare in open economies.

Scott Hacker, R., Karlsson, H.K. and Månsson, K., 2012. The relationship between exchange rates and interest rate differentials: a wavelet approach. *The World Economy*, 35(9), pp.1162-1185.

Shabangu, S (2012). Available at: <https://www.news24.com/News24/SA-mineral-wealth-close-to-R30-trillion-20150429>: 02 December 2021.

Shafiullah, M., Islam, F. and Navaratnam, R., 2020. The Harberger–Laursen–Metzler effect: evidence from five SAARC countries. *Empirical Economics*, 58(4), pp.1749-1777.

Sikhosana, A. and Aye, G.C., 2018. Asymmetric volatility transmission between the real exchange rate and stock returns in South Africa. *Economic Analysis and Policy*, 60, pp.1-8.

Singhal, S., Choudhary, S. and Biswal, P.C., 2019. Return and volatility linkages among International crude oil price, gold price, exchange rate and stock markets: Evidence from Mexico. *Resources Policy*, 60, pp.255-261.

Sinha, A.K., Mishra, A.K. and Patel, Y., 2019. Firm size, R&D expenditure, and international orientation: an empirical analysis of performance of Indian firms. *International Journal of Technological Learning, Innovation and*

*Development*, 11(4), pp.311-336.

Soe, T.T. and Kakinaka, M., 2018. Inflation targeting and exchange market pressure in developing economies: Some international evidence. *Finance Research Letters*, 24, pp.263-272.

Soon, S.V. and Baharumshah, A.Z., 2021. Exchange rates and fundamentals: further evidence based on asymmetric causality test. *International Economics*, 165, pp.67-84.

South African Government, (2012). Available at : [https://www.gov.za/sites/default/files/gcis\\_document/201409/ndp-2030-our-future-make-it-workr.pdf](https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf): 02 March 2018

Spronk, R., Verschoor, W.F. and Zwinkels, R.C., 2013. Carry trade and foreign exchange rate puzzles. *European Economic Review*, 60, pp.17-31.

Stann, C.M. and Grigoriadis, T.N., 2020. Monetary Policy Transmission to Russia and Eastern Europe. *Comparative Economic Studies*, pp.1-51.

Stotz, O., 2019. The response of equity prices to monetary policy announcements: Decomposing the announcement day return into cash-flow news, interest rate news, and risk premium news. *Journal of International Money and Finance*, 99, p.102069.

Stotz, O., 2019. The response of equity prices to monetary policy announcements: Decomposing the announcement day return into cash-flow news, interest rate news, and risk premium news. *Journal of International Money and Finance*, 99, p.102069.

Strojny, J., 2019. An assessment of Harberger-Laursen-Metzler effect in agribusiness sector in Poland. *Annals of Agricultural Economics and Rural Development*, 106(1), pp.36-50.

Takaendesa, P., 2006. *The behaviour and fundamental determinants of the real exchange rate in South Africa* (Doctoral dissertation, Rhodes University).

Tang, X., McLellan, B.C., Snowden, S., Zhang, B. and Höök, M., 2015. Dilemmas for China: energy, economy, and environment. *Sustainability*, 7(5), pp.5508-5520.

Tawadros, G.B., 2017. Revisiting the exchange rate disconnect puzzle. *Applied Economics*, 49(36), pp.3645-3668.

Tawadros, G.B., 2017. Revisiting the exchange rate disconnect puzzle. *Applied Economics*, 49(36), pp.3645-3668.

Taylor, M.P., 1995. The economics of exchange rates. *Journal of Economic literature*, 33(1), pp.13-47.

Taylor, M.P., 2006. Real exchange rates and purchasing power parity: mean-reversion in economic thought. *Applied Financial Economics*, 16(1-2), pp.1-17.

Tekgöl, Y.B., 2017. Harberger-Laursen-Metzler Etkisi: Türkiye Ekonomisi Üzerine Ekonometrik Bir Analiz. *Yönetim ve Ekonomi: Celal Bayar Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 24(2), pp.649-663.

Tervala, J., 2012. Money supply rules and exchange rate dynamics. *International Economic Journal*, 26(4), pp.547-565.

Tsaurai, K., 2018. What are the determinants of stock market development in emerging markets?. *Academy of Accounting and Financial Studies Journal*, 22(2), pp.1-11.

Vähämaa, S., 2005. Option-implied asymmetries in bond market expectations around monetary policy actions of the ECB. *Journal of Economics and Business*, 57(1), pp.23-38.

Valchev, R., 2015, March. Exchange rates and uip violations at short and long horizons. In *2015 Meeting Papers* (Vol. 1446). Society for Economic Dynamics.

Van der Merwe, E.J., 2004. *Inflation targeting in South Africa*. Pretoria: South African Reserve Bank.

Vermeulen, C., 2020. On the mandate, ownership and independence of the South African Reserve Bank. *South African Journal of Economic and Management Sciences*, 23(1), pp.1-11.

Vithessonthi, C. and Techarongrojwong, Y., 2013. Do monetary policy announcements affect stock prices in emerging market countries? The case of Thailand. *Journal of Multinational Financial Management*, 23(5), pp.446-469.

Vithessonthi, C. and Techarongrojwong, Y., 2013. Do monetary policy announcements affect stock prices in emerging market countries? The case of Thailand. *Journal of Multinational Financial Management*, 23(5), pp.446-469.

Wang, Q., Jiang, R. and Zhan, L., 2019. Is decoupling economic growth from fuel consumption possible in developing countries?—A comparison of China and

India. *Journal of Cleaner Production*, 229, pp.806-817.

Wang, R., Morley, B. and Stamatogiannis, M.P., 2019. Forecasting the exchange rate using nonlinear Taylor rule based models. *International Journal of Forecasting*, 35(2), pp.429-442.

Wang, S. and Mayes, D.G., 2012. Monetary policy announcements and stock reactions: An international comparison. *The North American Journal of Economics and Finance*, 23(2), pp.145-164.

Wang, S. and Mayes, D.G., 2012. Monetary policy announcements and stock reactions: An international comparison. *The North American Journal of Economics and Finance*, 23(2), pp.145-164.

Wang, S., Ye, S. and Li, X., 2017, July. The impact of real effective exchange rate volatility on economic growth in the process of renminbi internationalization an empirical study based on VAR model. In *Industrial Economics System and Industrial Security Engineering (IEIS'2017), 2017 4th International Conference on* (pp. 1-7). IEEE.

Wang, S., Ye, S. and Li, X., 2017, July. The impact of real effective exchange rate volatility on economic growth in the process of renminbi internationalization an empirical study based on VAR model. In *Industrial Economics System and Industrial Security Engineering (IEIS'2017), 2017 4th International Conference on* (pp. 1-7). IEEE.

Westerlund, J., 2015. The effect of recursive detrending on panel unit root tests. *Journal of Econometrics*, 185(2), pp.453-467.

Wongswan, J., 2009. The response of global equity indexes to US monetary policy announcements. *Journal of International Money and Finance*, 28(2), pp.344-365.

Wongswan, J., 2009. The response of global equity indexes to US monetary policy announcements. *Journal of International Money and Finance*, 28(2), pp.344-365.

World Integrated Trade Solution (2018). Available at: <https://wits.worldbank.org/CountrySnapshot/en/ZAF>: 02 March 2021

Wright, J.H., 2012. What does monetary policy do to long-term interest rates at the zero lower bound?. *The Economic Journal*, 122(564), pp.F447-F466.

Yang, Y.H., Shao, Y.H., Shao, H.L. and Stanley, H.E., 2019. Revisiting the weak-form

efficiency of the EUR/CHF exchange rate market: Evidence from episodes of different Swiss franc regimes. *Physica A: Statistical Mechanics and Its Applications*, 523, pp.734-746.

Zettelmeyer, J., 2004. The impact of monetary policy on the exchange rate: evidence from three small open economies. *Journal of Monetary Economics*, 51(3), pp.635-652.

Zettelmeyer, J., 2004. The impact of monetary policy on the exchange rate: evidence from three small open economies. *Journal of Monetary Economics*, 51(3), pp.635-652.

Yartey, C.A., 2008. The determinants of stock market development in emerging economies: is South Africa different?.

Petry, J., Koddenbrock, K. and Nölke, A., 2023. State capitalism and capital markets: Comparing securities exchanges in emerging markets. *Environment and planning A: economy and space*, 55(1), pp.143-164.

Hoque, M.E., Soo-Wah, L., Uddin, M.A. and Rahman, A., 2023. International trade policy uncertainty spillover on stock market: Evidence from fragile five economies. *The Journal of International Trade & Economic Development*, 32(1), pp.104-131.

Becker, T., Gelos, R.G. and Richards, A.J., 2002. Devaluation expectations and the stock market: a new measure and an application to Mexico 1994/95. *International Journal of Finance & Economics*, 7(3), pp.195-214.

Acikalin, S., Aktas, R. and Unal, S., 2008. Relationships between stock markets and macroeconomic variables: an empirical analysis of the Istanbul Stock Exchange. *Investment Management and Financial Innovations*, 5(1), pp.8-16.

Jang, K. and Ogaki, M., 2004. The effects of monetary policy shocks on exchange rates: a structural vector error correction model approach. *Journal of the Japanese and International Economies*, 18(1), pp.99-114.

Mtonga, E., 2011, March. Did it matter? Monetary policy regime change and exchange rate dynamics in South Africa. In *CSAE 25th Anniversary Conference*.

Frankel, B.L., Coursey, R.D., Buchbinder, R. and Snyder, F., 1976. Recorded and reported sleep in chronic primary insomnia. *Archives of General Psychiatry*, 33(5), pp.615-623.



Frankel, J.A., 1979. On the mark: A theory of floating exchange rates based on real interest differentials. *The American economic review*, 69(4), pp.610-622.

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08-02-2023

Mr Simiso Sinqumo Sanele Gary Msomi (207527293)  
School Of Acc Economics&Fin  
Westville

Dear Mr Simiso Sinqumo Sanele Gary Msomi,

**Original application number:** 00020223

**Project title:** The Monetary Model of Exchange Rate Behaviour: the case of South Africa

### **Exemption from Ethics Review**

In response to your application received on 08 February 2023, your school has indicated that the protocol has been granted **EXEMPTION FROM ETHICS REVIEW**.

Any alteration/s to the exempted research protocol, e.g., Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through an amendment/modification prior to its implementation. The original exemption number must be cited.

For any changes that could result in potential risk, an ethics application including the proposed amendments must be submitted to the relevant UKZN Research Ethics Committee. The original exemption number must be cited.

In case you have further queries, please quote the above reference number.

#### **PLEASE NOTE:**

Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours sincerely,



13 Feb 2023

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**Prof Josue Mbonigaba**  
Academic Leader Research  
School Of Acc Economics&Fin