UNIVERSITY OF CAPE TOWN

Monetary policy and exchange rates in different economic contexts: Case study of South Africa

Dissertation Presented to the Faculty of Commerce of the University of Cape Town
in Partial Fulfilment of the Requirements for the Degree of
Master of Investment Management

By

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July 2021

Declaration

I, Simbarashe Michael, hereby declare that this study is my own original work and that all references have been duly acknowledged.

I further declare that this research report in part or in its entirety has not been submitted to any other University for degree purposes or any other educational purposes.

Signature: Signed by candidate Date: 24/05/2021

Abstract

The aim of this study is to examine the relationship between the interest rate and money supply with the exchange rate in South Africa in three periods:- before the global financial crisis (GFC) (Jan 2002 – Jan 2007), during the GFC (Jan 2008 – Dec 2009) and after the GFC (Jan 2010 – Jan 2016). No clear direction on the relationship between the monetary policy and the exchange rate has been ascertained in developing and developed economies. The Autoregressive-Distributed Lag (ARDL) model is utilized to find the objective of this study.

Not much research has taken place involving the relationship of the interest rates, money supply with the exchange rate in the context of South Africa. To my knowledge this is the first study that incorporates the ARDL model to try and ascertain the type of relationship these variables have in South Africa. Therefore, new insights are yielded in the academic arena from this research's results.

The results show that there is no significant relationship between the money supply and the exchange rate both in the short and long run in all three economic contexts. A significant effect is found from the interest rate on the exchange rate in the short run during and after the GFC. However, no relationship is found before the GFC between the interest rate and exchange rate. In addition, no relationship is found in the long run between the variables in all three economic contexts. The results suggest that the South African Reserve Bank SARB had a huge influence on the exchange rate during and after the GFC through changing the repo rate.

KEYWORDS

Exchange rate, ARDL model, interest rate, money supply.

Table of Contents

Chapter 1: Introduction 6

1.1 Background 6

1.2 Study Objectives and Motivation 8

1.3 Research Questions 10

1.4 Significance of the Study 10

1.5 Organization of the Study 12

Chapter 2: Literature Review 13

2.1 Introduction 13

2.2 Theories on the nexus between Interest and Exchange Rates 13

2.2.1 The Purchasing Power Parity (PPP) Theory 14

2.2.2 The Uncovered Interest Parity (UIP) Theory 17

2.2.3 Interest Rate Parity (IRP) Theory 20

2.3 Empirical Studies that did not Incorporate the ARDL Model 22

2.4 Empirical Studies that Incorporated the ARDL Model 26

2.4.1 Developed and developing economies performance before, during and after the GFC 27

2.4.2 Studies conducted in Developed Economies 31

2.4.3 Studies conducted in Developing and Emerging Economies 36

2.5 South African Studies on the relationship between Interest and Exchange Rate 40

2.5.1 South African Empirical Studies that did not Incorporate the ARDL Model 41

2.5.2 South African Empirical Studies that used the ARDL Model 45

2.6 Summary to the Literature Review 46

Chapter 3: Research Methodology 47

3.1 Introduction 47

3.2 Sample selection procedure and data sources 47

3.3 The ARDL Model versus other models 49

3.4 Model specification, definitions and measurement of variables.....50
3.5 Summary and conclusions 52
Chapter 4: Empirical Results 53
4.1 Introduction.....53
4.2 The descriptive statistics of variables.....53
4.3 ADF unit root analysis.....56
4.4 ARDL Bounds test of Co-Integration.....58
4.5 Short run testing ARDL.....58
4.6 Summary.....59
Chapter 5: Summary, conclusion and recommendations 61
5.1 Introduction 61
This chapter compares the results collected from the data analysis with the objectives of this study. It also aims at answering the research questions in chapter 1 which are:- 61
In addition, recommendations are made for future scholars who are interested in contributing in this academic arena. 61
5.2 Study summary and conclusions.....61
5.3 Recommendations for future studies.....62
References 64

Chapter 1: Introduction

1.1 Background

The exchange rate is critical factor in the management of the economy. The nominal exchange rate is defined as the exchange rate of a currency expressed in current price terms, that is, making no allowance for the effects of inflation. While the real exchange rate is simply the exchange rate of a currency expressed in constant price terms to make allowance for the effects of inflation (Mussa, 1986; Basak & Gallmeyer, 2001). A change in the exchange rate would affect employment, production and consumption and the allocation of resources. Imports and exports form a significant aspect of the gross domestic product (GDP) in developing economies therefore any movement in the exchange rate would be significant to developing economies. Since, the exchange rate affects an economy's performance (particularly a developing economy), it is imperative to understand it's driving forces, in order to derive sustainable growth especially in the context of South Africa, given the history of its currency.

The rand officially became the legal tender in South Africa in 1961, when the country became a Republic (Rossouw, 2020). The South African Reserve Bank (SARB) adopted the freely floating exchange rate regime in 1995 (Takaendesa, 2006; Lardo, et al., 2013). This change has since seen an increased volatility with the exchange rate in recent years. Therefore, giving an incentive to seek out what causes this fluctuation in the exchange rate. According to the International Monetary Fund (IMF) in 1995 $1 was equal to R3.60 (IMF, 2021). Further, the same dollar in 2016 was valued at R16.50. This shows that from 1995 to 2016 the rand had exacerbated by 358%. The incentive to find out the factors that affect the exchange rate is even bigger with the introduction of inflation targeting in South Africa, which was formerly adopted in February 2000 by the central bank with the sole aim of administering the inflation rate within the 3-6% range through decreasing or increasing the repo rate (Resbank, 2021). In early 2006 the repo rate was 10%, in 2011, only 5 years later it had been cut to 5% with the sole purpose of keeping the inflation rate within the inflation target. Coincidentally the rand had been on a continuous decline between 2006 and 2011 (IMF, 2021). Not to say that the interest rates are the sole cause of the exchange rate movements, however, interest rate movements do affect other macroeconomic variables besides inflation. An understanding of the essential elements that cause

movements of the exchange rate is crucial for investors and policymakers in their decision making. Such knowledge would help with the development of South Africa through the policy makers implementing accurate measures to attain economic growth and stability in the long run.

A year later after the introduction of inflation targeting, in the last four months of 2001, the South African rand dropped in value relative to the U.S dollar by 42 percent (IMF, 2021). This unforeseen depreciation in the final months of the year led to citizens questioning the competency of the government. In addition, the change in the rand's value meant that the SARB would probably be faced with a potential increase in inflation. Many policymakers were under the notion that the catalyst of the rand depreciating could have been attributed to speculators taking short positions on the currency. Nonetheless, South Africa responded by setting up the Myburgh Commission of Inquiry, giving it an objective to examine the reasons of the depreciation in 2001. Further, the Myburgh Commission, the following year released documents which determined several macroeconomic elements as the factors behind the drop in value of the rand (Bhundia & Gottschalk, 2003). The critical factors that were ascertained were:- the exacerbation in South Africa's current account balance and the mitigation in productivity globally. However, its findings were asserted to be unreliable all in all. The current account balance shows the imports and exports of the goods and services of an economy, so a statement can be made that the current account balance represents the demand and supply of a currency. A decrease or increase in the money supply and demand would be reflected by the current account balance.

Through globalization, developed and developing countries have become intertwined, making it possible for the labour in developing economies to increase the labour in a developed economy (which in previous years would have been perceived as impossible), meaning that if a powerful country is to experience some type of recession or economic turmoil the rest of the world is likely to experience part of that effect (Kose, et al., 2020).

Global recessions seem to be a common event since evidence has shown that they take place periodically, over the past few decades the globe has experienced four global recessions in the years 1975, 1982, 1991, 2009 and 2020 (Jagannathan, et al., 2013; Kose, et al., 2020; Ozili & Arun, 2020), so we can assume that roughly every 10 years a global crisis is experienced. Further, "in each year the annual real per

capita global product contracted, and this contraction was accompanied by weakening of other key indicators of global economic activity," (Kose, et al., 2020, p. 22). Moreover, the global financial crisis (GFC) of 2008 was by far one of the worst recessions experienced out of the other years, where in the subsequent years the advanced economies have struggled to surmount the effects of the crisis. Conversely, most developing economies recovered relatively well.

It should be noted that some developing countries did not fully recover from the 2008 GFC, as will be explained in the proceeding chapter. Some attention has been given to the central banks and their role in mitigating the effects of global crisis (Sikwanda, 2011; Isiksal, et al., 2018). The primary objective of the SARB during and after a global crisis is to administer the undesirable effects of the crisis by using monetary policy instruments (Sikwanda, 2011). During the GFC most banks were required to regulate inflation through money supply and interest rate adjustments objectified to keep the economy stable. Past research shows that the financial crisis caused high volatility to many exchange rates (Ehrmann & Fratzscher, 2009; Backhaus & Isiksal, 2016). Many researchers have identified the importance of knowing what drives the movements of the exchange rate during and after a crisis (Baffes, et al., 1999; Montiel, 1999; Isiksal, et al., 2018).

The relationship between the interest rate and the exchange rate has been given tremendous focus by past scholars in the Finance and Economics area. Earlier research that has looked at the relationship between the interest rates and exchange rates have produced results that a relationship exists, among them are, Keynes (1923), Macdonald and Nagayasu (2000), Brailsford, et al., (2006), Lacerda, et al., (2010) and Machobani, et al., (2017). However, some studies have come to the conclusion that interest rates have no effect on the exchange rate at all, such as Fama (1984), Sachs (1985), DeGennaro (1994), Agénor, et al., (1997), Chinn (1998) and Hsing (2010). If this is the case, then one would ask why when policymakers adjust the repo rate the exchange rate is taken into account.

1.2 Study Objectives and Motivation

The objective of this present study is to examine the relationship between the nominal interest rate and money supply with the exchange rate during the period before, during and after the 2008 GFC using South African data.

Prior studies have tried to ascertain the variables that affect the exchange rate, among them is Cassel (1916), Keynes (1923), Aliber (1973), Adler and Lehmann (1983), Fama (1984), Isiksal, et al., (2018) and Karimi and Karameliki (2020) and, researchers in the South African context such as Takaendesa (2006), Dube (2008), Sikwanda (2011) and Lardo (2013). However, no clear direction on the relationship between the monetary policy and the exchange rate has been ascertained. In addition, as can be seen research in the context of South Africa is very recent and that may mean determining a clear direction may take a long time.

Prior studies, that have examined the relationship between the nominal interest rate and money supply on the exchange rate in South Africa have produced unclear results (Dube, 2008; Sikwanda, 2011; Lardo, et al., 2013).

Dube (2008) used macroeconomic variables and part of these variables were comprised of the interest rate and money supply, from utilizing the Autoregressive-Distributed Lag (ARDL) model the results showed that the variables had a significant impact on the exchange rate. Sikwanda (2011) examined the relationship of the interest rate yield bonds from years 0-3, 5-10 and 10 and beyond with the exchange rate, in all cases no significant relationship was found. Lardo, et al., (2013) examined the relationship of the money supply and the GDP with the exchange rate and found mixed signals.

This study also incorporates the ARDL model, “the ARDL approach does not require that all the variables be integrated of the same order. In fact, if some of the variables were I(0), classical approaches (e.g., Johansen and Juselius (1990) cointegration procedure) would produce misleading findings” (Oskooee, et al., 2020, p. 623). This present study differs from these previous studies because it examines the congruence of these variables before, during and after the crisis, whereas prior studies have not, see for example (Takaendesa, 2006; Lardo, et al., 2013).

Of all the literature reviewed in this present study, only one examined the variables before and after the GFC (Isiksal, et al., 2018). A recent study done by, Isiksal, et al., (2018), examined the relationship of the interest rate and money supply with the exchange rate in Turkey using an ARDL model. The timeline examined was before the financial crisis and after the crisis (Pre-crisis, December 2001-December 2007, and Post-crisis, January 2010-January 2016). According to their research, there was

a great effect from the money supply and short-term interest rates on exchange rates in Turkey before and after the GFC. The results showed that the surge in interest rates in Turkey caused an appreciation (and vice versa) on the domestic currency after the GFC. Further, the increase in money supply had a negative effect in the Turkish exchange rate before and after the GFC. Clearly more research needs to take place especially in the context of a developing economy regarding these vital macroeconomic variables.

Through reviewing previous researchers work, it is safe to state that there are no clear direction between the relationship of the interest rate and money supply with the exchange rate in developing and developed economies. With a lack of clear information comes inaccurate decision making which can potentially lead to personal and economic disaster.

1.3 Research Questions

This study aims to answer the following questions:

1) What is the relationship of the interest rate and money supply with the exchange rate before, during and after a crisis?
2) Does the relationship between the interest rate and money supply with the exchange rate differ/change in different economic situations, that is, before, during and after the 2008 GFC?

1.4 Significance of the Study

Prior studies that have examined the effects of different variables on the exchange rate have their deficiencies. Most of the prior studies examined in this present study utilized the cointegration technique of Johansen and Juselius (1990) to ascertain if a relationship did indeed exist with the exchange rate (Takaendesa, 2006; Lardo, et al., 2013). By these past studies using these models, the variables were assumed to be I(1), which ultimately meant that the studies were flawed (Olaniyi, 2013). For a researcher/scholar to implement the Johansen and Juselius (1990) approach, all the variables must be integrated of the same order, however, little consideration was taken in these studies about this element in their examination and proceeded to use variables of different orders (Nkoro & Uko, 2016). This present study utilizes the ARDL

co-integration technique with the sole purpose of surmounting this error in the examination of data. “The advantage of the ARDL approach is that it tests the cointegrating relationship without any necessity for same order of integration for all variables,” (Olaniyi, 2013, p. 4; Nkoro & Uko, 2016).

What sets this new model above other models, firstly, the mitigation of residual correlation, as mentioned by Nkoro and Uko (2016, pp. 78-9), “since each of the variables stands as a single equation, endogeneity is less of a problem in the ARDL technique because it is free of residual correlation. Also, it enables us to analyse the reference model.”

Secondly, in the presence of a single long run relationship, the ARDL model approach can differentiate between dependent and independent variables, further, the ARDL procedure is under the presumption that only a single mitigated form equation association exists between the dependent variable and the exogenous variables.
Lastly the empirical results show that the approach is superior and provides mostly consistent results for small samples (Nkoro & Uko, 2016).

However, one major drawback of the ARDL model is that it will not work in the existence of merged stochastic trend of I(2). To forestall effort in futility, it may be advisable to test for unit roots, though not as a necessary condition (Kumar, 2010; Nkoro & Uko, 2016; Oskooee, et al., 2020). Most studies that have employed similar models have assumed a symmetric effect of the monetary policy on the exchange rate.

Not much research has taken place involving the relationship of the interest rates, money supply with the exchange rate in the context of South Africa. To my knowledge this is the first study that incorporates the ARDL model to try and ascertain the type of relationship these variables have in South Africa. However, a multitude of studies have used the ARDL model involving the same or different variables, in developed and other developing economies and the results produced were mixed (Karaca, 2005; Khan & Sajjid, 2005; Long & Samreth, 2008; Olaniyi, 2013; Isiksal, et al., 2018; Karimi & Karamelikli, 2020). In addition, this present study explores the relationship before, during and after the 2008 financial crisis. This, I believe, is important because it allows us to have a better perspective on the relationship by seeing if it holds in different situations.

The study is beneficial to investors in that, it allows investors to be cognizant of the effects that come about with the changes in the repo rate and money supply to the exchange rate. Investors are better informed on whether to hedge against the interest rate or the exchange rate depending on the financial securities they invest their capital in. Further, I believe knowing the relationship of these variables before, during and after a crisis will help them with their decision making. For example, if an investor has information that the correlation between the repo rate and exchange rate is low during a crisis, then an announcement from the monetary policy Committee (MPC) of a repo rate being cut would not cause the investor to make a rushed decision such as selling and investing elsewhere. In addition, this study is also beneficial to policymakers. Since the SARB relies on the repo rate to keep the inflation rate within the inflation target, knowing the effects of the interest rate on the exchange rate would be imperative in order to know the overall outcome on the economy from a monetary policy change. Moreover, this information is important during a crisis, in that the SARB would be trying to curb any further debilitation within the economy, where a wrong adjustment in the repo rate would be tragic for the economy. Likewise, after a crisis, during the recovery period, knowing the relationship would prove to help the SARB in making a decision that wouldn't negate any progress made after the recovery.

1.5 Organization of the Study

The rest of this study is organized as follows. Chapter 2 reviews the relevant theories and the existing empirical literature. Chapter 3 presents the research methodology. Chapter 4 shows the empirical results from the data analysis. Chapter 5 presents a summary of the study and its major conclusion and recommendations for future research.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents the literature review relating to the theories and empirical evidence on the relationship of the monetary policy with the exchange rate. Scholars have carried out research pertaining to this relationship for centuries. The monetary policy has been examined in both developing economies and developed economies and the results, however, are inconclusive as many researchers have reported different results. The exchange rate is a key component in the functionality of any economy and has been a key focus for many economic researchers. The importance of knowing the relationship between the interest rate and money supply to the exchange rate is imperative for many reasons such as those mentioned earlier in chapter 1.

The rest of Chapter 2 is organized into five sections. Section 2.2 deals with the theories regarding the exchange rate movements, while Section 2.3 looks at the empirical studies that did not incorporate the ARDL model, Section 2.4 covers empirical studies that incorporated the ARDL model, while Section 2.5 deals with South African studies that have examined the relationship between the monetary policy and the the exchange rate. The summary of this chapter is covered in Section 2.6.

2.2 Theories on the nexus between Interest and Exchange Rates

One contentious question confronting international investors is, what causes movements in the exchange rates, since movements in the exchange rate affects the type of returns the investors procure. In this chapter, we look at the purchasing power parity (PPP), uncovered interest parity (UIP) and interest rate parity (IRP) theory. All three theories have been supported as satisfactory theories of the determination of the exchange rate by different authors. However, some authors dispute these theories as a reliable means of determining the exchange rate as shall be seen in the proceeding paragraphs.

2.2.1 The Purchasing Power Parity (PPP) Theory

"The PPP Theory is based on the idea that the cost of living in different countries is equal and that exchange rates adjust to offset inflation differentials across countries," (Brealey, 2012). In other words, equal purchasing power is seen from the exchange rate of two counties' currencies. For example, looking at two countries (South Africa and the United States), under the presumption that the exchange rate is 1 US dollar:1rand and prices are exactly the same in both countries. Under the PPP theory an increase in South Africa's prices is to lead to the depreciation of the rand to offset the price disparity between the countries. By the rand depreciating, the prices of the two countries are then the same. The origins of the theory were formed in the sixteenth century in Spain. With time the theory has been refined and this refinement is attributed to Cassel (1916)**.**

Although this theory has been around for centuries there are studies that go against the viability of this theory. Among the empirical studies that dispute this theory as being reliable are Alessandria and Kaboski (2006), Machobani, et al., (2017) and Villavicencio and Bara (2008). However, there are studies that still consider the PPP as a reliable theory at ascertaining the exchange rate, the papers presented in this study are Cassel (1916), Rogoff (1996) and Lacerda, et al., (2010).

In 1914 Cassel (1916) proposed calculating cumulative inflation rates using the difference between the rates of two economies to find the exchange rate changes needed to maintain PPP. The author also stated that in the long run, the exchange rate will eliminate the increase or decrease in the price discrepancies between two countries.

This makes sense, looking at a random economy for instance that has experienced a surge in its prices. This increase in prices would make the local products less competitive in the international market-place, therefore less exports would take place in the country, not only that but local consumers would prefer to import cheaper foreign products that would be discerned as being much cheaper than the local products. This would cause the demand for the local currency to drop, due to debilitated foreign demand and would cause the supply of the currency to increase due to the local citizens exchanging their currency in the market to acquire foreign currency. From these two changes the currency would depreciate relative to other currencies. However, after a period of time local prices would drop to a much lower

level. The combination of lower prices and the depreciation of the local exchange rate would in turn make foreign products appear expensive and local products appear cheaper to the local citizens. Further, the depreciation and lower prices would make the local products appear cheaper to the foreign market, thus, demand and supply for the local currency would push the inflation rate and exchange rate back to equilibrium (Szulczyk, 2014).

In an analysis of Bamford and Grant (2015) *Cambridge International AS and A Level Economics*, the authors mention that when prices surge the value of currency mitigates. The authors further assert how a rise in value in an economy's real exchange rate would increase its export prices and would decrease its import prices, leading to lower exports and increased imports. The drop in aggregate demand from the local and foreign consumers would see local prices drop. The drop in demand in the local goods would mean a drop in demand in the local currency and with time cause the currency to depreciate. The disinflation and drop in the exchange rate would increase the interest from the foreign market since their products would be perceived as being cheaper than their competitors, not only that but the local citizens would also shift their interests to the domestic goods. Therefore, this turn of events would see the local prices increase. An inference can clearly be drawn up stating that the inflation rate can be used to indicate the value of the exchange rate because as the exchange rate increases in value the inflation rate decreases (and vice versa). However, Szulczyk (2014) and, Bamford and Grant (2015) statements that support the PPP theory isn't based on empirical evidence.

Sikwanda (2011) claims that the exchange rate equals the inflation ratio between the two countries. Therefore, in the long-run the inflation between the two countries should be the same taking the exchange rate into account. Furthermore, using this statement as a guiding light, an increase in interest rates would see an influx of funds coming into a country from investors seeking higher interest yields, the surge in demand for bonds would result in higher bond prices and lead to lower interest rates in-order-to meet demand, thus equilibrium is derived in the long-run.

In a more recent study, Machobani (2017, p. 88), examined how reliable the PPP theory was in a South African context. The author also utilized the "ordinary least squares regression, cointegration, causality and impulse response functions." By collecting monthly data from 1999 to 2014 the author was able to show that the PPP produced an insignificant low t-statistics. Moreover, the R-squares for majority of the

time were determined to be small, indicating that other elements were at play that affect the exchange rate, not primarily the changes of the real and nominal inflation rates.

Alessandria and Kaboski (2006) investigated the law of one price and the PPP. The authors explored how shifts from the law of one price are an imperative reference of breach of the PPP. Using data from the US exports, they observed and wrote down their findings on "international price discrimination based on the local wage of consumers in the destination market," (Alessandria & Kaboski, 2006, p. 1). In addition, after more investigation, evidence showed that the PPP was breached by international disparity in wages. Moreover, by utilizing a model of pricing-to-market, they showed that "price-to-market of the form considered here accounts for at least 25% of the relationship between national price levels and income and 50% of the deviations from the law of one price," (Alessandria & Kaboski, 2006, p. 1).

Brealey (2012, p. 625) *Fundamentals of Corporate Finance*, describes the PPP as the weaker version of the law of one price. In the author's book, he asserts that, albeit hamburgers and haircuts, may have different prices in different countries, the required amount of money to purchase these goods should be similar for each individual despite location. This is because the differences in each countries inflation rate will be cancelled out by the changes in the exchange rate. Given that the PPP holds, the forecast of the difference in inflation rates is also your best forecast of the change in the spot rate of exchange.
For example, if the current exchange rate is R100 = USD1. Our inflation rate forecast is 6% in South Africa and 1% in the United States. Given that the living costs are the same then the expected high inflation rate will be offset by the rand depreciating from 100 to 105 (Brealey, 2012).

Expected difference in inflation rates

$$\frac{1 + \text{expected South African inflation rate}}{1 + \text{U.S inflation rate}} = \frac{1.06}{1.01} = 1.05$$

Expected change in spot exchange rates

$$\frac{\text{Expected rand exchange rate}}{\text{Current exchange rate}} = \frac{105}{100} = 1.05$$

However, most economists do not take PPP seriously as a short run method but only as a long-run method to ascertain the exchange rate (Rogoff, 1996).The theory also fails to show if an appreciation in the local currency caused by other elements could change the interest rate. Moreover, the theory doesn't exemplify the time lag involved between a change in one rate affecting another rate which is essential to investors and policymakers (Alessandria & Kaboski, 2006; Krugman & Obstfeld, 2006; Machobani, et al., 2017).

2.2.2 The Uncovered Interest Parity (UIP) Theory

The UIP is a theory which claims that the difference between nominal interest rates of two countries is reflective of the future nominal exchange rates of the two countries, further, the country with the higher nominal interest rate now is the one that is predicted to experience a depreciation in the exchange rate in the future (Isard, 2006).

The theory presumes equilibrium between the exchange rates, therefore when the interest rates of the domestic currency increase, the exchange rate depreciates relative to the foreign exchange rate to somehow match the expected returns of the foreign markets (Machobani, et al., 2017). The UIP is related to the law of one price, this law assumes that the price of a similar security exchanged anywhere in the globe, should have an identical price if traded in a free market (Sikwanda, 2011). The author further states that the two (UIP and Law of one price) are similar because they acknowledge that any change in return is pretty much eliminated due to the arbitrage opportunity.

As will be seen in the proceeding paragraphs in this section, there is contention to whether the UIP theory is a viable way to gauge the exchange rate. However empirically some studies support the UIP theory, while others do not support the UIP theory. Among the studies that support the theory are Keynes (1923), Macdonald and Nagayasu (2000), Brailsford, et al., (2006), Lacerda, et al., (2010) and Machobani, et al., (2017). Among the studies that dispute the UIP theory are Fama (1984), Sachs (1985), DeGennaro (1994), Agénor, et al., (1997), Chinn (1998) and Hsing (2010).

The theory of the UIP was given a lot of attention by Keynes (1923), as presumed, economies employing higher interest rates relative to their counterparts were seen to experience future depreciation in their exchange rate, this was said to be one of the

main reasons such countries offered higher nominal interest rates. Further, the high interest rates could have been discerned as economies offering investors similar returns as those economies offering lower interest rates, the higher interest rates being employed to compensate investors for when they exchanged a depreciated local currency for their appreciated home currency.

With the implementation of the floating exchange rate policy in an economy, capital investment from foreigners would impact the balance of payments (BOP) by causing a surplus. This would cause an appreciation in the short-term knocking down the UIP theory. However, according to Fama (1984), this appreciation only lasts for 1 month. However, the currency at the end of it all should drop in value. From this perspective, it is foreseen that the produced coefficient would be one, when the movement in the exchange rate is regressed on the local and the foreign interest rate difference.

Alexius (2003) asserts that most published UIP tests use data on short interest rates. However, the fluctuations of the exchange rate in the short-run are said to be hard to predict, whilst the assumed long-run equilibrium in the exchange rate makes predictability attainable.

DeGennaro, et al., (1994) made an argument backed by their findings that the relationship of long run interest rates in different countries did not support the UIP theory as a form of determining the exchange rate in the future. DeHaan, et al., (1991) performed a similar test however his results were labelled as being inconsistent.
According to Chinn (1998), the UIP as a theory has been rejected on a global scale in scholar's research as a determinant to the fluctuations in the exchange rate, though there is very little agreement on the reason why it is rejected as a theory. Unlike many previous studies that carried out the research using a narrow range of data, Chinn (1998), used interest rates on bonds that had a longer maturity date. It is known within the UIP realm that the longer-horizon regressions results are much more supportive towards UIP. The results that were produced were for both in the short-run and in the long-run. The author claimed that in the short run the failure of the UIP was due to risk premium shocks. In contrast, in the long run, the exchange rate was said to be affected by the interest rate differentials. In conclusion the UIP can be seen as a theory that only holds in the long run. In the opinion of Isard (2006) the hypothesis of UIP, foreseen movements in the nominal exchange rate should be positively correlated to the differences in the nominal interest rate among the economies. Moreover, this hypothesis asserts that the gradient coefficient from the regression of

the adjustment in the interest rate on the exchange rate difference should be one. If this parity isn't in existence, there lies a chance to make money.

An alternative way to view the interaction of the interest rate and the exchange rate is through the demand and supply interaction for a country's currency, when the supply of a country's currency is high in the market it loses value because everyone has it and its readily available, in contrast when the currency is scarce the value increases, the same goes with the demand for a currency, when demand is low the currency's value is low, conversely when the demand is high it creates pressure for the price of the currency to increase, therefore, an appreciation is seen (Bamford & Grant, 2015). Suppose a local citizen in France desires to purchase products from a Canadian business. The Canadian business is unlikely to accept euros as a form of payment. Moreover, the Canadian company would require Canadian dollars, the French consumer would have to purchase foreign currency in-order-to buy the products. Therefore, the French consumer would demand Canadian dollars for this transaction to take place thus cause the Canadian dollar's value to increase. Taking into account this interaction of demand and supply, the economies with higher interest rates are going to experience a higher demand for their currencies putting an upward pressure on the exchange rate, therefore more money is flowing into the economy which would cause a surplus in the BOP (Bamford & Grant, 2015). This viewpoint is also supported by Szulczyk (2014). Therefore, disapproving the UIP theory, however this analysis is not based on any empirical observations and instead based on a priori.

Sarno (2005), analyses the research that is mainly centred on nonlinear interactions of deviations from the UIP condition and that integrates term structure models. "This literature has established simply too clearly that the forward exchange rate is anything but an unbiased predictor of the future exchange rate, resulting in the conventional wisdom that the foreign exchange market is characterized by massive inefficiency," (Sarno, 2005, p. 27). However, the author states, in his research that there is evidence that suggests that the rejections may not be that profound. "While the forward rate is likely to be a biased predictor of the future nominal exchange rate, the term structure of forward premia appears to contain some valuable information about future exchange rate movements that may be easily captured using conventional partial adjustment models," (Sarno, 2005, p. 28). Chinn (2006), examines the soundness of the results with respect to the time horizon.

The early research that has been presented so far regarding the UIP was mainly focused on developed economies or developing economies outside of the African continent. Research that involves emerging economies located in Africa is rare. The main contribution to this scarcity can be attributed to the lack of credible data (Machobani, et al., 2017). As African economies such as South Africa begin to modernise, the data required to examine the UIP theory in an African context is slowly becoming more and more available. An examination was carried out on South Africa by, Lacerda, et al., (2010), regarding the UIP and PPP. The authors utilized the vector error correction model (VECM) which stems from the Markov-switching vector. Movements in the exchange rate and monetary regimes were included in the model, where the UIP and PPP are examined as a combined long-run relationship in the existence of shifts in the economic realm and in the political realm. The VECM results showed insufficient proof supporting the presents of the UIP and PPP in South Africa. However, evidence was ascertained advocating the presents of UIP and PPP in the Markov-switching VECM. Moreover, a better distribution of the residuals.

However, this theory does come with its limitations. For one, UIP assumes that the capital market is efficient and thus free flowing with no restrictions involved which is unrealistic. In addition, evidence has been exemplified by previous scholars that in the short and medium term, the countries that do adopt the higher nominal interest rates experience depreciation but not at the level implied by the theory. In some cases the country with the higher nominal interest rate experiences appreciation in the currency instead of depreciation, so the UIP can be discerned as being unreliable at predicting the value of the exchange rate (Adler & Lehmann, 1983; Machobani, et al., 2017).

2.2.3 Interest Rate Parity (IRP) Theory

The IRP theory asserts that differences in the interest rates between two countries is equivalent to the difference between the forward exchange rate and the spot exchange rate (Sikwanda, 2011).

An early researcher, Stein (1962), states that an examination on the performance of the foreign exchange market almost always requires the IRP theory. These examinations are under the basis that the difference between the noted forward rate and the expected forward rate are due to the interest agio.

Cosandier and Lang (1981, p. 189) state that:-

> *Conceptually, each arbitrage operation involves two currencies and four distinct transaction. i) selling assets or borrowing in the first currency, ii) buying spot the second currency, iii) purchasing assets denomination in the second currency, and iv) selling forward the second currency. Arbitrage activity does not take place unless the cost of these various transactions is more than covered by the gross profit of the operation, thus allowing for some departure from IRP.*

"The analysis of the behaviour in the foreign exchange market frequently rely on the IRP as the theorem relates to the forward exchange rate and to the money-market interest differential," (Aliber, 1973, p. 1451). Sikwanda (2011, p. 11) believed that the analyses carried out by Aliber (1973) were "based on the difference between observed forward rate and the forward rate predicted from the interest agio, for example on observed departures from interest parity."

More recent researchers, Coffey, et al., (2009), provide proof of the disparity in the IRP theory since the beginning of the crisis in 2007. The authors state that the deviations are present with respect to a variety of dollar interest rates and exchange rate pairs of the dollar and vice versa with other currencies. Researchers that support this observation are, Bottazzi, et al., (2013), who utilize the cross-currency basis model to capture the deviations of the interest rate parity. The results show the relative value of the currency that is in short supply as collateral in funding constraints. Borio, et al., (2016, p. 1), come to the same conclusions and state that, "the hedging demand the forward exchange rates out of line with CIP because, in aggregate, financial institutions charge a premium for provisioning for risks associated with exposures to FX derivatives needed to supply FX hedges."

Du, et al., (2017), investigated the deviations from interest rate parity and found large deviations which inferred significant, consistent, and systematic arbitrage opportunities in the asset markets of the world. This researcher's results are contrary to the theory. The author further states, these disparities for prominent currencies cannot be explained by credit risk or transaction costs.

Brealey (2012) in *Fundamentals of Corporate Finance,* claims that the relationship between the interest rate and the exchange rate, almost always works, even in the short run. The author also defines the interest rate parity as covered interest rates that are synonymous in all major currencies. An investor who endeavours to ask for

a loan in currencies with low interest rates can come out of the deal with profit given that they are able to bet accurately on the future exchange rate.

For example, an American investor has $1 million to invest for a duration of a year. In the United States the interest rate is 3% and in South Africa the interest rate is 8.1%. Just by looking at the interest rates the investor would assume the better investment would be in South Africa since the interest rate in much higher. However, for the investor to invest in South Africa they would need to convert their money into rands and at maturity convert their rands back to dollars. To alleviate risk the investor may fix the future value of the rand by selling them forward.

An illustration of this would be:-
In a scenario where the investor invests in his home country, with an interest rate of 3%, you get $1 million X 1.03 = $1.03 million.
In a scenario where the investor decides to invest in South Africa, under the assumption that the rand is trading at R15 = USD1. The investor would convert their $1 million to R15 million given that no charges exist for converting currencies. The interest rate being 8.1%, you get R15 million X 1.081 = R16,215 million. In this context the 1-year forward rate is R15.74 = USD 1. Therefore, by selling the rands forward, the investor does not benefit from investing in South Africa, R16,215/15.74 = 1.03 million.

Regarding the weakness of the theory, Cosandier and Lang (1981), believe that the IRP had a particular downside in that it has exemplified miniscule evidence of functionality due to the pursuits of manual intervention by reserve banks who work to position their currencies.

2.3 Empirical Studies that did not Incorporate the ARDL Model

Several empirical studies that have been undertaken to identify the possible relationship of the monetary policy with the exchange rate in South Africa and elsewhere have identified the monetary policy as a key component that causes the exchange rate to fluctuate (Botha & Pretorius, 2009; Achsani, et al., 2010; Bjornland & Halvorsen, 2014; Bonga & Kubundi, 2015; Yamacli, 2016; Ayomitunde, et al., 2019; Oskooee, et al., 2020). A number of empirical studies have also opposed the views of a relationship existing between the interest rate, money supply and the exchange

rate (Fama, 1984; Sachs, 1985; DeGennaro, et al., 1994; Agénor, et al., 1997; Chinn, 1998; Hsing, 2010). A lot of the research carried out between these variables stem from the theories that have been developed namely the PPP, UIP and the IRP.

Different models have been used in this study area and therefore different results have been shown in many studies. The older scholars mainly use the simple linear-regression and the more recent scholars use improved methods to approach the research such as performing co-integration tests (as a way of indicating a long run equilibrium association between the variables) and causality tests (to ascertain whether there is a cause-and-effect dynamic between the variables), as shall be observed in the proceeding paragraphs. Different models used produce different perceptions on the congruence of the variables being examined. Nevertheless, in all cases, the approach used has been aimed at supporting or disputing the PPP theory or the UIP theory.

An early study conducted by Eichenbaum and Evans (1995), investigated the impact of monetary policy shocks on the exchange rate in the U.S. The authors' results showed strong evidence that expansionary monetary policy led to huge, and continuous depreciations in exchange rates, both in nominal and real exchange rates. However, although the monetary policy had a significant impact on the movements of the exchange rate, the monetary policy did not explain a large amount of the fluctuations of the U.S exchange rate. Nonetheless, the authors findings can be said to support the UIP theory since an increase in the monetary policy would cause a decrease in the exchange rate. However, the UIP theory is based on the comparison of two country's interest rates, therefore, curbing its support to the theory since there is no other country's interest rate involved.

Macdonald and Nagayasu (2000) took a different approach and primarily investigated the long-run association between real exchange rates and real interest rate differentials over the recent floating exchange rate period for 14 industrialized countries. According to the research, there was a statistically significant long-run relationship between the real exchange rate and the real interest rate. The results support the UIP theory by meeting an inference of a relationship existing between the real interest rates and real exchange rates. In this context there are a multitude of countries involved therefore making comparisons possible with regards to the interest rate changes and the exchanges rate movements between countries. While a study carried out by Sollis and Wohar (2006) also observed a long run relationship between

real exchange rates and real interest rate differentials for six developed economies, which corroborated Macdonald and Nagayasu (2000) findings. The above observations are also supported by Sanchez (2008), who investigated the relationship between the interest rates and the exchange rates in small open economies. The author's results showed that the exchange rates and interest rates relationship is negative for expansionary depreciations.

Zettelmelyer (2004, p. 637) dealt with the impact of monetary policy shocks on the exchange rate in Australia, Canada and New Zealand and stated that:-

> *The approach taken in this paper is to study the immediate same day response of exchange rates to specific monetary policy actions, such as changes in official interest rates where the reaction of the 3-month T-Bill determined rate is used as a measure of the unanticipated content of the action.*

An association between the two variables was ascertained. The main take away from the results was that a repo cut of 100 basis points would appreciate the exchange rate by 2–3 percent on impact.

Although evidence is provided that a relationship exists between the interest rate and the exchange rate, in some instances the authors do not indicate if a positive or negative correlation exists between the variables (Macdonald & Nagayasu, 2000; Sollis & Wohar, 2006). If a positive relationship exists between the nominal interest rate and the nominal exchange rate then in the context where the interest rate is increased a presumption can be made that the exchange rate would increase too, thereby, opposing the UIP theory.

Some studies have incorporated the vector autoregression model (VAR) to investigate the relationship of the monetary policy with the exchange rate. A researcher in the 20th century, Andres, et al (1999), investigated the relationship between the monetary policy and the exchange rate in Spain. The results pointed out that the interest rate shock affected the exchange rate in the long run. A more recent researcher, Bjornland (2008), found considerable interdependence between the monetary policy and exchange rate. The author found that the monetary policy shock implied a strong and immediate appreciation of the exchange rate. However, afterwards the exchange rate would slowly depreciate back to the baseline which is broadly consistent with the UIP. Bjornland and Halvorsen (2014) utilized the VAR model for their examination and found the exchange rate was affected by a monetary policy shock in six countries they were conducting-an-investigation on. Moreover, four of the six countries were discerned to respond to an exchange rate shock. Bjornland

and Halvorsen (2014, p. 216) assert “An exchange rate shock that depreciates the exchange rate by one percent, increases the interest rate on impact (within a quarter) by 10–30 basis points. However, the effect dies quickly out and for Australia and the U.K, it is not really significant.”

Cardona (2014) argued that a strong relationship existed between the monetary policy and the exchange rate which is inconsistent with the previous research done on Columbia using the VAR model.

Other studies have used an UIP model in their pursuit. Although most of the findings oppose the UIP theory. Early researchers, Agénor, et al (1997), investigated the discrepancies in the UIP and found the relationships with positive shocks were responsible for the inflows of money and the appreciation in the real exchange rate opposing the views of the UIP theory. Further support comes from Chen (2006), the author claimed that it is a challenge managing the exchange rate by implementing high-interest rates. Huang, et al., (2010) asserted that the movements in the exchange rate could not be explained through capital inflow directly and indirectly. However, Brailsford, et al., (2006), shared their perspective in their research by showing that higher interest rates proved helpful for many Asian economies’ exchange rate when the economies were experiencing difficulties. These results align with the traditional perspective about this relationship between the interest rate and exchange rate. The researchers disputed the refined view of higher interest rates.

There are more authors that disputed the UIP theory that utilized different approaches to get their results. Such as Meese and Rogoff (1988), early scholars that investigated the relationship of the interest rate and the exchange rate found mixed results. Inci (2006) examined the relationship and found mixed results as exemplified by Meese and Rogoff (1988). Sachs (1985) and Frankel (1985) results showed that the appreciation of the currency had nothing to do with the expected changes in the exchange rate thus disputing the UIP theory. Edison and Pauls (1993) also examined the relationship between the interest rate and exchange rate and found no evidence of any association between the two variables. This study was conducted in the context of a developed economy, while research conducted by Calvo and Reinhart (1993) found that for less advanced economies, there is no systematic association between the interest rate and the exchange rate.

Meese and Rogoff (1988) research argued that there was little evidence of an association between the interest rate and exchange rate. The early scholars investigated the dollar/yen and the dollar/pound, they claim that there was no indication of any correlation between the interest rate differentials in the short-run and in the long-run with the exchange rate. Their findings showed evidence of the interest rate differential relationship possibly disturbing the financial market and the relationship being of little significance. Further, results showed evidence of a unit root in both real exchange rates and long-term real interest differentials, linearity wasn't ascertained therefore the non-stationarity in the two series cannot be pinned to the same variable.

More recent articles focusing on the developing economies have investigated the relationship between the interest rate and the exchange rate and have produced results that support earlier scholars such as, Meese and Rogoff (1988).Nwosa and Oseni (2012) reported no relationship existing in the short run between the exchange rate, inflation and short-term interest rate after using a VECM to conduct their investigation. Taking into account the causality of the variables, the author found no evidence of causation in the short run from the interest rate to the exchange rate. Based on the method used, the author however, did find a co-integrating vector among the variables.

Among the papers pertaining to developing economies was that of, Villavicencio and Bara (2008), who incorporated the VAR model to determine the short and long run determinants of the real exchange in Mexico. They concluded that the PPP theory is not reliable in the long-run and that more focus should be given to the real interest rate, relative productivity and stock of debt.

2.4 Empirical Studies that Incorporated the ARDL Model

This section of the literature review has three subsections, it begins by examining a few developed and developing economies performance before, during and after the GFC. Then presents research that utilizes the ARDL model to investigate the relationship of the monetary policy with the exchange rate. It offers a concentrated look at the relationship between the variables with no variations in the models used, with differences in models comes different perceptions of the association of the variables.

As highlighted in prior sections, the correspondence between the interest rate and the exchange rate has been a contentious issue for many researchers and not a clear direction has been established in both developed and developing economies. Nevertheless, scholars that have incorporated the ARDL model have mostly found a positive relationship between the monetary policy with the exchange rate. Separating developing economies from developed economies was a necessity due to the differences in infrastructure that would cause the relationship with the exchange rate to be different. Therefore, separating the two would allow us to see how the relationships are in a developed economy and in a developing economy, giving us a clearer perspective on the research.

2.4.1 Developed and developing economies performance before, during and after the GFC

Global recessions seem to be a common event since evidence has shown that they take place periodically. As mentioned earlier, over the past few decades the globe has experienced four global recessions, in the years 1975, 1982, 1991, 2009 and the most recent event in 2020 (Jagannathan, et al., 2013; Kose, et al., 2020; Ozili & Arun, 2020), so we can assume that roughly every 10 years a global crisis is experienced. The global crisis in 1975 was the result of a sharp rise in oil prices, the 1982 global crisis was the result of a mixture of factors but mainly oil prices and the tightening monetary policy in the United States, the 1991 global crisis was also due to a multitude of factors but the primarily causes were the Gulf war and the surge in oil prices and in 2009 the global crisis was a result of reckless lending (Kose, et al., 2020). Further, "in each year (1975,1982, 1991, 2009) the annual real per capita global product contracted, and this contraction was accompanied by weakening of other key indicators of global economic activity," (Kose, et al., 2020, p. 22). Moreover, the GFC of 2008 was by far one of the worst recessions experienced out of the other years, where in the subsequent years the advanced economies have struggled to surmount the effects of the crisis. Conversely, most developing economies recovered relatively well. Monetary and fiscal policies are usually exercised going into a crisis and are utilized after the crisis and during the recovery phase, for example after the GFC, in 2010 the advanced economies' central banks introduced unconventional expansionary measure to try and curb any further decrease in GDP. Developing economies implemented expansionary fiscal and monetary measures after the GFC

and adjusted the monetary policy instruments in response to cyclical conditions (Kose, et al., 2020).

A developed economy can be defined as a country with comparably high levels of economic growth and security (Carbaugh, 2015). In addition, the fundamentals that distinguish a developed economy from a developing economy are the standards of living, the level of industrialization and income per capita and obviously the amount of technological infrastructure. Developed economies are presumed to be safe places where investors can place their money during global uncertainties. If developed economies are perceived to be safe havens, that would mean not much movement in the exchange rate in expected during such a period.

From the years 1950-1990 developed economies made up an estimated of 75% of output in the world. However, after the crisis, in 2010 it had declined to 60% (Jagannathan, et al., 2013; Kose, et al., 2020). An assumption can be made that the diminishing GDP of the developed economies had a great effect in developing economies, since that meant global aggregate demand had declined. This assumption can be made due to cross border trade and financial linkages which are a manifestation of globalization, these assumptions are also supported by Kose, et al., (2020). So, in effect if a developing economy does not necessarily have to be doing badly prior to the global crisis to be affected. In his research, Kose, et al., (2020) asserts that in the global recovery of 1975 was the result of adequate global policies being implemented, global recovery is defined as a rebound in financial and macroeconomic activity. The author further states that the two policies utilized by an economy whether developing or developed often become expansionary during a global crisis and after the crisis.

Australia is a developed economy that is considered to have avoided the effects of the GFC and this assumption is based on the economy's positive real GDP during the GFC (Makin, 2019). During the GFC the Australian authorities deployed fiscal and monetary policies. With the central bank cutting the repo rate by 3%, thereafter, causing the exchange rate to fall exponentially as was intended by the authorities, it fell "by around a third against the U.S dollar, leading to a significant turnaround in the economy's international competitiveness," (Makin, 2019, p. 21), simultaneously, the Australian government implemented one of the largest fiscal responses between 2008 and 2009. A presumption can be made that the sole objective of these policy manoeuvres was to augment consumption and investment expenditure to curb the

effects of the GFC. However, Makin (2019) further claimed contrary to his initial statements that initially the Australian dollar fell due to a drop in demand for its commodities stemming from a decline in aggregate demand. These events made Australia competitive and insulated. Moreover, prior to the GFC its mining sector had been undergoing an uncommon boom, this in turn elevating national income, mining investment, mineral exports and employment. This in effect, is another viewpoint to why Australia managed to curb the GFC. In Australia's case, an assumption can be made that the authorities knew the correlation between the interest rates and the exchange rate. Nonetheless, even if they did not know the relationship between the two variables, their choices had a huge effect on the economic state during and after the GFC.

Developing economies are emerging market economies that become more and more engaged with global markets as they grow. As an emerging market economy grows it attracts a lot more investors represented by a surge in liquidity in local equity and debt markets (Szulczyk, 2014). Investors are notorious for seeking out emerging markets for their potential in offering higher returns, as these economies experience rapid economic growth (Carbaugh, 2015). However, these markets are much riskier than investing in an advanced economy, the risks stem mostly from structural and political problems, illiquid equity and currency volatility. In addition, emerging markets are not as developed as those in developed nations, the market is generally not as efficient and strict, standards in the accounting aspect and securities regulation are generally subpar relative to developed economies (Carbaugh, 2015).

Through globalization, developed and developing countries have become intertwined, making it possible for the labour in developing economies to increase the labour in developed economy, meaning that if a powerful country is to experience some type of recession or economic turmoil the rest of the world is likely to experience part of that effect (Kose, et al., 2020). Due to the risks that come with investing in the emerging market the financial securities from these markets are the first to be sold off in times of a crisis (Brealey, 2012), this in turn drops asset prices of the economy. Moreover, due to investors moving their money to safer havens (advanced economy's financial securities) there is the possibility that the GDP in that economy is also affected and a drop in GDP is experienced (Bamford & Grant, 2015). Further, the sell-off in financial securities would see a drop in demand for the domestic currency, causing depreciation. This presumably incentivises policy makers to step in with the mandate to revive the economy either through monetary or fiscal policies or a

combination of both. Huang and Wang (2017) attribute the movement of capital to herd behaviour. The two researchers were investigating the effect of the movements in the volatility index in Taiwan's stock market. The proof of herding behaviour is more aggressive in emerging markets than in more advanced markets due to investors having short investment horizons in emerging markets (Chang, et al., 2000).

To illustrate how devastating some recessions can be, let us look at the Zimbabwean economy. The GFC caused global activity to mitigate, due to declined global activities developing economies such as Zimbabwe experienced a steep decline in commodity prices (Mankiw, 2014). In addition, lower prices that stemmed from a decline from aggregate demand then reduced the export revenues of Zimbabwe. Although the economy had been experiencing problems prior to the GFC such as experiencing hyperinflation, according to Mudzingiri (2014), the GFC was the catalyst to Zimbabwe adopting the US dollar as their currency and completely dropping their own currency which was perceived as having no worth by the market in 2009. Unfortunately, the bank's focus is not to insulate the currency from capital mobility but to stabilize the economy through mitigating the movements of the inflation (Hayo, 1998). As can be discerned, the economy (Zimbabwe) struggled during the GFC due to prior poor management.

Another Developing economy that was severely-affected was Zambia. The GFC caused Zambia's terms of trade to diminish and simultaneously the copper prices also dwindled during this period (Baldini, et al., 2012). Baldini, et al., (2012), states that another shock experienced by Zambia was the surge in its risk premium as the demand for the economy's financial assets mitigated, this is congruent with the earlier statement of developing economies being discerned as risky investments even before any crisis. Further, as a result, banks augmented their lending rates and reduced their lending within the economy, this then led to decreased inflation which Zambia was experiencing high inflation. However, the authors argue that this was counterproductive because later in 2009 the banks decreased the interest rates and a surge in lending was discerned within the economy to try and revive it. The authors state that, "a more accommodating policy would have helped stabilize the economy earlier, albeit at the cost of higher nominal depreciation and inflation," (Baldini, et al., 2012, p. 4). The authors' suggestion would have been possible if the Zambian's central bank was well aware of the relationships of money supply, interest rates with the exchange rate and inflation in this context which is the GFC.

However, an economy that managed to curb the effect of the GFC and actually experienced economic growth during this catastrophic event was China, one of the primary reasons it managed to do this was because of its sound macroeconomic framework as claimed by Kshetri (2008). The author claims, its excellent monetary policies in conjunction with its fiscal policy helped alleviate some of the negative effects of the GFC. Moreover, the fact that China wasn't experiencing any economic problems prior the event was also a factor to why it wasn't affected as much as other developing economies. This is the reason to why this present study included the interest rates and money supply because knowing the relationship between these three variables would help South Africa avoid a situation where a global crisis could be catastrophic, not due to poor management but due to inaccurate action taking. We can safely assume that economies in different developmental stages experience different results regarding the monetary policy action.

2.4.2 Studies conducted in Developed Economies

According to the Organisation for Economic Co-operation and Development (OECD), Turkey has been an advanced economy since 1961 (OECD, 2021), and according to the Human Development Indices and Indicator, Turkey has been a developed economy since 2018 (Report, 2019) . Studies in Turkey have looked at the correspondence of the interest rate and the exchange rate by utilizing the ARDL model. Inconsistencies were produced from the studies. Research as early as 2005 utilized the ARDL model in the Turkish economy. Karaca (2005) investigated the relationship between the interest rate and the exchange rate in Turkey by looking at a timeline of 15 years from January 1990 to July 2005, using the ARDL model to analyse the association between exchange rate and interest rate. According to Karaca (2005), there wasn't a significant long-run link between the two variables. This inference opposes Isard (2006) and Machobani, et al., (2017) who are advocates of the UIP theory, since in Karaca (2005)'s research there is no link between the interest rate and the exchange rate there is no way for the UIP theory to hold. As stated in prior chapters UIP is a theory which claims that the difference between nominal interest rates of two countries is reflective of the future nominal exchange rates of the two countries, further, the country with the higher nominal interest rate now is the one that is predicted to experience a depreciation in the exchange rate in the future (Isard, 2006). In Karaca (2005)'s research, it was determined that the relationship was weak between the two variables.

Moreover, from 1990 to 2005 there was continuous fluctuation in the interest rate, with the highest repo rate being 183.2% and the lowest repo rate being 13.5% (IMF, 2021). However, analysing at the IMF's data-stream, taking the exchange rate into consideration not much fluctuation is seen, only gradual depreciation in the exchange rate from 1990 to 2002, with a gradual appreciation from 2003 to 2005 (IMF, 2021). Between 1990 and 2005 the weakest the Turkish Lira had been relative to the U.S dollar was 1.64 (Turkish Lira per US Dollar), contrast to that its strongest being 0.01 (Turkish Lira per US Dollar).

The UIP theory is based on the comparison of two counties. Taking into account the exchange rate and interest rate of the United States the UIP theory can be presumed to be unreliable. Looking at the IMF data-stream a significant change in the Turkish repo rate in the years 1993 to 1995 from 69.63% to 106.31% can be discerned, a 36.68% increase. Looking at the same timeline the Turkish Lira experienced a significant depreciation of 500% from 0.01 to 0.06. However, in 1993 the repo rate for the United States was only 3% and it only increased from 3% to 5.50%. As can be seen the country with the higher interest rate is Turkey, however, it has the much stronger currency. "According to the Uncovered Interest Parity (UIP) condition, interest rate differentials compensate for expected exchange rate changes, equalizing the expected returns from holding assets which only differ in terms of currency denomination" (Melander, 2009, p. 1).

Moreover, in the years 1999 to 2000 the repo rate surged from 69.97% to 183.2% which is more than twice the initial rate. Even so, the Turkish Lira in the years 1999 to 2000 depreciated by only 0.13. According to Froot and Thaler (1990) and (Chinn, 2006) some investors take time to respond to interest rate differentials, thereby, a lag in the exchange rate movements is expected. The Turkish Lira in 2000 does drop from 0.67 to 1.45 in 2001 which can be discerned as dropping more than twice the value, however, the drop is not proportional to the increase in the exchange rate. To further investigate we could also look at the Turkish Lira in 2002 which further depreciated to 1.67. On the surface this may seem to align with the UIP theory, however, when the United State's interest rate is also considered the theory falls apart. From 1999 to 2000 the repo rate increased from 5.5% to 6.5%. Again, the country with the higher repo rate is Turkey, however, the repo rate is exorbitantly much higher than that of the United State's. Whilst the exchange rate between Turkey and the United States in 2001 is 1.45:1. In real life there are a significant number of countries

involved making it a strenuous activity to actually ascertain the significance of the UIP theory.

Another study done by, Karimi and Karamelikli (2020), also examined the association between the interest rate and exchange rate in the Turkish economy between February 2003 and December 2016. The authors incorporated the U.S interest rates, Turkish interbank rate and the nominal exchange rate of Turkey. A non-linear ARDL (NARDL) model was used to analyse the asymmetrical association in the long run. Descriptive statistics of all the variables was carried out before carrying out the unit root tests and the NARDL model. Virtually most papers begin with descriptive statistics, they constitute the basis of most quantitative analysis of data (Blanca, et al., 2013). Further, they provide simple abstract of the sample population being used in the research. In the authors' research, kurtosis for all variables was determined to in close range of 3, further the skewness for all the variables was also within close range of 0. From these results an assumption of a normal sample population can made. "Parametric statistics are based on the assumption of normality. Recent findings suggest that Type I error and power can be adversely affected when data are non-normal," (Blanca, et al., 2013, p. 2). Therefore, it is of paramount importance to carry out descriptive statistics before inference statistics is done. Inferential statistics refers to the process of drawing conclusions from the model estimation (Byrne, 2007). After determining normality within the sample population the author's carried out the Augmented Dickey – Fuller (ADF) and Phillips – Perron (PP) tests. Before testing whether the exchange rate and interest rates are cointegrated through implementing the NARDL, the order of integration of each series should be checked (Isiksal, et al., 2018). The study utilized the ADF and PP unit root tests. Both tests are built on the Dickey and Fuller (1979) test. Unit root tests, test whether the time series of a variable is non-stationary thus possessing a unit root. This is done to avoid the Yule (1926) spurious correlation issue that comes up when analysing the relationship between two non-stationary series (Sikwanda, 2011).

A unit root is defined as stochastic trend in a time series which is also described as a random walk. If a time series has a unit root it represents a systematic trend that is unforeseeable. Moreover, if there are 4-unit roots, the process will have to be differenced 4 times in-order to make it stationary (Kumar, 2010). According to Kumar (2010), stationarity means that a variable's mean and variance are constant over time. A number of economic time series show a continuous upward and downward

trajectory solely caused by non-stationarity, as note by Sikwanda (2011, p. 28) who stated that:-

> *The regression of non-stationary time series on one another often yields significant regression results even though there is actually no meaningful relationship between the two variables and are actually only correlated through a third variable that is not included in the model. This is essentially the problem known as spurious correlations.*

The ADF framework to investigate a times series for stationarity has been given in the following equation, which is consistent with Kumar (2010).
Our null hypothesis when conducting a unit root test in the time series is the existence of non-stationarity (p=1). Therefore, if the null hypothesis is not rejected that would mean a unit root exists in the series, meaning that we accept the null hypothesis. Thereby, the unit root must be differenced to see if stationarity is achieved after first differencing (Isiksal, et al., 2018).

"The results reported in this study showed that after differencing the variables once, all the variables were confirmed to be stationary. The ADF and PP tests applied to the first difference of the data series reject the null hypothesis of non-stationarity for all the variables used in this study" (Karimi & Karamelikli, 2020, p. 6). Finally, the NARDL model is implemented. According to the authors, the results are threefold: first, an increase in the domestic interest rate in the short run had a positive but insignificant impact on the exchange rate relative to a decrease in the interest rate in the Long-run. Secondly, a strong negative correlation is found between the interest rate and the exchange rate. Thirdly, the results also reveal that the U.S interest rate was statistically insignificant to the Turkish exchange rate in the long run. Taking into consideration the possible time lag in respond from investors the authors results support the UIP theory, in that an increase in the interest rates will result in a depreciation in the exchange rate to compensate for expected exchange rate changes, equalizing the expected returns from holding assets which only differ in terms of currency denomination (Melander, 2009). The author suggested policymakers to be more cautious about decreasing and increasing the interest rates. From this, it-is-clear that a relationship between the interest rate and the exchange rate is inconclusive, this can be concerning. Many investors are warry of variations in macroeconomic variables and try avoid economies that are not economically stable or that suffer from political unrest. In other words, despite an economy being developed and being discerned as a safe place to move capital, many developed economies are still susceptible to economic uncertainty due to investors doubt in the policy-makers ability

to use policies (monetary and fiscal) to keep the economy stable. As was the case in the United States in 2008, where, due to investors panic, a huge sell off in financial securities was experienced.

The previous results, however, are inconsistent with the findings of Isiksal, et al., (2018), who found a strong relationship between the two variables. The researchers analysed the relationship between the interest rate and money supply with the exchange rate in Turkey by utilizing the ARDL model. The authors observed two periods, Pre-GF (December 2001-December 2007) and Post-GFC (January 2010-January 2016). No descriptive statistics were provided in this study. The unit root tests that were implemented in this study were the CMR unit root test, Perron-Vogelsang unit root test and Zivot Andrews unit root test. The results from the unit root tests claimed the existence of one and two structural breaks in the variables. These break dates were taken into account and it was shown by the unit root tests utilized that all the series are non-stationary at level, however, after first differencing they were stationary. Therefore, at level the null hypothesis (H_0) is accepted as the variables are discerned to be non-stationary. Nonetheless, after first differencing, the null hypothesis for the unit root for all three variables is rejected. The exchange rate, interest rate and money supply are said to have I(1) order of integration.

Next, the bounds test is carried out with the sole purpose to determine if a long run relationship exists between interest rate and money supply with the exchange rate. Isiksal, et al., (2018, p. 86), who asserted that:-

> *The major advantage of using the regressors could be of different orders of integration, meaning that they could be at level I(0) or could be at the first difference I(1). The test being based on F-statistics, which is derived from the ARDL approach. In order to determine if there is a long-term association, the F-statistics value was compared to the critical values that were introduced by* Pesaran, et al., (2001)*. The null hypothesis of no long-term association cannot be rejected if the F-statistics value is less than the lower bounds. In contrast, if the results are higher than the upper bounds, it means that the null hypothesis can be rejected and there is a long-term association among the variables. Finally, the result will be inconclusive if the F-statistics value falls between the lower and upper bounds.*

The authors' results from the ARDL bounds test of cointegration showed that the F-statistics exceeded the 5% upper limit critical values that were provided by Pesaran, et al., (2001). Since there F-statistics is above the 5% upper limit of the critical values, the null hypothesis (H_0) of the existence of no long-term relationship existing between

the variables is rejected, meaning that there is cointegration between the variables before and after the GFC. The short-term coefficients are also ascertained in the study by employing the ARDL, FMOLS, DOLS and CCR. The authors state that these models were implemented to test the strength and consistency of the long-run coefficient results. According to their research, there was a large effect from the money supply and short-term interest rates on exchange rates in Turkey before and after the GFC. The results showed that the surge in interest rates in Turkey caused an appreciation, conversely the results also showed that a fall in interest rates in Turkey caused depreciation on the domestic currency after the GFC. Further, the increase in money supply had a negative effect in the Turkish exchange rate before and after the GFC. These results align with the empirical research done by previous researchers such as Onis and Ozmucur (1990), Sensory and Sobaci (2014) and Andries, et al (2017).

As mentioned before, virtually most papers begin with descriptive statistics as they constitute the basis of most quantitative analysis of data (Blanca, et al., 2013). Further, they provide simple abstract of the sample population being used in the research. However, in this study the authors did not carry out any descriptive statistics, therefore, there is no way of discerning whether their sample population was normal. Parametric statistics are based on the assumption of normality. Recent findings suggest that Type I error and power can be adversely affected when data are non-normal (Blanca, et al., 2013). Therefore, it is of paramount importance to carry out descriptive statistics before inference statistics is done. Essentially, making the author's inference unreliable. Further, the results from Isiksal, et al., (2018) are contradictory with the UIP theory. In the UIP theory the interest rate and the exchange rate have a negative relationship whereas the author's results exemplify a positive relationship. Moreover, actually ascertaining if the UIP theory holds would require comparisons with other economies interest rates as well.

2.4.3 Studies conducted in Developing and Emerging Economies

Researchers have taken the time to examine different variables that may possibly have a relationship with the exchange rate in the context of a developing economy over the years to ascertain the relationship between the monetary policy and the exchange rate. Most of the research has found that the monetary policy has a significant relationship with the exchange rate using the ARDL model. Investigating

the short run and long run relationships of monetary dynamics with the exchange rate in Pakistan.

Khan and Sajjid (2005), found the existence between the monetary policy and the exchange rate. The authors investigated over a period 1982Q2 – 2002Q4.
No descriptive statistics or unit root tests are utilized by the authors. According to the authors:-

> *In applying any cointegration technique, the first exercise is to determine the degree of integration of each variable in the model. This of course, will depend on which unit root test one can use. To avoid this difficulty and per-testing of unit roots, Pesaran, et al.,* (2001) *introduced a relatively new cointegration test known as Autoregressive Distributed Lag (ARDL) approach. This test has several advantages. One of its most notable features is that the existence if the long run relationship is tested without any a priori knowledge of the order of the time series (i.e I(0) or I(1)) of the possibility of cointegration. Since the power of existing unit root tests to identify the order of integration, in particular, whether I(0) or I(1) is always questionable, hence their test may be useful* (Nagayasu, 1998)*.*

According to their research the authors imposed a two, four, six lags on each differenced variable and proceeded to calculate the F-statistics. The results show that when two lags are imposed there is a significant relationship therefore exemplifying evidence of cointegration. As mentioned earlier, Pesaran, et al., (2001) asserts:-

> *The null hypothesis of no long-term association cannot be rejected if the F-statistics value is less than the lower bounds. In contrast, if the results are higher than the upper bounds, it means that the null hypothesis can be rejected and there is a long-term association among the variables. Finally, the result will be inconclusive if the F-statistics value falls between the lower and upper bounds.*

In this context the F-statistic was 6.6933% which exceeds the critical value of the upper level of the band at 5% level of significance. This result indicates the presence of a long-run association among the variables which are the real money balances, inflation rate, real income, foreign interest rate with the real effective exchange rate. The author found that in the long run a 10% increase in the real effective exchange rate will cause an increase, on average, the real money balances by 2.4% per quarter. The author then implemented the error correction regression association. The error term derived is negative and significant, therefore advocating cointegration between the variables. In the end the authors concluded that there was a stationary long run association between real money balances, real income, inflation rate, foreign interest rate and real effective exchange rate. Moreover, the congruence of the interest rate to the exchange rate was low in the short run and in the long run. Further, results

showed that the impact of the money supply on the exchange rate was significant but only in the long run. Thus, they state that policy-makers should alter monetary and fiscal policies to respond to the exchange rate in order to maintain fluctuations in the domestic currency, thus, increasing confidence in the economy. An inference can be made that the monetary policy's effect on the exchange rate is mixed in the long run and insignificant in the short run for Pakistan. However, the author's conclusion does not support the UIP theory with there being no relation both in the short run and in the long-run. An argument can be made that the author not utilizing the descriptive statistics and the unit root tests could have marginally affected the final results. Khan and Sajjid (2005, p. 91) claims that "one of its most notable features is that the existence if the long run relationship is tested without any a priori knowledge of the order of the time series (i.e I(0) or I(1)) of the possibility of cointegration," however, many authors have carried out the descriptive analysis and unit root test before utilizing the ARDL model to ascertain the existence of cointegration (Ayomitunde, et al., 2019; Karimi & Karamelikli, 2020; Oskooee, et al., 2020).

Long and Samreth (2008), other researchers that used the ARDL model, found evidence that income, money supply and interest rates were factors to be used in determining the movements in the short-run and as well as in the long-run of the exchange rate in Philippines. Similar studies have been done in developing countries in Africa, particularly in Nigeria. Olaniyi (2013) investigates the validity of the monetary model of exchange in Nigeria over the timeline of 1998 to 2012. The monetary model of exchange rate consists of four variables which were the money supply, income and the interest rate and the exchange rate. The results from the F-statistics were shown to be significant. When first differenced the F- statistics of the model exceed the critical value both 10% and 5%, therefore, supporting long run cointegration relationship. Thereby, rejecting the null hypothesis of no long-run relationship existing. Moreover, from the Wald test the author's F-statistic exceeds the upper bound critical value at the 5% level. Thereby, the null hypothesis of no long-run cointegration is rejected, therefore, claiming the existence of long-run cointegration between the variables. According to the author a strong relationship is established between the variables and the exchange rate. Moreover, the adjusted R-squared exemplified 95.3% of the exchange rate's variation was attributed to the variables. The results corroborated that there was a long run relationship among variables of the monetary model of exchange rate for Nigeria. Olaniyi (2013, p. 11) asserted that "when the stability of the estimated model is tested with CUSUM, it shows that there exists a significant and stable monetary model of exchange rate determination for Nigeria." Thus, he

suggests that investors in the financial market should focus on the exchange rate fluctuations using money supply, income and the interest rate variables. A further review of literature in the context of Nigeria (using an ARDL model), revealed an existing negative relationship between the treasury bills and the exchange rate, whilst interest rates, money supply have a positive relationship with the exchange rate. Ayomitunde, et al., (2019) obtained these results by first carrying out a descriptive analysis on annual data from 1990 to 2015 of the interest rate, treasury bills, money supply and the exchange rate. The Jarque-Bera estimates indicated that all variables were fairly distributed due the values of the skewness being close to 0 and the values of the kurtosis not being far from 3. After the authors ascertained the normality of the sample population they carried out a unit root test. The authors implemented the ADF unit root test and the PP unit root test. The final results were a mixture of 1(0) and I(1). "The major advantage of using the regressors could be of different orders of integration, meaning that they could be at level I(0) or could be at the first difference I(1)" (Isiksal, et al., 2018, p. 86).

Thereafter, the authors carried out the ARDL bounds test and obtained an F-statistic of 2.644. However, at the 5% significance level the upper critical value was 2.86 and the lower critical value was 4.01. Thereby the null hypothesis (H_0) no long-run relationship cannot be rejected since the F-statistic of 2.644 does not exceed the lower and upper critical values. Hence, there was no presence of cointegration among the variables in the long-run using the ARDL model. The authors then proceeded to investigate the short-run relationship between the monetary policy and the exchange rate and showed that the monetary policy had a significant positive impact on the exchange rate. Furthermore, the monetary policy variables used in this study explained roughly 96% of the aggregate variation in the exchange rate. This implies the model was a good fit.

Further results showed that the policymakers aimed to keep the exchange rate stable in the short run, this indicates that whenever the central bank changed the monetary policy in order to mitigate the fluctuations in inflation, the central bank was cognizant of the effect the change had on it's exchange rate and how the overall economy would be affected by this policy change. Therefore, Ayomitunde, et al., (2019), claims that the policymakers should increase the rate at which it sells it's treasury bills to the commercial banks thus helping stabilize the exchange rate in the short-run, also, reducing the broad money supply and the repo rate in order to lower exchange rate depreciation in the country.

One of the key measures in determining an economy's performance relative to other economies is by observing how the country's exchange rate fairs with the others, two of the variables that are said to affect the exchange rate are a country's openness and terms of trade. Openness being defined as the lack of constraints that come with a country, in other words, the less import restrictions an economy has the more open it is (Kumar, 2010). Some economies like China actually go a step further and lower the taxes for international companies in order to accommodate the businesses. The results produced by Kumar (2010), are consistent with this presumption. The author attempted to determine which variables caused movements in the exchange rate. In the author's attempts, the results showed that productivity differential, external openness, terms of trade and net foreign assets were the variables that proved to be significant. The short-run interaction and long-run interaction are found to be relatively similar with their coefficients. The error term is statistically significant and negative indicating convergence in the long-run. Despite Kumar (2010) investigating a developing economy and using the same model, he found different variables affecting the exchange rate in India. Many developing economies are situated in different regions, therefore, many developing economies have different resources, meaning that they react differently to economic shocks.

2.5 South African Studies on the relationship between Interest and Exchange Rate

Different models used produce different perceptions on the congruence of the variables being examined. So, separating research that utilized the ARDL model from the research that did not in the context of South Africa would help the focus of this research.

The exchange rate is a critical factor in macroeconomic management for policy makers. The nominal exchange rate joins the price systems in different economies and makes it feasible for investors to relate to prices directly. A change in the nominal exchange rate has a direct effect on imports and exports, therefore fluctuations in the rand would greatly affect the imports and exports. For example, if a laptop costs £2000 in London and the pound/rand was 10:1 today, the laptop would cost a South African citizen R20,000 (£2000*10). If the importer was to delay the purchase by a month and the pound/rand was to move to 5:1 (an appreciation), the laptop would

cost R10,000. This would increase competition for local laptop manufacturers and ultimately lead to more imports. South Africa is renowned for its control of inflation. As mentioned in Chapter 1, it introduced inflation targeting in February 2000 and has managed to keep it within the 3-6% inflation band (Resbank, 2021; IMF, 2021). Ever since 2000 there have been a multitude of repo cuts and increases with the sole attempt to maintain inflation, in early 2006 the repo rate was 10%, in 2011, only 5 years later it had been cut to 5%. Coincidentally the rand was on a continuous decline between 2006 and 2011, with a few rallies (IMF, 2021).

When South Africa was experiencing depreciation pressures in 1998, the increase of the repo rate proved to be of no effect in improving the situation, as stated by the Financial Stability Forum, this was caused by institutions that were highly leveraged who sold the rand short, the act pushed the domestic interest rates up, meanwhile investors were selling short government assets in the hopes that the depreciation of the rand would allow them to make profits between the sale and repurchase timeline (Takaendesa, 2006). Takaendesa (2006) further states that, any intervention in the foreign exchange market was discerned as being ineffective in applying any pressure on the exchange rate, the South African policy-makers saw that intervening with the same strategy would be ineffective. A few years later in 2001, the rand depreciated due to an increase in money supply (M0 - coins and notes), this was due to inaccuracy on ascertaining the amount to be allotted towards the surge in cash demand (Bhundia & Gottschalk, 2003; Sikwanda, 2011). The few papers that have carried out research pertaining to the exchange rate have had mixed results to what truly affects the rand. With some literature stating monetary policy as the primary effect for the exchange rate fluctuations and other literature mentioning a variety of reasons.

2.5.1 South African Empirical Studies that did not Incorporate the ARDL Model

Using an empirical exchange rate model, Bhundia and Gottschalk (2003), investigated the sources of nominal exchange rate fluctuations in South Africa, using a narrow data range from 2001 to 2002. They argue that the root cause of exchange rate fluctuations was unclear. One of the aspects they investigated was the effects of currency speculation for which they found a relationship, however, the relationship was not significant. Currency speculation is when investors expect the economy to do well or badly and this in turn affecting the demand for the currency, with a shift in

demand comes an appreciation or depreciation in the currency. By conducting a preliminary investigation, they found that the movements of the exchange rate was linked to the interest rate policy in South Africa and in the United States, their impulse response analysis showed that the interest rate could have had a significant impact on the nominal exchange rate. However, in the case of the rand depreciating, a substantial amount of tightening would have been required to mitigate major depreciation from happening and in the context of growth this would have been inappropriate. Further, they also found that both broad money and narrow money in South Africa play a role in the exchange rate fluctuations. They suggest future researchers to analyse other market variables to gain further understanding of what affects the movements.

The findings in Bhundia and Gottschalk (2003) align with the findings in Isard (2006) and Machobani, et al., (2017) literature where the interest rate have a negative significant effect on the on the currency. These results seem to align with the UIP theory, however, a claim can be made that they only support a portion of the UIP theory.

As mentioned in prior chapters, the UIP theory is based on the comparison of two countries. The reality is there are many countries with their own currencies and monetary system. A claim can be made that, for the authors results to align with the UIP theory other countries interest rates must be stagnant or move relatively less than South Africa's interest rate. No evidence is provided of other countries interest rates in the author's research. As mentioned in Chapter 1, South Africa introduced inflation targeting in February 2000 and has managed to keep it within the 3-6% inflation band (Resbank, 2021; IMF, 2021). Ever since 2000 there have been a multitude of repo cuts and increases with the sole attempt to maintain inflation, in early 2006 the repo rate was 10%, in 2011, only 5 years later it had been cut to 5%. Coincidentally the rand was on a continuous decline between 2006 and 2011, with a few rallies (IMF, 2021). The results shown by Bhundia and Gottschalk (2003), suggest that the interest rate and money supply have a significant effect on the exchange rate, therefore suggesting that these variables could have been the cause of exchange rate movements.

From this, a claim can be made that the interest rate plays a role in the fluctuations of the exchange rate. Which can mean policy makers are aware that when maintaining the inflation rate they are also causing the exchange rate to move. This becomes

tricky however, during a crisis and after a crisis due to investors sentiment. Lardo, et al (2013) tested the relationship of money supply, real GDP with the exchange rate using annual data from 1910-2010. A VECM was used in this research to test the relationship. The results produced were at best mixed. Some support is found in the results for the model in the long run, co-integration was identified in the variables.
This author's results do not align with Bhundia and Gottschalk (2003). Bhundia and Gottschalk (2003) investigated variables in the short-term, whereas Lardo, et al (2013) investigated in the short-term in conjunction with investigating in the long-term. Their results in the short term were mixed prompting them to investigate in the long-term. Although the investigation done by the researchers was on the same country (South Africa) different results were produced. Despite this concentrated look at the relationship between the variables variations in results are discerned, a claim can be made that with differences in models comes different perceptions of the association of the variables. As highlighted in prior sections, the correspondence between the interest rate and the exchange rate has been a contentious issue for many researchers and not a clear direction has been established in both developed and developing economies. Nevertheless, scholars that have incorporated the ARDL model have mostly found a positive relationship between the monetary policy with the exchange rate.

Another researcher that made similar recommendations was, Sikwanda (2011). The researcher used regression analysis and co-integration using data available from 1998 through to 2010. He analysed the congruence of the bond interest rate yields from years 0-3, 5-10 and 10 and beyond with the exchange rate. In this study, no descriptive statistics were provided. However, the author carried out their investigation through carrying out a unit root test. An ADF test was utilized in this study and from the investigation results clearly exemplified that the original time series, had unit roots in them at the critical values of 1%, 5% and 10%, therefore, the null hypothesis (H_0) (which states that unit roots exist) is not rejected. Since the time series data was non-stationary it had to be differenced. After first differencing the time series data was stationary, thereafter, the author carried out an OLS regression and found the following results.

Sikwanda (2011) noted a positive correlation in the 5-10 years interest rate yields and in the 0-3 years as well, with the 5-10 years having a stronger correlation with the exchange rate. The author also observed a continuous decrease in the correlation, from bond yields of 10 years and beyond. Further analysis, however, using the OLS

method showed that there wasn't a significant relationship between the interest rate and exchange rate as exemplified by the low explanatory power in R-squared and correlation of co-efficient. South Africa is renowned as a growing economy with diverse minerals and for it's tourist attractions, therefore it is unlikely that one variable is the sole cause of the exchange rate fluctuations. Following an extensive inspection the researcher suggested that the association that existed was not significant and recommended that other authors incorporate other variables into their research.

A study done by Botha and Pretorius (2009), inferred that the rand's movements are significantly unpredictable. The paper compared models such as the univariate time series model and various multivariate time series models in forecasting the exchange rate. The researchers found that the most reliable approach when determining the exchange rate was the monetary approach despite not being a reliable approach-in-itself. In addition, 3 broad determinants of the exchange rate were ascertained which are real, monetary and financial variables. Cointegration was observed between these factors. When it came to examining large data ranges, the univariate models (autoregressive conditional heteroskedasticity (ARCH) and autoregressive integrated moving average (ARIMA) performed much better than the multivariate models (VAR models and vector autoregressive moving-average (VARMA)), however in the short-run, multivariate models outperformed the univariate models. The authors conclude that expectations in the exchange rates are the primary determinants of the exchange rate from their exploration. Therefore, supporting Bhundia and Gottschalk (2003) findings.

Again, mixed results were produced regarding the monetary policy and the exchange rate in the context of South Africa. However, in this study the researchers investigated a multitude of variables and used different models to try and ascertain the movements of the exchange rate. Despite this approach their final results were that speculation were the main drivers of the rand. Moreover, this study does little to support the UIP theory since the author's claimed the rand's movements were largely unpredictable.

A scholar from the University of Rhodes in South Africa examined the determinants of the exchange rate and found different results from the researchers mentioned above. Takaendesa (2006), explored different variables in the pursuit to find what affects the rand. Using quarterly data with a timeline from 1975 to 2005 while utilizing an empirical model VAR the scholar found that real interest differential, domestic credit, trade, openness and technology had a significant impact on the exchange rate.

The speed at which a developing economy will grow is predominantly contingent upon how open it is to trade, and since South Africa produces its own goods and exports minerals, openness would definitely affect the currency's demand. The estimate of the speed of adjustment coefficient produced in the research exemplified that approximately a third of the variation in the real exchange rate from the normal level was corrected within a quarter. He states that, the terms of trade, openness and domestic credit affect the exchange rate significantly in the short-run. However, persistent effects were ascertained in the trade and domestic credit whereas openness would affect the exchange rate periodically. The author concluded that the domestic credit, openness and terms of trade are the main variables that affect the exchange rate significantly.

2.5.2 South African Empirical Studies that used the ARDL Model

In a case study of South Africa, Dube (2008), carried out an investigation involving macroeconomic variables such as the interest rate, money supply, stock prices and income to try and find out if a long-run relationship existed with the exchange rate. The author utilized the ARDL model and found that the rand-dollar exchange rate had a strong relationship with most of the variables. The secondary time series data was from January 1995 to December 2006. However, the money supply had a weak long-run relationship which was explained by "the U.S growth of M2 being consistently higher than M3 growth in South Africa. Under this scenario, the rand would have to reflect appreciation and not depreciation," (Dube, 2008, p. 21). Overall, the results collected corroborated that the explanatory variables had a significant impact on the exchange rate. Stock prices being an important factor, particularly in the short run as shown in the paper. The author suggests that the relationship is also influenced by globalization.

Dahir, et al., (2017), examined the relationship of the exchange rate with foreign direct investment (FDI). As defined by the author, (FDI) is an investment made by an individual, firm or government in one country to another country. Hence, it is safe to say when FDI takes place, there will be a transfer of funds from one country to another country, consequently, resulting in higher demand for the foreign currency in order to invest in foreign lands. In this case the author was examining the relationship of these two variables in the context of South Africa whilst utilizing the ARDL model over a time period of 1987 to 2016, to examine if a long run relationship exists between the

two variables. The author found that the exchange rate had a strong impact on the amount of FDI both in the short-run and in the long-run. In the investigation it was ascertained that cointegration existed between the exchange rate and the FDI, indicating correlation in the long-run between the variables. Moreover, trade openness and domestic market size having a large impact on FDI as well. The author recommends that policy makers monitor the exchange rate. A stable exchange rate would motivate FDI for the economy.

As asserted earlier, FDI is capital transfer from one country to another thus increasing the demand for the foreign country's currency. According to Bamford and Grant (2015) *Cambridge International AS and A Level Economics*, an increase in demand in the market by investors for a foreign currency will cause that foreign currency to appreciate. So, we can assume that a decrease in demand for a currency in the market by investors will cause the currency to depreciate.

2.6 Summary to the Literature Review

To sum everything up, the literature review has exemplified that a multitude of the previous research has only used linear econometric models to investigate the relationship between the monetary policy and the exchange rate. In addition, the literature exemplifies how predominantly the monetary policy had a significant effect on the exchange rate both in developed or developing economies. The present study is aimed at determining the relationship between the interest rate and money supply with the exchange rate before, during and after a crisis in South Africa. The present study is a rare approach as it investigates the association of the interest rate, money supply with the exchange rate by using the ARDL approach in South Africa.

Chapter 3: Research Methodology

3.1 Introduction

This chapter describes the ARDL model and discusses other research methods such as the ADF unit root test and PP unit root test. This Chapter is organised into five sections: The first section is the introduction to the chapter. The second section is the sample selection procedure and data sources which describes the sample and data retrieved. The third section states why the study utilized the ARDL model instead of other models. The forth section specifies the model, provides definitions and measurement of the variables and the fifth section summarises the chapter and states a conclusion.

3.2 Sample selection procedure and data sources

Secondary data from 2002 to 2016 was collected for examination in this study. Monthly data was used due to the relatively short sample size before, during and after the GFC. Studies in the past that have used monthly data include Bjornland (2008), Isiksal, et al., (2018) and, Karimi and Karamelikli (2020). Monthly data used comprised of three time periods, from January 2002 to January 2007 (timeline before the GFC), January 2008 to December 2009 (timeline during the GFC) and from January 2010 to January 2016 (timeline after the GFC). Making it feasible to compare the before and during periods on their own, and then the during and after periods and lastly the before and the after periods. The set of variables incorporated in this study consisted of two independent variables and one dependent variable. The two independent variables were the nominal interest rates (South African repo rate) and the money supply (M3-Broad money). The independent variable was the nominal exchange rate, dollar to the rand.

This study focuses on nominal rates instead of the real rates, the fundamental assumption is that the investors are not too worried about the domestic inflation rate. Prior studies, such as Bjornland (2008), Sikwanda (2011), Olaniyi (2013), Isiksal, et al., (2018) Ayomitunde, et al., (2019) and Karimi and Karamelikli (2020) have also used nominal interest rates in their analyses. In essence, majority of studies have used the nominal interest rate instead of the real interest rate. A few studies such as

Villavicencio and Bara (2008) have used the real interest rate. Moreover, according to the PPP theory the exchange rate is ascertained by the disparity of two economies' inflation rate, so a presumption already exists on inflation being factored into the exchange rate (Sikwanda, 2011). Sikwanda (2011) states that using real interest rates would have been a contentious issue because a battle on which inflation index to use would have risen. Further, if a rate is finally chosen, another battle would still arise on whether to use the average rate or the future rate. However, Brealey (2012) states that investors are interested in the real interest rates when it comes to cross boarder investing to determine if that investment yields a higher profit or not. Nonetheless, in this present study, the nominal interest rates shall be used due to the assertions stated earlier in this paragraph.

The data used in this study was extracted from The International Financial Statistics (IFS) released by The IMF Database, which shows macroeconomic data for a multitude of economies (IMF, 2021). The IMF is an international financial institution with the purpose of observing the international monetary and financial system and monitoring the economic and financial policies of its member economies. This pursuit is known as surveillance and helps smooth international co-operation. Further, the IMF is a reliable source because it is a well-respected institution with free, accurate and up to date information (Bordo & James, 2020). In addition, the IMF has policies in place to make sure that pertinent and correct data, in its own role in the global economy and that of its member countries is provided in real time to its global spectators (Reinhart & Trebesch, 2016). Takaendesa (2006), Villavicencio and Bara (2008), Kumar (2010), Hnatkovska, et al., (2016) and Karimi and Karamelikli (2020), are authors of prior studies that used data from the IMF. Takaendesa (2006, p. 21) states that "the geometrical average real effective exchange rate index, reported by the IMF's IFS is employed in this study. Given its policy relevance, it is also the desirable index to model."

A statistical package, Eviews 12 was utilized to examine the statistical properties of the three variables involved in this study to derive an inference. Previous researchers such as Sikwanda (2011) and Ayomitunde, et al., (2019) also implemented this statistical software.

3.3 The ARDL Model versus other models

Econometrics models were produced to evaluate and specify policies, analyse ideas (theories) and to forecast data. The early models, however, were not able to identify when time series were non-stationary, which produced misleading inferences regarding the relationships of variables. To surmount this barrier of non-stationarity on the lag structure of a model, more focus has been devoted to cointegration (Nkoro & Uko, 2016). The two authors, Nkoro and Uko (2016), state that the basis for this movement is simple, cointegration is a potent form of identifying the existence of a steady state equilibrium amongst variables. In effect, here are some of the cointegration techniques known to date:- Granger (1981) and, Engle and Granger (1987), Johansen and Juselius (1990) and, ARDL cointegration technique or bound test of cointegration (Pesaran & Shin, 1999; Pesaran, et al., 2001).

In applied econometrics, the ARDL model is a cointegration technique in ascertaining the long run relationship amongst series that are considered to be non-stationary (Nkoro & Uko, 2016, p. 64). In these researchers paper, they argue that:-

> *The ARDL cointegration technique does not require pre-tests for unit roots unlike other techniques. Consequently, ARDL cointegration technique is preferable when dealing with variables that are integrated of different order, I(0), I(1) or combination of both and, robust when there is a single long run relationship between the underlying variables in a small sample size.*

In this study, the identification of cointegration among money supply, interest rate and exchange rate was originally analysed by the ARDL approach (Pesaran, et al., 2001). There are a number of reasons which set this new model above the other models.
first, the mitigation of residual correlation, as mentioned by Nkoro and Uko (2016, pp. 78-9), “since each of the variables stands as a single equation, endogeneity is less of a problem in the ARDL technique because it is free of residual correlation. Also, it enables us analyse the reference model.”

Secondly in the presence of a single long run relationship, the ARDL model approach can differentiate between dependent and independent variables. Further, the ARDL procedure is under the presumption that only a single mitigated form equation association exists between the dependent variable and the exogenous variables (Pesaran, et al., 2001). Lastly the empirical results show that the approach is superior and provides mostly consistent results for small samples (Nkoro & Uko, 2016).

However, one major drawback of the ARDL model is that it will not work in the existence of merged stochastic trend of I(2), in addition, forestall effort in futility. It may be advisable to test for unit roots, though not as a necessary condition (Nkoro & Uko, 2016, p. 64).

3.4 Model specification, definitions and measurement of variables

Before testing whether the exchange rate and interest rates are cointegrated, the order of integration of each series should be checked (Isiksal, et al., 2018). The study utilizes the ADF and PP unit root tests. Both tests are built on the Dickey and Fuller (1979) test. Synonymous results are produced from both tests so this study will only report the ADF results. Unit root tests, test whether the time series of a variable is non-stationary thus possessing a unit root. This is done to avoid the Yule (1926) spurious correlation issue that comes up when analysing the relationship between two non-stationary series (Sikwanda, 2011).

A unit root is defined as stochastic trend in a time series which is also described as a random walk. If a time series has a unit root it represents a systematic trend that is unforeseeable. Moreover, if there are 4 unit roots, the process will have to be differenced 4 times in-order to make it stationary (Kumar, 2010). According to Kumar (2010), stationarity means that a variable's mean and variance are constant over time. A number of economic time series show a continuous upward and downward trajectory solely caused by non-stationarity, as note by Sikwanda (2011, p. 28) who stated that:-

> *The regression of non-stationary time series on one another often yields significant regression results even though there is actually no meaningful relationship between the two variables and are actually only correlated through a third variable that is not included in the model. This is essentially the problem known as spurious correlations.*

The ADF framework to investigate a times series for stationarity has been given in the following equation, which is consistent with Kumar (2010):-

$$\Delta x_t = \beta 1 + \beta 2 + \theta x_{t-i} + \alpha_i \Sigma_i^n \Delta_{x_{t-1}} + \varepsilon t \quad (1)$$

Our null hypothesis when conducting a unit root test in the time series is the existence of non-stationarity (p=1). Therefore, if the null hypothesis is not rejected that would mean a unit root exists in the series, meaning that we accept the null hypothesis. Thereby, the unit root must be differenced to see if stationarity is achieved after first differencing (Isiksal, et al., 2018).

The hypothesis for the ADF test was as follows:-
HO: p = 0 (unit root)
H1: p $\neq$0

Decision rule:
If Test Statistic >Critical Values => failed to reject the null hypothesis i.e unit root is present
If Test Statistic < Critical Values => Rejects the null hypothesis. i.e unit root is not present

Consistent with the study done by Isiksal, et al., (2018), the ARDL model for this study is specified as follows:-

$$lnExt = \beta 1 + \beta 2\ lnINt + \beta 3\ lnMSt + \varepsilon t \quad (2)$$

Where $lnEx_t$ is the natural logarithm for the rand, *lnINt* is the natural logarithm of interest rates, and *lnMSt* is the natural logarithm of the money supply (M3). On the other hand, the terms β_1 - β_3 are parameters, εt is the error term.

This study incorporates the same model utilized by Isiksal, et al., (2018, p. 86), who asserted that:-

> *The major advantage of using the regressors could be of different orders of integration, meaning that they could be at level I(0) or could be at the first difference I(1). The test being based on F-statistics, which is derived from the ARDL approach. In order to determine if there is a long-term association, the F-statistics value was compared to the critical values that were introduced by Pesaran, et al (2001). The null hypothesis of no long-term association cannot be rejected if the F-statistics value is less than the lower bounds. In contrast, if the results are higher than the upper bounds, it means that the null hypothesis can be rejected and there is a long-term association among the variables. Finally, the result will be inconclusive if the F-statistics value falls between the lower and upper bounds.*

According to Isiksal, et al., (2018), the ARDL model in a general form (incorporating the exchange rate, interest rate and money supply) can be expressed as follows:

$$\Delta L_n Ex_t = \alpha_0 + \Sigma_{i=1}^{n} y_1 \Delta LnEx_{t-1} + \Sigma_{i=1}^{n} y_2 \Delta LnIN_{t-1} + \Sigma_{i=1}^{n} y_3 \Delta LnMs_{t-1} + \sigma_1 Ln\, Ex_{t-1} + \sigma_2 LnIN_{t-1} + \sigma_3 LnMs_{t-1} + \varepsilon_t \quad (3)$$

Where Δ is the first difference operator, *LnEx* is the logarithm of the exchange rate, $LnIN$ and $LnMS$ are the logarithms of the interest rate and money supply and represents the limit to the number of lags; and ε_t is the error term of the equation. The null hypothesis of the ARDL model is the lack of existence of cointegration, $\mathbf{H_0} = \sigma_1 = \sigma_2 = 0$; and it is tested against the alternative hypothesis, $\mathbf{H_a} \neq \sigma_1 \neq \sigma_2 \neq 0$.

After the stationarity is ascertained either in level form or by first differencing and the bounds test has been carried out the error correction model is used to estimate the short-run relationship between the variables (Isiksal, et al., 2018). The error correction is estimated by the following equation:

$$\Delta L_n Ex_t = \beta_0 + \Sigma_{i=1}^{n} \beta_1 \Delta\, Ln\, Ex_{t-1} + \Sigma_{i=1}^{n} \beta_2 \Delta\, Ln\, IN_{t-1} + \Sigma_{i=1}^{n} \beta_3 \Delta\, Ln\, Ms_{t-1} + \omega ECT_{t-1} + u_t \quad (4)$$

Where Δ exemplifies the change in LnEx, LnIN, LnMS. ECT_{t-1} is the one period lagged error correction term.

3.5 Summary and conclusions

To sum everything up, this chapter identified the sample data collected, which in this case is the nominal exchange rate, money supply (M3) and the nominal interest rate (repo rate). In addition, this chapter also presented the model specification, the measurements of the variables and the definitions of the methods used. Further, this chapter states the advantages of utilizing the ARDL model over other models. The present study is aimed at determining the relationship between the variables before, during and after the crisis in South Africa. In the next chapter, the results are formulated from the methods used.

Chapter 4: Empirical Results

4.1 Introduction

This chapter presents the data analysis relating to the relationship between the interest rate and money supply with the exchange rate. Other scholars have carried out research pertaining to the relationship of these three variables for many decades. These three variables have been examined in both developing economies and developed economies and the results, however, are inconclusive as many researchers have reported different results. The exchange rate is a key component in the functionality of any economy and has been a key focus for many economic researchers. The importance of knowing the relationship between the interest rate and money supply to the exchange rate is imperative for many reasons.

The rest of Chapter 4 is organized into five sections. Section 4.2 deals with the descriptive statistics results of the variables in the different economic contexts, while Section 4.3 looks at the ADF unit root results for the variables in each context, Section 4.4 covers the ARDL bounds test of co-integration, while Section 4.5 deals with the short run ARDL results. The summary of this chapter is covered in Section 4.6.

4.2 The descriptive statistics of variables

Using monthly data from South Africa for the period before the GFC (Jan 2002 – Jan 2007), during the GFC (Jan 2008 – Dec 2009) and after the GFC (Jan 2010 – Jan 2016), the descriptive statistics of the three variables are given in Table 1. The table shows the statistical features for all variables before, during and after the GFC. As can be discerned the Jarque-Bera estimates exemplifies that the three variables are fairly distributed in all three economic contexts. This assertion can be justified by the kurtosis being in close range to 3 in all contexts for all variables and the skewness being close to 0.

For descriptive statistics we are given three central tendency measures which are the mean, median and mode. Central tendency is a descriptive summary of a dataset through a single value that reflects the centre of the data distribution (Fisher & Marshall, 2009). However, in this study only the mean and median are derived from the statistical package utilized (E-views 12). The mean is used to explain the

population sample with a single value that exemplifies the centre of the time series data. Further, many statistical analysis use the mean as a standard measure of the centre of the distribution of the data. The central tendency is measured by both the median and the mean. Nevertheless, in a sample population it is usual to find outliers unusual, these outliers affect the median and the mean. However, the outliers affect the median less than they affect the mean. In this study the mean and the median are similar indicating that the distribution is symmetrical.

Fisher and Marshall (2009, p. 96) assert that:-

> *Determining the measure of central tendency is important to do before you decide which inferential statistical technique you will use to analyse data. Parametric statistics relies on the assumption that the scores are normally distributed. If the data are not normally distributed then the researcher needs to do one or more of the following:*
> 1. *Examine the data for outliers, delete them and recalculate measures of central tendency.*
> 2. *Correct the distribution by using the logarithm of the scores.*
> 3. *Use nonparametric statistics.*

Standard deviation is used to show how spread out the data is. "For continuous data the range, interquartile range and standard deviation (SD) are used to describe the spread or width of the distribution. The standard deviation is commonly used in reporting descriptive statistics for continuous data," (Fisher & Marshall, 2009, p. 96). A claim can be made that during unprecedented economic situations normality in data is not to be expected since the economy won't be in a normal economic state. Since the economy won't be in a normal state a further claim can be stated that high deviation is experienced. Thereby, if standard deviation is high in the descriptive analysis an assumption can be made of non-normality. With normal data, most of the observations are spread within 3 standard deviations on each side of the mean (Fisher & Marshall, 2009). In our Descriptive analysis our standard deviation for the exchange rate and money supply in all economic contexts fall below 3 standard deviations.

Table1:- Descriptive Statistics for interest rate, money supply and exchange rate before, during and after the GFC

Panel A: Before GFC

	EX	IN	MS
Mean	10.62849	9.254098	915869.0
Median	10.12612	8.000000	850851.7
Maximum	14.51677	13.50000	1348758.
Minimum	8.767731	7.000000	628232.9
Std. Dev.	1.681904	2.418028	214492.7
Skewness	1.059143	0.761571	0.570728
Kurtosis	2.888982	1.955161	2.143673
Jarque-Bera	11.43613	8.671284	5.175390
Probability	0.003286	0.013093	0.075193
Sum	648.3376	564.5000	55868007

Panel B: During GFC

	EX	IN	MS
Mean	13.02117	9.916667	1880654.
Median	12.48499	11.00000	1920647.
Maximum	15.52995	12.00000	1953019.
Minimum	11.10840	7.000000	1678622.
Std. Dev.	1.279001	2.088616	82685.39
Skewness	0.775719	-0.450425	-1.126078
Kurtosis	2.233898	1.446284	3.109858
Jarque-Bera	2.993871	3.225566	5.084278
Probability	0.223815	0.199332	0.078698
Sum	312.5081	238.0000	45135706

Panel C: After GFC

	EX	IN	MS
Mean	14.15168	5.619863	2409585.
Median	13.50366	5.500000	2373439.
Maximum	22.61427	7.000000	3002307.
Minimum	10.50306	5.000000	1923961.
Std. Dev.	2.817567	0.512194	307322.7
Skewness	0.611985	0.761485	0.265124
Kurtosis	2.709227	3.190805	1.963598
Jarque-Bera	4.813901	7.165693	4.122348
Probability	0.090090	0.027796	0.127304
Sum	1033.073	410.2500	1.76E+08

This table displays the descriptive statistics for the exchange rate (EX), interest rate (IN) and money supply (MS). The exchange rate and interest rate are expressed in their nominal form, money supply is expressed in it's numerical form. The statistical data is based on monthly data and is split into 3 panels, panel A representing the timeline before the GFC (Jan 2002 – Jan 2007), panel B representing the timeline during the GFC (Jan 2008 – Dec 2009) and panel C representing the timeline after the GFC (Jan 2010 – Jan 2016).

4.3 ADF unit root analysis

Prior to testing if the interest rate and money supply is cointegrated with the exchange rate, the order of integration for each time series is ascertained. For this study, stationarity is tested by implementing the ADF and PP unit root test. However, only the results of the ADF are reported in this study.

As mentioned in Chapter 3, unit root tests, test whether the time series of a variable is non-stationary thus possessing a unit root. This is done to avoid the Yule (1926) spurious correlation issue that comes up when analysing the relationship between two non-stationary series (Sikwanda, 2011).

The hypothesis for the ADF test was as follows:-

HO: p = 0 (unit root)

H1: p $\neq$0

Decision rule:

If Test Statistic >Critical Values => failed to reject the null hypothesis i.e unit root is present

If Test Statistic < Critical Values => Rejects the null hypothesis. i.e unit root is not present

Table 2 shows the results from the unit root test. As can be seen at level form I(0) the null hypothesis for all the variables is accepted, the null hypothesis being that the time series is non-stationary. As can be discerned virtually most variables' test statistic is greater than the critical values in most economic contexts. There are just three exceptions which are LnMs during the GFC focusing only on the intercept in the ADF test, LnMs focusing on both trend and intercept and focusing only on the intercept in both cases after the GFC in the ADF test, which rejected the null hypothesis. However, at first difference I(1) the time series for each variable is reported to be stationary in all economic contexts, when the ADF only incorporates the intercept in the test and when the ARDL incorporates the trend and intercept. Therefore, rejecting the null hypothesis of non-stationarity towards the three variables' time series used in this study. In this study, the Schwarz information criterion was utilized to determine the best lag length of the model. Since there is no I(2) variable, we are able to depend on the ARDL approach to determine if there is co-integration between the variables. Next, the bounds tests are carried out with the sole purpose to determine if a long run

relationship exists between interest rate and money supply with the exchange rate in three economic contexts.

Table2:- ADF test results, before, during and after.

Level Form				
Panel A: Before GFC				
	Intercept	Probability	Trend and intercept	Probability
LnEx	-2.266	0.1862	-1.02338	0.9327
LnIn	-1.6413	0.4553	-1.0499	0.9283
LnMS	0.9151	0.9951	-1.6805	0.7478
Panel B: During GFC				
LnEx	-1.8275	0.3586	-1.8353	0.6543
LnIn	-1.6919	0.4199	-2.8571	0.1954
LnMs	-4.4478*	0.0021	-2.1573	0.4892
Panel C: After GFC				
LnEx	-1.8275	0.3586	-1.8353	0.6543
LnIn	-1.6919	0.4199	-2.8571	0.1954
LnMs	-0.1754***	0.09358	-4.8922*	0.0009
FIRST DIFFERENCE				
Panel A: Before GFC				
	Intercept	Probability	Trend and intercept	Probability
Δ LnEx	-6.2432*	0	-6.7055*	0
Δ LnIn	-3.1340**	0.0295	-3.2802***	0.0798
Δ LnMS	-8.0792*	0	-8.2957*	0
Panel B: During GFC				
Δ LnEx	-3.958*	0.0066	-4.0234**	0.0233
Δ LnIn	-4.4829*	0.0020	-4.4829*	0.0020
Δ LnMs	-3.7486*	0.0105	-4.2719*	0.0148
Panel C: After GFC				
Δ LnEx	-3.958*	0.0066	-4.0234**	0.0233
Δ LnIn	-4.4829**	0.020	-4.7152*	0.0057

*This table displays the ADF test statistics. The prefix "Ln" is used as the abbreviation of log of the variable and Δ represents the 1st difference of the variable. The ADF tests the null hypothesis that the time series for all variables are non-stationary. The figures under the column heading intercept and trend intercept display the significance at the 90%, 95% and 99% levels in which the null hypothesis can be rejected. ***denotes significance at the 10% level. **denotes significance at the 5% level. * denotes significance at the 1% level. The table is divided into two components, the 1st displaying the level form of the variables and the 2nd displaying the 1st difference. Each component is further divided into 3 panels. Refer to Table 1 for the meaning of each panel, timeline and full names of variables.*

4.4 ARDL Bounds test of Co-Integration

Next, we estimate the linear ARDL model summarized in Eq. (3). We impose a maximum of 10 lags on each first-differenced variable and use the Akaike's information criterion (AIC) to pick an adequate model, this is synonymous with the steps taken by Ayomitunde, et al., (2019), Karimi and Karamelikli (2020), and Oskooee, et al., (2020). The cointegration results from the ARDL bounds tests are displayed in table 3. Table 3 shows that the F-statistics in all of the three economic contexts. The F-statistics for all the variables before the GFC is 2.1442, during the GFC 2.4330 and after the GFC 2.4331. The F-statistics are all below the lower bounds of all the critical values. Therefore, the null hypothesis of no long run relationship is accepted and the existence of cointegration among the variables is rejected before, during and after the GFC. Similar prior studies such as Olaniyi (2013) and Isiksal (2018) also produced similar results, these researchers had to first difference their time series in order for it to be stationary and proceed with the ARDL model. Since there is no presence of cointegration among the variables in the model, the results of this test warrants the estimation of short run association approximation with the implementation of ARDL model.

4.5 Short run testing ARDL

Table 4 presents the results of the short run ARDL tests. As can be seen from the table, the ARDL results regarding the short run association between the variables before the GFC shows that there is no significant effect from the changes in interest rate and money supply on the exchange rate since the probabilities are well above 0.05. The money supply has no significant effect in all contexts which is similar to the results obtained by Dube (2008). However, the interest rate has a significant level of 10% during and after the GFC, that means there is cointegration between the dependent variable and the covariate.

With a positive co-efficient of 0.16 (interest rate), then that means if the SARB is to increase the interest rate by 1% the exchange rate will increase by 0.16%. This result is in-line with the results of Sikwanda (2011) who carried out research on the bond interest rates and the exchange rate and found that a marginal relationship existed between the two variables. Despite adopting a different model and looking at the relationship in different contexts the results found are very similar.

Table 3:- Results of the ARDL bounds tests of co-integration

Period	Model	Lag	F-statistics	Decision
Before GFC	EX, IN, MS	(3,0,0)	2.1442	No Co-integration exists
During GFC	EX, IN, MS	(1,0,0)	2.4330	No Co-integration exists
After GFC	EX, IN, MS	(1,0,0)	2.4331	No Co-integration exists

Critical Values		
Level	I(0)	I(1)
10%	2.63	3.35
5%	3.10	3.87
2.5%	3.55	4.38
1%	4.13	5.00

Note: ARDL(3,0,0), ARDL(1,0,0) and ARDL(1,0,0) selected on the basis of AIC

Table 4:- Error Correction Representation for the Selected ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Panel A: Before GFC ARDL(3,0,0)				
C	-0.178015	0.214517	-0.829839	0.4104
LNEX(-1)	-0.067269	0.075059	-0.896211	0.3743
LNIN	0.014663	0.047120	0.311194	0.7569
LNMS	0.038627	0.031766	1.215966	0.2295
D(LNEX(-1))	0.190988	0.138549	1.378488	0.1740
D(LNEX(-2))	-0.259745	0.140630	-1.847004	0.0704
Panel B: During GFC ARDL(1,0,0)				
C	-2.215916	3.055842	-0.725141	0.4772
LNEX(-1)	-0.392633	0.167787	-2.340067	0.0303
LNIN	0.162791	0.081654	1.993660***	0.0607
LNMS	0.397469	0.497464	0.798990	0.4342
Panel C: After GFC ARDL(1,0,0)				
C	-2.215916	3.055842	-0.725141	0.4772
LNEX(-1)	-0.392633	0.167787	-2.340067	0.0303
LNIN	0.162791	0.081654	1.993660***	0.0607
LNMS	0.397469	0.497464	0.798990	0.4342

**denotes significance at 1% level. **denotes significance at 5% level. ***denotes significance at 10% level. Refer to table 1 for the meaning of each panel, timeline and full names of variables.*

4.6 Summary

Normal distributions were ascertained, and this was reflected by the kurtosis being nearly 3 and the skewness being close to 0. Most variables at level form were discerned as being non-stationary, therefore accepting the null hypothesis of the time

series of each variable being non-stationary. However, at first difference the variables were all discerned to be stationary therefore making it viable to utilize the ARDL model. The bounds test was used to examine if co-integration existed in the long run between the variables, as the results showed no co-integration existed in the long run. Next, the short run relationship was examined and a relationship was ascertained during and after the GFC regarding the interest rate and the exchange rate. The relationship is seen as of minimal significance. However, no relationship was found between the money supply and the exchange rate in all contexts in the short run.

Chapter 5: Summary, conclusion and recommendations

5.1 Introduction

This chapter compares the results collected from the data analysis with the objectives of this study. It also aims at answering the research questions in chapter 1 which are:-

1) What is the relationship of the interest rate and money supply with the exchange rate before, during and after the 2008 GFC?
2) Does the relationship between the interest rate and money supply with the exchange rate differ/change in different economic situations, that is, before, during and after the 2008 GFC?

In addition, recommendations are made for future scholars who are interested in contributing in this academic arena.

The rest of Chapter 5 is organized into two sections. Section 5.2 deals with the study summary and conclusions, while 5.3 covers the recommendations for future studies.

5.2 Study summary and conclusions

The objective of this study was to examine the relationship between the nominal interest rate and money supply with the exchange rate during the period before, during and after the 2008 GFC using South African data. In addition, the study also examines whether the relationship differs in different economic situations. A sample of the interest rate, money supply and exchange rate were tested for co-integration by using a statistical package named E-views 12.

The relationship between the interest rate and money supply with the exchange rate has been a contentious issue among academics, investors and policymakers. This study has yielded new evidence in the academic arena to try and explain the relationship in different economic contexts in South Africa, that is before, during and after the GFC. Moreover, this study also suggests a new way of testing these

variables by utilizing the ARDL model. The results have shown no existence of co-integration in the long run between the interest rate and money supply with the exchange rate in all the three economic contexts. However, the short-run results differ from the long run results. A significant relationship was found between the interest rate and the exchange rate during and after the GFC. According to the results the relationship is not only significant but also positive. This means that, a change in the interest rates during and after the GFC would have an effect on the exchange rate. An increase in interest rates would cause an appreciation in the exchange rate in those particular economic contexts in the short run. While in the long-run a change in interest rates would have no significant impact on the exchange rate. The results of this study are in line with many other empirical studies such as Alexius (2003), Chinn (2006) and Sikwanda (2011).

However, no relationship was found between the money supply and the exchange rate in the long-run and in the short-run in all the three economic contexts. This is similar to Dube (2008) results who found no relationship between the money supply and exchange rate in South Africa. As can be inferred the relationship does not change for money supply in all the three economic contexts both in the short and long-run. However, the relationship between the interest rate and exchange rate does differ in different economic contexts but only in the short run.

However, there are limitations to this study. One of these limitations include other important variables that were not included. A previous South African researcher Sikwanda (2011) suggested incorporating inflation, price movements in commodities such as platinum and gold. The reason this study only incorporates two variables (interest rate, money supply) to determine the exchange rate is because previous researchers that used the ARDL model such as Long and Samreth (2008), Olaniyi (2013), Isiksal, et al., (2018) Karimi and Karamelikli (2020) and Oskooee, et al., (2020) only included two or three variables. However, there are studies that used the ARDL model that incorporated more than three explanatory variables (Khan & Sajjid, 2005; Kumar, 2010; Ayomitunde, et al., 2019).

5.3 Recommendations for future studies

Despite the results showing a positive relationship between the interest rate and exchange rate in the short run in two of the three economic situations, there is still

room for the study to grow. Therefore, policymakers and investors should be meticulous when making decisions pertaining to the congruence on these two variables. Recommendation for researchers who wish to contribute to the topic are as follows:-

1. The inclusion of the inflation rate to see how foreign investors react to changes in the targeted inflation rate, helping the research ascertain if inflation is a factor that could cause a change in the currency being traded.
2. There is also a need to include the price movements in commodities such as platinum and gold. This dynamic would help explain the impact of South Africa's main sources of exports (which are sources of foreign currency which have an impact on the exchange rate).
3. A re-examination of this study by making use of a different data source, a different statistical package and a different timeline in order to allow for robustness tests. Future studies may consider making use of the latest two GFC, namely the 2008 GFC and the 2020 COVID-19 induced GFC.

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