

The Fundamental Determinants of the South African Real Exchange Rate from 1995 to 2014

A Research Report

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University of Cape Town

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MCOM in Development Finance Degree

by

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Glossary

ASGISA	Accelerated Growth and Shared Growth Initiative for South Africa
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criteria
ARDL	Autoregressive Distributed Lag
BEER	Behavioural Effective Exchange Rate
BIS	Bank of International Settlements
BS	Balassa-Samuelson
CLRM	Classical Linear Regression Model
CVAR	Cointegrated VAR
DOLS	Dynamic Ordinary Least Squares
ECM	Error Correction Method
EER	Equilibrium Exchange Rate
FEER	Fundamental Effective Exchange Rate
GDP	Gross Domestic Product
IMF	International Monetary Fund
JSE	Johannesburg Stock Exchange
RER	Real Exchange Rate
REER	Real Effective Exchange Rate
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
SARB	South African Reserve Bank
UIP	Uncovered Interest Parity
VAR	Vector Autoregressive
VECM	Vector Error Correction Model

Abstract

In a connected world, the foreign exchange rate for any country ensures that exports are competitive, imports are affordable, and there exists an economic environment conducive for sustainable growth of the economy. South Africa as an emerging country is no exception. Many stakeholders including, the South African Reserve Bank (SARB) as the monetary authority of the country are interested in understanding the key factors that influence the South African exchange rate and how these factors may be managed effectively to ensure sustainable economic growth for the South African economy. This research studies the fundamental determinants of the real exchange rate (RER) for South Africa under a market driven floating exchange rate arrangement from March 1995 to December 2014. The research investigates the effects of the fundamental determinants of the RER on the South African rand using Johansen's method and a Vector Error Correction Model (VECM). The results of the research show that five fundamental variables drove the RER for the 20 years from 1995 to 2014 mainly commodity prices, interest rate differential, net foreign assets, terms of trade, openness and productivity. The most significant of these determinants were commodity prices, openness and productivity. The interaction of commodity prices and the RER point to the fact that South Africa does not suffer from the Dutch Disease. The research also supports the Balassa-Samuelson effect where an increase in productivity causes RER appreciation. In terms of policy, the research recommends that South Africa should continue to strengthen the manufacturing export led strategy as well as diversifying the economy. This entails growing the manufacturing sector, diversifying the export markets to reduce reliance on China and the Euro Zone. South Africa should continue with the inflation targeting policy of the SARB, implemented through the interest rate instrument, which only affects the domestic economy and has no major effect on the RER.

Key Words: Real exchange rate, fundamental determinants, VECM, floating exchange rate regime, Dutch Disease, Balassa-Samuelson.

1 Introduction

From July 1944, the Bretton Woods system sought for countries, including South Africa (Van der Merwe, 1996) to adopt monetary policies that managed exchange rates by linking the currencies to gold. This system was however discontinued between 1968 and 1973, which saw the move away from fixed exchange rates. Foreign exchange rates and their prudent management became beneficial factors to the economic growth of countries, particularly developing countries or emerging markets, including South Africa.

South Africa subsequently adopted various exchange rate policies after the dissolution of the Bretton Woods agreement until 1995 (Van der Merwe, 1996) including a crawling peg, fixing the rand to the US dollar, a managed float, and a dual exchange rate regime (Gossel and Biekpe, 2012) comprising of the commercial and financial rand. For the period from March 1995 until 2012, South Africa adopted a floating exchange rate regime (Gossel and Biekpe, 2012) and South Africa has maintained the same regime for the period of the study.

Exchange rate regime is just one of the factors that influence the movement of RERs in the long run. Understanding the ecosystem of these factors and potential mechanisms to manage their behaviour has become important for the South African economic growth objective.

The research focuses specifically on analysing the fundamental determinants of the South African RER from March 1995 to December 2014 under a floating exchange rate arrangement.

The following sections delve into the matter at hand beginning with the importance of exchange rates, a discussion of the research area and problem, the key research questions, a brief view of the methodology, research ethics and layout of the research.

1.1 The Importance of Exchange Rates

In managing the macroeconomic policies of countries, many variables have to be managed at the same time to ensure that countries experience the desired growth rates. Some of the key economic objectives (Worthington, Britton, and Rees 2001. pp375-393) for most governments include controlling inflation, economic growth, reducing the unemployment rate, a positive balance of payments, managing government borrowing and a stable exchange rate.

Globally, the foreign exchange market is the biggest market with levels of high liquidity and daily trading in foreign exchange estimated to have averaged \$5.3 trillion in April 2013 (Bank of International Settlements 2013). If this number is compared to the record value of assets

traded on the Johannesburg Stock Exchange’s Equity Market on the 16th of October 2014 of \$2.16 billion it illustrates just how big this market is as depicted in Figure 1 below.

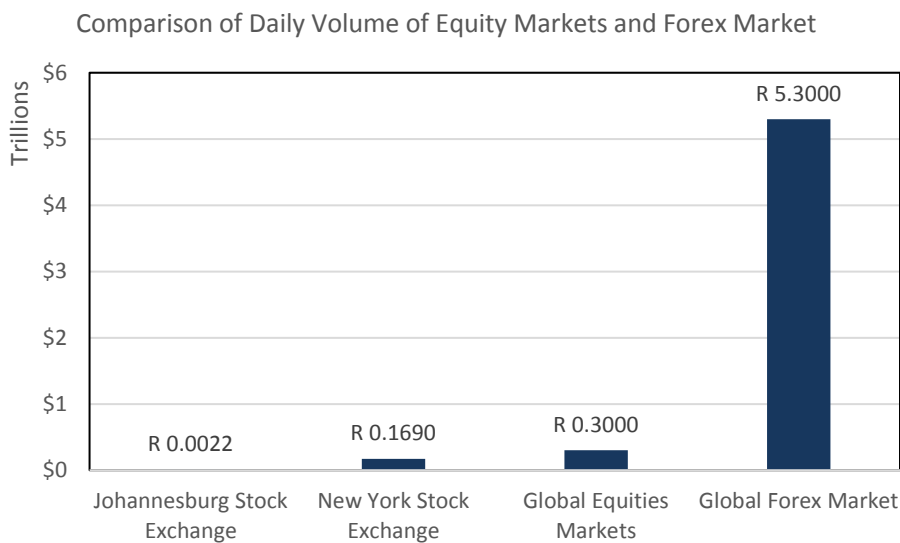


Figure 1: Comparison of daily traded volumes in the forex market relative to selected equity markets

Source: Bank of International Settlements

The valuation of the rand within this big forex market is important for South Africa’s economic growth, as (Sibanda, Ncwadi, & Mlambo, 2013) observed. When the South African currency was undervalued, economic growth was weak in the long run. The research also noted that economic growth was strong in the short run while the South African currency was undervalued. Their paper recommends that overvaluation and undervaluation of a currency were not sustainable measures to sustain the growth of the South Africa economy.

Prudent sovereign debt management suggests that governments should always limit their exposure to foreign currency loans but should rather approach the domestic market. This is because of the default dilemma that volatile unstable currencies pose when booming economies regress due to various factors. In such cases governments may not be able to honour sovereign debt as the local currency depreciates, placing the credit rating of the whole economy at risk.

Foreign exchange risk management (Abor 2005) has become important for companies dealing in international trade since 1971, when the Bretton Woods arrangement ceased to exist. The foreign risk exposure of these companies also increases as international trade increases and as economies become more open. This scenario in international trade also means that big and small companies alike are affected. Foreign currency fluctuations affect small companies

whose input costs are in foreign currency. All companies eventually pass on all transaction costs of the value chain to the final customer.

For ordinary South African consumers exchange rates are also important as they affect the prices of imported raw materials, goods and services linked to imported goods such as insurance of imported motor vehicles. The more the domestic currency depreciates the more South African consumers have to pay for these goods and services.

The foreign exchange rate therefore plays an important part in determining economic outcomes and manifests itself through nominal exchange rates and RERs.

RER, is defined as the nominal exchange rate that has been adjusted for consumer or producer prices and inflation. The effects of RER on any economy are transmitted through the performance of the economy and international competitiveness of the country, on the different productive and non-productive sectors of the economy, employment, foreign trade flows, and how the country manages its sovereign debt. RERs are important for emerging economies such as South Africa.

The nominal exchange rate is defined as the external value of a country's currency, and determines how much of another country's currency it can purchase (Worthington et al 2001, pp381). The nominal exchange rates are bilateral in relation to another country's currency. When the nominal exchange rate changes, the economy feels the effects through the prices of imports and exports, capital flows, balance of payments (Takaendesa, 2006). When a currency appreciates or becomes stronger relative to other currencies, exports become more expensive to its trading partners while imports become less expensive. When a country's currency depreciates, imports become more expensive while exports become less expensive or competitive to its trading partners. In this instance the country will be importing inflation. The key therefore between these extremes is to have a relatively stable nominal exchange rate that fosters an environment that is conducive to imports and exports and can attract investment capital flows.

This influence of the exchange rate on economics therefore requires that it is better appreciated so that it can be effectively managed. The previous section has highlighted how important exchange rates are in a global economy. The next section defines how this becomes a problem for a country such as South Africa. The section discusses the research area and defines the problem.

1.2 Research Area and Problem

The view by most development economists that exchange rates should not be considered as part of development policy, (Williamson, 2009) led to the opinion that most developing countries were, predominantly exporters of raw materials. The solution was therefore to reduce the demand for imports by industrial development or finding substitutes for imports. This thinking implied that devaluation of currencies was unlikely to have beneficial effects, and therefore there was no need to implement flexible exchange rate policies. According to this argument, the development policies of emerging countries were not required to focus on fiscal variables like the exchange rate but on the real economy.

Existing studies have found encouraging relationships between economic growth and RER undervaluation for developing countries (Rodrik, 2008). An unstable RER around its equilibrium level has been found to cause undesirable or encouraging impacts on economic growth.

The research on Malaysia by (Kogid, Asid, Lily, Mulok and Loganathan, 2012) found that there were long run cointegrating relationships between nominal and RERs and economic growth. The research also concluded that both the nominal and RERs contributed towards economic growth. For Malaysia, the study recommended that RER was an important variable, and monetary policy should consider a systematic exchange rate to promote stable and viable economic growth for the Malaysian economy.

The South African rand has recently been associated with the “Fragile Five” currencies in terms of the volatility of the exchange rate. Morgan Stanley coined the term “Fragile Five” in late 2013 to represent the currencies of emerging market economies that were depreciating at an alarming rate against the U.S. dollar. These were currencies of Brazil, India, Indonesia, South Africa, and Turkey respectively.

The South African government identified a volatile exchange rate as one of the key challenges preventing South Africa from achieving the desired growth rate (AsgiSA Annual Report, 2008). The report favoured a macroeconomic policy of inflation targeting as a mechanism to lower inflation and interest rate volatility. The report also supported managing exchange rates within a floating exchange rate arrangement and the increase of foreign reserves.

The New Growth Path (NGP) was released in November 2010 and targets a more competitive and stable exchange rate. Mechanisms identified to achieve these objectives included building up foreign reserves, and addressing the negative effects of short-term capital flows.

The NGP looks at guiding government through a flexible monetary policy with measures to manage inflationary pressures and enhance competitiveness. The NGP also identified the resource intensity of exports as one of the main economic diversification challenges facing the South African economy.

The National Development Plan (NDP) (National Planning Commission, 2012), identifies challenges to the South African economy linked to the volatile exchange rate. The document also supports managing exchange rates within a floating exchange rate policy, as this would protect the country from external shocks. Excessive overvaluation of the rand could potentially prevent the economy from diversification. An identified response to such a situation is the prudent accumulation of foreign exchange reserves.

Figure 2 below illustrates the volatility of the rand against the U.S. dollar from January 1995 to December 2014.

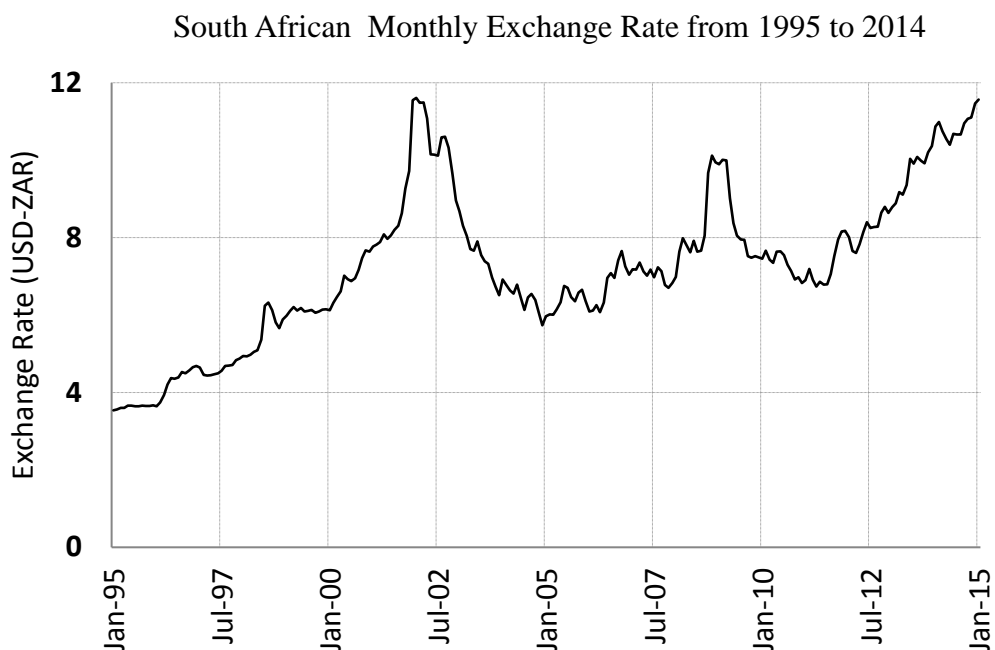


Figure 2: South African Nominal Exchange Rate versus US Dollar from 1995 to 2014

Source: South African Reserve Bank: Monthly USD-ZAR monthly data January 1995 to December 2014

The figure above shows that the South African rand has depreciated by almost 200% between January 1995 and December 2014. The trend presents a continual depreciation of the rand.

Figure 3 below contains commentary by Old Mutual on events that might have affected the valuation of the rand from 1980-2013. Comments in the Old Mutual graphic below highlight the complexities associated with the South African exchange rate. These include the relaxation of exchange controls, the market sentiment towards a current account deficit, the 1998 East Asian crises, dot.com crashes and political conditions in neighbouring countries, low interest rates and booming commodity prices, the Global Financial Crisis of 2008, labour unrest in South Africa and global investor sentiment on emerging markets.

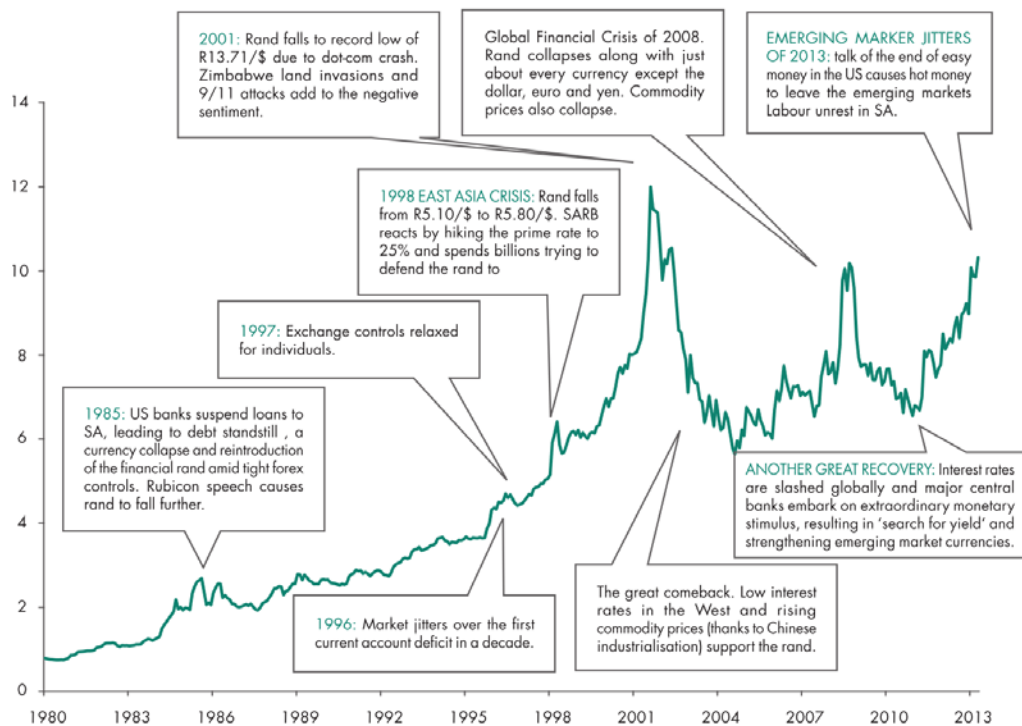


Figure 3: Old Mutual Commentary on Events Linked to the Rand

Source: [http://www.omwealth.co.za/Insights/MarketEconomicCommentary/History of the rand-dollar exchange](http://www.omwealth.co.za/Insights/MarketEconomicCommentary/History%20of%20the%20rand-dollar%20exchange)

The Old Mutual commentary indicates a combination of external and internal factors that might have influenced the rand-dollar exchange rate.

The key issues emerging above are the volatility and depreciation of the South African exchange rate and what would be the best intervention by the SARB to effectively manage the South African exchange rate. One would therefore want to understand what causes the volatility and depreciation of the exchange rate in the long term. Having identified the factors influencing the exchange rate the next step would be to identify mechanisms to effectively manage the exchange rate to support robust economic growth. The research focuses on identifying the key long term fundamental determinants of the exchange rate.

The main objective of this research with respect to the South African exchange rate is thus to answer the following questions for South Africa under a floating exchange rate regime:

- i) What are the fundamental determinants of the real exchange rate in South Africa for the period March 1995 to December 2014?
- ii) What might be the suitable South African Reserve Bank policy interventions for addressing the fundamentals that influence the South African real exchange rate?

Having set the context of the problem from a developmental point of view the next section proposes the hypotheses linked to the two research questions.

1.3 Hypotheses

To answer the questions above the research formulates the following hypotheses:

H1: Null Hypothesis: There are no significant relationships between the South African real exchange rate and its fundamental determinants.

Alternative Hypothesis: There are significant relationships between the South African real exchange rate and its fundamental determinants.

H2 Null Hypothesis: The South African Reserve Bank should not utilise policy interventions that target the fundamentals to influence the South African real exchange rate.

Alternative Hypothesis: The South African Reserve Bank should utilise policy interventions that target the fundamentals to influence the South African real exchange rate.

This study contributes to foreign exchange rate research on the fundamental determinants of RER in South Africa in a different manner from earlier research in that the study utilises data from 1995:1 until 2014:4, for a floating regime while previous studies have used data that

covered mixed periods where the South African economy was under different exchange rate policy arrangements. This will give a better appreciation of the dynamics of the RER for South Africa in a floating exchange rate environment.

This research will be useful to the SARB in considering foreign exchange management policies based on the fundamental determinants of the RER. The analysis will be useful to investors; multinational companies who import and export goods and services, and all institutions that participate in the South African economy affected by exchange rate movements.

1.4 Research Methodology

The research makes use of quarterly data from 1995 to 2014 from the International Monetary Fund (IMF), the SARB, Organisation for Economic Co-operation and Development (OECD), and DataStream. The use of monthly data would have been ideal; however, because of unavailability of such data for the variables under study, the research utilised quarterly data.

The study tests the first hypothesis through Johansen's procedures and VECM. Application of these procedures in a vector autoregressive (VAR) model, enable the study to determine the long run fundamental determinants of the RER. After testing the first hypothesis, the research recommends SARB policy actions based on the significant fundamental determinants identified, thus testing the second hypothesis.

An econometric method probes the fundamental determinants of the South African RER under a floating exchange rate regime from 1995 to 2014 and seeks to contribute to research specific to South Africa on foreign exchange rates by (Aron, Elbadawi and Kahn, 1997; Macdonald and Ricci, 2003; Takaendesa, 2006; Frankel, 2007; Saayman, 2010; De Jager, 2012; Gossel and Biekpe, 2012).

1.5 Research Ethics

The research used secondary historical time series data available through the University of Cape Town's subscription to World Bank data, OECD, the SARB and DataStream. These sources of data did not involve any human subjects, as the data is available in the public domain. The research therefore did not have any ethical risks associated with it and with the University of Cape Town Business School.

1.6 Layout of the Research

Chapter 1 presented the importance of exchange rates, a discussion of the research area and problem, the key research questions, a brief view of the methodology, research ethics and layout of the research. Chapter 2 is the literature review on exchange rates discussing regimes, analytical models and frameworks and the fundamental determinants. Chapter 3 defines the research method for examining the fundamental determinants of the South African RER. Chapter 4 analyses and discusses the results from the modelling of the fundamental determinants. Chapter 5 completes the research summarising the discoveries of the investigation, SARB policy recommendations, research limitations and areas for future study. Chapter 2 of this research examines the literature on foreign exchange rates, exchange rate regimes, exchange rate theory and empirical analysis of the determinants of RERs.

2 Literature Review

2.1 Introduction

To answer the questions and analyse the hypotheses in the previous chapter, the comparison of the values of a RER and its determinants play an important part in providing a solution to the research problem. The following literature review discusses the main topics that link to the research objectives, mainly the definitions of RER and EERs, selected theoretical frameworks and models of RERs, and empirical literature on the modelling of RER and the key factors. The literature review links exchange rate theoretical frameworks and models, exchange rate empirical findings and the potential fundamental determinants of RER in South Africa. The study uses the fundamental determinants and appropriate methodologies as input in Chapter 3.

Since the core of the research is an econometric investigation, the research applies the seven step framework recommended by (Maddala, 2001, pp.6-7). The figure below illustrates the recommended steps for an econometric investigation.

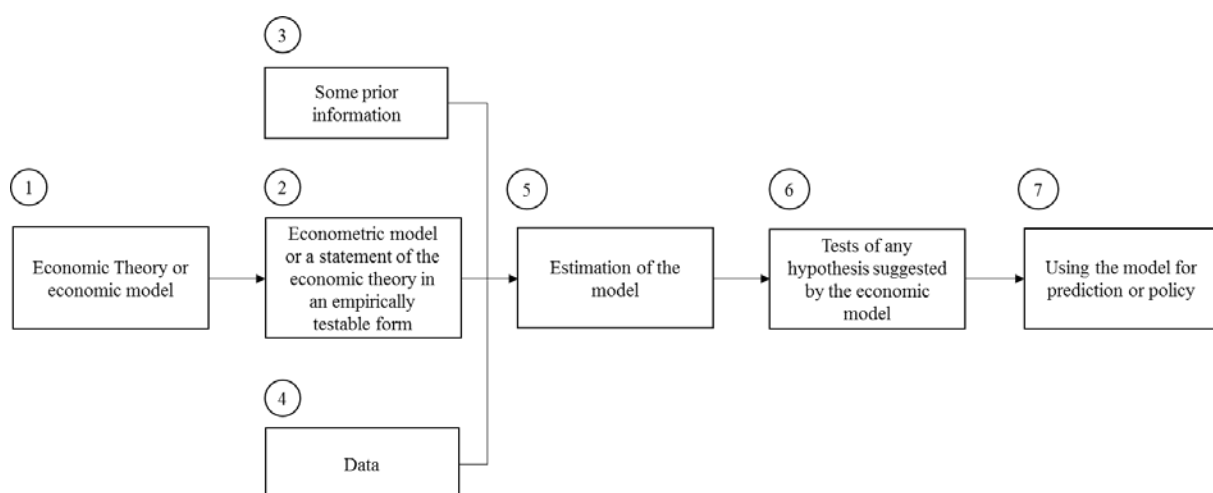


Figure 4: Framework for an econometric analysis.

Source: (Maddala, 2001, pp.6-7).

The research follows the framework and steps recommended by (Maddala, 2001, pp.6-7) and links the economic theory concerned with fundamental determinants of foreign exchange rates in a floating exchange rate environment. The following section starts with what determines how countries choose exchange rate arrangements for their economies and the effects of the regime chosen on the RER. Also discussed are the impacts of the chosen exchange rate regimes on the economies of countries.

2.2 Exchange Rate Regimes

The research is also interested in the period when the South African exchange arrangement was a floating regime. It is thus vital to review exchange rate regime literature in order to understand the impact of the floating exchange rate environment on the investigation.

The graph below illustrates the IMF (2012) categorisation of exchange rate arrangements according to their classification system.

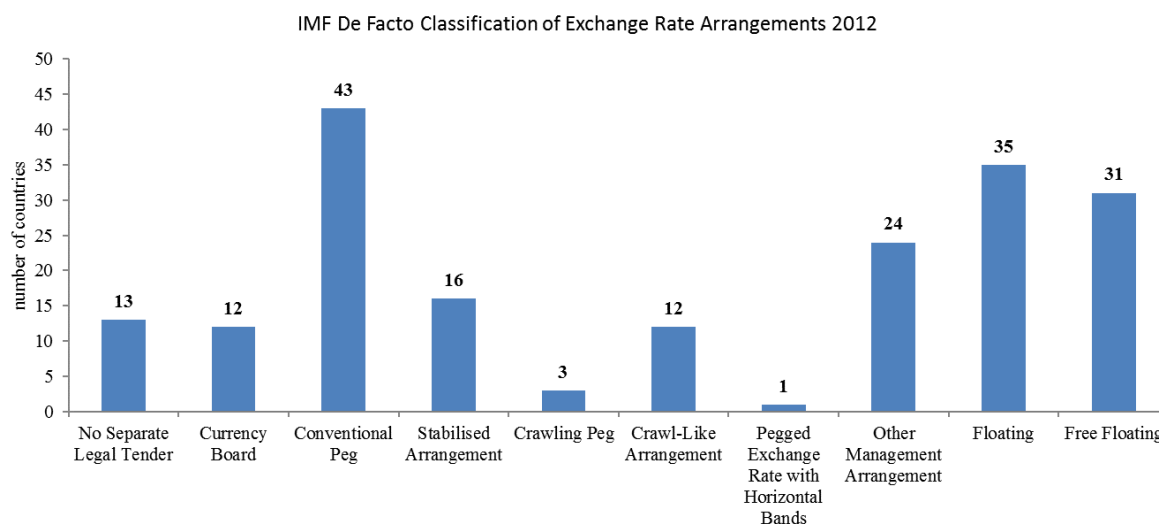


Figure 5: IMF exchange rate classification (2012)

Source: International Monetary Fund.

The figure above illustrates that of the countries analysed by the IMF in 2012, monetary authorities favour conventional pegs followed by floating exchange rate regimes and free floating arrangements. Each government or monetary authority had its own key considerations that informed the choice of the exchange rate arrangement and these are discussed in the following paragraphs.

A study into the factors contributing to the choice of an exchange rate regime from the period 1990-1998 for 93 countries by (Poirson, 2001) had some interesting findings. Highlighted criteria that had an important influence on the choice of regime were political uncertainty, government tendencies to borrow money and then pay back less due to inflation, dollarization, exposure to exchange rate fluctuations and the associated risk, economic size of a country, inflation, capital, mobility, production diversification, adequacy of foreign reserves, and external vulnerability. Factors such as trade openness and economic development level did not have a significant bearing on the choice of arrangement. The research also found that increased

financial integration promoted by optimum currency areas tended to promote the acceptance of floating exchange rate policies and arrangements.

In investigating if, the choice of the exchange rate regime affected the economic growth of non-industrialised countries, (De Vita and Kyaw, 2011) analysed data from 70 developing countries from the period 1981-2004. Their methodology utilised different exchange rate regime classifications to characterise policy. The research found that there was no clear bond between the choice of an exchange rate policy and economic growth. The research thus concluded that the exchange rate regime selected did not directly influence the long-term growth of developing countries.

An assessment of currency misalignments for emerging and developing countries by (Coudert and Couharde, 2009), estimated REERs by considering the BS hypothesis and the impact of net foreign assets. The research found that pegged currencies were more overvalued than floating currencies in both models.

Developing countries would benefit from an exchange rate regime that was in between a fixed and a floating regime (Dubas, 2009). This intermediate arrangement would prevent exchange rate misalignment. The research however found that for developed countries, the choice of exchange rate regime did not contribute to exchange rate misalignment.

Research by (Rose, 2011) provided a twist to the literature. The study noted that although governments of similar economies made different choices on preferred exchange rate systems, one could not pin point the causes of their decisions and one could not conclusively say that there was a consequence to the exchange rate arrangement chosen. This then made the issues of exchange rate regimes appear to be purely of academic interest.

The study by (Tsangarides, 2012) using growth rate data from 2003 to 2011 from more than fifty emerging economies including South Africa and exchange rate regime classifications from the IMF concludes that, for the world economic crisis period from 2008-2009, choice of exchange rate regime did not determine growth performance. Countries that had floating exchange rate regimes, however appeared to perform better than those that had pegged exchange rate regimes in the recovery period from 2010-2011. The research suggests an unbalanced effect of the exchange rate regime during the global financial crisis compared to the period after crisis.

(Bohl, Michaelis, and Siklos, 2015) recommend pegged exchange rate arrangements for emerging markets, and crawling pegs for G20 countries to support economic growth.

(Aron *et al*, 1997) confirm two key facts about South Africa in their study. The first key fact confirmed being that RER is a key policy variable in South Africa. The second fact mentioned is that South Africa is seen as an open economy. (De Jager, 2012) mentions that, it was not the SARB's policy to interfere in the foreign exchange markets. This implies that the South African rand can be considered to be freely floating from 1995 up to present day. The value of the South African currency is therefore influenced by supply and demand fundamentals governing price behaviour in the financial markets. Policymakers in South Africa therefore attempt to manage the RER indirectly through other policy instruments that affect the fundamental variables that influence the South African RER.

In conclusion, from March 1995 until 2012, South Africa adopted a floating exchange rate regime (Gossel and Biekpe, 2012) and South Africa has maintained the same environment up to 2014.

The next sections discuss the theories of RERs and start with the age old PPP.

2.3 Real Exchange Rates (RERs)

Exchange rate literature has different definitions of RERs and EERs. This research is therefore selective in the definitions that are used. The research aligns the definitions used to the specific areas of the research, which is the behaviour of the fundamental determinants of the RER for South Africa.

(Miyakoshi, 2003) highlights how the RER is a significant relative price associated with international trade and foreign investment and the importance of analysing RER determination.

The RER, (Colander, 2010, p. 482-487) defines the exchange rate recalculated for changes in inflation or changes in the price level. The definition of nominal exchange rate in contrast, is the value we see quoted in the news at any given time of the day.

A vast literature exists on theories and models of RER. The following section begins with the well-known purchasing power parity (PPP) doctrine and narrows down to theoretical frameworks and models that enable one to analyse the RER and its fundamental determinants including the Behavioural Effective Exchange Rate (BEER).

2.4 Purchasing Power Parity (PPP)

(Gustav Cassel, 1918), the Swedish economist formalised the PPP hypothesis in his comparison of Swedish exchange rates with those of Sweden's trading partners. (Frenkel, 1977) notes the doctrine of PPP to have been "originated by (Wheatley, 1803, 1807, and 1819) and (Ricardo, 1811, 1821)". The conclusion of the research refers to the doctrine as a guide to the general trend of exchange rates and not a guide to the day-to-day volatility of exchange rates.

The specific terminology of PPP (Taylor and Taylor 2004) became topical after World War 1, although the theory dates back in history for several centuries. The research defines the nominal exchange rate between two foreign currencies as the mathematical ratio of total price values between the two countries. The implication is that one can buy the same goods in a domestic and foreign country using the same unit of currency.

In support of the PPP doctrine, (Hakkio, 1984) credited failure of the PPP in the 1970s to lack of precision in the models used. Using a multi-country model of exchange rate significantly improved the performance of PPP and the research could not reject the PPP hypothesis, indicating that PPP held in the long run but that deviations from PPP were however persistent. In the short term, one could thus expect deviations from PPP.

Further support of the PPP came from (Pippenger, 1993), who used data from the IMF from January 1973 to June 1988. He tested for PPP using co-integration tests with more reliable data for the Swiss currency. The research compared the Swiss currency data to the currencies of European countries mainly France, Austria, West Germany, Denmark, the United Kingdom, Norway, Belgium and the Netherlands. Other countries in the study include the United States, Canada and Japan. The results obtained supported PPP as a long-run equilibrium economic condition.

Echoing these findings was (Manzur, 1990), who used Divisia index numbers to simultaneously test for PPP with two sets of data for currencies of France, Japan, the USA, West Germany, the UK, Italy, and Canada from the period 1973–1986. One set of data consisted of short run data. The second set of data consisted of long run data. The research found deviations from PPP in the short term. The study nevertheless found support for PPP in the long- run and suggested 5 years to signify the duration of the long run.

(Goswami *et al*, 2002) observe that the RER converges to PPP in the long run. The convergence rate is slow and is non-linear in the exchange rate level. The second observation of their investigation was that in the short term, deviations from PPP were considerable and unpredictable.

(Taylor and Sarno, 1998) in support of PPP found that RER adjusted for consumer price inflation for G-5 countries came back to their mean. The study utilised data from 1976-1996.

As indicated by (Castillo-Maldonado and Pérez-Macal, 2012), the PPP foreign exchange price differentials are determined by differences between domestic inflation and the inflation of the foreign economy. Their research notes that exchange rates tend to depart from PPP mainly over short-term horizons, because of terms of trade changes, productivity shocks, commodities, and structural differences in income elasticities and growth rates. The research however notes that exchange rates do converge on their PPP values in the long term.

(Lim, 1991) expressed opposing views on PPP through an econometric analysis of the US and G-10 countries, which produced results that rejected PPP as a possible reason for the behaviour of the RER in the long term. The analysis also rejected the uncovered interest parity as a philosophy that would explain short run behaviour. The research however agrees with fundamental determinants including productivity, real domestic interest rates, terms of trade, and real interest rates in influencing the behaviour of RERs between the United States of America and G-10 countries.

In conclusion, (Siregar, 2011) highlights PPPs theoretical and empirical shortcomings. The assumed law of one price (LOP) may not hold due to, for instance trade protection policies through tariffs, regulated prices and capital controls. Further, even if LOP holds, consumers as well as producers might change their product preferences. In this case, the assumption of identical basket of goods would not hold. Another key shortcoming in PPP highlighted was that it did not cater for the BS effect discussed later in this research.

There is therefore agreement that PPP might not be the most appropriate theoretical framework to utilise for the analysis of the RER and its fundamental determinants. With this in mind another theoretical framework, the monetary approach, was formulated to enhance PPP.

2.5 The Monetary Approach

The monetary approach is an extension to PPP and theoretically describes the nominal exchange rate and connects it to monetary fundamentals. Fluctuations in the exchange rate are due to the movement of monetary variables. The key overarching assumption in the monetary approach is the preservation of PPP between countries (Civcir, 2004). The key variables that influence the nominal exchange rate in the monetary approach are excess “domestic money supply relative to foreign money supply” (Siregar, 2011), productivity and nominal interest rate. The monetary approach therefore tries to address the limitations of the PPP.

(Macdonald and Taylor, 1994) re-analysed the sterling dollar exchange rate using the monetary model and multivariate cointegration techniques. The research utilised data of macroeconomic variables of the US and UK from January 1976 to December 1990. The research found evidence of statistical significant of domestic money supply, foreign money supply, productivity (industrial output) and long-term interest rates and the exchange rate. The research further found that after catering for short-run data dynamics, the unrestricted monetary model developed performed better than the naive random walk and other models when data other than for the research period was considered.

(Rapach and Wohar, 2002) utilised VECM models to test the long-term monetary model for fourteen industrialised countries and produced mixed backing for the monetary model. The analysis found significant support for the long-run monetary model based on the U.S. dollar for four countries, Italy, France, the Netherlands and Spain. The research found moderate results for three countries, Finland, Belgium, and Portugal and a weaker result for Switzerland. The surprise to the study was that for Norway, Australia, Denmark, Canada, the United Kingdom and Sweden however, the “long-run monetary model” did not hold. The research concludes that the cause of the non-agreement of the “long-run monetary model” for some countries was volatility in the long-term correlation of relative price levels and monetary fundamental variables for the concerned economies.

Further support and evidence for the monetary model came from (Civcir, 2004), who modelled the Turkish-lira-US dollar relationship using data from 1987-2000. The study found evidence of a cointegration relationship between the exchange rate, relative prices and monetary fundamentals. The research indicated that monetary fundamentals contribute to exchange rate movements in the long term.

(Engel, Mark and West, 2007) added to the growing confirmations and found evidence that monetary models based on panel techniques assist in forecasting exchange rates. The research also emphasizes the importance of monetary policy. A clearly communicated and understood monetary policy informs the market of how monetary conditions would look like in future. These expectations thus played a key part in defining current and future exchange rates.

(Uz and Ketenci, 2008) analysed the connection between exchange rates and monetary variables for Turkey and 10 EU members. The period of the analysis was from 1993-2005. The research catered for the short-term data problem by using a panel data set. The model included interest rate differential, price differential, output differential, and monetary differentials as explanatory variables. The study found that there was cointegration between exchange rates and the derived monetary model.

(Macdonald, 1999) observes that (Meese and Rogoff, 1983) found that a number of fundamentals-based models could not do better than a simple random walk in an out-of-sample forecasting analysis. The study by (Macdonald, 1999) however shows that using the monetary model, fundamentals had a clear and important role to play in defining the performance of exchange rate models. His study also strongly argues that sufficient evidence now exists to support exchange rates prediction for periods as short as one month ahead.

Support for the monetary model came from the investigation by (Loría, Sánchez and Salgado, 2010). Their study analysed both the short-run and long run relationships of the monetary model for the currency pair the Mexican Peso-U.S. dollar. The analysis used a cointegrated SVAR model for data from 1994-2007. The fundamentals selected were money supply, output differential and interest rate differential. The research showed that for Mexico, there were strong short and long run relationships in the monetary model, and that exchange rate movement in the nominal exchange rate reacted to fundamental shocks as predicted by a modified monetary model.

Although the monetary approach appears to be acceptable, empirical work on the model has not been convincing. Further, the monetary model does not cover the full set of fundamental determinants of RER. This gap has led to a number of additional theoretical frameworks including the portfolio balance approach and those based on fundamentals including the Fundamental Equilibrium Exchange Rate (FEER) and the Behavioural Equilibrium Exchange Rate (BEER).

2.6 The Portfolio Balance Approach

The Portfolio Balance Model approach was developed by (Metzler, 1951) and (Tobin, 1969), according to (Branson and Henderson, 1985). (Metzler, 1951) and (Tobin, 1969) introduced the model to explain the behaviour of floating exchange rates according to (Black, 2015). The model contains four assets, which are home money, foreign money, home currency securities and foreign currency securities. The model assumes “that there is imperfect substitutability between domestic and foreign assets”.

(Taylor, 1995) mentions that researchers had trouble in mapping portfolio balance models to financial data that was available in the real world. Methodological issues included the decision on what non-money assets to include in empirical models. The same review also highlights the importance of macroeconomic fundamentals as influencing exchange rates.

Recent results on the portfolio balance model study of (Black, 2015), note that the model while being attractive, failed together with other empirical models to provide convincing results. Over the years, extensions to the portfolio balance concept include a general equilibrium setting and a modification to include central bank intervention and non-rational expectations. The more recent use of order flows in the microstructural approach appears to show potential as an empirical explanation of exchange rate behaviour.

2.7 The Fundamental Equilibrium Exchange Rate (FEER)

The FEER model, developed by (Williamson, 1994), describes the RER when “internal and external balances” of a country are achieved. This condition is when output in an economy reaches its possible level and when the current account financing of the country is through long-term capital flows. Counter to PPP, a FEER approach admits that the EER will fluctuate over time. The FEER approach concentrates on “economic fundamentals” (Siregar, 2011).

The first factor guiding the FEER is differences in productivity in economies. These differences in productivity may be due to a variety of factors. One factor could be low domestic and foreign inflation. These “potential gaps in productivity growth”, (Balassa, 1964), tend to fluctuate the FEER “over time as countries grow at different rates” (Williamson, 1994).

The FEER secondly, considers the maintenance of a sustainable current account. In order for an economy to sustain a reasonable current account balance, the local currency responds by appreciating and depreciating accordingly. A sustainable current account level corresponds to an economy with full employment output and low inflation.

According to (Villavicencio, Mazier and Saadaoui, 2012), the FEER is closely related to the BEER, but differences in the model can be seen when assessing variables such as foreign assets for specific countries. The same authors further mention the improvement of FEER over PPP given the fact that FEER is cointegrated with RER and can explain industrialised countries exchange rate movements in the long term.

Nevertheless, (Terra and Valladares, 2010), highlight a key drawback of FEER being their inability to directly estimate equilibrium RER. The equilibrium RER derived from FEER are medium term because they estimate current accounts or complete macroeconomic models.

In addition, (Barisone, Driver and Wren-Lewis, 2006) describe the FEER as an alternative to PPP utilised for calculating EREER and this was confirmed by the results of the study although for Italy the FEER did not produce sensible results. The study also notes that FEERs had not been scrutinised in the same manner as the PPP. Another characteristic noted was that FEERs were utilised to analyse RER variations in the mid-term.

2.8 The Behavioural Equilibrium Exchange Rate (BEER)

Literature attributed the BEER to (Clark and Macdonald, 1998, 2000), who derived a theoretical exchange rate model that identified long run relationships between the RER and its “fundamental determinants”. The BEER approach expects the RER to be in equilibrium with a specific set of independent variables over an exact period of time. “This allows representation of the equilibrium RER in terms of the dynamic structure that generates the data on the RER and its fundamental determinants even though the variables themselves are derived from a long term structural model” (Hinkle and Montiel, 1999). The BEER is attractive because it provides a single equation relationship for the RER and its determinants.

(Zhang, 2001:83) mentions that the BEER diverges from the portfolio balance approach. The research advocates for the use of the BEER for developing countries where data limitation prevents the formulation of large and complex models.

The fact that the BEER considered interest rates and economic fundamentals to estimate effective RER attracted (Terra and Valladares, 2010) to use the model in their analysis of exchange rate misalignment for 85 countries.

(Jongwanich, 2009) suggests that the five key fundamental variables in a BEER model should be net foreign assets, productivity, government spending, trade policy, openness and terms of

trade. Other factors that are country factors that have a significant impact on the country's RER may also be considered for the model.

According to (Villavicencio, Mazier and Saadaoui, 2012), the BEER performs better than PPP in providing clarity on exchange rate movements of industrialised countries in the long term. The BEER is more realistic and more reliable (Siregar, 2011; Clark and Macdonald, 1998). The BEER thus appears as a leading framework to use in determining foreign exchange rate misalignments. (Kim and Korhonen, 2005) utilised the BEER to determine foreign currency misalignments.

There has been extensive application of the BEER approach by (Edwards, 1988), (Baffes *et al*, 1997), (Elbadawi, 1994), (Manthisen, 2003), and (Cady, 2003).

2.9 Balassa-Samuelson

The Balassa–Samuelson (BS) hypothesis developed by (Balassa, 1964) and (Samuelson, 1964), suggested that rich countries had higher absolute productivity and were more productive in internationally traded-goods. When these relative differences in productivity continued over time, they would mean that PPP no longer applied and long-run PPP would need to be adjusted accordingly. According to the BS, a country that has relatively high productivity growth experiences exchange rates that are overvalued relative to PPP. The overvaluation of the currency increases with the productivity gap between the domestic country and foreign countries.

(Lothian and Taylor, 2008) tested for the BS effect also known as the real effects of the EREER using data from 1820 for the U.S., the U.K. and France. The study found a statistically significant BS effect for the sterling-dollar relationship which captured its long-run trend and explained about 40% of the changes in the RER.

(Chong, Jorda and Taylor, 2012), investigated the BS effect for the period from 1973-2008 for 21 OECD countries. The research findings support the BS hypothesis. The research in addition found that equilibrium adjustment in the long run took between 1.5 to 2 years, much shorter than the findings of earlier studies.

The research by (Ricci, Milesi-Ferretti and Lee, 2013) used this relationship to approximate a panel cointegrating relationship between the RER and fundamental determinants for a set of 48 industrial and emerging countries. The research found that there was a strong positive

relationship between the CPI based RER and terms of trade based on commodities. The research also found the effect of “differences in productivity between traded and non-traded goods” to be small although statistically significant. The factors that appreciated RERs were net foreign assets, trade restrictions and government spending.

The failure of the BS effect is associated with its key assumptions. The Law of One Price (LOP) (Tyers and Zhang, 2014) under which only domestic prices determine the RER cannot be observed in the real world. This is due to factors such as “sticky prices, trade costs”, the difference in product specifications and prices, and “pricing to market” (Engel and Rogers, 1996). Thus, factors that affect price levels for goods that can be traded internationally for a country, as well as the relative prices of goods that can only sold within the domestic economy will affect the exchange rate.

2.10 Edwards Model

The seminal work of (Edwards, 1988) was the first study of the fundamental determinants of RER for a panel of developing countries. Edwards developed a theoretical model for the determination of RER that examined the equilibrium RER for Columbia, Brazil, El Salvador, India, Greece, Malaysia, Israel, South Africa, Philippines, Yugoslavia, Sri Lanka and Thailand. Edwards utilised a partial adjustment model that assumed that RERs were a function of capital controls, domestic credit, exchange controls, government expenditure, nominal devaluation, real growth, technical progress and terms of trade.

(Chowdhury, 1999) notes that the model describes a small open developing economy. The restrictive features of the small open economy include exchange and trade controls. Edward’s model restricts only the fundamental explanatory or real variables to influence the long run ERER. Real and nominal factors however affect the RER in the short run.

The above section has highlighted some of the theoretical frameworks and models that attempt to explain RER. The frameworks that come close to be useful to the research include Edwards’s framework and the BEER. Edwards’s model provides an attractive framework because it caters for developing countries such as South Africa, which is the focus of the research. The chosen variables in the model have quarterly data that is readily available to enable the analysis. The attraction of the BEER is that it enables a researcher to represent the determinants of the RER as a single equation.

The following section analyses literature on the determinants of RER. The objective of the following section is to find the fundamental determinants that can be utilised by the research to include in the econometric model for the fundamental determinants of the RER for South Africa from 1995 to 2014.

2.11 Review of Empirical Research

The review of empirical literature starts with developed countries, proceeds with emerging markets, analyses exchange rate literature from Africa and concludes with literature on South Africa.

2.11.1 Developed Countries

(MacDonald, 1998) developed a simplified model of the RER to analyse the long run determinants of RERs. The study analysed the RERs of the Yen, the U.S. dollar, and the Deutschmark for the period 1974-1993 using multivariate cointegration methods. MacDonald's reduced form model contained fiscal balances, interest rates, net foreign assets, productivity differentials, and terms of trade as key fundamental determinants of the RER. The study found evidence that the key fundamental determinants had a vital and statistically significant influence in contributing to both long and short run movement of RERs. The whole group of the fundamental determinants positively influenced the RER. An increase in any one of the explanatory variables led to a strengthening of the RER.

(Antonopoulos, 1999) applies the "Shaikh hypothesis" to investigate RER movements for Greece. The study used relative unit labour costs to proxy productivity differentials. Antonopoulos's model augmented the "Shaikh hypothesis" with capital flows and employed the cointegration methodology. The data from Greece used for the analysis was for the period 1960-1990. For Greece, the study concluded that the PPP hypothesis could not account for RER movements. The study also found evidence that the productivity of the Greek export sector relative to the rest of the world partially explained the RER. Net capital flows were not significant in determining RERs. The study showed that Greece's RER would appreciate if there was an expansion in the relative productivity of the Greek export sector and if there was an increase in capital inflows into Greece.

The ratio of US prices to foreign prices, the ratio of federal budget deficit to gross national product, output per hour for all business sector employees, "real long term weighted average

of foreign rates, real long term interest rate on US securities” were identified by (Lim, 1992) as some of the determinants of the RER between the U.S. and G-10 countries.

The paper by (Clostermann and Schnatz, 2000) analysed the empirical forces influencing the real euro-dollar exchange rate for the period 1975-1998 and constructed a euro-dollar exchange rate applying cointegration techniques. The study identified the difference in real interest rates, “prices in the traded and non-traded goods sectors, the real price of oil and the relative fiscal position” as the four key determining factors of the euro-dollar exchange rate. For the study, the single equation error correction model performed better than multivariate models.

(Mark and Sul, 2001) examined the behaviour of nominal exchange rates relative to monetary fundamentals. The study utilised quarterly panel data from 19 countries for the period 1973.1 to 1997.1. The data covered periods of floating exchange rate regimes against the US dollar. The variables used in the research were quarterly GDP data represented by quarterly industrial production indices, measure of money, money, and price levels. The research indicated that nominal exchange rates were “cointegrated with monetary fundamentals” and that the monetary fundamentals had substantial ability to predict exchange rates.

For the New Zealand dollar, (Macdonald, 2001) employed the BEER of (Clark and MacDonald, 1999). Their study derived the long-run EERs for the dollar. The research relied on data from the period 1986-2000 and used a single equation Dynamic OLS (DOLS) estimator to check the response to shocks of the estimates of the equilibrium relationship derived. The research used the difference in productivity of New Zealand and foreign countries, real interest rate and the terms of trade as variables. Interest rate differentials, the productivity gap, and the terms of trade were statistically significant.

(Lane and Milesi-Ferretti, 2002), for the Irish economy, modelled the long-run RER based on net foreign assets, output levels, and terms of trade. Data for the study was from 1988-1990 from Ireland and its major trading partners, the US, Germany, and the United Kingdom (UK). The study found a strong positive association between the relative output and the RER. The study could not conclusively pronounce that the terms of trade influenced the RER. There was however strong evidence that the net foreign assets had a strong influence on the RER.

The objective of the study by (Abhyankar, Sarno and Valente, 2004) was to investigate the ability of monetary fundamentals to predict exchange rates. The study concentrated on freely floating exchange rate regimes after the Bretton Woods period. Different to former research,

the study found the exchange rate forecasts inferred by monetary fundamentals to be considerably better predictions than a random walk over a range of periods of analysis.

(Maeso-Fernandez, Osbat and Schnatz, 2004) estimated the long-run relationship between exchange rates and fundamental determinants for countries from Central and Eastern Europe using the (BEER) approach. The research utilised annual data from 25 OECD countries from 1975-2002. The fundamentals used in the estimation were government spending, openness, and per capita income. The results of the research indicated that in the medium to long term the RER was influenced by the chosen proxy for productivity, government expenditure and openness. An increase in per-capita income and government expenditure were responsible for an “equilibrium appreciation of the currency, while an increase in openness was associated with equilibrium depreciation”.

Another attempt is (Lane and Milesi-Ferretti, 2004) who derived “a reduced-form long-run relation between the RER and a set of fundamentals”. One of the assumptions of the small open economy model was that the RER was affected by supply and demand factors. The RERs in this model are the consumer price index (CPI) RER and the wholesale price index (WPI) RER. The research also highlights the significance of net foreign assets as a key factor influencing RER.

Dornbusch’s model was the building block for the study by (Kempa, 2005). The author transformed the model to obtain exchange rate, output and price level variables. The data for the study was bilateral data for British-U.S., German-U.S. and Japan-U.S. RERs, “relative price levels and output movements” were split into parts connected with “nominal shocks as well as shocks to total supply and demand”. The two main factors driving exchange rates were financial markets and the real economy.

Utilising asset-pricing models of exchange rate, (Engel and West, 2005) found that exchange rates could help to forecast the fundamentals such as income, money, prices and interest rates in agreement with the asset-pricing models of exchange rates. For instance, exchange rates could “Granger-cause money supplies because monetary authorities” respond to the exchange rate in deciding on money supply. Further the research suggested that there might be a role for so-called un-observable fundamentals including money demand shocks, RER shocks and risk premiums.

The BEER approach by (Kim and Korhonen, 2005) developed “a dynamic heterogeneous panel model to estimate equilibrium RER” for Slovakia, Hungary, the Czech Republic, Poland, and Slovenia. The research used data from 1975 to 1999 for 29 middle and high-income countries. The selected variables to explain the RER were GDP per capita, “gross fixed capital formation as a percentage of GDP”, government spending as a percentage of GDP and the degree of openness. Exchange rates were over-valued in Hungary in 2002, but under-valued in Slovenia. The study found that all currencies were over-valued in 2002 if real effective exchange rates were used. The exception was Slovenia. The Hungarian currency had the largest RER misalignment.

Consistent data was an issue that led (Candelon, Kool, Raabe, and Van Veen, 2007) to use panel-cointegration techniques to estimate bilateral equilibrium RER for eight EU members against the euro in a BEER approach. The variables considered for the study included government expenditure, productivity levels and openness using 10 years of data from 1993. The findings of the research were a stable significant positive relationship for productivity and the RER and a significant and negative connection between openness and the RER.

The panel study by (Chen and Chen, 2007) analysed the long-run association between real oil prices and RER for a panel of G7 countries. The data utilised for the study was from 1972:1 to 2005:10. The study found that RER and real oil prices had a cointegrating relationship and that oil prices may have caused the RER movement for the period analysed. Further, real oil prices had significant estimating power for RER. The result of the research was that out-of-sample RER estimation using real oil prices performed better than a random walk model and producing better RER forecasts over longer horizons.

(Villavicencio and Bara, 2008) proposed a “simple model of exchange rate determination” that considered the fundamentals of real GDP per capita, the relative interest rate and net foreign assets as the key macroeconomic factors that influenced RERs for Mexico from the period 1960-2005. The RER was also determined by relative productivity as indicated by the BS approach. For Mexico, PPP could not be confirmed as a long-run equilibrium relationship and that RER did not converge to a persistent mean over time, but was dependent on several structural breaks that were linked to the economic predicament in Mexico. For the period of the study increased productivity in Mexico led to the appreciation of the RER as per the BS hypothesis. Higher interest rates led to inflows of capital into Mexico, which also appreciated the RER. Higher net foreign liabilities were associated with a weaker exchange rate. The

suggested policy interventions were increasing productivity, managing interest rates, and “managing capital movements when considering exchange rate objectives”.

(Sarno and Valente, 2009) used data for the UK, Japan, Canada, Germany, and Switzerland against US dollar exchange rates. The data utilised was from the period 1977-2003 except for Germany, which ended in 1998: Q4. The analysis included net foreign assets, interest rate differentials, and trade balance as additional variables. The study found that based on a reliable model selection criterion, allowing for the fundamental variables to change over time, and allowing for parameter instability enabled an accurate forecast of the exchange rate in some cases. The research then suggests that the relationship between fundamentals and RER varies across currencies.

Utilising data from 98 countries and a core set of monetary model fundamentals, money supply and relative outputs during the year, (Cerra and Saxena, 2010) analysed the relationship between nominal exchange rates and monetary fundamentals. There was strong evidence from the study of cointegration between such variables as relative money supplies, nominal exchange rates and relative output levels. Fundamentals-based models, based on the out-of-sample analysis performed better than a random walk. Concluding remarks note that (Meese and Rogoff, 1983) studied a small set of countries and that their levels of specification did not perform better than the error correction specification by (Mark, 1995).

The investigation by (Chen, Rogoff and Rossi, 2010) analysed the relationship between commodity prices and exchange rates through the terms of trade and income effects. The commodity currencies included the currencies of Canada, New Zealand, Australia, South Africa and Chile; however, the research later excluded the South African rand and Chilean Peso in the forecast model because of small sample sizes. The study controlled for time varying parameters and found that exchange rates could play a role in predicting commodity prices.

The study on the connection between RER and the “discovery of oil and an increase in global demand for natural resources” by (Hayat, Ganiev and Tang, 2013), focused on the period from 1994-2003 for Azerbaijan. The research found that the “overestimation of the oil reserves” and unrealistic “high expectations of future income” caused overshooting of the RER in the first five years of the period under study. Correction of the estimates to give smaller more realistic estimates of the reserves in the second half resulted in the “downward revision of future income and a depreciation of the RER towards its long-term equilibrium level”.

The theoretical monetary model of RER developed by (Kia, 2013), tested Canadian data from 1972-2010. The investigation established that “in the long term, the RER was influenced by real money supply, domestic and foreign interest rate, real GDP, real government expenditure, deficit per GDP, domestic and foreign outstanding debt per GDP, domestic and foreign externally financed debt per GDP and commodity price. All the variables except real money supply, domestic and foreign interest rate and domestic externally financed debt had no statistically significant impact on the RER of Canada”. In the short term, changes in the interest rate, money supply growth, commodity prices and the US debt per GDP had a negative impact on the RER.

(Chang and Su, 2014) examined the long run relationship, the short run dynamic correction and the direction of causality between exchange rates and macro-economic fundamentals for Pacific Rim economies. The tests could not find long run equilibrium for all country pairs except for Taiwan. The cointegration tests with structural breaks demonstrated long run relationships between fundamentals and RER for particular country pairs. In addition, the yen/dollar, the Canadian dollar/dollar, and baht/dollar exchange rates contained information about future estimates of macro-economic fundamentals.

An Autoregressive Distributed Lag (ARDL) investigation by (Chowdhury, 2012) analysed the determinants of the RER for Australia. The analysis utilised the theoretical framework adapted from Edwards’ (1988, 1989) model. The sample period for the investigation was from 1984:1 to 2011:1 under a floating exchange rate policy. The study found that if net foreign liabilities, government expenditures, terms of trade, increased in the long run, this led to the appreciation of the RER for Australia. The Australian RER, to the contrary depreciated when the interest rates differential, openness, and productivity increased. The study suggested that policy makers in Australia should focus on macroeconomic factors that would reduce the impact of inflationary pressures and ensure that exports and imports were competitive for the economy.

The review by (Chen, 2014) asserts that fundamental based exchange rate models do work for most currencies and can explain the value of exchange rates in the long run. PPP and living standards explain exchange rate movements beyond 3 to 5 years. From periods of a month to roughly two years, however, it has been observed that models based on traditional fundamentals continue to struggle, even with more modern flourishes such as behaviour adjustments, endogenous policy rules or non-linear dynamics.

In summary the empirical determinants of RER for developed countries range from commodity prices, interest rate differentials, money supply, openness, productivity, real GDP, government expenditure, net foreign assets and trade balances. The question that comes to mind is if these determinants are the same for emerging markets discussed in the following section.

2.11.2 Emerging Markets

(Edwards, 1988) identified the ratio of government consumption of non-tradable goods to GDP, external terms of trade, import tariffs, measure of technological progress, capital inflows, and excess supply of domestic credit as possible fundamental determinants of the RER for selected developing countries including El Salvador, Brazil, Colombia, Greece, India, Yugoslavia, Thailand and South Africa.

(Ghura and Grennes, 1993) utilised the Edwards model of RER determination with pooled time series data and cross-section data from 33 countries in Sub-Saharan Africa excluding South Africa. The study investigated the relationship between the RER alignment economic factors that included economic growth, saving and investment, imports and exports. The RER equation selected specified the ratio of GDP to the sum of imports and exports, terms of trade, nominal exchange rate, capital inflows, and excess domestic credit. The investigation found that variability in the RER had a negative association with exports, real income growth, imports and investment. The research also indicated that there existed “possible joint relationships between RER variability and misalignment” with potential to affect economic performance.

(Zhang, 2001) estimated the BEER for China and the resulting EER misalignment. Data that was utilised for the study was for the period 1952-1997. The variables utilised for the study were investment proxied by the index of gross fixed capital formation, government consumption, exports as a proxy for terms of trade and openness calculated as the sum of imports and exports divided by GDP in local currency. The analysis showed that domestic investment, export growth, and the trade regime were the long-run determinants of the EER in China.

The analysis of the variables affecting the long-run RER in Argentina, Mexico and Colombia by (Joyce and Kamas, 2003) attempted to differentiate real and nominal determinants of RER. The data utilised was for the period 1971-1995. The study also acknowledges (Edwards, 1989) for the variables utilised in the model. The study found that the RER had an equilibrium relationship with capital flows, government share of GDP, productivity and terms of trade. In

addition, the terms of trade and productivity were the most significant explanatory variables for the RERs. The analysis of nominal variables in the model showed that the nominal exchange rate exerted the greatest influence on the exchange rates of the three countries.

(Choudhri and Khan, 2004) carried out an empirical research to test whether the BS effects could account for the long-run behaviour of RER in developing countries. Panel data from 16 developing countries including South Africa from 1976-1994 informed the study. As explanatory variables, the study chose the relative price of non-traded goods, the terms of trade, and the traded-nontraded labour productivity ratio for the United States and each of the 16 countries. The study found “that the traded-non traded productivity differential was a significant determinant of the relative price of non-traded goods, and the relative price in turn exerts a significant effect on the exchange rate”. In addition, the terms of trade significantly affected the RER. The research argues that the study provided strong validation of the BS phenomenon for developing countries.

(Dufrenot and Egert, 2005) employed a combination of the BEER and the structural vector auto regression approaches. The key macroeconomic determinants of CPI and PPI REERs were analysed for Slovakia, the Czech Republic, Poland, Slovenia, and Hungary. The analysis selected to analyse the relative price of non-tradable goods, labour productivity, public deficit and current account deficit as determinants of the RER. The analysis utilised data from 1992:1 to 2002:2 for Poland and Hungary and from 1993:1 to 2002:12 for Slovenia, Czech Republic, and Slovakia. The study found strong evidence for the Balassa-Samuelson productivity effect; although it could have been exaggerated through non-market based non-regulated service fees. An increase in public deficit had a depreciating effect on the RER for Hungary, Poland and the Czech Republic. For all the countries studied, the current account over GDP ratio was highly significant.

For an “exchange rate determination” study for Korea, Japan, and Hong Kong, (Tsen, 2011), used data from 1960-2009. The study used the model of (Chen and Chen, 2007) extended by terms of trade and exchange reserve gaps. The productivity differential, real oil price, terms of trade, and reserve differential determined RER. For Japan the terms of trade, exchange reserve differential and the real oil price contributed to RER determination. For Korea, the important variables were terms of trade and reserve differential, while for Hong Kong, important variables were the reserve differential and real oil price. The research suggests that the impact of the same variables can be expected to be different across different economies because of

differences in exchange rate arrangements and different maturities of openness of the economies.

(Tang, 2014) analysed the influence of RERs on economic growth in China using a cointegrated VAR (CVAR) model. The data utilised for the analysis was from January 1994 to December 2012. The model constructed was based on the EER equation of (Edwards, 1988, 2011) and the “exchange rate fundamentals equation” of (Glüzmann et al., 2012; Rodrik, 2008). The variables identified were the real GDP, foreign exchange rate reserves, exports, foreign direct investment and imports. Exports and foreign direct investment had a positive influence on the RER and real GDP in the long-term. Foreign exchange reserves and imports had negative impacts on the real GDP and the RER. The cointegration tests of the study suggested that China’s growth could not have been caused by the depreciation of the Chinese currency because the economy was supported by the growth of exports and foreign capital inflows.

Using a monetary model specified in (Engel and West, 2005), (Sarno and Schmeling, 2014) included GDP growth, CPI inflation, real output and real money, risk premia, money growth, and interest rate differentials as independent variables in the exchange rate model. Their study investigated whether exchange rates forecast fundamentals. The research used data from 1900-2009 for 36 countries covering stable well established currencies and emerging country currencies including South Africa. The study concluded that “spot exchange rates do not have significant predictive power for future fundamentals. Future fundamentals seem to matter a lot for the determination of current exchange rates”. The research also suggests that CPI inflation, money growth, GDP data (nominal macro fundamentals), had a strong relationship with RER. Risk premia and real money and real output appeared to be unimportant since they were weakly related to exchange rates. The research concludes with the statement that “nominal fundamentals are most important for the determination of exchange rates whereas real factors appeared to matter only to a limited extent”.

The preceding section analysed the determinants of RER in emerging markets. Some of the common determinants of RER were terms of trade, interest rate differentials, foreign exchange reserves, productivity, government expenditure and net foreign assets. Again, one would be curious about how these determinants would fare in Africa. The following section details the determinants of RER for Africa.

2.11.3 Africa

The research on RERs in Africa includes the study by (Baffes, Elbadawi and O’Connell, 1997) which utilised a single-equation to estimate the equilibrium RER for Burkina Faso and Côte d’Ivoire. The econometric methodology also estimated the degree of currency misalignment for the two countries. The research data consisted of 29 annual observations for Côte d’Ivoire, and 24 annual observations for Burkina Faso. The research notes that empirical findings of the research for Burkina Faso and Côte d’Ivoire generally agree with studies on ERERs in developing countries, and with estimates obtained by other methods.

(Opoku-Afari, 2004) estimated the REER for Ghana using data from 1960-1999. The fundamental variables chosen for the analysis included capital inflows, openness, and government consumption of tradable goods and non-tradable goods. The research found that a CPI based index gave a better indication of the relationship between the fundamentals and the REER as compared to a GDP-deflator index. This was in line with the Dutch Disease hypothesis. The Dutch disease (Williamson, 2009) describes what happened to Holland following the discovery of natural gas in the 1970s. The export of natural gas appreciated the RER, which led to the country being more import dependent and highly dependent on exports of natural gas. This led to the reduction in exports of other goods produced in Holland and a reduction in manufacturing exports leading to the Dutch disease. The research also found that for Ghana, the choice of weights and the choice of trading partners were not important considerations because a “comparison of alternative measures with varying trade partners and weights” were highly correlated as per the finding by (Edwards, 1989).

(Ndhlela, 2012) utilised the BEER framework to analyse the influence of real gross domestic product growth on RER misalignment for Zimbabwe. The specification for the BEER exchange rate model to estimate the ERER selected net foreign assets, real interest rate differential, domestic credit expansion, the nominal devaluation or currency depreciation, trade restrictions, government expenditure, the ratio of domestic investment to GDP, net exports ratio to GDP and terms of trade. The research finds that exchange rate misalignment severely affected Zimbabwean economic growth. The research also concludes that the RER overvaluation was the key cause of the economic growth contraction of the Zimbabwean economy after 2000.

In line with (Oriavwote and Oyvwii, 2012), the government expenditure to GDP ratio, technological progress besides terms of trade were not important determinants of the Nigerian RER. The study however showed that nominal effective exchange rate, capital flows and price

level had a significant impact on the RER. The results of the Johansen cointegration test also showed a long run relationship among the variables. The research utilised data from 1970-2010 within a parsimonious ECM. The conclusion of the research was that Nigeria was experiencing the Dutch syndrome and suggested policies to manage the problem of inflation.

A more recent study by (Ajao and Igbekoyi, 2013) analysed the determinants of the volatility of the RER of the Nigerian Naira from 1981-2008. The research used the GARCH (1.1) technique and ECM technique to analyse the determinants of the RER volatility. The analysis showed that government expenditure, openness, interest rates, besides lagged exchange rate significantly influenced the RER volatility. The research advocated for policies from the central monetary authority that minimised the magnitude of exchange rate volatility. A further recommendation was for the federal government to control the macroeconomic variables that have a direct influence on exchange rate fluctuation in order to have a stable exchange rate environment.

The paragraphs above have detailed the determinants of the RER, which include interest rate, government expenditure, capital flows, nominal effective exchange rate, openness, and productivity. As discussed in the sections for developed countries and emerging markets, the determinants appear to be similar. The last analysis in the following paragraphs examines the determinants of RER for the focus country of the study South Africa.

2.11.4 South Africa

The first most prominent research that included South Africa was when (Edwards, 1988) identified the ratio of government consumption on non-tradable goods to GDP, import tariffs, measure of technological progress, capital inflows, excess supply of domestic credit, and external terms off trade as possible fundamental determinants of the RER.

For the period 1970–1995, (Aron, Elbadawi and Kahn, 1997) examined the short-run and long run equilibrium causal factors of the quarterly RER utilising single equation correction models. The research identifies terms of trade, trade policy, government expenditure, long and short-term capital flows, productivity growth differentials and foreign exchange reserves as determinants of the South African RER. It is important to note (Gossel and Biekpe, 2012) that from 1985 to 1995 South Africa had a “dual exchange rate system” mainly the “commercial and financial rand”.

Quarterly data from 1970 to the first quarter of 2002 was analysed by (Macdonald and Ricci, 2003) while estimating the equilibrium RER of South Africa. The variables used for the analysis were the real interest rate differential, fiscal balance, net foreign assets considering the forward book, per capita real GDP compared to trading partners, commodity prices, and openness. Commodity prices, real interest rate differentials, productivity, the fiscal balance, openness, and net foreign asset positions were the main explanatory variables for the RER.

Potential factors affecting the RER for the analysis by (Takaendesa, 2006), included government expenditure, real interest rate differential, trade policy, terms of trade, monetary policy, nominal exchange rate policy, degree of openness and measure of technological progress.

The paper by (Egert, 2009) used the monetary model to analyse the drivers of volatility of the South African rand against the US dollar from 2001:1 to 2007:7. The paper includes commodity prices, specifically the price of gold and metals, a productivity differential to explain the BS effect, stock prices and trade balances as proxy for country risk premium. A DOLS methodology estimated the long run relationship. According to the research, as the exchange rate appreciated above the monetary equilibrium, the exchange rate would revert to the long-run monetary equilibrium. The second finding was that higher gold prices tended to lead to a strong appreciation of the rand against the dollar in a non-linear manner. The third finding was that South Africa was seen as having the same characteristics as emerging market countries and negative risk perceptions on emerging markets tended to cause the rand to depreciate.

(Frankel, 2007) analysed real rand value, real world mineral price, South African GDP per capita as a ratio of foreign GDP per capita, interest rate differential, and country risk spread as explanatory variables for the South African RER based on data for the period 1984-2007. The research found commodity prices to be significant and that high levels of South African interest rates led to a stronger South African Rand. Because of the well-developed financial markets in South Africa, the rand behaved in some ways like currencies of industrialised countries.

The paper on the “impact of a natural resource boom on structural change and RER dynamics” by (Stokke, 2008) contributed to the Dutch disease literature, but also most importantly analysed the macroeconomic impacts of the gold price increases of the 1970s on the South African economy. The research showed that after the boom there was an increase in public

consumption, which caused a RER appreciation. The RER appreciation led to the growth of service companies with the neglect of the industrial tradable sector. The outcome was that there was a decrease in real industrial productivity, which gradually led to a depreciation of the RER.

(Gossel and Biekpe, 2012) mentioned trade openness, commodity prices, GDP differentials, the size of the fiscal balance, real long-term interest rate differentials, and net foreign assets as fundamentals that affect South Africa's RER.

In an attempt to define the relationship between the long-term South African EER of the rand and its fundamental determinants (Saayman, 2010), used the BEER methodology with dynamic ordinary least squares (OLS) augmented with fully modified OLS methods. The panel data approach used information from South Africa's major trading partners, Europe, the USA, Japan and the UK because the four currents were the major contributors to South Africa's EER, since they represented more than 75% of the country's EER. The research observed that economic growth, openness, foreign reserves, capital expenditure and the real gold price influenced the fundamental value of the South African EER.

(De Jager, 2012) adopted a VECM model to investigate South Africa's equilibrium real effective exchange rate with data from 1982 to 2011. The research concluded that the effects of key economic fundamentals could determine the EER. These fundamentals were commodity prices, interest rate differentials, productivity, capital flows and the fiscal balance.

(Egert, 2012) modelled exchange rates in South Africa by using an open stock flow method and extending the monetary model. Country risk premium and share prices augmented the monetary model. The data utilised was from 1980-2009 and included gold, coal, and iron, copper and platinum as the five contributors to the commodity price index. Although the research suggests that commodity prices were important in influencing real and nominal exchange rate, coefficients of commodity prices were sensitive to model specification. The research however concludes with the fact that commodity prices could not explain the depreciations of the rand observed in 2002 and 2008.

(Sibanda and Mlambo, 2014) investigated the influence of oil prices on the nominal exchange rate for South Africa using data from 1994 to 2012. The research utilised the generalised autoregressive conditional heteroscedascity (GARCH) test on monthly time series data. The research concluded that oil prices significantly affected the South African nominal exchange rates with increases in oil prices leading to a weakening of the rand exchange rate.

Table 1 below summarises the key determinants discussed in the paragraphs above as per (Takaendesa, 2006). The table includes work that is more recent and other studies not included by (Takaendesa, 2006).

Table 1: Determinants of RERs

Study	Countries	Methodology	Explanatory Determinants
(Ricci et al, 2013)	48 industrial and emerging countries	Panel DOLS	Productivity growth differentials, net foreign assets, trade restrictions, government consumption
(Chowdhury, 2012)	Australia	ARDL	Terms of trade, government expenditure, net foreign liabilities, openness, technological and productivity improvement, interest rate differential
(De Jager, 2012)	South Africa	Multivariate cointegration	Productivity, interest rate differential, commodity prices, fiscal balance, capital flows
(Saayman, 2010)	South Africa	BEER, multivariate cointegration	Openness of the economy, economic growth, foreign reserves, capital expenditure, real gold price
(Jongwanich, 2009)		Multivariate cointegration	Net foreign assets, productivity, government spending, trade policy openness and terms of trade
(Frankel, 2007)	South Africa	Multivariate cointegration	Real rand value, real world mineral price, South African GDP per capita as a ratio of foreign GDP per capita, interest rate differential, and country risk spread
(Takaendesa, 2006)	South Africa	Multivariate cointegration	Trade policy, terms of trade, government expenditure, real interest rate differential, monetary policy, nominal exchange rate policy, degree of openness and measure of technological progress
“(Kempa, 2005)	US Britain, Germany, Japan	Variance decomposition	Nominal shocks (financial market shocks), aggregate supply and aggregate demand shocks
(Coricelli and Jazbec, 2004)	19 Transitional economies	Classical regression	Productivity differential, share of non-tradable consumption in total private consumption and real government consumption
(Miyakoshi, 2003)	6 East Asian countries	Multivariate cointegration	Real interest rate differential, productivity differential
(Joyce and Kamas, 2003)	Argentina, Columbia, Mexico	Cointegration, variance decomposition and impulse response	Terms of trade, capital flows, productivity, government share of GDP, nominal exchange, broad money
(MacDonald and Ricci, 2003)	South Africa	Multivariate cointegration	Real interest rate differential, productivity, terms of trade, trade openness, fiscal balance, net foreign assets
(Mkenda, 2001)	Zambia	Multivariate cointegration	Terms of trade, government consumption, investment share in GDP, central bank reserves, trade taxes, technical progress, openness, aid
(Aron et al., 2000)	South Africa	Multivariate cointegration	Terms of trade, price of gold, tariffs, capital flows, central bank reserves, openness, nominal depreciation, domestic credit, technical progress, government expenditure.
(Antonopoulos, 1999)	Greece	Multivariate cointegration	Productivity differential, capital flows
(MacDonald, 1998)	U.S., German, Japan	Multivariate cointegration	Productivity differential, terms of trade, fiscal balance, net foreign assets, real interest rate differential.
(Elbadawi, 1994)	Chile, Ghana, India	Multivariate cointegration	Terms of trade, openness, ratio of net capital inflows to GDP, share of government spending in GDP, rate of export growth (productivity).
(Obadan, 1994)	Nigeria	Two-stage least squares regression	Terms of trade, net capital inflow, nominal exchange rate policy, monetary policy
(Ghura and Grennes, 1993)	33 Sub-Saharan African countries	Classical regression	Terms of trade, capital flows, openness, excess domestic credit, technical progress, nominal devaluation
(Edwards, 1989)	12 Developing countries	Multivariate cointegration	Terms of trade, level and composition of government spending, capital flows, openness, foreign exchange control, technical progress, nominal devaluation”

Source: (Takaendesa, 2006) and author’s additions.

2.12 Fundamental Determinants of RER in South Africa

Based on the factors identified by literature above, the research selects commodity prices, net foreign assets, interest rate differentials, openness, productivity and terms of trade as potential fundamental determinants of the South Africa exchange rate. The table below summarises how each of the chosen variables might interact with the RER.

Table 2: Effect of Fundamental Determinants on South African RER

Determinant	Effect on RER	Sources
Commodity prices	When commodity prices increase the RER appreciates.	(Bodart, Candelon, and Carpentier 2012)
Interest Rate Differential	High interest rates lead to an appreciation of the rand.	(Frankel, 2007)
Net Foreign Assets	An increase in net foreign assets is expected to result in an appreciated exchange rate in the long term.	(Macdonald and Ricci, 2003)
Openness	An increase in openness leads to depreciation of the RER.	(Hausmann, 2008)
Productivity	An increase in productivity favours the strengthening of the RER	(Edwards, 1994: 83, Montiel, 1999: 285, MacDonald, 1998: 121, and Saayman, 2010)
Terms of Trade	The overall effects of TOT on the RER are ambiguous.	(Montiel, 1999: 287 and Mkenda, 2001: 24)

2.13 Conclusion

The literature review has criss-crossed the globe from South Africa to Europe, America, New Zealand, and Asia including China, South America and come back to South Africa through Nigeria, Malawi, and Zimbabwe in search of the fundamental determinants of the RER.

The literature review above reveals some aspects of the South African exchange rate that have not been considered in the existing literature. One of the key themes from the literature review is that of analysing RER over different exchange rate regimes and consolidating the results into one finding. The research attempts to fill a gap for South Africa by focusing specifically on a floating exchange rate regime.

The following chapter outlines the implementation of the Johansen's cointegration methodology (Clark and Macdonald, 1998; Macdonald, 2007) as it is a stylised fact that economic data contains variables that in most cases are cointegrated.

3 Research Methodology

3.1 Data

The sample period for the study from 1995:1 to 2014:4 represents a floating exchange rate regime for South Africa. The sources of data for the variables are listed in the table below. DataStream provided the majority of the data for the analysis. DataStream in effect aggregates data from credible data sources and therefore provides credible secondary data. To test for the stability of the model a dummy variable represented the technology company “dot.com” bubble in 2001 and the global financial crisis in 2008.

Table 3: South African RER Model Variables

Variable	Description	Source
RER	Trade-weighted RER index from SARB	South African Reserve Bank (SARB)
COM	Gold price as a proxy for commodity prices	Datastream
IRD	Interest rate difference between South Africa and the Euro Zone	OECD main economic indicators
NFA	Net Foreign Assets	Datastream
OPEN	Calculated by [(Exports +Imports)/GDP]	Datastream
PROD	GDP per Capita difference between South Africa and the Euro Zone as a proxy	Datastream
TOT	Terms of trade	Datastream

It should be noted that South Africa has experienced increasing trade volumes with China in recent years. Obtaining data for China for the period of the study was a challenge and therefore the research settled on Euro Zone data as a proxy for commodity prices and interest rates.

3.2 Model Estimation

Based on the literature review, and equation (1) above the proposed econometric equation is:

$$\ln RER = \alpha_1 + \beta_1 COM_t + \beta_2 IRD_t + \beta_3 \ln NFA_t + \beta_4 \ln OPEN_t + \beta_5 \ln PROD_t + \beta_6 \ln TOT_t + \varepsilon_t \quad (2)$$

The analysis is on natural logarithm data in order to normalise the variables.

where $\ln RER$ is the logarithm of the RER, IRD is the interest rate differential, $\ln NFA$ is the Net Foreign Assets as a percentage of GDP, $\ln OPEN$ is the degree of trade openness, $\ln PROD$

is technological progress, $\ln\text{TOT}$ is the terms of trade. The error term is represented by ε_t . The research also adds commodity prices $\ln\text{COM}$ since past literature indicates the dependence of South Africa on mineral resource exports.

The mathematics underlying the econometric procedure in the following section are well documented in (Franses, Van Dijk & Opschoor, 2014; Vogelgang, 2005; Lutkepohl & Kratzig, 2004). The study does not discuss the mathematical principles as these are well established, but discusses the key concepts.

3.3 Econometric Procedure

Vector error correction modelling (VECM) involves four main steps. The first step is to test for unit roots (Saayman, 2010). The objective of unit root tests is to guard against nonstationary variables that might result in spurious results. Spurious results could lead to misleading results. A popular test for unit roots or stationarity is the Augmented Dickey Fuller (ADF) test.

The second step is cointegration testing. The importance of cointegration testing is to identify the number of cointegrating relationships in the variables. If there are no cointegrating relationships the model can be treated as a VAR. If cointegrating relationships are present, the model can be treated as a VECM.

The third step, once the variables have shown cointegrating relationships is VECM modelling. The VECM shows the long run and short run relationships of the explanatory variables with the dependent variable.

The last step is to confirm that the model is stable through three key diagnostic checks which include the Lagrange Multiplier test, the heteroskedacity test and the residual normality test. These diagnostics test for autocorrelation, heteroskedacity and the normality distribution.

Once the model has passed all the above tests, the study concludes on the results of the model.

The research is not concerned with forecasting the behaviour of the RER and therefore does not perform the variance decomposition and impulse response function tests.

3.3.1 Tests for Stationarity

Time series are a sequence of random variables indexed by time. Economic data exhibit the properties of time series. Economic data usually follows a non-stationary path as opposed to the classical regression model. Analysis of an economic variable that is linked to non-

explanatory variables will produce false, meaningless results. The false results might present themselves as significant t-ratios and high R^2 values. (Gujarati and Porter (2009:748). If $R^2 > d$ this can be a good indication that the estimated regression is spurious.

(Gujarati and Porter, 2009:740), “A stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed”. To avoid spurious regression (Gujarati and Porter (2009:760), the nonstationary time series is transformed to make them stationary. A commonly utilised test for unit roots is the ADF test.

3.3.2 Cointegration Tests

Cointegration testing assesses the long run interactions for a set of variables in a model. (Brooks, 2008) notes that “cointegration exists when variables are individually nonstationary but a linear combination of them is found to be stationary, such that there is a long run relationship between those variables”. The cointegration test in this study assesses the existence of a long run relationship between the RER and the selected explanatory variables for the model.

3.3.3 VECM

A VECM is a constrained VAR designed for use with cointegrated nonstationary series. The cointegrating association in the VECM restricts the long run behaviour of the variables to converge to their cointegrating relationships. Once estimation of the VECM is complete, the VECM is checked for normality, heteroskedacity and autocorrelation.

(Nilsson, 2004), (De Jager, 2012), (Sibanda et al, 2013) adopted a VECM model to analyse the relationship of variables to RER. The studies utilises the VECM method since it can separate the long run and short run determinants of the RER.

3.3.4 Diagnostic Checks

Diagnostic checks are essential in the analysis of the determinants of the RER because they confirm the stability of estimated model. Diagnostic checks test the model for residual autocorrelation, heteroskedasticity and normality.

The study does not perform variance decomposition and impulse response function tests on the model. These tests are concerned with the behaviour of the variables after the sample period.

3.3.5 Conclusion

This chapter has specified an empirical model for the RER and its fundamental determinants. The next chapter applies the estimation techniques discussed to analyse the relationship of the RER to the fundamental determinants of the South African RER. The next chapter achieves the key goals of the research which were introduced in Chapter 1 which are to test if fundamental determinants of the RER are responsible for the behaviour of the RER for the period from 1995 to 2014.

4 Analysis and Discussion

Chapter 3 positioned the Johansen estimation technique for the research. The data for the research is quarterly data for South Africa from 1995 to 2014. The data is specifically for the period in which South Africa adopted a floating exchange rate regime. On the back of the previous chapter, this chapter applies the estimation techniques to answer the questions and test the hypotheses that were raised in Chapter 1. The research employs the Johansen technique to provide answers to the questions raised. The next section presents the empirical findings.

4.1 Empirical Findings

The first sub-section discusses the outcomes of the unit root tests. The following subsection walks through the cointegration tests. The third subsection analyses the VAR and VECM of the fundamentals and the RER. The last subsection tests the derived model for stability. The natural logarithm \ln of all the variables except interest rate differential were utilised in the analysis to standardise the data (Saayman, 2010).

4.1.1 Unit Root Test Results

As economic time series raw data have non-stationary properties (Saayman, 2010), the first step when using the Johansen methodology is to determine the stationarity of variables or the presence of unit roots.

The graphical analysis of the variables in the figure below shows that RER has depreciated from 1995 to 2014, the interest rate differential (IRD) shows a downward trend, net foreign assets (NFA) shows an upward trend, trade openness (OPEN) shows an upward trend, the productivity differential (PROD) appears to be stationary while terms of trade (TOT) shows an upward trend.



Figure 6: Explanatory Variables of the RER

The formal test employed for the testing of unit roots/stationarity is the ADF test. The table below show the results of the tests with intercept.

Table 4: Results of ADF Unit Root Intercept Test

Variables	ADF Intercept		Order of Integration
	Level	First Difference	
ln(RER)	-2.190036	-7.436277	I(1)
Ln(COM)	0.109705	-7.191359	I(1)
IRD	-1.563205	-8.368757	I(1)
Ln(NFA)	-1.098222	-8.301294	I(1)
Ln(OPEN)	-0.589651	-7.900499	I(1)
Ln(PROD)	-7.142695	-11.05468	I(1)
Ln(TOT)	-1.041483	-10.29731	I(1)

The results of the unit root test therefore show that all the variables are first difference stationary I(1). All the series are cointegrated, the next step is cointegration tests for all variables.

4.1.2 Cointegration

When the variables are non-stationary at level the second step (Saayman, 2010), is the test for co-integration. During an econometric analysis of a set of two or more variables, the condition for co-integration is that there should exist a long-term equilibrium to which the series of variables trend to over time.

The table below displays the results of the suggested lag selection criteria for the VAR.

Table 5: Var Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-156.5236	NA	2.08e-07	4.480098	4.699731	4.567626
1	323.4257	854.7042	1.56e-12*	-7.326732	-5.569667*	-6.626511*
2	366.9568	69.17263	1.88e-12	-7.176898	-3.882401	-5.863984
3	422.8875	78.14984	1.71e-12	-7.366782	-2.534854	-5.441175
4	465.1169	50.90662	2.48e-12	-7.181284	-0.811925	-4.642985
5	531.0406	66.82678*	2.18e-12	-7.644948	0.261844	-4.493955
6	585.5146	44.77313	3.29e-12	-7.794920	1.649304	-4.031234
7	643.1566	36.32240	6.57e-12	-8.031689*	2.949966	-3.655309

The maximum lag chosen for the VAR is 7. The information criteria suggest different criteria for the lags with FPE suggesting 1 lag, AIC suggesting 7 lags, SC suggesting 1 lag and HQ suggesting 1 lag.

Based on the results of the lag selection criteria, the cointegration test is done under lag 1 and produces the results below.

Table 5: Results of Johansen Cointegration Test

Sample: 1 80
 Included observations: 78
 Series: RER COM IRD NFA OPEN PROD TOT
 Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	1	1
Max-Eig	1	1	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

The Johansen test was done on 1 lag and suggests that there are at least more than one cointegrating relationships for the Trace Test and for the Maximum Eigenvalue test. The results of the Johansen test confirm cointegrating relationships in the variables and the next step is the VECM.

4.1.3 VECM

Modelling the VECM at lag 1, lag 2 and lag 3 did not produce meaningful results. The research followed (De Mello and Pisu, 2010) who experienced the same problem and eventually modelled the VECM at 4 lags. The equation of the VECM modelled at 4 lags has a negative sign of -0.15 and a probability of 0.03% which is less than the 5% significance level. Both indicators are significant and therefore the next step is to test for the stability of the model using diagnostic tests. The study also introduced a dummy variable for the “dot.com” bubble in 2001 and the “global financial crisis” in 2008. The model still produced stable results displayed in the table below.

Table 6: Long Run Equilibrium Exchange Rate Model

Sample (adjusted): 6 80

Included observations: 75 after adjustments

Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1							
RER(-1)	1.000000							
COM(-1)	0.623081 (0.18695) [3.33290]							
DUMMY(-1)	-0.063805 (0.11676) [-0.54647]							
IRD(-1)	0.018933 (0.02143) [0.88337]							
NFA(-1)	0.046983 (0.09030) [0.52032]							
OPEN(-1)	-0.465824 (0.21051) [-2.21287]							
PROD(-1)	-0.143650 (0.01515) [-9.48306]							
TOT(-1)	-1.751532 (1.19053) [-1.47122]							
C	3.909647							
Error Correction:	D(RER)	D(COM)	D(DUMMY)	D(IRD)	D(NFA)	D(OPEN)	D(PROD)	D(TOT)
CointEq1	-0.154657 (0.03940) [-3.92565]	-0.111015 (0.05415) [-2.05022]	-0.075452 (0.22984) [-0.32829]	1.591969 (0.66156) [2.40637]	-0.310639 (0.13738) [-2.26111]	-0.086622 (0.06296) [-1.37592]	-8.305824 (5.17675) [-1.60445]	-0.020360 (0.02250) [-0.90505]

4.1.4 Diagnostic Tests

The next step is to analyse the residual diagnostics through the test for normality, the serial correlation Lagrange multiplier (LM) test and the Breusch-Pagan-Godfrey heteroskedacity test. All tests show that the model is viable. These tests are displayed in the table below.

Table 6: Summary of Diagnostic Tests

Test	Test Statistic	<i>p</i> -value	Conclusion
Jaque-Bera (Normality)	0.426	0.671	Viable
Breusch-Godfrey Serial Correlation LM Test:	0.941	0.350	Viable
Breusch-Pagan-Godfrey: Heteroskedasticity Test	0.547	0.586	Viable

The diagnostic tests show that the model performs well for normality, with no serial correlation and heteroskedacity.

The figure below illustrates the graphical representation of the normality test.

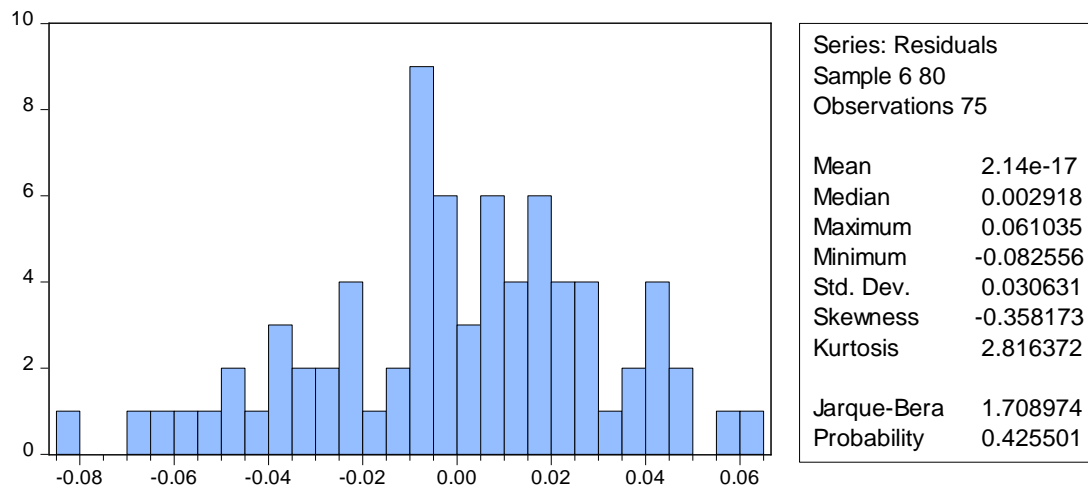


Figure 7: Test for Normality

The last test is the test for stability of the model using the CUSUM test. The test affirms the findings of the other tests and shows that the model is stable and can be accepted.

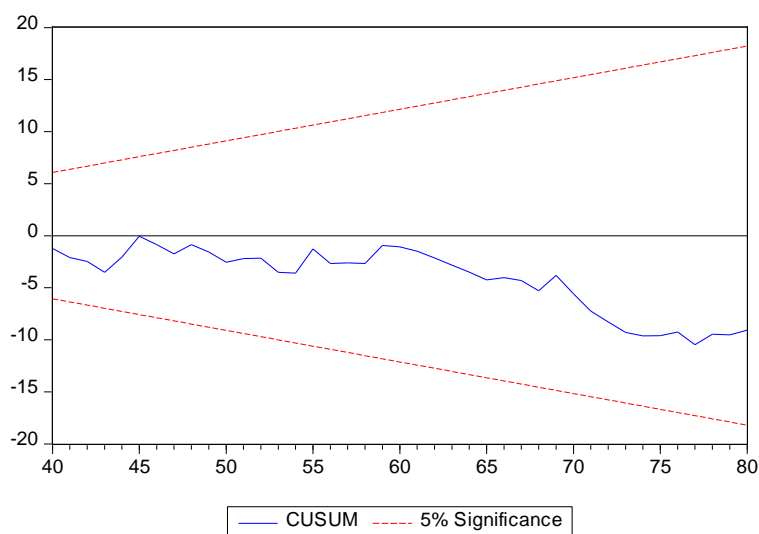


Figure 8: CUSUM Test for Model Stability

The tests above have confirmed that the model and its associated variables is viable. The last step in the research is to discuss the variables in the VECM model and suggest policy actions from the findings of the research. This is the last step recommended by (Maddala, 2001p.6-7). The research does not however predict or forecast the future trends of the RER.

4.2 Discussion

The study has the objective to determine if the fundamental determinants have any long run relationship with the RER and does not discuss the short run relationships from the VECM.

The coefficients of the selected explanatory variables VECM substituted into the estimating model gives the long term relationships of the variables with the RER.

$$\ln RER = -0.15 - 0.62\ln COM + 0.46\ln OPEN + 0.14\ln PROD - 0.019IRD - 0.047\ln NFA + 1.75\ln TOT$$

The result of the VECM shows that the sign of the *coefficient CE* is negative and statistically significant. Assuming that all things remain the same in the economy, 15% of the deviation from long run equilibrium will be eliminated every quarter. It therefore takes about 5 to 6 quarters to eliminate a shock to the system. (MacDonald and Ricci, 2003) found that all things being equal, it would take between 8 and 10 quarters to eliminate half of the shock. For (Aron et al., 1997), the adjustment factor is faster, taking less than ten months to eliminate of the shock. The study therefore is in between the adjustment speed of the two studies. It should also be born in mind that the study focuses on a floating exchange rate regime.

The variables that were found to be significant were COM, OPEN and PROD and these are further discussed in the paragraphs below.

4.2.1 Commodity Prices

Commodity prices were significant for the study with a negative sign. A 1% increase in COM causes a 0.6% depreciation in the RER. (Bodart, Candelon, and Carpantier, 2012) found that for small developing countries that are commodity exporting, when commodity prices increase, the RER appreciates. This causes an increase in domestic spending caused by the higher income and, (Ball, 2010) to the Dutch disease. The Dutch disease leads to a contraction of the manufacturing sector due to high commodity prices. The finding of this research agrees with (Hodge, 2015) clearly showing that South Africa does not suffer from the Dutch Disease after 1995. The South African economy shows a positive linkage between mining and manufacturing with an increase in mining activity directly related to increased activity within the

manufacturing sector. Consistent with (Gossel and Biekpe, 2012), the RER may be associated with global equity movements and has ceased to be a “commodity currency”.

4.2.2 Openness

Openness was significant in the study with a positive sign. The sign for OPEN shows that an increase in OPEN causes appreciation of the RER. A 1% increase in OPEN causes 0.4% appreciation in the RER. (Takaendesa, 2006) for the South African study also found openness to have a positive long relationship with RER. An open economy allows South Africa to export products as well as import products. The positive effect for South Africa is that this can lead to technology transfer to South Africa which can be utilised to increase productivity. The research makes this connection as the study found productivity to be positively correlated with RER appreciation.

4.2.3 Productivity

Productivity was significant in the study with a positive sign. The sign for PROD shows that an increase in PROD causes appreciation of the RER. A 1% increase in PROD causes a 0.1% appreciation of the RER. (MacDonald and Ricci, 2003), and (Takaendesa, 2006) found technological progress, a proxy for productivity differential to have a positive long relationship with the RER. The research therefore provides empirical support for the BS effect. The increase in productivity might be attributed to the increase in skilled labour and technology transfer due to openness.

The policy implication is then that South Africa should continue to increase the skills of employees as well as enter into technology transfer agreements with technologically more advanced countries. South Africa should also develop home grown technology to export to the international market supported by an appropriate research and development strategy.

5 Conclusion

5.1 Summary of the Study

The research analysed the fundamental determinants of the South African RER. The study reviewed the importance of exchange rates for a connected world.

The comprehensive literature review on the fundamental determinants of the RER guided the specified empirical model for the RER and its potential fundamental determinants.

The Johansen cointegration technique was utilised to understand the long run determinants of the RER. In applying the technique, the first step was formal tests for unit roots or stationarity on the data. The cointegrated properties of the data meant that the variables were modelled using a VECM. The results of testing the hypotheses are described in the following paragraphs.

5.2 Conclusion on H1

H1: Null Hypothesis: There are no significant relationships between the South African real exchange rate and its fundamental determinants.

This hypothesis was tested through the following fundamental determinants, commodity prices, interest rate differential, net foreign assets, terms of trade, openness and productivity.

The research found the explanatory variables that were significant were commodity prices, openness and productivity. The RER of South Africa for the period under study can therefore be explained by the mentioned fundamental variables. The null hypothesis is therefore rejected.

5.3 Conclusion on H2

H2 Null Hypothesis: The South African Reserve Bank should not utilise policy interventions that target the fundamentals to influence the South African real exchange rate.

This hypothesis was tested through the interest rate variable in the econometric model. The study found that interest rates were not a significant fundamental variable for the period of the study. In terms of SARB policy actions, the SARB implements its policy of inflation targeting through interest rates. The research therefore cannot reject the null hypothesis. This is consistent with (Kohlscheen, 2014) and (Demir, 2014) who assert that the interest rate lever should not be used to reduce exchange rate fluctuations but to target domestic inflation caused by exchange rate variations. Further, (Balcilar, Gupta and Jooste, 2016) point out that the influence of interest rates on RER might be weak for particular periods.

5.4 Conclusion of the Study

The study concludes that as much as some of the fundamentals explain the RER a certain movement of the RER during the floating exchange rate regime can be explained by other factors that have not been considered in this study such as speculative attacks on the currency and investor behaviour in global equity markets that lie within the domain of behavioural economics.

5.5 Policy Recommendations

Prudent exchange rate management under a floating exchange rate regime requires an empirical understanding of all the factors that influence the South African RER and the complex interlinkages of these factors that can clearly explain the appreciation or depreciation of the RER.

The research has found cointegrating relationships between the RER and some of its fundamental determinants. This implies that some of the variables should be used as levers to manage the RER. The significant variables such as commodity prices, openness and productivity cannot however be directly influenced by the SARB. The appropriate policy recommendations are elaborated on in the following paragraphs.

For developing countries, (Eichengreen, 2008) advocates a policy that maintains exchange rates at competitive levels while avoiding disproportionate volatility to stimulate economic growth through exports.

Export led-growth is important for South Africa and should be directly linked to a growing manufacturing sector. Rodrik's (2006) article in the compilations of development articles in United Nations (2007) encourages diversification, the growth of large manufacturing sectors, exports of more sophisticated goods as factors that have supported economic growth. South Africa therefore requires an industrial policy that grows new industries to develop new export products and new export markets. According to (Rodrik, 2006), this industrial policy should be sustained by an exchange rate policy that supports the production of tradable goods.

South African open trade policy should therefore be maintained as it is associated with an increase in productivity and appreciation of RER. The industrialisation policy for South Africa should support the increase of employee skills as well as technology transfer agreements with technologically more advanced countries. South Africa should also develop home grown

technology to export to the international market supported by an appropriate research and development strategy.

The SARB should still maintain its inflation targeting policy but the study has shown that this did not directly influence the RER during the period of the study potentially due to the progressively lower interest differential. (Ball, 2010) presents some simple rules for policy suggesting that the best policy response was based on an understanding of what had caused the exchange rate movement. Higher domestic spending for instance called for a raising of interest rates. If the exchange rate changed because of higher exports, it was prudent to understand why the exports rose.

5.6 Research Limitations and Areas for Future Study

The results from the research were obtained using a limited number of variables informed by the availability of data. The study was also conducted for a relatively short sample size. The recommendation for future work is the inclusion of more variables in the analysis as well as longer periods of data and alternative proxies for variables.

It is further recommended that future work compare the results of this study with results from an ARDL methodology, which has been highlighted as an improvement on the Johansen technique and is suggested to produce robust result for short-term periods.

The last recommendation for future research is a model that can describe the interaction of fundamental variables and behavioural variables to determine the RER of South Africa.

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