Fundamentals of the rand/euro exchange rate:

A behavioural approach

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ABSTRACT

A considerable share of attention from economists and analysts was focused on the fluctuations of exchange rates worldwide, including South Africa, over the last few years. Economists generally believe that there is a long-term equilibrium level to which the currency will converge, given that the exchange rate fluctuates over the short term. The aim of this study is to estimate the long term equilibrium exchange rate of the Rand against the currency of South Africa's main trading partner, the Euro.

The collapse of the Bretton Woods System changed exchange rate determination significantly. A more volatile international monetary framework followed, both worldwide and in South Africa. Today, South Africa has a formal inflation targeting framework and a free floating exchange rate regime in place.

A behavioural approach was followed to determine the equilibrium exchange rate, after analysing a variety of theories on equilibrium exchange rates that focus on different aspects of the equilibrium exchange rate. The econometric technique implemented is direct estimates of a single exchange rate equation. The behavioural, single equation approach is chosen for its simplicity on the one hand as well as for the fact that current variables that influence the exchange rate are identified via this approach.

Fundamental variables identified include the real GDP per capita, the real gold price and gross reserves of the SARB. A vector error-correction mechanism is used in the estimation of the long-term relationship. Significant values are found up to four lags, with 1 cointegrating equation at the 1 percent significance level.

The exchange rate is fluctuating around its long-term equilibrium level and is currently very close to the estimated equilibrium exchange rate. The trend in the data is slightly negative implying that the equilibrium level has decreased slightly. The closeness of the exchange rate to the long-term equilibrium is a positive sign for the economy, supporting the current stable inflation, low unemployment, and growth rate. Unfortunately, the time

series of data is very short. The results may therefore be biased as predicted by Maeso-Fernandez in 2004.

OPSOMMING

Ekonome en ontleders het die afgelope paar jaar merkwaardige hoeveelhede aandag gegee aan die fluktuasies van wisselkoerse wêreldwyd, insluitende diè van Suid-Afrika. Ekonome glo dat daar 'n langtermyn vlak bestaan waarna die geldeenheid sal konvergeer met die wisselkoers wat fluktueer in die korttermyn. Die doel van die studie is dus om 'n langtermyn ewewigswisselkoers te bereken vir die rand teenoor die geldeenheid van Suid-Afrika se hoof handelsvennoot, die euro.

Die ineenstorting van die Bretton Woods stelsel het die berekeninge van wisselkoerse aansienlik verander. 'n Meer onvoorspelbare monetere raamwerk het wêreldwyd gevolg asook in Suid-Afrika. Tot op hede het Suid-Afrika 'n formele inflasieteiken raamwerk en 'n vryswewende wisselkoersstelsel in werking.

'n Gedragspatroon benadering word gevolg om die ewewigswisselkoers te bereken nadat verskeie teorieë oor die ewewigswisselkoers, wat op verskillende aspekte van die ewewigswisselkoers fokus, geanaliseer was. Die ekonometriese tegniek wat toegepas word is die van direkte berekeninge van 'n enkel wisselkoers vergelyking. Die enkel, gedragspatroon vergelyking benadering is gekies vir sy eenvoudigheid en vir die feit dat huidinge veranderlikes wat die wisselkoers beinvloed geidentifiseer word deur die benadering.

Geidentifiseerde fundamentele veranderlikes sluit die BBP per kapita, die reële goudprys en die bruto reserves van die SARB in. 'n Vektor foutregstellende meganisme word gebruik in die berekening van die langtermyn verwantskap. Betekenisvolle waardes was gevind tot op die vierde sloering met een kointegreerende vergelyking op 'n 1 persent betekenisvolle vlak.

Die studie toon dat die wisselkoers fluktueer om die langtermyn ewewigsvlak en is huidiglik opmerklik naby aan die beraamde ewewigswisselkoers. Die neiging in die data is effens negatief wat toon op 'n ligte afname in die ewewig. Die huidige afstand tussen

die wisselkoers en die langtermyn ewewig is 'n positiewe ekonomiese aanduiding wat die huidige stabiele inflasie, lae werkloosheidsyfer en die groeikoers ondersteun.

Ongelukkig is die tydreeks van die data baie kort en mag die data eensydig wees soos voorspel deur Maezo-Fernandez in 2004.

To My Family

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CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

1.1 Introduction

After the breakdown of the Bretton Woods system in the 1970s, the reform of the international exchange rate system remained a global agenda. Many countries have suffered severe currency and financial crises, with an overwhelming toll on their economies, during the past few years. The views of many economists have changed with regard to exchange rate policies during the second half of the 1990s because of the financial and currency crises of emerging markets. Modern literature on exchange rate regimes for different countries emphasises the existence of both fixed and floating exchange rate regimes. The appropriate exchange rate regime for each country depends on the specific circumstances of the county, which includes the classic optimum currency area (Edwards, 2001).

The 1990s will be remembered as the decade of currency crises, including the Mexican crisis in 1994, the Asian crisis in 1997 to 1998, the Russian and Brazilian crises, both in 1999 and the Argentine currency crisis in 2001 to 2002. More traditional models suggest that currency crises are normally caused by deteriorating economic fundamentals and more recent models link crises to self-fulfilling prophecies and contamination effects (Savastano, 1999).

Many changes were brought about to the exchange rate regimes world wide, and in South Africa. Different regimes on floating exchange rate systems were implemented, significantly increasing fluctuations in the exchange rate. In May 1997 the speculative attack on the Czech crown turned out to be an eye opener for the policy makers on the importance of watching for early warning signals. These signals indicate that a mix of

economic policies is not consistent with economic development or with the exchange-rate regime. The development of a Czech FEER model gave valuable insights into understanding the dynamics of the Czech economy.

The issues related to exchange rate management became an important concern for economic reform in South Africa due to the rapidly changing environment. The real exchange rate signals intersectoral growth in the long run, and the level of the real exchange rate relative to an equilibrium real exchange rate, together with its stability, have an important influence on exports and private investment (Aron *et al.*, 1997).

Shocks that were experienced on the Rand from 1970 to about 1995 include significant gold price changes and political crises that led to capital outflows and intensified sanctions. From 1990, a more diverse and practical monetary policy framework was implemented, but large fluctuations were still visible in the weighted average of the Rand. A more stable period occurred eventually but lasted only until the beginning of 1996 when the Rand value dropped against the value of a basket of currencies. The Asian crisis added to the downfall of the Rand in 1997, followed by the Russian crisis in 1998. Adding to the list of problems, the Brazilian crisis in 1999 and the Argentinian crisis in 2001/2 also had an impact on currency instability. During 2000, a switch was made once again, this time to a formal inflation target and a floating exchange regime. The Rand was more stable but economists still expected the Rand to depreciate. Roux (2004) states that one of the lessons learned from all the above mentioned crises is that it does not work to try and manage the value of the exchange rate if there is pressure on it to weaken. In 2002, the Rand surprised them with stronger levels.

1.2 Problem Statement

Will the Rand depreciate gradually against developed country currencies including the US Dollar and the Euro, as generally expected, or will it follow its own power walk to stronger levels as it has been doing since 2002?

This question is one of the reasons for research on exchange rates in South Africa. Black (1994), comments on the current circumstances where we live in a world where exchange rates can fluctuate by 2 percent per day and 20 percent per year. No wonder economists evaluate the causes and consequences of such fluctuations.

Many articles written on the exchange rate of the Rand focused mainly on the depreciating trends of the Rand, and estimations of the real exchange rate were made mainly from a Purchasing Power Parity point of view. In 2004, MacDonald and Ricci evaluated the equilibrium exchange rate for South Africa with data up to 2002, in order to estimate the currency using the real effective trade weighted exchange rate as the dependent variable. Since then, the South African Rand has changed its path from a depreciating trend to an appreciating trend and shows stability at much lower exchange rate values. This has sparked much controversy, and many are of the opinion that the South African Rand is currently overvalued.

Studies done by Rogoff (1996), Sarno and Taylor (2002), and Cheung and Lai (2000), show that real exchange rates have a tendency to converge towards a stable rate in the long term. Studies that focus on real exchange rate movements over longer periods and real exchange rates between countries with similar economic structures and growth rates show these tendencies more clearly. Yet, Rogoff (1996) mentions that the elimination of differences between the actual real exchange rate and the equilibrium exchange rate might take a fairly long time (Rogoff, 1996).

With Europe being South Africa's biggest trading partner, it is important to keep a close eye on the Rand/Euro exchange rate. It is often said that the South African Rand also

follows the Euro valuation more rapidly than other currencies. To determine an equilibrium exchange rate between the Rand and the Euro will be helpful in making important economic decisions, for instance in connection with trade and the valuation of the Rand. A problem that might occur with the calculation of the Rand/Euro equilibrium exchange rate is the short time series of the Euro. With adequate data only available as from the 1990s, the limited amount of data might not give significant results.

1.3 Objectives and research

The aim of the study is not to predict the exchange rate between the South African Rand and the Euro, but to evaluate whether the currency is over or undervalued by determining a long run equilibrium exchange rate. By creating a framework to estimate the long-term fundamentals of the Rand/Euro exchange rate through a behavioural approach for the South African Rand versus the Euro, it will be possible to evaluate the impact on the current economic structure.

In order to reach the goal of the study, a number of secondary objectives are set, namely:

1. To understand the current South African exchange rate environment the importance of the different exchange rate regimes that were established in South Africa have to be taken into account to understand the current flexible exchange rate regime.
2. To analyse each equilibrium exchange rate theory and to choose the appropriate equilibrium exchange rate theory for the current South African situation. There are several theories on equilibrium exchange rates that focus on different aspects of equilibrium exchange rate determination.
3. To evaluate various estimation approaches to compute an equilibrium exchange rate with appropriate econometric techniques and choose an appropriate method.
4. To analyse the chosen data empirically and estimate a long term equilibrium level, with all the correct theories, estimations and techniques in place.

1.4 Methodology

The methodology of the study can be categorised as follows: a literature survey and an empirical analysis.

The literature study relied, amongst other things, on certain relevant research reports that were completed by international and national institutions including the World Bank, the International Monetary Fund (IMF), the South African Reserve Bank (SARB), the Journal of International Money and Finance, and research articles obtained from academic databases.

Different theories underline the models that estimate equilibrium exchange rates. Chapter 3 covers these different theories and chapter 4 makes a distinction between the different models. Based on the findings of chapters 3 and 4, the empirical analysis is carried out in chapter 5. The reduced form regression approach will be used to estimate an equilibrium exchange rate. This approach estimates the equilibrium exchange rate by estimating a single equation for the exchange rate as a function of medium-term determinants and key explanatory variables. Cointegration between the exchange rate and the variables will be analysed, and any misalignment between the two currencies will be indicated. This will determine whether the South African Rand is over or undervalued.

The method that will be used will be similar to that of MacDonald (2001), who estimated a behavioural equilibrium exchange rate for New Zealand. This is because New Zealand has similar economic characteristics to South Africa, including a small, open currency, and trading with the same major international trading partners and currencies.

1.5 Demarcation of the study

The study focuses on the long-term fundamentals that have an influence on the Rand/Euro exchange rate. Therefore it will not include other exchange rates. The study will include studies on purchasing power parity and uncovered interest rate parity, but will focus on the behavioural approach in estimation of a long-term equilibrium exchange rate. Chapter 3 will discusses this approach in detail.

1.6 Chapter Outline

Chapter 1 is an introduction to, and discussion on, the main problem to be addressed in the study. An overview of the study was presented by means of the problem statement, objective, methodology, chapter outline, and demarcation of the study field. What became evident is that the exchange rate deviates substantially in the short term, but not in the long term. The focus of this study is to determine an equilibrium Rand/Euro exchange rate in order to estimate the valuation of the South African currency.

The main aim of Chapter 2 is to understand the South African environment in which the monetary and exchange rate regime operates. A historical perspective will be provided in Chapter 2 on the operation of international monetary systems. This begins with fixed exchange rate systems including the Gold Standard, the Bretton Woods system, and the European monetary system. South Africa implemented these systems, but faced challenges in transforming to a flexible exchange rate system. The different phases experienced in this challenge are also discussed up to the current South African exchange rate regime.

Chapter 3 explains different theories for determining the equilibrium exchange rate. A large number of alternative approaches are currently available for determining an equilibrium exchange rate in order to estimate a possible misalignment. These models can

be distinguished by a few acronyms including BEER, DEER, FEER, PEER and NATREX. Each of these models will be discussed in detail in Chapter 3.

Chapter 4 discusses estimation approaches to compute an equilibrium exchange rate as well as econometric techniques to solve the equilibrium exchange rate equation. Because of the variety of theories, it is very important to find the correct estimation approach for the specific situation. The estimation approaches analysed are the complete macroeconomic model, the partial equilibrium model, and the reduced form regression equation.

In Chapter 5 the empirical study is executed. The chosen computer software is the fifth edition of EViews. Different combinations of the chosen fundamental variables will be tested for significant cointegrating coefficients. Exclusion tests will be used to determine whether variables or lags can be excluded from the chosen variable combination. Thereafter, the appropriate equilibrium exchange rate will be determined as well as the misalignment with the actual data.

Chapter 6 provides a short summary of this study as well as conclusions on the findings.

CHAPTER 2

OVERVIEW AND HISTORY OF DIFFERENT MONETARY SYSTEM AND EXCHANGE RATE REGIMES

2.1 Introduction

International finance deals with the complexities of international money changing. Many currencies are not free to float against each other. Due to these difficulties, exchange rates play a vital role in all international monetary systems. International monetary systems are classified according to the degree of flexibility of foreign exchange rates. Because exchange rates are determined within the milieu of an international monetary system, many currencies' ability to float against another is limited by their respective government or intergovernmental arrangements (Chacholiades, 1990:482).

According to ITRISA (2000), most countries today subscribe to a flexible exchange rate policy and the international monetary system represents the environment that facilitates the flow of trade-related payments and capital, the interaction of currencies, and the exchange of ideas and financial assistance at national and international level. Yet exchange rate regimes vary between countries. The regime depends on the circumstances of the country as well as the classic optimum currency area criteria. These factors indicate that, in order to choose a country's exchange rate regime, its history - and even more its inflation history - is important. In the process of stabilising inflation, many countries benefit from fixing their exchange rate.

The aim of this chapter is to fully explain the South African environment in which the monetary and exchange rate regime operates. In order to do so, history is recalled on exchange rate systems. The discussion begins with an overview of previous exchange rate regimes starting with the Gold Standard and its break-up in the 1930s. The Bretton

Woods system, initiated in 1944, which established the basic framework for the post-World War II international monetary system and, lastly, the European monetary system will be discussed. All of these systems took on a fixed exchange rate system. The chapter ends with a look at the South African situation, after the breakdown of the Bretton Woods system in the 1970s, where many challenges were faced and the transformation to flexible exchange rate systems was made.

2.2 Exchange Rate Systems

The exchange rate system of a country forms an important base for the functioning of other economic policy measures. Chacholiades (1990) defines an exchange rate as the price at which the national currency is valued against a foreign currency. Exchange rate systems have changed remarkably over time. From about 1870 fixed exchange rate systems were implemented, moving from the Gold Standard to the Bretton Woods system that was terminated in the 1970s. Thereafter, in 1973, most of the major currencies were allowed to "float" to a certain degree.

Each exchange rate systems will now be discussed in more detail.

2.2.1 Fixed Exchange Rate Systems

Before World War I, fixed exchange rates took the form of an international gold standard, where all the countries tied their currencies to gold allowing unrestricted import and export of gold. But, after World-War II, the world sought the advantages of the fixed exchange rate system and turned to the Bretton Woods System where the US Dollar was pegged to gold and the US was prepared to buy and sell unlimited amounts of gold at the official rate of US$35 per ounce of gold. Lastly, the European monetary system emerged in 1979 (Chacholiades, 1990).

These three fixed exchange rate systems will now be described.

2.2.1.1 The Gold Standard Period

The Gold Standard history can be traced back for many centuries. According to Salvatore (1998) the period known for the Gold Standard was between the years 1880 and 1914 but Chacholiades (1990) stipulates the years to be between 1870 and 1914. Nevertheless, the period 1870 to 1914 is regarded to be the most affluent period of the Gold Standard and is also referred to as the "classical Gold Standard", where virtually no capital movements were made (Bordo, 1993:225).

Under the terms of an international Gold Standard, countries tie their currencies to gold, allowing unrestricted imports and exports of gold. Each country's central bank stands ready to buy and sell gold freely at a fixed price in terms of the domestic currency. The private residents of each country are therefore free to export or import gold (Hill, 1999:295).

The core of the international Gold Standard is that the rates of exchange are fixed. Because countries defined the value of their currencies in terms of gold, provision was made for a system of fixed exchange rates in principle. The Gold Standard was also designed to bring balance of payment equilibrium in a country by influencing the price levels. Any country is said to be in balance of trade equilibrium when the income earned by residents from exports is equal to the money paid to people in other countries by the residents for imports. The Balance of Payments (BOP) mechanism appeared to be working smoothly and conflicts of policy among nations were exceptionally rare (Hill, 1999:296).

If individuals wished to make further payments to foreign parties under trade account deficit - that is where the value of imports exceeded the value of exports - their domestic currency had to be converted into gold and the gold was shipped. With the reduction of

gold, the domestic money supply would be reduced causing a contraction effect. Subsequent tightening of credit conditions and the raising of interest rates would discourage spending and the overall price level would drop. The lower domestic prices would, however, lead to more cost-efficient production of goods, followed by a reduction in imports due to the availability of cheaper domestic alternatives. Over time, this will reduce the current account deficit. This process to eliminate the BOP deficit is the adjustment mechanism of the Gold Standard and is known as the price-specie-flow mechanism (ITRISA, 2000:126).

Deficits were supposed to be settled in gold, but nations had limited gold reserves. These deficits could not go on forever, and had to be corrected quickly. For the adjustment process to work, nations were not allowed to sterilise the effect of a BOP deficit. On the other hand, the Gold Standard's rules of the game required that a deficit nation should reinforce the adjustment process by further restrictions on credit and a surplus nation should expand credit. Bloomfield (1959), found that the central banks did not really follow the rules of the game during the Gold Standard period; they sterilised payment imbalances, effectively shielding their money supplies from the BOP and this short-circuited the adjustment mechanism. Frank Taussig and his Harvard students found that, in the 1920s, the adjustment process seemed to work much too quickly and smoothly and there were few actual transfers of gold among nations. BOP disequilibria were thus settled mainly by international capital flows and not through gold shipments (Salvatore, 1998).

The Gold Standard reduced uncertainty and risk by stabilising exchange rates and was able to influence international trade performance positively. Over the four decades of the Gold Standard, world trade and investment flourished. This promoted international specialisation and global welfare (Chacholiades, 1990:489).

By 1880, most of the world's leading trading nations adopted the Gold Standard, including Great Britain, Germany, Japan, and the US (Hill, 1999:296). At the centre of the Gold Standard during that period was Great Britain, due to its leading role in both

commercial and financial affairs. Britain was the ultimate industrial nation, a significant importer of food and raw materials, the biggest exporter of manufactured goods, and the largest source of long- and short-term capital. London was the financial centre of the world in that period; Sterling came to be identified with gold and was freely accepted and generally used. Because a substantial proportion of world trade was financed with sterling, sizeable sterling balances were held in London. Britain, however, pursued a free-trade policy and acted as lender of last resort in times of exchange crisis.

Unfortunately, the Gold Standard did not really cover the entire world before World War I in 1914. Only the core of major European countries was on the Gold Standard and was maintaining fixed exchange rates. The exchange rates of less developed, primary-producing countries outside of the British Empire fluctuated widely due to shifts of foreign demand for their exports and sudden interruptions of capital inflows (Chacholiades, 1990).

After World War I, nations and scholars looked back on the pre-war Gold Standard with nostalgia. Today, it is impossible that the Gold Standard or anything similar to it could be re-established in the foreseeable future (Salvatore, 1999:680). The success of the Gold Standard can be seen as a myth in retrospect, because during the Gold Standard period from 1870 to 1914, the world economy did not experience any dramatic shocks. Take, for example, the World Wars I and II, the great depression in the 1930s, and the oil price increase from 1973 to 1974 that had a major impact on the world economy. The Gold Standard was not really put to the test. It existed during a tranquil period where the major trading countries experienced a broad synchronisation of fluctuations in the economy and parallel movements of their exports and imports, as individuals and as a group (Chacholiades, 1990).

In the ensuing years, exchange rates fluctuated chaotically, particularly in response to two great disturbances: World War I and the great depression.

2.2.1.1.1The Interwar Period

With the outbreak of World War I, the classical Gold Standard was abandoned. At first, the belligerent nations suspended convertibility of their currencies into gold and put an embargo on gold exports in order to protect their gold reserves. The shipping of gold under war conditions became too risky, and larger trading nations had to use a sizeable proportion of their gold reserves to finance the war effort. In an attempt to preserve gold, currencies were no longer allowed to be freely converted into gold and central banks took control of the gold reserves (ITRISA, 2000:127).

Private individuals could still trade one paper currency against another in the foreign exchange market, but at prices determined by supply and demand conditions. The fixed exchange rate system of the Gold Standard was succeeded by a purely floating exchange rate regime. Due to the fall of the Gold Standard, most countries experienced volatility in their exchange rates, which led to sharp rises in inflation.

Most nations viewed the regime of fluctuating exchange rates as temporary arrangements and fixed their attention on the problem of reforming the international monetary system. With the wild fluctuations in the exchange rates between 1919 and 1924, nations wanted to return to the Gold Standard. Gold, however, still valued at pre-war parities and, together with the rapid price inflations, a shortage of gold occurred.

In 1925, Britain re-established the convertibility of Sterling into gold and removed all restrictions on exports and imports. It was not long before other countries followed and went back to the Gold Standard. The new system was more in the line of a Gold Exchange Standard than a pure Gold Standard, where both gold and currencies convertible into gold were used as international reserves (Salvatore, 1998).

Widespread disagreements occurred as to where currency values should be set relative to each other. This led to inefficient functioning of the system. With the reintroduction, most countries wanted to keep their currencies at relatively low levels to make their

exports more competitive. With no agreement on the relative currency values, some countries allowed their currencies to float and others kept their currencies at specific levels through the intervention in the foreign exchange market of the governments concerned. This led to the overvaluation and undervaluation of some currencies, followed by large BOP deficits and surpluses (Bordo, 1993).

In 1931, the British had to suspend convertibility because of a run on their reserves. The system collapsed once again and the world was divided into three competing and hostile blocks. The Sterling block was organised around Great Britain, the Dollar block around the US, and the gold block was organised around France. Many other countries abandoned convertibility in total and enforced exchange control (Chacholiades, 1990:491).

2.2.1.1.2 The Impact of the Great Depression and World War II

Precipitated by the New York Stock Exchange crash of 1929, the start of the Great Depression of the 1930s facilitated a systematic return to the Gold Standard. The Depression proclaimed an era of low progress, poor trade performance, bank failures, and high unemployment throughout the world (ITRISA, 2000:128).

The decade of the great depression was a period of open economic warfare. As the depression deepened, governments pursued the hopeless game of competitive depreciations in the hope of eliminating their domestic unemployment and restoring external balance. In the period from 1931 to 1935, international cooperation reached its all-time low.

During the 1930s, no unified system of exchange rates was evident. Some countries floated their currencies and others reverted to the practice of anchoring their currencies to gold. In 1936, a sense of cooperation returned when Britain, France and the US signed the Tripartite Agreement. In terms of the agreement, France was permitted to devalue its overvalued Franc without retribution. World War II abruptly interrupted this cooperation

in 1939 and international monetary reform had to be postponed until the war was over (Chacholiades, 1990).

Before World War II came to an end during the early 1940s, a growing consensus developed among the Western powers that the inconvertibility of currencies was slowing down world trade and economic growth. Clearly the international monetary system needed new direction.

2.2.1.2 The Bretton Woods System

At the height of World War II in 1944, representatives for the United States, the United Kingdom, and 42 other countries held a conference in Bretton Woods, New Hampshire, in the US. South Africa was one of the representative countries. The main objective of the conference was to reform the international monetary system after the war (Salvatore, 1998:682).

With the impact of the Great Depression and the collapse of the Gold Standard fresh in mind, the idea of the conference was to build an enduring economic order that would facilitate post-war economic growth. The 44 representatives considered two plans: a British plan developed by Lord John Maynard Keynes and an American plan developed by Harry Dexter White of the U.S Treasury.

Keynes had called for the establishment of a clearing union, with overdraft facilities and the ability to create reserves. The clearing union should be able to create international liquidity based on a new international unit of account called the Bancor, which was to be used only on the books of the clearing union. Keynes feature plan was that both Bancor borrowers and Bancor creditors would pay interest on their balances. This was an attempt to place some part of the adjustment responsibility on surplus countries (Chacholiades, 1990:492).

However, the system the representatives finally approved was similar to the White plan, which later became known as the Bretton Woods system. The Bretton Woods era served the world for 27 years from 1944 to 1971.

The most important features of the Bretton Woods system were (Chacholiades 1990):

a. International institutions

The Bretton Woods conferees agreed that international monetary cooperation necessitates the creation of an international agency with defined functions and power (Chacholiades, 1990:492). In this case, they felt that a permanent institution was necessary to serve as a forum for international consultation and cooperation on monetary matters. The agreement reached at Bretton Woods established two multinational institutions: The World Bank and the International Monetary Fund (IMF). The World Bank had to promote general economic development. The IMF ensured that nations followed a set of agreed rules of conduct in international trade and finance. The IMF also provided borrowing facilities for nations experiencing temporary BOP difficulties. This provided the framework and determined the code of conduct for the post-war international monetary system (Eichengreen, 1993).

b. Exchange rate regime

Exchange rates were fixed in the short term, but were adjustable from time to time in the presence of "fundamental disequilibria". This combined general exchange rate stability with some flexibility (Chacholiades, 1990:492). In such a case, nations were allowed to change to the par value of their currency with the approval of the IMF. Fundamental disequilibrium was not clearly defined, but referred to large and continued BOP deficits or surpluses. Exchange rate changes of less than 10 percent were allowed without the approval of the IMF (Salvatore, 1998).

c. International monetary reserves

To provide smooth functioning of the adjustable peg system, countries required - both individually and in groups - large volumes of gold and currency reserves (Chacholiades, 1990:492). The Bretton Woods agreement demanded a fixed exchange rate system that was policed by the IMF with the agreement that all countries were to fix the value of their currency in terms of gold. The countries were, however, not required to exchange their currencies for gold (Eichengreen, 1993).

d. Currency convertibility

To enhance political harmony and economic welfare, all countries had to adhere to a system of unfettered multilateral trade and convertible currencies (Chacholiades, 1990:495). Nations were forbidden to impose additional restrictions on current international transactions; otherwise currency convertibility would not have much meaning. Counties were also not allowed to take part in any discriminatory currency arrangements or exchange control.

Only the US Dollar remained convertible into gold at a price of $35 per ounce. Gold was again given a fixed price but was only expressed in US Dollars. Other currencies were then assigned fixed prices in terms of US Dollars. The US Dollar was thus the only currency, which was directly convertible into gold, and the other currencies were convertible into US Dollars at a fixed rate (Chacholiades, 1990:493).

2.2.1.2.1 Weaknesses of the Bretton Woods System.

Pressure began to build up on the Bretton Woods System due to large deficits in the US BOP in the 1960s (van der Merwe, 2003:1). The use of gold as the ultimate reserve became a problem. Gold production was not keeping abreast of the growth in international trade. In the late 1960s and early 1970s, the first issues of Special Drawing Rights (SDRs) were given to member countries.

The SDR issues were in relation to the member's IMF quotas and gave countries the right to borrow in currencies in which they were short (Eichengreen, 1993:132). With the SDR development, it became apparent that the reserves held by most countries, either in the form of gold or US Dollars, were insufficient to sustain the prevailing rate of economic growth throughout the world.

The development of SDRs was seen as one of the most significant changes introduced into the Bretton Woods system. Sometimes referred to as paper gold, SDRs were accounting entries in the IMF books, and supplemented the international reserves of gold, foreign exchange, and reserve position in the IMF. SDRs were not backed by any currency or gold. They represented genuine international reserves that were created by the IMF (Salvatore, 1998:686). An SDR assigns an artificial value based on the average value of the world's major currencies, such as the US Dollar, the British Pound, the Japanese Yen and, more recently, the Euro. The allocation of SDRs to members is proportional to the members' quotas of reserves (ITRISA, 2000:133).

Although these had to be repaid, SDRs were an addition to international reserves and constituted an attempt to take some pressure off the US Dollar as practically the only source of world money. Countries began to supplement their gold reserves with considerable stocks of US Dollars and Pounds Sterling, leaving the US under increasing pressure to maintain the convertibility of such currency stock into gold.

Because of the BOP deficits Britain experienced, fears developed that the Pound would be devalued as a result of the country's poor economic performance. Speculative selling of Pounds made it very clear that the Pound was seriously overvalued. The US also started to experienced BOP deficits in the 1960s. This was due to massive expenditure on the Vietnam War and a rise in imports of competitively priced goods from the newly streamlined countries of Europe and Japan, accompanied by rising inflation. With a reduction in the gold reserves of the US in the late 1960s, a loss of confidence in the ability of the US to maintain US Dollar convertibility and in the US Dollar itself

occurred. This led to countries holding important currencies, other than the US Dollar, because they feared the devaluation of the US Dollar (Giovannini, 1993).

2.2.1.2.2The Collapse of the Bretton Woods System

The system of fixed exchange rates proposed at Bretton Woods served the world well until the late 1960s, when signs of strain began to show. As the demand for US Dollars decreased, and with the huge BOP deficit, the monetary authorities of the US concluded that the US Dollar must be devalued in 1971. As a result of these problems, the system of stable and fixed exchange rates was discarded in early 1973 and countries were required to fix the value of their currency against the US Dollar. The US monetary authorities could not unilaterally adjust the US Dollar value without the agreement of other countries to revalue the currencies relative to the US Dollar (Eichengreen, 1993).

With the rise in inflation and the worsening of the US foreign trade position, speculation rose in the foreign exchange market that the US Dollar would be devalued. It was not long before the US trade figures confirmed in 1971 that the US had been importing more that it was exporting since 1945. In August 1971, President Nixon of the US suspended the convertibility of the US Dollar into gold and announced the country's intention to devalue the currency. With the key currency under speculative attack, the Bretton Woods system could not function well. This could have been prevented if the US inflation rate remained low and they did not run a BOP deficit.

The breakdown history of the Bretton Woods system involved two interconnected processes: the development of an increasingly global system of production and finance, and the relative decline of the US within the Bretton Woods order and its move towards a new regime, based on the free movement of capital in order to maintain its position of global hegemony (Beams, 2001).

Unfortunately, the major financial nations of the world were not ready to accept the freely floating exchange rate regime. The Group of Ten, namely: Belgium, Canada, France,

Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the US, reached an agreement at the Smithsonian Institution in Washington D.C. on December 18, 1971. The agreement became known as the Smithsonian Agreement (Chacholiades, 1990:500).

The Smithsonian Agreement had the following major provisions:

a. The US increased the official gold price from $35 to $38 an ounce. The US, however, refused to re-establish the free convertibility of US Dollars into gold, but the US Dollar remained a reserve currency with all other currencies pegged to it. The system was therefore the US Dollar standard and paved the way for fixed exchange rates.
b. The remaining nations agreed to realign their exchange rates upward in order to cope with the overvalued US Dollar. The US Dollar was devalued by approximately 12 percent on the basis of a weighted average.
c. The exchange rate fluctuation was expanded to 2.25 percent from 1 percent in recognition of the volatile demand and supply circumstances in the foreign exchange market (Black, 1994).

Under the US Dollar standard, countries' monetary authorities held their reserves and settled their international debts in US Dollars. Without gold or anything else supporting the value of the US Dollar, the latter was vulnerable to diminishing demand and speculative attacks (ITRISA, 2000).

The Smithsonian Agreement did not fix any of the fundamental defects of the Bretton Woods system. The Pound Sterling had to return to a floating rate within six months. The US also had to raise the price of gold for a second time in February 1973. It rose to US$42.22 an ounce without restoring the free convertibility of dollars into gold. By March 1973, the world's major currencies started to float again and this led to the emergence of a new exchange rate regime. A system of managed floating exchange rates followed (Chacholiades, 1990:501).

The Bretton Woods system lacked a sufficient adjustment mechanism that nations would willingly use as a matter of policy. The US' BOP deficit persisted and damaged confidence in the US Dollar. The fundamental cause of the collapse of the Bretton Woods system is clearly in the consistent problems of adjustment, liquidity, and confidence.

Decades later, after the breakdown of the Bretton Woods system, the debates were still raging on over which exchange rate regime is best for the countries of the world. On the one hand, some economists supported a system where major currencies are allowed to float against each other. On the other hand, some argued for a return to a fixed exchange rate regime, somewhat similar to the Bretton Woods System.

2.2.1.3 The European Monetary System (EMS)

After the breakdown of the Bretton Woods system, European countries continued their efforts to coordinate their monetary policies and to prevent intra-European exchange rate fluctuation. In March 1979, the European Community put the EMS into operation. Members that participated were Germany, France, Italy, Belgium, the Netherlands, Luxembourg, Denmark and Ireland. They decided to fix their mutual exchange rates within certain bands and let their currencies fluctuate against the US Dollar within the EMS (MacDonald, 1999).

The EMS's main purpose was to encourage monetary stability in Europe. By 1994 the EMS was as a transitional step towards establishing the European Central Bank (ECB) and a common currency. In 1998 the ECB was established and was responsible for setting a single monetary policy and interest rates for the adopting nations.

At the beginning of 1999, European countries including Austria, Belgium, Finland, France, Germany, Italy, Ireland, Luxembourg, the Netherlands, Portugal and Spain adopted a single currency, the Euro. Derived from a basket of varying amounts of the

currencies of the European Union (EU) nations, the European Currency Unit (ECU) was a unit of accounting used to determine exchange rates among national currencies (Salvatore, 1995:659).

The Euro was formally established on 1 January 1999, and trading in the currency began on 4 January 1999. Although the Euro was a fully established currency from January 1999, Euro notes and coins were not to be issued until 1 January 2002. For most consumers and firms, the introduction of the Euro had the effect of establishing a fully fixed system of exchange rates (McDonald, 1999).

2.2.1.4 Conclusion

While fixed exchange rates had some early success, it was evident that a more volatile international financial environmental called for a different exchange rate regime. Since March 1973, exchange rates have become much more volatile and less predictable than they were in the period from 1945 to 1973. This volatility has been partly due to a number of unexpected shocks to the world monetary system such as: the oil crises in the 1970s, the loss of confidence in the US Dollar that followed the rise in inflation in 1977 and 1978, and the unexpected appreciation in the US Dollar between 1980 and 1985 (Black, 1985).

With all of these problems on the world economy, it is clear why the fixed exchange rate system collapsed. In January 1976, the flexible exchange rate system was formalised as a solution to the exchange rate system problems and this will be discussed in the following section.

2.2.2 Flexible/Floating Exchange Rate Systems

With flexible exchange rate systems, the central banks may intervene on a regular basis to eliminate wide fluctuations in the exchange rate. Other than that, the exchange rate is

determined daily in the foreign market by the forces of supply and demand, in other words: competitive market forces (Chacholiades, 1990:256).

With the formalisation of the flexible exchange rate system, IMF members met in Jamaica and agreed the rules for the international monetary system that are in place today. The Jamaica meeting was to revise the IMF Articles of Agreement so that they reflect the new reality of floating exchange rates. Main elements agreed on included abandoning gold as a reserve asset, the acceptance of floating exchange rates, and the increase of the total annual IMF quotas to US$41 billion – the amount that member countries contributed to the IMF (Hill, 1999:301).

A key feature of the Jamaican conference was the agreement that countries were free to choose the type of exchange rate system that best suited their own needs. Pegged and floating exchange rates were given equal status and countries were no longer obliged to maintain specific par values for their currencies. Countries were, however, urged to practise domestic economic policies that would encourage economic and financial stability (Chacholiades, 1990:455).

Broadly stated, floating exchange rate systems can be divided into two groups, free-floating exchange rate systems and managed floating systems. Each is subsequently discussed.

a.Free-floating exchange rate systems

Under the free-floating exchange rate regime, central banks do not intervene in the foreign exchange market. Central banks will rather allow private supply and demand to clear by themselves, and the values of foreign exchange rates are freely determined in the market.

This regime has the advantage that changes in nominal exchange rates should adjust to foreign and domestic shocks. High international reserves are not therefore required. The

free-floating exchange rate regime also has shortcomings. High nominal exchange rate volatility may distort resource allocation and monetary policy needs to be framed in terms of nominal anchors different from the exchange rate (Salvatore, 1995:655).

b.Managed floating exchange rate systems

Under the managed floating exchange rate system, the monetary authorities are able to smooth out short-term fluctuations while the underlying adjustment process takes effect. This system allows interference by the monetary authorities when they notice that current exchange rate movements will effect employment, inflation, and international competitiveness.

This exchange rate system is a guide to the underlying strengths or weaknesses of an economy and a tool to correct temporary imbalances. Industrial countries and some of the larger developing countries operate under a managed floating exchange rate system (ITRISA, 2000:110).

The meaning of managed floating may differ in different countries and different time periods. The effectiveness of managed floating depends on the government's ability to manage its exchange rate. This depends on the government's ability to manage reserves of foreign currencies, its ability to distinguish between reversible short-term influences and more fundamental ones, and the extent to which it is prepared to use monetary policy to influence the exchange rate rather than to pursue domestic policies such as the control of inflation (Pilbeam, 1998).

2.2.3Alternative Exchange Rate Regimes

Pure floating and fixed exchange rate regimes are only two of the possible exchange rate regimes that a county can choose, depending on the country's circumstances. According to Edwards (1999), there are many layers between these two extremes. Neither pure

floating nor fixed exchange rate regimes eliminate all the problems that came with modern-day globalised financial markets.

There are nine alternative exchange rate regimes, including floating within a band, sliding band, crawling band, crawling peg, adjustable peg, currency board, and full Dollarisation, ranked according to the degree of flexibility that they import to the economy and the relative stability they afford to the nominal exchange rate. The flexible exchange rate regime is the most flexible, followed by the managed floating exchange rate system. For more reading on these different exchange rate regimes refer to Salvatore (1995), Edwards (1999) and, Frankel (1999).

With a clear understanding of the difference between the floating exchange rate system and the managed floating exchange rate system, the South African situation can be examined. In the next section the monetary and exchange rate regime development in South Africa will be discussed.

2.3Monetary and Exchange Rate Regimes in South Africa

After being part of both the Gold Standard and Bretton Woods era, South Africa experienced major shocks during the period 1970 to 1995. These shocks include significant gold price changes and political crises that led to capital outflows and intensified trade sanctions. These shocks complicated exchange rate management and blurred the objectives of macroeconomic policies in South Africa (Aron *et al.*, 1997:2). Macroeconomic policies were aimed at different objectives at different times. For example, monetary and exchange rate policies. The focus was switched between the BOP and the anti-inflation stance.

South Africa also experienced current account deficits, financed by capital inflows, followed by periods of capital outflows and current account surpluses. These changes largely reflected political developments, which had an impact on the capital account and

thus on the adjustment process. Capital account deficits were experienced in the aftermath of the Sharpeville slaughter in 1960, the Soweto riots of 1976, and the long-lasting period of political unrest beginning in the second half of 1984 (Aron *et al.*, 1997:5).

Since the termination of the Bretton Woods System, the South African Reserve Bank (SARB) has operated different monetary and exchange rate policy regimes from 1970 to 2000. According to Dr. Ernie van der Merwe (2003), South Africa has experienced four distinct phases, or decades, of exchange rates and monetary arrangements in this period. This period also included a considerable degree of financial and external liberalisation, where external liberalisation included both trade reforms and capital control liberalisation (Jonsson, 2001:244). Each of these phases is subsequently reviewed:

2.3.1 The First Phase

The 1970s saw a phase of direct monetary controls and the desire to maintain some stability in the exchange rate of the Rand because South Africa's exchange rate policy mirrored volatile developments on the international front.

Between 1970 and 1979, the Rand was pegged to either the U.S. Dollar or the Pound Sterling. Frequent adjustments were made to the level of the peg in the form of discrete step changes (Jonsson, 2001:244). At first, when authorities were forced to adjust the country's exchange rate regime, the SARB devalued the Rand and pegged it to the US Dollar. This was because the relatively undeveloped domestic market in foreign exchange did not permit a floating exchange rate, and most of the foreign transactions were denominated in US Dollars. In June 1972, the Rand linked to Sterling because the value of the Pound Sterling fell against stronger currencies. South Africa saw an opportunity to maintain a recovery in the BOP. This, unfortunately, did not last long because only four months later the Rand was pegged once again to the US Dollar because of the continued

downfall of Sterling that was irreconcilable with domestic economic objectives (van der Merwe, 2003).

June 1974 saw the adoption of an "independent managed floating" policy to reveal the changes in South Africa's underlying BOP and domestic economic environment (van der Merwe, 2003:3). Frequent but small adjustments were made to the middle market rate of exchange with the US Dollar. Between June 1974 and June 1975, 11 adjustments were made. Following speculative pressures on the Rand, the SARB pegged the rate to the US Dollar once again in June 1975 (Aron *et al.*, 1997:2). Authorities announced that the Rand-US Dollar rate would be kept constant for longer periods and adjustments were only allowed when it was considered to be crucial in terms of basic changes in either the domestic or international situation.

Reasonably restrictive exchange control measures were applied to each exchange rate regime, which were relevant both to transactions by residents and to the repatriation of foreign investments. Exchange controls severely restricted the capital flows of residents, while non-residents had to place the proceeds from sales of South African assets in blocked Rand accounts, which could only be freely transferred overseas after five years (Jonsson, 2001:244). Other direct monetary controls were applied in addition to exchange control in order to maintain the parity of the Rand as well as low interest rates for mortgage bonds and agricultural loans. These controls included ceilings on bank credit to the private sector, deposit rate controls, import deposits, and hire-purchase controls.

The first phase, however, was unsuccessful in terms of price stability, BOP equilibrium, economic and employment growth. It also initiated an investigation into the monetary system and led to succeeding findings by "The Commission of Inquiry into the Monetary System and Monetary Policy in South Africa" known as the De Kock Commission. The findings include that deficiencies in the monetary system were: (van der Merwe, 2003:6):

a. The system did not control the rates of increase of monetary aggregates sufficiently.
b. Disintermediation and reintermediation practices were being applied and caused market variation in the velocity of movement of money.
c. Interest rates were not allowed to adjust to appropriate higher levels in order to attain more moderate and stable growth in both bank credit extension and money supply.
d. Both spot and forward rates of the Rand were kept from adjusting to levels that would have contributed to the suitable level of monetary demand.
e. Speculative capital outflows increased when the Rand moved with the US Dollar for long periods at a time. Domestic economic conditions were excluded because the Rand-US Dollar peg was changed only occasionally.
f. A heavy dependence was to be found on exchange control. This was an economically unproductive way of rationing the accessible foreign exchange among the various domestic users, which deterred the inflow of foreign capital.

2.3.2 The Second Phase

In the 1980s, a transition was made to more market-oriented measures and money supply targets, implementing the recommendations of the De Kock Commission (van der Merwe, 2003:6). Adjustments of short-term interest rates were made in an attempt to enhance the responsiveness of monetary aggregates to macroeconomic developments (Jonsson, 2001:244). At first, deposit rate controls were abolished followed by the abolition of bank credit ceilings. A relaxation and simplification of exchange control was instigated but, in 1985, authorities were forced to re-establish strict exchange control measures and to put a hold on repayments of foreign debt due to sanctions against the country.

A managed float, but dual exchange rate system, namely the Commercial Rand and the Financial Rand, was in place between 1979 and 1983. This applied exchange control

over non-residents. Financial transactions by non-residents were valued at a discounted exchange rate, the "Financial Rand mechanism", and current account transactions were valued at the Commercial Rand exchange rate (Jonsson, 2001:244). In February 1983, exchange control over non-residents was abolished and the Financial Rand disappeared, leaving South Africa with a unitary exchange rate system that lasted only for a short period. This was accompanied by the downscaling of liquid asset requirements, and dismantling of interest rate controls.

In 1985, the debt standstill was introduced when South Africa declared a moratorium on most of its debt obligations in consequence with the political disturbances in the mid-1980s. This led to a number of international banks refusing to roll over short-term loans to South Africa. The ensuing financial sanctions resulted in a debt standstill. The 1985 crisis was more severe than previous crises; no new loans were being granted and previous debt had to be repaid in terms of the debt rescheduling agreements. The situation was exacerbated by the fact that at the time of the debt crisis, approximately 72 percent of South Africa's debt, standing at 42 percent of GDP, was short term in nature (Aron *et al.*, 1997:5). This led to the reintroduction of the Financial Rand, which once again led to a dual exchange rate system where capital controls were effectively tightened. This system was operational for the rest of the 1980s.

The Financial Rand system was based on exchange control rulings and gave the SARB the power to interfere in the market by changing these exchange control rulings. Although the SARB could directly interfere in the market by selling/purchasing Financial Rand to manipulate the Financial Rand market, most transactions took place without interference from the SARB. The exchange rate of the Financial Rand was determined under reasonably free conditions. The thin market made this rate highly volatile (Aron *et al.*, 1997:2).

Neither interest rates nor exchange rates can be determined independently from the money supply, or from each other. Thus, due to the flexibility in the exchange rate together with the flexibility produced in the determination of interest rates, an opportunity

was created for authorities to introduce formal monetary targets in 1986 (van der Merwe, 2003:10).

Unfortunately, monetary targeting was implemented in a period of decline in the gold price and other commodities. Droughts in the country, together with social unrest and strikes, contributed to this difficult period. The international constraints on economic development through trade boycotts, the disinvestment campaign, and withdrawal of foreign loans from South Africa forced political changes. The economic growth rate dropped to low levels together with foreign reserves. The BOP experienced severe damage, budget demands increased, the proportion of shortage before borrowing widened, and unemployment rose. All this left monetary and other policy measures to focus on demand management in the short term. This ensured that foreign debt obligations were met without default, and that domestic expenditure was supported. Interest rates were kept at low levels to reduce unemployment. In the end, price stability was no longer a main priority to the authorities (Aron *et al.*, 1997).

2.3.3 The Third Phase

This phase focused on informal inflation targeting and a managed floating exchange rate regime in the 1990s (van der Merwe, 2003:11). Remarkable changes were made in the 1990s due to the successful completion of socio-political restructuring; South Africa was released from international disciplinary actions because of the empowerment of the Government of National Unity in April 1994, and was reintroduced into the world financial system. Following the general elections in 1994, the new government intensified liberalisation.

After the authorities took on a policy of gradually relaxing exchange controls, the dual exchange rate system was terminated in March 1995, eliminating almost every exchange control restriction on non-residents. Exchange controls on residents were relaxed in the

second half of the 1990s, with limits remaining only on certain transactions. Moreover, trade tariffs were lowered and exports and imports grew sharply (Jonsson, 2001:244).

The SARB focused monetary policy on a long-term view to create higher economic growth in the financial environment. Because of the emphasis on reducing inflation, this monetary policy framework can be described as an informal inflation-targeting framework. Although a target was set for inflation, no time period was specified in which to obtain the target. In order to protect local producers against international competition, the aim was to gradually bring the domestic inflation rate into line with the average inflation rate of major trading partners. This would avoid periodic disrupting adjustments in the Rand's exchange rate (Aron *et al.*, 1997).

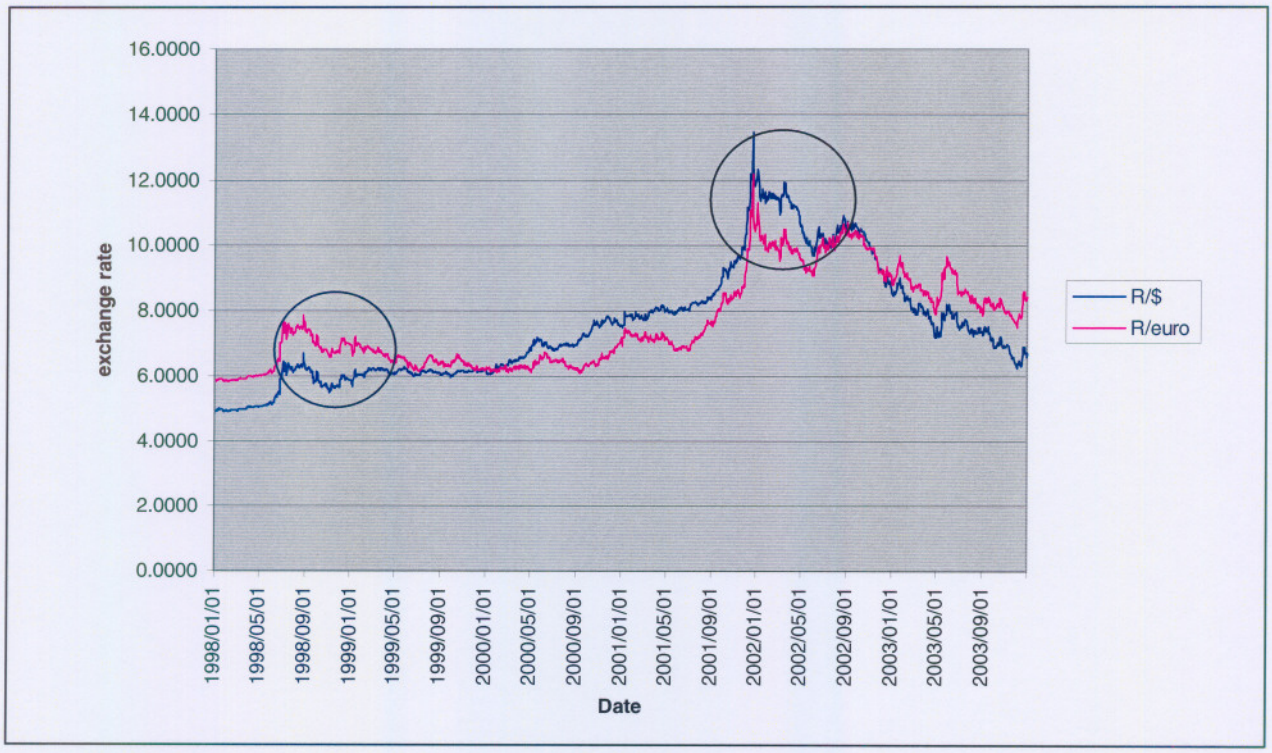
The informal inflation target, however, did not increase the transparency and accountability of the monetary policy (van der Merwe, 2003:14). This target differed from formal inflation targeting, where the growth in money supply (an intermediate target) anchors monetary policy decisions. Because of the domestic and international environment that had changed, it soon appeared unwise to place too much reliance on money supply to guide monetary policy. Money supply became difficult to control due to the operations of foreign banks and the easy access of domestic banks to financial resources. Money supply targets were soon referred to as money supply guidelines but, because most guidelines were missed, it became obvious that control was not possible without taking an undesirable stand on monetary policy.

Large increases in the money supply occurred during the liberalising and reintegrating process of South Africa into international financial markets. These were unrelated to spending on real goods and services. While the income velocity of circulation of the money supply declined and more money became available for every unit of goods and services in the country, inflation started to decline. The rise in money supply had no impact on inflation. This contrast led to an unstable relationship between money supply growth and inflation and limited the value of money targets for monetary policy purposes (van der Merwe, 2003).

The SARB switched to a diverse or practical monetary policy framework at the end of 1990. Furthermore, the SARB intervened, mainly on its own initiative, in both the spot and forward markets in order to influence supply and demand conditions in the domestic market in foreign exchange and to smooth short-term fluctuations in the exchange rate. The Bank, however, did not target the exchange rate; market forces were used to determine the level of the exchange rate of the Rand. Regardless of active intervention, large fluctuations were visible in the weighted average value of the Rand (Aron *et al.*, 1997).

The Rand cracked in February 1996 after a stable period. The effective exchange rate of the Rand depreciated by approximately 8 percent between end March 1996 and April 1996. By May 1996, the prime rate reached 20.50 percent. In the first 6 months of 1996, the Rand lost 15.7 percent of its value against a basket of currencies. The currency's problem paved the way for the Growth, Employment and Redistribution plan (GEAR) from a political perspective (Roux, 2004:18). When GEAR was introduced, a change in outlook towards the Rand occurred and the Rand kept its ground in 1997 during the early days of the Asian crisis. Unfortunately, this did not last long because, in the first couple of months in 1998, the Rand cracked once again and lost approximately 8 percent of its value. The Russian crisis, coupled with the SARB governor's end of term, sucked South Africa back into the vortex with the Rand loosing 23.2 percent of its value against the US Dollar from May to July in 1998 (Stein, 2002). Figure 2.1 shows the Rand-US Dollar and Rand-Euro daily exchange rate from 1998 to 2003 and the decline in the value of the Rand in 1998 is evident from this graph.

Figure 2.1:Rand-US Dollar and Rand-Euro daily exchange rate (1998-2003)



Source:SARB

Emerging market crises like the Brazilian crisis in 1999 and the Argentinian crisis in 2001/2 had a negative effect on world financial stability and also affected the value of the Rand. This is also shown in Figure 2.1. Stein (2002) stated that a lesson could be learned from all these crises; trying to manage the value of the exchange rate does not work if there is pressure on it to weaken.

2.3.4 The Fourth Phase

In February 2000, the SARB implemented a formal inflation target and a floating exchange rate regime. This framework was applied because (van der Merwe, 2003:18):

a. An anchor/ultimate objective was provided for monetary policy decision-making.

b. Better coordination was promoted between monetary and other policy measures.

c.It enhanced monetary policy transparency, which increased its effectiveness.

d. Monetary policy was more focused and the system's clear rules and procedures strengthen the accountability and governance of the central bank.

The introduction of the new monetary policy regime was also a result of the large fall in inflation during the 1990s. Annual growth in the underlying consumer price index fell from 18 percent in 1991 to 13 percent in 1993 and further to 7 percent in 1998. Thus, by 2002, the inflation target was set at an average rate of increase of 3 to 6 percent in the overall consumer price index (CPIX) (Jonsson, 2001:243). Price changes in metropolitan and other urban areas were included to use the most comprehensive price index in South Africa for setting the target. Mortgage interest costs in metropolitan and other urban areas were excluded. The inflation target was set in a range, leaving the central bank with some discretion on deciding on its stand on monetary policy.

Adopting an inflation target specifies the prevailing or primary objective of the central bank and that monetary policy cannot make a contribution directly to economic growth or employment creation. A stable financial environment policy contributes to economic development. The application of an inflation-targeting monetary policy framework expands monetary policy credibility by informing the public of the forward-looking approach. The preventative character of inflation targeting avoids wide fluctuations in prices, output and interest rates (Van der Merwe, 2003).

Sharp adjustments in the exchange rate may disturb financial stability and can force countries to take on inflation targeting combined with an inflexible or strictly managed exchange rate regime. South Africa took on formal inflation targeting combined with exchange rate flexibility because the central bank had no specified target for the exchange rate of the Rand, and not because the SARB was unconcerned about the impact of the exchange rate of the Rand on inflation The value of the currency was determined by supply and demand on the domestic market for foreign currency. The SARB exercised cautious management of its balance sheet and did not participate in buying and selling

foreign currencies in the market to keep the exchange rate of the Rand at a specified level or interval (Van der Merwe, 2003).

The formal inflation target with a floating exchange rate regime has been applied for five years now and a few concerns regarding the effectiveness of the regime in the South African environment come to mind. In the South African environment, exchange rate controls were gradually reduced and liberalised, and the question arose as to whether this was wise. South Africa has an emerging-market economy and inflation targeting is sometimes considered to be less appropriate for an emerging-market. Serious doubts exist about the effectiveness of inflation targeting. The process of the floating exchange rate regime is also a concern. Would it be better to apply a fixed exchange rate system? A preliminary conclusion can be drawn on each of these concerns. This is discussed under the headings of exchange controls; inflation targeting and, exchange rate regimes (Van der Merwe, 2003).

2.3.4.1 Exchange Controls

The motivation behind applying exchange controls is based on the assumption that they effectively regulate capital flows. Empirical evidence shows that different methods have been used to evade these controls, for example the under invoicing of exports and over invoicing of imports. Clearly capital controls in South Africa were not fail-safe, but exchange controls had some success in regulating capital flows. Even though exchange controls were fairly successful in keeping domestic savings inside the country, there were a few disadvantages (Van der Merwe, 2003:25). Monetary policy operates effectively if a close relationship is maintained between money supply, interest rates and exchange rates. To achieve this under exchange control is very difficult. Exchange controls deformed domestic interest rate levels at times, and discouraged foreign investments in South Africa. Furthermore, a large number of people are needed to administer exchange controls, incurring significant direct costs for both the central bank and for the private sector.

As a result of these disadvantages and the difficulty of applying exchange controls effectively, South African authorities decided to liberalise capital controls. The process was implemented gradually because an abrupt approach might have led to a huge outflow of capital. Gradual implementation allowed absorption of the consequences of relaxations before further steps was taken. The economy also had more time to adjust to the shocks created by the elimination of capital controls and the country achieved flexibility in the management of large and volatile international capital flows (Aron *et al.*, 1997).

2.3.4.2 Inflation Targeting

Over the last several years, support for conducting monetary policy increased with the help of specified inflation targets. The enthusiasm for inflation targeting extended to open and developing economies (Woglon, 2003). Inflation targeting may be seen as less appropriate for emerging-market economies for many reasons including (Van der Merwe, 2003:29):

a. Emerging-market economies are, in general, relatively open and more sensitive to elements such as external shocks, which complicate the implementation of inflation targeting.
b. Emerging markets are normally dependent on international capital flows, which have a marked impact on these economies.
c. Emerging markets have less-developed financial infrastructure.
d. Central banks in these economies do not have the self-sufficiency to apply an inflation-targeting framework in a credible manner.

Despite these characteristics, the South African government and the Reserve Bank successfully introduced and applied the inflation-targeting framework through sophisticated information and communication systems. The inflation target is set by both the government and the central bank to coordinate policy measures.

The effectiveness of inflation targeting is still a question. Since the introduction of the formal inflation-targeting framework in February 2000, a target was specified for one year only, the year 2002. On 20 March 2003 the Monetary Policy Committee indicated that the target was not met largely due to events that could not have been foreseen and which were beyond the control or influence of monetary policy. Four factors that were mainly responsible for the high rate of increase in the general price level (van der Merwe, 2003:33) are:

a. An increase in the risk-aversion of international investors coupled with leads and lags in payments for imports and exports. These occurred due to a sharp depreciation in the external value of the Rand. This depreciation was related to the contagion effects of the political situation in Zimbabwe and financial stability problems in emerging markets.
b. Food prices increased by 16.7 percent in 2002 due to the depreciation of the currency and a drought experienced by countries in Southern Africa.
c. The increase in international oil prices due to the possible US-led attack on Iraq and disturbances in the supply of oil following general strikes in Venezuela.
d. Administered prices increased, which have a weight of about 25 percent in the CPIX (consumer price index for metropolitan and other urban areas excluding mortgage interest costs).

The inflation target has been challenged by a number of external shocks beyond the control of monetary policy. When the inflation rate started to accelerate and it became clear that the inflation target would not be met, measures were taken to bring the rate of increase in CPIX within the target. In 2002 the repo rate, the SARB's official lending rate, was increased by 400 basis points to slow inflation. Even though these corrective measurements could have been taken in an informal inflation-targeting framework, or under the targeting of monetary aggregates, they would not have been taken so soon. Thus inflation targeting offers an option where decisions can be taken earlier. According to Woglon (2003), the SARB has acted flexibly and wisely in responding to the shocks.

Another advantage in the application of inflation targeting in South Africa is that the transparency and accountability of monetary policy has increased (Jonsson, 2001:243). The public was informed about certain monetary policy decisions immediately after each meeting. Meetings were held regularly. In addition, the forecasting models of the SARB have been improved significantly due to the introduction of inflation targeting, the revision of econometric techniques, and the model structure to smooth the progress of decision making. Policy measures must be forward looking to be most effective and, for that reason, the prediction of inflation is very important in monetary policy implementation.

With knowledge of the advantages and disadvantages of inflation targeting, international consensus indicates that the practice appears to be growing. Inflation targeting is proposed to provide benefits in terms of a credible commitment to control inflation along with the more reliable and conventional conduct of monetary policy. It is desirable to make the SARB's flexible response to exchange rate movements more transparent and it is feasible if the SARB would be willing to invoke explicitly the escape clause and to communicate how policy will be guided in the interim (Woglon, 2003).

2.3.4.3Exchange Rate Regimes

After adopting the freely floating exchange rate regime with the inflation-targeting monetary policy framework, the South African Rand has experienced some ups and downs in its exchange rate. The nominal effective exchange rate of the Rand decreased by 12,5 percent in 2000 and 34,5 percent in 2001, but increased again by 26 percent in 2002 and 19 percent in the first quarter of 2003 (Van der Merwe, 2003:35).

The real effective exchange rate in 2002 was 25 percent weaker that the previous year and 45 percent more depreciated than its average 1995 level (MacDonald & Ricci, 2003:3). Even though the Rand appreciated under the managed floating exchange rate system during the 1990s, the recovery in 2002 was the first time in the past 30 years that

such as sharp reversal in the exchange rate of the Rand has occurred (Van der Merwe, 2003:36). It was generally expected that the Rand would depreciate steadily against developed country currencies such as the US Dollar and the Euro, but from the end of 2002 the Rand recovered strongly against both the UD Dollar and the Euro, also to be seen in Figure 2.1.

The recovery of the Rand could be related to sound macroeconomic policies pursued consistently by the authorities, fairly high interest rates, uncertainties about economic conditions in most of the advanced economies, and a general flow of funds to emerging-market economies. These wide fluctuations in the exchange rate of the Rand complicated the decision-making process concerning monetary policy.

Under a freely floating exchange rate regime, South Africa would still prefer a stable exchange rate. When it comes to the choice between general economic stability and exchange rate stability, general economic stability is considered to be far more important. Thus, to achieve exchange rate stability, South Africa must apply healthy macro and micro economic policy measures. Unfortunately, it is difficult to achieve this goal due to large swings in international capital flows, mainly caused by developments in other countries. The following points explain why South Africa stays with a flexible exchange rate regime rather than a more stable fixed exchange rate regime (van der Merwe, 2003:37):

a. Authorities had to change to a flexible exchange rate approach after the failure of attempts to sustain a more fixed exchange rate system by pegging the Rand to the US Dollar, Sterling, and a basket of currencies.
b. South Africa does not have all the characteristics that are normally considered vital to accomplish and maintain a more fixed exchange rate regime. These characteristics are, for example: a small country relatively open to foreign trade, high labour mobility, available fiscal measures to cushion fluctuations in the business cycle, adequate levels of foreign exchange reserves, a well-supervised and regulated financial system, a

business cycle correlating closely with that of the country to which the currency will be linked, and the desire to integrate with a larger trading partner or currency area.

c. It is impossible to obtain complete exchange rate stability with floating exchange rates. The Rand could, however, be pegged to one foreign currency, such as the US Dollar, to which some other currencies may also be linked. The Rand could also be pegged to a basket of currencies, but would then float against all of them. Floating is unavoidable in one form or another in the present circumstances.

d. With Dollarisation, a currency board, or fixed pegging, monetary policy flexibility is lost. The authorities of the country to which the domestic currency is pegged determine interest rate levels. Changes in interest rates will therefore be based on developments in another country without necessarily taking domestic economic conditions into consideration. This might lead to unstable conditions in the domestic economy reduced economic growth and employment creation.

2.3.5 Conclusion

The first phase of the exchange rate regimes was a phase implementing direct monetary controls. Volatile developments on the international front were notched by the desire to maintain some stability in the exchange rate of the Rand. This failed to succeed in terms of price stability, BOP equilibrium, and economic and employment growth.

The second phase, covering the 1980s, saw the transition to a more market-oriented measurement and the setting of money supply targets. It also saw the implementation of the findings of the De Kock Commission. The third phase, the 1990s, focused on informal inflation targeting and a managed floating exchange rate regime. Remarkable changes were made due to successful completion of socio-political restructuring projects.

South Africa can be seen as a relatively open commodity-based economy, dependent on fluctuating international capital flows. Yet South Africa still fulfils the requirements for successfully implementing inflation targeting. Unfortunately, the target was not met in the first year due to unexpected actions that could not have been foreseen and that were beyond the control of monetary policy.

Exchange control restrictions had to be removed in a gradual manner because they were inconsistent with the effective application of monetary policy. In addition, they distorted domestic interest rate levels, deterred foreign investments, and had significant direct and indirect costs. Because international capital flows fluctuate widely, exchange controls that could change the composition of capital flows could be useful in creating stability if they were applied on a temporary basis. Unfortunately these restrictions tend to remain for long periods.

The liberalisation of exchange controls has led to sharp fluctuations in the exchange rate of the Rand. The recent wide fluctuations in the exchange rate of the Rand have complicated the task of the monetary authorities. Some of the fluctuations in the capital flows were not connected to domestic economic developments or policies, but were due to circumstances in other countries. These made the task of the monetary authorities even more complicated. Under present international arrangements it seems important that monetary policy be aimed consistently at the achievement of financial stability. Fluctuations, however, must be accepted in a world of floating exchange rates because it is impossible to obtain exchange rate stability under present circumstances. Even in the case of pegging the Rand to another currency or to a basket of currencies, Dollarisation, or a currency board, the Rand would still float against most currencies. Exchange rate stability can only be accomplished with a major revision of the international exchange rate regime.

2.4 Summary

Exchange rates form an integral part of international monetary systems, which are classified according to the degree of flexibility of foreign rates. Government or intergovernmental arrangements play a vital role in a currency's ability to float against another. The aim of this chapter was to understand the current monetary exchange environment in South Africa.

A brief background on both fixed and floating exchange rate systems was presented. Previous exchange rate regimes discussed under fixed exchange rate systems included the Gold Standard, the Bretton Woods system, and the European monetary system. It was shown that a changing environment necessitated a new framework for floating exchange rates

The focus fell on the South African situation with all the challenges faced and the transformation that was made to the current flexible exchange rate system. South Africa moved from a phase with direct monetary controls having the objective of maintaining stability in the exchange rate of the Rand to more market-oriented measures with money supply targets. A period of informal inflation targeting and managed floating of the Rand followed. Lastly, South Africa adopted a formal inflation-targeting monetary policy framework and a floating exchange rate regime.

While this chapter presented the environment in which this study takes place, the next chapter focuses on different theories to determine the equilibrium exchange rate.

CHAPTER 3

EQUILIBRIUM EXCHANGE RATE THEORY

3.1 Introduction

In the short term, foreign exchange rate movements appear to be inconsistent. When focusing on the medium to long term, economists believe that existing basic forces, called 'fundamentals', push a currency's exchange rate towards an equilibrium exchange rate. The real exchange rate is an important relative price that signals intersectoral growth in the long term. The level of the real exchange rate, relative to an equilibrium real exchange rate level and its stability, has been shown have an important influence on exports and private investment (Aron *et al.*, 1997:1).

Some concept of equilibrium is needed as a standard against which to measure actual exchange rate changes. This chapter focuses on different models for determining the equilibrium exchange rate. Currently, many alternative approaches are available for evaluating whether or not a currency is misaligned. These models are known by acronyms such as BEER, DEER, FEER, PEER, and NATREX. These models will be discussed in this chapter and their meanings explained.

3.2 Fundamental equilibrium exchange rate (FEER)

The Mundell-Fleming framework defines the fundamental equilibrium exchange rate (FEER) as the real exchange rate achieving both internal and external balance by some date in the medium-term future. This will allow the use of the interpretation of the equilibrium that is suitable for a transition country, which can go through a period of short-term imbalances, to catch up with the developed world without loosing the prospect

of a medium-term external balance. The FEER approach seems to be superior to the results of partial analysis that consider only trade balance equilibrium as a benchmark.

John Williamson introduced the concept of FEER in 1985. The term "fundamental equilibrium exchange rate" was established to accentuate the idea of what a country's exchange rate should be, thus, moving the focus away from momentary market equilibrium. An overvalued exchange rate would imply deflation in the economy or an untenable payment deficit. The contrary applies for an undervalued exchange rate. Clearly a fundamental equilibrium holds where neither of these undesirable outcomes exist (Williamson, 2003).

Many economists have used the FEER approach. Well known contributors are Williamson (1994), Barrel and Wren-Lewis (1989), Artis and Taylor (1995), and Barrell and Sefton (1997), Isard and Faruqee (1999), and Hinkle and Montiel (1999). Unfortunately, there is a considerable amount of uncertainty attached to FEER calculations. Assessing a currency as over or undervalued must be done with caution in relation to a calculated path or level for FEER.

Chronic themes that need to be taken into consideration with FEER calculations are: (i) the magnitude of income and price elasticity for import and export that might lead to unreasonable estimates for FEER, (ii) the properties of the macroeconomic model must be chosen carefully to be uncomplicated and transparent, and (iii) the specification of internal balance must be given a great deal of thought (Akram *et al.*, 2003).

3.2.1 Overvaluation and Undervaluation of a Currency

A tentative conclusion can be drawn as to whether an exchange rate is overvalued or undervalued in fundamental equilibrium through a rapid examination of a country's macroeconomic situation. A currency is undervalued when the economy of the country is overheating and experiences a larger current account surplus than is needed to sustain its

BOP position for the foreseeable future. This is also true for a reduction in the current account deficit. On the other hand, if the economy suffers from underemployment and a loss of reserves because of a current account deficit that is larger than that which can be financed by sustainable inflows, the currency is overvalued. However, the situation is more complex when different indicators point in different directions. This is when the use of a macroeconometric model - of some kind - is very important to reach a judgment (Williamson, 2003).

When the economy of a country is overheating, but the country has an unsustainable BOP deficit, the question arises as to what would happen if excess demand had been eliminated. When the use of a model indicates that the elimination of excess demand pressure would improve the BOP, the currency is not overvalued. It is therefore conceivable that, when the economy has reached an internal balance, the payments position might be in an unsustainable surplus, and the currency in this case would actually be undervalued (Williamson, 2003).

FEER is associated with underlying balances where economic forces have been worked out. This equilibrium exchange rate is consistent with ideal macroeconomic balance, meaning simultaneous internal balance and external balance in the economy, and will change gradually over time. Both the internal balance and the external balance have a normative element, because internal balance (Williamson, 1994:179) implies the recognition of historical wage rates and effective demand that can achieve the highest level of economic activity, given controlled inflation. External balance (Williamson, 1994:180) is normally defined in terms of a current account target, with the minimum criterion being the sustainability of the BOP.

Once the currency of a country is recognised as being misaligned, the degree of misalignment must be determined using a quantitative macroeconometric model that might be basic or even implicit. The model needed is one that can explain current account outcomes with a measure of economic activity and the real exchange rate. This allows the calculation of the real exchange rate. This is the rate that is needed to obtain a target

current account with a normal and sustainable level of activity. The change in the nominal exchange rate must be estimated to achieve the desired change in the real exchange rate, given that inflation can occur with depreciation, which will reduce the change in the real exchange rate (Akram *et al.*, 2003).

Exchange rates are, naturally, the business of more that one country. Where small countries are allowed to choose their exchange rates without any disturbances to the larger countries, the larger countries must recognise that their partners have a rightful interest in what they choose. This is because the choices they make will influence those partners' effective exchange rates. This emphasises the fact that FEERs need to be calculated simultaneously for all the larger countries.

3.2.2 Modelling the FEER

An FEER can be calculated either on an ex ante basis, anticipating a path to future internal and external balance, or an ex post basis, as the exchange rate that would have been consistent with internal and external balance. The purpose of an FEER is to establish a benchmark against which to measure misalignments in market exchange rates. These misalignments are due to temporary factors such as deviations from internal balance, trade restrictions, and abnormal capital flows. They signal the need for policy action. These misalignments and the associated disturbances are regarded as harmful and must therefore be avoided when possible (Black, 1994:280).

Williamson measures the real exchange rate as the ratio of the price of foreign to domestic goods. An assumption is made that both exports and imports are priced in the currency of the seller, with the prices being relatively sticky. A less-than-full employment situation is also assumed, given that output is adjusted for internal balance. The Keynesian structural model's familiar form of an open economy, along the lines of M. Fleming and R. Mundell is normally used in this framework (Black, 1994:281). The

FEER has been described as a current account approach to exchange rate determination. This approach is rooted in the BOP identity (Dvornak *et al.*, 2003:3):

$$\text{Capital account} = \text{Current account}\left[CA(E,Z)\right] = CA\left(E,P,P^*,Y,Y^*,Z\right) \quad (1)$$

The right hand side of the equation symbolises the current account of the BOP, which consists of the trade balance, net transfer flows, and net foreign income flows. The balance on the current account is extremely dependent on the real exchange rate, E·P/P*, which determines the prices and volumes of imports and exports. Other determinants of the current account are the levels of domestic and foreign income, Y and Y* respectively, and a variety of other factors (Z) that may shift the current account over time.

According to Dvornak *et al.* (2003), this approach can be implemented in three steps namely:

1. Choose a sustainable level for the capital account, KA_{target}. The target capital account is determined through judgement, and optimal savings and investment decision making. The medium-term average of the actual current account is normally taken as the target capital account, otherwise it must be modelled.

2. Derive the underling current account as in equation (1) above, given the potential output of the domestic and foreign economies and a set of exogenous factors (Z). Due to the agnostic view on the target capital account, focus is placed on the underlying current account. The current account is decomposed into three building blocks to identify the flexibility of each one towards any change in the exchange rate and output. The three blocks are: trade balance (X – M), net foreign income (NID), and net transfers (NT). Thus,

$$CA = X\left(E,Y^*\right) - M\left(E,Y\right) - NID(E) + NT \quad (2)$$

Net investment income and net transfers are modelled as suggested by Wren-Lewis and Driver (1998). The methods are quite simple; investment income is derived from assets denominated in foreign currency and moves directly with the exchange rate. Net transfers, on the other hand, are assumed to be independent of both demand and the exchange rate.

The difficult part of modelling the underlying current account equation lies in the trade balance. The price and income elasticities of trade flows underlying trade balance need to be estimated. With all the estimated trade elasticities the underlying current account can be modelled as a function of the exchange rate E with equation (2).

Comparisons need to be made over time between countries. Therefore the current account is modelled as a proportion of nominal GDP, which is P·Y. Equation (2) can then be written as:

$$\frac{CA}{PY} = \frac{1}{PY}\left[X\left(E,Y^{*}\right) - M\left(E,Y\right)\right] - \frac{1}{PY}\left[NID\left(E\right)\right] + \frac{1}{PY}\left(NT\right) \quad (3)$$

3. For each assumed value of KA_{target}, solve for the exchange rate that satisfies KA_{target} = CA (E, Z). Solving for the exchange rate is very basic. The level of the exchange rate E is estimated so that it, in turn, equates CA (E) with the target capital account. This is possible when equation (3) is estimated and output gaps are set equal to zero.

   When the exchange rate is, for example, E', step 2 will identify the underlying current account position as CA'. The value will, however, be different from the observed current account because output gaps are not equal to zero. The extent to which the exchange rate must change to equilibrate the underlying current account with the target KA will be determined in step 3.

3.2.3 Limitations to the FEER Approach

Several shortcomings occur in the execution of this approach. Firstly, judgement is necessary to determine the target capital account. Secondly, trade elasticities are difficult to calculate approximately and very low elasticities may entail questionably high estimates of the sensitivity of the equilibrium exchange rate to assumed capital account positions (Dvornak *et al.*, 2003:7). Thirdly, the dynamics of adjustment are not explained, and a more abstract problem is that the current account position, and thus the equilibrium exchange rate, may change over time due to other factors such as trends in world trade and trends in GDP growth (Wren-Lewis and Driver, 1998). Due to the limitations on the FEER approach the second approach, the desired equilibrium exchange rate approach, will be analysed.

3.3 Desired Equilibrium Exchange Rate (DEER)

The desired equilibrium exchange rate (DEER) approach has been used by many authors as an analytical device to assess exchange rate misalignment. These include Williamson (1985, 1990), Barrell and Wren-Lewis (1989), and Church (1992).

Wren-Lewis (1992) noted that the DEER is used as a comparative static calculation, but Williamson generally used large macroeconomic models to calculate the DEER. With the values of the current account and the full employment level of output as given, the DEER can be described as the real effective exchange rate level that is consistent with achieving these goals in the medium-term.

In order to make this comparative static, partial-equilibrium approach operational, three elasticities are needed. These are the current account sensitivity to domestic activity, foreign activity, and the real exchange rate. Other estimates of DEERs are found when different assumptions are used about (i) the underlying elasticities, (ii) the level of potential output, (iii) the historical period used as the base period, and (iv) the external

balance position. This indicates that reasonable estimates of DEERs vary over a rather wide range (Bayoumi *et al.* 1994).

3.3.1 The General Concept of the DEER

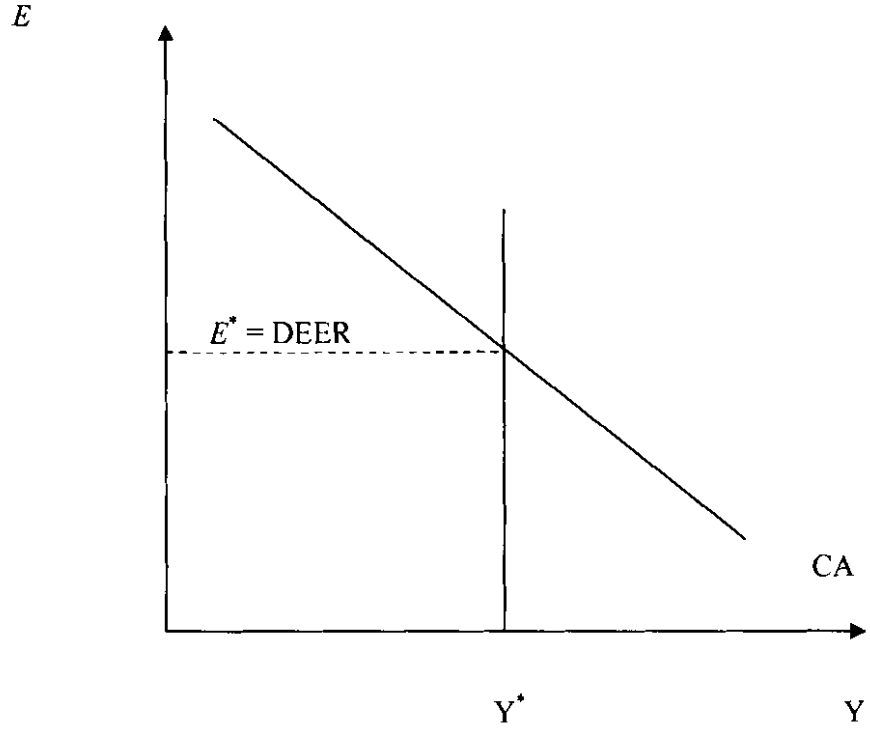
A definition for DEER can be stated as the real effective exchange rate at which an economy is in both internal and external macroeconomic balance in the medium term. This definition is the same as for the FEER approach, but medium term in this context means the period needed for output to return to potential, and for changes in competitiveness to be reflected in trade volumes (Bayoumi *et al.*, 1994:23). The medium-term referred to could be a period of approximately four to six years.

The DEER approach refers to the equilibrium real exchange rate that is consistent with macroeconomic balance, based upon a set of desired macroeconomic objectives. DEER does not take the actual internal and external balance into account, but is necessary for achieving the desired internal and external macroeconomic balance. This approach should therefore not be viewed as a target itself, but rather as facilitating the success of macroeconomic objectives (Bayoumi *et al.*, 1994:20). Figure 3.1 illustrates the DEER that is associated with internal and external balance.

Full-employment income, Y^*, is drawn as a vertical line in the real exchange rate, E, and real income, Y, space. The current account schedule, CA, is drawn for a given level of the current account balance. If the levels of domestic income, Y, foreign income, FY, and the current account that correspond to internal and external balance were denoted with asterisks, the DEER would be equal to E^*. E^* is the value of the real exchange rate E that is derived from the equation:

$$CA^* = CA(Y^*, FY^*, E^*) \quad (4)$$

Figure3.1:Internal and External Balance according to the DEER approach



Source:adopted from Bayoumi *et al.*, 1994

3.3.2 Advantages and Disadvantages of the DEER

Clearly a positive characteristic of the DEER approach is its simple and transparent calculations. This feature makes sensitivity testing of the calculations to alternative assumption very easy. Unfortunately, certain dynamic factors are ignored, and the approach assumes that the current account in the base period has already fully adjusted to output and real exchange rate changes in the past (Bayoumi *et al.*, 1994).

The impact of the DEER on the path of the equilibrium is also ignored. The comparative static, partial equilibrium approach abstracts from matters relating to asset market equilibrium and consequently assumes that interest rates have settled at their equilibrium levels in the medium term (Bayoumi *et al.* 1994).

3.3.3 Hysteresis in the DEER

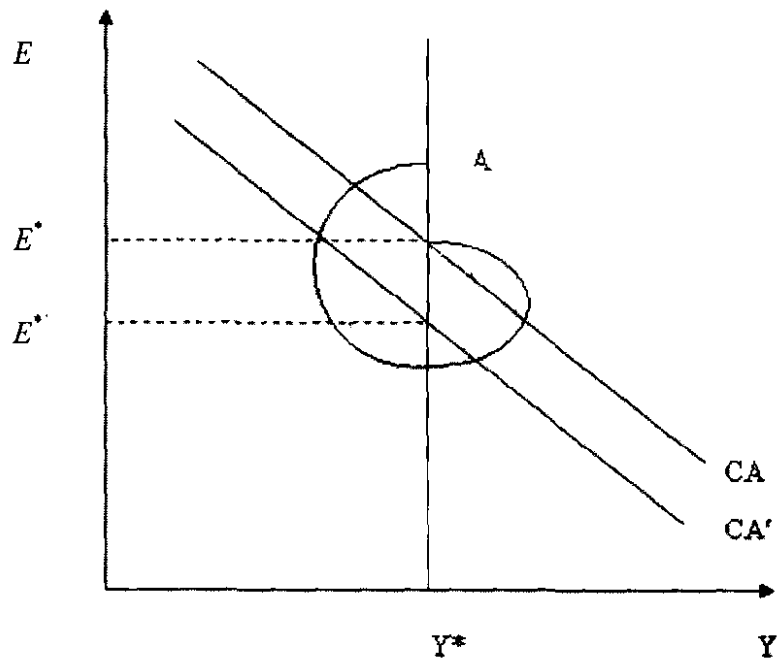
The comparative static approach does not include adjustments in the DEER that might be needed to take account of changes in the country's stock of international debt, as long as the current account is not at the desired level. The DEER therefore needs to be computed as a trajectory in order to take this dynamic behaviour into account. This is because the equilibrium exchange rate will be dependent on the path of the exchange rate towards its final sustainable value.

With another look at figure 3.1, it is very easy to understand how hysteresis can arise in the DEER. When the actual exchange rate corresponds initially to the value of its DEER and internal balance is at its desired level, this position will be at (Y^*, E^*) in figure 3.1. If a misalignment occurs in the next period in such a manner that the actual real exchange rate departs from its DEER value, the currency appreciates while output remains at Y^*. This appreciation will lead to deterioration of the current account relative to the initial equilibrium position and the DEER calculation must be executed one again because net foreign indebtedness increases as a result of the deficit and will create a responsibility to service the higher debt (Bayoumi *et al.*, 1994).

The departure of the actual exchange rate from its DEER value will force a revision of the existing DEER. According to Cross (1992), a so called "hysteresis loop" will develop if the previous DEER were to be re-established. In order to reinstate the previous schedule, the currency will have to over depreciate.

Figure 3.2 shows that the departure of the actual real exchange rate from its DEER value, for instance to point A, will require a real appreciation as well as a current account deficit relative to the current account balance underlying CA. The CA schedule must thus shift to CA′, and the DEER must devaluate from E^* to $E^{*'}$. However, if it were required that the stock of debt had to be reduced to the original level and the DEER had to return to E*, an over depreciation would be needed that would result in a hysteresis loop as seen in Figure 3.2.

Figure 3.2:Hysteresis effects



Source:adopted from Bayoumi *et al.* (1994)

Although the DEER approach is transparent and has simple calculations, it does not take the actual internal and external balance into account. The next approach, the behavioural equilibrium exchange rate approach, takes these values into account from a more statistical approach.

3.4 Behavioural Equilibrium Exchange Rate (BEER)

'Behavioural' in BEER means that there is no precise underlying structural model. Most empirical studies take the BEER approach where the underlying model is not specified. These studies include the work of, Clostermann and Schnatz (2000), Makrydakis *et al.* (2000), MacDonald (2001), MacDonald and Ricci (2003) and many more. These studies take a more eclectic approach and search for cointegrating equations in sensible variables that pass the usual econometric tests. Variables that were generally used in some of these

studies include net foreign assets to GDP, labour productivity, terms of trade excluding gold, real effective exchange rate, real commodity prices, and GDP per capita.

The BEER approach is a statistical/atheoretic approach because the underlying model is not specified. This means that the results do not depend upon any one model that may be incorrectly specified. This holds many useful advantages, since one can never be sure that one has the correct model, but it comes however at a high price. Firstly, the qualitative/sign results concerning the sign and significance of the variables depend greatly on which other variables are included in the regression. Secondly, it is often very difficult to interpret the results in economic terms (Stein, 2002:353).

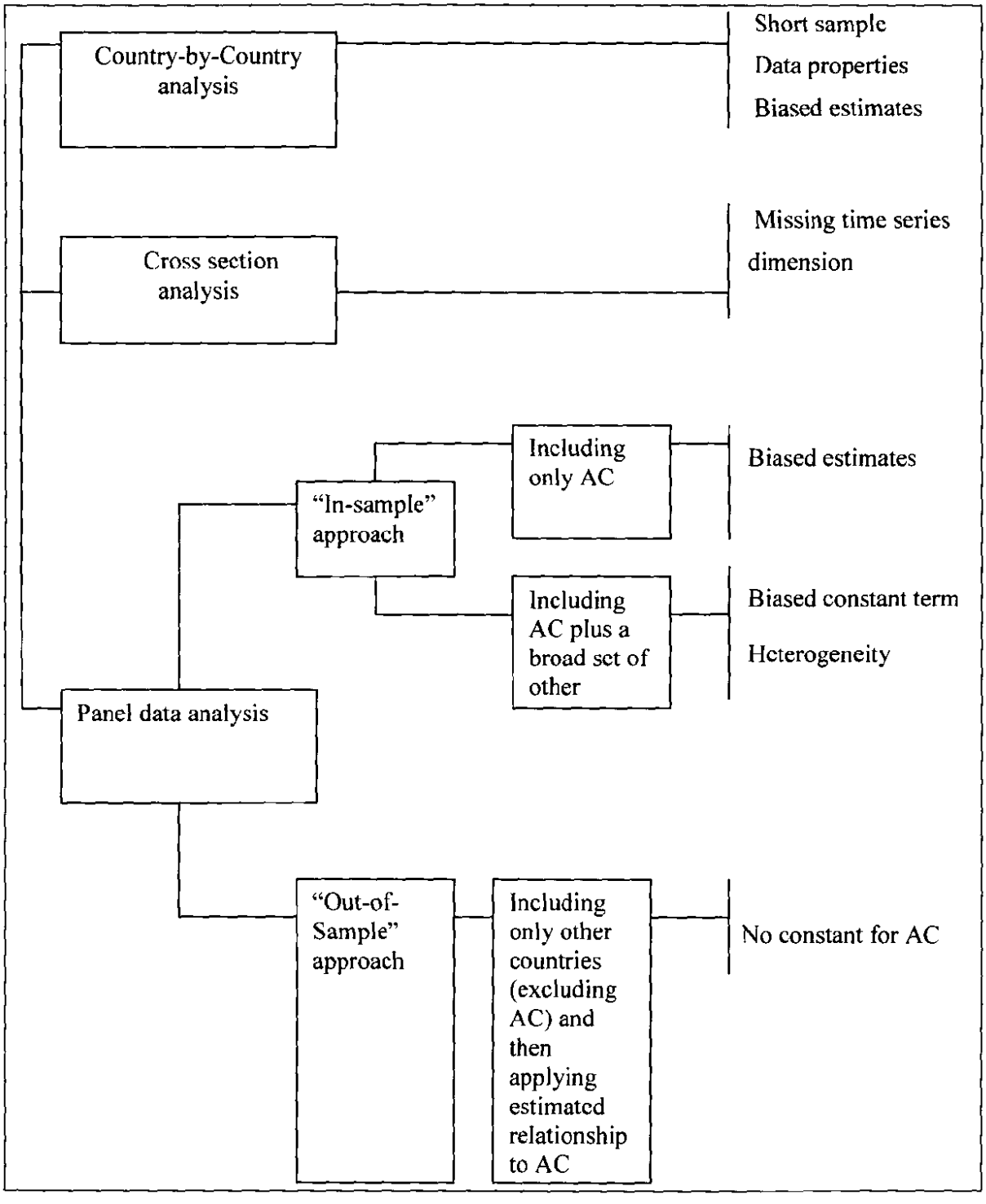
BEER subtracts the behavioural aspects from the normative aspects of exchange rate modelling. Firstly, the behavioural exchange rate relationship must be estimated so that, secondly, it can be determined whether or not the exchange rate is overvalued (MacDonald, 2001:1)

3.4.1 Three categories of BEER studies

In general, the existing empirical BEER studies can be divided into three categories. The first is studies that estimate the equilibrium exchange rate on a country-by-country basis. The second is cross-section analyses. The third is studies that are based on panel data (Maeso-Fernandez *et al.*, 2004). These three studies are illustrated in Figure 3.3 and will be discussed in short.

In the country-by-country approach, the equilibrium exchange rate is estimated for each country. This approach is very straightforward. Each country's individuality must,

Figure 3.3:Choosing an econometric strategy in a BEER framework



Source:adopted from Maeso-Fernandez, et al., (2004)

however, be taken into account. Data problems and the individuality of the transition period might lead to problems in interpretation.

Cross-section regression avoids the data problem experienced in the country-by-country approach. This approach is normally followed when equilibrium exchange rates are analysed from acceding countries using a graphical analysis approach.

Another approach to overcome the problem of short time series in a more sophisticated manner is the panel data approach. An "in-sample" approach focuses on the panel that includes acceding countries, with the advantage that the cross-section sample is fairly homogeneous. The "out-of-sample" approach is based on a two-step procedure for estimating equilibrium exchange rates for acceding countries. Firstly, the equilibrium exchange rate is estimated for non-acceding countries and then the equilibrium exchange rates for acceding countries are extrapolated on the basis of the estimated structural relationship.

3.4.2 Five Steps to the BEER Approach

According to Egert (2000) the BEER approach normally consists of five steps:

1. Estimate the relationship between the equilibrium real exchange rate and a number of fundamental and transitory factors. Since non-stationarity usually exists, cointegration techniques are normally used.
2. The transitory effects are set to zero and the actual values of the fundamentals are substituted into the estimated relationship. The misalignment is determined by comparing the actual real exchange rate to the estimated one.
3. The long-term or sustainable value of the fundamentals is estimated. This is done either by decomposing the series into permanent and transitory components by means

of a Hodrick-Prescott filter or Beveridge-Nelson decomposition or by evaluating the long-term value subjectively.

4. The estimated long-term values are substituted into the cointegration relationship and the variables that influence the equilibrium real exchange rate in the short term are set to zero.
5. The extent of total misalignment from equilibrium is the difference between the actual and estimated equilibrium real exchange rate as calculated in step 4.

According to Clark and MacDonald (1998), the BEER approach takes into account the possibility that the macroeconomic variables may create long swings and trend movements in the real exchange rate. This approach also allows cross country differences in productivity growth and fiscal and monetary policies to add to continual deviations from the purchasing power parity (PPP).

3.4.3 The Difference between FEER and BEER

The FEER and BEER approaches have some common features. The FEER model will have the same form as the BEER model in the case of a linear model. There is, however, a considerable difference between the FEER and BEER approaches.

The partial effects on the equilibrium exchange rate that are used to derive FEER, depend on the mechanisms in the macroeconomic model. This implies that a variable may have different effects in a BEER and in a FEER model. Take, for instance, a higher domestic economic growth that can have a positive effect on the equilibrium exchange rate in a BEER model, but has a negative effect on the equilibrium exchange rate in a FEER model (Clark and MacDonald, 1998).

3.4.4 Permanent equilibrium exchange rate (PEER)

In a paper by Clark and MacDonald (1998), the method of Granger and Gonzalo was used to estimate the permanent components of the real equilibrium exchange rates. This paper referred to the measures as the permanent equilibrium exchange rate (PEER). By decomposing the cointegration vector via the Gonzalo-Granger method, the total misalignment can be divided into permanent and transitory factors.

As an alternative approach, MacDonald (2001) implemented a Hodrick-Prescott (HP) filter to remove the business cycle from the data used in his study. MacDonald supports his methods with the fact that the PEER-based measure of equilibrium is essentially an atheoretical, or statistical, way of constructing an equilibrium exchange rate. After the HP filter is used to remove cyclical components from the data, it generates a measure of total misalignment.

The BEER and PEER approaches are very similar. However, the PEER-based approach produces estimates of the permanent and transitory components of all of the variables, which might be useful in circumstances where the BEER and PEER are very different.

The difference between the actual exchange rate and the BEER and the PEER gives an indication of the current possible misalignment between the two currencies. The misalignment between the current exchange rate and the PEER can be used to make meaningful inferences regarding future macroeconomic changes. The misalignment determined depends on short-term transitory factors and the departure of the fundamentals from their long-term value (Egert, 2002).

The PEER provides a much smoother, and therefore less volatile measure of equilibrium, but the PEER-based measure of equilibrium is basically an atheoretical/ statistical way of constructing an equilibrium exchange rate (MacDonald, 2001).

3.5 Natural real exchange rate (NATREX)

Economists encounter two basic problems with existing models, namely that (i) many models concentrate on modelling short-term movements in exchange rates and that the real fundamentals are generally ignored by assuming purchasing-power parity, (ii) that the mean and variance of the real exchange rate are invariant over time, and that the real exchange rate converges relatively rapidly to the unchanging mean. This implies that that the real exchange rate is stationary (Stein and Allen, 1995). A variable is said to be stationary if its mean and variance are both independent of time.

When looking at these problems, it is clear that exchange rates are determined largely by speculative capital flows in the short term. These determinations are based on expectations, and it is very difficult to state that these expectations are based on a wide set of fundamentals. Short-term movements in exchange rates are thus largely noise, because fundamentals progress gradually. In addition, little attempt has been made to explain the economic forces that determine the mean, and it is obvious that real exchange rates of major countries are not stationary.

The NATREX approach is more general than PPP. Real exchange rates are not stationary because the underlying fundamentals, productivity and thrift, do not have means that are independent of time. The goal of the NATREX approach is to clarify movements of medium to long term real exchange rates in terms of the fundamental real variables of thrift and productivity, with the assumption that real exchange rates adjust toward their equilibrium level, although these adjustments occur with a lag (Allen, 1995).

In this approach, focus is placed on the medium to longer term and the approach concentrates on real exchange rates. The fundamentals are productivity of capital and thrift, both at home and abroad. This approach is manageable and produces a testable model that simultaneously explains the equilibrium real exchange rates and non-speculative capital flows (Stein and Allen, 1995).

More importantly, NATREX is a moving equilibrium real exchange rate that refers to intercycling equilibrium exchange rates as determined by real fundamental factors in the medium term, and responds to continual changes in exogenous and endogenous real fundamentals (Allen, 1995:1). The NATREX theoretical approach clearly specifies the exogenous and control variables, and the variables that are endogenous. This approach identifies and models the fundamental determinants of equilibrium real exchange rates, consistent with their recent empirical movements in various countries.

A family of consistent general equilibrium models forms the core of the NATREX approach. These models are rational, optimising in behaviour, and determine medium-term equilibrium real exchange rates. More importantly, the models provide logical economic justifications for the empirical results.

Based upon stochastic optimal control models developed by Fleming and Stein, the NATREX model has a foundation of rational expectations for the private sector. The economy in total, which includes the public and political sectors, may make decisions that are far from optimal (Allen, 1995)

The model contains an explicit transmission mechanism linking the endogenous variables to the control variables. Very important results, for theory and policy, concern the effects of fiscal policy. In the traditional Mundell-Fleming model, an expansionary fiscal policy appreciates the real exchange rate. In the NATREX model, this is just a medium-term effect. As the stock of debt and growth rate varies endogenously, the real exchange rate depreciates below its initial level.

The NATREX optimisation process relies on feedback controls and dynamic programming, which guarantees that the ratio of net foreign assets to GDP will converge to an evolving, unpredictable, steady-state value (Stein and Allen, 1995). Dynamic equations are added to the NATREX model to generalise the macroeconomic balance models. The addition implies that many effects of changes in control and exogenous variables are more than reversed in the transition from the medium to the longer term.

3.5.1 Characteristics of the NATREX approach

As explained by Allen (1995), the specific characteristics of the NATREX model may vary according to the economy. The definition of the NATREX, according to Allen, is "NATREX is the equilibrium real exchange rate that clears the BOP in the absence of cyclical factors, speculative capital flows, and movements in international reserves" (Allen, 1995:6).

Focus is placed on real exchange rates for two main reasons: The real rate, and not the nominal rate, determines basic economic decisions about consumption, growth, and resource allocation. The other reason is that a moving inter-cyclical equilibrium can be expressed in real terms and which is neutral with respect to money supply and demand.

Changes in the real exchange rate closely follow movements in the nominal exchange rate. This is because prices of goods adjust slowly in the short term. For short-term movement, orderly explanations in exchange rates are hard to pin down. This is due to the overriding influences of speculative capital flows and the problems associated with the modelling and estimation of these flows. Thus real fundamentals, that change relatively little in the short term, have little influence on short-term exchange rates (Stein, 2002).

The NATREX approach avoids the modelling problems of speculative capital flows and cyclical factors when describing equilibrium situations. The starting point for the NATREX model is a medium-term equilibrium, equivalent to the 'long-term equilibrium'

of most monetary models. This medium-term equilibrium is where prices have adjusted and output has returned to its inter-cyclical potential level, real exchange rate has adjusted to its current equilibrium and demand for money equals the current supply of money with no foreign exchange interference by the central banks (Allen, 1995).

The familiar national income accounts equation can be used to describe the medium-term market clearing equilibrium of the NATREX model. In the medium term equilibrium, this equation can be interpreted as the equilibrium condition for the BOP and for the goods market:

$$I - S + CA = O \quad (5)$$

where

I is desired national investment,

S is desired national saving and,

CA is the desired current account.

All of these variables are measured when the economy is at capacity output and expectations about inflation are met. The real exchange rate will appreciate in response to an excess demand for goods, and this will ensure that equilibrium is upheld (Stein and Allen, 1995).

Desired national investment minus desired national savings (I - S), gives a description of the sum of the country's excess flow supplies of financial assets. With the assumption that the real exchange rate has no influence on I – S, the NATREX model is simplified and this has an influence on the trajectory of the real exchange rate. This is, however, not crucial to the NATREX approach that focuses on the results of investment, saving, and net capital flows over time.

Desired investment is also independent of the real exchange rate when domestically priced capital goods are used to produce domestically priced final goods and capital goods purchased at world prices are used to produce goods sold at world prices. Both investment and saving – that are relatively independent of the real exchange rate – depend on existing stocks of capital, wealth, and net debt to foreigners. As soon as these stocks change, the NATREX equilibrium exchange rate becomes a moving equilibrium (Stein, 1995).

The NATREX will reach a constant level as soon as the economy reaches a long-term equilibrium. This will be when the fundamentals, Z, and the stocks of real assets stay constant. However, when there is no growth in labour in the economy, the variables I, S, and CA will be equal to zero in the long-term steady state.

Exogenous fundamental disturbances, Z, influence the NATREX through affecting desired investment, savings, or the current account. This changes the NATREX in the medium term. These disturbances also change the rates of accumulation of the real stock of physical capital (k), wealth (w), and net debt to foreigners (F). The exogenous fundamentals modify the trajectory of the NATREX, through its movement toward the new long-term equilibrium. At any other stage than the long-term equilibrium, NATREX is a function of exogenous and endogenous fundamentals (Stein and Allen, 1995:8).

The full NATREX model establishes the medium-term equilibrium real exchange rate, R; its subsequent trajectory; as well as its eventual long-term equilibrium value, R^*. Nevertheless, frequent real fundamental disturbances send the NATREX continuously in the direction of a new long-term equilibrium, preventing it from reaching a steady state. Allen (1995) states that real exchange rates are non-stationary, due to the fact that exogenous fundamentals are non-stationary, which proves the assumption of continual movement in the equilibrium.

The medium-term equilibrium of the NATREX model is only a simulated creation toward which the economy tends, but never actually reaches. In the same line of thinking,

the NATREX itself can never be observed. The only observable feature is the actual real exchange rate that tends to adjust toward its moving equilibrium, the NATREX.

At the different stages of adjustment, the real exchange rate can be described as:

$R_t = R_t(Z, A, C)$ actual (disequilibrium) rate,

$R = R(Z, A)$ equilibrium rate (NATREX),

$R^* = R^*(Z)$ steady state rate.

where Z represents real exogenous fundamental factors,

A represents stocks of net real assets, and

C represents short-term cyclical and speculative factors.

The equilibrium real exchange rate on the trajectory between R and R^* is estimated as a function of the exogenous fundamental factors, Z, but only the actual rate, R_t, is observed. The NATREX is a positive, and not a normative, concept of the equilibrium real exchange rate that is implied by both the real fundamentals and the existing economic policies (Allen, 1995).

Cointegration analysis is designed to estimate both the long-term influence of independent variables on the dependent variables and, if adjustment takes some time, the deviations of the dependent variable from its long-term equilibrium. If the NATREX model can describe the structure and behaviour of the economy precisely, the long-term cointegration equation would approximate the effects of the fundamentals on the long-term, steady state NATREX. The error-correction estimate would simultaneously capture the direct medium-term response of the NATREX as stocks of real assets begin to change (Allen, 1995).

3.5.2 Characteristics of NATREX models

A few general characteristics are common to all NATREX models. These characteristics are (Allen, 1995:18):

a. The NATREX models' saving and investment functions are the products of intertemporal optimisations using all accessible and applicable information.
b. The focus is placed on national savings and national investment for the entire economy of a county, without distinction being made between private and public sources.
c. The NATREX approach considers exogenous changes in investment and savings as significant determinants of the equilibrium real exchange rate. This implies the assumption of relatively high long-term capital mobility. Changes in investment are due to changes in productivity and changes in savings are due to changes in thrift.
d. The long-term real interest rate gap between countries converges to the expected rate of changes of the real exchange rate under high capital mobility.
e. NATREX and monetary models are similar; both describe a world in which money supply and demand are neutral.

3.5.3 Different versions of the NATREX models

According to Stein and Allen (1995), different versions of the NATREX models can be categorised by the treatments of asset markets and of goods markets. The precise version, however, depends on several characteristics namely, the size of the economy relative to its trading partners in markets for tradeable goods and assets, foreign elasticities of demand and supply for goods and assets, and substitutability among goods and among assets, between countries and within the home country.

In modelling asset markets, three basic assumptions are made (Allen, 1995:19):

a. Countries that are rather small in the world asset market, but which have high capital mobility, are allowed to borrow as much as they wish at the world real interest rate.

b. In a country that is large enough to have an influence on the world interest rate and that has high capital mobility, the world real interest rate and the real exchange rate are determined at the same time by the interaction of two countries' basic market equations.

c. The third possibility is that capital mobility is less than perfect.

The goods market is cleared by two endogenous relative prices, which are the terms of trade that clear the basic market equation, equation (5); and the relative price of non-tradeables to exportables clears the excess demand in each goods market. Two assumptions are also made. Firstly, perfect substitutability between exportables and non-tradeable goods and complete specialisation in production of the exportable good. Secondly, that the country is small in the tradeable goods markets and faces perfectly elastic world demand for and supply of tradeable goods that makes the terms of trade exogenous (Allen, 1995:21).

3.5.4 The NATREX versus FEER

NATREX differs from the FEER since FEER is the real exchange rate that will bring the current account, measured at potential output, in line with some measure of "desired capital flows" that is the difference between levels of saving and investment that are not distorted by public policy. Since optimal policies are not part of NATREX, this forms the main difference between NATREX and FEER (Black, 1994:282).

The NATREX approach does not model differences between fixed and flexible exchange rates (Allen, 1995:33). NATREX therefore forecasts how a change will affect the equilibrium exchange rate, but not the desirability of the disturbance or outcome (Allen,

1995:10). This is one of the main reasons why the FEER and/or BEER framework is preferred in the context of this research.

3.6 Summary

Due to the need of an equilibrium that acts as a standard against which to measure actual exchange rate changes, different models for determining the equilibrium exchange rate exist. The aim of this chapter was to discuss the different theories that are used to determine the equilibrium exchange rate. Four different theories are identified in the literature namely the FEER, DEER, BEER and NATREX.

The FEER is associated with underlying balances where economic forces have been worked out. This equilibrium exchange rate is consistent with ideal macroeconomic balance (internal and external balance in the economy simultaneously). The DEER does not take the actual internal and external balance into account, but rather the desired internal and external macroeconomic balance. The BEER approach subtracts the behavioural aspects from the normative aspects of exchange rate modelling. The behavioural exchange rate relationship must therefore be estimated so that it can be determined whether or not the exchange rate is overvalued.

The BEER approach is followed by PEER measures. By decomposing the cointegration vector via the Gonzalo-Granger method, the total misalignment, which depends on short-term transitory factors, can be divided into permanent and transitory factors. Lastly, the NATREX, which is a moving equilibrium real exchange rate, refers to intercycling equilibrium exchange rates as determined by real fundamental factors in the medium term. NATREX forecasts how changes will affect the equilibrium exchange rate.

For the purpose of this study, a BEER approach is preferred because it is a more statistical approach determining cointegration between the fundamental variables and it determines a misalignment. Other reasons supporting the decision to use the BEER

approach are that the DEER approach is a more static, partial-equilibrium approach, and the NATREX approach forecasts the effect of changes on the equilibrium exchange rate and not the desirability of the disturbance or the outcome. Furthermore, the FEER framework mainly makes use of the complete or partial model approaches while the BEER framework mainly makes use of a single equation regression approach

In chapter 4, different estimation approaches and econometric techniques are discussed. A preview of the estimation approach that will be used in this study will also be given at the end of chapter 4.

CHAPTER 4

ESTIMATION METHODOLOGIES

4.1 Introduction

Fifty years after the Bretton Woods System conference (discussed in chapter 2), the reform of the international exchange rate system remained a global agenda. The monetary system called for a reform of the exchange rate regime. A central issue in the international monetary debate was the feasibility of calculating the "fundamental equilibrium exchange rates" on which the new regime would rest. The issue was treated in 1985, but John Williamson felt it necessary to review the situation in 1994.

While the previous chapter discussed the different theories underlying the estimation of the equilibrium exchange rate, the aim of this chapter is to focus on the different estimation approaches to equilibrium exchange rate computation and the econometric techniques to solve for the equilibrium exchange rate.

However, before equilibrium exchange rate estimations can be made, the real exchange rate has first to be estimated. The first section of this chapter will therefore cover the topic of the real exchange rate.

4.2 The Real Exchange Rate

The real exchange rate can always be described as a relative price between some produced goods in the home county and other produced goods in the foreign country. Economists, however, differ on their choices for the relative price.

The constant level of the real exchange rate can correspond to conditions that require sustainable, but stable deviations from the absolute PPP. These deviations may be credited to transport costs or to trade barriers or technical reasons. Technical reasons include the different calculation methods of the general price level at home and abroad. Any deviation from the equilibrium level may increase the internal and external imbalances that will bring the real exchange rate back to its equilibrium level.

When the actual real exchange rate is stronger than the equilibrium real exchange rate, domestic goods will cost more than foreign goods. A trade deficit may then occur through poor competitiveness along with low domestic activity and unemployment. Consequently, the trade deficit may lead to a weaker nominal exchange rate, and low activity levels may slow wage and price inflation down at home relative to other countries. An increase in the nominal exchange rate and relative price levels will, in turn, lead to a weaker real exchange rate in order for it to return to its equilibrium level (Akram *et al.*, 2003).

The real exchange rate can thus be defined in general terms as the nominal exchange rate that is deflated by the ratio of overall purchasing power in two countries (Allen, 1995):

$$R \equiv E\frac{P^f}{P} \quad (6)$$

Where E is the nominal exchange rate and represents the price of the foreign currency in domestic currency units and $\frac{P^f}{P}$ is the ratio between the general price level at home and abroad. A constant real exchange rate implies equal rates of price inflation at home and abroad when adjustments are made for the changes in the nominal exchange rate (Akram *et al.*, 2003). An increase in R indicates an appreciation of the currency in real terms, and an increase in E indicates an appreciation of the currency in nominal terms (Lim and Stein, 1995).

If a home country builds up foreign debt in the case where the exchange rate is stronger than an equilibrium exchange rate, the real exchange rate may become weaker than the equilibrium level before the equilibrium level is stabilised. A trade surplus may be

obtained when the exchange rate depreciates relative to the equilibrium exchange rate. This makes service and repayments of accrued foreign debt much easier. The convergence speed of the real exchange rate towards the equilibrium exchange rate depends on the reaction of the nominal exchange rate and prices on the deviations from the equilibrium level (Akram *et al.*, 2003).

Analysis of exchange rate adjustments focuses on the relative prices of export and import goods, in other words, the terms of trade. When focusing on a simple macro model of countries that produce a single good for domestic use and for export, the overall price index is the price of this single exportable good. The real exchange rate then becomes the terms of trade (Lim and Stein, 1995).

For small countries facing exogenous world prices of traded goods, the terms of trade are exogenous. Endogenous relative price adjustment can only occur between prices of tradeable and non-tradeable goods. The real exchange rate is then defined as the relative prices of tradeable and non-tradeable goods. When an increase occurs in the home country in the relative price of non-tradeable goods to exportable goods, the real exchange rate will appreciate. It is, however, difficult to find sufficient definitions and price indices for non-tradeable goods. Furthermore, the distinction between tradeable and non-tradeable goods relies on prices and transport costs (Lim and Stein, 1995).

Because of the data limitations on prices of tradeable and non-tradeable goods, other proxies have been used widely. Zhang (2000) used a common proxy by multiplying the nominal exchange rate E by a fraction that consists of the foreign wholesale price index (WPI^*) in the numerator and the domestic consumer price index (CPI) in the denominator:

$$R = E\frac{(WPI^*)}{(CPI)} \quad (7)$$

Balvers and Bergstrand (1997) used another proxy by multiplying the nominal exchange rate E by a fraction that consists of the foreign consumer price index (CPI^*) in the numerator and the domestic consumer price index (CPI) in the dominator:

$$R = E\frac{(CPI^*)}{(CPI)}(8)$$

Now that the real exchange rate is defined and different approaches to estimate the real exchange rate have been discussed, this chapter will discuss the different estimation approaches to compute an equilibrium exchange rate.

4.3 Estimation approaches to equilibrium exchange rate computation

When it comes to estimating the equilibrium real exchange rate for the accessing country, estimates can be distinguished by their theoretical background. The theories of these methods do not differ much; therefore they are distinguished by the techniques that are used to implement their theories (Wren-Lewis, 2003:2).

According to Wren-Lewis (2003), the estimation approach of computing an equilibrium exchange rate can be divided into four categories, a complete macroeconomic model, a partial equilibrium model, a reduced form regression equation, and direct estimates of the PPP. Each is subsequently reviewed.

4.3.1 Complete Macroeconomic model

Policy analysts must make tough choices: should they use a model where the economic behaviour is stripped down and easy to understand, but whose fit to the data is crude, or should they use a model whose fit and forecast performance are good, but with economic behaviour that is not very detailed. The need to tell tidy stories frequently dominates the desire to fit data, but a model must be simple if it is to be understood, and must be understood if it is to inform policy debates. Unfortunately, models are understood on a qualitative level, while they are used for policy analysis on a quantitative level. Tension

arises when moving from qualitative discussion to quantitative prediction (Wren-Lewis, 2003).

The adoption of a complete macroeconomic model reduces the number of exogenous independent assumptions required for the equilibrium exchange rate computation. The equilibrium exchange rate is simultaneously computed along with the other endogenous variables in the model, implying that any possible relation between the equilibrium exchange rate and the rest of the economy is completely accounted for. The model can be used to describe either a small open economy, with external variables that are exogenous to the model, or a multi-country, global model of the world economy (Piscitelli and Westaway, 2004). Note that this is a popular method for both FEER and DEER models.

In the complete macroeconomic model approach, the equilibrium exchange rate is the outcome from a complete set of macroeconomic identities and behavioural equations. Here, the real exchange rate is included in a complete system of equations as one variable. The complete macroeconomic approach estimates predicted values for each variable in the equation. The major requirement is that the model in use must have a well-defined equilibrium. This approach has been used by many researchers such as Barrel *et al.* (1991), Church (1992), Bayoumi *et al.* (1994) and Piscitelli and Westaway (2004).

If the model abstracts from cyclical factors through ignoring nominal inertia, it is strictly medium-term. This makes it possible to ignore monetary policy in assessing the equilibrium exchange rate. In the case where the model is strictly medium-term, the solution for the real exchange rate is the equilibrium exchange rate. A medium-term equilibrium is the solution to a set of equations where the asset stock variables are irregular. An increase in world demand and/or domestic supply, the stock of overseas assets, and fiscal policy will, however, influence the medium-term equilibrium exchange rate (Wren-Lewis, 2003).

A shortcoming of this approach is that existing macroeconomic models are not restricted to the medium term, and it may be difficult to split the medium term from the short term. The shortcoming will not have much impact if the interest lies in equilibrium exchange rate for some years ahead. Any forecast far ahead must, by definition, be a medium-term equilibrium project. Possible techniques to use, even when it is useful to know what the complete macroeconomic model implies for the equilibrium exchange rate today, is to start the forecasting in the past that projects equilibrium values for exogenous variables and that ignores any explicit nominal inertia parameters (Wren-Lewis, 2003).

The results from a complete macroeconomic model are easy to interpret because they are structural, but they could generate the wrong equilibrium exchange rate due to an incorrect model for trade and incorrect exogenous inputs (Wren-Lewis, 2003).

4.3.2 Partial equilibrium model

Although many economists contributed to the partial equilibrium model, the main architects of the partial equilibrium model were Bickerdike (1920), Robinson (1947), and Machlup (1939, 1940).

The partial equilibrium model approach estimates a value for aggregate trade flows with the help of existing estimates for medium-term capital flows and key variables. This approach estimates only part of the economic system and treats the other variables as exogenous input, based on judgement. Key exogenous inputs are medium-term capital flows and the cyclically adjusted level of output. These medium-term trade flows are modelled and the equilibrium exchange rate is the rate that produces a current account that matches the assumptions about medium-term capital flows (Wren-Lewis, 2003).

An advantage of this approach is its simplicity and clarity. It provides a direct relationship between the equilibrium exchange rate and the fundamentals of the economy (Piscitelli and Westaway, 2004). Because calculations of FEER require an empirical model of macroeconomic variables that are influenced by the real exchange rate studies, we can use either (i) a complete macroeconomic model for one or more countries or (ii) a partial model for the BOP. The partial equilibrium approach seems more popular than the complete macroeconomic model because the mechanisms that determine FEER are more transparent and because model development and maintenance require fewer resources (Akram *et al.*, 2003).

The model is explicitly medium term and ignores short-term dynamics, thus eliminating the problems of extracting medium-term values that arise in the complete macroeconomic models (Wren-Lewis, 2003). A stylised version of a partial model for the BOP can be used to derive FEER and can be used as a reference for discussing issues arising from the calculation of FEER (Akram *et al.*, 2003:43).

4.3.3 Reduced form regression equation

The reduced form regression approach estimates the equilibrium exchange rate by estimating a single equation for the exchange rate as a function of medium-term determinants and key explanatory variables. Wren-Lewis (2003) concludes that there seems to be no compelling reason to prefer one approach to the others, although he indicates that the partial equilibrium approach is more meticulous in terms of equilibrium exchange rate estimation and its advantages and disadvantages can be appreciated by comparing it to the complete model approach. When all of these explanatory variables in the regression were equivalent to the exogenous variables of the structural model, the regression is similar to a reduced form of the complete model. In the single equation time series technique, the estimation of BEER was done by Clark and MacDonald (1998).

The sample periods of the BEER studies are relatively short, with a time frame of about 10 years. Cointegration analysis is used because the real exchange rate and the underlying macroeconomic fundamentals are usually found to be non-stationary variables. Unfortunately, cointegration statistics and estimates are biased in samples this small. Fluctuations caused by real exchange rates can cause long lasting effects and a sample of a mere 10 years might not reflect these movements around some equilibrium schedule.

The BEER approach can be based on the hypothesis of either the uncovered real interest parity (UIP) or PPP. The PPP will be discussed in section 4.3.4 and a discussion on the UIP follows.

4.3.3.1 The Uncovered Real Interest Parity (UIP)

The theory of UIP is the capital market analogue to PPP. It states that if interest rates in South Africa are higher than similar interest rates is Europe, investors must be expecting depreciation in the South African currency. Otherwise investors will have greater motivation to purchase South African assets, driving the South African spot exchange rate up or, alternatively, driving interest rates down (Stephens, 2004:3).

In an analysis of the empirical research on selected conditions of uncovered interest parity, Moosa and Bhatti (1997) came to the conclusion that UIP has been rejected by studies in various forms. One difficulty with measuring the effect of UIP on the exchange rate, using short-term interest rates, is that unobservable expectations of future interest rate differentials may be important.

If a differential in 90-day rates is expected to continue, the exchange rate depreciation may also continue. The spot exchange rate would then have to increase initially by a larger increment to hold the longer expected depreciation. To help avoid the problem of unobservable expectations of future short-term interest rates, longer time horizons must be used. Stephens (2004:4) recommends that 5-year interest rates are a reasonable

alternative for current and expected future 90-day interest rate differentials during the business cycle.

The UIP condition often motivates the BEER approach in some situations although it is a more statistical model, and will be explained below, (following MacDonald (2001:1- 3) and Maeso-Fernandez, *et al.*, (2004: 8-11)).

The expected nominal value of the Rand against the Euro, for example, is:

$$E_t(\Delta s_{t+k}) = -(i_t - i_t^*) \quad (9)$$

where

s_t is the Euro price of a unit of the Rand;

i_t is the nominal interest rate;

i_t^* is the corresponding interest rate in Europe.

E_t is the conditional expectation operator, Δ is the first difference operator, $t + k$ is the maturity horizon and a * denotes a foreign variable. The expected real value of the Rand can be deduced from equation (9) by subtracting the expected inflation differential between RSA and Europe:

$$E_t(\Delta p_{t+k} - \Delta p_{t+k}^*)$$

from both sides of the equation. Rearranging the result gives:

$$q_t = E_t(q_{t+k}) + (r_t - r_t^*) + e_t \quad (10)$$

with e_t being the disturbance term. The ex ante real exchange rate of the Rand is:

$$q_t = s_t - E_t(\Delta p_{t+k})$$

and the ex ante real South African interest rate is:

$$r_t = i_t - E(\Delta p_{t+k})$$

Equation (10) describes the current equilibrium exchange rate as a product of two components, the expectation of the real exchange rate in period $t+k$ and the interest differential with maturity $t+k$. The influence of fundamentals exclusive of interest rates, represented by the unobserved expectation of the exchange rate is:

$$E_t(q_{t-k})$$

The current equilibrium exchange rate is thus:

$$q_t = \bar{q}_t + (r_t - r_t^*) \quad (11)$$

As indicated by equation (11), the current equilibrium Rand/Euro exchange rate is influenced by two factors, a systematic component and the real interest rate differential.

Factors causing the systematic variability in the current exchange rate were investigated by Faruqee (1995), MacDonald (1997) and Stein (1999). From their results, the long-term equilibrium exchange rate in their studies is influenced by factors such as net foreign assets, labour productivity, the output gap relative to the trading country, and terms of trade. Note that this is only an example.

$$\bar{q}_t = f\left(\overset{+}{nfa_t}, \overset{+}{prod_t}, \overset{+}{gapd_t}, \overset{+}{nztot_t}\right) \quad (12)$$

Where *nfa* is the ratio of foreign assets to GDP; *prod* is South Africa's labour productivity relative to that in Europe; *gapd* is the SA output gap relative to the output gap in Europe; and *tot* is the South African terms of trade. The *nfa* and *prod* terms may be thought of as driving the longer term systematic component in the real exchange, and the remaining variables have a more cyclical medium term relationship with the real exchange rate.

After estimating equation (12), the PEER must be calculated. The choice of variables that are included in the model and the estimations of their effects will clearly have an influence on the magnitude of a misalignment. Assumptions made about the equilibrium level or path will also have an impact on the magnitude of a misalignment. A considerable number of demands is therefore placed on real exchange rate models, because a visible over or undervaluation may be due to inaccurate specifications of the model. Requirements are stated to overcome this problem, namely that the effects of all variables that are important in the medium and long term are represented in the model, and that estimates of the equilibrium values of explanatory variables are reasonable (Akram *et al.*, 2003).

These calculations are covered in uncertainty; and therefore it is important to make the assumption that deviation must be of a given scale before it can be considered to be significant. The difference between the actual real exchange rate and the estimated equilibrium exchange rate is often required to go above approximately twice the estimated standard deviation before the conclusion can be drawn that a currency is over or undervalued (Akram *et al.*, 2003).

4.3.4 Direct estimates of PPP

The direct estimate of the PPP approach measures prices of similar baskets of goods across countries. The Swedish economist Gustav Cassel's (1922) idea, that the nominal exchange rate should replicate the purchasing power of one currency against another, remains a continuing principle of international economics (Breuer, 1994:245). Fluctuations in real exchange rates are often treated as temporary deviations from the long-term equilibrium real exchange rate, for which PPP remains the popular theory. The theory of PPP is thus a usual starting point for calculations of the equilibrium rate.

Consistent with this theory, domestic and foreign goods will cost the same in general when measured in a common currency with adjustments made for international trading costs. This indicates that the general terms of trade will be in equilibrium at a specific level when measured in terms of the real exchange rate. Then again, it could be stated that the equilibrium real exchange rate, R^*, is constant (Akram *et al.*, 2003:2). Since PPP yields a constant real exchange rate, it follows that movement in real exchange rates must be deviations from the equilibrium level. PPP thus serves as an ultimate benchmark for the relative values of currencies, but provides a poor measure of equilibrium exchange rates in the presence of several fundamental real disturbances to both the current and long-term capital accounts (Allen, 1995).

Estimates of PPP can be divided into two categories, the relative version and the absolute version PPP theory. Each is subsequently reviewed.

4.3.4.1 The Relative Version of the PPP Theory

The weakest PPP condition requires that the equilibrium level of the exchange rate diverges, ceteris paribus, to offset differential inflation. The stronger use of PPP involves choosing a base period in which the economy is thought to have been in equilibrium, and the real exchange rate for that year is called the equilibrium for the remainder of the sample period. The problem with stronger PPP conditions are that, theoretically, the real exchange rate moves over time in an economy in equilibrium and there is a risk that the identification of a misalignment may only be an equilibrium movement in the real exchange rate (Elbadawi, 1994:93).

Both these "relative versions" of PPP hold that the equilibrium exchange rate must change to offset differential inflation between the two countries and thus leave the real exchange rate unchanged as discussed in section 4.2.

The relative version of the PPP theory makes a convincing point, that monetary conditions have an important influence on the exchange rate. Unfortunately, this theory has a major drawback. Not only does this theory have difficulty with statistical verification, but it rests on a critical assumption, that technology, tastes, factor supplies, levels of employment, trade impediments, and capital movements do not change over the conversion period. Clearly these changes take place continuously in the international economy and put intense pressure on the exchange rate (Salvatore, 1998).

4.3.4.2 The Absolute Version of the PPP Theory

The "absolute version" of PPP holds that the equilibrium exchange rate between two currencies will be such as to equate purchasing power in the two countries involved (Williamson, 1994:2). Thus implies one-to-one terms of trade between domestic and foreign goods.

According to Chacholiades (1990), the absolute version of the PPP theory is useless, because there is no reason to abandon the supply-demand analysis of the foreign exchange rate market and to use the ratio of price levels to determine the equilibrium rate of change. In addition, the relationship of the equilibrium rate of exchange - that is equal to the ratio of the home country's price level to the rest of the world's price level- must hold trivial for any rate of exchange, not just the equilibrium rate. Thus the equilibrium real exchange rate relationship cannot be used to determine the equilibrium rate and this is a disturbing blow for the absolute version of the PPP theory (Chacholiades, 1990:474).

4.3.4.3 Empirical testing of the PPP theory

The methods used to test PPP were ordinary and generalise least squares. But since the mid-1980s, various models have been used to include advances in econometrics for non-stationary time series. Equation (13) presents the regression specification typically used to test PPP when the data are non-stationary but cointegrated.

$$s_t = \alpha + \beta(p_t - p_t^*) + u_t \quad (13)$$

The exchange rate s and the domestic and foreign price series p and p^* are expressed in logarithms. The terms α and β are estimated regression coefficients, t denotes time, and u is an error term. Absolute PPP would be confirmed if $\alpha = 0$ and $\beta = 1$. Classical hypothesis testing of equation (13) is inappropriate when the regressors are non-stationary because their variances do not converge to a constant and standard errors will be underestimated. More recent tests address the stochastic behaviour of the real exchange rate, and are restricted versions of the cointegration test. β is implicitly constrained in equation (13) to equal one, so that the behaviour of the real exchange rate is studied rather than an exchange rate/price relationship (Breuer, 1994).

4.3.4.4 PPP and different exchange rate environments

Rejection of PPP occurred in the flexible exchange rate era that was discussed in chapter 2, section 2.2.2. The first shortcoming was the distinction made between the short and long term, where only the long term served as the basis for rejection or confirmation of PPP. Taylor (2001) indicates that the use of annual data, instead of quarterly or even monthly data is better for capturing price adjustments when they occur. The second shortcoming was that newer interpretations began to require the real exchange rate to be stationary rather than fixed as required by traditional PPP. Lastly, the coefficient restrictions implicit in the original conception of PPP have been disregarded (Breuer,

1994). According to Stein (1995) the PPP theory cannot provide a definition of the equilibrium rate and is also incapable of precise interpretation (Stein, 1995:134).

4.3.5 Conclusion

From the discussion above, it is clear that the complete macroeconomic model is where the equilibrium exchange rate is the outcome from a complete system of identities and equations. This is mostly associated with FEER and DEER models. The partial equilibrium model estimates a value for aggregate trade flows, but uses existing estimates for medium-term capital flows and key variables and is also a popular method for FEER models.

The reduced form regression equation is the estimation of a single equation for the exchange rate as a function of medium-term determinants and is used in BEER models. Lastly, direct estimates of the PPP approach measure prices of similar baskets of goods across countries.

4.4 Econometric techniques and the equilibrium exchange rate

Apart from the different theoretical models and approaches used as a background, it is also possible to distinguish between studies regarding the econometric techniques employed. These can be broadly divided into two categories, studies based on time series and studies based on panel data (Egert, 2002:1). Using time series techniques allows the identification of country specific factors. However, the lack of data on a quarterly or even monthly basis required by the short time span may force a switch to annual data This would require the use of panel techniques because it is impossible to conduct time series analysis on 10 observations. These techniques will now be discussed briefly:

4.4.1 Panel data techniques

Panel data studies calculate the approximate relationship between the equilibrium exchange rate and the fundamentals to obtain some kind of "average" coefficients for a set of countries. The so called "average" coefficients illustrate the long-term behaviour of the individual countries' real exchange rates given that, in the long term; the real exchange rate is expected to respond in a similar manner to changes in the fundamentals in each country. By substituting the observed fundamental time series into the estimated equation, the equilibrium exchange rate for each country can be derived.

Panel data techniques will not be further discussed, because this study focuses on the Rand/Euro exchange rate equilibrium. For more information on the Panel data techniques in estimating real equilibrium exchange rates, refer to Jeong *et al.* (2004), MacDonald and Hoffmann (2001), and Maeso-Fernandez *et al.* (2004).

4.4.2 Time series techniques

Using time series techniques, a structural macroeconomic model or a single equation regression model can be derived. Macroeconomic model time series studies in estimating the FEER include the study by Smĭdkova (1998) on the Czech exchange rate. When using the FEER approach, the elasticity of the current account to both domestic and foreign income, and to the real effective exchange rate, must be estimated. Thereafter a value for the real equilibrium exchange rate must be determined so that the current account and domestic and foreign income will converge towards their equilibrium values.

The alternative - more often employed - way to estimate the equilibrium exchange rate is the single equation time series approach to the BEER. Single-equation time series techniques include the study on estimation of the BEER by Clark and MacDonald (1998).

More studies follow the BEER approach than the FEER approach, and the use of the cointegration approach is common in most studies (Egert, 2002).

The BEER estimates presented in Clark and MacDonald (1998) may also be contrasted with the popular PPP hypothesis, which ignores any fundamentals and empirical estimates, indicating that there is a very long convergence to PPP. The approach used stressed two points: (i) Real fundamentals exist which can be used to explain systematic exchange rate movements, and (ii) convergence in the estimated models is relatively swift.

As it is generated from variables that are highly persistent and often non-stationary, the measured BEER is itself likely to be a highly persistent series. Using the methods of Beveridge and Nelson (1981), papers such as Clarida & Gali (1995), and Huizinga, (1987) have interpreted the persistent, or permanent, component of the real exchange rate as a measure of equilibrium.

4.5 Equilibrium exchange rate research in South Africa

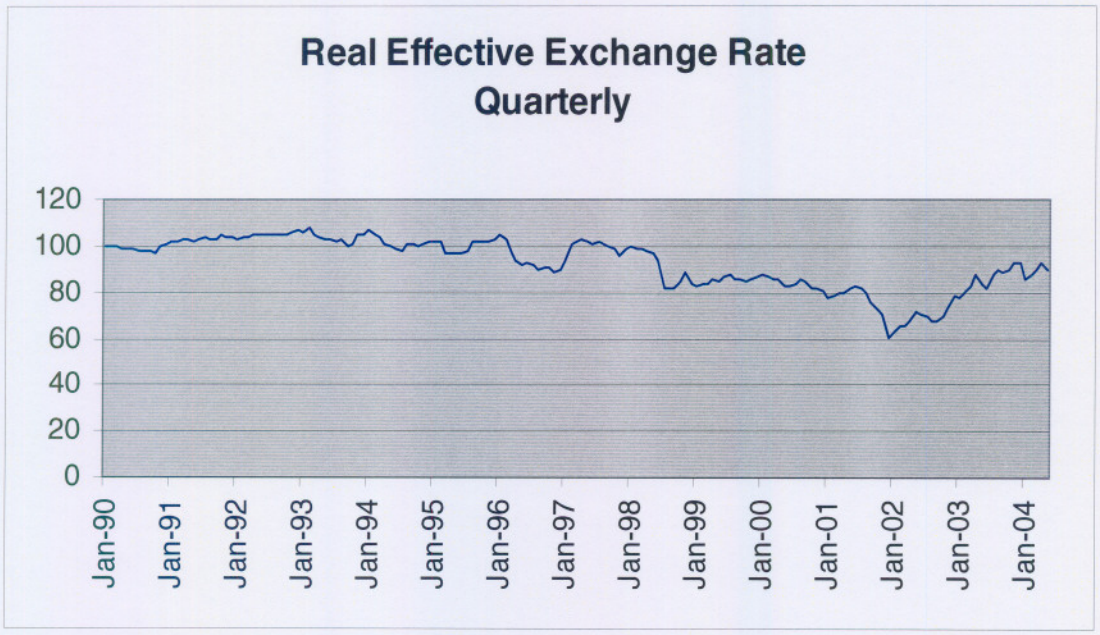
In determining the equilibrium real effective exchange rate for South Africa, Aron *et al.* (1997) used a cointegration framework with single equation equilibrium correction models to examine both the short-term and long-term equilibrium determinants of the quarterly real exchange rate for the term 1970:1 to 1995:1. The real equilibrium exchange rate is defined according to the macroeconomic balance approach. The cointegration equilibrium obtained was from a theoretical model that characterised the equilibrium through internal and external balance for sustainable capital flows, trade, and tax regimes.

The fundamentals used are trade policy, terms of trade, capital flows, foreign exchange reserves, government expenditure, and per capita real GDP growth. The theoretical model specifies the equilibrium real exchange rate as a forward-looking function of the chosen fundamentals. The model supports a flexible active adjustment towards the equilibrium real exchange rate. Concern was expressed on adjustments to equilibrium from disequilibrium positions that occur due to changes in the short-term, together with the likely real appreciation/depreciation that is required from changes in the fundamentals. Trade liberalisation and management of the exchange rate were addressed. According to the model, the real exchange rate shows itself to be irregular over time, but responds to changes in fundamentals and shocks to the economy (Aron *et al.*, 1997).

According to MacDonald and Ricci (2003), much of South Africa's real effective exchange rate long-term behaviour can be explained by real interest rate differentials and GDP per capita – both relative to trading partners – real commodity prices, trade openness, the fiscal balance, and the extent of net foreign assets. According to these fundamentals, the real exchange rate was considerably undervalued in 2002 with respect to the estimated equilibrium level.

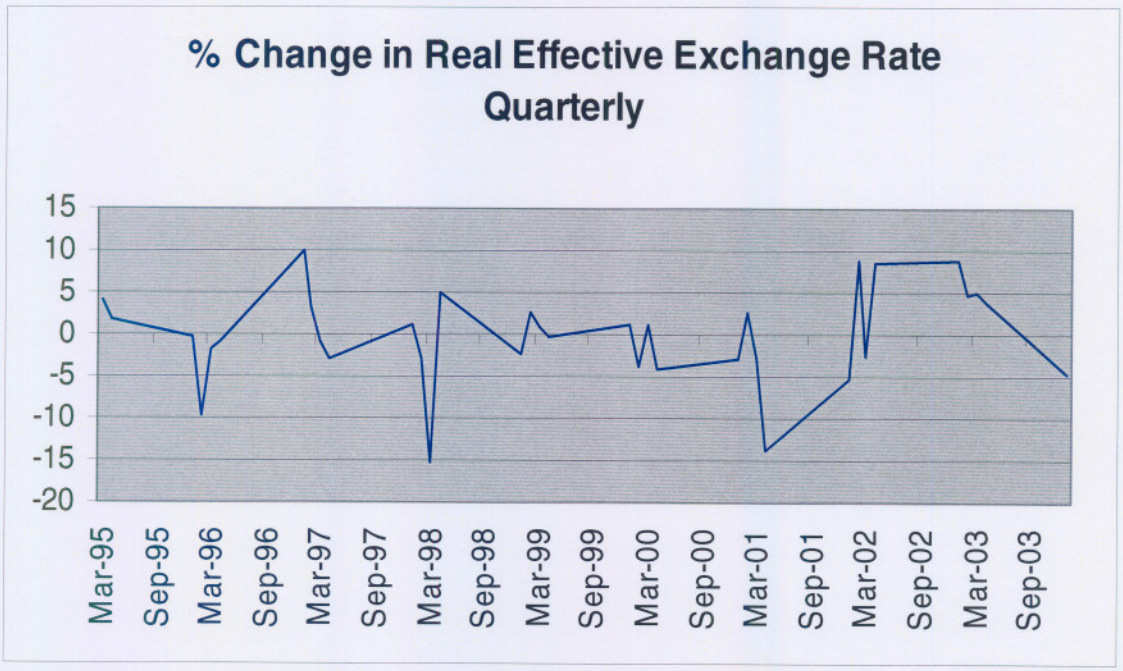
The real effective exchange rate and main variables that were used in the empirical analysis were used over the period 1970 to 2001. The Johansen cointegration estimation techniques were used as the econometric methodology. According to the analysis, the real exchange rate was relatively close to its equilibrium level in the first half of the 1990s. The subsequent depreciation, until early 2002, was due to movements in the explanatory variables. MacDonald and Ricci (2003:2) note that an overestimation problem might have occurred because the calculations that were used did not account for structural factors such as unemployment and the HIV/AIDS pandemic.

Figure 4.1:The real effective exchange rate of the Rand (1990-2004)



Source: SARB

Figure 4.2: The percentage change in the real effective exchange rate of the Rand (1995-2003)



Source: SARB

In the studies of MacDonald and Ricci (2004) and Aron *et al.* (1997), the dependent variable selected for the analysis was the Real Effective Exchange Rate (REER) series published by the SARB, shown in Figures 4.1 and 4.2. The REERs are nominal effective exchange rates adjusted for price differentials between a country and its trading partners.

The Rand's weighted average exchange rate is estimated with trade in manufactured goods as well as the expenditure of manufactured goods between South Africa and its main trading partners as described in an article in the Quarterly Bulletin of the Reserve Bank on September 1999. The weighted average exchange rate of the Rand is calculated against 13 currencies as of 1 January 2003, and the new weights of the four major currencies are (with the weights of 1999 in brackets): Euro 36,38 (35,70), US Dollar 15,47 (15,15), British Pound 15,37 (14,91), Japanese Yen 10,43 (10,26). Index: 1995 = 100 (SARB, 2004).

The SARB's aim with the REER series is to measure South Africa's international competitiveness. The international competitiveness of a country is an important determinant of the increase of exports and the restraint of imports, and thus the promotion of economic growth. Because the concept of international competitiveness is multidimensional, it is difficult to capture it effectively in a single indicator at a macroeconomic level. However, when REERs are properly constructed, they can give a fair indication of relative price competitiveness in international trade, and are widely used for this purpose (Walters and De Beer, 1999:54).

This study limits itself to single equation time series techniques with the aim of determining the long-term fundamental exchange rate against the Euro - with Europe being South Africa's main trading partner - and no research is done on a single currency.

4.6 Summary

Much has been said about determining the equilibrium exchange rate and the estimation of whether a currency is over or undervalued. A variety of modelling approaches can be acknowledged. Firstly the equilibrium exchange rate can be the outcome from a complete macroeconomic model where the real exchange rate is included as a variable in a complete system of equations. This approach is very familiar with the FEER model. Secondly, a partial equilibrium model approach can be altered where a part of the economic system is estimated, and where the other variables are treated as exogenous input variables based only on judgement. This approach is known to be simple, clear and also familiar with the FEER model. Thirdly, a single equation regression approach, identified with a BEER model, can be used to estimate an equilibrium exchange rate. Here, a single equation is used with a number of key variables. Lastly, direct estimates of PPP can be used to measure prices of a similar basket of goods across the different countries. When analysing econometric techniques to estimate the equilibrium exchange rate, time series or panel data series can be used.

Research on the equilibrium exchange rate of the Rand is limited. Only recent studies by MacDonald and Ricci (2004) and Aron *et al.* (1997) looked at the Rand exchange rate. Nevertheless, in both these cases, the weighted average exchange rate of the Rand is used as the dependent variable. For the purposes of this study, the estimation approach of the Rand/Euro BEER will reflect the study done by MacDonald (2001), which models the long-term effective exchange rate of the New Zealand Dollar. Details of the empirical study follow in Chapter 5.

CHAPTER 5

EMPIRICAL ANALYSIS

5.1 Introduction

In the international environment, much has been written on equilibrium exchange rates. Research on the equilibrium exchange rate of the Rand is limited. A search of the South African Journal of Economics reveals that 40 articles have been published discussing the Rand exchange rate since the 1970s (Saayman and Styger, 2005). These articles were published due to changes in exchange rate regimes and the problems related to the different phases as discussed in chapter 2.

Only a few articles focused on the determinants of the Rand exchange rate, and most of these articles were purchasing power parity (PPP) based. MacDonald (1995) and Rogoff (1996) indicated that that the PPP is not an appropriate model for the determination of equilibrium exchange rates due to the slow mean reversion of real exchange rate to a constant level – the long-term equilibrium level. In 2004, MacDonald and Ricci broke away from the pure PPP theory to estimate the equilibrium exchange rate for South Africa.

In the previous three chapters, the history of the South African currency, the theory around equilibrium exchange rates, and the research methodologies to determine equilibrium exchange rates were explored. The aim of this chapter is to identify the factors that influence the long-term value of the Rand/Euro exchange rate, to determine its long-term equilibrium level, and to investigate the effects on the economy if the exchange rate is above or below the long-term equilibrium level. Correspondingly, the gap between the actual and the equilibrium levels will be estimated.

The methodology followed is similar to that proposed by Clark and MacDonald (1998), who engaged time series cointegration techniques in order to connect the real exchange rate to fundamentals. They introduced the idea of the BEER and PEER, discussed in chapter 3, where the equilibrium real exchange rate is obtained by substituting the long-term values of the fundamentals into the estimated cointegration vector (Egert, 2002). The data and methodology is further explored in the next two sections, after which the results and implications of the results follow.

5.2 Data

In chapter 4, reference was made to the previous South African studies on equilibrium exchange rate levels, namely that of Aron *et al.* (1997) and MacDonald and Ricci (2003). The variables that these authors employed in estimating the equilibrium real effective exchange rate of the Rand are indicated in Table 5.1. In both studies quarterly data is used.

Table 5.1:South African exchange rate variables

MacDonald & Ricci	**Aron, Elbadawi & Kahn**
Real interest rate	Terms of trade
Real GDP per capita	Real US Dollar gold price
Real commodity prices	Custom receipts to imports
Openness	Openness
Fiscal balance	Long-term capital flows
Net foreign assets	Total capital flows
	Gross reserves of the SARB
	Government expenditure
	Total domestic credit extension
	Short-term capital flows

Source:Aron *et al.* (1997) and MacDonald & Ricci (2003)

According to MacDonald and Ricci (2003), the main explanatory variables that are identified in the literature for developing countries include commodity price movements or terms of trade, productivity and real interest rates differentials vis-à-vis trading partner countries, measures of openness of the trade and exchange system, the size of the fiscal balance, and the extent of net foreign assets. The investment-to-GDP ratio and the net capital inflows-to-GDP ratio are also often included as variables. The rationale behind most of these variables is based on the neoclassical theoretical framework where it is assumed that the prices of tradeable goods are equalized across countries.

Based on these variables, the fundamentals that were initially chosen for this study are real interest rates, real GDP per capita, the real gold price, openness of the South African economy, gross reserves of the SARB, total domestic credit extended by all monetary institutions, terms of trade excluding gold, net foreign assets, and the fiscal balance. The variable description and abbreviation is indicated in Table 5.2. These were chosen to represent all the various aspects of the economy, including fiscal policy variables, monetary policy variables, international capital variables, competitiveness, and internal growth and will be represented in quarterly data.

A few important facts regarding the data calculations must be noted. Firstly, the real interest rate used is the differential between the real interest rates of the South African Rand and the Euro. Furthermore, the real GDP per capita variable is GDP/population converted into US Dollar terms at a 2000 exchange rate constant according to the method of the SARB. The real exchange rate is determined in an alternative way, as discussed in chapter 4, due to data limitations on the prices of tradeable and non-tradeable goods. This study will determine the real exchange rate as the nominal exchange rate, E, multiplied by a fraction that consists of the foreign wholesale price index, WPI^*, as the numerator and the domestic consumer price index, CPI, as the denominator. See equation (7), section 4.2. (Zhang, 200:86):

$$\text{Real exchange rate} = E\left(\frac{WPI^*}{CPI}\right)$$

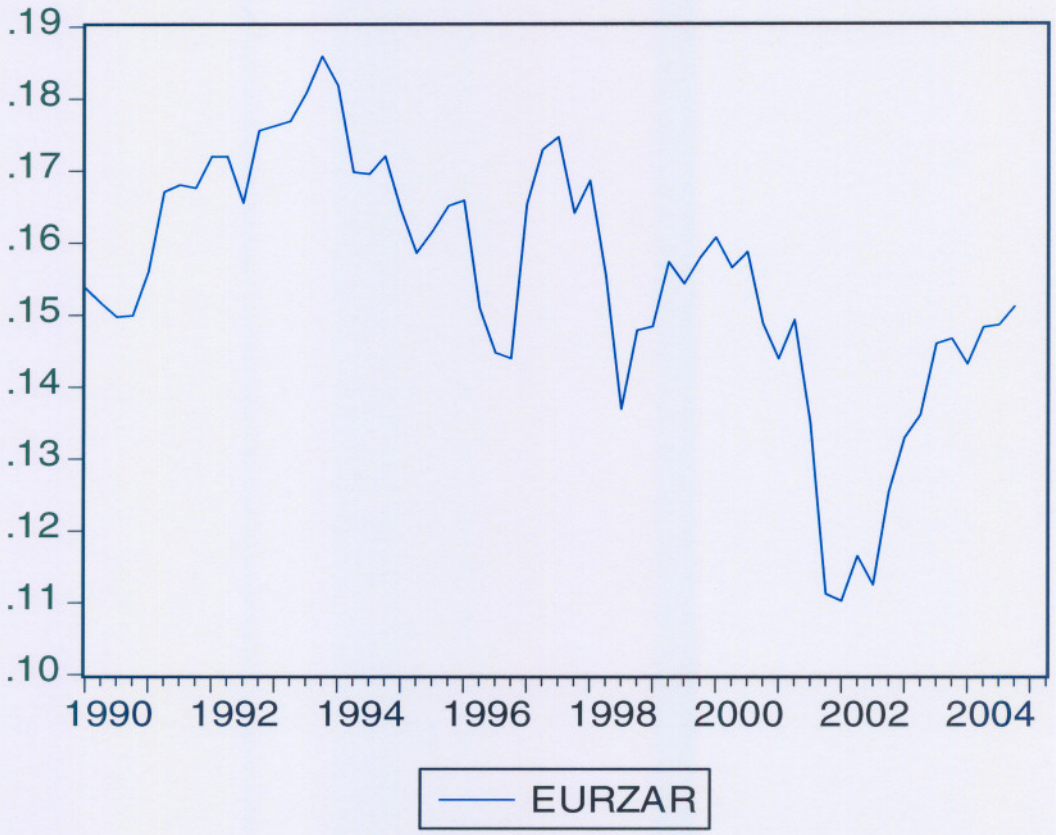
Table 5.2:Data description and sources

Variable	Description	Source
irate	Real interest rate differential: South Africa vs. Euroland	OECD, SARB and INTL
lgdppc	Log of the relative GDP per capita of South Africa vs. Euroland (constant 2000).	SARB
lrgold	Log of the real gold price. The gold price was deflated by the USA CPI	INTL and Wall Street Journal
lopen	Log of the openness of the South African economy; measured as (X+M)/GDP	SARB
lgr	Log of the gross reserves of the SARB as a percentage of GDP	SARB
ldc	Log of the total domestic credit extended as a percentage of GDP	SARB
Ltot	Log of the South African terms of trade (excluding gold)	SARB
nfa	Net foreign assets of the South African monetary sector	SARB
fisb	Ratio of the fiscal balance to GDP	SARB
leurzar	Log of the Rand/Euro exchange rate in real terms	ABSA, SARB and INTL

Productivity is not included in this study since MacDonald and Ricci (2003) indicated that productivity appears to be insignificant in South African exchange rate estimations because labour productivity in the manufacturing sector performs no better than the real GDP per capita as a proxy for the Balassa-Samuelson affect. More on this effect will be discussed in section 5.2.1.1.

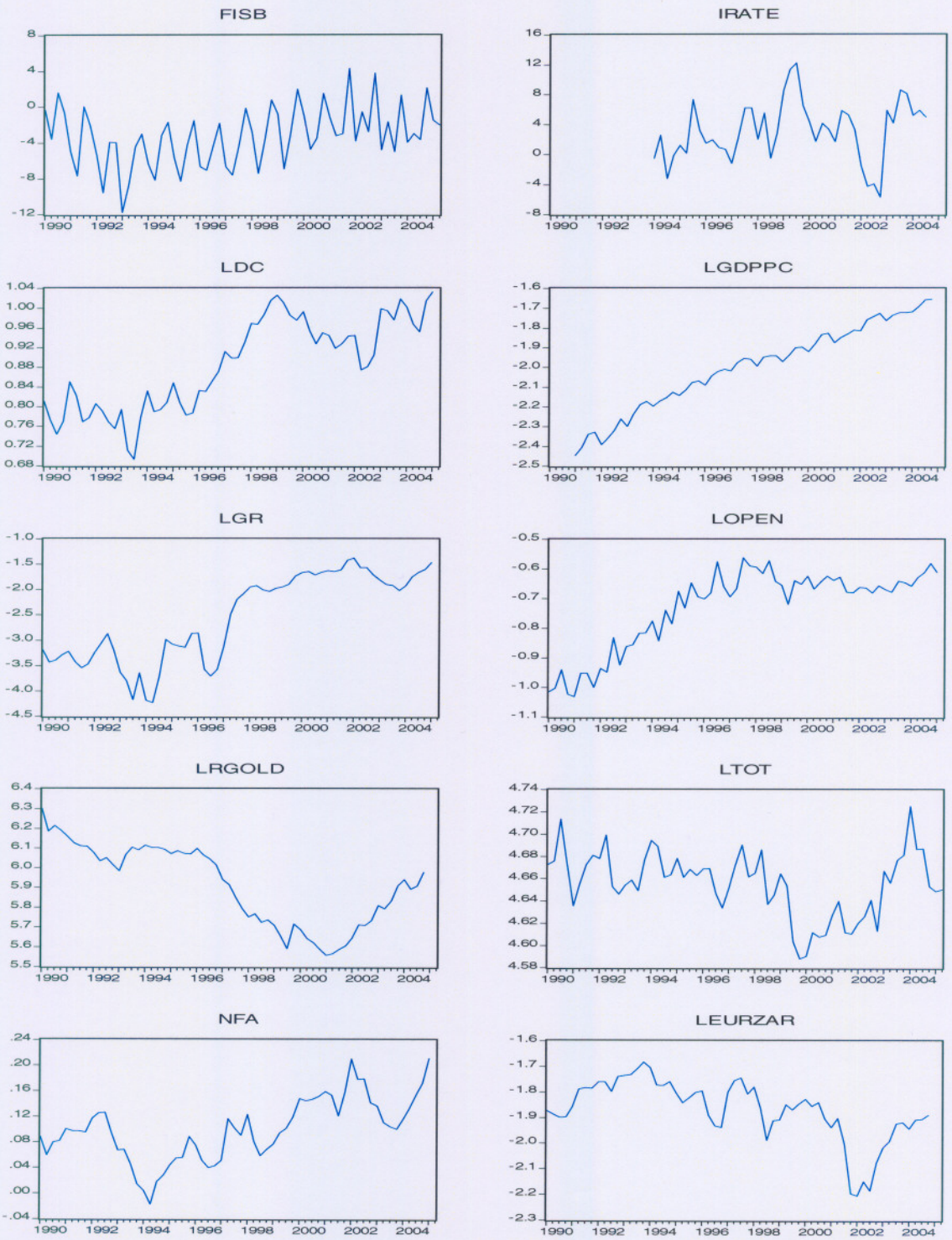
The real exchange rate and the main explanatory variables employed in the empirical analysis are plotted over the period 1990-2005 in Figure 5.1 and Figure 5.2. Note that some of the variables are in log form.

Figure 5.1:The South African real ZAR/Euro exchange rate



Source:Determined with data from ABSA and the South African Reserve Bank

Figure 5.2:Explanatory variables of the South African Real Exchange Rate



Source:Estimated with data form ABSA and the South African Reserve Bank

5.2.1Explanatory variable description

The rationale behind including the various explanatory variables and their expected influence on the exchange rate will now be discussed.

5.2.1.1Real interest rates

Aggregate demand, productivity, and persistent monetary policy are all represented by the real interest rate differentials. All of these factors have a positive relationship with the real exchange rate; an increase in absorption relative to savings would put positive pressure on the real interest rate in an economy that does not have perfect capital mobility. Consequently, demand for tradeable and non-tradeable goods will increase; provoking an increase in the price of non-tradeables and this will lead to an appreciation of the real exchange rate (MacDonald and Ricci, 2003).

Real interest rate differentials may also reflect productivity differentials to the extent that the measures used to proxy the Balassa-Samuelson effect are not perfect. The real interest rate differential may help empirically to capture this, and if the productivity of capital shows an increase with respect to trading partners, capital will flow to the home country, inducing an appreciation of the real exchange rate. The prices of tradeable goods and the interest rate are determined in the world market and are thus exogenous according to the Balassa-Samuelson effect (Egert *et al.*, 2003)

The Balassa-Samuelson effect is a classical example of an equilibrium deviation from PPP. The PPP need not hold between countries with differing levels of development (Guillaumont *et al.*, 2002). In the case of a monetary union, the difference is due to the different prices of non-tradeable goods in each country, which is caused by the different productivity levels in the sectors of goods traded among the union's member countries. This effect can be applied in general to market-oriented economies and trading partners within the same monetary union. For more reading on this effect see Balassa (1964) and Samuelson (1964).

This Balassa-Samuelson effect described the appreciating trend on the real exchange rate when a country experiences an increase in the productivity of the tradeable sector. For given tradeable prices, this strong productivity will induce higher wages in the tradeable sector. If wages are equalized across sectors, non-tradeables would also experience higher wages and an increase in the consumer price index relative to that of trading partners will consequently follow (MacDonald and Ricci, 2004).

The relative price of non-tradeables is not only influenced by differential productivity growth, but also by the balance of productivity growth between the sectors of tradeables and the non-tradeables. This is because balanced productivity growth raises the wage rate and does not have an effect on the rental rate of capital (Motonishi, 2002).

Guillaumont *et al.*, (2002) used the Balassa-Samuelson effect to explain why the exchange rate between two countries with different currencies may move away from PPP when considering the long term and when the levels of per capita income are different. This effect provides a supply-side explanation of the real exchange rate relying on well-built hypotheses of constant returns to scale and perfect international and internal mobility of capital. Note that the Balassa-Samuelson effect is based on the difference between prices of tradeable and non-tradeable goods internationally.

One of the main hypotheses of the Balassa-Samuelson effect as stated by Balassa (1964), is that, assuming prices and marginal costs are equal to the inter-country wage differences in the sector of traded goods, these will match productivity differentials and the internal labour mobility within each economy.

According to a study done by Faria and Leon-Ledesma (2003), the real exchange rates seem to have a long-term impact on the relative growth rate. Furthermore, if the productivity of traded goods grows faster than the productivity of non-traded goods in the home country than abroad, the home country will experience an appreciation of the real exchange rate.

As described by Dornbusch (1976), the tightening in monetary policy would raise real interest rates. This effect can be associated with an expectation of currency depreciation with the interest parity condition as given. In this situation, the nominal exchange rate will appreciate beyond its long-term value in order to allow the expected depreciation to occur once the monetary policy shock had disappeared. If price inflexibility is present, the real exchange rate could also be appreciated relative to its long-term value. This could be persistent if the monetary shock - the rise in real interest rates - is persistent. Cointegration analysis will capture this effect as part of the long-term relationship.

5.2.1.2Real commodity prices

When the price of exported commodities increases, the real exchange rate will be likely to appreciate. An increase in the real exchange rate will lead to higher wages and also to higher prices on non-tradeable goods. If an increase in commodity prices occurs, a positive wealth effect will lead to an increase in domestic demand and prices of non-tradeable goods (Cashin *et al.*, 2002).

Because the terms of trade's numerator encompasses all exports and its denominator reflects the import prices specified in a country, as opposed to the numerator encompassing only commodity based exports and the denominator an industrial county export deflator, these effects should be captured in more detail by the terms of trade.

Many studies show that commodity prices are strongly cointegrated with the real exchange rate of commodity exporters. This is supported by the relative accuracy of the measurement of commodity prices compared to the arbitrariness that is involved in the construction of country-specific export and import deflators. Furthermore, because commodity prices are made available frequently, financial markets can more frequently adapt their financial decisions concerning the currencies of commodity exporters to the prices of these commodities (MacDonald and Ricci, 2003).

Even though the value of gold depreciated over the last few years, it still remains one of the biggest exported commodities from South Africa. For this reason, gold is included as a variable for the purposes of this study.

5.2.1.3Openness of the economy

According to Goldfajn and Valdes (1999), a more open trade regime is associated with a more depreciated real exchange rate. Because trade restrictions increase the price of tradeable goods domestically, the overall price level is increased together with the real exchange rate. For the purpose of this study, the degree of openness is calculated as the ratio of exports plus imports to GDP. This measure is widely used even though it is an imperfect substitute. This reflects a variety of other factors than trade and exchange restrictions (MacDonald and Ricci, 2003).

5.2.1.4Gross reserves of the SARB

The theoretical model states that the stock of foreign exchange reserves is expected to have a positive effect on the real exchange rate. This is consistent with the role of the foreign exchange reserves as a relatively liquid indicator of the stock of national wealth. Reserve movements have shown a tendency to reflect gold prices changes and political events. These movements are more evident for net reserves because the Reserve Bank borrows to support gross reserves when it is under pressure. These actions might reduce the downward trend on the gross reserves.

When the balance of payments has improved, the Reserve Bank has repaid previous reserve-related borrowing with the reserves; this mitigates the rise in gross reserves and reduces the difference between net and gross reserves (Aron *et al.*, 1997).

5.2.1.5Terms of trade excluding gold

The effects of trade shocks are theoretically ambiguous. South Africa's general terms of trade excluding gold shows a deterioration during the 1970s in the study done by Aron et al. (1997), with sharp declines that are associated with shocks due to the oil price and with the general downward trend in primary commodity prices during the same period.

Gelb (1991) found another factor that had a great impact on the terms of trade decline during the 1970s. This was that imports were dominated by capital goods where the rate of rise in the price level of imported machinery was faster than the overall import price index. More stable oil prices and more favourable commodity prices during the 1980s reversed the downward trend. Another contribution to the swing in direction was the fact that a greater proportion of South Africa's exports were manufactured and semi-manufactured goods. This reduced the impact of commodity price fluctuations to some level on the terms of trade as described before in section 5.2.1.2

A variation in the terms of trade will have an effect on the relative price of non-tradeable goods according to the Balassa-Samuelson effect. If there is an increase in the price of exported goods, implying an improvement in the terms of trade, there will be an increase in wages, which tends to increase the prices of non-tradeable goods. Furthermore, when domestic income increases, an improvement in the terms of trade will increase the demand for non-tradeable goods, leaving a further increase in the prices to re-establish market equilibrium (Guillaumont *et al.*, 2002).

5.2.1.6Net foreign assets

The magnitude of net foreign assets is associated with a more appreciated exchange rate in the long term. Increased expenditure on domestic goods results from higher net foreign assets and therefore increases the price of non-tradeables and appreciates the real exchange rate. An alternative mechanism is based on the absence of price equalisation of

tradeables. In other words, a country that has reached a higher level of net foreign assets is in a position to finance a worse current account balance and can thus maintain a loss in competitiveness associated with a more appreciated real exchange rate (MacDonald and Ricci, 2003)

5.2.1.7The fiscal balance

Once the fiscal balance improves, it will have an ambiguous effect on the real exchange rate. Depreciation might occur because the improved fiscal balance would normally induce a less-than-proportional reduction in private saving. This will decrease total domestic demand while overall savings will increase. When part of the decline in spending falls on non-tradeable goods, prices will drop and this will lead to a depreciation of the real exchange rate. If the fiscal improvement comes from a reduction in government consumption, this effect is likely to be stronger. The fiscal effect should be part of the main aggregate demand effect in principle. Whether the interest rate fully captures both effects remains an empirical question (MacDonald and Ricci, 2003).

5.3Methodology

The methodology that will be employed to estimate the equilibrium exchange rate is the single-equation approach to the BEER as discussed in Chapter 5. The five steps to determine the BEER were also discussed in Chapter 3, section 3.4. A quick review on the five steps follows (Egert, 2002):

Firstly, the relationship between the equilibrium real exchange rate and a number of fundamental and transitory factors must be estimated. Cointegration techniques are normally used when variables are non-stationary.

Secondly, the transitory effects are set to zero and the actual values of the fundamentals are substituted into the estimated relationship. The misalignment is then determined by comparing the actual real exchange rate to the estimated one.

Thirdly, the long-term or sustainable value of the fundamentals is estimated. This is done either by decomposing the series into permanent and transitory components by means of a Hodrick-Prescott filter or Beveridge-Nelson decomposition, or by evaluating the long-term value subjectively.

Fourthly, the estimated long-term values are substituted into the cointegration relationship and the variables that influence the equilibrium real exchange rate in the short term are set to zero.

Lastly, the extent of total misalignment from equilibrium is the difference between the actual and the estimated equilibrium real exchange rate.

The methods of Johansen (1995) are used in this study to verify the existence of cointegration, or long-term relationships, and also to generate estimates of the BEER. Studies done by MacDonald and Ricci (2003:10) and MacDonald (2001:4) include the Johansen method in the analysis. In this study, the Johansen (1995) maximum likelihood estimator will be used to correct autocorrelation and endogeneity parametrically with the use of a vector error-correction mechanism (VECM) (MacDonald and Ricci, 2003:10). According to the methodology by Johansen a vector x_t must be defined as follow:

$$x_t = [irate_t, lgdppc_t, lopen_t, lgr_t, ldc_t, ltot_t, nfa_t, fisb_t, leurzar_t, lrgold_t]' \qquad (14)$$

where all the terms are as defined in Table 5.2. Next, it is assumed that a (nx1) vector has a Vector Autoregression (VAR) representation of the form:

$$\mathbf{x}_t = \eta + \sum_{i=1}^{p} \Pi_i \mathbf{x}_{t-i} + \varepsilon_t, \qquad (15)$$

where η is a (nx1) vector of deterministic variables, ε is a (nx1) vector of white noise disturbances, with mean zero and covariance matrix Ξ. Π_i is a (nxn) matrix of coefficients and p is the lag length. Expression (15) can be inserted into the so-called VECM as a new parameter:

$$\Delta\mathbf{x}_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta\mathbf{x}_{t-1} + \Pi_i \mathbf{x}_{t-i} + \varepsilon_t, \qquad (16)$$

where Δ denotes the first difference operator, Φ_i is a (nxn) coefficient matrix that is equal to $-\sum_{j=i+1}^{p} \Pi_j$. Π is a (nxn) matrix equal to $\sum_{i=1}^{p} \Pi_i - \mathrm{I}$.

The presence of cointegration is indicated by the rank of Π. No cointegration amongst the elements in the long-run relationship if Π is either full rank, n, or zero rank, this is when Π=0. In such an event it is more appropriate to estimate the corresponding levels or first differences. On the other hand, if Π is of reduced rank, r, thus r<n, there will exist (n x r) matrices α and β such that $\Pi = \alpha\beta'$ where β is the matrix with linear independent cointegration vectors as columns, and α is the matrix that is interpreted as the adjustment matrix that indicates the response speed to the previous period's deviation from the equilibrium exchange rate level.

Johansen also proposed two tests to determine the existence of cointegration amongst the variables contained in x_t. The existence of cointegration determines the existence of the VECM model, in other words a VAR in first differences. According to the Granger representation theorem in the study done by Engle and Granger (1987), the existence of cointegration among a group of variables implies the existence of an error-correction representation (MacDonald, 2001).

The first test for the existence of cointegration among variables is the Trace test statistics (TR). For the hypothesis that there are r distinct cointegration vectors at most, the form is as follows:

$$TR = T\sum_{i=r+1}^{N} \ln\left(1-\hat{\lambda}_i\right), (17)$$

where $\hat{\lambda}_{r+1},.....,\hat{\lambda}_N$ are the N-r smallest squared canonical correlations that exist between x_{t-k} and Δx_t series that are corrected for the effect of the lagged differences of the x_t process. In this series, all the variables that enter x_t are assumed to be $I(1)$. More detail on how to extract the $\lambda's$ can be seen in Johansen (1988) and Johansen and Juselius (1990).

Secondly, the likelihood ratio statistic (LR) can be used for testing at the most r cointegrating vectors against r+1 can be defined as follows:

$$LR = T\ln\left(1-\hat{\lambda}_{r+1}\right), \qquad (18)$$

Both the TR and LR statistics have non-standard distributions under the null hypothesis as shown by Johansen (1995). These provide approximate critical values for the statistics generated by the use of the Monte Carlo methods. An advantage of the Johansen methodology, as stated by MacDonald and Ricci (2003), is that the estimated coefficient, namely the β vector, can used as measurement proof of the equilibrium real exchange rate and thus a quantification of the gap that occurs between the prevailing real exchange rate and its level of equilibrium (MacDonald and Ricci, 2003). For more reading on the Johansen method and the equations described above refer to Harris and Sollis (2003) and also Favero (2001).

5.4Econometric results

The sample period used in the study is from 1990 quarter 1 up to 2005 quarter 2. All estimates were done using the software package Eviews 5.1. All the variables described in Table 5.2 were tested and the insignificant variables were excluded. This was done with the help of Granger Causality tests and correlation test between the variables and the exchange rate. The results can be seen in Appendix A, Table A1 and Table A2. Note that quarterly data is used.

The Granger Causality tests applied, found that there is an inverse relationship between some variables and the real exchange rate. For example, changes in the real exchange rate cause changes in real interest rates, total domestic credit extended by all monetary institutions, and the fiscal balance. In other words, the exchange rate is more likely to influence these variables than the other way round. Both net foreign assets and gross reserves of the SARB where compared as proxies for the capital account and it was found that gross reserves cointegrates better with the exchange rate. It was found that there exists insignificant correlation between terms of trade and the real exchange; therefore terms of trade were not included. The remaining variables were real GDP per capita, gross reserves and the real gold price.

The method of Ordinary Least Squares was used to estimate an equation in the VAR-space. The dependent variable is the real Rand/Euro exchange rate and the independent variables are real GDP per capita, gross reserves and the real gold price. Thus, according to the methodology of Johansen, the vector x_t will be as follows:

$$x_t = [\ lgdppc_t, lgr_t, leurzar_t, lrgold_t\ ]'$$

The test for cointegration within variables will only be valid when the series are known to be non-stationary. With the use of the augmented Dickey-Fuller unit root tests, it is clear that the variables are non-stationary when using the Johansen test, and that the lagged

polynomial has a unit root. Thus the order of integration of variables is $I(1)$. The VECM that was used also eliminates stationarity within the variables.

Table 5.3: Dickey-Fuller Unit Root Test

Series	Prob.	Series	Prob.
IRATE	0.0192	D(IRATE)	0.00
LDC	0.7875	D(LDC)	0.00
LEURZAR	0.3883	D(LEURZAR)	0.00
LGDPPC	0.4361	D(LGDPPC)	0.05
LGR	0.7953	D(LGR)	0.00
LOPEN	0.1101	D(LOPEN)	0.00
LRGOLD	0.3029	D(LRGOLD)	0.00
LTOT	0.0229	D(LTOT)	0.00
NFA	0.7174	D(NFA)	0.00
FISB	0.6623	D(FISB)	0.00

The Johansen cointegration test is performed in the VAR model to determine existence of cointegration. The trace test that indicates the number of distinct cointegration vectors can be seen in Table 5.4, which suggests that there may be an existence of up to 2 cointegrating equations at a 5 percent significance level. It is evident that the hypothesis of 2 cointegrating equations is not rejected with a probability of 0.2116.

Table 5.4:Trace Test at 5% significance level

Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LEURZAR LGDPPC LRGOLD LGR
Exogenous series: S1 S2 S3 SDUM
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.562513	88.36605	63.87610	0.0001
At most 1 *	0.398380	46.20395	42.91525	0.0226
At most 2	0.311803	20.28936	25.87211	0.2116
At most 3	0.023862	1.231691	12.51798	0.9967

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.562513	42.16209	32.11832	0.0022
At most 1 *	0.398380	25.91460	25.82321	0.0486
At most 2	0.311803	19.05767	19.38704	0.0558
At most 3	0.023862	1.231691	12.51798	0.9967

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5.5:Trace Test at 1% significance level

Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LEURZAR LGDPPC LRGOLD LGR
Exogenous series: S1 S2 S3 SDUM
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.01 Critical Value	Prob.**
None *	0.562513	88.36605	71.47921	0.0001
At most 1	0.398380	46.20395	49.36275	0.0226
At most 2	0.311803	20.28936	31.15385	0.2116
At most 3	0.023862	1.231691	16.55386	0.9967

Trace test indicates 1 cointegrating eqn(s) at the 0.01 level
* denotes rejection of the hypothesis at the 0.01 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.01 Critical Value	Prob.**
None *	0.562513	42.16209	37.48696	0.0022
At most 1	0.398380	25.91460	30.83396	0.0486
At most 2	0.311803	19.05767	23.97534	0.0558
At most 3	0.023862	1.231691	16.55386	0.9967

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.01 level
* denotes rejection of the hypothesis at the 0.01 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5.6:Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: LEURZAR LGDPPC LGR LRGOLD
Exogenous variables: C

Sample: 1990Q1 2005Q2
Included observations: 48

Lag	LogL	LR	FPE	AIC	SC	HQ
0	84.31112	NA	4.14e-07	-3.346297	-3.190363	-3.287369
1	270.2130	333.0742	3.50e-10	-10.42554	-9.645875*	-10.13091*
2	282.1780	19.44316	4.20e-10	-10.25742	-8.854017	-9.727071
3	294.6387	18.17177	5.05e-10	-10.10994	-8.082811	-9.343888
4	322.1581	35.54586	3.36e-10	-10.58992	-7.939051	-9.588152
5	345.6431	26.42067*	2.79e-10	-10.90180	-7.627194	-9.664319
6	372.5127	25.75000	2.17e-10*	-11.35469	-7.456359	-9.881507
7	390.8922	14.55044	2.68e-10	-11.45384	-6.931771	-9.744943
8	416.4804	15.99265	2.91e-10	-11.85335*	-6.707547	-9.908743

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

However, in Table 5.5 it is shown that for a 1 percent significance level, there is only 1 cointegrating equation. Therefore, this study accepts a 1 percent significance level. The hypothesis of 1 cointegrating equation is not rejected with a probability of 0.0226. For the purposes of the study the 1 cointegrating equation at the 1 percent significance level will be used to estimate the long term relationship. MacDonald and Ricci (2003) also used a 1 percent significance level in order to address potential small sample bias in the estimates.

The results for the VECM estimation were obtained using the following variables: the log of the Rand/Euro exchange rate in real terms (leurzar), the log of the relative real GDP per capita of South Africa versus Euroland divided by an average of the US$/Rand monthly exchange rate for the year 2000 (lgdppc), gross reserves of the SARB, and the real gold price. The coefficients of the cointegrating vector appear to be significant, plausible and, importantly, of the correct sign.

The studies by Ricci and MacDonald (2001) and Aron *et al.* (1997) found significant results up to four lags. In Table 5.6 the lag order selection criteria indicates that up to 8 lags can be chosen. Four lags are however included for the changes in the variables for the purposes of this study. Centred seasonal dummies were included, namely s1, s2 and s3, which is quite common when employing quarterly data (MacDonald and Ricci, 2003:11). A structural dummy (sdum) was also introduced and takes the value of 1 for 1998Q1 and 1998Q2 during the Asian crisis and also at 2001Q1, 2001Q2, 2001Q3 and 2001Q4 for the Argentinian currency crisis. The results of the VECM estimates using dummies to control the presence of outliers are shown in Table 5.7. Note that there is an intercept and trend in the cointegrating equation but no trend in the VAR. With the R-Squared value at 0.49 as displayed in Table 5.7, the model might not fit the data perfectly. The linear equation gives the best fit for the data. Other equations were also tested; and their results can be seen in Appendix B.

Table 5.7:Vector Error Correction Estimate with Dummies

Sample (adjusted): 1992Q2 2004Q4			
Standard errors in ( ) & t-statistics in [ ]			
Cointegrating Eq:	**CointEq1**		
LEURZAR(-1)	1.000000		
LGDPPC(-1)	3.716335	(1.41616)	[2.62424]
LRGOLD(-1)	1.007827	(0.44681)	[2.25558]
LGR(-1)	0.772571	(0.16255)	[4.75296]
@TREND(90Q1)	-0.079020	(0.02296)	[-3.44173]
C	7.897148		
Error Correction:	**D(LEURZAR)**		
CointEq1	-0.102083	(0.05216)	[-1.95709]
D(LEURZAR(-1))	0.034290	(0.16397)	[0.20912]
D(LEURZAR(-2))	-0.221839	(0.16347)	[-1.35702]
D(LEURZAR(-3))	0.045343	(0.15416)	[0.29413]
D(LEURZAR(-4))	-0.132292	(0.14539)	[-0.90989]
D(LGDPPC(-1))	0.487977	(0.62859)	[0.77630]
D(LGDPPC(-2))	0.376911	(0.61214)	[0.61573]
D(LGDPPC(-3))	-0.332794	(0.56526)	[-0.58875]
D(LGDPPC(-4))	0.540050	(0.59044)	[0.91465]
D(LRGOLD(-1))	-0.068998	(0.21457)	[-0.32156]
D(LRGOLD(-2))	-0.013296	(0.21942)	[-0.06060]
D(LRGOLD(-3))	-0.102987	(0.22444)	[-0.45886]
D(LRGOLD(-4))	-0.173703	(0.26026)	[-0.66742]
D(LGR(-1))	0.078296	(0.04170)	[1.87756]
D(LGR(-2))	-0.004538	(0.04090)	[-0.11095]
D(LGR(-3))	0.000852	(0.03967)	[0.02149]
D(LGR(-4))	0.063793	(0.03940)	[1.61927]
C	-0.044949	(0.04125)	[-1.08955]
S1	0.072039	(0.05551)	[1.29785]
S2	0.050343	(0.05333)	[0.94395]
S3	0.020075	(0.05560)	[0.36104]
SDUM	-0.110863	(0.03216)	[-3.44764]
R-squared	0.490809		
Adj. R-squared	0.122084		
Sum sq. resids	0.085462		
S.E. equation	0.054286		
F-statistic	1.331098		
Log likelihood	90.61763		
Mean dependent	-0.002532		
S.D. dependent	0.057938		

To confirm that the model is significant and well specified exclusion tests, weak exogeneity tests and normality tests will be performed and discussed, consecutively.

5.4.1Exclusion and Weak Exogeneity tests

The Wald exogeneity test determines which variables can be excluded from the long-term relationship. The exclusion test suggests that none of the variables should be excluded from the long-term relationship. The results from the exclusion test can be seen in Table 5.8, where the significant probability value of each variable is displayed.

Table 5.8:Wald exogeneity test

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1990Q1 2005Q2
Included observations: 51

Dependent variable: D(LEURZAR)

Excluded	Chi-sq	df	Prob.
D(LGDPPC)	1.841005	4	0.7650
D(LRGOLD)	0.949301	4	0.9174
D(LGR)	4.792581	4	0.3092
All	6.234445	12	0.9038

The Lag exclusion test, as indicated in Table 5.9, shows that up to four lags are significant when looking at the joint p-values, and thus necessary in the VECM specification.

Table 5.9:Wald Test for Lag Exclusion

VEC Lag Exclusion Wald Tests Sample: 1990Q1 2005Q2 Included observations: 51					
Chi-squared test statistics for lag exclusion: Numbers in [ ] are p-values					
	D(LEURZAR)	D(LGDPPC)	D(LRGOLD)	D(LGR)	Joint
DLag 1	3.908133	1.793499	1.190964	24.98712	37.55959
	[0.418582]	[0.773671]	[0.879584]	[5.06e-05]	[0.001748]
DLag 2	2.143308	2.231900	0.932228	6.804504	13.45635
	[0.709421]	[0.693194]	[0.919892]	[0.146587]	[0.639144]
DLag 3	0.586381	4.159482	7.611727	17.49129	31.26599
	[0.964565]	[0.384852]	[0.106882]	[0.001551]	[0.012441]
DLag 4	3.967456	0.962582	0.765296	17.60248	27.12168
	[0.410428]	[0.915416]	[0.943039]	[0.001476]	[0.040150]
Df	4	4	4	4	16

5.4.2 Normality tests

The VEC residuals normality tests indicate that the hypothesis stating that the residuals – the difference between the observed value and the fitted value - are normally distributed is rejected due to the excess kurtosis as shown in Table 5.10. According to Paruolo (1997), the Johansen test is not affected when normality is rejected due to excess kurtosis rather than skewness. The data distribution is therefore flat – platykurtic – relative to the normal. In Figure 5.3, the fundamentals' residuals can be seen and it is evident that none of the residuals have a trend in the data.

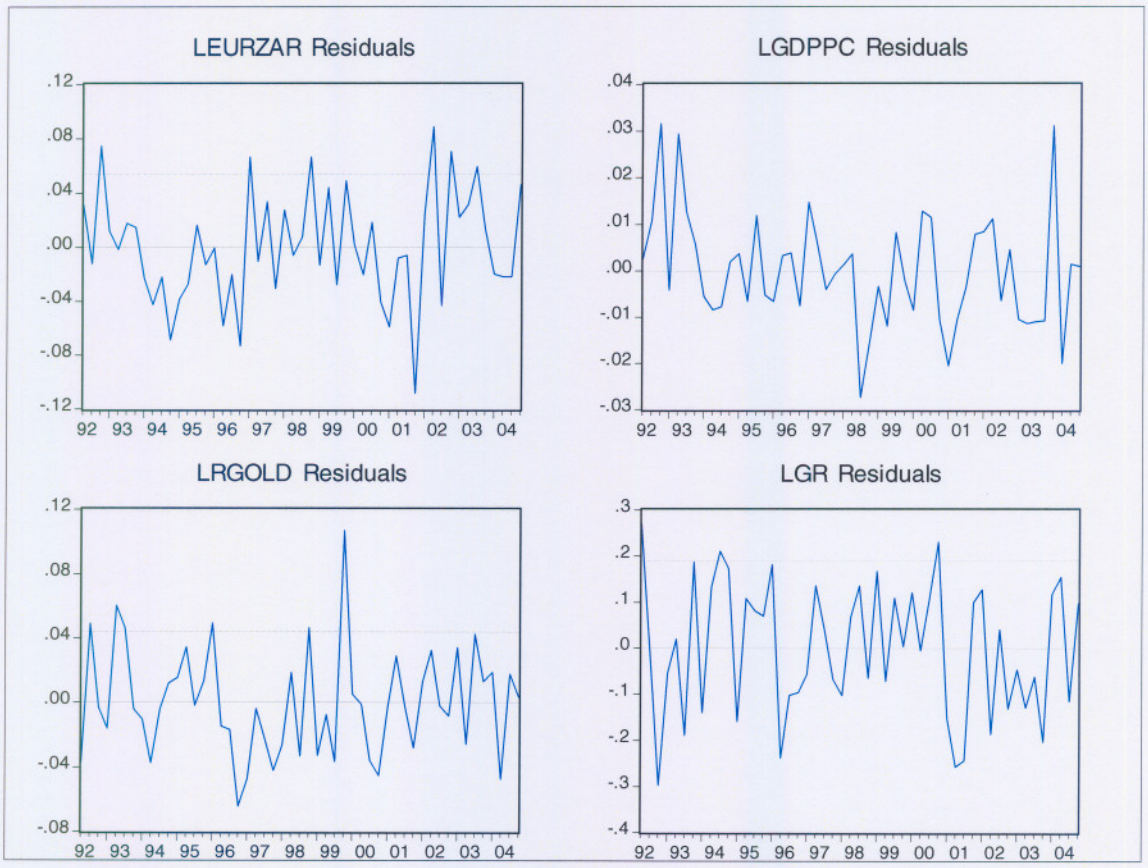
Table 5.10: Vector Error Correction Residual Normality Tests

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1990Q1 2005Q2
Included observations: 51

Component	Skewness	Chi-sq	df	Prob.
1	-0.010474	0.000932	1	0.9756
2	0.209136	0.371772	1	0.5420
3	0.198525	0.335002	1	0.5627
4	-0.115033	0.112476	1	0.7373
Joint		0.820183	4	0.9357

Component	Kurtosis	Chi-sq	df	Prob.
1	0.935318	9.058685	1	0.0026
2	1.165358	7.152561	1	0.0075
3	1.043439	8.134778	1	0.0043
4	0.657659	11.65895	1	0.0006
Joint		36.00497	4	0.0000

Figure 5.3:Residual of the fundamentals



Now that the fundamental variables were analysed and tested for significance in a model, a linear equation can be derived to determine the BEER. The long-term equation will be formulated and evaluated in the following section.

5.5 Equilibrium Real exchange rate

Table 5.7 shows evidence that cointegration occurs between the real exchange rate and the explanatory variables in the long term and, as indicated, it is clear that the coefficient of each fundamental is highly significant. The behavioural, single equation is as follow:

$$leurzar_t = 3.716 lgdppc_t + 0.773 lgr_t + 1.008 lrgold_t - 0.079 trend(90Q1) + 7.897 \quad (19)$$

The relationship between the real exchange rate and these variables can be interpreted in both the long term and short term. These relationships follow in the next section.

5.5.1 The Long-term and Short-term Relationship

1. An increase of 1 percent in the real GDP per capita relative to Euroland will be associated with an appreciation of the real exchange rate of about 3.7 percent.
2. An increase of 1 percent in the real gold price will be associated with an appreciation of the real exchange rate of about 1 percent.
3. An increase of 1 percent in the gross reserves of the SARB will be associated with an appreciation of the real exchange rate of about 0.7 percent.
4. There appears to be a negative trend from the beginning of the time series indicating that the real exchange rate weakened by 0.079 percent.

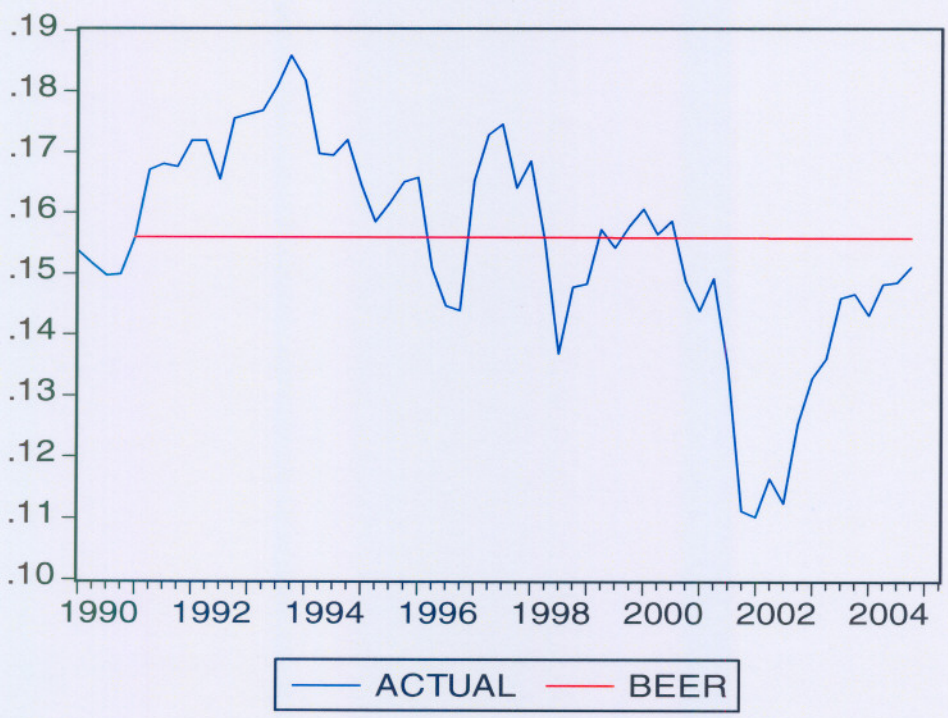
The results obtained by the real gold price are consistent with the strong income effect reflecting the important role of the gold sector in the South African economy and its relatively closed society status vis-à-vis the rest of the economy (Aron *et al*, 1997).

Aron *et al.* (1997) also found gross reserves to have a positive and significant effect, which is consistent with the theoretical role. It has to measure relatively liquid foreign assets as well as the capacity of the Reserve Bank to defend its currency. MacDonald and Ricci (2003) also concluded that the real GDP per capita relative to trading-partner countries is positive and significant.

The short-term effects are found to be insignificant, except for the dummies, and since this study concentrates on the long-term relationship, no more variables were added to the model. MacDonald and Ricci (2003) found insignificant short-term effects across various specifications.

The estimated BEER derived from equation (19) is plotted in Figure 5.4 against the actual real exchange rate in euro per rand. MacDonald and Ricci (2003) and MacDonald (2001) found the estimated BEER to be more volatile than the actual real exchange rate series. The BEER movements in this study are not so clear and visible. One of the reasons for this problem could be the short time series at hand. The real exchange rate is likely to differ from the equilibrium level at any given time because of a change in the explanatory variables that alters the equilibrium level or because temporary factors, such as financial market pressure on the Rand, move the real exchange rate away from it (MacDonald and Ricci, 2003).

Figure5.4:The South African BEER versus the Actual Exchange Rate

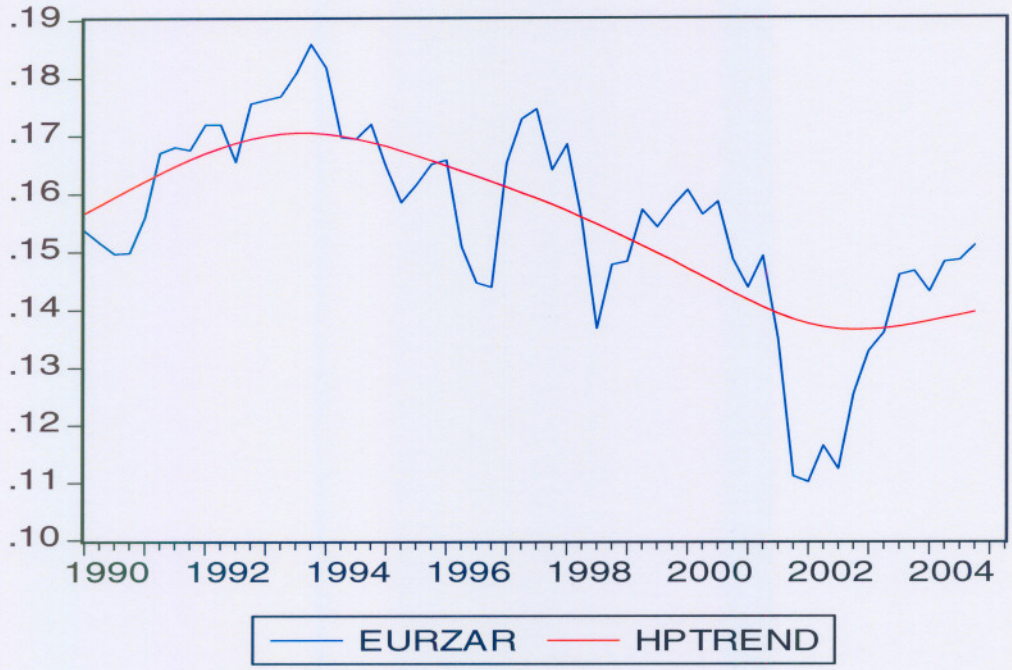


Clark and MacDonald (1999) refer to the over or undervaluation as a current measure of misalignment. It may happen that the variables that enter the BEER calculation are not at their equilibrium values (MacDonald, 2001). A simple way to adjust the variables is to remove the business cycle from the data using a Hodrick-Prescott (HP) filter – in other words determining the PEER.

Clark and MacDonald (2001) proposed an alternative measure, similar to the HP filter. Their measure involves using an atheoretical decomposition of the series into their permanent and transitory components using of a vector moving average representation of the VECM equation (16). Granger and Ganzola (1995) point out that there are linear combinations of Δx_t that have the common feature of not containing the levels of the error-correction model in them. With this identification, Granger and Ganzola obtained permanent and transitory decomposition.

For the purposes of this study the Hodrick-Prescott (HP) filter is used to remove the cyclical components from the data. This measure also generates a measure of total misalignment. The reason for choosing this method is that the PEER equilibrium measurement is an atheoretical way of constructing an equilibrium exchange rate (MacDonald, 2001). In Figure 5.5, the real exchange rate and the real exchange rate HP filter are drawn. The removal of the cyclical components can be seen clearly in the much smoother HP line. Note that the y-axis is marked in euro per rand.

Figure 5.5:The South African Real Exchange Rate and its PEER



With the implementation of HP filters on each variable in the BEER equation, the PEER is estimated. In Figure 5.6, the BEER and PEER graph is drawn and it is clear that, in this study, these estimates are very similar with a slightly negative trend that can be seen in Figure 5.7. Note the small scaling on the y-axis that makes it possible to view the negative trend. For this reason, when the BEER and PEER estimates are compared to the actual data, see Figure 5.8, both these estimates appear to be in a straight line and the BEER line is therefore not visible. The short time series and the linear equation might be the reason for this result.

Figure 5.6:The South African BEER and PEER

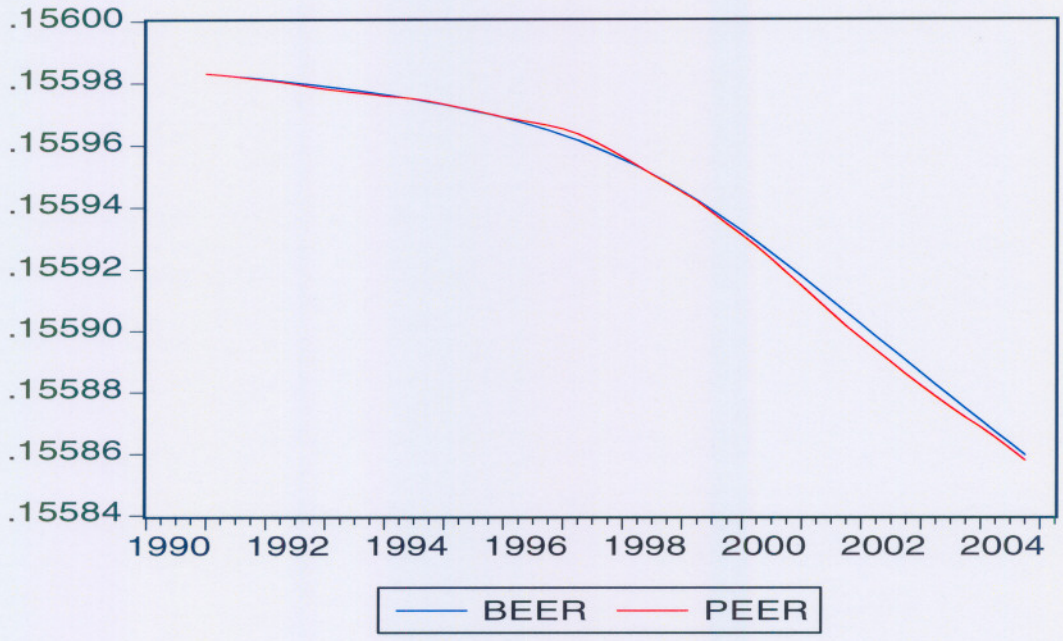
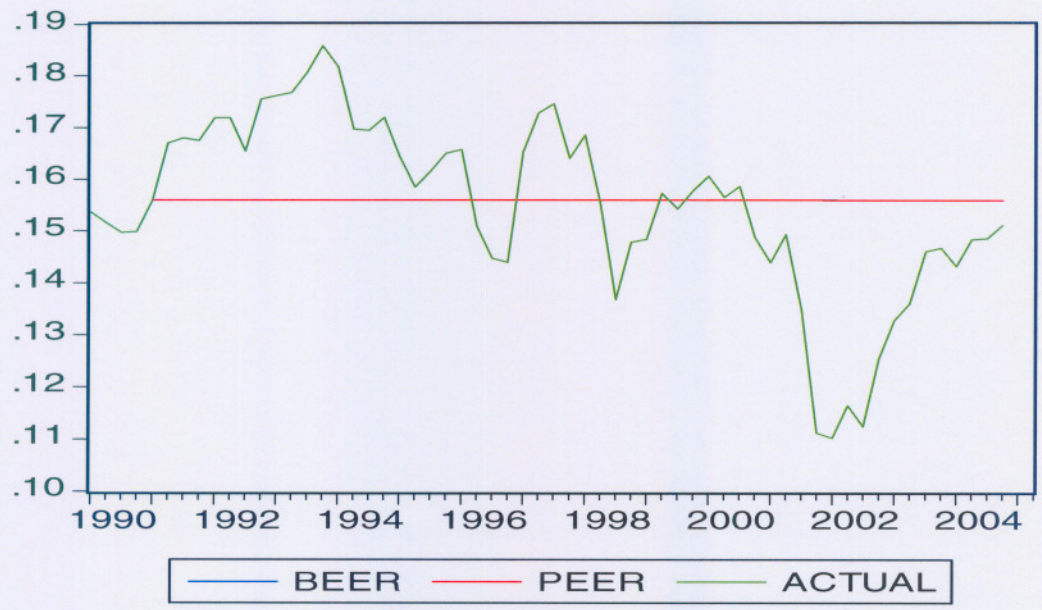


Figure 5.7:The South African PEER and PEER versus the Actual Exchange Rate



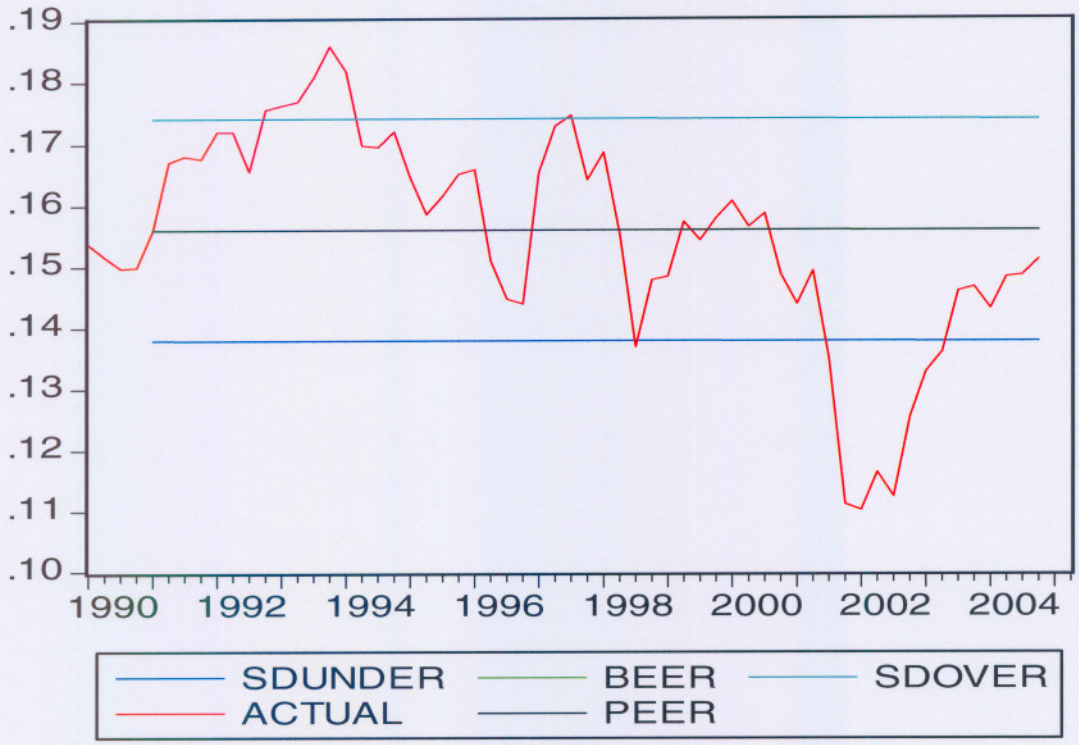
The real exchange rate will tend to converge to its equilibrium level as soon as a gap arises between the exchange rate and its equilibrium level. The adjustment that needs to be made depends on the cause of the gap. The adjustment also requires that the exchange rate must move progressively towards a new equilibrium or it must return to the original equilibrium value from its temporary deviation (MacDonald and Ricci, 2003). At this time, the real exchange rate is very close to the equilibrium.

5.6 Implications

When estimating an equilibrium exchange rate, many difficulties are faced in terms of the correct date, the correct model, the correct econometric techniques and so forth. Akram *et al.* (2003) stated requirements to overcome inaccurate specifications of an equilibrium exchange rate model, namely that the important variables' effects in the medium to long term must be presented in the model and the estimates of the equilibrium values of explanatory variables must be reasonable. In order to draw an accurate conclusion on the valuation of the currency, the difference between the actual and the estimate equilibrium exchange rate must be, as often required, greater than approximately twice the estimated standard deviation.

In Figure 5.8, the estimation of twice the standard deviation can be viewed between SDOVER and SDUNDER. This presents a valuation band and it is evident that at present the exchange rate is within the band, making it difficult to state whether the currency is over or undervalued. South Africa has experienced an appreciating trend, as can be seen in the graph after experiencing a good economic growth rate, lower unemployment levels, and a stable inflation rate within the target level.

Figure 5.8:Standard deviation bands for valuation



When currency turns out to be overvalued, the economy will still move towards the equilibrium exchange rate but domestic prices will have to decrease to make this movement possible. In order for domestic prices to fall, deflation would almost certainly be required. Deflation means lower output and higher unemployment, which will have a negative influence on economic growth. Furthermore, the costs of achieving this deflation in terms of higher unemployment and lower output would be considerable (Wren-Lewis, 2003).

Adjustments through changes in inflation my be achieved at lower cost over a long period where an equilibrium exchange rate can be expected to manifest itself over 20 or 30 years. When the focus is on a real exchange rate that is likely to occur over a medium-term horizon of 5 to 10 years, this might get more interesting (Wren-Lewis, 2003). One factor that brought about some stability in the South African currency, by keeping the Rand at stronger levels, is commodity prices. This is due to the strong production and

export figures of South African commodities. The exchange rate will, however, fluctuate in the short term.

According to the Balassa-Samuelson effect, there will be an appreciation of the real exchange rate if GDP grows faster in the home country than abroad. A stronger GDP, together with a stronger growth rate and lower unemployment levels, will bring about a stronger GDP per capita and, according to the findings of the study, a stronger GDP per capita indicates a stronger exchange rate with a ratio of 1:3.7 percent.

As discussed in chapter 2, the equilibrium exchange rate can be thought of as a weak but steady attractor for the actual exchange rate, which gradually pulls the actual rate towards itself. Deviations from the equilibrium exchange rate may be large and long lasting under a flexible exchange rate system. The flexible exchange rate adds to fast adjustments towards the equilibrium because the nominal exchange rate might move very quickly.

The study by MacDonald and Ricci (2003) found that, due to tight monetary policy, real interest rates increased in the 1990s. In chapter 2, it became evident that monetary policy reacts to the movements of the exchange rate when the task of the monetary authorities is complicated by wide fluctuations in the exchange rate of the Rand. Some of the fluctuations in the capital flows were due to circumstances in other countries and were not connected to domestic economic developments or policies. This further complicated the task of the monetary authorities. Monetary policy must therefore be used consistently to achieve financial stability with the present international arrangements. Fluctuations must be accepted in a world of floating exchange rates, because it is impossible to obtain exchange rate stability under present circumstances.

5.7Summary

In this study, the BEER approach was used to provide a measure of the real exchange rate equilibrium. The study started with the real interest rates, real GDP per capita, the real

gold price, openness of the South African economy, gross reserves of the SARB, total domestic credit extended by all monetary institutions, terms of trade excluding gold, net foreign assets, and the fiscal balance as the independent variables. After a few models were assessed, the most insignificant variables were excluded, and the remaining variables were real GDP per capita, the real gold price, and gross reserves of the SARB.

The Johansen method was used to test for the existence of cointegration between these variables. Trace tests indicated 1 cointegrating equation at a 1 percent significance level. None of the variables proved to be weakly exogenous and therefore none of the variables had to be excluded from the long-term relationship. Significant results were found up to four lags. Hodrick-Prescott filters were used to remove business cycles from the data, determining the PEER. The estimated BEER and PEER values are very similar with a slightly negative trend. When compared with the actual exchange rate, the BEER and PEER appear to be a straight line. One of the possible reasons might be the short time series.

It became evident that the present exchange rate level is very close to the estimated equilibrium exchange rate. The Rand/Euro exchange rate is influenced in the long term by the fundamental variables on a 1:3.7 percent ratio for GDP per capita, a 1:0.7 percent ratio for gross reserves of the SARB, and a 1:1 percent ratio for the real gold price.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1Summary

Fluctuations of exchange rates worldwide, as well as in the South African currency, have demanded a substantial share of attention from economists and analysts over the last few years. These fluctuations reflect the different exchange rate regimes that were implemented not only in South Africa, but also in the rest of the world. Yet, given that the exchange rate fluctuates in the short term, economists generally believe that there is a long-term equilibrium level to which the currency will converge over time. The aim of this study was to estimate the long-term equilibrium exchange rate of the Rand against the Euro – the currency of South Africa's main trading partner.

To reach this objective, the events that led to a changing exchange rate environment had first to be evaluated. In chapter 2, it was indicated that the main change in exchange rate determination occurred after the collapse of the Bretton Woods System, when a transition was made from a fixed exchange rate to a more flexible exchange rate regime. This led to a more volatile monetary framework worldwide as well as in South Africa. After the implementation of a flexible exchange rate regime, different monetary system policies were applied and today South Africa has a formal inflation targeting framework and a free floating exchange rate regime in place. With no government intervention in the foreign exchange market, the Rand has experienced periods of sharp depreciation (especially during the emerging market currency crises) as well as the sharpest appreciation in the last three decades since 2003.

The approach to determine the equilibrium exchange rate had to be established next. The variety of theories on equilibrium exchange rates that focus on different aspects of the equilibrium exchange rate were covered in Chapter 3. Each equilibrium exchange rate

theory was analysed, namely the FEER, DEER, NATREX and the BEER. It became evident in this chapter that the BEER approach, followed by PEER measures, is best for the purpose of this study due to its statistical nature that determines cointegration between the fundamental variables and determines a misalignment with the use of a single equation regression approach.

The most straightforward method of calculating equilibrium exchange rates is purchasing power parity (PPP) but, if this parity does not hold, the equilibrium exchange is likely to depend on a number of macrocconomic variables and relationships that are influenced by a number of macroeconomic forces. Therefore the econometric technique that was used in the study is direct estimates of a single exchange rate equation extracting an estimate of the equilibrium exchange rate as discussed in Chapter 4. The single equation approach was chosen for its simplicity on the one hand and, on the other hand, for the fact that current variables that influence the exchange rate are identified via this approach.

An analysis of previous research on the equilibrium exchange rate of South Africa provided much insight, even though these studies focused on the real effective exchange rate. The application of the BEER approach for the New Zealand currency also provided assistance in the creation of a framework for the estimation of the long-term fundamental of the Rand/Euro exchange rate via a behavioural approach. This made it possible to evaluate the impact of the exchange rate on the current economic structure.

The empirical analysis was conducted in Chapter 5, where the behavioural, single equation approach was applied to South African data in order to estimate the long-term relationship between the Rand and the Euro. Variables similar to those used in previous South African studies as well as the New Zealand BEER study were extracted and the significant variables were identified with the help of the Johansen cointegration test. The identified variables are the real exchange rate between the Rand and the Euro, real GDP per capita, the real gold price, and gross reserves of the SARB.

All these variables proved to be non-stationary in first differences and a vector error-correction mechanism was used in the estimation of the long-term relationship. Further diagnostic tests included exclusion tests on both the lags and exogenous variables in the equation. These tests indicated that all the variables and lags were significant. Significant values were found up to four lags, with two cointegrating equations at the 5 percent significance level and one cointegrating equation at the 1 percent significance level. This study therefore used the 1 percent significance level that also addresses potential small sample bias in the estimates.

The calculated equation used three seasonal dummies and a structural dummy that were added to control the presence of outliers due to both the Asian and Argentinian currency crises. The normality tests on the VECM residuals indicate that the hypothesis, which states that the variables are normally distributed, is rejected due to excess kurtosis. This had no affect on the Johansen test and the results can therefore be accepted.

After the BEER was determined, Hodrick-Prescott filters were used to remove the business cycles from the data and to determine the PEER. Unfortunately, the difference between the BEER and the PEER is very small. This could be due to the short time series available and for the same reason it is found that the BEER is almost a straight line with an intercept and a negative trend in the cointegration equation when compared to the actual data.

6.2 Conclusion

At present the exchange rate level is at 0.151 Euro per Rand, and the estimated equilibrium level is at 0.154 Euro per Rand. The trend in the data is slightly negative implying that the equilibrium level has slightly decreased by 0.079 percent per quarter. The Rand/Euro exchange rate is influenced in the long term by the fundamental variables on a 1:3.7 percent ratio for GDP per capita, a 1:0.7 percent ratio for gross reserves of the SARB, and a 1:1 percent ratio for the real gold price.

The estimated long-term equilibrium exchange rate equation was then compared to the actual exchange rate. Akram *et al.* (1997) stated that the difference between the actual and the estimated equilibrium rate must be approximately twice the standard deviation before the currency can be classified as over or undervalued. It became evident with the standard deviation band that the South African currency was overvalued in the period of 1993 to mid 1994. This might be due to the election period, which occurred in 1994 when the world had confidence in South Africa's economy. In 2001, the South African currency experienced depreciation and from the period mid 2001 to 2003 the South African currency was undervalued. One of the main reasons for the depreciation of the South African currency was the Argentinian crisis in 2000/2001

To conclude the study, it is found that the exchange rate is fluctuating around its long-term equilibrium level and is currently very close to the estimated equilibrium exchange rate. This is a positive sign for the economy, supporting the current stable inflation, low unemployment, and growth rate. The current experience where the exchange rate is appreciating, while the economy experiences strong growth and an increase in employment, supports the notion that the South African currency was undervalued. The stronger currency may, however, have a negative effect on exports while it supports imports. This will have a less positive effect on the economy in terms of growth and employment.

Unfortunately, the time series of data is very short, the results may therefore be biased as predicted by Maeso-Fernandez (2004). In order to eliminate this problem, the study should be repeated when more data are available. Future research may also include a different model, for example the partial equilibrium exchange rate model, to eliminate the shortcomings of the single equation approach and to provide more economic rationale.

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Appendix A

Table A1: Correlation between the exchanger rate and fundamental variables

	LEURZAR
LEURZAR	1.000000
FISB	-0.433994
IRATE	0.252735
LDC	-0.300150
LGDPPC	-0.661501
LGR	-0.547552
LOPEN	-0.187297
LRGOLD	0.491874
LTOT	0.375946
NFA	-0.624982

The following variables have strong correlation with the exchange rate as shown in Table A1:

- fisb – fiscal balance
- lgdppc –GDP per capita
- lgr – gross reserves
- lrgold – real gold price
- nfa – net foreign assets

Table A2:Granger Causality Tests

Pairwise Granger Causality Tests
Sample: 1990Q1 2005Q2
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
FISB does not Granger Cause LEURZAR	56	1.61116	0.18714
LEURZAR does not Granger Cause FISB		0.73332	0.57385
IRATE does not Granger Cause LEURZAR	39	0.52487	0.71821
LEURZAR does not Granger Cause IRATE		3.70037	0.01453
LDC does not Granger Cause LEURZAR	56	0.68053	0.60892
LEURZAR does not Granger Cause LDC		0.44476	0.77562
LGDPPC does not Granger Cause LEURZAR	52	1.80789	0.14483
LEURZAR does not Granger Cause LGDPPC		0.39459	0.81138
LGR does not Granger Cause LEURZAR	56	2.99443	0.02783
LEURZAR does not Granger Cause LGR		0.10077	0.98167
LOPEN does not Granger Cause LEURZAR	56	1.42467	0.24052
LEURZAR does not Granger Cause LOPEN		2.14738	0.08967
LRGOLD does not Granger Cause LEURZAR	56	2.63912	0.04541
LEURZAR does not Granger Cause LRGOLD		0.23874	0.91502
LTOT does not Granger Cause LEURZAR	56	1.61926	0.18510
LEURZAR does not Granger Cause LTOT		1.72948	0.15932
NFA does not Granger Cause LEURZAR	56	2.50881	0.05438
LEURZAR does not Granger Cause NFA		1.36463	0.26052

The following variables granger causes the real exchange rate, as evident from Table A2:

- lgr
- lrgold
- nfa

Appendix B

Other models fitted:

Table B1:No intercept or trend in Cointegration Equation or VAR

Vector Error Correction Estimates
Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LEURZAR(-1)	1.000000
LGDPPC(-1)	-0.630012 (0.21454) [-2.93663]
LRGOLD(-1)	0.211400 (0.06340) [3.33429]
LGR(-1)	0.192820 (0.04156) [4.63906]

Error Correction:	D(LEURZAR)
CointEq1	-0.209449 (0.07372) [-2.84119]
D(LEURZAR(-1))	0.025728 (0.15169) [0.16961]
D(LEURZAR(-2))	-0.173755 (0.15347) [-1.13220]
D(LEURZAR(-3))	0.085891 (0.13838) [0.62069]
D(LEURZAR(-4))	-0.007585 (0.14294) [-0.05306]
D(LGDPPC(-1))	0.318108 (0.53063) [0.59949]
D(LGDPPC(-2))	0.116250 (0.42464) [0.27376]
D(LGDPPC(-3))	-0.285024 (0.48371) [-0.58925]
D(LGDPPC(-4))	0.411484 (0.48926) [0.84104]
D(LRGOLD(-1))	-0.078939 (0.19952) [-0.39563]
D(LRGOLD(-2))	-0.076180 (0.20765) [-0.36688]
D(LRGOLD(-3))	-0.109979 (0.20524) [-0.53586]
D(LRGOLD(-4))	-0.203553 (0.22399) [-0.90878]
D(LGR(-1))	0.058891 (0.03380) [1.74242]
D(LGR(-2))	-0.024437 (0.03348) [-0.72979]
D(LGR(-3))	-0.022790 (0.03376) [-0.67508]
D(LGR(-4))	0.036389 (0.03231) [1.12618]
S1	0.049631 (0.03463) [1.43308]
S2	0.053748 (0.03677) [1.46184]
S3	0.014464 (0.03791) [0.38156]
SDUM	-0.121709 (0.03030) [-4.01649]

R-squared	0.539109
Adj. R-squared	0.231849
Sum sq. resids	0.077355
S.E. equation	0.050779

F-statistic	1.754568
Log likelihood	93.15903
Akaike AIC	-2.829766
Schwarz SC	-2.034308
Mean dependent	-0.002532
S.D. dependent	0.057938

Table B2: Intercept (no trend) in Cointegration Equation - no intercept in VAR

Vector Error Correction Estimates
Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LEURZAR(-1)	1.000000
LGDPPC(-1)	-0.685593 (0.23156) [-2.96070]
LRGOLD(-1)	0.258361 (0.33930) [0.76145]
LGR(-1)	0.212559 (0.09598) [2.21472]
C	-0.338136 (1.88908) [-0.17900]
Error Correction:	**D(LEURZAR)**
CointEq1	-0.195329 (0.07177) [-2.72150]
D(LEURZAR(-1))	0.023579 (0.15301) [0.15410]
D(LEURZAR(-2))	-0.178531 (0.15469) [-1.15409]
D(LEURZAR(-3))	0.079181 (0.13933) [0.56828]
D(LEURZAR(-4))	-0.015069 (0.14385) [-0.10476]
D(LGDPPC(-1))	0.292662 (0.53419) [0.54786]
D(LGDPPC(-2))	0.091753 (0.42770) [0.21453]
D(LGDPPC(-3))	-0.288462 (0.48797) [-0.59114]
D(LGDPPC(-4))	0.389570 (0.49280) [0.79053]
D(LRGOLD(-1))	-0.068982 (0.20117) [-0.34290]
D(LRGOLD(-2))	-0.062118 (0.20859) [-0.29780]
D(LRGOLD(-3))	-0.097597 (0.20636) [-0.47296]
D(LRGOLD(-4))	-0.196581 (0.22605) [-0.86962]
D(LGR(-1))	0.058692 (0.03418) [1.71708]
D(LGR(-2))	-0.023841 (0.03387) [-0.70391]
D(LGR(-3))	-0.021536 (0.03408) [-0.63187]
D(LGR(-4))	0.036821 (0.03263) [1.12851]
S1	0.048239 (0.03489) [1.38263]
S2	0.051996 (0.03702) [1.40438]
S3	0.012998 (0.03821) [0.34020]
SDUM	-0.121175 (0.03059) [-3.96146]
R-squared	0.530905
Adj. R-squared	0.218176
Sum sq. resids	0.078732
S.E. equation	0.051229
F-statistic	1.697649

Log likelihood	92.70912
Akaike AIC	-2.812122
Schwarz SC	-2.016665
Mean dependent	-0.002532
S.D. dependent	0.057938

Table B3: Linear trend in data, Intercept (no trend) in Cointegration Equation and VAR

Vector Error Correction Estimates
Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LEURZAR(-1)	1.000000
LGDPPC(-1)	-0.734063 (0.24301) [-3.02072]
LRGOLD(-1)	0.289691 (0.35607) [0.81357]
LGR(-1)	0.227385 (0.10072) [2.25762]
C	-0.713419

Error Correction:	D(LEURZAR)
CointEq1	-0.180468 (0.07167) [-2.51796]
D(LEURZAR(-1))	0.017742 (0.15655) [0.11333]
D(LEURZAR(-2))	-0.189980 (0.15899) [-1.19492]
D(LEURZAR(-3))	0.091095 (0.14930) [0.61015]
D(LEURZAR(-4))	-0.025628 (0.14703) [-0.17431]
D(LGDPPC(-1))	0.346001 (0.57833) [0.59828]
D(LGDPPC(-2))	0.222481 (0.58837) [0.37813]
D(LGDPPC(-3))	-0.369801 (0.54219) [-0.68206]
D(LGDPPC(-4))	0.471794 (0.56524) [0.83467]
D(LRGOLD(-1))	-0.071833 (0.20681) [-0.34734]
D(LRGOLD(-2))	-0.052018 (0.21246) [-0.24483]
D(LRGOLD(-3))	-0.093311 (0.21061) [-0.44305]
D(LRGOLD(-4))	-0.166772 (0.24024) [-0.69418]
D(LGR(-1))	0.061922 (0.03632) [1.70491]
D(LGR(-2))	-0.025243 (0.03490) [-0.72328]
D(LGR(-3))	-0.022729 (0.03521) [-0.64555]
D(LGR(-4))	0.041463 (0.03547) [1.16909]
C	-0.038425 (0.03910) [-0.98283]
S1	0.062035 (0.05328) [1.16426]
S2	0.063861 (0.05188) [1.23085]
S3	0.025539 (0.05339) [0.47831]
SDUM	-0.119229 (0.03149) [-3.78659]

R-squared	0.526973
Adj. R-squared	0.184436
Sum sq. resids	0.079392
S.E. equation	0.052323
F-statistic	1.538440

Log likelihood	92.49623
Akaike AIC	-2.764558
Schwarz SC	-1.931221
Mean dependent	-0.002532
S.D. dependent	0.057938

Table B4: Quadratic trend in data, Intercept and trend in Cointegration equation – linear trend in VAR

Vector Error Correction Estimates
Sample (adjusted): 1992Q2 2004Q4
Included observations: 51 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LEURZAR(-1)	1.000000
LGDPPC(-1)	7.846721 (2.37037) [3.31034]
LRGOLD(-1)	1.913319 (0.74788) [2.55833]
LGR(-1)	1.407080(0.27207) [5.17178]
@TREND(90Q1)	-0.145002
C	14.55367

Error Correction:	D(LEURZAR)
CointEq1	-0.027479 (0.03548) [-0.77451]
D(LEURZAR(-1))	-0.045814 (0.17440) [-0.26270]
D(LEURZAR(-2))	-0.292870 (0.16918) [-1.73108]
D(LEURZAR(-3))	0.037499 (0.15780) [0.23763]
D(LEURZAR(-4))	-0.139803 (0.14993) [-0.93245]
D(LGDPPC(-1))	0.523198 (0.65343) [0.80070]
D(LGDPPC(-2))	0.481758 (0.63201) [0.76226]
D(LGDPPC(-3))	-0.268920 (0.58188) [-0.46216]
D(LGDPPC(-4))	0.755819 (0.63425) [1.19168]
D(LRGOLD(-1))	-0.095825 (0.22056) [-0.43446]
D(LRGOLD(-2))	-0.015990 (0.22460) [-0.07119]
D(LRGOLD(-3))	-0.105691 (0.23073) [-0.45807]
D(LRGOLD(-4))	-0.126263 (0.26419) [-0.47792]
D(LGR(-1))	0.061969 (0.04383) [1.41391]
D(LGR(-2))	-0.027190 (0.04460) [-0.60967]
D(LGR(-3))	-0.017561 (0.04343) [-0.40439]
D(LGR(-4))	0.048318 (0.04238) [1.14005]
C	-0.096516 (0.05507) [-1.75259]
@TREND(90Q1)	0.001343 (0.00073) [1.85091]
S1	0.076072 (0.05687) [1.33772]
S2	0.053335 (0.05464) [0.97613]
S3	0.025204 (0.05689) [0.44307]
SDUM	-0.117922 (0.03397) [-3.47105]

R-squared	0.488591
Adj. R-squared	0.086770
Sum sq. resids	0.085834
S.E. equation	0.055367

F-statistic	1.215943
Log likelihood	90.50683
Akaike AIC	-2.647327
Schwarz SC	-1.776111
Mean dependent	-0.002532
S.D. dependent	0.057938