

**The effect of real exchange rate  
misalignment on economic growth in South  
Africa**

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## Abstract

The growth performance of the South African economy over the past two and a half decades has been disappointing. The economy has not reached the high growth rates of the 1960s, which is desperately needed to alleviate poverty in the country. While the sources of growth have been a subject of much debate, recently the notion that the Real Exchange Rate (RER) level of a country matters for growth has attracted attention. While it is generally expected that the value of the currency should not remain constant and that the exchange rate fluctuates over time, in the long-term, it is expected to converge to an equilibrium level

South Africa follows an inflation targeting framework and a free floating exchange rate regime. The exchange rate has been highly volatile since the abolishment of the dual exchange rate system in 1995. This implies that there were periods of overvaluation and undervaluation from the equilibrium level; in other words the rand experienced times of misalignment. In the event of misalignments, the RER is moved to levels which make it difficult for an economy to sustain international competitiveness over the long-run, and this is harmful to growth rates in the economy. This is especially true for countries, such as South Africa, which is heavily dependent on exports. The RER is therefore very powerful and has been argued to be the cause of loss of competitiveness and growth slowdowns. This study investigates this notion for South Africa.

The main aim of this study is therefore to investigate the effects of RER misalignment on economic growth in South Africa. This implies that the study aims to determine the level of RER equilibrium, the misalignment in the real value of the rand, and how this misalignment has affected economic growth in the country.

The Behavioural Equilibrium Exchange Rate (BEER) approach is followed to determine the Equilibrium Exchange Rate (EER), which allows for the use of fundamental macroeconomic variables to determine the real equilibrium level of the rand. Identified fundamental variables, which are the main drivers of the current RER in South Africa, include GDP per capita, trade openness, terms of trade, gross fixed capital formation and the real interest rate differential. A Vector Error-Correction Mechanism (VECM) is used in the estimation of the Real Equilibrium Exchange Rate (REER). Misalignment is calculated as the difference between the actual and the equilibrium real exchange rate. It is found that during the

period under investigation (1985 to 2011) there have been substantial misalignments in the RER of the rand, though the currency was mostly overvalued. It is also shown that the rand does revert to its equilibrium level over time.

The least square method is used to determine the effect of this RER misalignment on economic growth. Additional variables such as the initial level of GDP per capita, trade openness, terms of trade as well as gross fixed capital formation, are included in the growth specification. Trade reforms emphasise the importance of export-led growth in a commodity-rich economy, such as South Africa. The results indicate that the RER misalignment has a positive coefficient; this implies that a misalignment in the rand has not necessarily been harmful to economic growth. Therefore, it can be concluded that in the case of South Africa, misalignment is generally stimulating growth, but more so when the currency is undervalued. The results therefore show that the RER should be kept at competitive levels in order to boost economic growth in the country. The results also show support for the strategy of export-led growth in South Africa.

**Key terms:** behavioural equilibrium exchange rate, economic growth, misalignment, overvaluation, South Africa, undervaluation

## Opsomming

Die groeiprestasie van die Suid-Afrikaanse ekonomie oor die afgelope twee en 'n half dekades was teleurstellend. Die ekonomie het nie die hoë groeikoerse van die 1960's, wat dringend nodig is om armoede in die land te verlig, bereik nie. Terwyl die bronne van groei 'n onderwerp is wat heelwat debat ontlok, het die idee dat die reële wisselkoersvlak van 'n land van belang is vir groei, onlangs aandag getrek. Terwyl dit algemeen verwag word dat die waarde van die geldeenheid nie konstant bly nie en dat die wisselkoers met verloop van tyd skommel, word dit oor die lang termyn verwag om na 'n ewewigvlak te konvergeer .

Suid-Afrika volg 'n inflasieteiken-raamwerk en 'n vryswewende wisselkoersregime. Die wisselkoers was sedert die afskaffing van die dubbele wisselkoersstelsel in 1995 baie onstabiel. Dit impliseer dat daar periodes van oorwaardering en onderwaardering vanaf die ewewigvlak was, met ander woorde, die rand het tye van wanpassing ervaar. In die geval van wanpassings word die reële wisselkoers verskuif na vlakke wat dit moeilik maak vir 'n ekonomie om internasionale mededingendheid oor die lang termyn te handhaaf, en dit is skadelik vir groeikoerse in die ekonomie. Dit is waar vir veral lande, soos Suid-Afrika, wat sterk afhanklik van die uitvoer is. Die reële wisselkoers is dus baie sterk, dit word aangevoer as die oorsaak van die verlies van mededingendheid en groeivertraging. Hierdie studie ondersoek hierdie idee vir Suid-Afrika.

Die hoofdoel van hierdie studie is dus om ondersoek in te stel na die gevolge van die reële wisselkoerswanpassing op ekonomiese groei in Suid-Afrika. Dit impliseer dat die studie ten doel het om die vlak van die reële wisselkoersewewig, die wanpassing in die reële waarde van die rand, en hoe hierdie wanpassing ekonomiese groei in die land geraak het, te bepaal.

Die gedragsewewig-wisselkoersbenadering word gevolg om die ewewigswisselkoers vas te stel, wat die gebruik van fundamentele makro-ekonomiese veranderlikes moontlik maak om die regte ewewigvlak van die rand te bepaal. Geïdentifiseerde fundamentele veranderlikes, wat die belangrikste drywers van die huidige reële wisselkoers in Suid-Afrika is, sluit in die BBP per capita, die openheid van handel, die ruilvoet, bruto vaste kapitaalvorming en die reële rentekoers-differensiaal. 'n Vektor-foutaanpassings model word gebruik in die beraming van die werklike ewewigswisselkoers. Wanpassing word bereken as die verskil tussen die werklike en die ewewig-reële wisselkoers. Daar is gevind dat gedurende die tydperk van die ondersoek (1985-2011) daar reeds aansienlike wanbalanse in die reële wisselkoers van die rand was, maar die geldeenheid is meestal oorwaardeer . Daar word ook aangetoon dat die rand terugkeer na sy ewewigvlak met verloop van tyd.

Die kleinste-kwadraatmetode is gebruik om die effek van die reële wisselkoers-wanpassing op ekonomiese groei te bepaal. Addisionele veranderlikes soos die aanvanklike vlak van BBP per capita, die openheid van die handel, die ruilvoet, sowel as bruto vaste kapitaalvorming, is ingesluit in die groeispesifikasie. Handelshervormings beklemtoon die belangrikheid van die uitvoer-geleide groei in 'n kommoditeit-ryk ekonomie, soos dié van Suid-Afrika. Die resultate dui daarop dat as 'n reële wisselkoers-wanpassingskoëffisiënt positief is, 'n ondergewaardeerde geldeenheid groei stimuleer, terwyl die oorwaardering nie noodwendig skadelik vir groei is nie. Daarom, wanpassing stimuleer oor die algemeen groei in Suid-Afrika, maar meer so wanneer die geldeenheid onderwaardeer is. Die resultate toon dus dat die reële wisselkoers op mededingende vlakke gehou moet word ten einde ekonomiese groei in die land te verhoog. Die resultate toon ook ondersteuning vir die strategie van die uitvoer-geleide groei in Suid-Afrika.

**Sleuteltermes:** ekonomiese groei, gedragsewig-wisselkoers, oorwaardering, onderwaardering, Suid-Afrika, wanpassing

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## List of Abbreviations

ADF: Augmented Dickey-Fuller

ANC: African National Congress

ASGISA: Accelerated and Shared Growth initiative for South Africa

BEER: Behavioural Equilibrium Exchange Rate

CA: Current Account

CEE: Central and East European

DEER: Desired Equilibrium Exchange Rate

EER: Equilibrium Exchange Rate

ERER: Equilibrium Real Exchange Rate

FDI: Foreign Direct Investment

FEER: Fundamental Equilibrium Exchange Rate

GATT: General Agreement on Tariffs and Trade

GDP: Gross Domestic Product

GEAR: Growth, Employment and Redistribution

GEIS: General Export Incentive Scheme

HP: Hodrick-Prescott

ICP: International Price Comparison Programme

IFS: International Financial Statistics

IMF: International Monetary Fund

KA: Capital Account

LM: Langrage Multiplier

LOOP: Law of One Price

LR: Likelihood Ratio

NATREX: Natural Rate Of Exchange

NFA: Net Foreign Assets

NTB: Net Trade Balance

OECD: Organisation for Economic Co-Operation and Development

PEER: Permanent Equilibrium Exchange Rate

PPP: Purchasing Power Parity

R&D: Research and Development

REER: Real Effective Exchange Rate

RER: Real Exchange Rate

RSA: Republic of South Africa

SAICA: The South African Institute for Chartered Accountants

SARB: South African Reserve Bank

SARS: South African Revenue Services

TFP: Total Factor Production

TNT: Non-Traded Goods

TOT: Terms of Trade

TR; Trace ratio

UIP: Uncovered Interest Parity

UNCTAD: United Nations Conference on Trade and Development

US: United States

VAR: Vector Autoregressive

VECM: Vector Error Correction Model

WTO: World Trade Organisation

# Chapter 1 Introduction and Problem Statement

## 1.1 Background

The South African economy has grown substantially since 1994. The new government implemented much needed changes that have resulted in impressive growth in the economy. The average real Gross Domestic Product (GDP) growth rate for the decade since 1994 (1995-2004) was 3% and in per capita terms 1% (SARB, 2012). According to Du Plessis and Smit (2007), economic growth in the economy, can be attributed, in part, to the openness of trade and capital flows, which has seen the transition of the economy. Brave macroeconomic reforms have boosted competitiveness, leading to growth, job creation and an opening up of South Africa (SA) to world markets; these have in turn built a solid macroeconomic structure. According to the South African Reserve Bank (SARB), the country has experienced an unprecedented 62 quarters of economic growth from the first quarter of 1993 until the interruption brought by the United States (US) financial crisis of 2008/9. The South African economy went into recession for the first time in 15 years during the third quarter of 2008 when the US financial crisis made its presence felt. This recession continued to 2009 where GDP growth was at -6.4% and -3% in the first and second quarter, respectively. Just prior to the crisis, in the year 2006/7, the country had its first ever budget surplus of 0.3%. These macroeconomic reforms and policies have built a concrete macroeconomic structure.

In addition to the above, the taxation rate has declined continually during the period from 1994 until 2010, tariffs have been dropped substantially, and this has also encouraged international trade. The fiscal deficit has been decreased and inflation has been curbed – as at November 2010 it stood at 3.7%, whereas its highest point was 20.8% in January 1986 (IMF, 2011).

Exchange controls in the country have also been greatly relaxed over the years of which the liberalisation of the exchange rate formed a central part. During the 1980s to the mid-1990s, the rand exchange rate was determined according to a managed floating system and the dual exchange rate; the commercial rand and the financial rand were in use (Saayman, 2007). The financial rand was abolished in 1995 and exchange rate controls were then relaxed, which left South Africa with one exchange rate which has proven to be highly volatile (van der Merwe, 2003). After the dual exchange rate system was abolished, there was some stability in the rand for a short period; however; the volatility began to escalate in February 1996. Between end of March 1996 and April 1996 the effective exchange rate of the country took an 8% plunge. The prime rate also rose

substantially and reached a high of 20.5% in May 1996 whilst the rand lost 15.7% to a basket of currencies (Saayman, 2007).

The Growth, Employment and Redistribution Programme (GEAR) changed the perceptions of the international market towards South Africa and the 1997 Asian crisis did not have the detrimental effect on the economy as would have been the case had it not been for the programme. However, the rand fell by approximately 8% in 1998. The Russian crisis, which occurred as the South African Reserve Bank governor had reached the end of his term, also hurt the South African currency which lost 23.2% of its value against the dollar from May to July 1998 (Steyn, 2004).

The vulnerability of the rand continued during the emerging market crises that occurred in Brazil and Argentina in 1999 and 2001/2, respectively, which led to financial instability in the world. As a result of these crises, the nominal effective exchange rate of the rand decreased by 12.5% in 2000 and by a further 34.5% in 2001. The Reserve Bank implemented a formal inflation targeting approach and a flexible exchange rate in February 2000 (Fourie, 2007). This approach has not really made the rand immune to crises and devaluations; however, Steyn (2004) states that a lesson learnt from all the crises is that it does not work to try and manage the value of the rand when there is pressure on it to weaken.

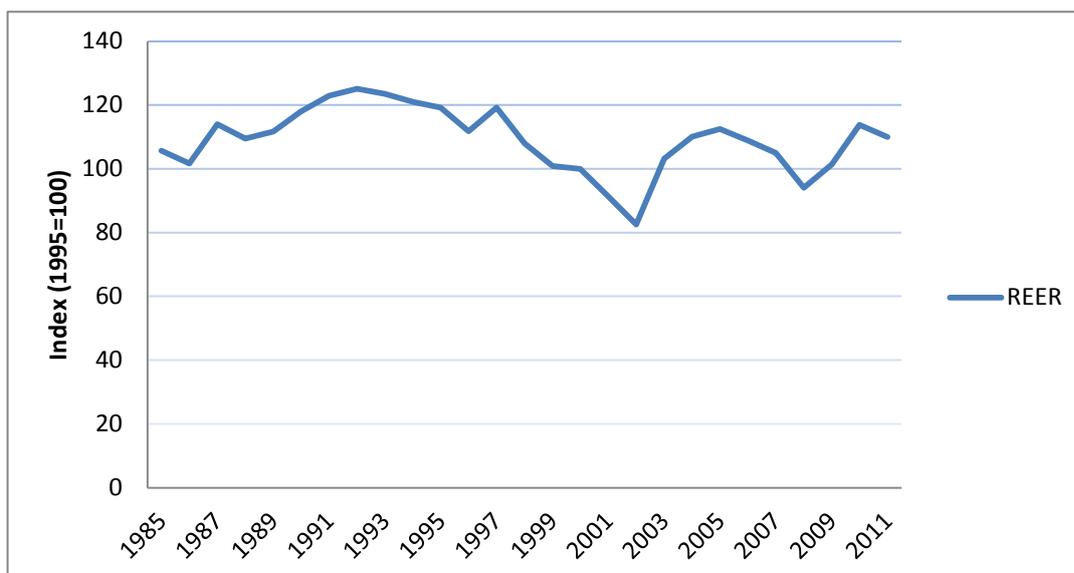
The rand has strengthened against currencies of developed countries since 2002 with the aid of the inflation targeting approach and the flexible exchange rate. The value of the rand has continued to increase against developed currencies over the years 2002 to 2008. According to van der Merwe (2003), the recovery in the rand in 2002 marked the first time in 30 years that such a sharp reversal in the exchange rate of the rand occurred. Despite the movements in the rand after changes in macroeconomic trade and exchange rate policies had been made, changing these policies, together with accelerated integration into global markets, led to a rapid growth in merchandise exports, which is partly related to improved export incentives (Lewis, 2001).

The growth and positive picture painted above of the South African economy is offset by the perception that the performance of the country has been disappointing since 1994. These perceptions are fuelled by the inconsistent real GDP growth rate, job losses in the formal sector that continue to increase, and that the key objectives of poverty reduction and improved service delivery remain unmet (Lewis, 2001). Domestic savings in South Africa continue to be low, private savings have been stable, and government savings have been fairly volatile reaching negatives in the early 1990s (Johnson and Teffer, 2001).

One very disappointing statistic for South Africa remains its inability to attract foreign investment. Between 1994 and 1999, Foreign Direct Investment (FDI) in South Africa was less than 1% of GDP and estimates show that this figure fell below 0.5% in 2000 (SARB, 2012). This has changed over the years having been reported at 3.49% of GDP in 2008, according to the World Bank (2012). However, this is still low and this can be attributed to several factors, including global imbalances pertaining to RER and their effect on influencing perceptions about the South African economy.

Rahman and Serletis (2009) argue that the openness of the economy to capital flows and the increase in financial transactions in recent years did not just increase growth but had an adverse effect on the exchange rate, in the sense that it became more volatile. By the end of 2011, the exchange rate remains volatile and growth is picking up slowly in the South African economy. Berg and Miao (2010) give good reason and evidence that suggest the importance of the RER for economic growth. The “Washington Consensus” view is that RER misalignments are caused by macroeconomic imbalances which themselves are not good for growth. Berg and Miao (2010) also find that the determinants of exchange rate misalignment are likely to be drivers of growth, which assert the relationship between exchange rate misalignments and growth. The exchange rate can be argued to work through production costs, which impact investment and ultimately growth.

The years 2004 to 2011 were characterised by a number of events that have shaken the value of the rand greatly, some which prove the resistance of the rand to external factors. Some foreign investors still see it as a safe haven in times of currency crises, hence the strong inflow of foreign capital during the European crisis of 2011. Figure 1.1 depicts the trend for the Real Effective Exchange Rate (REER) from 1985 through to 2011, when the rand experienced strong volatility. Using data from 1972 to 2003 and an equilibrium correction model of the rand’s RER drawn on existing literature, Mtonga (2006) finds that from 1994 to 1996, as well as 1998, the rand’s RER was undervalued by approximately 10%. By 2002, this undervaluation had reached 20%. The strong recovery of the rand in 2002 reversed this overshooting and pushed the RER above its equilibrium by an average of about 16% by the end of 2003. South Africa lost much trade competitiveness during 2003, exports fell significantly resulting in growth decline; a nominal depreciation was needed to correct the imbalance. The REER shows depreciation from 2005 until 2008 and a rebound in 2009, which has awakened much discussion amongst different stakeholders about its impact on job creation, manufacturing output and growth in exports.



**Figure 1.1 Real effective exchange rate of the South African rand (1985-2011)**

Source of data: South African Reserve Bank (series: KBP5378J)

Since the recovery of the rand after 2002, the trend has been fairly positive but there have been calls by different stakeholders to have the rand depreciated as the strong rand is believed to have weakened trade competitiveness and undermined growth. Whether the rand should be depreciated or not is outside the scope of this study; the focus is whether the misalignments have affected growth and if so, to what extent. The South African exchange rate policy stance will also not be discussed in this study as currency appreciation is inevitable with any regime.

## 1.2 Problem Statement

International trade has grown substantially over the years, countries have become more financially integrated, and this integration has contributed to the rise in global imbalances. By global imbalances, or more precisely global current account imbalances, one normally implies the large current account deficits and surpluses that have emerged in the world economy. According to Adams and Park (2009), persistent global imbalances can be viewed as the continuous financing of United States (US) consumption with the net savings of the surplus countries. The imbalances have centred on the large current account deficits of the US, which peaked at close to 6% of GDP in 2006 (IMF, 2012), and the corresponding surpluses in the rest of the world. These imbalances make the study of the impact of currency misalignments on growth important as it can be postulated that RER gaps are bound to affect economic growth of countries. Questions that need to be addressed include

the

following:

- (1) If these RER imbalances persist, how does it affect a country's growth potential?
- (2) Does deviation from exchange rate equilibrium create growth opportunities and constraints? or
- (3) Does economic growth rather flourish under exchange rate stability?

Theoretically, there is a rather indirect relationship between RER misalignment and growth. The economy may be affected through many different channels and these include domestic and foreign investment through its effects on the capital accumulation process. The economy may also be affected through the tradable goods sector and the competitiveness of the sector when compared to the international market (Abida, 2011). This relationship between RER misalignment and growth will be discussed further in this study.

Research based on the Maghreb countries (Morocco, Tunisia and Algeria) has found that a misaligned exchange rate can either help or harm long-run economic growth (Abida, 2011). As it has been mentioned in the background, there are perceptions that South African economic growth has not been as impressive as some researchers would like to believe. This means that there is potential for higher growth levels, this research investigates the exchange rate misalignment as a limiting factor to this potential for higher growth.

Razin and Collins (1997) found that a volatile economic environment, such as the volatility of terms of trade, the exchange rate, money supply and productivity, have a harmful effect on economic performance. Razin and Collins (1997), in their investigation of the relation between economic growth and RER misalignment, found that RER misalignment can influence domestic and foreign savings by influencing the capital accumulation process which is a well known engine of growth. South Africa only receives 3.49% of the world's investments, as indicated above, and South Africans are constantly being encouraged to save as there are not enough domestic savings. Could it be that this misalignment in the rand is affecting the level of investment in the country? Is it contributing towards scaring away investors? According to Calvo, Leiderman and Reinhart (1993), capital inflows for most countries have been accompanied by an appreciation in the RER, faster economic growth, and the accumulation of international reserves, booming real estate and stock markets, and a strong recovery of secondary-market prices for foreign loans.

In the past, capital inflows were stimulated by economic and political reforms that have taken place in developing countries, as well as the restructuring of external debts. An increase in capital inflows leads to a further appreciation in the RER in most countries, which was also the case in the Latin American countries. When there are high volumes of capital from abroad, the need for greater

domestic absorption develops (Perkins, Radelet and Lindauer, 2006). In addition, the more people are educated, the larger is investment in human capital, and economic development takes place. The higher the level of economic development, the more capital flows to that particular country, and the more the currency appreciates and the cycle continues (Calvo, Liederman and Reinhart, 1993).

This has not been the case in South Africa and it is important to investigate the contribution of RER misalignment on the relative weak economic growth performance of the country. A brief review of the performance over the last decade yields the following: The South African rand was undervalued in 2001 when it lost 37% of its value and reached a low of R13,84 against the US dollar (IFS, 2012); this however had a positive effect on exports as they became cheaper for foreign buyers. By 2001, the mix of exports reflected a structural shift away from mineral exports toward manufactured exports (National Treasury, 2008). However, this did not result in an increase in investment in the economy. With the appreciation of the rand between 2002 and 2008, manufacturers felt that the rand was overvalued, their traded and non-traded goods were more expensive and their exports have decreased considerably. It is therefore not surprising that the Reserve Bank and government were and still are under pressure from participants in the economy - both the manufacturers and labour unions - to devalue the rand even under its current policy of a flexible exchange rate (SA Labour News, 2011). The rand, however, declined again in 2008 due to the United States' financial crisis which decreased the demand for the rand. The rand devalued in Purchasing Power Parity (PPP) against the US dollar, against a basket of commodity currencies with which it is often associated and against the euro, the unit of South Africa's largest trading bloc (Garrow, 2008). According to Razin and Collins (1997), this volatility again produced RER misalignment and this RER misalignment could distort price signals, result in misallocation of resources across sectors, and generate a negative impact on growth.

Could this misalignment therefore contribute to explaining the relatively slow growth of the South African economy? Although the currency has been undervalued in most instances as stated above, it has not been established whether economic growth benefitted from the lower currency. These misalignments also contribute to the country's economic vulnerability since theory and literature imply that RER misalignment is an important indicator in identifying a country's economic vulnerability (Abida, 2011).

Karminsky, Lizondos and Reinhardt (1998) and Razin and Collins (1997) believe that the overvaluation of the RER often points to some irregularity in decision taken, relating to macroeconomic policies which in turn may lead to cumulative external debt as the risk of

conceivable speculative attacks, as well as an unsustainable current account deficit. An undervalued RER however, has the potential to encourage exports and promote growth.

### **1.3 Objectives and Aims**

Given the importance of global imbalances explained above, this study investigates the relationship between RER misalignment and economic growth in South Africa, using quarterly data starting from 1985 to 2011, South Africa experienced bankruptcy for the first time in 1985 following a recession in the late 1970s and a series of droughts (Cincotta and Engelman, 1997). The period starting in 1985 is characterised by much volatility in the rand, per capita GDP continued on a declining trend, but real wealth was no different than it had been in the 1970s. Within this period, South Africa experiences a highly volatile exchange rate, population explosion, very high unemployment rates, and the inception of a new government. The country experienced 62 quarters of uninterrupted economic growth from first quarter of 1993 to second quarter of 2008 followed by a recession in the third and fourth quarters of 2008. The details of the events within the selected period are explained further in Section 3.3, this period has been selected as it depicts the elasticity of the South African economy. The aim of this study is to determine whether the real over-valuations or under-valuations of the South African rand have had a negative effect on economic growth in the country, since RER misalignments affect various factors that contribute to economic growth in the country.

The main objective of this study is therefore to explore the relationship between RER misalignment and economic growth. The first issue that needs to be addressed is how misalignments are measured, which requires the measuring of the Equilibrium Exchange Rate (EER). In other words, the EER is estimated first before the extent of misalignment can be assessed, based on variations around the EER.

To achieve the main objective of the study, the secondary objectives of this study are as follows:

- To present an overview of equilibrium exchange rate theory and currency misalignment;
- To identify factors, called fundamentals, which are driving the current RER;
- To determine the factors which influence economic growth;
- To analyse growth in South Africa from 1985 to 2011;
- To determine the equilibrium exchange rate;
- To determine the extent of currency misalignment during the period of investigation; and
- To determine the effect of the RER misalignment on economic growth in South Africa.

## 1.4 Data and Methodology Used In This Study

### 1.4.1 Data

A data set on variables consisting of quarterly observations from 1985 to 2011 is employed. The data is obtained from the South African Reserve Bank's (SARB) online database and the International Monetary Fund's *International Financial Statistics* (IFS) online database. The specific variables used in the analysis are further explained in Chapter four.

### 1.4.2 Method

Measuring misalignment requires an empirical analysis of RER determinants because the usual simple comparison of PPP rates over time is not a good indicator of disequilibrium situations affecting growth (Cottani, Cavallo and Khan, 1990). The approach that will be used is twofold – firstly, the equilibrium exchange rate has to be estimated and the subsequent misalignment determined; secondly, the influence of the misalignment on growth has to be determined.

Nurkse (1945) defines RER as the relative price of traded goods and non-traded goods that achieves simultaneously external and internal equilibrium. Misalignments could be caused by inadequate macroeconomic policies, trade policies and exchange rate policies. (Aguirre and Calderon, 2005; Toulaboe, 2006)

RER is the broad summary between measures of the prices of one country to the price of another. The RER ( $Q$ ) is thus the nominal or current exchange rate ( $e$ ) multiplied by the ratio of the foreign price ( $P^*$ ) to the local price ( $P$ ). In other words (Saayman, 2007):

$$Q_t = e_t \frac{P_t^*}{P_t} \quad (1.1)$$

The method followed in this study to determine the equilibrium exchange rate is similar to the one used by MacDonald (2001) and MacDonald and Ricci (2003), and the discussion of the method is therefore based on their discussion. The underlying model used in this study is the Behavioural Equilibrium Exchange Rate (BEER) model. This model is used because the equilibrium exchange rate is determined by an appropriate set of explanatory variables and is not derived from the macroeconomic balance (Saayman, 2007), unlike the Fundamental Equilibrium Exchange Rate (FEER). The RER is therefore calculated using the fundamental determinants of the actual RER. According to Zhang (2001), the actual exchange rate is in equilibrium in a behavioural sense when its

movements reflect changes in these fundamentals. The degree of over- and undervaluation is assessed using a single equation regression approach.

The relationship between the actual values of the RER and its exchange rate and its fundamental determinants can be presented thus (Saayman, 2007):

$$\ln Q_t = \hat{\beta}' F_t + \varepsilon_t, \quad (1.2)$$

Where  $Q_t$  is the RER,  $F_t$  is the vector of fundamentals and  $\varepsilon_t$  is the white noise variable with a zero mean and constant variance.

For  $F_t$ , the fundamental term, variables to be included in this term are taken from studies of previous researchers in South Africa such as Aron, Elbadawi and Kahn (1997) and MacDonald and Ricci (2003). The variables included in this study are real interest rate, real GDP per capita, openness of the economy, fiscal balance and net foreign assets. Other variables considered, include the terms of trade, real US dollar gold price, gross fixed capital formation, gross reserves of the SARB, government expenditure (see Chapter four for a full discussion of the variables).

The study focuses on the impact of exchange rate misalignment on economic growth. Hence, the first step is to determine the equilibrium, before misalignment can be determined. Once the equilibrium RER has been determined, the misalignment will be indicated by the difference between the actual RER and the equilibrium exchange rate. According to Razin and Collins (1997), the RER misalignment is calculated as the difference between the actual RER and its predicted equilibrium value, that is:

$$MIS_t = Q_t - \bar{Q}_t, \quad (1.3)$$

Where  $Q_t$  is the actual RER value and  $\bar{Q}_t$  is the predicted equilibrium value. If the difference is positive, that means the local currency is overvalued – a negative difference implies an undervalued currency.

The macroeconomic fundamentals for calculating RER misalignment have been introduced. Now the relationship between the RER misalignment and economic growth can be investigated. The approach used by Berg and Miao (2010) will be followed. They estimate the following variation of the standard growth regression:

$$\Delta y_{i,t} = \beta y_{i,t-1} + \beta X_{i,t} + \theta MIS_{i,t} + \varepsilon_{i,t}, \quad (1.4)$$

for  $i=1,\dots;N$ , and  $t=2,\dots;T$ , where  $\Delta y_{i,t}$  is the real GDP per capita,  $y_{i,t-1}$  is the logarithm of real GDP per capita at the beginning of each period (a proxy of the initial income),  $X_{i,t}$  is a vector containing the explanatory variables measured during that period (period average),  $MIS_t$  indicates RER misalignment.

By following Berg and Miao (2010), various usual determinants can be retained. Firstly, according to the neoclassical growth theory, the economic growth rate is determined by the initial position of the economy. The conditional convergence hypothesis states that, other things being equal, *ceteris paribus*, a country with lower GDP per capita will grow more than a richer country due to the higher marginal returns on capital stock (Sørensen and Whitta-Jacobsen, 2005). The initial position of the economy is accounted for through the initial level of real GDP per capita to control for conditional convergence (Barro and Sala-i-Martin, 1996). Developments in the endogenous growth theory allow for the inclusion of determinants reflecting trade policies, macroeconomic stabilisation policies and institutions. Since the focus is on misalignment, this study considers the following variables: (1) openness of the economy (in percentage of GDP) as a proxy for structural policies; and (2) the terms of trade used to capture the effect of external shocks on economic growth. To these determinants the RER misalignment is added in order to examine the impact of local currency over- or under-valuation on economic growth.

## **1.5 Demarcation of the Study**

The study concentrates mainly on the long-run fundamentals that have an influence on the rand/US dollar exchange rate. The South African rand/US dollar was chosen because in global trade, the US dollar is a widely used exchange rate; many products and services, especially commodities, are priced in US dollars. Therefore the exchange rates of other economies will not be included. The study includes studies on different ways of determining the equilibrium exchange rate but will only focus on the behavioural approach in estimating the long-term equilibrium exchange rate. Chapter two will discuss this in detail.

## **1.6 Division of Chapters**

The aim of the study is to investigate the existence of a relationship between the RER misalignment and economic growth in South Africa. The study will be divided into five chapters, as follows:

Chapter one presented an overview of the study by indicating the scope of the study and methods used. It included a background on the South African economy, the problem statement, the objectives and aims of the study, a description of the methodology, and a demarcation of the study field.

Chapter two presents the literature review which seeks to highlight the equilibrium exchange rate determination and documented efforts of past researchers. Different theories and approaches for determining the equilibrium exchange rate, and therefore estimating a misalignment are explained. Factors that influence the exchange rate in South Africa and how they have grown over the years are also discussed.

Chapter three explores the relationship between currency movements and economic growth. Different economic growth theories and models are discussed, including classical and neoclassical growth theories which originated with the work of Solow (1956) and Swan (1956). The chapter gives an outline of the performance of the South African economy amidst currency volatility.

In Chapter four the data and methodology to be used in the study, as well as the econometric analysis of the employed data linked to the methodology will be presented and the results will be given. The chosen computer software for the empirical study is the seventh edition of EViews (Asteriou and Hall, 2007). Different combinations of fundamental variables are tested for significant cointegration coefficients. Exclusion tests are used to determine the lags and variables which 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. Once this is done, a growth equation is estimated and the effect of this misalignment on economic growth is determined.

Chapter five summarises the overall research study and gives a conclusion on the findings. The conclusions for each chapter are discussed in Chapter five, recommendations are made and direction for future study is given.

## Chapter 2 Equilibrium Exchange Rate Theory

### 2.1 Introduction

Theoretically, an exchange rate can either be overvalued, undervalued, or be at equilibrium- the desirable point when the exchange rate is a true reflection of economic conditions prevalent in the country. An exchange rate is called “undervalued” when it is more depreciated than the ideal, and it is called “overvalued” when it is more appreciated than ideal (Razin and Collins, 1997). This study focuses on the RER misalignments and its implications for growth. Misalignments imply that there should be an equilibrium exchange rate since variation of the exchange rate from equilibrium is referred to as a misalignment (Clark and Macdonald, 2000; Ègert, Halpern and Macdonald, 2005).

According to Razin and Collins (1997), RER misalignment describes a situation whereby a country’s actual RER deviates from some concept of an “implicit ideal” RER or equilibrium. Misalignments are based on perceptions that RERs have been moved to levels which make it difficult for countries to sustain their international competitiveness over the long-run, and levels that may induce macroeconomic imbalances (Isard and Faruqee, 1999). The RER is indeed argued to have been the cause of loss of competitiveness and growth slowdowns. It is also blamed for currency crises when there are sustained overvaluations, overheating in the event of sustained undervaluations, sectoral misallocation of resources, and global macroeconomic imbalances (Siregar and Rajan, 2006).

Rahman and Basher (2001) estimate misalignment as the percentage difference between actual and “equilibrium” exchange rate. Misalignments are believed to influence economic behaviour. Overvaluation is expected to hinder economic growth, while undervaluation is sometimes thought to produce an environment conducive to growth (Edwards, 1989 and 2000; Williamson, 1983 and 1994; Stein and Allen, 1995; Jongwanich, 2009). This concept of misalignment implies that there is a favourable point at which the exchange rate can be, when all else remains unchanged, if countries do nothing to manipulate their currencies. This favourable point is referred to as the Equilibrium Real Exchange Rate (ERER) and will be discussed at length in this chapter. One cannot determine whether there is misalignment if there is no equilibrium. The aim of this chapter is, therefore, to define and theorise on the determinants of equilibrium exchange rate and why deviations from this equilibrium occur. This is done by studying different equilibrium exchange rate concepts.

The construction of the RER, as well as the overview of the different equilibrium exchange rate models, is given in the next section, followed by a discussion on Purchasing Power Parity (PPP) in Section three. Section four gives an overview of the Monetary Approach while in Section five a

discussion on the Fundamental Equilibrium Exchange Rate (FEER) is provided. Section six is a brief discussion on the desired Equilibrium Exchange Rate (DEER), and Section seven explains the Behavioural Equilibrium Exchange Rate (BEER). Section eight explains the Permanent Equilibrium Exchange Rate, and Section nine the Natural Rate Of Exchange (NATREX) approach. Section ten contains factors that have had an effect on the exchange rate in South Africa then the chapter concludes.

## 2.2 The Real Exchange Rate (RER)

An exchange rate is known as the rate at which one currency is exchanged for another or the value of one country's currency in terms of another currency (Cypher and Dietz, 2009). The RER is the purchasing power of a currency relative to another. RERs can also be defined as nominal exchange rates that have been adjusted for inflation differentials between two countries (Kipici and Kesriyeli, 1997; Jongwanich, 2009). The basic construction of the RER is called the absolute PPP, and is as follows (Saayman, 2007; Siregar, 2011):

$$Q = \frac{E \cdot P^*}{P}, \quad (2.1)$$

Where (Q) is the RER, which is the nominal or current exchange rate (E) multiplied by the ratio of the foreign price (P\*) to the local price (P). The exchange rate is expressed in units of domestic currencies per unit of foreign currencies. Therefore, a rise in (E) causes an increase in (Q) and implies appreciation in the nominal and real exchange rate.

In logarithmic forms ( $\ln q = \ln e + \ln p^* - \ln p$ ), both domestic price ( $p$ ) and foreign price ( $p^*$ ) can be expressed as the sum of tradables and non-tradables, as by Siregar and Rajan (2006) and Siregar (2011):

$$p = \beta \cdot p^{NT} + (1 - \beta) \cdot p^T, \quad (2.2a)$$

$$p^* = \beta^* \cdot p^{*NT} + (1 - \beta^*) \cdot p^{*T}, \quad (2.2b)$$

Where ( $p^{NT}$ ) and ( $p^{*NT}$ ) represent the domestic and foreign non-tradable prices, respectively, ( $p^T$ ) and ( $p^{*T}$ ) are domestic and foreign tradable goods prices, respectively. ( $\beta$ ) and ( $1 - \beta$ ) are the shares of non-tradable and tradable sectors for the domestic economy, respectively ( $\beta^*$ ) and ( $1 - \beta^*$ ) are the corresponding shares for the foreign economy respectively. Equation (2.2a) and (2.2b) are substituted into Equation (2.1), RER, Q is redefined as  $q$  and the result is:

$$q = (e + p^{*T} - p^T) - ((1 - \beta)(p^{NT} - p^T) - (1 - \beta^*)(p^{*NT} - p^{*T})). \quad (2.3)$$

This equation suggests that fluctuations or RER movements are potentially driven by two different sources: the RER of tradable goods ( $e + p^{*T} - p^T$ ), and the ratio of the domestic to the foreign relative prices of non-tradable and tradable goods ( $((1 - \beta)(p^{NT} - p^T) - (1 - \beta^*)(p^{*NT} - p^{*T}))$ ).

Equation (2.3) generally emphasises that the movements of RER at any point in time can be driven by changes in prices that occur in both the tradable and non-tradable sectors domestically and those in its trading partners, as well as in the changes in the structures of the two economies,  $\beta$  and  $\beta^*$  (Siregar, 2011).

Changes in exchange rate are not limited to changes in prices or structures of domestic or foreign economies. In an analytical model by Montiel (1999) four sets of factors that determine RER are determined by:

- a) Domestic supply side factor, which is referred to as the theory of Balassa-Samuelson effect. This theory states that productivity in the tradable sector has appreciative effects on the exchange rate, because excess demand in the non-tradable sector is created and the trade balance is improved.
- b) The fiscal policy factor- a tax-financed increase in government spending on non-traded goods creates an excess demand for them later, this has an appreciating effect on the exchange rate. The opposite will happen if there is an increase in government spending of non-traded goods. Thus, the share of government spending of traded versus non-traded goods appears to be important in determining equilibrium RER.
- c) The international economic environment which includes the world inflation rate, world real interest rate, the availability of international transfer as well as the terms of trade. A change in world inflation rate, through its effect on transaction costs associated with change in real balance, affects the equilibrium exchange rate. An increase in world interest rates leads to capital outflow and thus requires depreciation of equilibrium exchange rate. An increase in flow of transfer leads to an appreciation. Improvement in the terms of trade increases national income in terms of imported goods, which in turn may increase demand for tradable goods and a resulting appreciation of currency.
- d) The trade policy factor- trade liberalisation lowers support to import competing industries and resources are channelled to the non-traded goods sector which ultimately results in depreciation.

These are but a few additions to the factors that affect the exchange rate. They also count as macroeconomic fundamentals that should be analysed in the study of RER movements. The most important question in terms of equilibrium exchange rates is: Does the speed with which the equilibrium exchange rate appreciates, corresponds to that of the observed RER? If so, the observed appreciation is fully an equilibrium phenomenon. Otherwise, there is scope for undervaluation or overvaluation. Economic fundamentals should be included if one is to test whether the observed RER is indeed at the equilibrium level. Economic fundamentals are used because the EER depends on a range of macroeconomic fundamentals, many of which are endogenously determined within the economy (MacDonald and Ricci, 2003).

The consistency between the country's economic fundamentals and REER is also important and should be considered and there are a few approaches which can aid in assessing the extent of this consistency. New models are constantly being studied to test EER relationships (Hinkle and Montiel, 1999; MacDonald 2000; and Williamson 1994). Increasingly, these models have been used by both practitioners and policymakers to address issues of exchange rate misalignment and to test for overvalued currency.

The estimation of an equilibrium exchange rate and the degree of exchange rate misalignment is a challenging empirical problem, because equilibrium is not observable directly. The simplest and most commonly used approach is the PPP approach, which is further explored below. According to this approach, equilibrium in real exchange is achieved in the year when the economy is considered to be in a macroeconomic equilibrium (Rahman and Basher, 2001) and the country has only one trading partner (Kipici and Kresriyeli, 1997).

### **2.3 Purchasing Power Parity (PPP)**

PPP asks how much money would be needed to purchase the same goods or service in two different countries and uses that to calculate an implicit foreign exchange rate. The PPP approach is heavily reliant on the nominal exchange rate (Brook and Hargreaves, 2001). Exchange rate misalignment is measured as the deviation of RER from its value at this "base" period (Razin and Collins, 1997). This approach, thus, has a major drawback in that it chooses a single equilibrium rate for a period of over ten years.

PPP is the most simple and popular approach to determining equilibrium exchange rate and has been used for many decades (Siregar, 2011). The Law of One Price is the basic foundation of PPP,

which relates exchange rates and price levels (Brook and Hargreaves, 2001). It states that identical goods should, under certain conditions, sell for the same price in two different countries, at the same time. The most famous example of the PPP is the Big Mac Index as applied by the magazine, *The Economist*. In the last quarter of 2011, the Big Mac was R19.45 in South Africa and US\$2.87 in the United States. This produces a PPP exchange rate of US\$4.78 (the actual exchange rate was US\$6.77 in July 2011), and implies that the USD/ZAR exchange rate in the fourth quarter of 2011 was over 29% undervalued.

While the *Economist's* Big Mac Index receives more popular attention than other comparable efforts, there exist better cross-country price comparisons. For example, the Organisation for Economic Co-Operation and Development (OECD) and the United Nations (UN) are involved in the *International Price Comparison Programme (ICP)*, which surveys a wider range of prices and therefore produces more rigorous estimates of the exchange rates that would eliminate price differences between their member nations.

The absolute PPP exchange rate equates the national price levels in two countries if expressed in a common currency at that rate (Siregar, 2011), as indicated in Equation (2.4).

$$P^i = P^{*i} \cdot E \quad (2.4)$$

When both countries are operating at full employment and there is no hindrance to international trade and capital flows, with both economies operating in a market-based price system, identical goods ( $i$ ) must sell for the same price expressed in the same currency. In other words, if two economies are operating in similar economic conditions and there are no impediments to trade, prices of identical goods will be the same in both countries (Siregar, 2011).

The absolute PPP concept claims that the general level of a basket of similar products in different countries will always be equalised when they are measured in a common currency (Balassa, 1964; Williamson, 1994; Driver and Westaway, 2004), as shown in Equation (2.5):

$$P = P^* \cdot E \quad (2.5)$$

What is actually claimed by the PPP concept is that price levels determine the Equilibrium Exchange Rate. If all else remains unchanged, a rise in the local price should raise  $E^{PPP}$  (the exchange rate) (Balassa, 1964), the opposite is also true. Rearranging Equation (2.5) shows that:

$$E^{PPP} = \frac{P}{P^*} \quad (2.6)$$

The PPP exchange rate is always constant and equal to one (Siregar, 2011). This can be shown by substituting Equation (2.6) into Equation (2.1):

$$Q = \frac{E \cdot P^*}{P} \quad (2.7)$$

$$\text{Therefore: } Q = \frac{\frac{P}{P^*}}{\frac{P}{P^*}} = 1 \quad (2.8)$$

Given the basic assumptions of price rigidity in the short-run, the PPP is often referred to as the long-run equilibrium exchange rate (Isard, 2007). In the short-run, however, the prevailing nominal exchange rate may differ from the PPP rate. This deviation is often referred to as “under” or “over” valuation of the domestic currency. If  $\left(\frac{E}{E^{PPP}}\right) > 1$ , the local currency is overvalued, if  $\left(\frac{E}{E^{PPP}}\right) < 1$ , the local currency is undervalued (Siregar, 2011).

Relative PPP is seen as a suitable indicator for the equilibrium exchange rate between currencies, with relative inflation rates determining the rate of change of the nominal exchange rate over time (Driver and Westaway, 2004). The application of the relative PPP involves using the actual exchange rate to compute relative price levels in common currency terms. When the RER deviates from the base value, this is taken as an indication of a misalignment meaning that the exchange rate has shifted away from its equilibrium PPP value (Balassa, 1964; Brook and Hargreaves, 2001; Driver and Westaway, 2004; Siregar and Rajan, 2006; Siregar, 2011). For example, suppose the rate of inflation in South Africa is higher than that in the United States, causing the price of a basket of goods in South Africa to rise. PPP requires the basket be the same price in each country, so this implies that the rand must depreciate *vis-à-vis* the US dollar. The percentage change in the value of the currency should be equal to the difference in inflation rates between the two countries (Moffatt, 2012).

Absolute PPP between South Africa and the United States, for instance, implies that similar goods should cost the same price in the two different countries, once the exchange rate is taken into account. Any deviations from this (if a basket of goods is cheaper in South Africa than in the United States), and we should expect relative prices and the exchange rate between the two countries to move towards a level at which the baskets of goods have the same price in the two countries (Brooks and Hargreaves, 2001).

### 2.3.1 Limitations of PPP

Several researchers have found that the PPP theory has shortfalls and fails to hold in many instances. A feature of the PPP hypothesis is that exchange rates are assumed to be stationary; however, several researchers have noted that this is hardly ever the case (Isard and Symansky, 1996; Chinn, 1997, 1998), thus making PPP an unreliable measure for equilibrium exchange rates. Some researchers have stated that prices or exchange rates are mean reverting implying that they move back towards either the historical average or an average determined by economic fundamentals (Edison, 1987; Frankel, 1986 and 1988; Abuaf and Jorion, 1990; Grilli and Kaminski, 1991; Diebold, Husted and Rush, 1991); Rogoff (1996) however, finds that the findings of these researchers were based on a period of about two years each, a number which is very low to be consistent with a traditional form of PPP.

According to Driver and Westaway, (2001); Brunetti, Kisonku, and Weder, (1997); and Tybout, (2000), trade barriers and transport costs also make the PPP an unreliable measure of equilibrium exchange rate. Transport costs tend to differ from country to country; this is why the Big Mac may be cheaper in South Africa than it is in the United States. Input costs also tend to be higher in the United States than they are in South Africa, while inflation also accounts for difference in pricing in the two countries.

Imperfect competition is another reason why the PPP does not hold. Firms may have a degree of market power, giving them the possibility of pricing to market. Pricing to market means that the full impact of changes in the exchange rate is not passed on to imported consumer goods (Brooks and Hargreaves, 2001). This may result in price gaps which are created by productivity gaps between developed and developing economies. Using the PPP as a first approximation for price differences will therefore have inconsistent results, because of the price gaps between different economies (Égert and Lareche-Revil, 2003).

Another weakness of this approach is found in empirical evidence which shows that deviations from the PPP are significant, volatile and persistent, even across highly traded and sophisticated manufactured goods (Rogoff, 1996). In other words, nominal exchange rates are far more volatile than relative prices (price of a commodity in terms of another) and PPP is based on nominal exchange rates. Basing equilibrium exchange rate calculations on a highly volatile variable, such as the nominal exchange rate, can give results that are not reliable (Kohli, 2000; Eichengreen, 2008). Even if there was a chance for PPP to hold, shares or weights ( $\hat{a}$  or  $\hat{a}^*$ ) of different sectors or products may lead to its failure. In the long-run, consumer preferences change and producers

choose different products to maximise their profit. So, it is not always the same goods that make up the consumer basket.

One of the main reasons why the PPP does not hold is that it does not include non-tradable goods in its calculation of equilibrium exchange rate. The PPP may seem like a good measure at first as it measures the costs of similar goods on an international level; however, it only captures the price of tradable goods and does not take into account shocks caused by the non-tradable goods sector (Metin, 1994; Telatar and Kazdagli, 1998). A recent study by Civcir (2004) provides evidence for the weak form of PPP, where symmetric restrictions on the prices hold but unitary coefficients on the prices are rejected. Even if the PPP does hold for individual goods that are traded internationally, arbitrage will not be able to equilibrate the prices of non-tradable goods and services around the world. Even many traded goods include a significant non-traded component when sold (Brook and Hargreaves, 2001). For example, although clothing is a tradable good, the main costs that face a clothing store include wages, rent and power, which are all non-tradable. As mentioned above, the PPP does not include input costs. The contribution of non-tradable sectors in developing, as well as developed nations, has been found to be quite significant and cannot be ignored (Égert, Halpern and MacDonald, 2005). The contribution of non-tradable sectors therefore has to be included in the calculation of the EER.

The mere definition of the PPP, as well as the breakdown of Equation (2.3), shows that the PPP only captures the RER for tradable goods ( $e + p^{*T} - p^T$ ). It does not capture shocks in the non-tradable sector ( $(1 - \hat{a}^*)(p^{*NT} - p^{*T})$ ). Therefore, there will always be a difference between  $q^{PPP}$  and  $q$ .

Differences in the relative productivities of tradable as opposed to non-tradable goods sectors of the local and foreign economies also result in the failure of PPP – this is often referred to as the Balassa-Samuelson (B-S) effect. PPP is based on the Law of One Price, but it has been well understood over the years that the presence of non-traded goods -for which there is no one price – can lead to systematic movements in the RER that may be inconsistent with PPP (Balassa, 1964, Samuelson, 1964). If the domestic economy is less productive in the tradable sector than the foreign economy, the exchange rate is likely to be undervalued. In addition, the B-S effect positively associates movements in relative income with the overall price in an economy, which may also not be captured by the PPP. Countries with very productive tradable goods sectors are likely to have higher wages. This, in turn, increases national asset prices and national wages, increasing production costs in the non-tradable goods sector. As the exchange rate only captures the cost of tradable goods, the prices of non-tradable goods in countries with productive tradable sectors tend to be relatively high.

For example, although hairdressers in the United States may be just as productive as South African hairdressers, they could demand a higher wage because they could earn more in alternative employment in the tradable goods sector. That also explains why non-tradable goods cost more in Japan than India. Tradable goods also cost more in Japan because their price includes the cost of non-tradable services such as rent and retail mark-ups. In the long-run the Balassa-Samuelson (B-S) hypothesis is assumed to provide a reference for measuring real equilibrium exchange rates. However, as shown in the early 2000s (Égert, 2002a, 2002b; Égert and Lahreche-Revil, 2003; Flek, Markova and Podpiera, 2002; Kovacs, 2002, and Mihaljek and Klau, 2003), the B-S effect turns out to be a relatively weak yardstick for equilibrium exchange rates in Central and East European countries (CEE), which calls for a more structural approach as will be discussed in the section to follow.

The PPP approach is therefore not a good measure of the RER approach; it also fails to take into account major determinants of RER, such as relative economic activity levels and foreign assets, while the influence of capital flows on the exchange rate is also ignored (MacDonald, 2000). However, despite its shortcomings and restrictiveness, economists still use the PPP as the first model of equilibrium to assess if a currency is misaligned. The Monetary Approach is subsequently discussed.

## **2.4 The Monetary Approach**

A direct expansion of the PPP approach is the Monetary Approach, which establishes a theoretical link between the nominal exchange rate and a set of monetary fundamentals. This approach assumes the flexibility of price and incorporates the concept of PPP and it can be characterised as a long-run concept to equilibrium exchange rate. The Monetary Approach states that productivity, nominal interest rate and excess money supply in the local economy relative to their levels in the foreign economy are important drivers of movements of the nominal exchange rate ( $e$ ) (Siregar, 2011). The Monetary Approach is mainly based on the addressed limitations of the PPP. The monetary model of exchange rate traces movements in the exchange rate by examining monetary variables under the crucial assumption that PPP is maintained between countries for broad price indices (Civcir, 2004).

As followed by Siregar (2011), under a money market equilibrium condition, a log-linearised basic money demand (function of income and nominal interest rate) is set equal to an exogenously determined money supply:

$$m_t - p_t = \alpha_1 y_t - \alpha_2 i_t \quad (2.9)$$

$$m_t^* - p_t^* = \hat{a}_1 y_t^* - \hat{a}_2 i_t^* \quad (2.10)$$

Where  $(m_t)$  and  $(m_t^*)$  denote domestic and foreign money supply, respectively while  $(p)$  and  $(p^*)$  are domestic and foreign price level, respectively.  $(i)$  represents domestic nominal interest rate.  $(\alpha_1, \alpha_2, \hat{a}_1$  and  $\hat{a}_2)$  are coefficient parameters, where all of them are theoretically expected to be greater than zero. The monetary models of exchange rate determination start with the assumption of perfect capital mobility (Civcir, 2004). PPP and interest rate parity conditions are used in the models to define equilibrium conditions.

Solving for price level in both Equations (2.9) and (2.10), and subtracting the foreign price from the domestic one, the following relationship can be derived (Siregar, 2011):

$$p_t - p_t^* = (m_t - m_t^*) - \alpha_1 (y_t - y_t^*) - \alpha_2 (i_t - i_t^*) \quad (2.11)$$

We assume that  $(\alpha_1 = \hat{a}_1)$  and  $(\alpha_2 = \hat{a}_2)$  for the sake of simplicity. Under the assumption of long-run flexible price and that the PPP condition holds a reduced form, the Monetary Approach of exchange rate can be constructed as follows (Siregar, 2011):

$$e_t = p_t - p_t^* = (m_t - m_t^*) - \alpha_1 (y_t - y_t^*) - \alpha_2 (i_t - i_t^*) \quad (2.12)$$

The Monetary Approach simply states that the movement of nominal exchange rate  $(e_t)$  is driven by the excess money supply, output and nominal interest rate in the local economy relative to their levels in the foreign economy.

In most literature, the monetary model is used for testing the rationality of the approach for exchange rate determination and in terms of its out-of-sample forecasting properties. This model, or its variants, is not usually used for assessment purposes. Chinn (2000); Husted and MacDonald (1999); and La Cour and MacDonald (2000) are notable exceptions. These papers assess whether currencies are overvalued against the US dollar or Japanese yen before the 1997 Asian crises.

When Civcir (2004) attempted to model the Turkish-lira-US dollar exchange rate over the period 1987-2000, using a monetary model, he found evidence in favour of the monetary model. He found a cointegration relationship between exchange rate, the monetary fundamentals and relative prices, indicating that monetary fundamentals affect the exchange rate in the long-run.

Theoretically, the Monetary Approach seems appealing, but empirical work on the model has not been conclusive. This has led to a number of alternative theories based on fundamentals, of which the first to be discussed is the Fundamental Equilibrium Exchange Rate (FEER).

## **2.5 The Fundamental Equilibrium Exchange Rate (FEER)**

The first approach, based on fundamentals, defines the Fundamental Equilibrium Exchange Rate (FEER) as the RER which is consistent with macroeconomic balance (Wren-Lewis, 1992). It is identified as the rate that brings the current account into equality with the underlying or sustainable capital account, where the determinants of both the current account and the capital account have been set at their full employment level (Siregar and Rajan, 2006). In contrast with the PPP, the FEER approach acknowledges and recognises that the equilibrium exchange rate will vary across time.

The estimation of large macroeconomic models, inspired by Williamson (1994), defines the FEER model as the RER that allows for the simultaneous attainment of internal and external balances, i.e. when output is set to its potential level and when the current account is financed through long-term capital flows.

The FEER aims to capture factors beyond just monetary variables in determining movements of equilibrium exchange rate. Some of the first researchers who attempted to derive FEER estimates include Frankel and Goldstein (1986); Williamson and Miller (1987); Borell and Wren-Lewis (1989); Currie and Wren-Lewis (1989a and b); Williamson (1993 and 1994); Artis and Taylor (1995); and Frankel (1996). Its basic concept is based on the notion of macroeconomic balance, i.e. internal and external balance. Internal balance is reached when the economy is at full employment output and operating in a low inflation environment. External balance is characterised by a sustainable balance of payment position over a medium-term horizon, ensuring desired net flows of resources and external debt sustainability. A minimum criterion for external balance is that the current account has to be sustainable (Williamson, 1994). This macroeconomic balance framework has origins that trace back to Nurkse (1945); Metzler (1951); and Swan (1963) who made significant contributions and put simultaneous balance paradigm on centre stage in open economy macroeconomics.

The FEER approach focuses more on “economic fundamentals” which are expected to persist on the medium-term horizon. Hence, it is considered as the medium-run equilibrium exchange rate model. The FEER is considered as a normative measure of equilibrium exchange rate as it is the rate that will

be consistent with ideal economic circumstances of macroeconomic balances, both internal and external (Siregar, 2011).

The FEER approach, unlike the PPP, recognises that the equilibrium exchange rate will vary across time. The first factor that guides FEER is related to the determination of potential output growth associated with low inflation in both domestic and foreign economies. Due to potential gaps in productivity growth as stated by Balassa (1964), the FEER will have to appreciate and depreciate over time as countries grow at different rates (Williamson, 1994). The second factor addresses what is considered as a sustainable current account level. Maintaining current account balance at a targeted rate requires the local currency to appreciate and depreciate accordingly. It is usually assumed that internal balance will automatically be satisfied when the external balance is achieved, meaning, when the current account level is sustainable, the economy will experience full employment output and low inflation. Thus, as shown by Clark and MacDonald (1998) and MacDonald (2000), the most popular method of generating a FEER involves two steps:

Step 1: Identify the external balance equation by equating the current account balance (CA) to the negative capital account balance (KA).

$$CA = -KA \quad (2.13)$$

The current account is a sum of net trade balance (*ntb*) and returns on net foreign assets (*nfa*) (Calvo, Liederman and Reinhart, 1993). The net trade balance is then assumed to be a function of full employment outputs of the local and foreign economies, i.e. (*Y*) and (*Y\**) respectively, and the real effective exchange rate (*q*). The return on net foreign assets is also influenced by the movements of the exchange rate. An accumulation of foreign liabilities will have to be financed. This condition necessitates currency depreciation in order to improve the trade balance and net foreign asset position. Key relationships for the FEER approach can, therefore, be summarised, as by Siregar (2011), in the following equations:

$$CA = ntb + nfa \quad (2.13a)$$

$$ntb = \ddot{a}_0 + \ddot{a}_1 q + \ddot{a}_2 \bar{y}_d + \ddot{a}_3 \bar{y}_f \quad (2.13b)$$

Where:  $\ddot{a}_1 > 0$ ,  $\ddot{a}_3 > 0$ , and  $\ddot{a}_2 < 0$

$$nfa = f(q) \quad (2.13c)$$

Where  $\ddot{a}_2\bar{y}_d$  represents full employment outputs of the domestic economy and  $\ddot{a}_3\bar{y}_f$  denotes full employment outputs of the foreign economy. In most applications of the FEER approach, the level of equilibrium capital account over the medium term ( $\overline{KA}$ ) is exogenously determined and is said to exclude speculative capital flow. By combining Equation (2.12) and (2.13), Siregar (2011) generates the following medium-term balance of payment equation:

$$CA = f(q^{FEER}, Y, Y^*) = -\overline{KA}. \quad (2.14)$$

In short, there are three vital elasticities to be calculated under the FEER approach, namely, the elasticity of the current account to domestic activity ( $Y$ ), the elasticity of current account to foreign output ( $Y^*$ ), and the elasticity of the current account to the real effective exchange rate ( $q^{FEER}$ ). This will show the sustainability of the current account (Siregar, 2011).

Given full employment outputs of the local and foreign economies, ( $Y$ ) and ( $Y^*$ ), respectively, and that of medium-term equilibrium ( $\overline{KA}$ ), the level of RER to be derived from Equation (2.14) is the FEER. The purpose of a FEER is to establish a benchmark against which to measure misalignments in market exchange rates (Saayman, 2005). These misalignments are due to transitory factors such as deviations from internal balance, trade restrictions and abnormal capital flows, and signal the need for policy action (Black, 1994). Solving for ( $q^{FEER}$ ) will ensure that one achieves the macroeconomic balance (Siregar, 2011).

$$q^{FEER} = f(\overline{KA}; Y; Y^*). \quad (2.15)$$

### 2.5.1 Limitations of FEER

The assumption on which FEER is based, namely that of a sustainable current account or external balance, has been criticised. Considering the simplest form of current account Equation (2.13a) where the ( $nfa$ ) component is assumed to be zero or relatively small when compared to ( $ntb$ ), the RER elasticity of imports must, therefore, be close to the RER elasticity on exports under the assumption of “external balance”. In other words, the estimated trade elasticity of the FEER is effectively close to zero (Goldstein and Khan, 1985; and Wren-Lewis, 1992). Too much dependence on trade elasticity may yield an inaccurate estimate of the FEER path. Siregar (2011) finds that a depreciation of the RER of the domestic currency would lead to an improvement in both ( $ntb$ ) and ( $nfa$ ). If the FEER only captures the changes in ( $ntb$ ) and assumes the impact on ( $nfa$ ) to be exogenously determined (as done by Williamson, 1994; and Bayoumi, Clark, Symansky and Taylor,

1994), then the size of the required RER appreciation may be overestimated. Hence the size of currency misalignment estimated by FEER is likely to be an inaccurate one.

Assessing a country's underlying current account balance necessitates adjusting for its business cycle and lagged effects of past exchange rate movements, both of which are difficult to estimate precisely (Dunaway, Leigh and Li, 2006).

There are also analytical limitations of the FEER due to possible fluctuations on the returns of net foreign assets (Siregar, 2011). As much as the FEER seems to take all important variables into account, it is almost impossible that the economy can be in macroeconomic balance. The FEER is highly normative in this regard; it implies almost everything, most of which are not prevalent facts in economies. For instance, many economies do not have full employment or low inflation and internal balance is almost a myth. A concept closely related to the FEER is the Desired Equilibrium Exchange Rate (DEER) which is investigated subsequently.

## **2.6 The Desired Equilibrium Exchange Rate**

The Desired Equilibrium Exchange Rate (DEER) is an extension of the FEER approach. Given the normative nature of the FEER, it has been suggested that the REER, derived from the FEER, be called the DEER (Bryant, 1983). In the study by Bayoumi *et al.* (1994), they claim that the calculated medium-term DEER equilibrium exchange rate is consistent with and necessary for achieving desired positions of internal and external balance. The calculation of the DEER follows that of FEER and different estimates of the DEER are calculated to generate a set of equilibrium exchange rates under different economic circumstances and policy choices. For policy purposes, this approach is therefore quite useful (Siregar, 2011).

The equilibrium exchange rate derived from the FEER approach is called "desirable" or the DEER (Byrant, 1983). This is derived, given the normative assumption of what the level of internal and external balance would be, especially by the size of a targeted sustainable current account. Bayoumi *et al.* (1994), in their work on the DEER, focus on the claim that the calculated medium-term DEER equilibrium exchange rate is consistent with, and necessary for achieving "desired" positions of internal and external balance. They specify the medium-term as the period needed for output to return to potential and for changes in competitiveness to be reflected in trade volumes, which would appear to be in the range of four to six years.

The difference between FEER and DEER is that in the case of DEER, external equilibrium is defined in terms of optimal policy. Therefore, the current account target and the subsequent foreign debt should be in line with what policymakers deem to be optimal (Égert, 2004). The DEER refers to the equilibrium RER consistent with macroeconomic balance, based upon a set of desired macroeconomic objectives (Saayman, 2005). In other words, the actual internal and external balance is not considered, but rather the desired internal and external macroeconomic balance in this approach. The exchange rate is therefore not the actual exchange rate, but an estimate of what the exchange rate should be at the desired internal and external macroeconomic balance. It is mostly a static view of the exchange rate in the medium-term (Bayoumi *et al.*, 1994).

Égert (2004) summarizes the steps as to how to derive the fundamental or DEER as follows:

- a) Determining the required current account position;
- b) Estimating the elasticity of the current account to domestic and foreign output and to the real effective exchange rate ( $CA = f(Y, Y^*, REER)$ );
- c) Working out the change in the real effective exchange rate (REER) that would place domestic and foreign output on their potential path and that would achieve the targeted current account. However, the simultaneous achievement of this triple goal is hardly possible. Therefore, it is normally assumed that internal balance both in the home and foreign economies is reached without the help of the REER;
- d) Seeking the change in the REER that would make the current account move to its target value, adjusted for internal balances (i.e. the current account that would prevail at potential output). The change in the REER is tantamount to the total misalignment; and
- e) Calculating the bilateral equilibrium nominal exchange rates. The current nominal effective exchange rate needs to be adjusted with the required change in the REER, and subsequently the bilateral nominal exchange rates are to be extracted.

As in the case of the FEER, Siregar (2011) finds that different estimates of the DEER are often calculated to generate a set of equilibrium exchange rates under different economic circumstances and policy choices. Therefore, this approach has proven to be a very useful policy tool in estimating different equilibrium rates under varying sets of hypothetical policy current account/external balance targets. Another approach that attempts to further extend the FEER is the Behavioural Equilibrium Exchange Rate (BEER) approach discussed in the next section.

## 2.7 The Behavioural Equilibrium Exchange Rate

The Behavioural Equilibrium Exchange Rate (BEER) is an approach in line with the FEER approach, but based on a single-equation estimation. The BEER relates to the deviation between the actual exchange rate and the value given by the estimated equilibrium relationship. Siregar (2011) states that the BEER tries to explain the behaviour of the exchange rate by considering the origins of cyclical and temporary movements of the RER and also by taking into account the given values of the fundamental determinants of the RER. However, they do not necessarily have to be at full employment. The misalignment captured using the BEER approach is often referred to as the current misalignment rate (MacDonald and Dias, 2007; Siregar, 2011).

The BEER is not based on macroeconomic balance like the FEER; it is therefore more realistic and more reliable (Siregar, 2011; Clark and Macdonald, 1998). The BEER was developed by Clark and MacDonald (1998) and provides a more statistical definition of the equilibrium exchange rate. The fundamental determinants of the RER are measured using econometric estimations with an extended version of Uncovered Interest Parity (UIP)<sup>1</sup> as the theoretical background. The BEER is recorded as one of the best models to use in determining misalignments. Harplen and Wyplosz (1997); Kim and Korhonen (2005); and Randveer and Rell (2002) and several others<sup>2</sup> made use of the BEER approach to estimate the equilibrium exchange rate and compare it with the actual exchange rate in order to determine the extent of misalignments.

The BEER approach entails an estimation of the relationship between the RER and several fundamental and transitory factors (Clark and Macdonald, 1998; Siregar, 2011). The long-run equilibrium exchange rate is calculated using long-term values of the fundamentals, which one would obtain by either disintegrating the series in question into permanent and temporary components (using Beveridge-Nelson decomposition, or Hodrick-Prescott filter), or by conducting a subjective evaluation of the long-run value (Baffes, Elbadawi, and O'Connell, 1997). The long-run equilibrium exchange rate is therefore used to derive the departure of the actual exchange rate from its long-run equilibrium value. The total deviation depends on the short-term transitory factors and the departure of the fundamentals from their long-term value. Alternatively, Clark and MacDonald

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<sup>1</sup> Uncovered Interest Parity: the parity condition stating that the difference between two countries is equal to the expected change in exchange rates between the countries' currencies. If this parity does not exist, there is no opportunity to make a profit. High interest rate currencies tend to appreciate. UIP predicts that high interest rate currencies will depreciate relative to low interest rate currencies. The evidence is primarily about short-term interest rates and currency depreciation rates (Backus, Gavazzoni, Telmer and Zin, 2010).

<sup>2</sup> MacDonald and Ricci, 2003; Saayman, 2007; Driver and Westaway, 2004; Mtonga, 2006; Aron, Elbadawi and Kahn, 2000 also used the BEER approach to estimate EER.

(2000) show that it is possible to obtain the deviation by decomposing the cointegration vector itself into a permanent and a transitory component (see the section on Permanent Equilibrium Exchange Rate (PEER) below) via the Gonzalo-Granger method. Thus, after estimating the long-run relationship, there is no need to evaluate long-term values for the fundamentals.

In a study by Dufrenot and Égert (2005) on RERs of Central European transition countries, namely Czech Republic, Hungary, Poland, Slovakia and Slovenia, it was found that firstly, productivity had a strong influence on the REER. Productivity not only affects the RER through the traditional service price channel as maintained by the Balassa-Samuelson effect, but also through the non-tradable component of tradable prices and the increasing capacity of the tradables industry to produce goods of higher quality. In addition, service prices are not only determined by productivity developments, but also by factors such as over-proportionate changes in administered and regulated prices. There is also a demand-side effect that contributes to real appreciation (Dufrenot and Égert (2005).

Secondly, they found that public finances and the current account had a large impact on the RER (especially in Hungary). A shock which causes deterioration of the public deficit causes RER depreciation after a while, whereas a negative shock to the current account immediately leads to a real depreciation (Dufrenot and Égert (2005). To conclude; productivity, public deficit and the current account are all found to be important determinants of the RER of these countries. And despite the existence of differences, strong similarities appear as to how the RER reacts to changes in the fundamentals. The BEER framework is discussed and explained in detail in the next section.

### 2.7.1 Theoretical Framework of the BEER

To illustrate the general framework of the BEER approach, the following discussions are based on a number of early works on the BEER by MacDonald (1997) and Clark and MacDonald (1998). The theoretical underpinning of this approach, which would arguably allow for the short-run or temporary analyses of the RER, rests on the basic concept of UIP:

$$E_t(e_{t+1}) - e_t = i_t - i_t^* \quad (2.16)$$

Where  $E_t(e_{t+1})$  represents the expected value of the nominal exchange rate in period ( $t$ ) for period ( $t + 1$ ).  $e_t$  is the nominal exchange rate at period ( $t$ ), defined in terms of domestic currency per unit of foreign currency. Thus, a rise in ( $e$ ) implies a depreciation of the local currency. ( $i_t$ ) and ( $i_t^*$ ) denote local and foreign nominal interest rates, respectively. Subtracting the expected inflation differential,  $[E_t(p_{t+1}) - p_t] - [E_t(p_{t+1}^*) - p_t^*] = E_t(\Delta p_{t+1}) - E_t(\Delta p_{t+1}^*)$ , from both sides of Equation

(2.16), allows the conversion of nominal interest rate parity into the real interest rate parity as shown below:

$$E_t(q_{t+1}) - q_t = r_t - r_t^* \quad (2.17a)$$

$$\text{Where: } r_t = \text{domestic real interest rate} = i_t - E_t(\Delta p_{t+1}) \quad (2.17b)$$

$$r_t^* = \text{foreign real interest rate} = i_t^* - E_t(\Delta p_{t+1}^*) \quad (2.17c)$$

$E_t(q_{t+1})$  denotes the expected RER at time ( $t$ ), and  $q_t$  is the observed RER. ( $p_t$ ) and ( $p_t^*$ ) are domestic and foreign price level respectively, at period ( $t$ ). ( $\Delta p_{t+1} = p_t - p_{t-1}$ ) and ( $\Delta p_{t+1}^* = p_t^* - p_{t-1}^*$ ) are the changes in domestic and foreign price level, respectively. By rearranging Equation (2.17a), the observed RER ( $q_t$ ) can be represented as a function of the expected value of the RER,  $E_t(q_{t+1})$  and the current real interest rate differential.

$$q_t = E_t(q_{t+1}) - (r_t - r_t^*) \quad (2.18)$$

Under the BEER approach, the unobservable expectation of the RER,  $E_t(q_{t+1})$ , is assumed to be determined solely by long-run economic fundamentals ( $Z_t$ ). In other words, the BEER approach produces estimates of equilibrium RER ( $q^{REER}$ ), which incorporates both the long-run economic fundamentals and ( $E_t(q_{t+1}) = f(Z_t)$ ) and the short-run interest rate differentials.

$$q_t^{REER} = f(Z_t, (r_t - r_t^*)). \quad (2.19)$$

To illustrate the BEER approach further, Clark and MacDonald (1998) assumed three long-run determinant variables of vector ( $Z_t$ ), namely terms of trade ( $tot$ ), Balassa-Samuelson effect, i.e. the relative price of non-traded goods ( $tnt$ ), and net foreign assets ( $nfa$ ).

$$Z_t = f(\overline{tot}_t, \overline{tnt}_t, \overline{nfa}_t), \quad (2.20)$$

Tille, Stoffels and Gorbachev (2001) confirm empirically that developments in relative labour productivity can account for a portion of the change in the external value of a currency. According to the Balassa-Samuelson framework, the distribution of productivity gains between countries and across tradable and non-tradable goods sector in each country is important for assessing the impact of productivity advances to the RER. This confirms the findings by Dufrenot and Égert (2005) as discussed earlier. When a country is productive, the RER is bound to appreciate due to the increase in demand for the products, which the international economy is aware the domestic economy is able to produce.

As the productivity increase raises future income and thus wealth, and if consumers value current consumption more than future consumption, they will try to smooth the consumption pattern

(Bailey, Millard and Wells, 2001). This leads to an immediate increase in demand for both non-tradable and tradable goods. The increase in demand for traded goods can be balanced by a running trade balance deficit. The increase in demand for non-tradable goods however, cannot be satisfied and will lead to an increase in the price of non-tradable goods instead. Thus, demand effects lead to a relative price shift and ultimately to a real appreciation (Schnatz, Vijselaar and Osbat, 2004).

The demand effects associated with a rise in productivity may also generate a temporary increase in the real interest rate, triggering a real appreciation of the domestic currency (Nilsson, 2004). As consumers spread the increase in expected income to the current period by decreasing current savings, they will also drive up the real interest rate. Consumption smoothing not only affects relative prices, but also the interest rate. Therefore, an increase in average labour productivity will affect the RER also via a real interest rate channel. Such a channel can be motivated formally through the real interest rate parity condition.

In a discussion Schnatz *et al.* (2004) suggest that the equilibrium RER will unmistakably appreciate following an actual or expected shock in average labour productivity in the tradable-goods sector. The RER declines in the long-run if the productivity shock occurs in the non-tradable-goods sector, giving rise to an increase in the production of non-tradable-goods in the home market, which requires a decline in the relative prices. However, this decline is likely mitigated or even reversed in the medium term by demand-side effects. A productivity shock, regardless of its origin, also generates a rise in the real interest rate differential and capital inflows, reinforcing the productivity effect of a shock in the tradable-goods sector and counterbalancing the productivity effect of a shock in the non-tradable goods sector. On the whole, their discussion suggests that a rise in productivity, regardless of its origin, is likely to result in the appreciation of the RER, but it is difficult to determine *a priori* the magnitude of the impact of the rise in productivity. The BEER, as an alternative measure of EER is compared to the FEER in the following section.

### **2.7.2 Comparison of FEER and BEER**

Comparing Equation (2.18) of the BEER approach and Equation (2.15) of the FEER approach, a number of similarities and differences can be highlighted (Siregar, 2011):

- Unlike the FEER, the BEER approach is not a normative one. While the FEER considers “sustainable external balance” and “internal balance”, the BEER, on the other hand, is the equilibrium rate consistent with the prevailing levels of economic fundamentals. It can be used regardless of macroeconomic balance;

- The BEER takes into account short-run cyclical/temporary factors that may contribute heavily to medium-to-long-run movements of the equilibrium exchange rate. The adoption of interest rate parity allows for the BEER approach to capture the sources of changes in the capital account which may then also affect the current account and the “behaviour” of the exchange rate. The basic FEER approach, in contrast, only captures the behaviour of the exchange rate driven by positions of external and internal balances;
- As will be further explained in the NATREX model, the introduction of debt stock as one of the determinant variables, allows the BEER to capture the long-run trajectories of the equilibrium exchange rate; and
- Lastly, the BEER may converge to the FEER in the medium-run, under economic conditions of full employment and sustainability, impacting on changes in the equilibrium exchange rate.

Having compared the two approaches, it is easier to now estimate the BEER with an understanding of what comprises both the FEER and the BEER.

### 2.7.3 Estimating the BEER

Since the equilibrium exchange rate is not an officially observable variable, a common empirical approach to estimate the BEER involves a series of steps. To illustrate this, the BEER model as applied by Clark and MacDonald (1998) is reviewed

- Step 1: estimate the long-run (cointegration) relationship between the prevailing RER and the set of short-run and long-run economic fundamentals listed in Equation (2.23), which include the real interest rate differential, terms of trade, non-traded goods and net foreign assets.

$$q_t = \alpha + \beta_0(r_t - r_t^*) + \beta_1 tot_t + \beta_2 tnt_t + \beta_3 nfa_t \quad (2.22)$$

- Step 2: using the coefficient parameters of each fundamental variable ( $\hat{\alpha}, \hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2,$  and  $\hat{\beta}_3$ ), the BEER RER can be calculated.

$$q_t^{BEER} = \alpha + \hat{\beta}_0(r_t - r_t^*) + \hat{\beta}_1 tot_t + \hat{\beta}_2 tnt_t + \hat{\beta}_3 nfa_t \quad (2.23)$$

- Step 3: calculate the level of misalignment rate, measured as the difference between the prevailing exchange rate ( $q_t$ ) and the BEER RER  $q_t^{BEER}$ .

The BEER is a popular model used to determine the equilibrium exchange rate since it does not depend on a particular economic condition to hold, and therefore a normative component is removed. It includes shocks from the tradable sector, as well as the non-tradable sector. The BEER is

an all encompassing model and lends itself to capture misalignment based on fundamentals as reflected by the exchange rate itself. The BEER can be further extended by applying the Permanent Equilibrium Exchange Rate (PEER). The PEER is a concept narrowly related to the BEER and is discussed in brief below.

## 2.8 The Permanent Equilibrium Exchange Rate

The Permanent Equilibrium Exchange Rate (PEER) is an extension of the BEER. It depicts an estimation of the equilibrium exchange rate driven by the long-run sustainable levels of identified economic fundamentals. The difference between the actual exchange rate and the PEER is referred to as total misalignment. In addition, contrasting the current misalignment of the BEER and the total misalignment of the PEER aids in identifying further sources of misalignments (Siregar, 2011). The PEER takes the captured current misalignment and derives the total misalignment studying long-run economic fundamentals unlike the BEER which only focuses on the prevailing rates.

The PEER can simply be described as a BEER with the independent variables set at their permanent values (Cline and Williamson, 2007). In the analysis of the BEER, it has been indicated that the equilibrium exchange rate is derived, based on the prevailing levels of economic fundamentals. Hence, the misalignment captured from the steps above is often referred to as the *current* misalignment rate. However, as the prevailing rates of economic fundamentals may deviate significantly from the “sustainable level” or the “long-run/permanent level”, early studies<sup>3</sup> have extended the analysis of the BEER by estimating the equilibrium level of exchange rate driven by the long-run sustainable levels of identified economic fundamentals. This equilibrium rate is called the Permanent Equilibrium Exchange Rate (PEER) (Siregar, 2011). The difference between the actual exchange rate and the PEER is referred to as *total* misalignment.

In order to generate the PEER, each of the relevant long-run economic fundamentals included in  $Z_t$  (see Equation (2.19)) need to be decomposed into their temporary and permanent components, this is one of the first and critical steps. The PEER, as an extension of the BEER, relies on decomposing  $Q$  (RER) into permanent and transitory components as shown in Equation (2.24) below, where  $Q^P$  is the permanent component and  $Q^T$  is transitory.

$$Q = Q^P + Q^T \tag{2.24}$$

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<sup>3</sup> Studies by Elbadawi (1994) and Clark and MacDonald (2000) extended the analysis of the BEER by applying the PEER.

The PEER is a reliable approach however, it is determined by the BEER, and this shows the importance of the BEER approach. The Natural Rate of Exchange (NATREX) is an approach which is closely linked to the both the PPP and the FEER, it can also be referred to as the extension thereof. The similarities between the FEER and the NATREX motivate the use of the BEER methodology in this study.

## **2.9 The Natural Rate of Exchange (NATREX)**

Another approach which is closely related to the FEER is the NATREX. Stein (1994), who originally formulated the NATREX, defined it as the rate that would prevail if speculative and cyclical factors could be removed and unemployment was at its natural rate. Further work on the NATREX has been done by Stein and Allen (1995); Lim and Stein (1995); Stein and Paladino (1997); Verrue and Colpaert (1998); as well as Gandolfo and Feletigh (1998). The approach is an attempt to link the RER to a set of fundamental variables explaining savings, investments and the current account.

NATREX is based on the thorough modelling of the stock-flow interaction in a macroeconomic growth model. The NATREX is a moving equilibrium exchange rate, and the trajectory of the exchange rate can be decomposed into three components: the medium-run, the longer-run and the steady state (Gandolfo and Felettigh, 1998). The medium-run is affected by changes in the stock of capital and debt due to changes in fundamentals, the external and internal equilibrium prevails. The long-run is consistent with the PPP rate and has constant foreign debt and a capital stock at its steady state level. In fact, NATREX's contribution is in providing the trajectory of the medium-term equilibrium to its long-run equilibrium (Detken, Dieppe, Henry, Marin and Smets, 2002).

The NATREX, derived from a specific theoretical dynamic stock-flow model, relies on a similar definition as the FEER, although its ambition is more positive than normative. It is intended to detect fundamental determinants that influence the behaviour of the RER, through reduced form equations and time series analysis (Égert, Halpern and MacDonald, 2005). NATREX is a moving equilibrium exchange rate that responds to continual changes in exogenous and endogenous real fundamentals. The FEER on the other hand, is the RER that will bring the current account, measured at potential output, in line with some measure of desired capital flows. This desired capital flow is the difference between savings and investment that is not distorted by public policy. The major difference therefore between the NATREX and the FEER is that optimal policies are not part of the NATREX, whereas they make up a great part of the FEER (Saayman, 2005). According to Stein and Allen

(1995), NATREX predicts how a change will affect equilibrium exchange rate, but not the desirability of the disturbance or outcome.

There are three basic foundations for the NATREX approach. The first approach lies within the standard national income accounting equation (Siregar, 2011):

$$I - S + CA = 0, \tag{2.25}$$

Where ( $I$ ) is the desired investment, ( $S$ ) the desired saving and ( $CA$ ) the desired current account. The levels of desired saving and investment depend on the existing stock of capital, wealth, and net debt to foreigners.

Equation (2.25) captures the medium-run equilibrium when the economy is operating at full capacity output and expectation about inflation is met – which are both similar to that of the FEER approach. The medium-run position is characterised by the following conditions: the domestic securities market clear; cyclical and short-term speculative capital flows cancel out; and any difference between investment and saving represents the excess flow of supply of tradable long-term securities. Hence, under these conditions, Equation (2.25) also captures the balance of payment equilibrium (the sum of capital and current account). The medium-run NATREX is the equilibrium rate consistent with the desired balance of payment equilibrium or the macroeconomic balance (Siregar and Rajan, 2006).

Secondly, in the approach Stein (1994) defines the fundamentals as the disturbances to productivity and social thrift (time preference of consumption/expenditure by household and government) at home, and abroad, denoted by vector ( $Z(t)$ ). The exogenously determined fundamentals will not only affect the desired investment, saving, and current account, but will also influence the trajectory of the NATREX. ( $Z(t)$ ) will affect capital formation, the rate of debt accumulation, as well as the interest rate. As desired saving and investment change, the NATREX will fluctuate accordingly (to new rates). In other words, the NATREX approach adds dynamics (i.e. changes in capital stock and debt) which then feed back into macroeconomic balance. This feature allows the NATREX approach to look at the path of the exchange rate from the medium-term to the long-run equilibrium, which is arguably missing under previous models (MacDonald, 2000; Siregar and Rajan, 2006).

Lastly, the NATREX will converge to a static long-run exchange rate when there is no further changes in the fundamentals (hence no changes also on the stocks of the capital and debt) (MacDonald, 2000; Siregar and Rajan, 2006).

The NATREX is therefore a moving equilibrium exchange rate, and the trajectory of the exchange rate can be decomposed into three components: the medium-run, the longer-run and the steady state. For clearer illustration, the RER can be depicted as being in three phases or stages (Siregar, 2011):

- The first stage is the actual/ spot rate:  $q_t = q_t(k_t, F_t, \varepsilon_t; Z_t)$ , which is the realised rate at time  $(t)$ , given the stock of capital  $(k_t)$ , stock of debt  $(F_t)$  and the presence of the speculative capital flows. As discussed, the stock of capital and debt is influenced by the changes in fundamentals  $(Z(t))$ ;
- The second stage is the medium-run NATREX:  $q = q(k_t, F_t; Z_t)$ , which is affected by the changes in the stocks of capital and debt (due to changes in the fundamentals as mentioned in the first stage). However, unlike the spot rate, speculative flows do not influence the medium-run NATREX. Hence, this rate is also what is supposedly obtained by the FEER approach; and
- In the long-run (third stage), the NATREX converges to a static long-run rate:  $q^* = q^*(Z_t)$ . This constant or stationary long-run real equilibrium NATREX is consistent with the PPP rate. Hence, the NATREX extends early models such as the PPP and the FEER by focusing its analyses on the periods when the fundamentals are not stationary and generating the trajectories of the exchange rate from the spot/short-term to the medium-run, and from the medium-run to the static long-run position.

Based on the analyses above, the spot real rate is, therefore, not necessarily an equilibrium rate, i.e.  $q_t(k_t, F_t, \varepsilon_t; Z_t) \neq q(k_t, F_t; Z_t)$ , and it can be decomposed into three phases of exchange rate movements and states (Equation (2.26)):

$$q_t(k_t, F_t, \varepsilon_t; Z_t) = \{ (q_t(k_t, F_t, \varepsilon_t; Z_t) - q(k_t, F_t; Z_t)) \} + \{ q(k_t, F_t; Z_t) - q^*(Z_t) \} + \{ q^*(Z_t) \}. \quad (2.26)$$

Note:  $\{ (q_t(k_t, F_t, \varepsilon_t; Z_t) - q(k_t, F_t; Z_t)) \}$  captures the trajectory from the spot rate to medium-run rate; and  $\{ q(k_t, F_t; Z_t) - q^*(Z_t) \}$  denotes the longer-run trajectory (from medium-run equilibrium position to the long-run static equilibrium rate). To illustrate the directions of the trajectories, one can consider the impact of an increase in government expenditure (social preference) in the medium-and long-term horizon. In the medium-run, the rise in government expenditure will increase aggregate demand and cause an appreciation of the RER of the local currency (Siregar and Rajan, 2006). The strengthening of the local currency would, in turn, worsen the current account position through a possible deterioration in the net interest flows on foreign debt. In the long-run, a

depreciation of the local currency is needed to stabilise net foreign assets (Siregar, 2011). An estimation of the NATREX is given in the following section.

### **2.9.1 Estimating the NATREX**

The estimation of the NATREX raises two issues. The first issue is associated with the selection of the fundamentals that capture the shocks in productivity and social thrift (time preference). The second issue is the testing procedures, i.e. between testing a single reduced form equation (much like the BEER) and estimating structural equations (Siregar, 2011).

As expected, on the selection of the fundamental variables, productivity and social thrift/time preference are commonly considered the fundamental variables in all applications of NATREX. To capture productivity, some authors use the productivity of labour, measured by (GDP/total employment) while others adopt total factor productivity (Stein, 2002). By definition, social thrift reflects the changes in total consumption (household and government) over GDP during the observation period. However, since household consumption is found to be stationary over the long-term span for some countries, only the ratio of government expenditure over GDP is considered as a proxy for thrift (Stein and Paladino, 1999; and Rajan and Siregar, 2002). As for other fundamentals that may influence the evolution of capital and debt, their selection is highly influenced by the types of economies being considered, i.e. developing and developed economies.

The theory on six equilibrium exchange rate concepts, which are closely linked, has been discussed. However, as they somehow build upon each other, the one that has been proven to be more reliable by theorists to estimate the misalignment of the current RER, remains the BEER. This research will therefore follow the BEER approach as it helps in determining the current misalignment taking macroeconomic fundamentals into account, within ever-changing macroeconomic conditions. So it can be used whether the economy is not in macroeconomic balance, unlike the FEER. The macroeconomic fundamentals which influence the exchange rate are discussed in relation to the South African economy in the subsequent section.

## **2.10 Factors That Influence the RER in South Africa**

Cypher and Dietz (2009) define the exchange rate as the number of units of a foreign currency that can be obtained for each unit of a domestic currency, or simply put, the number of units needed to

buy one unit of some foreign currency. South Africa decided to do away with its ability to influence the price the economy will pay to get a foreign currency when the government decided to operate with a freely floating exchange rate (Fourie, 2007). The nominal value of the rand, relative to other currencies, depends solely on the demand for and the supply of domestic currency on the foreign exchange market which can partly be explained by neoclassical growth theories. There is a link between the exchange rate in South Africa and neoclassical growth theories.

The RER did not feature in early neoclassical growth theories. Solow's (1956) main focus was on capital, labour and technology, while Rostow (1960) focused on the determinants of savings and investment. Even classical economists, as will be discussed in the next chapter, did not touch on the exchange rate; their main concern was capitalism and the pessimistic population growth theories. The models were mainly closed-economy models, which meant there was no role for the exchange rate, and that domestic institutions were the main focus, which meant that their role was, at times, overstated (Abramovitz, 1956).

The rationale for the factors that influence the exchange rate is, however, based on the neoclassical theoretical framework that assumes the prices of tradable goods are equalised across countries. Since South Africa is an open economy, the exchange rate becomes a key policy variable (Aron, Elbadawi and Kahn, 1997). The RER in South Africa, however, is not planned or controlled by policymakers directly; it is rather an outcome of other policies and processes that influence supply and demand (Fourie, 2007). These policies and processes are the fundamental variables that influence the RER in South Africa (Aron *et al.*, 1997; MacDonald and Ricci, 2003; Saayman, 2007). According to Aron *et al.* (1997), and MacDonald and Ricci (2003), these fundamental variables include: trade policy, terms of trade (gold price), long-run and short-run capital flows, foreign exchange reserves, government expenditure and productivity growth differentials. Each of these determinants or fundamentals of the RER is subsequently reviewed.

### **2.10.1 Trade Policy**

There have been significant changes in South Africa's trade regime since the 1980s (also see Chapter 3, Section 3.4). Trade was initially characterised by import protection and export bias, but by the end of the 1990s the economy was then pushing for export-led growth (Section 3.4). This was by means of government incentives to firms that were involved in export, thereby encouraging production for export (Cassim, 2003).

Trade liberalisation progressed slowly during the 1980s with custom duties only declining by less than 3% in the 1982-1992 periods, from 8.7% to 6%. This implies that, although the overall protection in the South African economy as compared to international economies is not high, the system has been found to be unstable, complex and with a high degree of tariff dispersion (Fallon and Pereira de Silva, 1994).

South Africa had used tariffs as the main instrument of protection, but other instruments such as export incentives and import surcharges were employed. These export promotion strategies included sector-specific export incentives, exporter's allowance and custom duties exemption. The most significant export promotion policy was introduced in 1990, the General Export Incentive Scheme (GEIS). The aim of the GEIS was to overcome the anti-export bias and to promote fully manufactured exports (SAICA, 1996). When the GEIS was found to contravene with the General Agreement on Tariffs and Trade (GATT) and the World Trade Organisation (WTO) regulations, it was phased out, in 1996.

The main motivation for the use of tariffs, according to Aron *et al.* (1997) was to protect the balance of payments. These tariffs were enforced very strongly after the 1976 Soweto uprising whereby capital outflows climaxed, they remained in force until March 1980 when the high gold price boosted the current account. They were reintroduced in 1982 until November 1983 and again in 1985 following the debt crisis. The import surcharges were increased in 1988 following the increased pressure on the current account, and they often generated more revenue than custom duties. The charges were abolished at the end of 1995 by the democratic government, which came in place in 1994.

An open trade regime is however associated with a more depreciated RER (Goldfajn and Valdes, 1999; Aron *et al.*, 1997; MacDonald and Ricci, 2003; Eichengreen, 2008). Trade restrictions increase the price of tradable goods and therefore the RER of the domestic economy.

### **2.10.2 Terms of Trade**

The terms of trade encompasses all exports and import prices specified in a country (Driver and Westaway, 2004). An increase in world prices of the commodities that a country exports tends to cause appreciation in the RER. This increase would then induce higher wages and higher prices of non-tradables (Cashin, Céspedes and Sahay, 2002). This increase in commodity prices would then

also induce a positive wealth effect, which would raise domestic demand and hence the price of non-tradables (Cashin *et al.*, 2002).

Consistent empirical studies show that improved terms of trade and higher government expenditure tend to lead to RER appreciation because the income effect of terms of trade improvement usually dominates its substitution effect, and government tends to have a higher propensity to spend on non-traded goods than does the private sector (Edwards, 1989).

The South African terms of trade showed deterioration during the 1970s with sharp declines associated with shocks in the oil price, as well as the general downward trend in primary commodity prices (Gelb, 1991). According to Gelb (1991), the fast rising import prices, due to the dominance of capital goods in South Africa's imports, also became a problem as import prices rose faster than the overall import price index. The downward trend was reversed by the more stable oil prices in the 1980s and the export of more manufactured and semi-manufactured goods. This reduced the fluctuation of terms of trade to a large extent.

The gold price has always been volatile and rose to extremely high levels in the 1980s (IFS, 2012). The gold price has a dominant role in the South African economy and when it is included in the terms of trade, the gold price movements tend to outweigh the non-gold terms of trade. After its peak in the early 1980s, the importance of the gold price started declining in the mid-1980s, due to an increase in the volume of non-traditional exports (Aron *et al.*, 1997). The importance of the gold price was then seen again in 2011 when the Euro zone faced a financial crisis and investors sought refuge in gold, which caused appreciation in the RER (SARB, 2012).

### **2.10.3 Capital Flows**

Theory assumes that long-term capital flows would be a long-run determinant of the RER whilst short-term flows are expected to influence the adjustment to equilibrium (Aron, *et al.*, 1997; Driver and Westaway, 2004; Isard, 2007). The disinvestments that took place as a result of the sanctions in the 1970s and 1980s became long-run capital outflows because the direct investment was withdrawn from the country and did not return, which had a direct effect on the RER, as well as the balance of payments (Mohammed and Finoff, 2004).

The capital flows situation was positive in the first half of the 1980s but the debt crisis of 1985 made it almost impossible for South Africa to raise long-term loans, while at the same time facing the

commitment of repaying previous loans (Aron *et al.*, 1997). After the transition into a democracy in 1994, the capital account and net capital long-term flows became positive, and apart from some volatility in 2001, 2008 and most recently in 2011, the trend has been somewhat positive.

#### **2.10.4 Foreign Exchange Reserves**

Theoretically, a positive reserve of foreign exchange is expected to appreciate the RER (Krugman, 1979; Flood and Garber, 1984; Aron *et al.*, 1997). This is because foreign exchange reserves act as a relatively liquid indicator of the stock of national wealth. When there are changes in gold prices and adverse political events, the foreign exchange reserves are known to move in a manner which reflects the direction of these changes. Net reserves are the first to suffer in light of these movements as the Reserve Bank borrows to support gross reserves when it is under pressure. Borrowing helps maintain gross reserves at sustainable levels, which are healthy for the economy. When the Reserve Bank has repaid reserve related borrowings and the balance of payments has improved, the rise in gross reserves is mitigated and the difference between net and gross reserves is reduced (Aron *et al.*, 1997).

Foreign exchange reserves in the South African economy peaked in the late 1970s and early 1980s due to the commodity price boom, but went back to relatively low levels thereafter. In recent years, the government, through finance minister Pravin Gordhan (2011), has worked together with the Reserve Bank in foreign exchange reserve accumulation. In his 2011 budget speech, Gordhan (2011) stated that foreign exchange reserves had increased by \$5.8 billion to \$45.5 billion in 2010 and the Reserve Bank had entered into long-term currency swaps in order to sterilise foreign currency flows.

#### **2.10.5 Net Foreign Assets**

The volume of net foreign assets in an economy is usually associated with an appreciation in the RER whilst the volume of foreign liability is associated with depreciation in RER. A large stock of foreign liability impairs the ability of the economy to repay its foreign loans and that discourages investors (MacDonald and Ricci, 2003). The repayment of the foreign liabilities accumulated would, however, eventually require a depreciation of the RER.

When the economy has higher foreign assets, larger expenditure on domestic goods is induced and the RER appreciates. If there is no price equalisation of tradables, an alternative mechanism will

emerge. A country that has reached a high level of foreign assets is in a position to finance a current account deficit and can thus maintain a loss of competitiveness that is associated with an appreciated RER (Lane and Milesi-Ferretti, 2002).

### **2.10.6 Government Expenditure**

Changes in the fiscal balance tend to have an ambiguous effect on the RER (Saayman, 2007). A positive fiscal balance may induce a reduction in private savings; this may cause a fall in domestic demand and a rise in overall savings. The price of non-tradable goods will also fall, bringing about depreciation in the RER (Macdonald and Ricci, 2003). This effect might be stronger if fiscal improvement comes from a reduction in government rather than an increase in taxes. The fiscal effect should, in principle, be part of the main aggregate demand effect (MacDonald and Ricci, 2003). Higher government expenditure, according to Edwards (1989), may also tend to RER appreciation because the government tends to have a higher propensity to spend on non-traded goods than does the private sector.

In South Africa, the aim of the government has been to reduce a relatively high fiscal balance resulting from the adverse conditions of the 1980s. After the democratic elections of 1994, fiscal policy has helped stabilise a fragile economy, thereby supporting faster and less volatile growth. It has also sustainably financed the significant growth in spending, thereby steadily increasing the contribution of the state to the economic and social development of the country's people (National Treasury, 2009).

According to Naidoo, Willcox, Makgetsi and Stott (2008), government spending in South Africa was very slow in periods prior to 2000, but an increase in spending is seen from 2001 as many areas received increased resources from government, including defence, education and health. The increase in social grants also contributed to the increase in government spending, with the number of social grants increasing from less than 3 million in 1999 to above 11 million in 2006 (more than 3.3% of GDP). The built environment infrastructure was noted by the National Treasury (2009) as the fastest growing sector of government in terms of resources allocation.

### **2.10.7 Productivity Growth Differentials**

According to the Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964), when there is an increase in productivity in the tradable goods sector, the RER of the economy will tend to appreciate. Higher wages, given the extent of the productivity increase, are bound to follow. If wages in all sectors have equalised, the prices of non-tradable will also increase, followed by an increase in the consumer price index.

The improvement in productivity in South Africa has been very positive, especially after 1994 (Du Plessis and Smit, 2007). The rise of the tertiary sector relative to the rest of the economy has contributed about 78% of GDP to growth in the period after 1994; in the years prior to 1994 the tertiary sector had contributed about 94% of GDP. The manufacturing sector, however, has had far less success; it has only provided 16.3% of the growth in GDP since 1995, and it is still declining as a share of total output. The primary sector still provides the smallest contribution to GDP. The share of mining and quarrying, and agriculture is still far too small (SARB, 2012). An improvement in the productivity growth levels of the different sectors in the economy will result in RER appreciation, whereas low productivity growth levels discourage many economic activities and eventually result in a depreciated currency (Saayman, 2010).

### **2.10.8 Real Interest Rates**

There exists a direct relationship between real interest rates and the RER as the real interest rate represents factors that directly affect the RER (MacDonald and Ricci, 2003; Saayman, 2007; Driver and Westaway, 2004; Mtonga, 2006). Aggregate demand, productivity and persistent monetary policy are all represented by the real interest rate differential. If there is an increase in absorption relative to savings, this would put upward pressure on the real interest rate in an economy that does not have perfect capital mobility. The demand for both tradable and non-tradable goods would rise, leading to an increase in prices of non-tradables and consequently leading to an appreciation of the RER (MacDonald and Ricci, 2003).

Real interest rates have been found to also reflect on productivity levels where the proxy for the Balassa-Samuelson fails. The real interest rate may capture this empirically. If the productivity of capital increases, when compared to that of trading partners, capital inflow to the home country may increase, thereby inducing appreciation of the RER. Égert, Drine, Lommatzsch, and Rault (2003)

state that the prices of tradable goods and the interest rates are exogenous as they are determined in the world market according to Balassa-Samuelson effect.

Dornbusch (1976) found that a tightening of monetary policy would raise interest rates. This outcome is, however, associated with the expectations of currency depreciation as the interest parity condition is taken as given. According to Dornbusch (1976), in such a situation, the nominal exchange rate will appreciate beyond long-run value, in order for the depreciation to take place when the monetary policy shock has disappeared. If prices are not elastic, the RER could appreciate relative to its long-term value (Obstfeld and Rogoff, 1996). If the monetary shock, or the rise in interest rates persists, the situation described above could persist as well.

South Africa's long-term interest rates have been seen to follow international trends, although short-term interest rates have been high compared to historical standards (SARB, 2012; IFS, 2012). Inflation and the oil crises of the post-war period resulted in positive real interest rates in the 1980s of over 2% (SARB, 2002). In addition, the inflation targeting regime that was adopted by the Reserve Bank in the 1999 helped the economy to lower these inflation rates and raise interest rates, resulting in relatively stable interest rate since 1999. The real interest rate was reported at 4.24% in 2009 and 1.64% in 2010, a sharp decline from a 5.72% rate of 2008 (World Bank, 2010), partly due to the United States debt crisis of 2008.

## **2.11 Summary**

The aim of this chapter was to outline the different measures of equilibrium exchange rates and to emphasize the use of the BEER, which will be the methodology that will be followed in this study. The factors that influence the long-term value of the RER, the rand, over the years were also touched upon.

As much as tradable goods are major determinants of the exchange rate, non-tradable goods play a significant role and therefore have to be included in the estimation of the equilibrium exchange rate. Economic phenomena that impact the relative price of non-tradable goods must be included in models of RER determination. The FEER approach takes both tradable and non-tradable sector values into account, although macroeconomic balance may be difficult to attain and therefore the condition for FEER remains unrealistic. The BEER approach, in determining the current misalignment, takes macroeconomic fundamentals into account, although macroeconomic balance is not a necessary condition. The NATREX is also an approach which can be followed since it takes

unemployment at its natural rate into account, and there are no speculative or cyclical factors. Determining the equilibrium exchange rate brings one closer to determining the misalignment.

Factors that influence the fundamental value of the RER were also discussed. These factors included the trade policy, terms of trade, capital flows, foreign exchange reserves, net foreign assets, government expenditure, productivity growth differentials, and real interest rates. The changes in these factors that occurred in the South African economy were briefly reviewed. These factors will therefore be taken into account when determining the fundamental or long-run value of the RER or the real equilibrium exchange rate.

One cannot know if there is a misalignment if there is no equilibrium because the “desirable” point – when all else remains equal – is not known. The misalignment, given the equilibrium exchange rate, either an undervaluation or overvaluation can then be determined. Bear in mind that the study focuses on the effects of these misalignments on economic growth in South Africa; this therefore makes the study on economic growth imperative. Once the misalignment is determined, the effect of this misalignment on growth is estimated in Chapter four. The next chapter gives a review of different growth theories and guides one through economic growth in South Africa.

## Chapter 3 Economic Growth Theory

### 3.1 Introduction

In the previous chapter, it was shown that productivity; demand pressures; international environmental integration; foreign indebtedness; the gold price and real interest rates are factors that influence exchange rate movements in an economy such as South Africa's economy. Since this study focuses on the effect of exchange rate misalignments on economic growth in South Africa, this chapter turns to investigating economic growth in the country.

Although post-1994 growth was less than what stakeholders had expected, as they had expected a huge financial turnaround for the country, growth rates post-1994 still exceeded growth rates of the two decades prior to 1994. Du Plessis and Smit (2007), in their attempt to identify factors that explain South Africa's growth recovery since 1994, find that aggregate sectoral growth is the main driver of growth. In addition, growth is induced by the increase in foreign capital inflows and total factor productivity. Capital inflows allowed the country to invest in some human capital, as well as physical capital which is essential for substantial growth. There are, however, other contributors to growth in South Africa and these will be discussed further in this chapter. The aim of this chapter is to explain the theory of economic growth, and provide an outline of growth trends in the South African economy, as well as the different factors that were the drivers (or inhibitors) of growth, from the 1980s through to 2011.

The economy prior to 1994 was characterised by slow growth, inequality and the adverse political dispensation (Faulkner and Loewald, 2008). This political dispensation led to the international community posing sanctions on South Africa. The disinvestments that followed in the late 1980s eventually led to the abolition of apartheid in 1994 (Mohammed and Finoff, 2004), and a new political system was put in place. The economy opened itself up to trade with international markets and growth began to increase. Mohammed and Finoff (2004) found that investors were, however, very reluctant to invest in the new South Africa, wealthy South Africans decided to invest abroad as they feared that the strategies that will be initiated by the new government would threaten their financial wealth. According to Mohammed and Finoff (2004), although capital inflow increased, the outflow of domestic savings more than countered this increase.

In order to understand growth in South Africa this chapter is structured as follows: the different growth theories and models are discussed in Section two, including total factor productivity and endogenous growth. Section three focuses on growth in South Africa and evidence of growth in the

country. The study of the economy and all the factors that influenced growth over the years, from 1985 through to 2011, is undertaken. Section four studies the effects of the exchange rate on growth or *vis-à-vis* in South Africa, and Section five concludes.

### 3.2 Economic growth theory

Growth theory identifies capital accumulation and to some extent, its interaction with savings behaviour in the economy as the potential drivers of growth. Romer (1994) suggests the following factors be taken into consideration when analysing growth theory; these are assumptions that are made about factors of production. These have been taken for granted and have posed as a problem to many economists.

- There are many firms in a market economy;
- Discoveries differ from other inputs in the sense that many people can use them at the same time. Ordinary goods are rival goods, information is non-rival;
- It is possible to replicate physical activities. Replication implies that the aggregate production function representing a competitive market should be characterised by homogeneity of degree one in all of its conventional inputs. If output is represented in the form of  $Y = A(K, H, L)$ , then doubling all three K, H and L should give a double output. There is no need to double the non-rival input A because the existing pieces of information can be used in both instances of the productive activity at the same time;
- Technological advance comes from things that people do. No economist has given evidence that technological advancement is literally a function of a period. The aggregate rate of discovery is determined by things that people do. If one is prospecting for gold, success will be by chance. Discovery will seem like an exogenous event because it is not controlled by the person. The aggregate rate of discovery is, however, endogenous. When more people start prospecting for gold, more valuable discoveries will be found. This is true even when discoveries are accidental side effects of some other activity (finding gold as a side effect of ditch digging); and
- Many individuals and firms have market power and earn monopoly rents on discoveries. Because people and firms have control over information produced by most discoveries, it cannot be treated as a public good.

These points are the foundation of the neoclassical growth model; the fourth point, however, also supports endogenous growth. The Solow growth model is a neo-classical growth model that has

been the foundation of most growth theories since the 1950s. It is therefore a solid economic growth model that serves as input to many other growth theories and key to any analysis of growth.

Economic growth literature puts emphasis on two growth models, the classical growth model and neoclassical growth model. The classical growth theory states that productive capacity allows for growth, the improving and increasing of capital to allow that capacity is the “wealth of nations”. Classical economists stressed the importance of agriculture and saw the urban industry as one that could never fail. Smith (1776) extended this notion that manufacturing was central to the whole economy, and if this kept improving then returns would continue to increase. The neoclassical growth model assumes diminishing returns to capital and that the economy converges towards a steady-state rate of growth (Solow, 1956). When there is a constant rate of labour force growth and no technical progress, there will be no growth in per capita income– technical progress is required. The various growth models and the contributors to these theories are discussed below.

### **3.2.1 Classical Growth**

#### **a) Adam Smith Theory of Competitive Capitalism**

In his book entitled “An Inquiry into the Nature and Causes of the Wealth of Nations”, of 1776, Smith is primarily concerned with economic growth. According to Smith (1776), population growth is endogenous as it depends on the sustenance available to accommodate the increasing workforce. Investment is also endogenous as it is determined by the rate of savings, mainly by the capitalists (Smith, 1776). Land growth is dependent on the attainability of new land through channels such as colonisation, or technological improvements of fertility of old lands (Higgins, 1968). Because savings create investment and hence growth, Smith (1776) saw income distribution as one of the main determinants of the speed of economic growth in an economy.

The Smith (1776) theory of absolute advantage emphasises the so-called “invisible hand”- the forces of demand and supply driven by personal interests – the way in which division of labour can increase productivity, output and per capita incomes, as well as a “Law of Accumulation” whereby surpluses are re-invested. Smith (1776) found that individuals are always seeking to maximise utility whereas producers are looking to maximise profits. When there is perfect competition, the system will be balanced and will benefit all. Smith (1776) also advocated that the state would have to play a limited role in the economy as this capitalism would push entrepreneurs to form monopolies, prices would

increase to unsustainable levels, and consumers would suffer (Cypher and Diets, 2009). The role of the state would be therefore to protect consumers from imperfect market operations.

Division of labour is very important in the Classical model. The results of this include a considerable decrease in production costs, increase in output, increased productivity and effectiveness, entrepreneurs become more competitive, and there is an average increase in per capita incomes (Kleynhans and Naudé, 1999). The role of the state is, however, limited, the state should be on the lookout, see that nothing goes wrong. The state has to promote free trade and protect competitive markets, but it should not interfere in the free market as that would have a negative effect on welfare for all (Smith, 1776). Apart from the increasing returns, Smith (1776) posited a ceiling on growth. He therefore did not see growth as eternally rising, and there is a form of stationary state where population growth and capital accumulation are zero.

### **b) Ricardo's Theories of Decreasing Higher Yield and Comparative Advantage**

David Ricardo (1817) modified Smith's (1776) economic growth model by including diminishing returns to land. Output growth requires an increase in factor inputs, but, unlike labour, land is fixed in supply and variable in quality (Ricardo, 1817; McCulloch, 1881). Ricardo (1817) felt that economic growth would ultimately be linked to an equilibrium situation where workers would only receive enough wages in order to be able to survive due to diminishing returns in agriculture. The population would grow, more agricultural land cultivated, and the marginal yield from agriculture would decline because quality of land and its productivity would decline. The rising costs of food production and the increase in the demand for food would both push the price of food higher. For landowners, the rise in food prices would lead them to earn undeserved profits (Fourie and Mohr, 2008).

Once a growing economy reaches its maximum income per capita the increase in inflation will lead to a fall in disposable income, causing per capita income to decline to survival levels. Although nominal wages rise, saving for industrialisation drops. Ricardo (1817) says that this phenomenon cannot be avoided; however, an improvement in technological advancement can cause economic growth to be sustainable. As is seen today, genetically modified foods provide to the needs of many people in many developed countries in the medium-to-long-term. In his book, "Principles of Political Economy and Taxation", Ricardo (1817) asserted his support of free international trade and encouraged specialisation in products in which the country had competitive advantage. He found that it was through international trade that the above could be realised. Larger imports would create great competitiveness domestically, which would lead to lower food prices, and which would cause nominal wages to remain low. It was specialised free trade, coupled with low nominal wages-

greater profits for industrialisation- and technological progress that became the cause of essential factors for sustained economic growth.

When a long-term, dynamic view is taken, it is clear that what is important for a country is not specialisation per se, but the choice of product to specialise in. For example, Ricardo (1817) referred to wine production in Portugal, and textile production in England, as examples of international specialisation. Both these had unanticipated returns in future, as Robinson (1973) found that the imposition of free trade killed a promising textile market in Portugal and left them with a slow-growing export market for wine, which drained the economy. In England, exports of cotton led to accumulation, mechanisation and the whole spiralling growth of the industrial revolution. This implies that countries should create a competitive advantage in the type of goods for which world demand will increase in the future (Verbene, van Zon, and Muysken, 1996).

### **c) Malthus' Theory of Population Growth**

Malthus' (1798) theory of population growth states that populations will always increase when wages are higher than what is needed for simple survival and that the poor are responsible for their own misery due to the capitalist system. He surmised that population growth itself is not enough to induce economic advance, rather, population growth is the end product in the economic growth process (Malthus, 1798). His view was that the population can only increase when accompanied by an increase in wealth.

Malthus (1821) later became concerned about the population growth and the scarcity of resources that would result and bring economic growth to a standstill. He was of the belief that as populations will increase multiplicatively (2, 4, 6, 8...) and food production only arithmetically (1, 2, 3, 4...); famines will result as there will not be enough food to sustain the population. His pessimistic view sees causality; economic growth which leads to population growth will eventually lead to poverty and degradation. It is not clear whether Malthus (1821) considered resources in the framework of fixed labour which does not get depleted or non-renewable resources which get depleted.

Classical economic growth models have many limits that are interwoven in the process of growth. These limits encompass demographic, as well as social and political domains. Classical economists realised that the growth of wealth could not continue indefinitely; they expected and feared eventual collapse (Saeed, 2008).

### **3.2.2 Marx's Model of Capitalist Economic Growth**

Adam Smith (1776), Thomas Malthus (1821), and David Ricardo (1817) all regarded capitalism as the natural state of things. They assumed that investment in and ownership of means of production, distribution, and exchange of wealth would always be made and maintained primarily by the private sector and the state should not interfere in the economy.

Karl Marx (1894) believed capitalism was overrated. He pointed out in his book, *Das Kapital* that the capitalist system was the most effective in terms of production in that it had created more wealth in a century than all other previous economic systems in human history. His main concern with the system was the unequal distribution of wealth that resulted. According to Marx, the unequal distribution between the capitalist and the worker would, through revolution, lead to the downfall of capitalism, which was contrary to what other classical economists believed (Marx, 1894).

In his theory of production, all capital is created by labour. Marx described capital as “dead labour” (Marx, 1894). The working class sells its labour to the capitalist at a wage less than the value of the production rendered. Marx (1894) referred to this exploitation as the “surplus value” of production. He argued that there is a direct relationship between the surplus value and profits. If the surplus value increases, profits also increase and thus accumulation of capital. Greater capital accumulation will give rise to a greater capital-labour ratio, which would, as a result of a decreasing yield, lead to lower profits, assuming that labour productivity remains constant (Kleynhans and Naudé, 1999). The rate of return declines as the unemployed working class is unable to buy produced goods and the production capacity cannot be utilised, leading to the creation of idle capital (Wolff, 2003; Higgins, 1968). Marx (1894) predicted that the rate of profit would fall over time, this would eventually lead to a crisis and then socialism would replace capitalism as part of a natural historic process.

### **3.2.3 Neoclassical Growth**

Contrary to the classical and Marxism view, neoclassical growth or exogenous growth is more optimistic. In classical economics, equilibrium occurs when savings are equal to investment. Neoclassical economic has equilibrium anywhere where there is an intersection on the supply and demand curve. In classical economics profit is a payment to a capitalist for performing a socially useful function; however, if value equals cost, then where does the profit come from? This is the problem with classical economics. In neoclassical economics, profit is a surplus of earnings over expenses (Fourie and Mohr, 2008). Therefore, investment, which is driven by profits, drives all:

capital formation, technological growth and labour hiring (Saeed, 2008). These make up the argument of neoclassical economists.

### a) The Harrod-Domar Model

The Harrod-Domar model, which was developed in the 1930s, explains economic growth in an economy in terms of the level of saving and productivity of capital (Harrod, 1939; Domar, 1947). This adapted version of the Harrod-Domar model used by Hussein and Thirlwart (2000), states that the growth of GDP is proportional to the share of investment spending in GDP.

$$g = \Delta Y/Y = \Delta K/K \quad (3.1)$$

Where  $g$  represents the growth rate, which is proportional to the share of investment spending in GDP, and  $K$  presents physical capital. Based on the above, the rate of growth in an economy can be increased by either increasing the stock of capital in the economy or reducing capital output ratio. If savings are available, capital will be available. If the economy is without savings, naturally, foreign aid will be used. To attain an equilibrium state or steady state where growth will not result in hyperinflation or unemployment, state intervention is required and should attempt to change saving tendencies in the economy, as well as the effectiveness with which capital is used (Kleynhans and Naudé, 2003). Harrod (1939) and Domar (1947) then calculate the desired equilibrium growth rate and the precondition for economic growth as:

$$\Delta y = \frac{s}{v}, \quad (3.2)$$

Where  $\Delta y$  denotes changes in per capita GDP,  $s$  is the marginal propensity to save and  $v$  is incremental (marginal) capital output proportion. Should real  $\Delta y > \frac{s}{v}$  then inflationist growth will occur, but should real  $\Delta y < \frac{s}{v}$  unemployment will occur (Fourie, 2007). Growth will only be at equilibrium for specific levels of “ $s$ ” and of “ $v$ ”. Basically, an increase in savings implies an increase in money supply, there can be no inflation if there is no increase in money supply. Solow (1956) later showed this instability of the Harrod-Domar model could be attributed to the fixed relationship production functions which are specified. When a Cobb-Douglas production function, with positive substitution between capital and labour is used, the problem of instability disappears without state intervention being needed. Kaldor (1957) believes that Harrod’s (1939) failure to see the inconsistency between a continuous underemployment and equilibrium and a steady growth, led him to the belief that a dynamic equilibrium of growth is unstable.

Further limitations of the Harrod-Domar model, especially for developing countries, include:

- The difficulty of increasing savings in developing countries where incomes are low. The marginal propensity to save in developing countries is usually low (Loayza, Schmidt-Hebbel and Serven, 2000);
- The majority of developing countries lack a good financial system. Increased household savings do not necessarily mean greater funds available for firms to borrow (Barth, Caprio and Nolle, 2004);
- Improving capital/output ratio is difficult in developing countries as the majority of the workforce is unskilled and poorly educated (Ali, 2007). Therefore, achieving efficiency is difficult; and
- Research and development that will aid with efficiency are often under-funded in poor countries (United Nations, 2005).

The Harrod-Domar model does not include labour in its production function, because it was developed just after the Great Depression, unemployment was high and an unlimited labour supply was assumed. In 1957 Evsey Domar, complaining of a guilty conscience, disavowed his model altogether saying that “my model was intended to comment on an esoteric debate on business cycles, not to derive an empirically meaningful rate of growth”. He said his model made no sense for long-run growth (Easterly, 1997). However, the Harrod-Domar model remains a widely applied growth model in economic history.

The Harrod-Domar model is very rigid with several shortcomings, the Solow model however provides a more flexible alternative. The Solow model concludes that, in certain circumstances, when production takes place under the usual neo-classical conditions of variable proportions and constant returns to scale, no conflict between the natural and the unwarranted rates of growth in the Harrod-Domar model is possible (Sato, 1964). This invalidates the theory of extreme instability of long-run growth equilibrium. Given sufficient time, the actual growth rate can adjust to any given initial condition, achieving balanced growth in the long-run (Solow, 1987).

### **b) The Solow Model of Economic Growth**

The Solow model is the growth model that has influenced growth theory the most. Although there are shortcomings in the model, which encouraged the study of endogenous growth, several researchers proved that observations made by Robert Solow (1956) are true and are applied in several growth studies (Sato, 1964; Mankiw, Romer and Weil, 1992; Temple, 1999; Pistone and Madison, 2009; Fedderke, 2010).

The Solow model has two main inputs, namely capital and labour, because output in each period is determined by the available supplies of capital ( $K$ ) and labour ( $L$ ). Solow (1956) proposed that the study of economic growth begins by assuming a standard neoclassical production function with decreasing returns to capital. Total saving and investment are assumed to be an exogenous fraction of total income, and the labour force is assumed to grow at a given rate with exogenous technological progress having an impact on both capital and labour (Mankiw *et al.*, 1992; Solow, 1987). Factor accumulation is also assumed as exogenous (Solow, 1956). The Cobb-Douglas production function is used; therefore production at time  $t$ , with technology assumed as labour-augmented, is given by:

$$Y_t = (AL_t)^{1-\alpha}K_t^\alpha, \quad (3.3)$$

Where  $0 < \alpha < 1$

The assumption here is that both inputs show positive marginal returns but at a diminishing rate, i.e.

$$\frac{\partial Y}{\partial K}, \frac{\partial Y}{\partial L} > 0; \frac{\partial^2 Y}{\partial K^2}, \frac{\partial^2 Y}{\partial L^2} < 0;$$

$$L_t = L_0 e^{nt} \quad (3.4)$$

In the absence of technological change  $n$  is Harrod's (1939) natural rate of growth. In Equation (3.3) ( $L$ ) stands for total labour, in Equation (3.4) ( $L$ ) stands for available supply of labour.

$$A_t = A_0 e^{gt} \quad (3.5)$$

In addition, the number of effective units of labour,  $A_t L_t$ , grows at rate  $n + g$ . For given levels of ( $L$ ) and ( $A$ ), Equation (3.4) and (3.5) imply that labour and knowledge grow exponentially. However, there exist decreasing returns to the individual factors of production capital ( $K$ ) and labour ( $L$ ). In the long-run there are constant returns for all the factors of production together. Greater utilisation of capital ( $K$ ) with constant growth in labour ( $L$ ) will yield limited output. In other words, as ( $K$ ) increases, the growth rate declines (Zhang, 2005). This is a result of decreasing marginal returns to the use of capital (Solow 1956; Swan, 1956). Given a constant rate of savings (which equals investment) the yield on capital for investors will decrease as the capital supply increases, until the amount of capital reaches a steady state level where all new investment will be enough to maintain the capital supply. Equation (3.3) can translate into (Solow, 1956):

$$y = k^\alpha \quad (3.5)$$

With  $k$  as capital per unit of effective labour and  $y$  as output per effective unit of labour.

Solow (1956) therefore denotes diminishing marginal product of capital as:

$$f'(k) = \alpha k^{\alpha-1} > 0, \quad (3.6)$$

$$f''(k) = -\alpha (1-\alpha)k^{\alpha-2} < 0. \quad (3.7)$$

Note that  $f'(k) = \frac{\partial Y}{\partial K}$  and therefore:

$$\begin{aligned} \frac{\partial Y}{\partial K} &= \alpha K^{\alpha-1}(AL)^{1-\alpha} \\ &= \alpha \frac{K^{\alpha-1}}{(AL)^{1-\alpha}} \\ &= \alpha k^{\alpha-1}. \end{aligned} \quad (3.8)$$

At  $y = k^\alpha$ , per capita income will achieve a maximum level. This factor implies that a country cannot increase its economic growth by increasing percentage of investments; this merely increases the level of per capita income, which can have a crowding out effect<sup>4</sup> (Kleynhans and Naudé, 1999).

The Solow (1956) growth model also implies that poorer countries will grow faster than rich countries, given that both countries have the same growth rates in savings, investments and population. When all these are the same, the Solow model predicts convergence of per capita incomes between these different countries, which implies that countries starting at a lower base will grow faster to catch up with countries with a higher level of per capita income (Solow, 1987). By taking the rate of savings and population growth as exogenous and a constant depreciation rate of capital  $\delta$ , Solow (1956) showed that these variables determine the steady-state level of capital per unit of effective labour which can also be per capita income as one determines the other (Fedderke, 2006b). In the Solow model, capital per unit of labour accumulates according to:

$$\dot{K}(t) = sY(t) - \delta K(t). \quad (3.9)$$

The dynamics of capital per effective unit of labour ( $k = \frac{K}{AL}$ ) can be explained as follows:

$$\dot{k}_t = sf(k(t)) - (\delta + n + g)k(t). \quad (3.10)$$

In Equation (3.10),  $sf(k(t))$  is the actual investment in physical capital per unit of effective labour.  $(\delta + n + g)k(t)$  is the effective depreciation of capital per effective unit of labour. Steady state equilibrium occurs at the value of capital per effective unit of labour ( $k^*$ ) where  $\dot{k}(t) = 0$ .

$$sf(k^*) - (\delta + n + g)k^* = 0. \quad (3.11)$$

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<sup>4</sup> Crowding out effect: refers to when government must finance its spending with taxes or with deficit spending, this leaves businesses with less money and effectively “crowds them out” (Fourie, 2007).

At  $k^*$ , investment equals effective depreciation and  $k$  remains constant overtime. The steady state value of capital then is (Solow, 1956):

$$k^* = \left( \frac{s}{\delta + n + g} \right)^{\frac{1}{1-\alpha}} \quad (3.12)$$

The central theme of the Solow model is to show the impact of saving and population growth on real income (Solow, 1956). Equation (3.12) shows that there is a positive relationship between steady-state level of capital and savings. Several other researchers prove this point (see Modigliani, 1970; Maddison, 1992; Bosworth, 1993; and Carrol and Weil, 1994). Equation (3.12) also shows an inverse relationship between the steady-state of capital and population growth, which Basetto and McGranahan (2009) also proved in their study on mobility, population growth and capital spending in the United States.

Substituting Equation (3.12) into the production function, an expression for the steady-state output per effective labour and output per worker can be found as:

$$y = \left( \frac{s}{\delta + n + g} \right)^{\frac{1}{1-\alpha}}, \quad (3.13)$$

Which translates into a steady state value of income per capita of:

$$\frac{Y(t)}{L(t)} = A \left( \frac{s}{\delta + n + g} \right)^{\frac{1}{1-\alpha}}, \quad (3.14)$$

Substituting for knowledge,  $A(t) = A(0)e^{gt}$  and taking logs:

$$\ln \left[ \frac{Y_t}{L_t} \right] = \ln A_0 + gt + \frac{\alpha}{1-\alpha} \ln(s) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta), \quad (3.15)$$

Assuming  $A(0) = \alpha + \epsilon$  then:

$$\ln \left[ \frac{Y_t}{L_t} \right] = \alpha + gt + \frac{\alpha}{1-\alpha} \ln(s) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta) + \epsilon. \quad (3.16)$$

This implies that the Solow model does not only predict the signs but also the magnitudes of the effects of the savings rate and population growth on output per worker. For  $\alpha = \frac{1}{3}$ , the elasticity of output per worker with respect to the saving rate should be 0.5, while that with respect to  $\delta + n + g$  should be  $-0.5$  (Mankiw *et al.*, 1992).

Mankiw *et al.* (1992) note three reasons why the independence assumption is made about saving and population. Firstly, in any model in which saving and population growth are endogenous but preferences are isoelastic,  $s$  and  $n$  are unaffected by country-specific factors. In other words, under isoelastic utility, permanent differences in the level of technology do not affect saving rates or population growth rates. Secondly, many economists have argued that the Solow model does not

account for international differences in income and this failure of the model has motivated study on endogenous factors of growth. Romer (1987, 1989) suggests that saving has a great influence on growth and takes this as evidence for positive externalities from capital accumulation. Lucas (1988) also emphasises that variation in population growth cannot account for any substantial variation in real incomes along the lines predicted by the Solow model. By maintaining the assumption that  $s$  and  $n$  are exogenous factors, determining whether systematic examination of the data confirms these informal judgements is then made possible. Thirdly, because the model predicts not just the signs but also the magnitudes of the coefficients on saving and population growth, it is possible to estimate whether there are important biases in the estimates obtained with Ordinary Least Squares (OLS) (Kleynhans and Naudé) .

Kleynhans and Naudé (1999) summarise the main features of the Solow model as:

- The imperative of exogenous technological progress for long-term growth;
- The achievement of a long-term equilibrium solution of no further economic growth in the absence of technological progress;
- The inability to increase economic growth in the long-term by means of investment;
- The importance of savings and investment for a country's per capita income level; and
- Convergence of per capita incomes between countries with the same savings rates and same population growth rate.

Given the Solow model, the recommendation one could make is that, if countries desire to improve their standard of living, they should save and invest more. Greater investment leads to greater capital formation, both human and physical, and a higher capital labour relationship leads to greater productivity and growth, these all form part of Total Factor Productivity (TFP) which is discussed in the next section.

### **c) Total Factor Productivity (TFP)**

In the Solow model explained above, technology is assumed to be labour-augmented. TFP is of significance as it shows the level whereby capital is applied most effectively (Comin, 2006). Abramovitz (1956) was one of the first authors who attempted to determine the causes of productivity growth. When he could not identify the main sources of productivity growth in the United States, he argued that productivity growth had to be determined by some unexplained factor in economic growth. Cypher and Dietz (2009) categorise all growth that cannot be explained by increases in physical input as TFP.

The significant role of TFP in explaining economic growth was further stressed by later studies (see amongst others, Romer, 1986, 1990; Lucas 1988). Most empirical studies addressing this issue (Krugman, 1994; Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999; Easterly and Levine, 2001) support Abramovitz's (1956) view and agree that TFP is important in explaining economic growth. Comin (2006) asserts the above and adds that TFP is a portion of output that cannot be explained by the amount of inputs applied, its level is rather determined by how efficiently and intensely inputs are applied in production.

TFP occurs when efficiency is considered to contribute more to growth than factors of production themselves. The dominance of TFP in an economy can also signify the importance of technological progress in that country (Fedderke and Simkins, 2004). Solow (1956) showed that cross-country differences in technology may generate cross-country differences in income per capita. This implies that when processes are more efficient than the norm or compared to other countries, it can be owed to technological progress in that country. A country that is technologically advanced allows the skills of its labourers to be aided by technology and that increases productivity, such as Japan (Hayami and Ogasawara, 1999). There is therefore a positive relationship between TFP and technological change. TFP growth provides more direct information on growth due to technological change. Faulkner and Loewald (2004) define TFP as a conveyer of efficiency with which factor inputs are combined in the production process.

As only a conveyer of efficiency, TFP cannot be measured directly. It is a residual, often called the Solow residual, which accounts for effects in total output that were not caused by the inputs. Comin (2006), in his study on TFP, states that the Solow residual accurately measures TFP growth if a) the production function is neoclassical; b) there is perfect competition in factor markets; and c) the growth rates of inputs are measured accurately.

TFP can result from many factors, as much as it can be enhanced by several factors. The weakness of TFP is that not much research has gone into identifying the determinants of TFP and its components, although enhancers of TFP have been found by several researchers. Fedderke (2005) and Du Plessis and Smit (2004) find that openness to international trade might have increased TFP growth. Openness to trade may also enhance TFP growth through the direct transfer of technology, either as information or embodied in trade goods (Arora and Bhundia, 2003). Romer (1986) and Miller and Upadhyay (2000) find that TFP might have resulted from spill-overs associated capital investment. Lucas (1988); Benhabib and Spiegel (1994, 2005); Vandensbussche, Aghion, Meghir (2006) show evidence that TFP has resulted from spill-overs associated with investment in human capital.

Fedderke (2005) and Kneller and Stevens (2006) find some evidence for the notion that investment in Research and Development (R&D), often called Schumpeterian growth, also enhances TFP.

Although relatively small and sometimes not realised, the contribution of FDI through technological spill-overs cannot be ignored (Coe, Helpman and Hoffmaister, 1997). In addition, according to Bosworth and Collins (2003), investment is endogenous in the sense that a portion of the change in capital is induced by an increase in TFP.

Computation of TFP growth is generally by means of the standard primal estimate given by (Fedderke, 2001):

$$TFP = \frac{\dot{Y}}{Y} - s_K \frac{\dot{K}}{K} - s_L \frac{\dot{L}}{L}, \quad (3.17)$$

Where  $s_L$  and  $s_K$  denote the share of capital and labour in output, respectively, Y represents output, K capital and L labour. However, the above simple decomposition approach has some limitations. Firstly, the approach does not disaggregate factor inputs by quality classes, this carries a substantial impact for conclusions that would be drawn from this simple decomposition approach (see the work of Jorgenson and Grilliches (1967); Jorgenson, Grilliches and Fraumeni (1987)).

Secondly, the simple growth decomposition attaches to the assumption that factor social marginal products coincide with observable factor prices. The problem is of particular significance for the capital growth rate, for which capital utilisation carries important limitations, as well as the likelihood of an underestimation of the contribution of growth in the capital stock to output growth (Fedderke, 2001). Having said thus, the most significant limitation according to Fedderke (2001) of the simple decomposition approach is its assumption of constant returns to scale. Since endogenous growth directs its most fundamental challenge against traditional growth theory against this very assumption (Jones, 1995; ), this therefore constitutes a fundamental limitation.

An alternative decomposition, when there are increasing returns due to spill-over effects can be written as such (Fedderke, 2001):

$$\begin{aligned} TFP &= \frac{\dot{Y}}{Y} - \alpha \frac{\dot{K}}{K} - (1-\alpha) \frac{\dot{L}}{L} \\ &= \frac{\dot{A}}{A} + \beta \frac{\dot{K}}{K}, \end{aligned} \quad (3.18)$$

Where  $\frac{\dot{A}}{A}$  captures exogenous technological progress and  $\beta \frac{\dot{K}}{K}$  represents the spill-over effect due to factor production with a weight greater than that implied by its income share.

Under a Schumpeterian approach with an increasing variety of intermediate goods, TFP can be written out as follows (Fedderke, 2001):

$$\begin{aligned} TFP &= \frac{\dot{Y}}{Y} - s_L \frac{\dot{L}}{L} - s_X \frac{\dot{X}}{X} \\ &= \frac{\dot{A}}{A} + b \frac{\dot{N}}{N}, \end{aligned} \tag{3.19}$$

Where X is intermediate capital goods, and  $\frac{\dot{N}}{N}$  denotes the endogenous expansion of intermediate good varieties such as technological progress. Through asymmetrical variation,  $\frac{\dot{N}}{N}$  denotes overall quality growth (Mankiw *et al.*, 1992, Fedderke, 2005). Under the varieties approach,  $b$  can be shown to equal  $(1-\alpha)$  where  $\alpha$  has the usual elasticity interpretation with respect to intermediate inputs, while under the quality ladder interpretation  $0 < b < 1$  with  $b \rightarrow 1$  associated with high quality differentials, and  $b \rightarrow 0$  denoting small quality differentials (Fedderke, 2006b).

In an attempt to find the determinants of TFP, Danquah, Moral-Benito and Outtarra (2011) find that:

- Country-specific fixed effects are the most important determinants of both TFP growth and its components; they find that a large portion TFP variation in countries is owed to country-specific effects;
- Once fixed effects have been accounted for, the main determinants of overall TFP growth are private consumption and a measure of trade openness;
- There is evidence of conditional convergence with poorer countries tending to have higher TFP growth rates. This notion can also be applied to companies. Smaller companies tend to have higher TFP growth rates, while big companies tend to be less efficient with time; and
- Regardless of initial GDP and fixed effects, technological progress greatly influences TFP.

Comin (2006) emphasises the link between TFP and innovation. He finds that by linking TFP and innovation, endogenous growth models shed some light on the determinants of TFP growth. R&D subsidies and an abundance of skilled labour reduce the marginal cost of conducting R&D and increase the rate of innovation development and therefore, the TFP growth rate. In addition, increases in the size of markets increase the innovator's revenue leading to more innovation and

higher TFP growth. Economic growth, which can be explained as the increase in per capita income in an economy with an aggregate production function must be driven by TFP (Solow, 1956).

### **3.2.4 Endogenous growth theory**

Endogenous growth means that economic growth is an endogenous outcome of an economic system and not the result of external forces (Romer, 1994). The focus therefore is on the behaviour of the economy as a whole. Whilst the Solow model assumes that all factors other than technology, labour, and capital are exogenous, researchers try to endogenise them because a steady state is never fully reached. Solow (1956) assumes that there is a steady state when it comes to growth, a point whereby, with given technology, labour and capital will reach a point where they do not contribute any more to growth than they already have (Solow, 1956). However, it has been shown that growth does continue even when investment in technology has reduced or stopped. Endogenous growth explains that growth that the Solow model has failed to account for. Endogenous growth theory puts emphasis on the distinction between physical and human capital and argues that differences in technological advancements contribute to variations in the speed of convergence across countries (Bosworth and Collins, 2003).

Endogenous growth literature suggests that economic policies and institutions play a role in increasing TFP, while Romer (2006) and Grossman and Helpman (1997) also find that R&D can be important determinants of TFP. This therefore implies that there are many factors which contribute to endogenous growth and most of them are controlled internally. Even TFP can be controlled internally, since capital enhances the efficiency of TFP, meaning, by investing in human and physical capital, the country is influencing the growth of the economy (Danquah *et al.*, 2011; Miller and Upadhyay, 2000; Kneller and Stevens, 2006; Benhabib and Spiegel, 1994, 2005; Bosworth and Collins, 2003; Fedderke and Garlick, 2008). By not investing, growth is being limited and even suppressed within the economy.

Bosworth and Collins (2003) argue that the focus on changes in the capital-labour ratio overstates the role of capital and undervalues the role of TFP, because it ignores the fact that investment is endogenous in the sense that a portion of the change in capital is induced by an increase in TFP. If there is not effectiveness internally, there will be no change to capital, if anything, it will be wasted. They therefore maintain that growth in physical capital induced by rising productivity, influenced by growth in human capital, should be attributed to productivity. The effect of human capital on productivity should not be understated. Therefore, the formulation of a relationship between factor

inputs and outputs is an extension of Equation (3.1) and rewritten as follows (Bosworth and Collins, 2003):

$$Y_t = AK^\alpha(LH)^{1-\alpha} \quad (3.20)$$

H is the measure of human capital or education attainment used to adjust the work force, while L represents labour input. Bosworth and Collins (2003) show that Equation (3.20) can be rewritten to limit capital's contribution to increases in the capital-output ratio.

### **a) Technology**

Solow (1956) emphasises the importance of technology in an economy. However, he does not take into consideration the importance of equipping the workforce with the ability to use this technology in the most effective way. It has been proven that much change in the economy over the years is owed to technological change. In 1982, Maddison (1982) found that output per hour worked was 10 times more valuable than output per hour worked 100 years earlier. Today, output worked per hour is more than 10 times more valuable than when Maddison (1982) made this discovery. In the 1950s, economists attributed all the change in productivity to technological change (Abramovitz, 1956; Kendrick, 1956; Solow, 1956). They explained that, although the raw materials used in production had not changed, trial and error, experimentation, refinement, and scientific investigation meant that raw materials were then being combined in more sophisticated ways. Technological change provided the incentive for continued capital accumulation and, together, capital accumulation and technology accounted for much of the increase in productivity during that time.

An essential premise of technology, as emphasised by Romer (1990), is that once the cost of a new set of instructions has been incurred, the instructions can be used repeatedly at no additional cost. Therefore, developing new and improved instructions for application works as a fixed cost, and as proven by Helpman and Krugman (1985), fixed costs lead to gains from increases in the size of the market. Also, in South Africa, openness to trade has allowed technology traders to take advantage of that opportunity. Romer (1990) takes this property as a defining characteristic of technology.

Investment in technology does not only mean the investment in computer software or mere programmes, but also includes investment in R&D, learning-by-doing programmes or on-the-job-training, such as learnerships and internships (Fedderke, 2001; Romer, 2006; UNCTAD, 2005). It includes all ways in which an economy can increase the level of technology it acquires as well as the level of output that is generated from the existing technology (Romer, 2006). A firm that increases its physical capital simultaneously learns how to produce more efficiently. This is a case of learning-

by-doing or learning-by-investing (Barro and Sala-i-Martin, 1995). The model given by Romer (2006) that includes both capital and technology, or so-called learning-by-doing is thus:

$$\dot{K}(t) = s(1 - a_K)^\alpha(1 - a_L)^{1-\alpha}K(t)^\alpha A(t)^{1-\alpha}L(t)^{1-\alpha} \quad (3.21)$$

Where again, technology is labour-augmenting and,  $K_t$  and  $L_t$  are the conventional inputs and  $A_t$  is the index of knowledge available at time  $t$ . There are positive and diminishing marginal outputs of each input, and constant returns to scale. Technology is assumed to be labour-augmenting so that a steady state can be reached when  $A_t$  grows at a constant rate. The production function for knowledge is not assumed to have constant returns to scale to capital and labour. The production of new ideas depends on the quantities of capital and labour in research and on the level of technology. Doubling the inputs has a doubling effect on the amount that can be produced (Romer, 2006).

Investing in technology or knowledge can give a firm a competitive advantage (UNCTAD, 2005). Once the firm has produced the design for durable good  $i$ , it can obtain a patent for that design. When the firm manufactures  $x(i)$  units of that durable article, it rents it out and makes a profit. The firm then has competitive advantage and owns that durable good  $i$ , this is an example of endogenous growth (Romer, 1990). Endogenous growth emphasises different growth opportunities in physical capital and knowledge. It also shows the marginal returns to physical capital and constant or even increasing returns to knowledge, as shown by the firm producing durable good  $i$ . Technology works together with human capital as the workforce has to be geared to use this new technology in the most efficient way.

## **b) Human Capital**

The concept of human capital, described as years of education and training that an individual undergoes, is close to the one used in labour market contexts (Heckman, 1976; Rosen, 1976). It corresponds to the practice in growth accounting applications that takes account of changes in the quality of the labour force due to changes in observables, such as the level of education or experience (Gollop and Jorgenson, 1980). Romer (1990) gives an extension of the Solow model that includes both human capital, as well as physical capital:

$$Y(t) = K(t)^\alpha [A(t)H(t)]^{1-\alpha}. \quad (3.22)$$

$Y$ ,  $K$ , and  $A$  are the same as in the Solow model,  $H$  is the total amount on productive services by workers.  $H$  includes both the contributions of raw labour, as well as acquired skill. Taking Equation (3.17) and writing it as (Romer, 1990):

$$\dot{k}_t = sk(t)^\alpha - (n + g + \delta)k(t) \quad (3.23)$$

It is determined that  $k$  converges to the point where  $\dot{k} = 0$ , this value of  $k$  is  $[s/(n + g + \delta)]^{1/1-\alpha}$  which denotes the steady state of capital,  $k^*$ . Once  $k$  reaches  $k^*$ , the economy reaches a steady growth path with output per worker growing at rate  $g$ . The impact of the change in output per worker is determined by the impact it has on growth (Romer, 2006). In other words, how human capital affects growth in an economy is determined by economic growth itself. As an economy grows, development takes place; the standard of living of the people is improved upon, the level of education rises as well as the number of educated people. This has a positive impact on output per worker, which in turn impacts growth (Romer, 1990).

Many explanatory variables in growth regressions are endogenous, although Solow assumed them as exogenous. In Bosworth and Collins' (2003) study on growth, they estimated growth regressions in 84 countries that together represent 95% of growth in world production and 84% of world population over a period of 40 years from 1960-2000. They stated that growth regressions usually include institutional quality, openness to trade, and policy measures, which have been used by many other researchers (see Du Plessis and Smit, 2007; Mohammed and Finoff, 2004) to measure economic growth, and have found them to be endogenous. Trade and trade policies have both also been found to be endogenous contributors to growth (Bosworth and Collins, 2003). Institutions, such as the structure of financial markets, mechanisms of income redistribution, social safety nets and regulatory and tax systems also tend to be endogenous although there are some discrepancies per country (Bosworth and Collins, 2003).

These factors mentioned above were not always included in growth regressions. Growth theory has developed from the pessimistic classical growth theories that assumed diminishing returns to most production factors to endogenous growth theories which do acknowledge diminishing returns to physical capital but not for human capital. The Solow model puts most production factors together and allows one to determine the effect of factors such as capital, labour, technology, human capital, population growth and the savings rate on economic growth (Solow, 1956; Mankiw *et al.*, 1992; Fedderke, 2005).

In this study, a combination of both exogenous and endogenous variables will be made as will be seen in Chapter four. The Solow approach to economic growth determination will be pursued; however, as Solow has limitations and cannot explain some aspects of growth the endogenous approach will also be included. The advantage of endogenous growth models is that institutional quality, openness to trade and policy measures can be included in regression. These factors have a

significant influence on the RER of the economy (Bosworth and Collins, 2003). As has been noted above, there is no major difference between the Solow approach and Romer's endogenous growth approach. Where Solow assumes a steady state, Romer proves that there is much activity in an economy before growth reaches a steady state. Romer (1990) attributes the growth that cannot be explained by labour and capital or savings and population growth to total factor productivity. He also says that total factor productivity can be enhanced by investing more in human capital and technology. Therefore, the principal components of this study in determining economic growth are productivity growth, as well as trade reforms, which have an impact on the export activities of a country. It is important to have a better understanding on what has been going on the South African economy in terms of growth before estimations on misalignments and growth can take place therefore, in the next section the history of South African economic growth, from 1985 to 2011, is discussed.

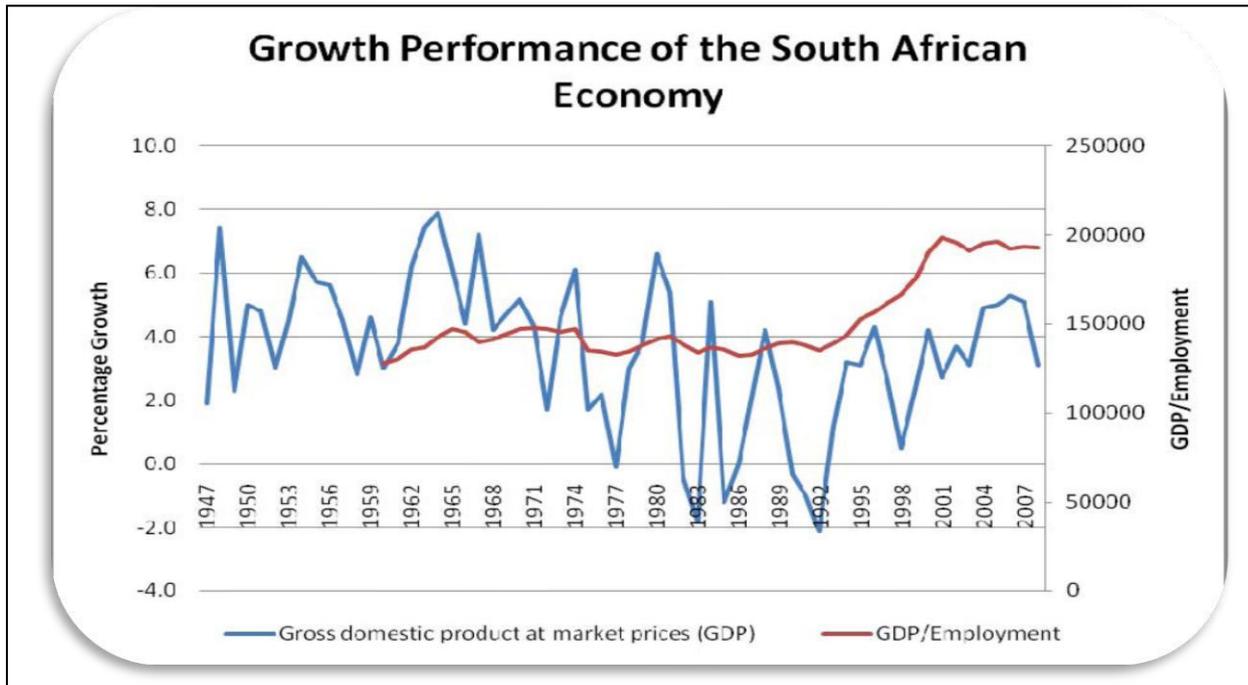
### **3.3 Economic Growth in South Africa**

Growth in South Africa has been highly volatile over the three decades from the 1980s to the 2000s. A major change in the economy took place after 1994 after the first democratic election. The events leading up to this shift in powers, include sanctions that were placed on South Africa and political unrest, which caused economic instability (Mohammed and Finoff, 2004; Borat and Oosthuizen, 2005; Arora and Bhundia, 2003). After 1994, growth was expected to rise, although the change was not very evident at first. Growth was seen in the short term but on average, growth rates remained low (Du Plessis and Smit, 2007). According to Jones and Inggs (2003), this can be partially explained by the fall in savings and capital flight, as well as increased public expenditure to rectify previous inequalities which dampened growth. However, South Africa's growth performance remains disappointing and the growth rate never reached the level of the 1960s again as can be seen in Figure 3.1. This section provides an overview of South Africa's growth performance.

South Africa's growth performance has been on a steady downward rate from the 1970s, as shown by the downward trend in GDP (see Figure 3.1). By the 1990s, the GDP growth rate was negative rather than positive. Fedderke (2006b) finds this as evidence of structural decline since the poor performance started long before the 1990s.

The private sector was the driving force behind growth in South Africa since sustained growth began in the nineteenth century (SARB, 2011). This was still the case in the 1990s, although there was

increasing state interference and threats to the security of property rights (Du Plessis and Smit, 2007). These inauspicious developments restricted the freedom of market forces to generate adequate economic growth at a time when the population was increasing rapidly and gold production was falling (Jones and Inggs, 2003; Mohr, 2003). In the 1990s decade, real per capita GDP fell by 0.4% a year.



**Figure 3.1 South Africa’s growth and employment performance**

Source of data: South African Reserve Bank (series: KBP6006Z, KBP6006Y, KBP7002J, KBP7008J)

This economic decline was deeply rooted and closely linked to the political situation in the country. It began in 1976 when the Soweto riots frightened the business community and led to an immediate fall in foreign investment. Jones and Inggs (2003) argue that the events of 1976 were not the primary cause of the decline; they merely determined its timing. According to these authors, the population explosion was the major cause of the decline in per capita GDP, since the entire African continent faced a real threat of the Malthusian crisis, and it was not confined to South Africa alone.

Until 1976, a growing economy, supported by increasing gold output, was able to keep pace with population growth in South Africa. After 1976 the costs of increasing government expenditure in the economy, because of the massive misallocation of resources required by apartheid policies, combined with a growing and wasteful military expenditure, brought growth to a halt, except for a few years at the height of the gold price boom in 1979 and 1980 (Jones and Inggs, 2003). Growth in

mining and agriculture, which contributed most to national output, stagnated in the late 1970s, and the services sector, especially the insurance industry, financial facilities, and transport services, became the fastest growing economic sector (Bhorat and Oosthuizen, 2005; Banerjee, Galiani, Levinson, McLaren and Woolard, 2008). This change in the economy is clearly illustrated in Figure 3.1, with the downward trend in the economic growth rate visible since the mid-1970s.

The slow economic growth of the 1970s was not only due to declining gold revenues, but also because of the rising price for oil imports and increased international competition in other traditional export commodities. A recession occurred in 1976, following dramatic oil price hikes (Jones, 2002). Strong export growth based on higher gold prices helped the recovery from this recession, but the recession was followed by a series of droughts in the 1980s, which affected agricultural output.

In Figure 3.1 it is evident that the declining growth rate of the economy continued for most of the 1980s. The South African economy experienced very little growth in the 1980s and bankruptcy in 1985, resulting in the overall decline in living standards. Cincotta and Engelman (1997) found that during the 1980s, population growth dampened GDP per capita growth for several countries, including South Africa. The rapid population growth dampened an already slow expansion of the economy. Per capita GDP declined by more than 10% during the decade, and for the average individual, real wealth in 1990 was no different than it had been in 1970 (SARB, 2006).

National economic stagnation continued in the early 1990s. GDP declined in 1991 and 1992 and registered only weak positive growth in 1993, as can be seen in Figure 3.1. Private consumption accounted for 57% of GDP in 1993, and was constrained by high indebtedness and concerns over violence and job security. Unemployment grew by a large margin in the 1990s (Du Plessis and Smit, 2007), from 13% to almost 30% by the end of the decade (Banerjee, Galiani, Levinsohn, McLaren, and Woolard, 2008), as more women entered the labour market and the demand for unskilled labour declined. The recovery strengthened in 1994 when GDP grew by 2.6% over the previous year, placing South Africa among the World Bank's upper-middle-income developing countries. The recovery continued in 1995 and the trend has been positive since then.

The economic change that came with the inception of the new government was insignificant at first. The high population growth rate flooded the job market with poor new entrants, the majority of which were poorly qualified because of apartheid policies and ANC's "liberation before education", which stopped many schools from functioning and led to their destruction. Although in the 1970s, the fall of GDP did not reach negative, as seen in Figure 3.1, by the 1980s, GDP fell to significantly

low levels and this had a negative effect on the labour market's ability to absorb new job entrants. As a result, Jones and Inggs (2003) find that, whereas in the 1970s 75% of new entrants to the labour market could hope to find employment, by 1990 this had fallen to below 8%. The graph might show an increase in employment, but it is important to note that there was a high population growth rate and an increase in employment might not have been in line with what was required, given the size of the population. An economic growth rate of 8.8% was needed to prevent unemployment from rising further, but this was far from achievable. The economy had stopped absorbing new entrants to the labour market as employment contracted by 1.5% a year by 1996 (Barber, 1996), and labour was not prepared to accept the increasing elasticities in wages. Jones and Inggs (2003) hold government policies responsible for much of the increasing unemployment.

The declining growth in the South African economy mirrors declining growth rates elsewhere in the world. However, middle income countries grew at an average of 2.7% per annum over the 1980-1990 period and an average of 3.9% per annum over the 1990-1998 period (World Bank, 2012). In the case of East Asia, the acceleration was around 8.0% per annum over the same period and even before (Lau and Park, 2003). This implies that South Africa, as a middle income country, has performed well below the average maintained by economies that are in a similar class.

Employment shrank during 1994-2001, as the positive annual average growth of 0.2% during 1980-1993 was replaced by negative growth of 1.6% (Lewis, 2001). The contribution of capital and labour to GDP growth fell from 1 percentage point annually during 1980-1993 to negative 0.3 percentage points after 1994. This implies that the face of growth changed over the years. As has been discussed in earlier sections (see Section 3.2.3.c), as capital has diminishing returns, technology and human capital have taken over and become the main drivers of growth.

South Africa's real economic growth rate averaged 3.1% (1.1% in per capita terms) during 1995-2004, a substantial improvement from the 0.8% average growth rate (-1.3% in per capita terms) of the previous decade. Although this was a welcome improvement, South Africa's growth has remained relatively low by world standards (Rodrik, 2006).

Du Plessis and Smit (2007), as well as Edwards and Alves (2005) find evidence which proves that openness to trade and capital flows, lower uncertainty and lower interest rates have been the main drivers of growth in South Africa since 1994. The lower systematic risk associated with the post 1994 political dispensation has economic, as well as social value and the orthodox macroeconomic policies of this period (Aron and Muellbauer, 2007; Ajam and Aron, 2007) have lowered overall risk and the user cost of capital.

From the first quarter of 1993 to the second quarter of 2008 the country enjoyed an unprecedented 62 quarters of uninterrupted economic growth. Average annual growth in the capital stock declined from just over 2% during 1980-1993 to 1.3% during 1994-2001 (Arora and Bhundia, 2003). In 2005 the growth rate reached 5.1% and forecasters were optimistic that it would remain above an average of 4% for the remainder of the next few years (Laubscher, 2006). But as the United States financial crisis made its presence felt, GDP contracted in the third and fourth quarters of 2008, officially plunging the economy into recession. This contraction continued into the first and second quarters of 2009 with GDP growth at -6.4% and -3.0%, respectively.

South Africa's economy grew at a rate of 4.4% from -1.5% in 2009, solely because of the World Cup soccer tournament hosted in the country. GDP growth by the end of 2010 reached an average of 2.9%. South Africa's economy had grown at a rate of 3.2% by the fourth quarter of 2011, up from a revised 1.7% in the third quarter, with the country's trade industries - wholesale, retail and motor, catering and accommodation - leading the way (SARB, 2012). According to the IMF (2011), slower growth is, however, expected for South Africa in 2012, with lower demand from European countries likely to depress exports and production in agriculture, mining and manufacturing sectors.

According to Berg and Miao (2010), the RER is endogenous and economic growth can have an influence on it. If growth is assumed to be endogenous, and exchange rate also being endogenous, it means both are controlled internally, both have a great influence on each other. If a country fails to implement proper policies in governing its institutions and ends up with malfunctioning institutions, investors will look elsewhere and capital inflows will decline. If growth is largely determined by capital inflows, and growth has an effect on exchange rate, it means policies put in place by the government have an influence on the exchange rate (as mentioned in Section 2.10). Other endogenous variables, such as interest rates and inflation also have an influence on the exchange rate (MacDonald and Ricci, 2003; Saayman, 2007). The factors that have had an influence on long-run growth in South Africa such as those discussed in the growth theory are discussed from the South African perspective in the following section.

### **3.4 Review of the Empirics of Growth in South Africa**

As has been discussed in previous sections (Sections 3.2 and 3.3), there are several theories that explain economic growth and several factors that determine growth. It was shown that an economy's growth rate is determined by the rate of increase in the use of capital, labour, and other

factors of production, including human capital as suggested by Lucas (1988) and earlier theorists who, however, did not assume that these factors work together. Subsidiary factors which have an effect on growth include regulations and other microeconomic structures, the macroeconomic management of the economy through the business cycle, labour productivity, the market structures, and economic growth in trading partners (Faulkner and Loewald, 2008). The determinants of growth which include productivity growth, trade reforms, as well as export-led growth will be discussed from the South African perspective. Growth in productivity will be analysed first in the following section.

### **3.4.1 Productivity Growth**

TFP assumes that efficiency contributes more to growth than the actual factors of production. One should also consider that TFP is the portion of growth that cannot be explained by initial input. In other words, when the factors of production are used at the optimal efficiency level, growth will accelerate, but this is not determined by initial input, but rather by the efficiency in the employment of that input. The initial level of technology will determine the magnitude and the speed of economic growth, efficiency in technology will be followed by a further increase in productivity. These are in line with the conditional convergence theory (Solow, 1992). An increase in human capital or investment in education going towards needed skills will result in an increase in productivity when those skills are applied efficiently. An increase in the efficiency of labour will result in an increase in productivity (Bosworth and Collins, 2003).

In addition to the above, openness to trade is also found to impact productivity growth positively, and industry concentration has a negative impact on productivity growth (Fedderke, 2010).

#### **a) Capital**

Marx's (1894) theory of capitalist growth suggests that all capital is created by labour. Solow (1992) puts capital and labour together, arguing that output is dependent on available supplies of both capital and labour. However, capital has diminishing return, which implies that greater utilisation of capital with constant growth in labour yields limited output (Solow, 1956; Swan, 1956; Zhang, 2005).

A range of growth accounting studies have shown that capital accumulation has been declining in South Africa since the 1970s (SARB, 2012). Foreign capital inflows to South Africa had been negative for decades leading up to 1994, but a positive trend began in 1995. A change in capital flows is seen after 1995 but only slightly so, depressing growth in the economy. Since South Africa is a middle

income country, factor accumulation should remain a significant component of growth in real per capita GDP (Fedderke, 2010). The fall in investment therefore posed as a limitation of sustainable growth in the economy.

The main source of the funds for investment and capital accumulation is saving. The saving propensity in South Africa remains relatively low, relative to that of other emerging countries, which are said to be on the similar development level as South Africa. The saving rate in international comparative perspective is 6 percentage points below that of the average in upper middle income countries for the 2000-2005 period, and 26.6% and 12.5% below Chinese and Indian levels. This therefore is a performance that raises specific policy challenges (Fedderke, 2010).

### **b) Technology**

Economists attributed all the change in productivity to technological change, as noted in earlier sections (see Sections 3.2.3.b- 3.2.4.b). The fixed cost of acquiring technological capital is one that yields returns long after it has been incurred. Romer (1990) talks of this as the essential premise of technology. Once technology has been gained or software invented, it can be used many times; technology is therefore important for endogenous growth.

The weakness of R&D expenditure in South Africa is a sign of weakness in TFP. Even with respect to China, with its lower level of GDP per capita, the R&D performance of South Africa is still not satisfactory. The proportion of GDP spent on R&D has not yet reached the 1% mark unlike the 2 - 4% reported by countries with strong reliance on innovation and their growth structure (Fedderke, 2006a). In his estimation of a Schumpeterian growth model, Fedderke's (2006a) findings show that R&D expenditure has a more than proportional impact on real output in South African manufacturing.

### **c) Human Capital**

Modern growth theory emphasises the importance of human capital in productivity growth. This is emphasised in the central theoretical contributions to endogenous growth theory (Romer, 1990; Aghion and Howitt, 1992) and the extension of the Solow framework (Mankiw *et al.*, 1992). Human capital is an essential part of endogenous growth as discussed in earlier sections (see Section 3.2.4, particularly 3.2.4.b). Equation 3.19 shows that when human capital is coupled with labour, this yields increasing returns to economic growth. Human capital is assumed as an endogenous factor because it is controlled internally. Funds that go towards education and training are determined within the economy, by its very own government and that determines the magnitude and speed of human capital and therefore growth.

There is evidence suggesting that human capital has been and continues to carry significance for growth in South Africa. Fedderke (2006b) finds that the performances in the mathematics and science dimensions are the key drivers for long-run productivity growth (Fedderke, 2006b). The universal dramatic downward trend in both the proportion of matriculants that graduate with mathematics, and the proportion natural, engineering and mathematical sciences university degrees calls for concern (Fedderke, De Kadt and Luiz, 2000, 2003). Despite the government's increased expenditure on education the situation has not improved (Simkins, 2005a, 2005b; Van Den Berg, 2009). Fedderke (2010), when analysing human capital in South Africa, further finds the country spends a similar portion of GDP as comparator countries. However, the number of R&D scientists is less than in the same comparator countries.

As much as there has been growth in expenditure on human capital, the growth is far from what it could be. Government is investing in education and training but the return is still low. This may be partly due to people that have been trained and have used up state funds, but do not contribute to productivity. This may be attributed to the high HIV/Aids pandemic and other factors<sup>5</sup> (Banerjee *et al.*, 2008).

#### **d) Labour**

As mentioned earlier, capital and labour work together, and output is determined by the available supplies of capital and labour and they both have decreasing returns. Neoclassical economics firstly concentrates on the accumulation of labour, amongst other production factors as an important source of growth as shown by Equation (3.3).

Labour is an important productivity factor; without it there would be no produce. It, however, comes at a cost. The labour market in South Africa is bound by many constraints which pose as a challenge. Trade unions also add unnecessary pressure on labour markets demanding higher wages and ultimately increasing the cost of the perceived cost of labour (Fallon, 1992). This makes capital-intensive methods more favourable compared to the restrictive labour legislation.

Output per worker is an important aspect of labour. Real output per worker was constant over the 1960-1990 period, and it only started rising in the 1990s due to the labour shedding, but declined in 2000 when the economy started absorbing labourers again. Fedderke (2000) states that, the

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<sup>5</sup> Other factors may include the (1) brain-drain, whereby the government invests in its people, when they have acquired the skill they leave the country and seek employment in more developed countries. (2) Illness, although the individual might not be sick himself, he might need to leave his work because of a family member who is sick and needs constant supervision. (3) People may struggle to find employment after completing their training/studies because there are not enough job opportunities. (Banerjee *et al.*, 2008)

problem in South Africa is that, employment creation seems to be associated with productivity losses rather than productivity gains.

Another important aspect in the labour market is that the price of labour in South Africa remains high in comparison with the returns or productivity gains. While there have been labour disputes in recent years where firms were expected to increase the salaries and wages of employees, there has been no report of whether this increase was coupled by an increase in productivity (Banerjee *et al.*, 2008). Strong trade unions in the South African labour market contribute to this adverse situation.

### **3.4.2 Trade Reforms**

Trade reforms are part of drivers of growth through their impact on international trade. As stated earlier, openness to trade may increase TFP growth, and TFP growth implies an increase in efficiency, meaning openness to trade has an effect on economic growth (see Section 3.2.3.c). Therefore, trade reforms, which are closely linked to the exchange rate, have an impact on economic growth. Trade in the 1980s was characterised by import protection and export bias. There were no incentives to exports and importing was just as expensive. The economy underwent a steady process of trade reforms in the 1990s, which influenced the way resources were re-allocated from one sector of the economy to another. The new government's commitment to trade reform showed an acknowledgement of serious inefficiencies that existed in the South African economy brought about by high levels of protection (Cassim, 2003).

Cassim (2003) conducted a critical study on trade reforms in South Africa. He found that not much change occurred in the economy at first as South Africa's export profile was dominated by minerals. However, as the years progressed, a more significant and sustained process of trade liberalisation began. Trade liberalisation then became more about giving firms incentives to export, yet protecting complacent firms. As the country's commitment to the World Trade Organisation (WTO) increased, many import tariffs had to be reduced; this was a critical landmark. Tariff peaks did not, however, end immediately, a range of sectors still had to pay high import tariffs beyond 2000, these sectors include the clothing and textiles and motor industry.

Trade liberalisation can therefore be characterised as gradual, not rapid. The evidence of this steadiness is shown by the fact that very sensitive sectors such as clothing, textile and the motor industry maintain very high tariffs (SARS, 2012). Cassim (2003) does find significant reduction in

tariffs from about 80% to 40%, and sectors with low levels of tariffs, from 5% to 20%, saw a reduction of smaller percentages.

One can argue that a more dramatic liberalisation would have been more desirable for the economy and would have had a greater impact on growth, but there is no evidence that this gradual liberalisation did not harm growth in any way nor that it hurt employment or exacerbated poverty. Cassim (2003) highlights that trade reform is but one policy amongst many which can play a role in increasing efficiency in the economy. Cassim (2003) however criticises trade reform for increasing capital intensity and causing some unemployment in the process. However, no firm can blame its downfall on tariff phasing out or the end of subsidies as this happened gradually, giving firms time to adjust. Rather factors such as low domestic demand, low investment, lack of skills and technological change can explain the demise of some firms.

Trade liberalisation should be noted as a factor that has not negatively impacted the labour market. The positive impact of trade liberalisation is confirmed by Fedderke (2010), and further by Fiandeiro and Rankin (2008). This does not dispute the impact globalisation has on technological change, which is labour saving, but trade liberalisation does not appear to have been harmful to employment in South African manufacturing. However, provided there is a link between industry concentration and industry pricing power, as appears to be supported by the empirical evidence reported in Fedderke, Kularatne and Mariotti (2007), there are arguably positive developments for South African manufacturing industry over the course of the 2000s.

Trade reforms and the economy's openness to trade in the 1990s did bring about change in the country's growth, regardless of the magnitude of that change. South Africa's increasing openness to international trade is found by Du Plessis and Smit (2007) to be the leading cause behind rising productivity locally. Trade reforms paved a way for international trade to be a possibility in South Africa and to be a viable venture.

### **3.4.3 Export-led growth of the South African Economy**

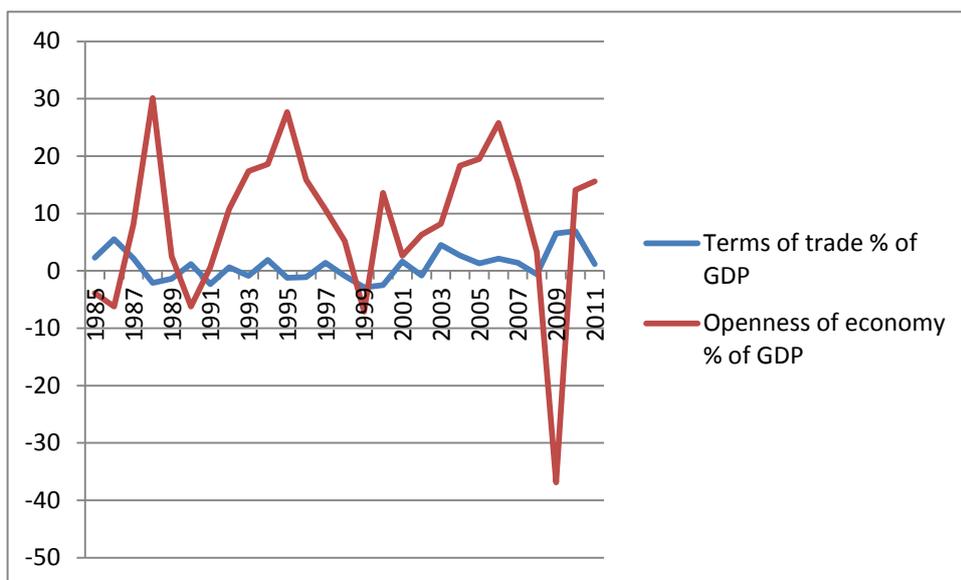
It has been found that export performance plays a predominant role in economic growth in South Africa; this implies that the economy is outward-oriented (Holden, 1993). This statement is justified by the high economic growth rate of the country in periods of commodity booms and when the exchange rate is undervalued. Before the dawn of democracy in the country, the University of

Pretoria Focus No 48 (1992) suggested that a policy regime conducive to increasing South Africa's share in world trade could grow South Africa out of its inward-oriented poverty trap.

The South African economy is dependent on the global economy. Foreign trade flows account for more than 30% of GDP and this explains why the stability of the RER is seen by government as key to the attainment of growth objectives. The RER impacts both global and domestic demand for South Africa's production, since it affects domestic prices. Since the RER is a relative price of domestically produced goods for foreign goods, it provides a measure of how much, on average, the cost of South African-produced goods and services will be relative to a comparable basket of foreign-produced goods. It is therefore a measure of a country's competitiveness over time. Moreover, exports reflect foreign demand of South Africa's production. An increase in exports therefore implies that all output, employment, and income associated with production may increase over time, thereby contributing to the growth rate of the economy. Unwarranted fluctuations of the RER therefore tend to be detrimental to the competitiveness of exports (Mtonga, 2006).

Studies of export-led growth in developing countries, such as China, have shown that the role of exports in promoting growth is highly positive (Ram, 1987; Zhu and Kotz, 2010). The problem in South Africa may be that exports were not high enough to accelerate growth to required levels. Holden (1993) stresses the importance of an outward-orientated trade policy. Holden (1993) also highlights that when exports were given more attention by policymakers, it was found that growth in manufacturing exports closely tied to the growth in the economy. This growth, however, is not a South African experience. Domestic expenditure on R&D shows that industries with high propensity to export have not been R&D intensive. Holden (1993) found that R&D expenditure was not the only problem with exports in South Africa, but trading patterns in the economy appeared to be primarily driven by factor endowments, including the availability of natural resources.

Having said the above, it should be noted that the economy's export growth volume has been increasing, as can be seen in the terms of trade and the openness of the economy (Figure 3.2). However, the country's share in world trade has been on a downward trend, from 1.6% in the 1960s to 1.2% in the 1970s. The decline reached 1% in the 1980s and fell further to 0.3% in the 1990s. South Africa's share in world trade rose to 0.5% in the 2000s and to 0.7% in 2011. Since exports constitute approximately a third of GDP, wealth would be expected to fall behind in world terms over the long-term.



**Figure 3.2 South Africa's openness and terms of trade indices (2005=100)**

Source of data: South African Reserve Bank (KBP5036X, KBP6013Z, KBP6014Z)

Zhu and Kotz (2010), in their study on the dependence of China's economic growth on export and investment, find that the fast-paced growth of this emerging market is driven by an increase in exports and investments. Jongwanich (2009) says that RER misalignment could have a negative effect on export performance in developing Asia, export performance being the main source of growth in the region. According to Zhu and Kotz (2010), the Chinese government has even taken efforts to increase incentives for export by increasing the tax rebates to exporters. Over the period from 2001 to 2007, it was found that over a third of GDP growth was accounted for by growth in foreign demand for Chinese output. They found that exports and fixed investment in that period together contributed about 69.4% of GDP growth. The sustainability of this export-led boom in growth in China is questionable; however, it is outside the scope of this study.

Several researchers have found that the RER, amongst other factors, had a direct influence on trading patterns of the country (Edwards and Alves, 2005; Mtonga, 2006; Vacek, 2002). Edwards and Alves (2005) have found that export growth in South Africa was constrained by factors that affect the profitability of the exports, such as infrastructure costs, skilled labour, tariff rates and the real effective exchange rate, which all happened to be important factors of export supply. Mtonga's (2006) conducted a study on the effects of the RER misalignment in the rand on export competitiveness. He found that, from 1993 to 1996, and also in 1998, the rand's RER had been overvalued by 10%, while the 2001 rand crisis caused an undervaluation of 20% at the start of 2002. This strong appreciation in the rand, beginning in the first quarter of 2002 had culminated into an

average overvaluation of 15% by the end of 2003. He found that this put export competitiveness at a disadvantage.

It can therefore be concluded that export competitiveness, which is affected by the exchange rate, has an influence on economic growth (MacDonald and Ricci, 2003). It is also important to note that the relationship between commodity prices and the exchange rate is bidirectional. As much as the movement in commodities and their prices can influence exchange rate, the exchange rate itself can influence the price of commodities, which should be kept in mind (Koranchelian, 2005).

A strong currency usually creates a favourable environment for combating inflation; however, it can make exports uncompetitive in global markets (Holden, 1993; Berg and Miao, 2010). According to Holden (1993) successful exporters should experience greater increases in TFP and should be able to locate higher value-added industries. It will be difficult for exporters to attain this level of success if their exports are not competitive. Imports which are also unattainable also raise prices for producers who use imported inputs in their production processes; therefore, a stable RER which facilitates foreign trade is important for the economy (Lewis, 2001).

Therefore, the stimulation of exports has the potential to create jobs and steer the country closer to achieving higher growth in GDP (Holden, 2005; Lewis, 2001). However, for that to happen, factors that act as barriers to export growth such as a misaligned RER have to be controlled.

### **3.5 Summary**

The aim of this chapter was to analyse economic growth in South Africa from the year 1985 right through to 2011 and explain factors that determine growth from a South African perspective. The aim of the whole study is to determine whether the misalignment in the exchange rate has had an effect on economic growth. This chapter aimed to give a thorough analysis of growth in South Africa so that it will be easier to determine the impact of exchange rates in the next chapter, once there is a proper understanding of growth in the economy thus far.

The different growth theories were discussed and the finding is that, although both classical growth theory and neoclassical growth theory assume both savings and investments to be essential for any economic activity, there are some discrepancies. For instance, classical economists are of the view that productive capacity allows for growth; therefore, increasing and improving on capital is the

“wealth of nations”. Smith (1776) believed that manufacturing was central to the entire economy, while Ricardo (1817) stressed the theory of comparative advantage encouraging free trade.

Neoclassical economics assumes diminishing returns to capital. Once capital is increased with no increase in other factors of production, then output falls because it then takes more input to produce the same level or even less output and the economy converges to a steady-state rate of growth. The Solow model provided the basis for the factors that influence growth, exogenous as well as endogenous factors (technology and human capital).

South Africa’s economic growth behaviour was subsequently analysed and it was shown that, although the growth rate did not reach expected levels after the 1994 democratic elections, economic growth did set on a more positive trend, with less volatility. Figures 3.1 and 3.2 showed that international integration and economic growth follow a similar trend. When international integration increases economic growth also increases. This may be explained by an increase in exports, which make up a third of South Africa’s GDP. This phenomenon will be further tested in the following chapter.

In terms of the factors that influence economic growth, from the South African perspective, productivity factors and initial levels of production set the pace for ultimate growth which can be achieved, according to the conditional convergence hypothesis. The growth theories showed that capital is needed for undertaking any kind of profit-gaining activity. In South Africa, uncertainty about investments and property rights manages to scare many investors and increases capital flight, while the role of institutions remains important in the economy to ensure that history does not repeat itself. In addition, predictability of policy direction and clear rigorous macroeconomic stabilisation policy are further requirements. The low domestic savings have also impaired growth as savings in the country are at very low levels and the economy therefore has to rely on foreign capital.

The high price of labour in the economy has stood as a barrier for economic growth. The finding of Fedderke (2010) that employment creation in the South African economy is associated with productivity losses rather than gains, shows an impediment to growth. The unemployment level in the country has always been high, but when it is lowered, productivity does not seem to increase. Furthermore, human capital and R&D activity in the economy continue to constitute a limitation on the ability of the economy to switch to a TFP-intensive growth path. South Africans fail to take advantage of new technological advancements, because there is no absorptive capacity and this hampers growth.

Trade reforms have also played a major role in South Africa's economic growth. Trade reforms and the economy's openness to trade in the 1990s brought change in the country's growth. South Africa's increasing openness to international trade is found by Du Plessis and Smit (2007) to be the leading cause behind rising productivity locally. Trade reforms paved a way for international trade to be a possibility in South Africa and to be a viable venture.

Lastly, exports make up a third of South Africa's GDP; this is over 30% of economic growth. The volatility in export supply can be attributed to several factors, one of which being the RER. An overvalued currency in the past was harmful for growth, while an undervalued currency proved to be good for export promotion, as well as growth. This phenomenon can also be seen for other developing countries such as China. Therefore, a sustainable RER is needed for export growth, and this export growth is necessary for economic growth. In other words, a sustainable RER is a necessity for economic growth.

In the next chapter, an empirical analysis of the study will be conducted. The first objective is to find the equilibrium RER using macroeconomic fundamentals mentioned in Chapter two. The misalignment in the rand will then be determined by analysing the difference between the actual RER and the BEER. Lastly, the impact of this misalignment in the RER on economic growth will be studied.

## Chapter 4 Empirical Study

### 4.1 Introduction

Exchange rate misalignments refer to the percentage difference between the actual and equilibrium exchange rate (Rahman and Basher, 2001), and these misalignments are believed to influence economic behaviour. This implies that the equilibrium exchange rate should first be determined before the misalignment can be calculated. Once that is found, it can be determined whether the prevailing exchange rate has harmed or boosted growth in South Africa. Therefore, the first step in the analysis is the determination of the equilibrium exchange rate and the subsequent misalignment. The second step is to determine the influence of misalignment on South Africa's growth performance.

The aim of the study is to determine if there is any relationship between the RER misalignment and economic growth in South Africa and it is also the focus of the empirical investigation presented in this chapter. This chapter is organised in the following way: the first section explains the time series data used in the analysis. The second section deals with the estimation of the REER of South Africa against the US dollar by using the methodology of MacDonald (1997), known as the BEER (see Section 2.6). The third Section is dedicated to the exploration of the relationship between economic growth and RER misalignment. The estimation results are discussed in the fourth section of the chapter, before concluding remarks are given in the final Section.

### 4.2 Data

This study uses quarterly data for the years starting in 1985 to 2011. The motivation for the use of these particular years is explained in Section 1.3 as well as Section 3.3. The data is obtained from the South African Reserve Bank's (SARB) online database and the International Monetary Fund's *International Financial Statistics* (IFS) online database. Since the analysis is conducted in two stages, namely (i) finding the equilibrium exchange rate, and (ii) investigating the relationship between misalignment and economic growth in South Africa, two sets of data are also needed. The first set of data is the fundamental factors that determine the REER, and this is subsequently discussed. The data and variables for the growth regression are discussed after the BEER estimation and results in Section 4.4.

## 4.3 BEER Regression

### 4.3.1 Fundamental Factors

The fundamentals that will be applied are found in studies by Aron *et al.* (1997) and MacDonald and Ricci (2003). These papers both use the REER as the dependent variable. This study uses various fundamental variables that influence the real South African rand/US dollar exchange rate, since this exchange rate is the dependent variable. These fundamentals or variables, which are explained in Chapter two, can be classified into four categories according to the manner in which they influence the equilibrium RER:

- a) **Productivity differences proxies**, including GDP per capita (**GDPPC**). An increase in productivity is associated with an appreciated currency according to the Balassa-Samuelson hypothesis (Balassa, 1964; Samuelson, 1964).
- b) **International economic environment and integration proxies**, including openness (**OPEN**) as measured by the sum of exports and imports relative to GDP, real interest rate differential (**IRATE**), and terms of trade (**TOT**). Firstly, the real interest rate differential between South Africa and the US can be considered, the long-run bond rate for both countries is used and deflated using the consumer price index. A larger differential is associated with a more appreciated currency as it represents aggregate demand, productivity and persistent monetary policy discrepancies (MacDonald and Ricci, 2003). When all the underlying factors represented by the interest rate differential are positive, the RER will appreciate. Secondly, a more open economy is associated with a more depreciated RER (Goldfajn and Valdes, 1999), while the opposite is true for terms of trade. The increase in export prices relative to import prices, such as that given by the terms of trade, leads to an appreciation in the currency (Saayman, 2007).
- c) **Demand pressure proxies**, including government expenditure (**GOV**), fiscal balance (**FISCAL**) and gross fixed capital formation (**GFI**). Rising government expenditure (and an increasing fiscal deficit) is associated with a decline in the RER as private savings are assumed to be reduced (MacDonald and Ricci, 2003). Private savings are assumed to be reduced, because government provides more for people, which reduces the incentive to save. For example, workers save less for retirement because the government provides monthly pension grants to South Africans. Contrary to this, increased capital formation captures business confidence or may be an indication of technological progress and supply capacity (Kim and Korhonen, 2005), inducing a more appreciated RER.
- d) **Foreign indebtedness** as measured by foreign reserves (**RES**). An increase in the stock of foreign exchange reserves is associated with an appreciated RER in the long-run (Aron *et al.*,

1997), because the foreign exchange reserves serve as a relatively liquid indicator of the economy's stock of national wealth.

Commodities still play a major role in the South African economy; therefore, the gold price index is included as an additional variable (see MacDonald and Ricci, 2003). The descriptions of the data and variables that will be assessed for inclusion in the analysis are given in Table 4.1. A visual representation of the variables is provided in the Appendix, as well as a correlation matrix, which indicates the linear relationship between the variables. Based on the visual inspection of the variables and the correlation matrix, the fiscal balance is disregarded from the analysis, due to a strong seasonal pattern that the series exhibits. The remaining two demand proxies, i.e. gross fixed capital formation and government expenditure, are therefore rather used in the analysis.

Based on the above discussion, the RER equation that includes fundamental variables is defined as (Saayman, 2010):

$$\bar{q}_t = f(\text{productivity}, \text{demand}, \text{integration}, \text{findebt}, \text{gold}) \quad (4.1)$$

<b>Variable</b>	<b>Description</b>	<b>Source</b>
RER	Real exchange rate, calculated as in Equation (2.1) and denominated in US dollars for South African rands	IFS
GDPPC	GDP per capita, in 2005 South African rand. Calculated as real GDP divided by population	IFS and SARB
OPEN	Exports plus imports as a percentage of GDP expressed as a ratio of SA openness to foreign markets	IFS and SARB
IRATE	Real interest rate differential between SA and USA (real interest rate = nominal interest rate - inflation rate)	IFS and SARB
GOV	Government expenditure as a percentage of GDP	SARB
FISCAL	Fiscal balance to GDP	SARB
TOT	South African terms of trade index (excluding gold) (2005=100)	SARB
GFI	Gross fixed capital formation as a percentage of GDP	IFS and SARB
RES	Gross reserves of the SARB (excluding gold) in US dollars as a percentage of GDP	IFS and SARB
GOLDI	Gold price index with 2005=100	IFS

**Table 4.1 Variables and sources**

### 4.3.2 Methodology

The methodology that will be used to determine the equilibrium exchange rate is the single-equation approach of the BEER, described in Chapter two. The BEER explains the behaviour of the exchange rate by taking into consideration the causes of the movements in the RER; it is also not derived from macroeconomic balance like the FEER. The BEER enables the calculation of the RER using fundamental determinants of the actual exchange rate. The exchange rate will be in equilibrium when the changes in the RER reflect changes in the fundamentals (Zhang, 2001).

Using the single-equation process also assists in the assessment of the degree or extent of over- or under-valuation. The BEER method followed in this study is similar to that explained by Siregar (2011) and followed by Baffes *et al.* (1997), MacDonald (1997), MacDonald (2001), and MacDonald and Ricci (2003).

The relationship between the actual values of the RER and its fundamental determinants can be presented as follows (MacDonald, 1997; Clark and MacDonald, 1998, and Siregar, 2011):

$$q_t = E_t(q_{t+1}) - (r_t - r_t^*) \quad (4.2)$$

Where the unobservable expectation of the RER,  $E_t(q_{t+1})$ , is assumed to be determined solely by long-run economic fundamentals, it can also be written as  $\bar{q}_t$ . In this approach, both long-run economic fundamentals, as well as short-run interest rate differentials are incorporated to produce estimates of equilibrium exchange rate ( $q^{REER}$ ). This was discussed in detail in Section 2.7.

MacDonald (1998) shows that the following steps should be followed in estimating the BEER (see Section 2.6.3).

- a) Step 1: Estimate the relationship between the equilibrium RER and the fundamental factors that affect the RER.

Before the model is estimated, the variables have to be scrutinised for stationarity. In the case of non-stationarity, cointegration techniques may be used. Cointegration analysis tests for the existence of a systematic equilibrium relationship between the RER and its determinants. It captures the long-run relationship between the actual RER values and economic fundamentals. The Johansen (1995) co-integration test is therefore used to investigate the existence of a long-run relationship between the RER and the economic fundamentals. The vector is given as follows, as given in Equation (4.1) is:

$$\bar{q}_t = f(\text{productivity, demand, integration, findebt, gold}). \quad (4.3)$$

All the terms are described above.

Testing for cointegration, as done by using the Johansen (1995) approach, can only be valid when results are generated by a non-stationary process. Therefore, before testing for cointegration, the order of the integration of the data has to be established. The Augmented Dickey-Fuller tests (ADF) by Dickey and Fuller (1981), are a widely used methodology for testing the order of integration of variables. It is a test for the existence of unit roots, assuming that the time series data under investigation is generated by a first order autoregressive process of the form:

$$s_t = \alpha_0 + \alpha_1 t + \rho s_{t-1} + \varepsilon_t, \quad (4.4)$$

Where  $\alpha_0$  is a constant,  $t$  is a deterministic trend, and  $\varepsilon_t$  is a white noise stochastic process. By subtracting  $s_{t-1}$  on both sides, Equation (4.4) can be written as follows:

$$\Delta s_t = \alpha_0 + \alpha_1 t + \gamma s_{t-1} + \varepsilon_t, \quad (4.5)$$

Where  $\gamma = \rho - 1$ .

The ADF test is performed on this re-parameterised form of the autoregressive process. In particular, the hypothesis for a unit root is given as:  $H_0: \gamma = 0$  which implies that the process  $\{s_t\}$  is non-stationary, against the alternative hypothesis given as  $H_0: \gamma < 0$ , which implies that the process is stationary (Asteriou and Hall, 2007).

In its practical application, the ADF test only requires estimating a general autoregressive process that includes lagged difference of the variable under investigation, which is included in order to control for autocorrelation in the stochastic error term. In practice, the test involves estimating the following regression model:

$$\Delta s_t = \alpha_0 + \alpha_1 t + \gamma s_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta s_{t+i} + \varepsilon_t. \quad (4.6)$$

The ADF tests provide critical values for testing the unit root hypothesis. MacKinnon (1991) has revised and extended the Dickey-Fuller tests, and he provides estimates that are appropriate for any sample size.

If it is found that if  $y_t$  is not stationary, in other words,  $y_t \sim I(n), n > 0$ , the BEER should be estimated only after establishing whether cointegration exists.

b) Step 2: Using the values of the fundamentals, the BEER can be estimated.

If it is assumed that a (nx1) vector has a Vector Autoregressive (VAR) representation of the form (MacDonald and Ricci, 2003; Saayman, 2007):

$$x_t = \eta + \sum_{i=1}^p \Pi_i x_{t-i} + \varepsilon_t, \quad (4.7)$$

Where  $\eta$  is a (nx1) vector of deterministic variables,  $\varepsilon$  is a (nx1) vector of white noise disturbances, with mean zero and covariance matrix  $\Xi$ .  $\Pi_i$  is a (nxn) matrix of coefficients and  $p$  is the lag length. Equation (4.7) can be inserted into the so-called Vector Error Correction Model (VECM) as a new restriction (MacDonald and Ricci, 2003; Saayman 2007)):

$$\Delta x_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta x_{t-1} + \Pi x_{t-i} + \varepsilon_t \quad (4.8)$$

Where  $\Delta$  denotes the first difference operator,  $\Phi_i$  is a (nxn) coefficient matrix that is equal to  $-\sum_{j=i+1}^{p-1} \Pi_j$ .  $\Pi$  is a (nxn) matrix equal to  $\sum_{i=1}^p \Pi_i - I$ .

The presence of cointegration is indicated by the rank of  $\Pi$ . If  $\Pi$  is either full rank, ( $\Pi = n$  or zero rank ( $\Pi = 0$ )), there is no cointegration amongst the variables in the long-run. In such cases, one should estimate the corresponding levels, or first differences. However, if  $\Pi$  is of reduced rank, ( $\Pi = r$  and  $r < n$ ), there will exist  $(n * r)$  - matrices  $\alpha$  and  $\beta$  such that  $\Pi = \alpha\beta'$  where  $\beta$  is the matrix with linear independent cointegration vectors as columns, and  $\alpha$  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 (MacDonald and Ricci, 2003; Mtonga, 2006; Saayman, 2007).

The Johansen (1995) cointegration test is used to investigate the existence of a long-run relationship between the real exchange rate and the variables defined in Table 4.1. The presence of cointegration determines the existence of the VECM model, a VAR of first differences. The study done by Engle and Granger (1987) on Granger causality suggests that the existence of cointegration among a model 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 written out as:

$$TR = -T \sum_{i=r+1}^N \ln(1 - \hat{\lambda}_i), \quad (4.9)$$

Where T is the sample size, p is the number of variables, and  $\hat{\lambda}$  represents the i-th order eigenvalue. In this series, all the variables that enter  $x_t$  are assumed to be I(1). Johansen and Juselius (1990) go into more detail as to how to extract the  $\lambda$ 's. The  $L_{max}$  statistic tests the hypothesis that there are  $r (\leq p - 1)$  cointegration relations against the alternative of  $r + 1$  such relations. The trace test statistic tests the hypothesis that there are  $r (< p)$  cointegration relations against the alternative of  $p$  such relations.

$$L_{max} = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (4.10)$$

Both the TR and  $L_{max}$  statistics have non-standard distributions under the null hypothesis as shown by Johansen (1995). These provide approximate critical values for the statistic generated by the use of the Monte Carlo methods. MacDonald and Ricci (2003) find that the advantage of the Johansen methodology is the fact that the estimated coefficient, the  $\beta$  vector, can be used as a measurement proof of the equilibrium RER and thus a quantification of the gap that occurs between the prevailing RER and its level of equilibrium. Harris and Sollis (2003) and Favero (2001) explore the Johansen cointegration test method and also use the equations that are described above. The equilibrium RER is therefore given by the expression below (Mtonga, 2006):

$$\bar{q}_t = \hat{\beta}' Z_t, \quad (4.11)$$

Where  $\hat{\beta}$  denotes the vector of estimated long-run coefficients.

- c) Step 3: The current misalignment can be measured as the difference between the prevailing exchange rate and the BEER.

Saayman (2010) explains the misalignment as the variation of the actual exchange rate from its long-run value as determined by the co-integration relationship. The estimated degree of RER misalignment is therefore the difference between the actual RER and its computed equilibrium value obtained using Equation (4.11).

$$misalign = RER - q_t. \quad (4.12)$$

### 4.3.3 Estimation Results

#### 4.3.3.1 Equilibrium exchange rate

The explanatory variables of the South African exchange rate are shown in Figure A1 in the Appendix. The variables for the BEER equation have been tested for unit roots, using the Augmented Dickey-Fuller (ADF) test as well as the Phillips-Perron unit root test. The results of the ADF tests are indicated in Table 4.2 to 4.4 below. The results show that all the variables are stationary in first differences,  $y_t \sim I(1)$ , although the interest rate differential (IRATE), as well as reserves (RES), shows signs of stationarity in levels. The other variables need to be differenced once in order to obtain stationarity and the real GDP per capita (GDPPC) is only stationary in first differences if no intercept or trend is assumed. The results of the Phillips-Perron tests are indicated in Table A2 to A4 in Appendix A. These results also indicate stationarity of variables in first differences although GDPPC and IRATE are both stationary in levels. Note that the "L" prefix indicates that natural logs of the variables were taken to standardise the data, where appropriate.

Series	Prob.	Series	Prob.
LRER	0.2406	D(LRER)	<0.001
LOPEN	0.3790	D(LOPEN)	<0.001
LRES	0.8126	D(LRES)	<0.001
LTOT	0.8673	D(LTOT)	<0.001
LGOV	0.6666	D(LGOV)	<0.001
LGOLDI	1.0000	D(LGOLDI)	<0.001
LGFI	0.1518	D(LGFI)	<0.001
LGDPPC	0.6340	D(LGDPPC)	<0.2461
IRATE	0.1251	D(IRATE)	<0.001

**Table 4.2 Results of ADF Unit Root Test- Intercept, no trend**

Table 4.4 shows that the interest rate differential is stationary when assuming no intercept or trend. Given the specification of the BEER model, the interest rate differential is not included in the long-run but rather in the short-run part of the model (see Equation (4.2)). Furthermore, stationarity of the reserves variable cannot be excluded and therefore it is also disregarded in the subsequent cointegration test. The variables that are  $I(1)$  can therefore be subjected to the Johansen (1995) cointegration test in order to assess whether there exist a long-run relationship between the variables.

Series	Prob.	Series	Prob.
LRER	0.1046	D(LRER)	<0.001
LOPEN	0.2550	D(LOPEN)	<0.001
LRES	0.0052	D(LRES)	<0.001
LTOT	0.8838	D(LTOT)	<0.001
LGOV	0.9333	D(LGOV)	<0.001
LGOLDI	0.9999	D(LGOLDI)	<0.001
LGFI	0.4039	D(LGFI)	<0.001
LGDPPC	0.7853	D(LGDPPC)	<0.1629
IRATE	0.2078	D(IRATE)	<0.001

**Table 4.3 Results of ADF Unit Root Test- Individual intercept and trend**

Series	Prob.	Series	Prob.
LRER	0.5209	D(LRER)	<0.001
LOPEN	0.7350	D(LOPEN)	<0.001
LRES	0.9856	D(LRES)	<0.001
LTOT	0.9162	D(LTOT)	<0.001
LGOV	0.7299	D(LGOV)	<0.001
LGOLDI	0.9993	D(LGOLD)	<0.001
LGFI	0.4705	D(LGFI)	<0.001
LGDPPC	0.8662	D(LGDPPC)	0.0438
IRATE	0.0169		

**Table 4.4 Results of ADF Unit Root Test- No intercept or trend**

The two demand variables, namely gross fixed capital formation (GFI) and government expenditure (GOV), are highly correlated (see the correlation matrix in Appendix A) and therefore they will not be used together in the model. In order to determine which vector of variables best suits the model, two sets of analyses were done, one including gross fixed investment and the other government expenditure as demand proxies. The vectors ( $x_t$ ), are indicated by Equations (4.13) and (4.14).

$$\text{Model 1: } (x_t = lrer_t, lgdppc_t, lopen_t, lgfi_t, ltot_t, lgoldi_t) \quad (4.13)$$

$$\text{Model 2: } (x_t = lrer_t, lgdppc_t, lopen_t, lgov_t, ltot_t, lgoldi_t,) \quad (4.14)$$

The procedure, as explained below, were followed for each of the vectors described in Equation (4.13) and Equation (4.14), but significant results could only be found with Model 1 – when GFI was included instead of GOV. Therefore, the remainder of this chapter describes only the results of Model 1.

In determining the lag order of the model, the studies by MacDonald and Ricci (2003) and Aron *et al.* (1997) found significant results up to 4 lags. The lag order selection test indicated that up to 8 lags could be significant according to the Akaike information criteria and the modified LR statistic. The Schwarz information criterion indicates that only 1 lag should be used, while the FPE statistic indicates 2 lags (see Table A5 in Appendix A). For the purpose of this study, one and two lags are tested, which is similar to the approach followed by Saayman (2010). Seasonal dummies are included (denoted by s1, s2 and s3), which is commonly applied when employing quarterly data in order to account for any shocks that may occur (MacDonald and Ricci, 2003). A structural (shift) dummy (sdum) is also introduced and takes the value of 1 for the political unrest and subsequent debt standstill from 1984Q2 to 1985Q4, the Asian currency crisis of 1998Q2 to 1998Q4, the 2001Q1 to 2001Q3 during the Argentinean currency crisis and the Zimbabwean crisis, as well as the United States mortgage crisis of 2008.

The Johansen (1995) cointegration test is performed in the VAR space to determine the existence of cointegration. For the purpose of this study, a 5% significance level will be used to estimate the long-run relationship and a linear trend will be assumed. The trace test results, that indicate the number of distinct cointegration vectors, can be seen in Table 4.5, which suggests that there may be an existence of up to 2 cointegrating equations at a 5% level of significance, especially when no trend in the data is assumed. This changes when a linear or quadratic trend is assumed. The maximum Eigen value statistic confirms the results of the trace test statistic, and indicates only one cointegrating vector when a linear or quadratic trend in the data is assumed.

<b>Data Trend:</b>	<b>None</b>	<b>None</b>	<b>Linear</b>	<b>Linear</b>	<b>Quadratic</b>
<b>Test Type</b>	<b>No Intercept</b>	<b>Intercept</b>	<b>Intercept</b>	<b>Intercept</b>	<b>Intercept</b>
	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>Trend</b>	<b>Trend</b>
<b>1 lag</b>					
Trace	2	2	1	1	1
Max-Eig	2	1	1	1	1
<b>2 lags</b>					
Trace	2	2	2	1	1
Max-Eig	2	1	1	1	1

**Table 4.5 Johansen cointegration test results summary**

<b>Cointegrating Equation:</b>	<b>Coefficient</b>	<b>t-statistic</b>
LRER(-1)	1.000000	
LGDPPC(-1)	3.087713	[ 3.35454]
LGFI(-1)	-1.868633	[-5.38349]
LOPEN(-1)	1.619225	[ 7.61096]
LGOLDI(-1)	0.522282	[ 3.54421]
LTOT(-1)	-4.264173	[-5.19713]
@TREND(80Q1)	-0.007931	[-5.02080]
C	-13.35155	
<b>Error Correction:</b>	<b>D(LRER)</b>	
CointEq1	-0.116523	[-2.42849]
D(LRER(-1))	0.034134	[ 0.30020]
D(LRER(-2))	-0.222499	[-2.08254]
D(LGDPPC(-1))	1.372734	[ 1.37051]
D(LGDPPC(-2))	1.576783	[ 1.58456]
D(LGFI(-1))	0.123663	[ 0.49069]
D(LGFI(-2))	-0.243127	[-1.02268]
D(LOPEN(-1))	-0.026885	[-0.20274]
D(LOPEN(-2))	-0.112872	[-0.92821]
D(LGOLDI(-1))	-0.110388	[-1.02067]
D(LGOLDI(-2))	-0.010868	[-0.09553]
D(LTOT(-1))	-0.041413	[-0.17512]
D(LTOT(-2))	0.106372	[ 0.49916]
C	0.010633	[ 0.84359]
S1	0.006433	[ 0.42978]
S2	0.012511	[ 0.51787]
S3	0.005074	[ 0.21233]
IRATE	-0.008817	[-5.37469]
SDUM	-0.067201	
R-squared	0.465925	
Adj. R-squared	0.357910	
F-statistic	4.313521	
Akaike AIC	-2.879073	
Schwarz SC	-2.407216	

**Table 4.6 Vector Error Correction Estimates**

Given the results of the Johansen (1995) cointegration test, a VECM is estimated for the model using both one and two lags, and assuming a linear trend in the data. The best model found is a VECM estimated with 2 lags and co-integration assuming a linear relationship between the variables, where an intercept and trend are accepted in the VECM (option 4 in Table 4.5). The results, which show both the long-run coefficients, as well as the short-run, are presented in Table 4.6. It is evident that all the variables are significant in the cointegrating equation. The model is further tested for exogeneity and normality in the succeeding sections.

#### 4.3.3.1.1. Weak Exogeneity test results

The Wald Test determines which variables can be viewed as endogenous in the VAR system, and which are weakly exogenous. Based on the above estimations, the Wald Test was performed and the results show that the null hypothesis of exogeneity cannot be rejected in the case of the RER. Table 4.7 below shows the results of the exogeneity test for the RER. The full test results are included in Appendix A, Table A7. Individually, the results show that causality runs from the real GDP per capita to the exchange rate, but that there is no Granger causality running from the other variables to the RER. This proves there is causality between economic growth and the exchange rate, in other words, the exchange rate may have a measurable an impact on economic growth.

The lag exclusion test is shown in Table A6 in Appendix A and indicates that the 2 lags are significant when looking at the joint p-values, and thus necessary in the VECM specification.

Dependent variable: D(LRER)			
Excluded	Chi-sq	Df	Prob.
D(LGDPPC)	5.166976	2	0.0755
D(LGFI)	1.067014	2	0.5865
D(LOPEN)	0.892241	2	0.6401
D(LGOLDI)	1.095589	2	0.5782
D(LTOT)	0.486266	2	0.7842
All	10.07350	10	0.4341

**Table 4.7 Wald Exogeneity Test**

#### 4.3.3.1.2 Normality Test

The null hypothesis of normality for the VECM residuals is rejected due to skewness. However, individual variable normality tests indicate that the null hypothesis of normality of the residuals - the difference between the observed and the fitted value - cannot be rejected either due to skewness or excess kurtosis for the first component (the RER) as indicated in Table 4.8. This indicates that the error for this equation in the VECM is normally distributed. The rejection of normality is mainly caused by component five in the VAR, namely the gold index.

Component	Skewness	Chi-sq	Df	Prob.
1	0.407299	2.986057	1	0.0840
2	0.299975	1.619735	1	0.2031
3	-0.072208	0.093852	1	0.7593
4	-0.304461	1.668538	1	0.1965
5	0.870201	13.63050	1	0.0002
6	-0.233904	0.984802	1	0.3210
<b>Joint</b>		20.98348	6	0.0018
Component	Kurtosis	Chi-sq	Df	Prob.
1	3.668409	2.010468	1	0.1562
2	2.947743	0.012288	1	0.9117
3	3.866341	3.377457	1	0.0661
4	2.889489	0.054957	1	0.8147
5	3.781657	2.749445	1	0.0973
	3.201667	0.183013	1	0.6688
<b>Joint</b>		8.387629	6	0.2111

**Table 4.8 Vector Error Correction Residual Normality Test**

In Figure A2 (see Appendix A), the residuals of the fundamentals can be seen and it is evident that none of the residuals have a trend in the data. The fundamental variables have been analysed and tested for significance in a model, and a linear equation can be derived to determine the BEER. The actual values of the variables are substituted in the estimated long-run relationship in order to determine the BEER (see Equation (4.16)).

$$(x_t = lrer_t, lgdppc_t, lopen_t, lgfi_t, ltot_t, lgoldi_t) \quad (4.15)$$

The long-run equation will be formulated and evaluated in the following section.

#### 4.3.3.1.3 Equilibrium real exchange rate

Table 4.6 shows evidence that cointegration occurs between the RER and the explanatory variables in the long-term and, as indicated, it is clear that the coefficients of the fundamentals are highly significant. The behavioural, single equation is as follows:

$$\begin{aligned} lrer = & -13.3515 + 3.0877lgdppc - 1.8686lgfi + 1.619lopen + 0.5222lgoldi - 4.2641ltot \\ & - 0.00079trend \end{aligned} \quad (4.16)$$

The relationship between the RER and these variables can be interpreted in both the long-run and the short term. The long-run relationships are explained below. Note that the RER is estimated as the US dollar amount required in purchasing a South African rand (i.e. indirect quote). The coefficients of the estimated model show that:

- The relationship between the RER and GDP is positive, as expected, and a 1% increase in South Africa's GDP per capita thus leads to a 3.08% appreciation in the rand via the Balassa-Samuelson effect. Saayman (2010) found similar results for South Africa, while Abida (2011) also found that an increase in domestic productivity differential relative to trading partners led to an appreciation in the local currency.
- A negative coefficient for investment indicates that a 1% increase in gross fixed capital information leads to a 1.86% fall in the RER. This negative coefficient is against theoretical expectations; however, it is important to note the problems that South Africa has had pertaining to foreign capital flows. Despite being an attractive investment destination, South Africa remains with low levels of foreign investment (World Bank, 2011). The South African rand has experienced low foreign capital inflows that have not been adequate to have a positive effect on either the RER or growth. According to Basu and Srivinasa (2002), South Africa still receives low levels of inward FDI, with the exception of a few years, i.e. 1997, 2001 and 2005. Africa's share in FDI has declined from 5.3% of the 1980s to approximately 2.3% in 2000, which has somehow stabilised at around 3% since around 2002. In addition, fixed investment in South Africa usually goes towards imports (the acquisition of capital-intensive goods). This undermines the domestic currency because, even though the investments increase, they are coupled by an increase in the demand for foreign currency.

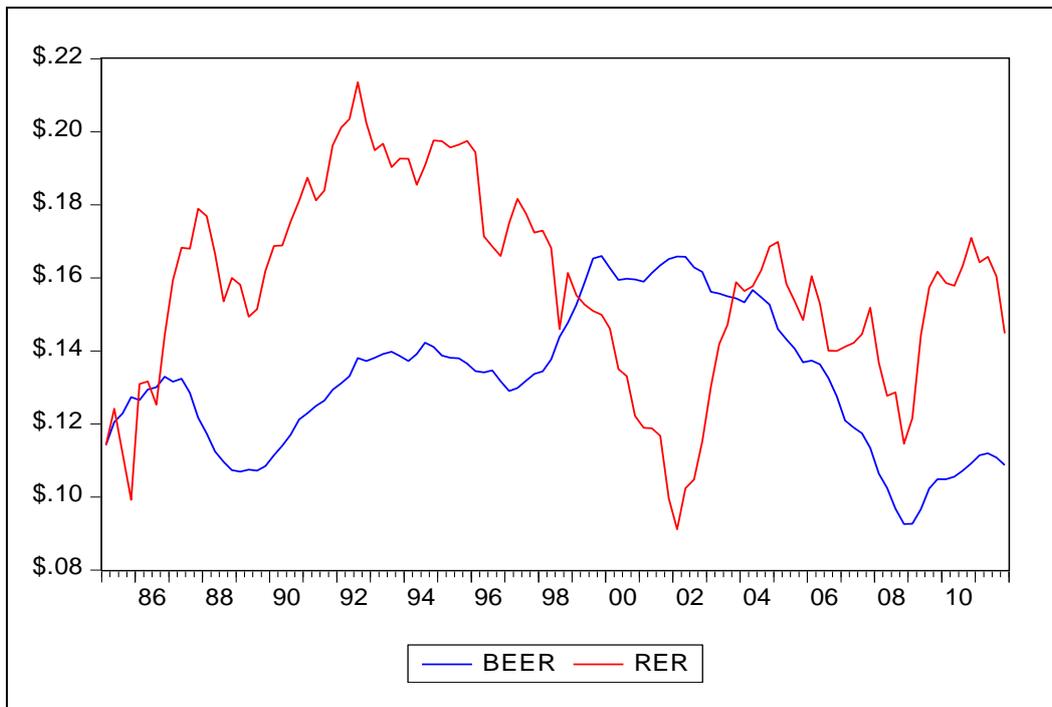
- A 1% increase in the terms of trade leads to a 4.26% depreciation in the rand. In Section 2.9.3, theory dictates that terms of trade have an appreciating effect on the exchange rate. Results, however, prove otherwise. An increase in the South African terms of trade has had a negative effect on the RER; this can be due to the substitution effect, as discussed in Section 2.9.2. Weaknesses have been found in South Africa's export performance (Tsikata, 1999; Van Seventer and Gibson, 2004; Edwards and Alves, 2005). This poor performance has impelled trading partners to seek substitutes for goods which could have been supplied by South Africa; the income effect is therefore foregone. This explains the reason why, even with increasing terms of trade, the returns are not seen in a rising RER.
- A positive coefficient for openness indicates trade liberalisation or the openness of the economy has had an appreciating effect on the rand. A 1% increase in the level of openness of the economy leads to a 1.61% rise in the South African exchange rate. Although Saayman (2010) and MacDonald (2001) found opposite results for the effect of openness of the economy on the exchange rate, Drine and Rault (2006) noted that an increase in the liberalisation of the economy has the ability to induce an appreciation in the RER. They found that the openness of the Egypt, Bahrain and Kuwait economies had led to an appreciation in the currencies of these Mena nations. In the South African context, this suggests that the gains from trade with other nations have exceeded the loss in protection of industries. The open trade regime has been beneficial for the economy and its RER.
- An increase in gold price is associated with an appreciation in the rand. These results confirm those of Aron *et al.* (1997); MacDonald and Ricci (2003); as well as Saayman (2010) who have found that a rising RER can be associated with an increase in the gold price.

The short-run effects are not all significant and have not been discussed in this study; however, the study concentrates on the long-run relationship. This is also not unique to this study since MacDonald and Ricci (2003) and Saayman (2010) found insignificant short-run effects across various specifications. However, the real interest rate differential is significant and indicates that, in the short-run, an increase in the real interest rate differential has depreciating effects on the rand. Drine and Rault (2006) also found a similar relationship between the currency and the real interest rate differential. They found in the Mena countries Egypt, Kuwait and Tunisia, an increase in the interest rate differential had led to depreciation in the currencies of those nations.

Another important element is the adjustment factor of the cointegration equation. Generally, once a gap between the RER and the estimated equilibrium exchange rate has developed due to shocks or

for whatever reason, the RER will converge back to its equilibrium level overtime (Saayman, 2010; de Jager, 2012). Depending on the misalignment, the adjustment factor ensures that the RER gradually moves towards the defined equilibrium level. The result of the VECM model shows that the speed of an adjustment run is statistically significant with a negative value of 0.11. This result suggests that, on average, 11% of the gap will be eliminated every quarter, assuming that there are no further shocks to the economy. In other words, it takes slightly less than 5 quarters to eliminate 50% of the shock. The adjustment factor in this study is in line with that which was found by MacDonald and Ricci (2003). They found that, in the absence of any further shocks, it would take between 2 and 2½ years for half of the shock to be eliminated. This adjustment factor is, however, slower than that which was found by Aron *et al.* (1997); they report that, it will take less than three and a half quarters to eliminate 50% of the shock.

The South African rand/US dollar exchange rate is influenced in the long-run by the fundamental variables – an increase in GDP per capita leads to a 3.08% appreciation in the rand, an increase in foreign capital leads to a 1.86% depreciation in the rand, an improvement in trade openness appreciates the rand by 1.61%, an increase in the gold price leads to a 0.52% rise in the RER, while an improvement in the terms of trade depreciates the rand by 4.26%. In the short term, an increase in the real interest rate differential leads to a 0.01% depreciation in the rand. The estimated behavioural equilibrium and actual exchange rates are indicated in Figure 4.1. The actual and behavioural exchange rates follow a similar pattern although the BEER is much lower than the actual RER; yet the actual exchange rate crosses the BEER at certain points – this is where the actual exchange rate is equal to its fundamental value. These unequal exchange rates lead to periods of under and overvaluation of the rand from the long-run fundamental exchange rate. Another reason for the difference in the BEER and the actual exchange rate is that explanatory variables change all the time and they alter the equilibrium level. Temporary factors such as financial market pressure on the rand can also not be ignored, as they move the RER away from the equilibrium exchange rate (MacDonald and Ricci, 2003). The misalignment ( $misalign = RER - \bar{q}_t$ ) is calculated and shown in Figure 4.2. The lower bars indicate periods of undervaluation, while the upper bars show periods of overvaluation.

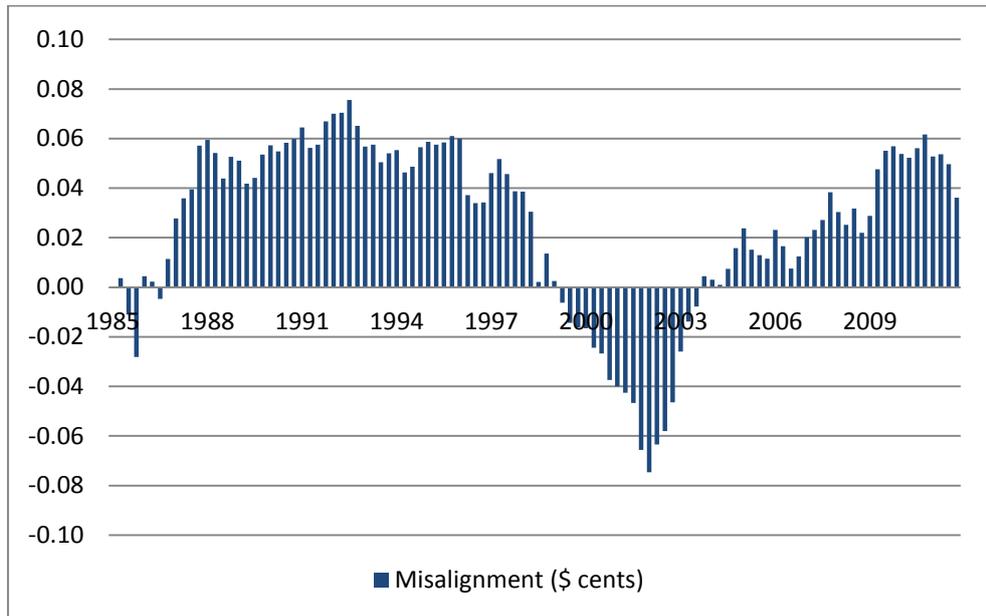


**Figure 4.1 The South African BEER versus the Actual Real Exchange Rate**

The misalignment graph indicates that after some time of over- or undervaluation, the South African rand usually reverts back to its equilibrium level. Starting from an overvalued exchange rate of 3.08% against the US dollar in 1985, the rand lost ground and showed an undervaluation of about 22.08% by 1985Q4. An overvaluation of 3.49% followed in the very next year, yet there was always a tendency for the exchange rate to move back to its fundamental long-run level. The rand continued in its overvaluation from 1986Q4 and reached its peak overvaluation of 54.71% in 1992Q3. It continued fluctuating at an overvalued rate until 1999. The rand's overvaluation dropped significantly to only 1.64% in 1999Q1. A relatively long period of undervaluation began in 1999Q2, it reached its lowest point of undervaluation in 2002Q1 of 45.03%. The undervaluation thinned and the rand was, again overvalued, relative to its trading partners by 2003Q4. The rand had been rising sharply since 2004Q3, although there were some volatility and a decline in overvaluation around 2008 and 2009. This decline did not, however, reach the equilibrium or undervaluation, it rather picked up and by the end of the period under investigation, the rand was overvalued by 33.21%. Again, the rand tends to revert back to its fundamental long-run level overtime.

When there is a gap between the exchange rate and its equilibrium level, the RER tends to converge to its equilibrium level overtime, as can be seen in Figure 4.1, as well as Figure 4.2. The adjustment that needs to be made is determined by the cause of the gap. The adjustment also requires that the exchange rate moves progressively towards a new equilibrium or must return to the original

equilibrium value from its temporary deviation, which is also seen above (MacDonald and Ricci, 2003). When this happens, the RER is very close to equilibrium.



**Figure 4.2 Current Misalignment**

#### 4.4 Growth Regression

As indicated above, there have been discrepancies between the actual RER and the equilibrium exchange rate. Literature suggests that this discrepancy may have affected economic growth. This section studies the impact of the RER misalignment on economic growth using the Solow model.

<b>Variable</b>	<b>Description</b>	<b>Source</b>
Growth	Quarterly growth in real GDP per capita of South Africa (compared to similar quarter last year)	IFS
GDPPC	GDP per capita in constant 2005 SA rands	IFS
Misalign	The difference between the actual RER and the equilibrium exchange rate	Calculated
GFI	Gross fixed capital formation as a percentage of GDP	IFS
OPEN	Exports plus imports as a percentage of GDP expressed as a ratio of SA openness to foreign markets	IFS and SARB
TOT	South African terms of trade index (excluding gold) (2005=100)	SARB

**Table 4.9 Variables and sources**

#### 4.4.1 Variables and Methodology

The variables used in this section are described in Table 4.9 above and a graphical illustration of the variables is presented in Appendix B (see Figure B1). Since this study aims to determine the influence of currency misalignment on the growth performance of South Africa, the focus of the growth equation is on export-led growth and therefore international competitiveness and openness are main components in this estimation.

The relationship between economic growth and RER misalignment is presented, using a growth equation as specified by Chen (2011):

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta X_t + \varepsilon_t, \quad (4.17)$$

for  $t=2, \dots, T$ ; where  $\Delta y_t$  is the log difference in GDP per capita,  $y_{t-1}$  is the logarithm of real GDP per capita at the beginning of each period (a proxy of the initial income); and  $X_t$  is a vector containing the explanatory variables measured during that period (Cottani *et al.*, 1990; Ghura and Grennes, 1993; Ding and Knight, 2009). In respect of those proposed in literature (Razin and Collins, 1997; Aguirre and Calderon, 2005; Rodrik, 2007), the estimated growth equation can be adapted to include exchange rate misalignment as follows:

$$growth_t = \beta_0 + \beta_1 lgdppc_{t-1} + \beta_e misalign_t + \beta' X_t + \varepsilon_t, \quad (4.18)$$

Where:

- $growth_t$ : the dependent variable is the log difference in real GDP per capita. It reflects the growth rate of the real gross domestic product per capita. It is an economic performance indicator, which quantifies economic growth.
- $lgdppc_{t-1}$ : the initial GDP per capita of the South African economy, which, as a proxy, accounts for conditional convergence. The conditional convergence hypothesis states that, other things remaining equal, countries with lower GDP per capita are expected to grow more rapidly due to higher marginal returns on capital stock. Therefore, initial GDP per capita is included to control for conditional convergence (Barro and Sala-i-Martin, 2004; Berg and Miao, 2010).
- $misalign_t$ : RER misalignment obtained by following the procedure described in the previous sections (see Section 4.3), estimated in Equation (4.12).
- $X_t$ : vector of additional explanatory variables. Relying on developments of the endogenous growth theory, determinants which reflect trade policies, macroeconomic stabilisation policies and institutions are included (Abida, 2011). The following variables are considered:

(i) trade openness, (ii) investment and (iii) terms of trade. Trade openness is included as it is considered to have a positive effect on economic growth and poverty reduction, based on both the neoclassical trade models (via comparative advantage) and the endogenous growth literature (via the economies of scale or technology's diffusion). As discussed in Section 3.4.2, South Africa's openness to trade was the leading cause behind rising productivity in the economy. South Africa, being an outward-oriented economy, the terms of trade, as well as openness of the economy to international trade, play very important roles in economic growth (see Section 3.4.3).

Capital formation, which results from investment, is also very important for growth, as has been stated in Section 3.2.3c. Therefore gross fixed capital formation (GFI) will also be included in the growth equation. Fedderke (2002) and Fedderke and Simkins (2004) found that the contribution of capital to growth performance in the South African economy was due to investment growth. In addition, capital formation formed the basis of the neoclassical growth equations.

The terms of trade (TOT) as a measure of international competitiveness are included although the effect may be ambiguous. An increase in the terms of trade may indicate increased competitiveness of South African exports and that may lead to an increase in investment and thus economic performance (see Bleaney and Greenaway, 2001; Blattman, Hwang and Williamson, 2003). However, Eicher, Schubert, and Turnovsky (2008) argue that an improvement in the terms of trade harms economic growth in the long-term.

The estimation method applied is ordinary least squares as a precise unbiased estimation technique. The regressions are tested for errors, normal distribution and correlation between the variables, which results in the presence of some first order lags and differenced independent variable.

Based on the above discussion, the economic growth equation is defined as follows:

$$growth = f(lgdppc_{t-1}, misalign_t, ltot_t, lopen_t, lgfi_t) \quad (4.19)$$

By splitting the RER misalignment into an under- and over-valuation indicator, the model (Equation (4.18)) is re-estimated by using the following specifications of the growth regression:

$$growth_t = \theta_0 + \theta_1 lgdppc_{t-1} + \theta_2 over_t + \omega' X_t + \varepsilon_t \quad (4.20)$$

$$growth_t = \gamma_0 + \gamma_1 lgdppc_{t-1} + \gamma_2 under_t + \mu' X_t + \varepsilon_t \quad (4.21)$$

Where:

- $over_t$ : measures the degree of the overvaluation of a currency in respect to its equilibrium value, while it takes the value of zero otherwise; and
- $under_t$ : reflects the degree of undervaluation of a currency in respect to its equilibrium value, while it takes the value of zero otherwise.

## 4.4.2 Estimation Results

### 4.4.2.1 Unit Root Test

As with the RER regression, a unit root test has to be performed in order to determine the order of integration of the variables. Again, the ADF unit root test was used (see Section 4.3.2 for a discussion of the test). The results are presented in Table 4.10. Only the results of the variables that have not been tested yet are present, i.e. the results of the growth variable and the misalignment variable.

It is evident that growth is non-stationary when assuming an intercept in the variable. However, the growth variable is stationary when assuming an intercept and trend in the variable or assuming no intercept or trend. The conclusion therefore is that growth is stationary at levels and first or second differences do not need to be taken in order to reach stationarity. There is evidence of non-stationarity for the misalignment variable at levels when assuming an intercept in the variables, an intercept and trend in the variables, or neither an intercept nor a trend in the variables. Misalignment is only stationary in first differences. These results are shown in Table 4.10 below. Since the dependent variable is stationary in levels, the equation is estimated using non-transformed data.

Null Hypothesis: Unit root (individual unit root process)					
Series: GROWTH, LGDPPC, MISALIGN, LOPEN, LTOT, OVER, UNDER					
Intercept, no trend		Intercept and trend		No intercept or trend	
Series	Prob.	Series	Prob.	Series	Prob.
GROWTH	0.1052	GROWTH	0.015	GROWTH	0.0144
MISALIGN	0.5575	MISALIGN	0.8176	MISALIGN	0.3039

**Table 4.10 Results of ADF Unit Root Test**

#### 4.4.2.2 Misalignment estimation

Three categories of models were estimated, three growth regression models were estimated by introducing in the analysis the RER misalignment, overvaluation and undervaluation. The effects of the misalignment on economic growth were analysed first before proceeding to the over- and undervaluation effects. The first equation, as shown in Equation (4.19), is given below:

$$growth = f(lgdppc_{t-1}, misalign_t, ltot_t, lopen_t, lgfi_t) \quad (4.22)$$

This estimation of growth showed evidence of serial autocorrelation according to the Breusch-Godfrey LM test. The model is therefore re-estimated with two lagged dependent variables to control for autocorrelation. The results with no autocorrelation and with normally distributed errors (see Figure B2 in Appendix B) and probabilities are presented in Table 4.10.

*(dependent variable is rate of growth in South Africa)*

<b>C</b>	-0.093 [-0.510]	-0.105 [-0.575]	-0.146 [-0.804]
<b>LGDPCC(-1)</b>	0.001 [0.001]	-0.003 [-0.114]	0.007 [0.251]
<b>LOPEN</b>	0.042 [3.361]**	0.029 [2.600]**	0.037 [3.775]**
<b>LTOT</b>	0.009 [0.376]	0.024 [1.052]	0.011 [0.508]
<b>LGFI</b>	-0.040 [-3.622]**	-0.031 [-3.115]**	-0.044 [-3.913]**
<b>MISALIGNMENT</b>	0.078 [1.85]*		
<b>OVERVALUATION</b>		0.028 [0.573]	
<b>UNDERVALUATION</b>			0.168 [2.337]**
<b>GROWTH(-1)</b>	1.195 [13.77]*	1.234 [14.44]**	1.188 [13.89]**
<b>GROWTH(-2)</b>	-0.440 [-5.622]*	-0.448 [-5.652]**	-0.441 [-5.702]**
R-squared	0.923049	0.920674	0.924537
Adjusted R-squared	0.917663	0.915121	0.919254
Akaike info criterion	-6.92511	-6.89471	-6.94463
Schwarz criterion	-6.72644	-6.69604	-6.74595
F-statistic	171.3623	165.8032	175.0212

**Table 4.11 The RER Misalignment and Economic Growth**

Notes: *t*-values in [ ]; \* denotes significance at 10% level, \*\* denotes significance at 5% level

#### 4.4.2.3 Overvaluation Estimations

The effects of overvaluation on economic growth were analysed subsequently. As indicated above, the misalignment is divided into times when the RER was either overvalued or undervalued. The equation is given below:

$$growth = f(lgdppc_{t-1}, over_t, ltot_t, lopen_t, lgfi_t) \quad (4.23)$$

The first estimation of overvaluation also showed evidence of serial autocorrelation and the model was re-estimated with two lagged dependent variables. The results as presented in Table 4.10 show coefficients with significant probabilities. The Breusch-Godfrey autocorrelation tests indicated that there is no presence of autocorrelation in the model, while the normality test in Figure B3 (Appendix B) proves that the errors are normally distributed, indicating a valid model.

#### 4.4.2.4 Undervaluation Estimations

The last estimations are those of the undervaluation model. The effects of undervaluation on economic growth are analysed using this equation:

$$growth = f(lgdppc_{t-1}, under_t, ltot_t, lopen_t, lgfi_t) \quad (4.24)$$

This estimation showed evidence of serial autocorrelation and, like the previous models; it was re-estimated including two lagged dependent variables. The results of the coefficients with their significant probabilities are presented in Table 4.11. The Breusch-Godfrey LM tests indicated that there is no evidence of autocorrelation in the model, and the normality test in Figure B4 (Appendix B) proves that the errors are normally distributed and the model is therefore valid. These results are further discussed in detail in the following section.

### 4.5 Discussion of results

Firstly, relating to the control variables, apart from initial GDP per capita, the variables have the same signs whether it is with misalignment, over- or undervaluation. The initial GDP per capita, which accounts for conditional convergence, is positive during currency misalignment or undervaluation. This indicates that an improvement of economic growth in the previous period is positively transmitted to the next period. The initial position of the economy, as recognised by the

neoclassical theory is an important determinant of growth. However, when the rand is overvalued, the initial GDP per capita tends to have a negative effect on economic growth.

The investment variable has a negative sign, different from that which is suggested by theory, which states that there exists a positive relationship between capital accumulation and growth. Foreign direct investment is seen as a way to provide the needed capital to stimulate growth in a domestic economy; however, this has not been the case in South Africa. The inflow of FDI avails foreign exchange in an economy, which should improve the balance of payments account, particularly the current account. FDI can provide managerial knowledge and skills, including organisational competence and access to foreign markets. It can enable the transfer of technology from developed countries to the developing nations. It may provide a wide range of goods and services to residents in the recipient country. FDI can also create jobs and capital for new investments, while providing access to lucrative exports markets (Asiedu, 2002). The low levels of FDI in South Africa imply that the country has not had efficient exposure to these benefits of FDI, which play a major role in growth.

South Africa receives comparatively low levels of foreign capital and Thomas and Leape (2005) attest to that notion. They state that the country is yet to experience the high levels of FDI required to increase the economic growth rate. Foreign investors still show very limited interest in acquiring, creating or expanding domestic enterprises, despite the perceived improvement in the overall macro conditions and the wealth of the country in terms of natural resources and market size. The major source of FDI to South Africa is still the UK. There remains a poor correlation between economic performance and the magnitude of foreign investments in South Africa, as well as Southern Africa (Dahl, 2002; Clark and Bogran, 2003). Lastly, according to Eichengreen (2008), an unstable RER has a negative impact on the status of an economy as a destination for foreign investment. This is another reason why foreign investments have not grown at a favourable rate for economic growth or an appreciated RER. Foreign investors are not confident, given the unstable state of the rand and that discourages investors, which has a further negative effect on the same RER.

Favourable terms of trade shocks enhance economic growth. Thus, the more outward-oriented the South African economy is, the more this contributes positively to economic growth. The same can be said for openness of the economy, which also enhances economic growth. These results are comparable with those found by Cottani, Cavallo and Kahn (1990), Aguire and Calderon (2005), Dufrenot, Mignon and Tsangarides (2009), and Abida (2011). More generally, according to the neoclassical approach, the positive impact of trade on growth is explained by comparative advantages, which may be in resource endowments or differences in technology (Béreau, Lopez-

Villaviciencio and Mignon, 2009). These results go to prove that in South Africa exporting plays an important role in economic growth; hence a competitive RER is needed for exports to increase (also see Mtonga, 2006).

Sadly, the export sector has not been performing very well. In 1994, the new democratically elected government out in place measures to stimulate growth. This government had inherited an economic system characterised by declining economic and employment growth, which both had an influence on the RER (see Section 3.3). One of those measures was export promotion (RSA, 1996). Research shows that, although exports of manufactured goods have increased, they have not been enough to generate an export-led boom such as has been seen with East Asian economies. The manufactured exports of the local economy remain resource-based, they have not been restructured towards dynamic, high technology products. The slow restructuring of exports, according to Edwards and Alves (2005) is one of the explanations for the poor performance of South African exports. South Africa, being a middle-income country, has not upgraded from their export structure, from a low-skilled to a market-dynamic, technology intensive structure (UNCTAD, 2002). An improvement in export performance is a necessity for South Africa, seeing as export-led growth is a worthwhile direction to take.

Turning to the main variables of interest, there appears to be a positive relationship between economic growth and the RER misalignment. Estimation results suggest that the RER misalignment is beneficial for growth over the period of evaluation. More precisely, in a quarter a 1% increase in the misalignment accelerates real GDP growth at a 0.07% rate. The results also indicate that an undervalued RER is good for growth. These results are consistent with those of Aguirre and Calderon (2005); Rodrik (2007); Berg and Miao (2010); and Abida (2011). The results indicate that overvaluation also encourages growth; however, the overvaluation coefficient is not significant.

Taking the textbook explanation as reference, it is generally accepted that undervaluation boosts growth; however, after splitting the exchange rate misalignment into undervaluation and overvaluation indicators, it was found that both of them had a positive effect on growth, the only difference was the magnitude. Overvaluation results are, however, insignificant so they cannot be trusted fully. What can be drawn from these results is that, since the misalignment indicates that deviation from the equilibrium exchange rate is beneficial for growth, when the exchange rate is undervalued, economic growth improves significantly, whereas, when the exchange rate is overvalued, it has no significant impact on economic growth. These results, showing undervaluation as a good advocate for growth, were also found by Aguirre and Calderon (2005); Rodrik (2007); Berg and Miao (2010); and Abida (2011); Eichengreen (2008); as well as by Gala and Lucinda (2006).

According to Abida (2011), a persistent misalignment in the RER can sometimes be considered as a potential crisis with disastrous consequences for the economy. In the South African case, results indicate that a deviation from the RER seems to facilitate growth, or stimulate it in some way, and although the misalignment shows some persistence, there is convergence to equilibrium. A 1% misalignment in the rand is associated with a 0.07% improvement in economic growth, whilst an undervalued RER is associated with a larger 0.16% improvement in the growth rate of the economy. These results are not unique to South Africa; Rodrik (2007) found that an undervalued exchange rate had been a growth stimulant for Asian economies, as well as for African economies, while Abida (2011) found that undervaluation facilitated growth in the Maghreb countries.

According to Abida (2011), an overvalued exchange rate could be a warning sign of adjustment of relative prices and a possible decline in the aggregate growth rate of the economy; hence it is a lesser effective stimulant for growth than undervaluation. Aguirre and Calderon (2005), Gala and Lucinda (2006); Rodrik (2007); Eichengreen (2008); Berg and Miao (2010); as well as Abida (2011) agree that overvaluation is a lesser effective stimulant for growth it rather discourages growth.

Therefore, given the results above, it can be concluded that it is more preferable that the currency be undervalued rather than overvalued in order to accelerate economic growth. South Africa should avoid long periods of overvaluation and instead adopt economic policies that are able to keep the RER at competitive levels which, most of the time, should be associated with a more depreciated RER relative to its equilibrium (Abida, 2011).

Therefore, what can be concluded given the results above, is that undervaluation facilitates growth, as has been proven by previous researchers. Overvaluation, however, does not seem to be bad for growth. Keeping the RER at levels which will facilitate growth is important for an economy like South Africa and in this case, competitive levels are associated with a depreciated rand.

## **4.6 Summary**

In this chapter, the BEER approach was used to provide a measure of the equilibrium RER. The study started with the fiscal balance, gross reserves of the South African Reserve Bank, the real interest rate, GDP, the real gold price index, the South African terms of trade excluding gold, openness of the RSA economy, government expenditure and gross fixed capital formation as the independent variables. After the data had been assessed, the specification of the BEER equation included the

independent variables of GDP per capita, trade openness, gross fixed capital formation, the terms of trade, and the gold price index.

The Johansen (1995) method was used to test for the existence of cointegration between these variables. The LR test and the trace tests indicated 1 cointegration equation at a 5% significance level. The weak exogenous test indicated that long-run causality ran from real GDP per capita to the RER. The results of the BEER showed that there was a negative relationship between the RER and gross fixed capital formation, as well as terms of trade. BEER results indicated a positive relationship between the RER and GDP per capita, trade openness and the gold price. When compared with the actual exchange rate, the BEER moved in a similar pattern as the actual exchange rate, although there was a relatively large difference between the two figures during some quarters. The misalignment also showed the movement in the rand from equilibrium, indicating currency overvaluation and undervaluation.

The least squares method was used to estimate the growth regression. The independent variables that were applied entailed the initial GDP per capita, the misalignment, over- and undervaluation, the terms of trade, trade openness of the South African economy, and gross fixed capital formation. The overall results implied that economic growth can be influenced by these variables in this way: a rise in the current misalignment leads to a 0.07% increase in the growth rate, a 1% increase in the overvaluation of the rand leads to a 0.2% increase in the growth rate of the economy; while, an undervaluation of 1% accelerates economic growth by 0.16%. In addition, it takes roughly 5 quarters for the economy to eliminate 50% of the shock, given that there are no further shocks within that 5 quarter period.

The results indicated that, although the misalignment in itself is positively associated with economic growth, it is better that a currency be undervalued rather than overvalued. This is in agreement with earlier discussions on the relationship between the RER and economic growth. Therefore it can be concluded that there is a positive relationship between economic growth and the RER misalignment. The result shows that undervaluation is good for growth, while overvaluation does not harm growth.

## Chapter 5 Summary and Conclusion

### 5.1 Introduction

The growth in performance of the South African economy, over a two and a half decade period, has been cause for concern (Fedderke, 2010). The growth levels have not reached the high levels of the 1960s, with average real GDP growth only reaching a high of 3.1% (1994-2005) (SARB, 2012). This slowdown in growth began in the early 1970s (Du Plessis and Smit, 2007). This study therefore investigates behaviour of growth within the 1985- 2011 period, when growth improved after the democratic elections, but not at the expected rate.

There is reason to believe that the RER had an effect on the economic growth rate of South Africa. For one, exchange controls have been greatly relaxed in the country during the period under investigation and it is important to investigate if this has had a positive (negative) effect on growth at all. Saayman (2010) found that the RER has been highly volatile for a long period and although it reached some stability in 2002, the volatility continued, although it was at a lower magnitude. Volatility in the rand RER implies that there might have been misalignment in the rand during this period. A RER misalignment is defined by Razin and Collins (1997) as the deviation of the country's actual RER from the equilibrium exchange rate, or the "implicit ideal" RER. Isard and Faruqee (1996) also mention that misalignments mean that the RER is moved to levels which make it difficult for an economy to sustain international competitiveness over the long-run, and this is harmful to South Africa, which is heavily dependent on exports. The RER is therefore very powerful and has been argued to be the cause of loss of competitiveness and growth slowdowns.

The above led the study in a direction of investigating the link between RER misalignment and economic growth in South Africa. Firstly, when a currency is misaligned, it is either overvalued or undervalued and Edwards (1989 and 2000), Williamson (1985 and 1994), Stein and Allen (1995), as well as Jongwanich (2009), all agree that overvaluation is expected to hinder economic growth, while undervaluation is sometimes thought to produce an environment conducive to growth.

This implies that one has to establish whether there were periods when the rand deviated from the equilibrium exchange rate, before determining whether this misalignment (over- or undervaluation) had a negative effect on growth in South Africa, through its effects on factors that contribute to growth, such as export performance, gross capital formation, amongst others. The main aim of this study was to investigate the effects of RER misalignment on economic growth in South Africa.

In order to reach this goal the main objectives of the study, as indicated in Section 1.3, included the following:

- Objective 1: To present an overview of equilibrium exchange rate theory and currency misalignment.
- Objective 2: To identify fundamental factors which are the main drivers of the current RER.
- Objective 3: To determine factors that influence economic growth in an economy such as that of South Africa.
- Objective 4: To determine the equilibrium exchange rate.
- Objective 5: To determine the extent of currency misalignment during the period of investigation.
- Objective 6: To determine the effect of the RER misalignment on growth following a standard growth equation.

The following sections draw conclusions based on the study and will show how the various objectives were achieved.

## **5.2 Conclusions**

### **5.2.1 Conclusion with regard to exchange rate theory**

An overview of equilibrium exchange rate theory and currency misalignment was given in Chapter two (Section 2.3 to 2.8). To fulfil objective 1, a thorough analysis of different measures of equilibrium exchange rates was done, including the NATREX approach, the PPP, the FEER method, the DEER approach, as well as the PEER approach. It was found that, given the macroeconomic imbalance found in the economy, the more appropriate methodology to use would be the BEER methodology.

It can be concluded that the BEER would be an appropriate approach to follow, given that it is less normative in nature and does not depend on certain macroeconomic conditions to give a reliable representation of the equilibrium exchange rate (Siregar, 2011). The BEER helps in the determining of the current exchange rate by taking into account macroeconomic fundamentals which influence the exchange rate (MacDonald, 2000; Siregar, 2011). It is a flexible single-equation approach which brings one closer to determining the misalignment, although it is atheoretical.

The BEER also allows factors which determine the exchange rate to be included in the model which helped in fulfilling objective 2. These factors, which are the fundamental macroeconomic variables or the main drivers of the current RER were identified in Section 2.9. The macroeconomic fundamentals include trade policy (openness of the economy to global trade), terms of trade, capital flows, foreign exchange reserves, net foreign assets, government expenditure, productivity growth differentials, real interest rates differentials and commodity prices. Clark and MacDonald (2000), Berg and Miao (2010), Saayman (2010) and Abida (2011) also use these macroeconomic variables to determine the equilibrium exchange rate and subsequently, the misalignment.

### **5.2.2 Conclusions with regard to growth in South Africa**

Chapter three aimed to shed light on growth in South Africa over the period under investigation. Firstly, different growth theories were discussed in Section 3.2. The views of both classical and neoclassical economists, as well as more recent growth theories were given. From this discussion, it can be concluded that the Solow model, a neoclassical growth model, which encompasses both exogenous and endogenous factors which influence economic growth is one of the mostly widely used models. The Solow model also accounts for total factor productivity by including technology and human capital in the model. By applying the Solow model, it was concluded that factors such as capital, labour, technology, the savings rate, as well as endogenous factors such as institutional quality and trade openness could be included in the regressions.

In terms of the factors which influence growth in South Africa, productivity factors set the pace for ultimate growth which can be achieved, based on the hypothesis of conditional convergence. For the purpose of this study, productivity factors were taken as initial economic growth. The uncertainty about investments and property rights in the late 1980s and early 1990s scared many investors, the low levels of capital inflow to South Africa and high volatility had a negative influence on economic growth in the country. The low domestic savings also impaired growth as it made the economy more reliant on already low levels of foreign capital inflows. The low level of capital inflows to South Africa from the rest of the world has not yet exceeded 5% (World Bank, 2011). Low FDI in the country means that South Africa has not had the full benefits of accompanying spillovers, including new technology, advanced managerial skills, as well as connections with global markets and production networks - which are needed for enhanced productivity and higher growth (Borenstein, José, and Jong-waha, 1998).

The growth in technology that has been experienced in South Africa thus far has had a positive effect on economic growth through its impact on production and efficiency. This growth, however, has not met the standards of other emerging countries. The finding is that South Africans do not always have the necessary skills to achieve absorptive capacity and therefore growth does not accelerate at the potential rate.

Government expenditure in South Africa has also not been beneficial for growth. It was found that the investment of government in human capital may not be seeing the expected results. This can be owed to government financing the acquisition of non-scarce skills or even people using up government funds then not applying their skills in the country – the so-called brain drain, as well as illnesses which take people out of work and make them less productive (see Footnote 5). The increase in social transfers has the poor society heavily reliant on social grants, which do not have profitable financial returns for the economy.

An important contributor to growth has been trade reforms. Trade reforms have made a great contribution to growth in the country by opening the economy up for international trade. It is through these trade reforms and other various channels that the RER influences economic growth in South Africa. This openness to trade is found by Du Plessis and Smit (2007) to be the leading cause behind rising productivity growth in the economy. These trade reforms have allowed the exporting market to perform more efficiently; exports now make up a third of South Africa's GDP. Had it not been for trade reforms, 30% of South Africa's growth, which is attributed to exports, would have been difficult to achieve. In other words, growth in exports, which was largely due to the trade reforms has contributed 30% to GDP which would not have been the case had it not been for these trade reforms. South Africa's growth, being heavily dependent on the export of goods and services, and imports being used in production imply that a sustainable level of the RER is important for economic growth. This confirms that export-led growth is important for an outward-oriented economy such as South Africa's. The exchange rate must therefore be in such a way that exports remain competitive.

After the careful analysis of the empirics of growth in South Africa, it was concluded that productivity, foreign direct investment, technology, government expenditure, trade reforms and exports are the main drivers of growth in South Africa (see Section 3.4). This satisfied objective 3 and ushered the study into the effect of the RER misalignment on economic growth.

### 5.2.3 Conclusion with regard to the empirical chapter

The aim of this study was to determine the extent to which fluctuations in the RER signify misalignment in the currency, thereby affecting economic growth in South Africa. The misalignment is assessed with reference to a benchmark long-run equilibrium value. Based on the literature review, which gave several different methods of determining the equilibrium exchange rate, and having concluded that the BEER was the most appropriate approach for this study, the BEER approach was followed to estimate the equilibrium exchange rate.

Chapter four therefore embarked on establishing various channels through which the RER misalignment influences growth, so as to accomplish the last three objectives. Firstly, to satisfy objective 4, the equilibrium exchange rate was determined by investigating the extent to which observable changes in the RER are explained by fundamental determinants. Several researchers including, but not limited to Mtonga (2006), MacDonald and Ricci (2003), as well as Berg and Miao (2010), followed the same procedure. Based on the Johansen cointegration estimation methodology, it was found that in the long-run, the rand's RER depreciates in response to changes in the terms of trade and foreign investment and appreciates in response to an increase in GDP per capita, trade openness and the gold price in the long-run. It was also found that, in the short run, an increase in the real interest rate differential also has a depreciating effect on the RER of the economy. The depreciation effect associated with foreign investment goes against theoretical expectations; however, due to the capital-intensive imports of the South African economy, depreciation is bound to follow. This happens because even though the investments increase, they are coupled by an increase in the demand for foreign currency due to increased imports, which undermines the domestic currency. In addition, South African FDI inflows have not been enough to bring about the desired effects on the RER.

It was concluded that GDP per capita, terms of trade, foreign investment (gross capital formation), trade openness and the real interest rate differential are part of macroeconomic fundamentals and are the main drivers of the current RER in South Africa, and they determine the EER. The EER aided in the determining of the RER misalignment, which is the difference between the actual exchange rate and its equilibrium value (Razin and Collins, 1997). It was found that the rand's equilibrium exchange rate was volatile and for a long period, there was a significant difference between the equilibrium value and the actual RER.

The extent of the misalignment was determined and it was shown that the rand has been overvalued for most of the period under investigation, although it reverted to equilibrium and

sometimes lost ground and became undervalued (see Section 4.3.3.1.3 and Figure 4.4). Between 1986 and 1999, the rand spent most of the period overvalued; there were fluctuations, but the rand remained above the equilibrium level. A relatively long period of undervaluation began in the second quarter of 1999 and lasted 17 quarters as the undervaluation thinned, the rand proceeded to equilibrium and by the end of 2004 the RER was overvalued again. During 2008, even though the rand was overvalued, there was some downward movement, but there was a quick recovery and then overvaluation followed. By the end of the period under investigation, the rand was overvalued by 33.21%. It seems that the currency, after spending time in a misaligned position, always reverts back to its long-run equilibrium level and that the Reserve Bank policy of non-intervention has caused the exchange rate to fluctuate around the equilibrium. Although one would argue that it spent too much time in a misaligned state. It can thus be concluded that, during the period under investigation, there were misalignments in the South African RER, which were mainly of an overvalued nature, and that the rand still reverted to equilibrium time and again. Therefore, objective 5 of the study was satisfied.

After calculating the RER misalignment, objective 6 had to be accomplished by determining the effect of the RER misalignment on economic growth. Economic growth (measured by the first difference of the log GDP) was studied by performing time series analysis through different growth regression models. Additional explanatory variables were introduced in the above-mentioned models, such as: the first lag of the first difference of the log GDP in order to quantify the transitional convergence of GDP, the degree of trade openness that accounts for structural policies, the terms of trade which capture the effect of external shocks on economic growth, as well as gross fixed capital formation, which accounts for the ability of the economy to attract foreign investment. Similar variables were employed by Mtonga (2006), Rodrik (2007), as well as Berg and Miao (2010) amongst others. The trade reforms were again added to this growth regression as they remain the main channels through which the RER misalignment influences growth. Trade reforms are also found by Edwards and Alves (2005) to be enablers of export promotion in an export-led economy such as South Africa. The inclusion of these trade reforms therefore signifies the importance of export-led growth.

The results indicated that there is little evidence of non-linearity between the RER and an economy's economic growth. It was found that misalignment in the RER has positive implications for growth. A 1% increase in the RER misalignment enhances economic growth by approximately 0.07% over a period of a quarter. The study also confirms the findings of Rodrik (2007); Razin and Collins (1997); Gala and Lucinda (2006); as well as Berg and Miao (2010), that undervaluation stimulates growth. An

undervalued exchange rate enhances growth by approximately 0.16% in a quarter. It was also found that overvaluation is a stimulant of growth at a 0.02% rate, the coefficient was however insignificant, so one can assume that overvaluation does not matter for growth. Therefore, as has been found in East Asian economies Rodrik (2007), a misaligned currency, especially undervalued, helps growth and the study finds that, an overvalued exchange rate is also not necessarily bad for growth. Razin and Collins (1997) also found that high overvaluations are associated with slower growth, and they may not necessarily be bad for growth.

In conclusion, it was found that the misalignment in the South African rand, which occasionally reverted to equilibrium, had not necessarily been bad for growth. Although an undervalued RER is more efficient to jump-start growth. One can also conclude that, had the currency been undervalued more, growth rates would have been higher by at least 0.14%.

This study shows that misalignments are not necessarily bad for growth. What is not clear, however, is at what level the misalignment is detrimental to growth. In other words, there is no clear indication how big an undervaluation (overvaluation) is needed to stimulate growth and when this undervalued (overvalued) currency stops facilitating growth and starts being harmful.

Finally, the main aim of the study was to show the effects of the RER misalignment on economic growth, and it was found that, the RER misalignment has positive effects on economic growth in the country. This is also proved by the fact that, although the rand has been misaligned, the economy still grew. Therefore, it can be concluded that an undervalued currency is efficient for growth whilst an overvalued currency may not necessarily be bad for growth.

### **5.3 Recommendations**

Based on the results of this research, the following recommendations are made. Firstly, the rand should be realigned through nominal depreciation from time to time, in order to keep the RER at a level whereby growth will be enhanced. The results show that an undervalued valued RER is more efficient for economic growth than an overvalued one. The South African rand shows prolonged periods of currency overvaluation, and results have shown that overvaluation, although not necessarily bad for growth is not as productive as undervaluation in promoting growth. A currency which reverts back to equilibrium and perhaps fluctuates between over- and undervaluation is essential for growth in South Africa. The floating exchange rate system of South Africa is constructive for growth; however, market forces keep it at an overvalued position and that somehow reduces the benefits that the country would gain from this floating exchange rate.

Secondly, Eichengreen (2008) refers to the RER as a facilitating condition and therefore, keeping it at competitive levels and avoiding excessive volatility helps in efforts to capitalise on macroeconomic fundamentals. This would be very helpful in terms of the South African rand as the economy is already heavily dependent on international trade. Keeping the RER at competitive levels means that exports of the country will be more competitive, as found by Mtonga (2006). Therefore, some moderate intervention by monetary authorities is recommended to keep the RER at competitive levels.

Eichengreen (2008) states that it is best that the RER of an economy be kept at a competitive level so that it can foster growth, and an overvalued currency does not produce the desired impact on growth. This calls for concern, as the results indicate that the South African RER has been more overvalued than the alternative (see Figure 4.4). Several researchers (Dahl, 2002; Clark and Bogran, 2003; Edwards and Alves, 2005; Du Plessis and Smit, 2007) give several factors that may contribute to South Africa's slow economic growth, such as inadequate FDI, and the poor performance of South African exports in international markets. This study implies that the RER of the country is also a contributing factor to the slow economic growth experience by the economy overtime.

Thirdly, export-led growth is important for a commodity-rich economy such as South Africa. Asian countries, particularly China, achieved remarkable growth by controlling its exchange rate, keeping it at competitive levels and having a booming export market. Edwards and Alves (2005) show that South Africa is heavily reliant on export, even though these very same exports have not met their full potential. South African export performance, when compared to other emerging markets, leaves much to be desired, but favourable export behaviour can be achieved. However, the RER has to certify that exports are competitive (Mtonga, 2006). It would be a futile exercise to promote export-led growth, give incentives to exporters, and then have their products deemed uncompetitive due to a misaligned RER which is unsustainable.

There is no reason why South Africa cannot have high economic growth such as was experienced before the 1960s, when the country seemed to be proving the conditional convergence hypothesis right (Du Plessis and Smit, 2007). By investing in industries that can achieve the required export levels through education and R&D, export-led growth can be achieved in the country and the terms of trade, as well as openness (as proxies for international integration) will both have a positive effect on economic growth. Going back to recommendation 1 and 2, a competitive exchange rate is necessary. The development experience of East-Asian, countries amongst other high-growth economies signifies the importance of keeping the exchange rate at competitive levels as this is critical to jump-start growth.

## 5.4 Further Research

The aim of this study was to investigate the effect of the RER on economic growth in South Africa. The study found that a real exchange misalignment is good for growth. However, the results do not indicate what magnitude of misalignment is good, which point of overvaluation (undervaluation) is too high (low) and may start being harmful to growth. Future research would do well to determine at which level undervaluation (overvaluation) starts being harmful for growth.

In this study only the theoretical BEER methodology was used to estimate the equilibrium exchange rate, although research has shown that there are several other methodologies that can be used. The different methodology does, however, have conditions that are not met by the South African economy, such as full employment and macroeconomic balance. Future research, however, should use different methods to determine the equilibrium exchange rate as they can show factors that the BEER may not have shown.

The relationship between the RER and economic growth can be explained by more factors than the ones used in the regressions; these additional factors have been discussed in earlier chapters (see Chapters 2 and 4). Further research should include different growth regressions. One may find that domestic savings may have a different impact on growth than trade openness. Using different regressions may be necessary to fully understand the relationship between the RER and growth.

Lastly, export-led growth is a venture South Africa should take seriously, as it may have returns that far exceed the current growth paths such as the GEAR and ASGISA. Further research should investigate ways in which export performance can be improved upon and ways in which the rand can be kept at competitive levels without government intervention.

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# Appendixes

## Appendix A

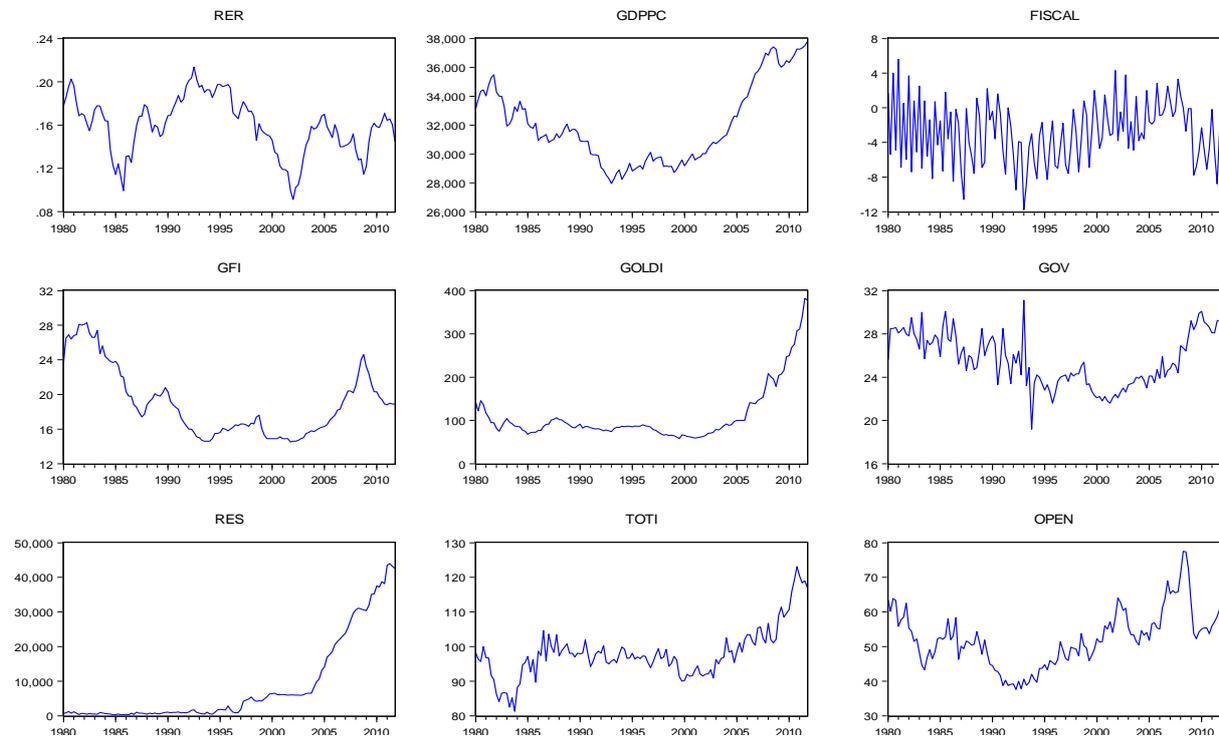


Figure A1 Explanatory Variables of the South African Real Exchange Rate

	RER	GDPPC	FISCAL	GFI	GOLDI	GOV	RES	TOT	OPEN
RER	1.000000								
	-----								
GDPPC	-0.242329	1.000000							
	0.0059	-----							
FISCAL	-0.291255	0.212014	1.000000						
	0.0009	0.0163	-----						
GFI	-0.008532	0.612100	0.131878	1.000000					
	0.9238	0.0000	0.1378	-----					
GOLDI	-0.015023	0.786277	-0.024890	0.219415	1.000000				
	0.8663	0.0000	0.7803	0.0128	-----				
GOV	0.046704	0.587303	-0.157078	0.719640	0.483876	1.000000			
	0.6006	0.0000	0.0766	0.0000	0.0000	-----			
RES	-0.242225	0.763100	0.084664	0.028271	0.884946	0.260868	1.000000		
	0.0059	0.0000	0.3420	0.7514	0.0000	0.0029	-----		
TOT	0.025225	0.523570	-0.095755	-0.127527	0.818480	0.276428	0.778977	1.000000	
	0.7775	0.0000	0.2823	0.1514	0.0000	0.0016	0.0000	-----	
OPEN	-0.600527	0.705741	0.382829	0.339067	0.423784	0.157863	0.548982	0.250222	1.000000
	0.0000	0.0000	0.0000	0.0001	0.0000	0.0751	0.0000	0.0044	-----

Table A1 Correlation matrix

Series	Prob.	Series	Prob.
LRER	0.4791	D(LRER)	<0.001
LOPEN	0.7496	D(LOPEN)	<0.001
LRES	1.0000	D(LRES)	<0.001
LTOT	0.8947	D(LTOT)	<0.001
LGOV	0.7189	D(LGOV)	<0.001
LGOLDI	0.9957	D(LGOLDI)	<0.001
LGFI	0.4491	D(LGFI)	<0.001
LGPPC	0.0001	D(LGPPC)	<0.001
IRATE	0.0368	D(IRATE)	<0.001

**Table A2: Results of PP Unit Root Test- No intercept, no trend**

Series	Prob.	Series	Prob.
LRER	0.1192	D(LRER)	<0.001
LOPEN	0.3790	D(LOPEN)	<0.001
LRES	0.8792	D(LRES)	<0.001
LTOT	0.6198	D(LTOT)	<0.001
LGOV	0.0019	D(LGOV)	<0.001
LGOLDI	0.9999	D(LGOLDI)	<0.001
LGFI	0.1858	D(LGFI)	<0.001
LGPPC	0.4014	D(LGPPC)	<0.001
IRATE	0.2447	D(IRATE)	<0.001

**Table A3: Results of PP Unit Root Test- Intercept, no trend**

Series	Prob.	Series	Prob.
LRER	0.2334	D(LRER)	<0.001
LOPEN	0.2747	D(LOPEN)	<0.001
LRES	0.0051	D(LRES)	<0.001
LTOT	0.4734	D(LTOT)	<0.001
LGOV	0.0164	D(LGOV)	<0.001
LGOLDI	0.9998	D(LGOLDI)	<0.001
LGFI	0.4093	D(LGFI)	<0.001
LGPPC	0.0000	D(LGPPC)	<0.001
IRATE	0.3921	D(IRATE)	<0.001

**Table A4: Results of PP Unit Root Test- Individual intercept and trend**

Endogenous variables: LRER LGDPPC LGFI LOPEN LGOLDI LTOT						
Exogenous variables: C S1 S2 S3 IRATE						
Included observations: 108						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	728.8802	NA	9.65e-14	-12.94223	-12.19719	-12.64014
1	1436.454	1271.012	3.85e-19	-25.37878	-23.73970*	-24.71419*
2	1474.378	63.90973	3.76e-19*	-25.41441	-22.88129	-24.38732
3	1505.559	49.08081	4.21e-19	-25.32517	-21.898	-23.93558
4	1539.276	49.32712	4.57e-19	-25.2829	-20.96168	-23.5308
5	1573.236	45.90892	5.06e-19	-25.24512	-20.02986	-23.13052
6	1601.866	35.52137	6.38e-19	-25.10862	-18.99932	-22.63152
7	1648.206	52.34717	6.02e-19	-25.30011	-18.29676	-22.4605
8	1698.775	51.50572*	5.52e-19	-25.56991*	-17.67252	-22.3678
* indicates lag order selected by the criterion						

**Table A5: VAR Lag order selection criteria**

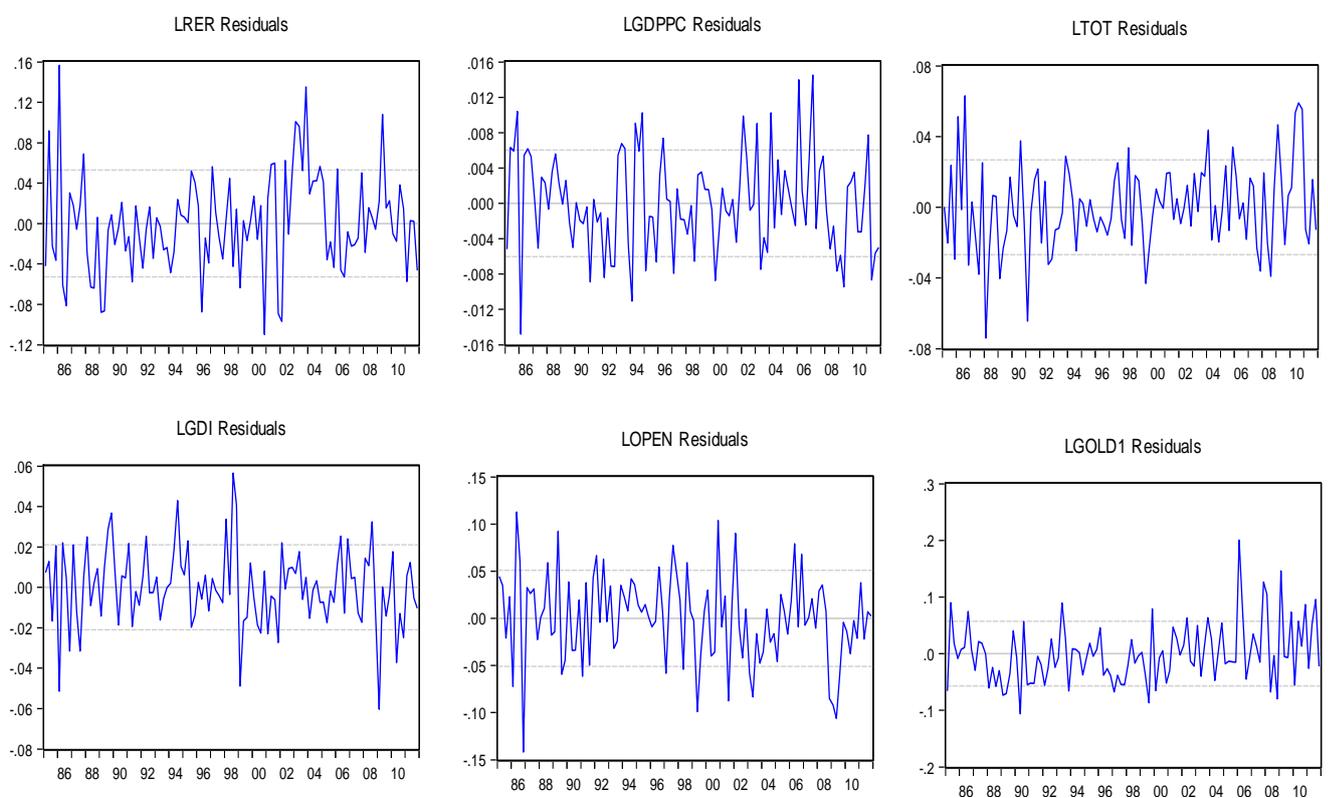
	D(LRER)	D(LGDPPC)	D(LGFI)	D(LOPEN)	D(LGOLDI)	D(LTOT)	Joint
<b>DLag 1</b>	3.075	19.799	25.903	17.096	4.902	14.003	96.481
	[ 0.799]	[ 0.003]	[ 0.0002]	[ 0.008]	[ 0.556]	[ 0.029]	[ 1.99e-07]
<b>DLag 2</b>	9.709	7.619	6.274	14.434	8.933	5.648	55.995
	[ 0.137]	[ 0.267]	[ 0.393]	[ 0.025]	[ 0.177]	[ 0.463]	[ 0.017930]
<b>Df</b>	6	6	6	6	6	6	36
Numbers in [ ] are p-values							

**Table A6 VEC Lag Exclusion test**

Dependent variable: D(LRER)			
Excluded	Chi-sq	df	Prob.
D(LGDPPC)	5.166976	2	0.0755
D(LGFI)	1.067014	2	0.5865
D(LOPEN)	0.892241	2	0.6401
D(LGOLDI)	1.095589	2	0.5782
D(LTOT)	0.486266	2	0.7842
All	10.07350	10	0.4341
Dependent variable: D(LGDPPC)			
Excluded	Chi-sq	df	Prob.
D(LRER)	0.441895	2	0.8018
D(LGFI)	1.610773	2	0.4469
D(LOPEN)	3.402443	2	0.1825
D(LGOLDI)	5.009157	2	0.0817
D(LTOT)	6.449387	2	0.0398
All	23.52871	10	0.0090
Dependent variable: D(LGFI)			
Excluded	Chi-sq	df	Prob.
D(LRER)	3.595067	2	0.1657
D(LGDPPC)	0.266287	2	0.8753
D(LOPEN)	4.422802	2	0.1095
D(LGOLDI)	0.771648	2	0.6799
D(LTOT)	13.77790	2	0.0010
All	21.81654	10	0.0161
Dependent variable: D(LOPEN)			
Excluded	Chi-sq	df	Prob.
D(LRER)	2.437733	2	0.2956
D(LGDPPC)	7.313579	2	0.0258
D(LGFI)	0.807667	2	0.6678
D(LGOLDI)	5.298660	2	0.0707
D(LTOT)	4.323080	2	0.1151
All	28.38657	10	0.0016
Dependent variable: D(LGOLDI)			
Excluded	Chi-sq	df	Prob.
D(LRER)	0.012820	2	0.9936
D(LGDPPC)	3.320630	2	0.1901
D(LGFI)	2.527497	2	0.2826
D(LOPEN)	3.626144	2	0.1632
D(LTOT)	0.959083	2	0.6191
All	10.89404	10	0.3658

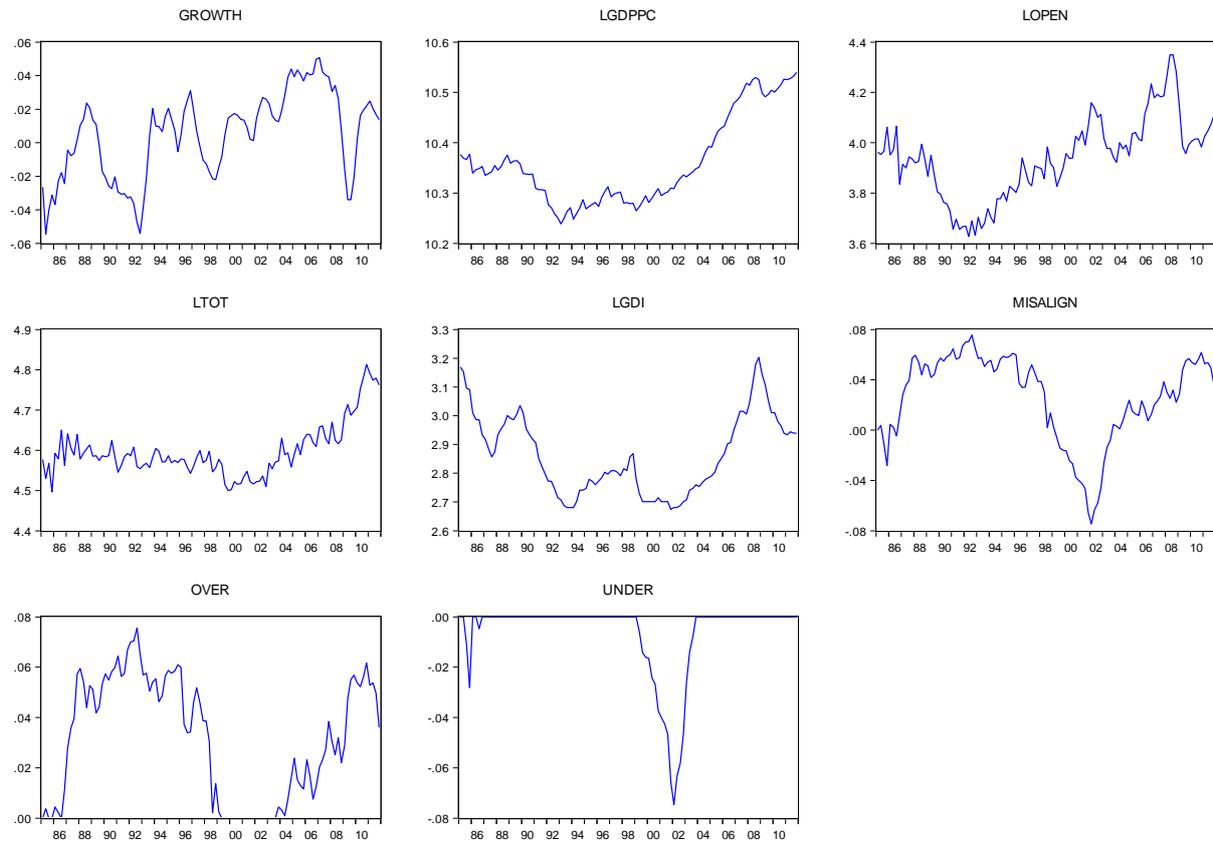
Dependent variable: D(LTOT)			
Excluded	Chi-sq	df	Prob.
D(LRER)	2.678585	2	0.2620
D(LGDPPC)	2.786691	2	0.2482
D(LGFI)	1.669209	2	0.4340
D(LOPEN)	1.563087	2	0.4577
D(LGOLDI)	0.945195	2	0.6234
All	9.742308	10	0.4634

**Table A7 Wald exogeneity test results**

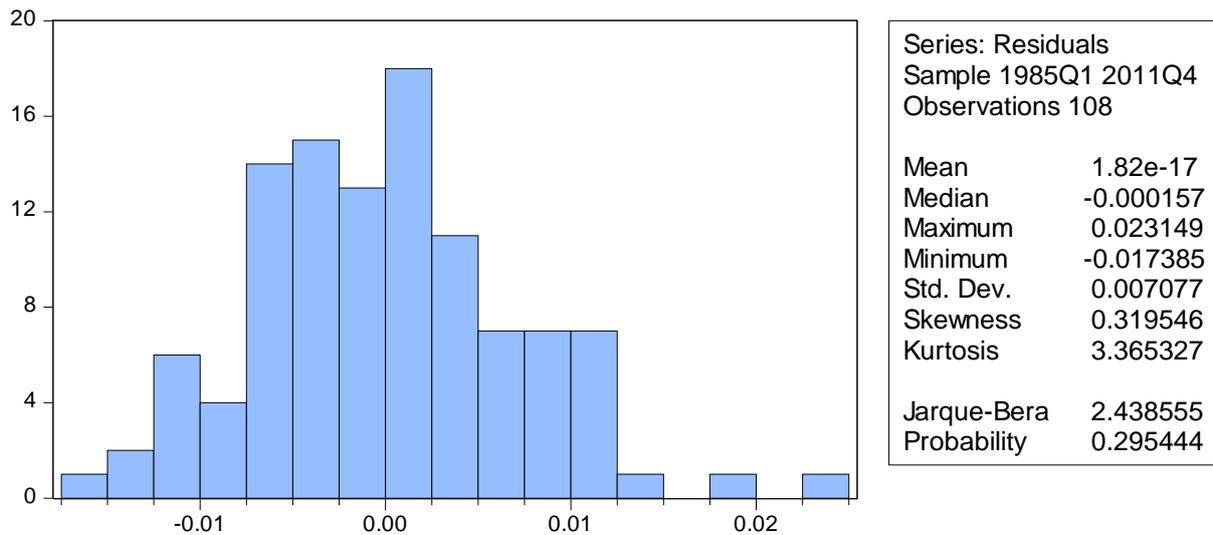


**Figure A2 Residuals of the fundamentals**

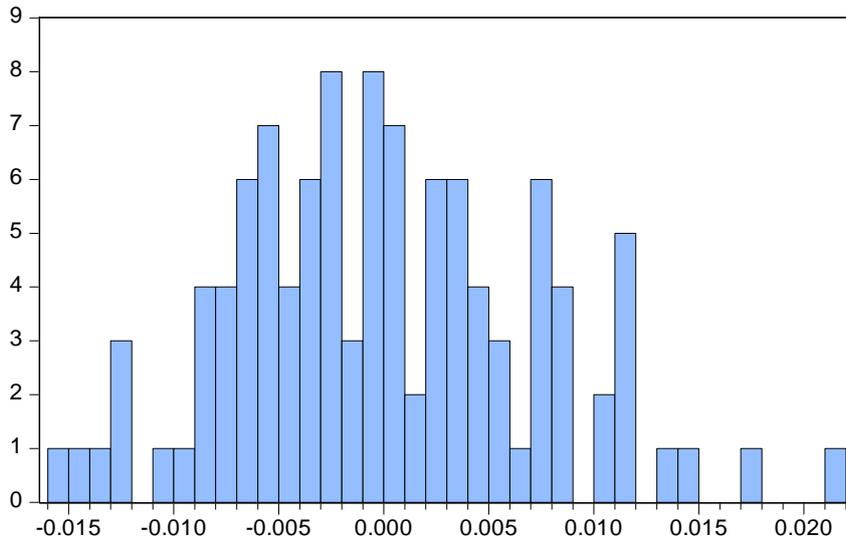
## Appendix B



**Figure B1: Explanatory variables of South African economic growth**

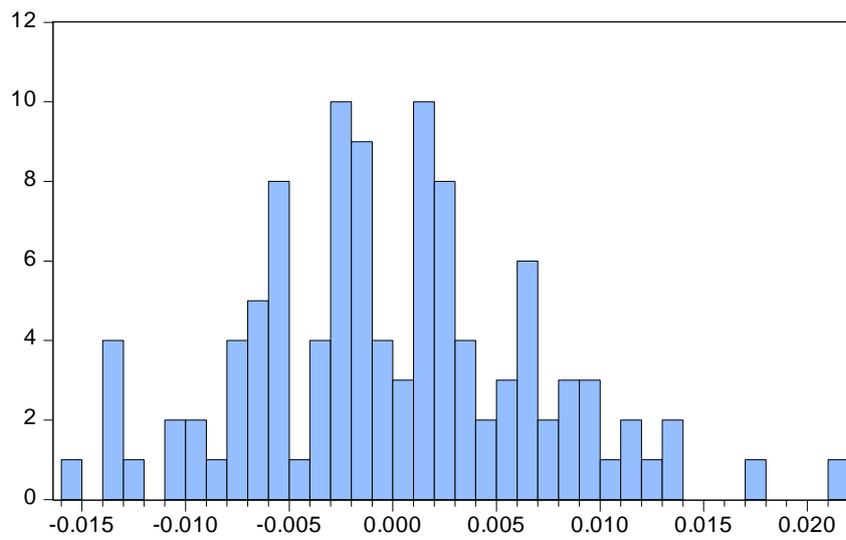


**Figure B2 Residuals Normality Test (Misalignment)**



Series: Residuals	
Sample 1985Q1 2011Q4	
Observations 108	
Mean	1.13e-17
Median	-0.000315
Maximum	0.021933
Minimum	-0.015311
Std. Dev.	0.007185
Skewness	0.336582
Kurtosis	3.023084
Jarque-Bera	2.041569
Probability	0.360312

**Figure B3 Residuals Normality Test (Overvaluation)**



Series: Residuals	
Sample 1985Q1 2011Q4	
Observations 108	
Mean	-1.88e-17
Median	-0.000251
Maximum	0.021724
Minimum	-0.015749
Std. Dev.	0.007008
Skewness	0.246997
Kurtosis	3.159434
Jarque-Bera	1.212522
Probability	0.545386

**Figure B4 Residuals Normality Test (Undervaluation)**