THE BEHAVIOUR AND FUNDAMENTAL DETERMINANTS OF THE REAL EXCHANGE RATE IN SOUTH AFRICA

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ABSTRACT

Real exchange rates have important effects on production, employment and trade, so it is crucial to understand the factors responsible for their variations. This study analyses the main determinants of the real exchange rate and the dynamic adjustment of the real exchange rate following shocks to those determinants, using quarterly South African data covering the period 1975 to 2005. It begins with a review of literature on the determinants of the real exchange rate and provides an updated background on the exchange rate system in South Africa. An empirical model linking the real exchange rate to its theoretical determinants is then specified. In contrast to previous analyses, this study augments the cointegration and vector autoregression (VAR) analysis with impulse response and variance decomposition analyses to provide robust long run effects and short run dynamic effects on the real exchange rate.

The variables that have been found to have a long run relationship with the real exchange rate include the terms of trade, real interest rate differential, domestic credit, openness and technological progress. The estimate of the speed of adjustment coefficient found in this study indicates that about a third of the variation in the real exchange rate from its equilibrium level is corrected within a quarter.

The impulse response functions broadly corroborate the theoretical predictions, but only the terms of trade, domestic credit and openness have a significant impact on the real exchange rate in the short run. However, only shocks to the terms of trade and domestic credit have persistent effects on the real exchange rate. Results from the variance decompositions are largely similar to those from the impulse response analysis. The terms of trade, domestic credit and openness are the only variables found to significantly explain the variation in the real exchange rate. The most interesting result that emerged from this analysis and is supported by previous research is that among other determinants, the terms of trade explain the largest proportion of the variation in the real exchange. On balance, the evidence therefore suggests that real exchange rate fluctuations are predominantly equilibrium responses to real and monetary shocks rather than fiscal policy shocks.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND, CONTEXT AND RATIONALE FOR RESEARCH

The relationship between a country's exchange rate and economic growth is a crucial issue from both the descriptive and policy prescription perspectives. As Edwards (1994: 61) puts it "it is not an overstatement to say that real exchange rate behaviour now occupies a central role in policy evaluation and design". A country's exchange rate is an important determinant of the growth of its cross-border trading and it serves as a measure of its international competitiveness (Bah and Amusa, 2003: 2; Walters and De Beer, 1999: 60). The real exchange rate, in particular, defined as the relative price of foreign goods in terms of domestic goods, is of greater significance, as it is an important relative price signalling inter-sectoral growth in the long run and acts as a measure of international competitiveness. In other words, the real exchange rate plays a crucial role in guiding the broad allocation of production and spending in the domestic economy between foreign and domestic goods.

The real exchange rate's level, relative to an equilibrium real exchange rate level, and its stability have been shown to importantly influence export growth, consumption, resource allocation, employment and private investments (Serven and Solimano, 1991: 6; Aron *et al*., 1997: 1; Burda and Wyplosz, 1997: 502 and Takaendesa *et al*., 2005: 15). Because of this important role the real exchange rate plays in the economy, emerging economies, in particular,[1] are encouraged to conduct their policies so as to get this macroeconomic relative price right. The 'right' real exchange rate is one that does not stray too far from its equilibrium value.

[1] Real exchange rate misalignment mostly affects economic performance in emerging economies possibly due to the dependence on imported capital goods, specialisation in commodity exports and accessibility to world financial markets, which helps to finance trade imbalances.

The deviation of the actual or observed real exchange rate from the equilibrium real exchange rate is referred to as misalignment (Montiel, 2003: 318). When the real exchange rate is misaligned, it can lead to a distortion in price signals that affect the allocation of resources in the economy. In developing countries, misalignment in the real exchange rate has often taken the form of overvaluation, which adversely affects the tradables sector (export sector). Overvaluation results in a real decline in the price of foreign goods relative to domestic goods. A decline in the price of foreign goods in terms of domestic goods has two primary effects on the export sector. First, on the production side, fewer resources will be allocated towards producing goods that can be exported, since these goods will be expensive for foreigners; at the same time, production of substitutes for foreign goods will also decline. These both destroy the current account. Second, on the consumption side, a fall in the price of foreign goods relative to domestic goods will stimulate domestic spending on foreign goods. The net effect is making exports less competitive in foreign markets, while stimulating imports, hence a current account deficit. Consequently, domestic manufacturer's incentives and profits will be lowered leading to declining investment and export volumes. In other words, this situation lowers the growth and international competitiveness of an economy.

In addition, when the real exchange rate is perceived to have become excessively misaligned, the expectation will be created that it will adjust toward its equilibrium level in the future. To the extent that this adjustment is expected to take place through an appreciation or depreciation in the nominal exchange rate, this will discourage domestic agents from holding assets denominated in the domestic currency, which is a potential source of capital outflow and exchange rate crisis (Montiel, 2003: 311). Importers, exporters, investors and the monetary authorities are all concerned with the behaviour of the exchange rate, as it directly or indirectly affects them. The behaviour of the exchange rate is, therefore, a useful indicator of economic performance that needs to be understood.

The outward looking trade policy adopted by South Africa since the early 1990s has ensured that export growth plays a critical role in the government's Growth, Employment and Redistribution (GEAR) strategy (Naude, 2000, in Bah and Amusa, 2003: 2). GEAR is aimed at promoting policies that support free market activities in order to strengthen South Africa's external competitiveness and foster long-term economic growth.[2] The link between the exchange rate and export growth is therefore one of the major motivations for understanding the behaviour of the exchange rate and its fundamental determinants.

The South African Reserve Bank (SARB) has adopted a non-interventionist policy stance in the foreign exchange rate market since 1995. This adoption of the freely floating exchange rate regime has been followed by the variability of the value of the rand in recent years and this calls for the understanding of the factors that are driving the movements of the exchange rate. An understanding of these fundamental factors is critical for policy makers designing and implementing a framework for exchange rate and trade policies. Such knowledge should result in policies that aid the attainment of real exchange rate stability and economic growth in the long run. In other words, the policy issues for South Africa include judging an appropriate level of the real exchange rate that is consistent with the simultaneous attainment of both the internal and external balances – markets for nontradable goods and labour must both be in equilibrium and the economy's current account deficit must be equal to the value of the sustainable capital inflows, respectively.

This analysis should also help to evaluate the appropriateness of the SARB's objective of achieving inflation parity with its major trading partners while adopting a non-interventionist policy stance in the foreign exchange market. The main question in relation to this stance is whether market forces alone are capable of eliminating the misalignment that may exist in the real exchange rate or whether the adjustment of the nominal exchange rate by the

[2] For more details on GEAR policies, see the 1996 GEAR document prepared by South Africa's Department of Finance.

SARB will be necessary. Although misalignment is not measured in this study, the first step in measuring it is the identification of the determinants of the real exchange rate, which is the subject of this study.

A number of researchers have pointed out the importance of the real exchange rate in the economy and why it is important to understand its fundamental determinants (see, for example, Baffes *et al*., 1999: 408; Khan and Montiel, 1996: 15; Mkenda, 2001: 2; and Aron *et al*., 1997: 2). However, most of the studies on this relationship have placed particular emphasis on analysing industrialised and Asian countries. There are very few studies that have looked at this relationship in South Africa, for example Aron *et al*. (1997) and MacDonald and Ricci (2003), and the majority of these were done using data for the period before the transformation to a new political dispensation; leaving out the post 1994 period which is characterised by policy changes and reforms,[3] which call for a fresh analysis of this relationship. In addition, our study employs more recent econometric techniques,[4] whose application is still in its infancy in Africa.

1.2 WHY ARE EXCHANGE RATES IMPORTANT?

The nominal and real exchange rates are crucial variables in macroeconomic management, but the nominal exchange rate tends to overshadow the real exchange rate because of its central position in everyday foreign exchange market transactions. The nominal exchange rate is defined as the price of one national currency in relation to another, while the real exchange rate is normally defined as the nominal exchange rate adjusted for relative inflation differentials. The nominal exchange rate connects the price systems in different countries and allows international traders to compare prices directly.

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[3] The successful transformation of South Africa to a new political dispensation in 1994 allowed the monetary authorities to embark on financial liberalisation and the integration of the South African economy into the world economy.
[4] Cointegration and ECM econometrics and the impulse response and variance decomposition analysis. To the best of our knowledge, this study is the first in South Africa to employ the latter in analysing this relationship.

Changes in the nominal exchange rate have a direct impact on the current account (imports and exports trade) as well as the financial account (capital flows) and hence the balance of payments. With regard to its impact on foreign trade, a currency appreciation (rise in value relative to other currencies) renders a country's goods expensive abroad and foreign goods cheap in that country.[5] Conversely, when a country's currency depreciates (weakens in value relative to other currencies), its goods and services abroad become cheaper and foreign goods (imports) in that country become more expensive. For example, if a car costs $5 000 in the United States of America (US) and the rand/dollar exchange rate is USD/ZAR 10 today, the car would cost a South African importer R50 000 ($5 000 * 10). If however, a South African importer waits for two weeks and the exchange rate moves to USD/ZAR 6 (the dollar depreciates and the rand appreciates) the car would now cost R30 000, assuming the dollar price of the car remains unchanged. This would clearly make it harder for domestic car manufacturers to sell their cars in the US and they will be facing increased competition at home from US imports, which are now cheaper.

The real exchange rate, which reflects the nominal exchange rate adjusted for changes in the price level differential between the domestic economy and the rest of the world (external real exchange rate), is however, even more significant than the nominal exchange rate. Several researchers have argued that real exchange rates have important effects not only on general economic performance and international competitiveness, but also on the different sectors of the economy, foreign trade flows and balance of payments, employment, structure of production and consumption, external debt crisis and allocation of resources in the economy. In addition, they further argue that real exchange rates are particularly important for developing economies, where traded good sectors are an important share of gross domestic product (see among others Obadan, 1994: 20; Edwards and Savastano, 1999: 2 and Joyce and Kamas, 2003: 155). Since the real exchange rate is a crucial variable not only for macroeconomic performance, but also for sectoral

[5] Assuming domestic prices are held constant in the two countries.

performance, it is crucial to understand it so as to better manage it and place the economy on a path of growth and sustainable development.

1.3 OBJECTIVES/GOALS OF THE RESEARCH

The main objective of this study is to investigate the fundamental determinants of the real exchange rate in South Africa. This broad objective is explored through the following sub-objectives:

- To identify the long-run fundamental determinants of the real exchange rate;
- To identify the short-run determinants of the real exchange rate; and
- To investigate how the real exchange rate reacts to shock(s) in the real exchange rate fundamentals and to determine which of the shock(s) has the most important influence on the real exchange rate (in terms of the time it takes to impact and the duration of the impact).

1.4 METHODOLOGY

The motivation behind this section is to explain how the three sub-objectives of this study will be achieved. The study employs quarterly South African data for the period 1975:1 – 2005:2 from the International Monetary Fund's (IMF) International Financial Statistics (IFS), December 2005 CD-ROM and the SARB online download facility. To provide an answer to the first two sub-objectives (long run and short run determinants of the real exchange rate), the cointegration and vector error correction modelling (VECM) by Johansen (1991, 1995) is employed. This approach applies maximum likelihood estimation to a vector autoregressive (VAR) model to simultaneously determine the long run and short run determinants of the dependent variable in a model. This approach also provides the speed of adjustment coefficient, which measures the speed at which the real exchange rate will revert to its equilibrium following a short term shock to the system.

Finally, to investigate how the effects of shock(s) on the determinants of the real exchange rate are transmitted to the real exchange rate and which is the most important, impulse response and variance decomposition analyses as developed by Lütkepohl and Reimers (1992) and Mellander *et al*. (1992) are used. In particular, the Cholesky orthogonalisation approach, which is a multivariate model extension of the Cholesky factorisation technique, is used in this study. This approach is preferred because, unlike other approaches, it incorporates a small sample degrees of freedom adjustment when estimating the residual covariance matrix used to derive the Cholesky factor (Lütkepohl, 1991: 155-158). Graphical analysis will be used to perform a preliminary examination of the data and to explain the behaviour or evolution of the real exchange rate and its determinants over the study period.

1.5 ORGANISATION OF THE STUDY

This study is divided into seven chapters. Following this introductory chapter, Chapter 2 sets the conceptual framework and gives an overview of the foreign exchange market. It is intended to shed more light on the terminology of the exchange rates and to provide a background on the foreign exchange market, which is the market in which the exchange rate is determined. Chapter 3 reviews both the theoretical and empirical literature pertaining to real exchange rate determination. A brief overview of the exchange rate regimes that the country has had and the evolution of the real exchange rate during those periods are provided in Chapter 4. Chapter 5 presents the analytical framework for analysing the determinants of the real exchange rate. Chapter 6 presents the empirical findings, while Chapter 7 concludes the study.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND AN OVERVIEW OF THE FOREIGN EXCHANGE MARKET

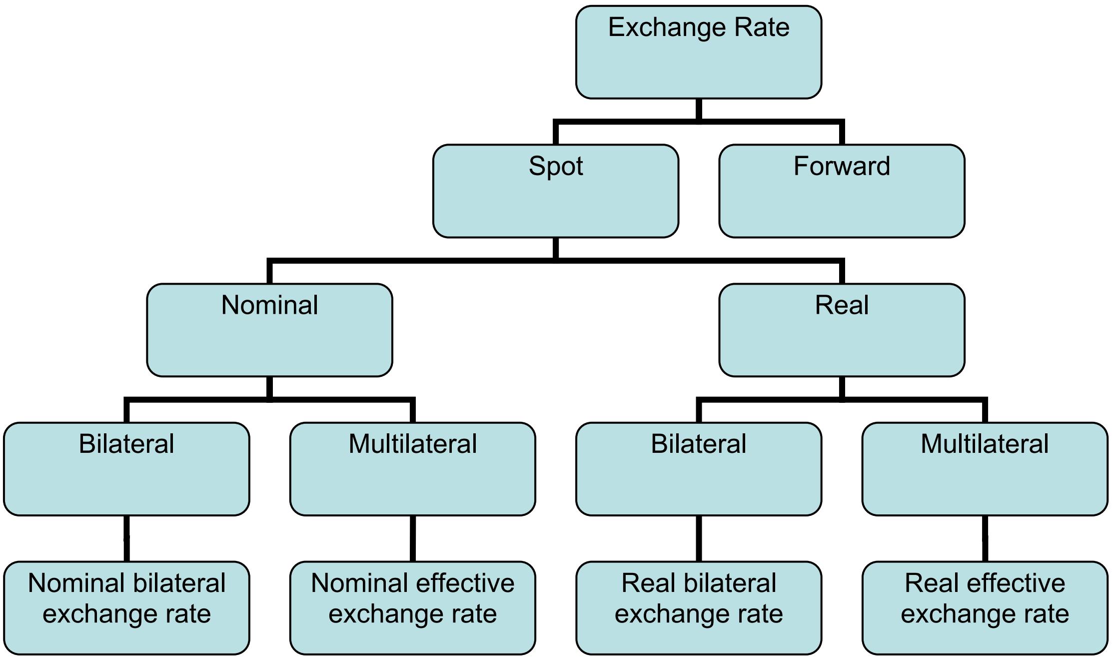
2.1 INTRODUCTION

The first step in estimating the long run equilibrium real exchange rate is the measurement of the actual real exchange rate. Unfortunately, there are both conceptual and empirical difficulties in the measurement of the real exchange rate. There are several definitions of both the nominal and real exchange rate, which are based on different analytical frameworks and used for different purposes. These multiple conceptual definitions are often misunderstood and have complicated the analysis of exchange rate issues. This chapter is divided into three sections. The first section takes up these definitional and measurement issues in detail. An analysis of exchange rates would be incomplete without an understanding of the foreign exchange market. The second section of this chapter gives an overview of the foreign exchange market. Since the foreign exchange market is the market in which the exchange rate is determined, an understanding of some of its features may be crucial to policy makers in terms of their understanding of the behaviour of exchange rates. The chapter ends with some concluding remarks to serve as a summary to it.

2.2 CONCEPTUAL FRAMEWORK

The terminology that is used in the foreign exchange market is often confusing to the uninformed. Further, there are conceptual difficulties in the measurement of, in particular, the real exchange rate. This section addresses this issue by defining and considering alternative measures of exchange rates. A conceptual framework is proposed in Figure 2.1, which may assist in understanding the different measures of the exchange rate that are used by economists and market participants. This framework is then followed in this section to define the various measures of the exchange rate until we put the real effective exchange rate, variable of interest in this study, in context.

Figure 2.1: A simple conceptual framework of the exchange rate



2.2.1 Foreign exchange market

Most countries have their own currencies, which are officially recognised as legal tender within their borders. Trade between countries, however, involves the mutual exchange of different currencies.[6] For funds to be transferred from one country to another they have to be converted from the currency in the country of origin into the currency of the country they are going to, for example, if one needs to transfer funds from South Africa to the US, they have to convert rand into US dollars. The foreign exchange market is where this conversion takes place and also it is a conduit in moving funds between countries, hence facilitating trade. The foreign exchange market is also important because it is where the foreign exchange rate is determined. The question that immediately comes to mind is what foreign exchange rate is.

[6] Mostly in the form of bank deposits denominated in different currencies.

2.2.2 Foreign exchange rate

Foreign exchange rate is merely the price of one currency in terms of another. In other words, it is the rate at which currencies are exchanged, for example the units of rand needed to buy a unit of a dollar or the reverse. There are two major types of exchange rates. The predominant one, called the spot exchange rate, is the exchange rate for immediate (two-day) exchange of bank deposits or currencies. The second is called the forward exchange rate, which is the exchange rate for the exchange of bank deposits at some specified future date (forward transaction). When a currency falls in value in relation to another, it is said to be depreciating. Conversely, when a currency increases in value in relation to other currencies, it is experiencing appreciation. There are various other measures of the exchange rate that are used by economists and market participants. The major ones and those that are relevant to this study are discussed in the following sections.

2.2.3 Nominal exchange rate

The nominal exchange rate (NER) is the same as the spot exchange rate introduced above. It is the price of one currency in terms of another and may be viewed in two ways:

- As the price of a unit of foreign currency in terms of the units of local currency, for example 6.35 units of the South African rand (ZAR) per US dollar (USD) – USD/ZAR 6.35; and in the reciprocal manner as:
- The price of the local currency in terms of units of foreign currency, for example ZAR/USD 0.1575 (units of US dollar per rand).

The first expression is called an indirect (European) quotation against the US dollar. This is the quotation used in South Africa. The second definition is merely the mirror image of the first and is called a direct (American) quotation against the US dollar. Obadan (1994: 3), among others, shows that it does not matter which of these definitions is chosen for analysis so long as the measure is well defined and consistent. The indirect quotation, units of rand per dollar, tells us immediately by how much the price of international goods has risen or fallen relative to domestic prices. The direct quotation tells us the proportion of the depreciation or appreciation of the rand. The NER has largely overshadowed other measures of the exchange rate, because it is directly observable and enables traders and the common man to compare goods prices directly. However, an appreciation or depreciation in the currency as measured by the NER tells us little about the real competitiveness of the currency over time, since it does not consider inflation differentials. For this purpose, the real exchange rate is constructed.

2.2.4 Real exchange rate

The problem of defining and measuring the equilibrium real exchange rate is complicated by a variety of factors. The basic one is that the definition of the real exchange rate (RER) is not unanimous among economists. Since economists employ different types of macroeconomic models for different purposes, a variety of analytical RER definitions tend to be used. Theoretically, two principal definitions of the RER are distinguished as:

- The ratio of the domestic price of tradable to non-tradable goods within a single country (internal RER); and as
- The NER adjusted for price level differences between countries (external RER).

The internal RER is an indicator of domestic resource allocation incentives in the home country, as it is defined as the internal relative price incentive for producing or consuming tradable goods as opposed to non-tradable goods. Different expressions of the internal RER can be derived depending on whether we are looking at two or multi-good models. The most used definition of the internal RER derives from the Salter-Swan non-traded goods model (Black, 1994: 285). The RER in this case is expressed as the ratio of the price of tradable to nontradable goods as follows:

$$q = E\frac{P_T^*}{P_N} \qquad (2.1)$$

Where q is the RER, P_T^* is the world price of traded goods, P_N is the domestic price of nontraded goods and *E* is the NER. In this case, therefore, an increase in *q* means depreciation, while a decrease means an appreciation.

The RER can also be expressed in its inverse as:

$$1/q = \frac{P_N}{EP_T^*} \quad \text{……………………………………………………………………..(2.2)}$$

An increase in *q* means an appreciation of the domestic currency, while a decrease means its depreciation.[7]

The second type of RER, the external real exchange rate, has widely been used in empirical studies of the equilibrium real exchange rate (see for example, Edwards, 1994: 10; Elbadawi, 1994: 15 and Faruqee, 1995: 90). This definition is derived from the purchasing power parity (PPP) theory, which compares two countries and the relative prices of baskets of goods produced or consumed. In this case, the RER is defined as the ratio of the price of foreign to that of domestic goods, expressed in domestic currency (Montiel, 2003: 313). The RER is calculated by beginning with the NER – the home country price of foreign exchange – then dividing by a home country price index for the class of goods in question and finally multiplying by the corresponding foreign price index.

Suppose, for example, that we take the South African price of the US dollar denoted by E_t and multiply it by P_t^*/P_t, where P_t^* and P_t represent consumer price indexes for the US and South Africa, respectively. These steps give the RER (q_t) for period t as:

$$q_t = \frac{E_t P_t^*}{P_t} \quad \text{………………………………………………………………………(2.3)}$$

[7] Details on the models of the internal real exchange rate are provided in Chapter 3.

The calculated RER expresses the price of US consumer goods in terms of South African consumer goods. The absolute level of such an index is arbitrary and thus of no significant use, but movements over time in the index would provide useful indications of whether the South African price of US goods was rising or falling. There is a problem, though, with such movements as it is not possible to exchange typical South African consumption bundles for typical US consumption bundles, since both bundles include services that are nontradable internationally. A more interesting RER index may, therefore, be one that uses producer price indices for P_t^* and P_t.[8]

A country may also be interested in the exchange rate between itself and its major trading partners, rather than only between itself and another country. This phenomenon has been taken into account in Figure 2.1, where two categories of real exchange rates have been identified: bilateral real exchange rate and multilateral real exchange rate. The former is applied where the computation of the real exchange rate involves only two currencies, while the latter is employed when the computation of the real exchange rate involves the currency of the focus country and usually those of its major trading partners – more than one country.

2.2.5 The bilateral real exchange rate

As noted above, the external real exchange rate for the home country can be defined either in a bilateral or multilateral context. The bilateral context is relevant where the interest is in computing the real exchange rate involving only two currencies, for example rand and US dollar.

The bilateral real exchange rate (BRER) is the simplest and easiest to calculate of the external real exchange rate indices and is useful as a more general indicator of the external real exchange rate in cases in which a

[8] Other measures use even narrower classes of goods, for example, goods from industries specialising in exports. In addition, the IMF moves further away from consumer prices by using indices of normal labour costs per unit of output in the manufacturing industry (Hinkle and Montiel, 1999: 46).

country belongs to a currency bloc or has one dominant trading partner (Hinkle and Montiel, 1999: 45). The BRER with a major trading partner is both simple to compute and more broadly representative than the BRER with a smaller trading partner. The computation of the BRER is the same as in equation (2.1), (2.2) and (2.3) provided in the previous section, hence it is not repeated here. The BRER compares the price of a representative production or consumption basket in the home country with the price of a similar basket in a foreign country measured in the same currency, domestic or foreign, and indicates the relative value of the domestic and foreign currencies. A number of variants of the BRER can be computed, however, depending on the purpose for which they are being calculated.[9] These include the BRER which importers may face and that which exporters may face. These BRER indices take into account the tariff on imports and export duties, respectively. If the interest is on the competitive position of the country with its major trading partners, a trade weighted or multilateral real exchange rate will be of relevance.

2.2.6 Multilateral/Effective exchange rates

The multilateral or effective exchange rate index is used when multiple trading partners are considered. The term ‘effective’ has two common but different meanings – weighted average and an exchange rate that includes the effects of tariffs and subsidies – when used to describe exchange rates in the economic literature (Hinkle and Montiel, 1999: 49). The first meaning, weighted average, is used in this section since the interest here is in a multilateral measure of South Africa’s currency. There are two types of multilateral or effective exchange rates as was presented in Figure 2.1: the nominal effective exchange rate and the real effective exchange rate. Both concepts are derived from the need to measure the average rate of change of a country’s currency against all other currencies, usually those of its major trading partners, which may be changing simultaneously.

[9] See Hinkle and Montiel (1999: 45-48) for an extensive discussion on the variants of the BRER.

Suppose the rand has depreciated against the US dollar, in other words, the price of dollars has risen. Does it mean that the international value of the rand has fallen? Or would it be accurate to say that the international value of the dollar has risen? From a purely bilateral view, the two amount to the same thing. However, a bilateral perspective is, for many purposes, far too narrow or inadequate (Copeland, 1994: 8 and Obadan, 1994: 14). For example, when the price of a single good goes up, while others remain the same, we say the price of that good has risen. On the other hand, when the price of the good rises simultaneously as all other prices, we say the value of money has fallen. In the same way, if the rand price of dollars goes up, while the rand price of all other currencies is unchanged, we say the US dollar has appreciated or strengthened. On the other hand, if the rand price of all other currencies has risen or moved against the rand, the rand has weakened.

This example should serve to illustrate why, for some purposes, it will suffice to look at the exchange rate in a bilateral context, while for other purposes this narrow approach could be completely misleading.

We can therefore safely conclude that a change in the bilateral exchange rate could be indicative of either a decline in the international value of the domestic currency or a rise in that of the other country, or both, of course. How can we be sure which? How can we get some indication of what has happened to the overall value of the domestic currency or that of the foreign country with which we are comparing it? In the same way we use the consumer price index to measure changes in the price of goods in general, this is where the effective or trade weighted exchange rate comes in. It measures changes in the price of foreign currencies in general by looking at an index of a currency's international value.[10] The tendency for frequent fluctuations to occur in the exchange rates of several currencies (volatility) has been observed since the demise of the Bretton Woods Monetary System in 1973 and the subsequent introduction of a system of floating exchange rates. Accordingly, trade

[10] The other way would be simply to look at the cross rates of the two currencies to see how they have moved against a third currency. The problem with this approach, however, comes when a currency appreciates against one currency but depreciates against another – is the net effect an appreciation or depreciation?

weighted multilateral exchange rate indices have been devised to measure, for each country, the average change in the value of its currency in relation to all other currencies, but usually those of its major trading partners. As has been noted, the effective exchange rate can be analysed in nominal or real terms.

2.2.6.1 Nominal effective exchange rate

The nominal effective exchange rate (NEER) or trade weighted nominal exchange rate of a currency is a weighted average of its exchange rate against other currencies. The weights used are usually the proportion of a country's trade with another country. The origin of the concept of NEER can be traced as far back as Hirsch and Higgins (1970: 460). The NEER index is multilateral rather than bilateral and can also be defined as a weighted average of a basket of currencies over time, deriving from nominal exchange rate movements. It indicates the effects of exchange rate movements relative to a selected basket of currencies in a given base period. The NEER has several variants, which differ with regard to the following five major aspects:[11]

- The trading partners included in calculating the index;
- The base period of the index;
- The calculation of the proportionate changes in exchange rates;
- The weights used; and
- The type of averaging formula used.

Obadan (1994: 15) argues that the choice of weights used in the computation of the index is of particular importance because the interpretation of the index depends on an appropriate choice of weights assigned to each country's currency. The choice of weights depends on a particular policy objective. This surely makes the construction of the index subjective. However, the merchandise trade/current account balance, rather than export earnings or import payments, is usually the focal policy objective. For this objective, it has been suggested that the calculation of weights for an effective exchange rate index requires the use of a model that reflects the multilateral structure of

[11] See Obadan (1994: 15-16) and Hinkle and Montiel (1999: 49), for a detailed discussion.

trade, its commodity composition, the price elasticities of trade flows and the effects of changes in exchange rates on prices and costs (Rhomberg, 1976: 89; Obadan, 1994: 15; and Hinkle and Montiel, 1999: 49).

Ha and Fan (2003: 17) further noted that the most commonly used weighting scheme and price index are based on merchandise trade and the Consumer Price Index (CPI), respectively. CPIs have the advantage of being relatively accurate, frequently published and are based on a basket of commodities that is broadly comparable across boundaries. However, CPIs may be a poor proxy for prices of traded goods, since they include nontraded goods.

As previously defined, the NEER is a weighted average[12] of foreign currencies. The averaging can be done in two basic ways; in the form of an arithmetic average and a geometric average. Starting with the arithmetic average approach, the NEER can be computed as:

$$NEER_A = \sum_{i=1}^{n} w_i \frac{E_{it}}{E_{i0}} \quad \text{...(2.4)}$$

And employing the geometrical mean approach:

$$NEER_G = \prod_{i=1}^{n} w_i \frac{E_{it}}{E_{i0}} = 100 Exp \sum_{i=1}^{n} w_i \log\left[\frac{E_{it}}{E_{i0}}\right] \quad \text{..........................(2.5)}$$

Where:

$NEER_A$	= arithmetically computed NEER of the focus country's currency;
$NEER_G$	= geometrically computed NEER of the focus country's currency;
w_i	= weight assigned to country *i*'s currency;
E_{it}	= exchange rate of the domestic currency in terms of currency *i* at time *t*;

[12] In general, a weighted average of three numbers: A, B and C is calculated as: $w_1 A + w_2 B + w_3 C$, where the weights w_1, w_2 and w_3 are proportions or probabilities so that we have: $w_1 + w_2 + w_3 = 1$.

E_{i0} = exchange rate of the domestic currency in terms of currency *i* in the base period;

Exp = "take the anti-log of";

$\prod$ = product over all *I*; and

log = logarithm.

The arithmetical average is a single sum of exchange rate relatives weighted by the weight assigned to each country's currency. On the other hand, the geometrically computed NEER averages the percentage changes in the individual exchange rates to arrive at the percentage change in the index.

It should be noted that the NEER computed in this way is multilateral rather than bilateral. Further, as is the case with the CPI, there is no meaning to be attached to the absolute level of the NEER – it all depends on our choice of base year. As was the case with the nominal exchange rate, the NEER does not take into account changes in prices in the countries with which the country trades. For this purpose, the real effective exchange rate is calculated.

2.2.6.2 Real effective exchange rate

The concept of real effective exchange rate (REER) goes beyond finding the weighted average of currencies to incorporate differences in inflation rates between countries. In other words, it incorporates both the concepts of NEER changes and inflation differentials, with the ultimate aim of deflating the exchange rate indices by corresponding indices of relative prices. Deflating the NEER has a significant benefit under conditions of worldwide inflation at nationally different rates. The REER is thus the NEER of a currency adjusted for inflation differentials between the home country and other nations to be included in calculating the index. As is the case with the NEER, the REER is multilateral, the exchange rate of a currency in relation to a basket of other currencies, rather than bilateral.

Although it is argued that a deflated nominal exchange rate index no longer embodies an exchange rate concept,[13] the REER is crucial to indicate the direction of movements of the exchange rates in terms of real appreciation or depreciation and may provide some indications of the gain or loss in price or cost competitiveness relative to the selected base period (Hinkle and Montiel, 1999: 50). The REER can also be computed using either the arithmetic average approach or the geometric average approach. The arithmetic average approach uses the following formula:

$$REER_A = \sum_{i=1}^{n} w_i \left(\frac{E_{it}^{\Pr} / P_{it}^{\Pr}}{E_{i0}^{\Pr} / P_{i0}^{\Pr}} \right) * 100 \quad \ldots\ldots(2.6)$$

And using the geometric mean approach, the REER is defined in domestic currency terms as:[14]

$$REER_{Gdc} = \prod_{i=0}^{n} \left[E_{dc1} P_{Gi} \right]^{w_i} * \frac{1}{P_{Gd}} \quad \ldots\ldots(2.7)$$

Where:

$REER_A$ = real effective exchange rate (REER) calculated using the arithmetic average approach;

$REER_{Gdc}$ = REER calculated using the geometric mean method and defined in domestic currency terms;

$\prod$ = the product of the bracketed terms over the *n* countries;

n = number of trading partners or competitors of the home country;

$E_{it}^{\Pr}$ and $E_{i0}^{\Pr}$ = the ratios of the bilateral exchange rates of the *i*th partner country to the reporting country at time 1 and 0, respectively;

$P_{it}^{\Pr}$ = price index of the *i*th foreign country at time *t* relative to the base year;

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[13] See among others, Maciejewski (1983: 520-521)

[14] See Hinkle and Montiel (1999: 49-51)

E_{dc1} = index of the nominal exchange rate, defined as units of domestic currency per unit of foreign currency;

P_{Gi} and P_{Gd} = the foreign and the domestic aggregate price indexes, respectively;

w_i = the weight assigned to the *i*th foreign currency;

i = (*i* = 1,2, …*n*); and the sum of weights (w_i) must be equal to one, as shown in equation (2.8):

$$\sum_{i=1}^{n} w_i = 1 \qquad (2.8)$$

The REER can also be expressed in foreign currency terms ($REER_{fc}$) as in equation (2.9):

$$REER_{fc} = \prod_{i=1}^{n} \left[\frac{E_{fci}}{P_{Gi}} \right]^{w_i} * P_{Gd} = \frac{1}{REER_{dc}} \qquad (2.9)$$

As derived in equation (2.9), the REER expressed in foreign currency terms is merely an inverse of the REER defined in domestic currency terms. An increase in $REER_{Gdc}$ means depreciation of the domestic currency, while an increase in $REER_{fc}$ means an appreciation of the domestic currency.[15]

A choice has to be made whether to use the arithmetic average approach or the geometric approach. Although the arithmetic mean approach is easier to calculate, the geometric averaging technique has several advantages over the arithmetic one. It has certain symmetry and consistency properties that an arithmetic index does not – an arithmetic index gives an asymmetrical treatment to depreciating and appreciating currencies and results in an

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[15] The REER can also be derived from the NEER as: $REER = NEER * \frac{P_{Gd}}{P_{Gf}}$ where P_{Gd} is the domestic price index and P_{Gf} is the weighted average of the consumer price indices of the trading partners.

upward bias. In other words, the arithmetical average gives larger weight to those currencies that change more than other currencies in the index. Further, an arithmetical average is sensitive to the definition of the exchange rate, while a geometrical mean is independent of it (Maciejewski, 1983: 520 and Hinkle and Montiel, 1999: 51; among others). In the light of these advantages, the geometrical average real effective exchange rate index, reported by the IMF's IFS is employed in this study. Given its policy relevance, it is also the desirable index to model.

2.2.7 Concept of equilibrium real exchange rate

Having considered the measurement issues of the real exchange rate, the question that may come to mind is how to judge an appropriate level of the real exchange rate in an economy. The definition and estimation of the equilibrium real exchange rate provide an answer to this question. The equilibrium real exchange rate (ERER), bilateral or multilateral, is the relative price of tradable goods to nontradable goods which, for given sustainable values of the other relevant variables such as taxes, terms of trade, commercial policy, capital flows and technology, results in simultaneous attainment of internal and external balance (Williamson, 1994: 84, Edwards, 1989: 16 and Hinkle and Montiel, 1999: 22).

Internal equilibrium means that the nontradable goods market clears in the current period and is expected to clear in future – demand and supply of nontradable goods must be equal. On the other hand, external equilibrium is defined as a balance of the current account, which is compatible with long term sustainable capital flows (Edwards, 1989: 4). The ERER is a medium or long run concept that is determined by structural or fundamental factors (Obadan, 1994: 19). Thus, it differs from the market equilibrium rate, or short-term equilibrium rate, which is the rate that equates current supply of and demand for foreign exchange in unregulated markets. Obadan further notes that the real exchange rate prevailing at any point in time may be determined by both fundamental and short run factors. Short run factors refers to the role of certain macroeconomic policies such as fiscal and monetary policies, which may change the path of the real exchange rate in the short run; independent of the directions dictated by the underlying structural factors.

Thus, an understanding of both the fundamental and short run factors that determine the real exchange rate is crucial to the attainment of the ERER, which ensures both internal and external balance in the economy. A hint has already been given as to the significance of the real exchange rate, but the next section briefly touches on this subject to clearly justify the measurement of this often ‘confusing’ concept.

2.2.8 Significance of the real exchange rate

The real exchange rate, both bilateral and multilateral, has been a policy target, and in most exchange rate regime changes the aim is to maintain a stable and competitive real exchange rate. Why is it necessary to maintain a stable and competitive real exchange rate? A number of researchers have argued that real exchange rates are crucial not only for attaining sustained general economic performance and international competitiveness, but have a strong impact on resource allocation amongst different sectors of the economy, foreign trade flows and balance of payments, employment, structure of production and consumption and external debt crisis (Edwards, 1989: 5, Aron *et al*., 1997: 25 and Edwards and Savastano, 1999: 3).

With regard to the impact of the real exchange rate on international trade (the genesis of all other impacts), the real exchange rate is usually used as an indicator of the need for devaluation of a currency. An appreciation in the real exchange rate may signify that a country may experience current account difficulties in the future because it usually leads to an overvaluation of the exchange rate. Overvaluation makes imports artificially cheaper for consumers and exports relatively expensive for producers and foreign consumers; hence it reduces the external competitiveness of a country. In other words, overvaluation has the net effect of a large import bill and reduced export receipts. A fall in a country’s international competitiveness results in poor economic performance and several associated problems. Thus, the most important use of the real exchange rate is as an indicator of a country's international competitiveness. This concept is, therefore, of greater significance to South African policy makers, as it is to those of many other developing countries, where the export sector is expected to contribute more to the growth of the economy and address the problem of unemployment that has recently raised much criticism of the South African government.

2.3 AN OVERVIEW OF THE FOREIGN EXCHANGE MARKET

The foreign exchange market is the genesis of exchange rates. In other words, it is the market in which exchange rates are determined. Exchange rates are simply prices in this market, which are determined by supply and demand of foreign exchange, assuming a free float of course. It is, therefore, necessary to have an understanding of this market in order to understand the behaviour of the exchange rate. This section provides an overview of the foreign exchange market and introduces some of its most important features in the determination of exchange rates. It is divided into five subsections covering the organisation and size of the foreign exchange market, foreign exchange market day, foreign exchange classification and institutional arrangements in South Africa.

2.3.1 Organisation of the foreign exchange market

The foreign exchange market plays a unique role within the universe of financial markets,[16] as it underpins all other financial markets. It is essentially a global market where participants from different countries, centres and jurisdictions continually operate under a set of rules mostly agreed upon under market practice or convention. As noted above, it plays the essential role of facilitating all payments across international borders by providing instruments or mechanics for transferring funds between parties in different countries.

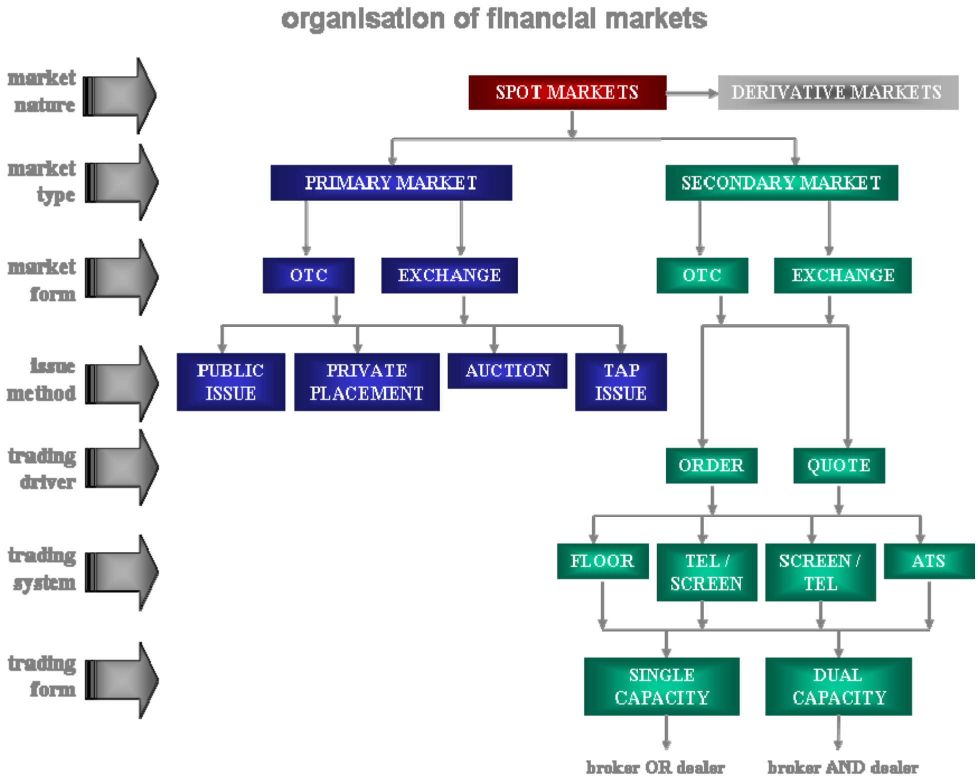
[16] Some researchers have argued that the foreign exchange market is not a financial market in the strict meaning of the word, as no borrowing and lending takes place in this market (see Faure, 2005: 10).

The foreign exchange market is not a formal exchange (see SAIFM[17], 2003: 33; Mishkin, 2004: 438 and Faure, 2005: 13). Instead, it is organised as an over-the-counter (OTC) market in which several dealers, mostly banks, stand ready to buy and sell deposits denominated in foreign currencies. Mishkin (2004: 439) argues that because these market markers are in constant telephone and computer contact, the market is very competitive and functions no differently from a centralised market. By saying that the market is OTC, it is meant that it is decentralised consisting of numerous closely cooperating markets. In other words, there is no centralised location such as a stock exchange where all currencies are traded and exchange rates determined.

Currency prices (exchange rates), at any given moment, vary from dealer to dealer – there is no one global price for any currency pair at any given moment in time. This is because every market maker or broker is free to set the prices he wants and the customer is also free to accept or reject or negotiate the price (SAIFM, 2003: 33). Thus, trading in this market is based on trust between participating parties. Figure 2.2 presents the organisation of financial markets of which the foreign exchange market is a part.

[17] SAIFM is an acronym for South African Institute of Financial Markets.

Figure 2.2:



Source: Faure (2005: 13), The foreign exchange market.

Foreign exchange is also traded on organised exchanges in the form of derivative instruments such as currency futures and certain currency options.[18] As shown in Figure 2.2, the foreign exchange market can be categorised into the spot and derivative markets. The spot market is where trading in currencies is for settlement on the conventional settlement date, which is T+2 internationally. Any other trading in currencies, which does not settle on these terms, is regarded as a derivative transaction. In the foreign exchange market, these include forward exchange contracts, currency swaps, futures and options. The foreign exchange market does not have a primary and secondary market, but its features resemble the secondary market. The market form is OTC and exchange, as noted above. The spot, forward, swap and some options markets are OTC, while the futures and options on futures markets are formalised (Faure, 2005: 13).

[18] One currency contract called the USD/ZAR dollar (RNDD), with a nominal value of US$100 000, is traded on the SAFEX division of the JSE Securities Exchange (SAIM, 2003: 36).

The trading drivers, order and quote, both apply to the foreign exchange market. The quote system is the domain of banks that trade as market makers by quoting buying and selling prices simultaneously, while ‘order trading’ is the domain of the foreign exchange brokers. The trading system is telephone-screen, while the trading form is both single and dual capacity. Foreign exchange brokers deal in single capacity as agents, while banks deal in dual capacity as market makers. To a large degree, the foreign exchange market is an interbank market, since the majority of deals take place between banks (Faure, 2005: 14). As provided above, the foreign exchange market underpins all other financial markets. One would, therefore, wonder what the size of such a market is.

2.3.2 The size of the foreign exchange market

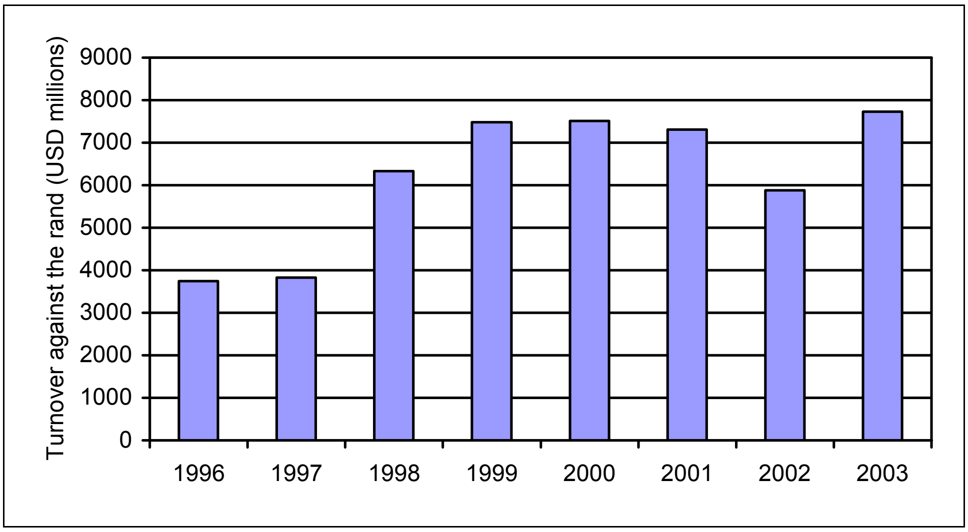
The foreign exchange market is huge and liquid in comparison with all other financial markets. It consist of dealers in the dealing rooms of about two thousand major commercial and merchant banking institutions in the global financial centres, trading with bank clients and, more often, amongst each other (SAIFM, 2003: 34). The size of the market is very important as it contributes towards specific characteristics[19] important for all participants in this market and for the determination of fair currency prices (exchange rates).

The foreign exchange market is a very dynamic and sensitive market as can be deduced from Cross’s statement that “individual trades of $200 million to $500 million are not uncommon. Quoted prices change as often as twenty times a minute. It has been estimated that the world’s most active currency’s exchange rates can change up to 18 000 times during a single day …” (Cross, 1998, in SAIFM, 2003: 38). It is estimated that the annual trading volume in the world’s foreign exchange market is in the region of US$ 200 trillion and R20 535 trillion in South Africa (Faure, 2005: 107-8). Daily turnover has grown both globally and in South Africa. Globally, it stood at US$ 1.9 trillion in April 2004, a 36 per cent rise over its level in 2001 (US$1.2 trillion) at constant exchange rates (Bank for International Settlements, 2005: 2). Figure 2.3

[19] Characteristics include price stability, high efficiency, around the clock trading, around the globe trading and continuous and full liquidity.

shows the average daily net turnover in the South African foreign exchange market from 1996-2003.

Figure 2.3: Average daily turnover in the South African Foreign exchange market, 1996-2003

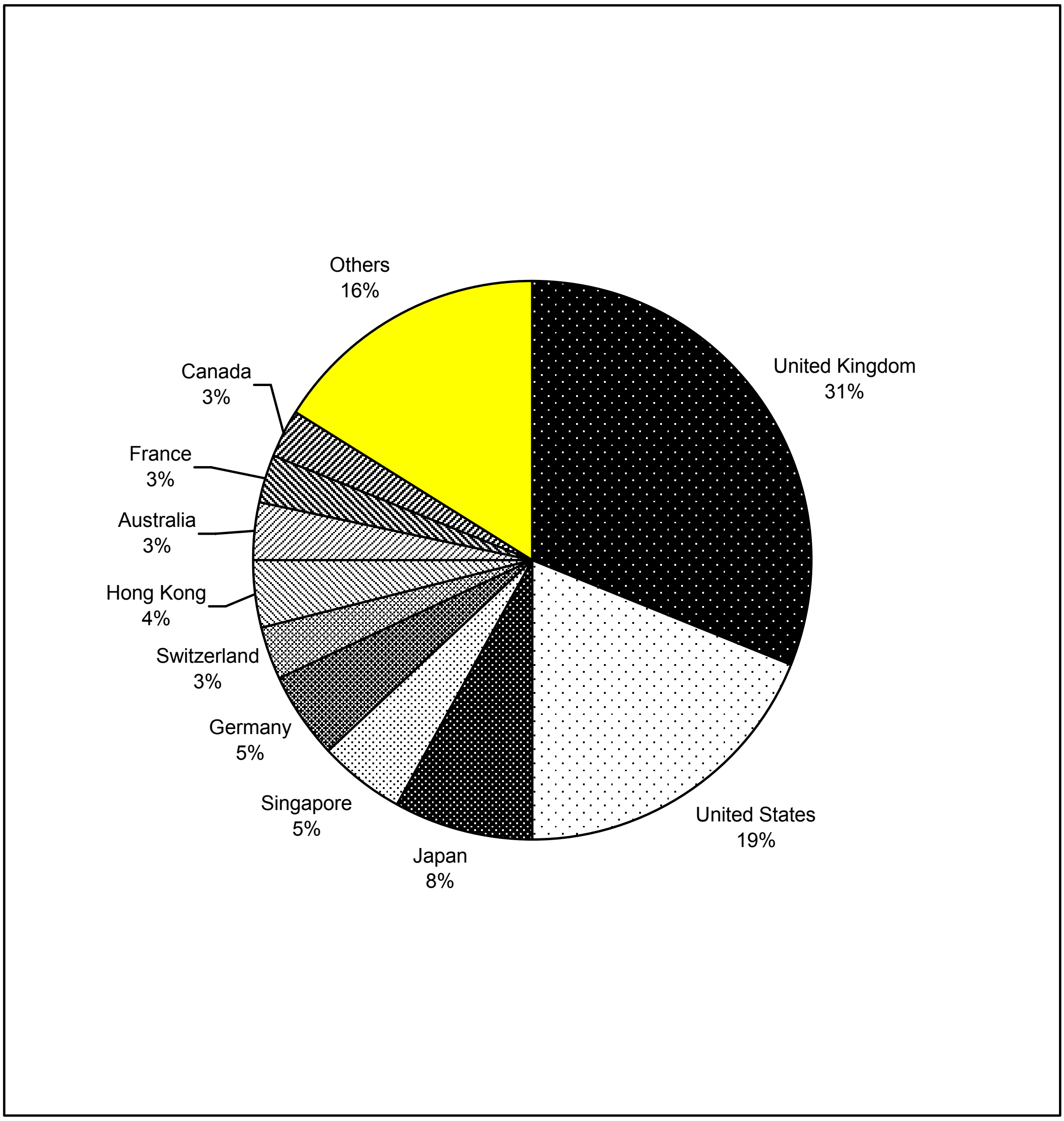


Data source: South African Reserve Bank, quoted in Faure (2005: 108).

As presented in Figure 2.3, daily turnover in the South African foreign exchange market is growing. The growth in foreign exchange trading could be a result of globalisation of financial markets, the formation of major trading blocks and the huge growth in international capital flows and financial instrument innovation.

Figure 2.4 shows the distribution of foreign exchange volume amongst the world's largest trading centres. A great number of financial institutions dealing in foreign exchange are located in London (United Kingdom) and the largest amount of foreign exchange trading also takes place there.

Figure 2.4: Distribution of foreign exchange trade volumes amongst the world's largest trading centres



Data source: Bank for International Settlements (BIS) (2005).

Figure 2.4 shows that 31 per cent of daily trading takes place in the United Kingdom (London) and more than 80 per cent of all foreign exchange trading takes place in Europe, East Asia and the Western hemisphere. Despite the dominance of London in foreign exchange trading, the pound sterling (GBP) is not the most traded currency and US institutions dominate the business in London (SAIFM, 2003: 38). London's dominance is due to several reasons, including its time zone advantage. Issues pertaining to the time zones (foreign exchange market day) and foreign exchange classifications are covered in the following sections.

2.3.3 The foreign exchange market day

Trading in the foreign exchange market takes place 24 hours a day, as it follows the sun around the earth. This means that trading almost never ceases except for short periods over weekends. The foreign exchange "week" begins at 05:00 Sydney time on Monday mornings, according to the *Association Cambiste Internationale* (ACI) code of conduct. The 24-hour trading day of the global foreign exchange market is presented in Table 2.1.

Table 2.1: The 24-hour trading day of the global foreign exchange market

JHB Time	London Time	New York Time	Action
Monday 01:00	Monday 00:00	Sunday 19:00	Trading starts in Tokyo
Monday 03:00	Monday 02:00	Sunday 21:00	Hong Kong, Singapore open
Monday 08:00	Monday 07:00	Monday 02:00	Trading starts in Europe
Monday 09:00	Monday 08:00	Monday 03:00	Tokyo closes
Monday 09:00	Monday 08:00	Monday 03:00	London opens
Monday 10:00	Monday 09:00	Monday 04:00	Hong Kong closes
Monday 14:00	Monday 13:00	Monday 08:00	New York opens
Monday 17:00	Monday 16:00	Monday 11:00	San Francisco opens
Monday 19:00	Monday 18:00	Monday 13:00	Europe, London close
Monday 22:00	Monday 21:00	Monday 16:00	New York closes
Tuesday 01:00	Tuesday 00:00	Monday 19:00	San Francisco closes
Tuesday 01:00	Tuesday 00:00	Monday 19:00	Trading starts in Tokyo

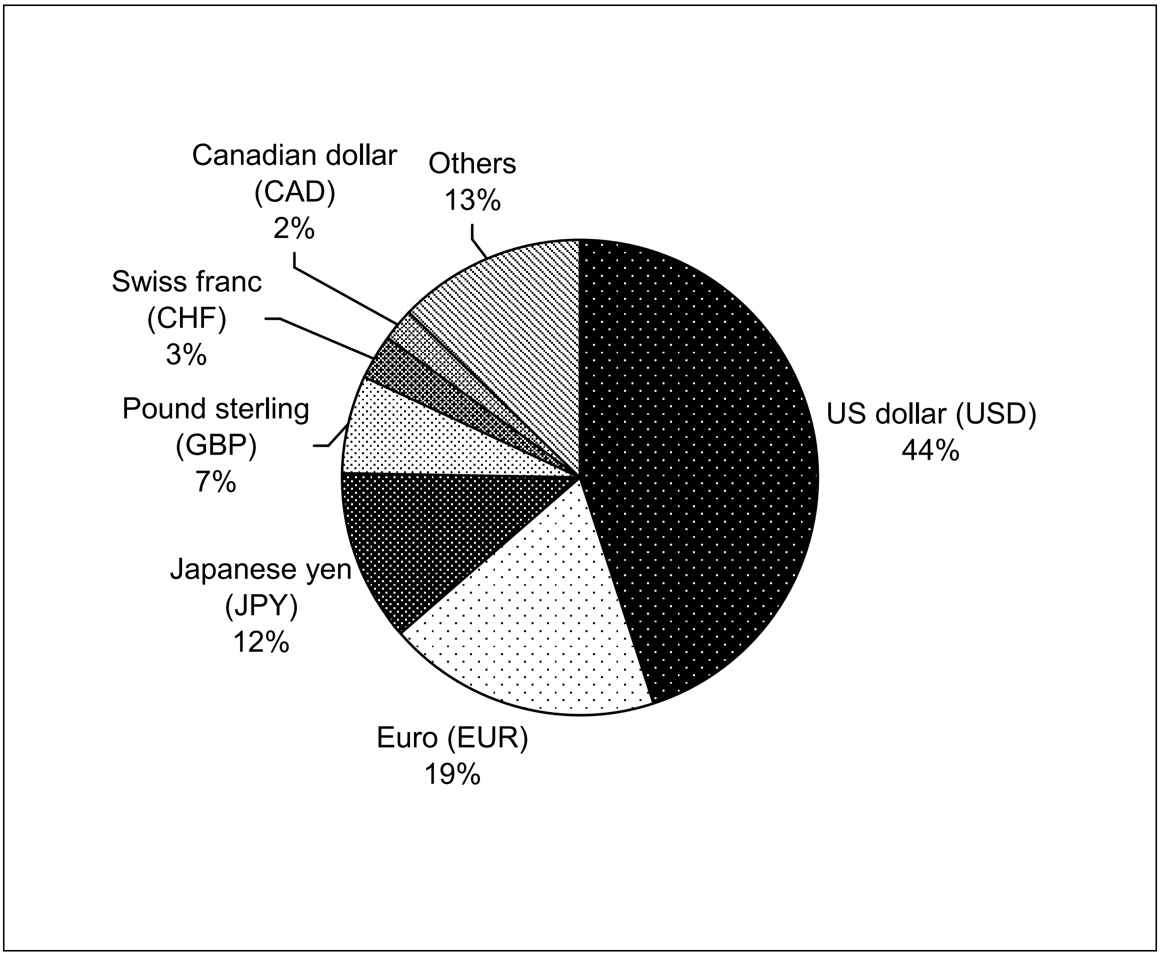
Source: SAIFM (2003: 39)

As can be seen in Table 2.1, there are actually three "trading days" in each 24-hour day. There is a day each for the Asian time zone, European time zone and American time zone. The 24-hour day characteristic of the foreign exchange market has major implications for participants in the market with regard to physical delivery and settlement of transactions. It also has important implications on the short-term price behaviour, for example, there is a possibility of sharp price movements during a participant's off hours.

2.3.4 Foreign exchange classifications

Currencies are classified according to the volume of trade in them and their availability. Figure 2.5 shows the most widely traded currencies in the global foreign exchange market. The US dollar is the most widely traded currency despite the dominance of London as a foreign exchange trading centre. The most popular currency trade has become the exchange rate between USD and Euro (EUR), accounting for 30 per cent of currency trading and followed by the USD/Japanese yen (JPY) (Bank for International Settlements, 2005: 2).

Figure 2.5: Most widely traded currencies



Data Source: Bank for International Settlements (2005)

There are four categories of currencies when categorised in terms of their availability. These are (1) major currencies, (2) minor currencies, (3) exotic currencies and (4) emerging market currencies. Major currencies are the most liquid and available, while emerging market currencies are the least liquid.

Despite its liquidity and availability in Southern Africa, the South African rand belongs to the emerging market currencies category; together with some currencies from South America and the old Eastern bloc (SAIFM, 2003: 42).

The classification of currencies is important in this study as the liquidity of a currency has an impact on exchange rate movements. In particular, emerging markets are lumped together from an institutional investor's point of view and any occurrences affecting one emerging market currency may spread through all other emerging market currencies. South Africa is seen as one of the emerging and commodity country markets, therefore, the rand is very sensitive to global events affecting emerging markets (Van der Merwe, 1996: 9 and SAIFM, 2003: 42), for example the 1997 East Asian crisis led to a sharp depreciation of the rand.

2.3.5 Institutional arrangements in South Africa

The State President is empowered, in terms of section nine of the Currency and Exchanges Act (Act No. 9 of 1933), to issue regulations in regard to any matter directly or indirectly related to or affecting or having any bearing on currency, banking or exchanges. The State President has appointed the Minister of Finance to act on his behalf and the Minister, in turn, has delegated most of his powers to the Governor and or the Deputy Governor of the Exchange Control Department of the South African Reserve Bank (SARB). The SARB is, therefore, responsible for the day-to-day administration of exchange control. In addition, the SARB's direct participation in both the spot and forward markets only seeks to smooth out "undue short-term fluctuations in the exchange rate of the rand" (Van der Merwe, 1996: 12).

To assist the SARB in the administration of exchange control in South Africa, the Minister of Finance has also appointed some banks and a few other institutions to act as authorised dealers in foreign exchange. There are 34 Authorised Dealers currently (in 2005), listed in Appendix 1. They are made up of 27 banks, 5 bureaux de change and 2 other institutions. These Authorised Dealers are not agents for the SARB, but act on behalf of their clients. Only these Authorised Dealers are allowed to deal in foreign exchange and they must adhere to all the regulations regarding foreign exchange transactions. The gist of the main exchange control regulation is that one is not allowed to make private foreign exchange deals (SAIFM, 2003: 105). In other words, all foreign exchange transactions must be disclosed and must be within the limits of the client's category in order to avoid huge and unanticipated capital flows, which may destabilise the exchange rate.

South Africa is a member of the Multilateral Monetary Agreement of 6 February 1992 between itself, Lesotho, Namibia and Swaziland. This agreement and other bilateral arrangements with each of these other members of the Common Monetary Area determine the currency (not the exchange rate) and other arrangements in the monetary union between the four countries (Van der Merwe, 1996: 23).

These institutional arrangements have led to an "effective" functioning of the foreign exchange market in which the rand finds its level in a relatively competitive market free from monopolistic exploitation. These arrangements could also have contributed to the remarkable stability of the exchange rate of the rand in the long run by protecting the currency from huge and unexpected capital flow shocks. Further, they imply that the effectiveness of the rand exchange rate system should not be evaluated in terms of the South African situation alone, but in terms of all the members of the Common Monetary Area.

2.4 CONCLUDING REMARKS

This chapter was intended to provide a background to this study by covering definitional and measurement issues of the exchange rate and by providing an overview of the foreign exchange market. The first step in estimating the long run equilibrium real exchange rate is the definition and measurement of the actual real exchange rate, which, in turn, is derived from the nominal exchange rate. There are several definitions of both nominal and real exchange rates, which are based on different analytical frameworks and for different purposes. Thus, the choice of a measure or definition of the exchange rate is based on the purpose of the analysis to be carried out. Consequently, this has brought conceptual and empirical difficulties in the measurement of, in particular, the real exchange rate.

The distinction between nominal and real exchange rates has become increasingly important for policy purposes. The nominal exchange rate tends to overshadow the real exchange rate because of its central position in day-to-day foreign exchange market transactions, but the real exchange rate is of higher significance for policy purposes. While the nominal exchange rate is a monetary concept that measures the relative price of two currencies (price of one currency in terms of another), the real exchange rate is the relative price of tradable to nontradable goods. The other categorisation that is crucial for policy purposes is the distinction between bilateral and multilateral exchange rates. The former is applicable when the interest is in calculating the exchange rate of only two currencies, while the latter is used when multiple trading partners are considered.

Most countries are interested in their competitive position relative to their trading partners. The most important use of the real exchange rate is, therefore, as an indicator of a country's international competitiveness. The most appropriate variant of the real exchange rate is thus the trade-weighted or real effective exchange rate. Consequently, this study investigates the fundamental determinants of the real effective exchange rate and its behaviour.

An overview of the foreign exchange market was necessary as it is the market in which the exchange rate is determined. An understanding of the features of this market may, therefore, help policy makers understand the behaviour of exchange rates. The classifications of currencies and institutional arrangements, in particular, have an important impact on exchange rates. The South African rand is classified under the emerging markets' currencies category, which is lumped together from an institutional investor's point of view. Consequently, the exchange rate of the rand is sensitive to global events affecting other emerging markets currencies. Clearly, several factors drive the exchange rate of the rand in the global market. This is the subject of the next chapter, which considers the theoretical and empirical determinants of the real exchange rate.

CHAPTER THREE
LITERATURE REVIEW

3.1 INTRODUCTION

The motivation behind an analysis of the determinants of the real exchange rate and the effects of real exchange rate misalignment is the desire to determine an appropriate concept of equilibrium exchange rate and to estimate its value. The nominal exchange rate is considered appropriate if it is such that the actual real exchange rate coincides with the long run equilibrium real exchange rate. There is arguably some consensus that the equilibrium real exchange rate is one that is consistent with the attainment of both the external and internal balance of the economy. Usually, the nominal exchange rate is the only variable that is directly observable, while the actual real exchange rate needs to be constructed and the equilibrium real exchange rate to be estimated. Chapter 2 considered the conceptual framework and detailed the measurement of the actual real exchange rate, which is necessary in the estimation of the equilibrium real exchange rate. The aim of this chapter is to identify the set of variables that may potentially act as determinants of the real exchange rate. The chapter is divided into three sections. The first section covers theoretical literature on the determination of the real exchange rate, while the second section covers empirical findings on this subject. The last section concludes the chapter.

3.2 THEORETICAL LITERATURE

This section is aimed at investigating the theoretical determinants of the real exchange rate. It is only after the determinants of the equilibrium real exchange rate have been determined that the equilibrium real exchange rate can be estimated and the behaviour of the actual real exchange rate in relation to the equilibrium real exchange rate (degree of misalignment) can be measured. The estimation of the equilibrium real exchange rate depends on the definition and measurement of the actual real exchange rate. There is no single definition of the real exchange rate that is widely accepted among economists. The definition and measurement of the real exchange rate depends on the particular analytical framework (the specific macroeconomic model) being used. Chapter 2 covered the measurement of the actual real exchange rate in detail, but different theoretical models relating to the definition and measurement of the real exchange rate are briefly covered here as they are important inputs into the real exchange rate determination models.

3.2.1 Theoretical models of the definition and measurement of the real exchange rate

In broad terms, the real exchange rate was defined in the last chapter as simply the relative price of foreign goods in terms of domestic goods. The problem with this definition is that "what constitutes domestic and foreign goods depends on the particular analytical framework being used" (Montiel, 2003: 312). The assumed production structure of the model is a key factor that affects the definition of the real exchange rate in analytical models. There are four modelling frameworks that include the one-good model, complete specialisation models, dependent-economy models and the three-good model. These models are briefly discussed below.

3.2.1.1 One (tradable) good model

This framework assumes a single good that is assumed to be internationally traded and arbitrage is expected to equalise its price in all markets – the law of one price. Clearly, there can be no real exchange rate in such models, because the real exchange rate draws a distinction between domestic and foreign goods. Montiel (2003: 313) shows that such models are useful for the analysis of purely monetary phenomena, such as inflation and certain approaches to the explanation of the determinants of the balance of payments.

3.2.1.2 Mundell-Fleming (complete specialisation) models

The Mundell-Fleming framework assumes that the domestic economy and the rest of the world are each specialised in the production of a single good and that these goods, which are traded internationally, are not perfect substitutes for each other. This framework is therefore applicable to countries whose trade consists largely of manufactured goods, rather than primary goods or raw materials. Manufactured goods tend to be imperfect substitutes for what the rest of the world produces. In this context, the real exchange rate is defined as the number of units of the domestically produced good that have to be given up for each unit of the foreign good (Montiel, 2003: 313). The role of the real exchange rate in the Mundell-Fleming model is to determine the composition of absorption between goods produced at home and those produced abroad. This framework results in the real exchange rate coinciding with the country's terms of trade, although the two concepts are different from each other. This is due to the assumption of complete specialisation in production. Although this framework is clearly not applicable to most emerging markets whose exports are largely not manufactured goods, the real exchange rate determines the aggregate demand for the domestic good and is also an important determinant of the country's trade balance in this framework.

3.2.1.3 Dependent-economy (Salter-Swan) models

This framework is also referred to as the traded-nontraded goods model. The Salter-Swan framework has a production structure that contains two goods. One is produced and consumed only at home (nontraded good), while the other is produced and consumed both at home and abroad (traded or foreign good). In this context, the real exchange rate is defined as the number of units of the nontraded good required to purchase a unit of the traded good. This definition corresponds to the internal real exchange rate expressed in equation (2.1), covered in Chapter 2. Since there is only one type of foreign good in this model, there are no terms of trade (the relative price between exports and imports). In addition, the economy is a small economy that cannot affect its terms of trade. This model is therefore applicable to analysing issues for which the role of exogenous changes in the terms of trade are not important; in the context of economies whose terms of trade are exogenous, such as most emerging economies (Hinkle and Montiel, 1999: 116).

3.2.1.4 Three-good (exportable-importable-nontradable) model

The Salter-Swan model assumed that terms of trade are exogenous, but in the three-good model, terms of trade do matter. This framework consists of exportable and importable goods (both of which may be produced and consumed at home, but one of which is exported and the other imported), as well as nontradable goods. This framework suggests two real exchange rates, as well as a separate and distinct definition of the terms of trade, since there are two foreign goods. The first definition of the real exchange rate, called the exportables real exchange rate, is defined as the ratio of the domestic currency price of the exportable good to the price of nontradable good. The second, called the importables real exchange rate, is the ratio of the domestic currency price of the importable good to the price of the nontradable good, while the terms of trade are defined as the ratio of the domestic currency price of the exportable good to the domestic currency price of the importable good. Montiel (2003: 314) shows that this framework is useful for analysing the macroeconomic effects of terms of trade changes, as well as effects of changes in commercial policies that affect the domestic relative prices of exportables and importables. In my opinion, this framework is also most suited to developed economies that have an influence on their terms of trade.

As noted in the previous section, the Salter-Swan framework is the most applicable to small or emerging economies which do not have an influence on their terms of trade.

Once the analytical framework that is suitable for the problem at hand has been identified, the next issue in empirical applications is to translate the relevant concept into an empirical measure of the real exchange rate. The actual computation of the internal real exchange rate based on the Salter-Swan framework poses both conceptual and empirical problems. In theory, the internal real exchange rate should be measured by using domestic price indices of tradable and nontradable goods. In practice, however, price data are only available for exports, imports and domestically produced goods, not for tradable and nontradable goods. Because of this problem, external real exchange rates are used as proxies for the internal real exchange rate (Hinkle and Montiel, 1999: 114). Thus, for the purpose of this study, the external real effective exchange rate reported by the International Monetary Fund (IMF) is adopted. Once the appropriate definition and measurement of the actual real exchange rate has been identified, the next step is to turn to the determinants of the real exchange rate.

3.2.2 Theoretical determinants of the real exchange rate

Williamson (1994: 178) notes that the motivation behind the preoccupation with issues of the real exchange rate by economists has been the desire to "identify an appropriate concept of equilibrium exchange rate and estimating its value". The behaviour of the real exchange rate relative to its equilibrium value has significant implications for international competitiveness and domestic resource allocation between tradable and nontradable goods sectors, as noted in the previous chapter. Having covered issues relating to the actual real exchange rate, it is opportune in this section to define and investigate the theoretical determinants of the equilibrium real exchange rate. Chapter 2 introduced the conceptual framework relating to the equilibrium real exchange rate, but it is covered in detail here, as the conceptual framework of the equilibrium real exchange rate is crucial to understanding the theoretical models of its determination.

Several definitions of the real exchange rate were provided earlier in this study. Whichever definition is used, the equilibrium real exchange rate is one that is consistent with both the external and internal balance of the economy (Mkenda, 2001: 17 and Williamson, 1994: 178). Montiel (2003: 315) notes that whether a country operates with a fixed or floating nominal exchange rate, the real exchange rate is an endogenous variable. Consequently, it must therefore be determined as the outcome of the economy's macroeconomic equilibrium. This phenomenon and other related issues have caused some economists to question the whole notion of distinguishing between the actual real exchange rate and its equilibrium value.

Objections to the definition and measurement of the equilibrium real exchange rate are three-fold.[20] First, some economists argue that any observed real

[20] See Montiel (2003: 312) for details of this issue.

exchange rate must be an equilibrium one and as such it is meaningless to distinguish between the actual and the equilibrium real exchange rates. Second, others object that even if it is possible to make such distinction, measuring the equilibrium real exchange rate is impossible. Finally, other economists have added that even if it is meaningful to make a distinction between the actual real exchange rate and its equilibrium value and to measure it, it is pointless to do so, because gaps between actual and equilibrium real exchange rates (misalignment) have no policy implications.

With regard to the first objection, Montiel (2003: 316) argues that the "objection to defining and measuring the equilibrium real exchange rate is fundamentally misguided. The distinction between the actual real exchange rate and its equilibrium value is not one between disequilibrium and equilibrium, but rather between different types of equilibria". Williamson adds that "there is going to be a continuing need for analysis of where an exchange rate lies in relation to its long run equilibrium level. Authors (Hinkle and Montiel) have generously chastised me for the somewhat apologetic tone in my introduction where I seek to defend the value of this exercise … there is indeed a serious job of work to be done" (Williamson 1999, in Hinkle and Montiel, 1999: ix).[21] These authors suggest that defining and measuring the equilibrium real exchange rate is a 'can-not-do-without' exercise in the economy.

The second objection will be addressed in Chapter 5 of this study under methods of estimating the equilibrium real exchange rate. In my opinion, the last objection is also misguided in the case of extended periods of misalignment in the exchange rate. Surely there must be policy implications, such as the adoption of exchange rate management policies, movements in prices of domestic goods to adjust the actual real exchange rate to the equilibrium real exchange rate and changes in the policy components of the fundamentals to move the equilibrium real exchange rate closer to the prevailing value of the actual real exchange rate.

[21] See also Hinkle and Montiel (1999: 11).

There are several models for modelling exchange rates, but some do not refer to the real exchange rate. These models include balance of payments models, monetary models, portfolio balance models and the so-called "fundamentals" models, among others. It is very difficult to compile theoretical literature on exchange rate determination, since "there is no generally accepted exchange rate model one could resort to" (Kempa, 2005: 443). Moreover, the majority of the studies on this subject avoid the theoretical issues on the determination of the real exchange rate.

Mundell (1971) provided an early formal analysis of the determination of the equilibrium real exchange rate, using a macroeconomic model of a monetary economy. Mundell's model assumed a small, open monetary economy that faces given prices (no influence over terms of trade) and defined the equilibrium real exchange rate as the relative price of international to domestic goods that equilibrates the money market. The problem with Mundell's model and the other models mentioned above, with the exception of the "fundamentals" models, is that they do not allow for a distinction to be drawn between the effects of temporary (short run) and permanent (long run) changes in the determinants of the real exchange rate.[22] Fundamentals models are relatively new models of the determination of the equilibrium real exchange rate, which synthesises previous or existing literature (models mentioned above) on the determinants of the equilibrium real exchange rate. There are several variants of the fundamentals models, but the two most used as analytical frameworks in empirical studies are by Edwards (1989) and Montiel (1999). These models are discussed below with the aim of identifying the potential determinants of the real exchange rate.

3.2.2.1 Edwards's theoretical model of the real exchange rate

Edwards (1989) arguably pioneered the fundamentals models of the determination of the real exchange rate for developing countries. He developed a real intertemporal theoretical model and devised an empirical equation of how to estimate the equilibrium real exchange rate and its

[22] This problem is over and above their individual weaknesses that include being too simplistic and their "dismal failure in predicting exchange rates" (Kempa, 2005: 443).

dynamics. Edwards' model is a dynamic model of a small and open economy with a dual nominal exchange rate system, in which both tradables and nontradables are exchanged, and it provides a framework to investigate the fundamental variables that are associated with an equilibrium real exchange rate. The model captures the short and long run behaviour of the economy and suggests that the long run equilibrium real exchange rate is a function of real variables only, which can be categorised into internal and external fundamentals. Nevertheless, in the short run the real exchange rate may be driven by both real and nominal factors. To appreciate the framework in which this model was constructed and what constitutes real and nominal factors, the model is briefly presented here.

Edwards' (1989) model, which was later revised (Edwards 1994, in Williamson, 1994: 62-68) analyses the relative importance of monetary and real variables in the process of real exchange rate determination in both the short and the long run. It was used to capture macroeconomic features of developing economies, such as the existence of exchange controls, trade barriers and a market-determined parallel exchange rate for financial transactions.[23] It also allows both real and nominal factors to play in the short run, but in the long run only real factors (fundamentals) influence the equilibrium real exchange rate, as will be shown by the model below.

Edwards' model considers a three-good – exportables, importables and nontradables – small and open economy with no price rigidities and no intertemporal credit rationing. The model assumes that this nation produces exportable (X) and nontradable (N) goods and consumes the importable (M) as well as the nontradable goods. Nationals of this country hold both local money (M) and foreign money (F). The private sector has inherited a given stock of foreign money. The government consumes importable and nontradable goods and uses nondistortionary taxes and domestic credit creation to finance its expenditures. Initially, there is an assumption of no capital mobility between nations, but this is later relaxed; the government is

[23] Most of these features characterized the South African economy prior to the transformation in 1994.

not subject to capital controls and thus there are some capital flows across the borders.

The dual nominal exchange rate system is characterised by a fixed rate for commercial transactions (E) and a market determined rate for financial transactions (δ). The freely floating financial rate adjusts in order to achieve asset market equilibrium. It is also assumed that the nation levies a tariff on imports (τ) and that its proceeds are handed back to the public in a nondistortionary way. The price of exportables in terms of foreign currency is fixed (since the nominal exchange rate for commercial transactions is fixed) and equal to unity ($P_X^* = 1$). Finally, the model assumes that economic agents have perfect foresight, such that they respond immediately to an unstable current account by changing their consumption and investment decisions.

The model starts from the portfolio decisions and divides the economy into the demand side, supply side, government sector and the external sector:

<u>Portfolio decisions</u>

$A = M + \delta F$ ……………………………………………………………………(3.1)

$a = m + \rho F$ ……………………………………………………….………………(3.2)

Where: $a = A/E, m = M/E, \rho = \delta/E$

$m = \sigma(\dot{\delta}/\delta)\rho F, \sigma' < 0$ ……………………………………………………….... (3.3)

$\dot{F} = 0$ ....(3.4)

In equation (3.1), total assets (*A*) are defined in domestic currency as the sum of domestic money (M) and foreign money (F) multiplied by the market determined nominal exchange rate (δ). Equation (3.2) defines real assets in terms of the exportable good, where $\rho = \delta/E$ is spread ($\delta - E$) between the free market and the fixed commercial nominal exchange rate. Portfolio composition is represented by equation (3.3) which suggests that the desired ratio of real domestic money to real foreign money is a negative function of the expected rate of depreciation of the market determined rate. Edwards suggests that since there is perfect foresight expected depreciation can be replaced by the actual rate of depreciation in equation (3.3). Finally, equation (3.4) confirms that there is no capital mobility and that no commercial transactions are subject to the financial rate, but the economy has inherited a positive stock of foreign money.

Demand side

$$P_M = EP_M^* + \tau; e_X = E/P_N, e_M = P_M/P_N, e_M^* = (P_M^* E)/P_N \quad \text{.........(3.5)}$$

$$C_M = C_M(e_M, a); \frac{\partial C_M}{\partial e_M} < 0, \frac{\partial C_M}{\partial a} > 0 \quad \text{.........(3.6)}$$

$$C_N = C_N(e_M, a); \frac{\partial C_N}{\partial e_M} > 0, \frac{\partial C_N}{\partial a} < 0 \quad \text{.........(3.7)}$$

Supply side

$$Q_X = Q_X(e_X); \frac{\partial Q_X}{\partial e_X} > 0 \quad \text{.........(3.8)}$$

$$Q_N = Q_N(e_X); \frac{\partial Q_N}{\partial e_X} < 0 \quad \text{.........(3.9)}$$

In equations (3.5) through (3.9), variables e_M and e_X are the domestic relative prices of importables and exportables, respectively, with respect to nontradables. Variable e_M includes a tariff on imports, while e_M^* is e_M excluding a tariff. The demand for nontradable and importable goods depends on the relative price of importables as well as on the level of real assets, while supply functions depend on the price of exportables relative to nontradables.

Government sector

$G = P_N G_N + EP_M^* G_M$ ....(3.10)

$g = g_M + g_N$ ....(3.10`)

$\frac{EP_M^* G}{G} = \lambda$ ....(3.11)

$G = t + \dot{D}$ ....(3.12)

The government sector is represented in equation (3.10) and (3.11), where G_N and G_M are government consumption of nontradables and importables, respectively. Equation (3.10`) is merely an expression of real government consumption in terms of exportables, where $g = G/E$ and $g_N = G_N P_N / E$. Equation (3.11) expresses the ratio of government consumption on importables as λ, while the government budget constraint is defined in equation (3.12) and requires that government consumption has to be financed through nondistortionary taxes (*t*) and domestic credit creation ($\dot{D}$). However, under a fixed nominal commercial exchange rate, a positive rate of growth of domestic credit ($\dot{D}$>0) is not sustainable. A steady-state, then, is achieved when *G* = *t* and $\dot{D}$=0.

<u>External sector</u>

$CA = Q_X(e_X) - P_M^* C_M(e_M, a) - P_M^* G_M$ ....(3.13)

$\dot{R} = CA$ ....(3.14)

$\dot{M} = \dot{D} + E\dot{R}$ ....(3.15)

$e = \alpha e_M^* + (1-\alpha)e_X = \frac{E\left[\alpha P_M^* + (1-\alpha)P_X^*\right]}{P_N}$ ....(3.16)

Equation (3.13) says the current account (*CA*), in foreign currency, is the difference between output of exportables (Q_X) and total consumption of importables. The balance of payment ($\dot{R}$) is identical to the current account in equation (3.14), because of the assumption of no capital mobility and a freely determined financial transactions nominal exchange rate. *R* is the stock of international reserves held by the central bank and is expressed in foreign currency. Equation (3.15) provides the link between changes in international reserves, changes in domestic credit and changes in the domestic stock of money. Finally, equation (3.16) defines the real exchange rate as the relative price of tradables to nontradables, but excluding tariffs on imports.

A steady-state, which is the long run sustainable equilibrium, is attained when the nontradable goods market and the external sector are simultaneously in equilibrium. Long run sustainable equilibrium in the external sector implies that the current account is always in equilibrium, given tight exchange controls. In the short run, however, there can be departures from this condition resulting in the accumulation or drain of international reserves. A steady-state is thus achieved when the following four conditions hold simultaneously: portfolio equilibrium holds, the nontradables market clears (demand and supply for nontradables are equal), the external sector is in equilibrium ($\dot{R} = 0 = CA = \dot{m}$) and fiscal policy is sustainable (*G* = *t*). Edwards (1994, in Williamson, 1994: 65) shows that the real exchange rate prevailing under these steady-state conditions is the long run equilibrium real exchange rate (*q*). The nontradable goods market will be in equilibrium when:

$$C_N(e_M, a) + e_X g_N = Q_N(e_X) \qquad (3.17)$$

From equation (3.17) it is possible to express the equilibrium price of nontradables as a function of a, g_N, P_M^* and τ :

$$P_N = v(a, g_N, P_M^*, \tau); \frac{\partial v}{\partial a} > 0, \frac{\partial v}{\partial g_N} > 0, \frac{\partial v}{\partial P_M^*} > 0, \frac{\partial v}{\partial \tau} > 0 \qquad (3.18)$$

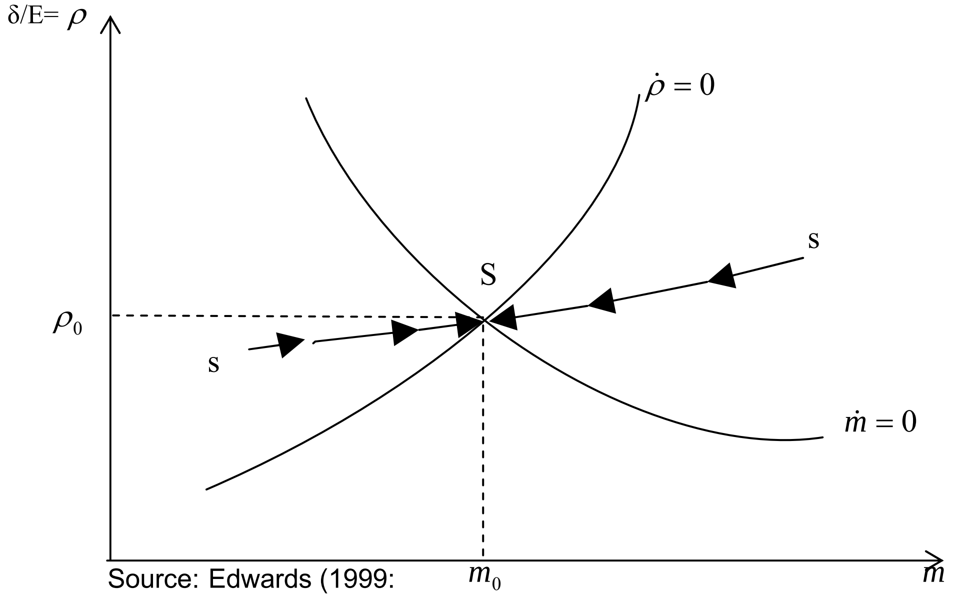
However, since the real value of total assets (*a*) is an endogenous variable, there has to be an investigation into how changes in g_N, P_M^* and τ influence real wealth before solving for P_N.

By revisiting the portfolio equilibrium in equation (3.3) and substituting the rate of change of the spread ($\dot{\rho}/\rho$) for ($\dot{\delta}/\delta$), because the nominal exchange rate for commercial transactions is fixed, we can write $m/_{\rho F} = \sigma(\frac{\dot{\rho}}{\rho})$. By inverting this equation and solving for $\dot{\rho}$, the following equation is obtained:

$$\dot{\rho} = \rho L(\frac{m}{\rho F}); L'(*) < 0 \quad \text{.....(3.19)}$$

The equilibrium real balances and the parallel market premium are represented in Figure 3.1.

Figure 3.1: Equilibrium real balances and parallel market premium



Source: Edwards (1999: 69)

The $\dot{\rho} = 0$ schedule has been drawn in Figure 3.1 and has a positive slope, because the public has to hold more of *m* as ρ increases. The greater the spread, the lower the expectations of further increases in the free market rate and thus the greater the amount of domestic money the public is prepared to hold. By combining equations (3.10), (3.12), (3.13), (3.14) and (3.15), the following expression for $\dot{m}$ can be constructed:

$$\dot{m} = Q_X(e_X) - C_M(e_M, a) + g_N - t/E \quad \text{...(3.20)}$$

Equilibrium of the external sector requires that $\dot{m}$ = *0*. In addition, the $\dot{R} = 0$ schedule and the $\dot{m}$ = *0* schedule coincide under the steady-state requirement that government expenditures are fully financed with taxes and domestic credit creation. The $\dot{m}$ = *0* schedule has a negative slope in Figure 3.1 because an increase in *m* results in a higher *a* and in a current account deficit; in order to restore equilibrium, real assets (*a*) should go down through a fall in ρ.

The steady-state level of real balances (m_0) and the steady-state parallel market premium (ρ_0) are shown in Figure 3.1 by the intersection of the two schedules. Edwards's model suggests that this system is characterised by saddle path equilibrium and (ss) is the saddle path with arrows denoting the dynamic forces at work in the system.

Finally, after the steady-state values of ρ and *m* are identified, equation (3.18) can be used to find the long run equilibrium price of nontradables given the corresponding values of g_N, P_M^* and τ. Equation (3.16) can then be used to find the long run equilibrium real exchange rate (*q*):

$$q = v(m_0 + \rho_0 F_0, g_{N_0}, \tau_0, P_{M_0}^*) \quad \text{...(3.21)}$$

Equation (3.21) shows that the long run equilibrium real exchange rate is a function of real variables (fundamentals) only. A change in any of these fundamentals results in changes in the equilibrium real exchange rate. In the short run, however, changes in the nominal variables, such as monetary variables ($D, \dot{D}$ and *E*), will also impact on the real exchange rate. The fundamental variables in this model can be categorised into external and domestic real exchange rate fundamentals (Edwards, 1989, in Mkenda, 2001:

17). The external real exchange rate's fundamental variables include international terms of trade, international transfers (including foreign aid), and world real interest rates. Domestic fundamentals, on the other hand, include those variables that are directly affected by policy decisions, such as import tariffs, import quotas and export taxes, capital and exchange controls, the composition of government expenditure, and those that are independent of policy decisions, for example technological progress. Edwards (1994, in Williamson, 1994: 68) shows how each of these variables affect the equilibrium real exchange rate, but this will only be covered after considering another theoretical model which, in my opinion, is an extension to Edwards's model.

3.2.2.2 Montiel's model of the long run equilibrium real exchange rate

Montiel's (1999) model is, in my opinion, an extension to Edwards' model and is based on the notion that the real exchange rate is an endogenous variable. In this model, the economy's endogenous variables are determined by three types of variables:

i. Predetermined variables
ii. Exogenous policy variables
iii. Other exogenous variables

Predetermined variables are endogenous variables that change slowly over time, such as the economy's capital stock, technology, net international creditor position and nominal wage. Exogenous policy variables include fiscal and monetary policies, trade policies and other variables under the control of the domestic authorities. Other exogenous variables include observable variables, such as the terms of trade, world interest rates etc., unobservable variables (random shocks) and bubble variables. Bubble variables are those that affect the economy only through their influence on sentiment.

Since the real exchange rate (q) is an endogenous variable, Montiel (1999, in Montiel, 2003: 316) expresses it as determined by the reduced form relationship:

$$q_t = F[X_1(t), X_2(t), X_3(t), B(t)] \quad \text{...(3.22)}$$

where X_1 represents the current values of a set of predetermined variables, X_2 represents the current and expected future values of a set of real policy variables, X_3 is the current and expected future values of a set of exogenous variables (observable and unobservable) and B indicates bubble variables. However, the long run equilibrium real exchange rate is not affected by all the categories of variables given in equation (3.22), but is affected only by the sustainable values of the exogenous and policy variables called the long run fundamentals, as shown in equation (3.23):

$$q^* = F(X_2^*, X_3^*) \quad \text{...(3.23)}$$

where q^* is the long run equilibrium real exchange rate, and X_2^* and X_3^* represent steady-state variables or the long run fundamentals. As mentioned in the introduction to this chapter, the fundamentals must be identified before the long run equilibrium real exchange rate can be estimated. This is where this model comes in to attempt to identify the fundamentals.

In this model, the equilibrium real exchange rate is defined as the value of the real exchange rate that is simultaneously consistent with internal and external balances, conditioned on sustainable values of exogenous and policy variables. The model builds on the three-good production framework presented in the previous section, but simplifies it by assuming that exportable goods are not consumed at home. It assumes that capital is fixed and not mobile across sectors, but labour is intersectorally mobile. Because the capital stock is fixed, the model does not allow for investment spending. The economy is assumed to be financially open and residents pay a premium for external borrowing, which depends on the country's net creditor position. The model is quite detailed[24], but can be summarised in the form of two equations

[24] For full details of the model see Montiel (1999, in Hinkle and Montiel, 1999: 264-290).

– (3.24) and (3.25) – representing internal and external balance, respectively. The internal balance condition for simultaneous equilibrium in the market for nontradable goods and labour is expressed in equation (3.24):

$$Y_N(q,\phi) = (1-\theta)qc + g_N \quad \text{...(3.24)}$$

where:

Y_N = level of output of nontradable goods in the economy;

q = importables real exchange rate (price of importable goods in terms of nontradable goods);

ϕ = relative price of exportable goods in terms of importable ones (terms of trade);

θ = share of importables in private absorption;

c = private absorption, measured in terms of importable goods; and

g_N = government consumption of nontradable goods.

The left-hand side of equation (3.24) is the supply of nontradable goods, while the right-hand side represents the demand for such goods. The supply and private absorption of nontradable goods are dependent on the real exchange rate in equation (3.24).

The external balance condition requires full adjustment of the country's net creditor position, and thus sets the current account deficit equal to the sustainable level of capital inflows as given by:

$$\pi^* f^* = \phi Y_X(q,\phi) + Y_Z(q,\phi) + (r^* + \pi^*) f^* + t - [\tau(\pi^*) + \theta]c - g_Z \quad \text{....................(3.25)}$$

Where:

π^* = world rate of inflation;

f^* = the economy's steady-state net international creditor position;

Y_X and Y_Z = the levels of output of exportable and importable goods, respectively;

r^* = the world real interest rate;

t = the value of international transfers received by this economy;

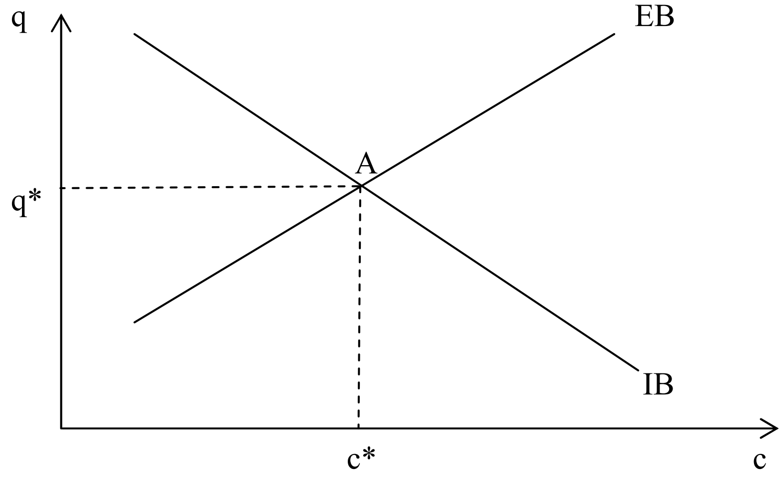
τ = the cost, per unit of consumption, of making transactions; and

g_Z = the government's consumption of importable goods.

Transaction costs (τ) are included in Montiel's model to explain why people hold money. Money is held to reduce the cost of making transactions and this cost is lower when more money is held. Since the demand for money inversely depends on the domestic rate of inflation (equal to the world rate π^* under fixed exchange rates), transaction costs per unit of consumption are increasing in π^*. In equation (3.25) domestic output of tradable goods is the sum of production of exportables and importables ($\phi Y_X + Y_Z$). Domestic spending on tradable goods is the sum of private spending and government spending $[(\tau + \theta)c + g_Z]$. The domestic excess supply of tradable goods, which is the difference between the supply of and demand for tradable goods, is equal to the trade balance surplus. Adding net interest receipts from abroad $[(r^* + \pi^*) f^*]$ and the receipt of net international transfers (*t*) to the trade balance yields the current account of the balance of payments. As has been noted above, for the external balance to hold, the current account must be equal to the sustainable capital inflow, which is the amount of new borrowing required to offset the inflationary erosion of the country's net international creditor position in the presence of world inflation. This is given by the expression on the left-hand side of equation (3.25).

The solution of Montiel's model for the long run equilibrium real exchange rate is shown in Figure 3.2, which plots the internal balance condition [equation (3.24)] and the external balance condition [equation (3.25)], with real private consumption (*c*) on the horizontal axis and the real exchange rate (*q*) on the vertical axis.

Figure 3.2: Determination of the equilibrium real exchange rate



Note: An upward movement in q is a depreciation of the real exchange rate
Source: Montiel (1999: 278)

The external balance curve (EB) has a positive slope, because an increase in the consumption of nontradable goods due to an increase in consumption increases the trade deficit, as more of imported goods will ultimately be consumed. This situation requires a real exchange rate depreciation (an increase in q in Figure 3.2) to shift resources into the production of traded goods in order to maintain external balance. On the other hand, the internal balance curve (IB) has a negative slope, because increases in consumption increase the demand for nontradable goods, which must be offset by an increase in their relative price (an appreciation or reduction in q), so as to maintain equilibrium in the nontradable goods market. As already noted, the long run equilibrium real exchange rate is that which is simultaneously consistent with external and internal balances in the long run. It is labelled q* in Figure 3.2, where it is illustrated by the intersection of the IB and EB at point A.

Montiel's model suggests that the long run equilibrium real exchange rate will be affected by factors that cause changes in the positions of the IB and EB curves. A myriad of such factors exist and all those factors together represent the relevant set of long run fundamentals. Montiel (1999: 279) shows that these factors include changes in fiscal policy, changes in the value of international transfers, changes in international financial conditions, the Balassa-Samuelson effect, changes in the terms of trade and changes in commercial policy. Permanent changes in any of these fundamentals will change the long run equilibrium real exchange rate in predictable directions (Montiel, 2003: 325).

By consolidating Edwards' (1989) model and Montiel's (1999) model, the variables that affect the real exchange rate include the terms of trade, changes in fiscal policy (sectoral composition of government spending), changes in the value of international transfers, changes in international financial conditions, the Balassa-Samuelson effect (differential productivity growth in the tradable goods sector), changes in commercial policy, changes in monetary policy, changes in foreign exchange reserves and changes in nominal exchange rate policy. The impact of these variables on the real exchange rate is briefly discussed below.

Terms of trade

Terms of trade are defined as the ratio of the price of a country's exports to the world price of imports. In other words, they are defined as the price of exportables in terms of importables. Thus, the effect of the terms of trade on the real exchange rate operates through import and export price variations. The impact of a change in the terms of trade on the real exchange rate is theoretically ambiguous. It depends on the relative strength of the income and substitution effects, which emerge from changes in the prices of both imports and exports. If the direct income effect dominates the indirect substitution effect following an increase in the price of exports relative to imports (an improvement in the terms of trade), the real exchange rate will appreciate. This is because when the price of South Africa's exports increases, the income of the country increases and, in turn, raises the demand for nontradable goods and hence a real exchange rate appreciation. On the other hand, the indirect substitution effect may dominate the direct income effect leading to opposite terms of trade effect; an improvement in the terms of trade may lead to a depreciation in the real exchange rate (Montiel, 1999: 287 and

Mkenda, 2001: 24). Thus, a fall/rise in the terms of trade tends to stimulate a depreciation/appreciation of the real exchange rate when the income effect is stronger than the substitution effect. The opposite is true when the substitution effect dominates the income effect.

Fiscal policy

The impact of government consumption on the real exchange rate depends on whether such spending is predominantly on tradable goods or on nontradable goods. An increase in government spending on tradable goods creates a trade deficit, which requires a real depreciation in the exchange rate in order to maintain external balance. The real depreciation in the exchange rate induces an increase in the production of tradable goods, allowing an increase in total spending on tradable goods. In contrast, an increase in government spending on nontradable goods leads to an increase in their relative price in order to maintain equilibrium in the nontradable goods market. An increase in the relative price of nontradable goods, in turn, appreciates the real exchange rate (Edwards, 1994: 70 and Montiel, 1999: 281). Thus, the real exchange rate is a function of the sectoral composition of government spending, with an increase in government spending on tradable goods leading to a depreciation of the real exchange rate, and when its increase falls heavily on nontradables, the real exchange rate appreciates.

The value of international transfers and capital inflows

Montiel (1999:281) shows that changes in the level of international transfers received by the domestic economy have an impact on the equilibrium real exchange rate. An increase in this variable results in an addition to household incomes equal to the amount of the transfer. Additional transfer income permits an expansion of consumption which, in turn, will raise the price of nontradable goods and eventually an appreciation of the real exchange rate (Montiel, 1999: 282). Edwards and Montiel differ on the treatment of capital flows in their models. Edwards assumes that net capital flows are restricted to the government and are exogenous. On the other hand, Montiel assumes that the volume of capital inflows is an endogenous variable that can arise from a variety of changes in domestic and external economic conditions. However, the two are in agreement that an increase in capital inflows permits an expansion of absorption and consequently an appreciation of the real exchange rate (Edwards, 1994: 70 and Montiel, 1999: 282). Another way capital flows affect the real exchange rate is through an appreciation in the nominal exchange rate. Under a flexible exchange rate regime, as in South Africa, an increase in net capital inflows produces an excess supply of foreign exchange which, in turn, leads to an appreciation of both the nominal and real exchange rates, assuming that prices are slow to respond.

International financial conditions

Montiel treated capital flows as endogenous since they are influenced by real interest rate differentials between the home country and the rest of the world. However, real interest rate differentials could represent several factors, including increased aggregate demand and productivity, and persistent monetary policy. An increase in any of these factors, together with induced capital flows, appreciates the real exchange rate through an increase in the price of nontradable goods (Montiel, 1999: 283 and MacDonald and Ricci, 2003: 4). Thus, an increase in the real interest rate differential has the effect of appreciating the real exchange rate irrespective of the channel chosen to trace their transmission.

Relative productivity growth in the tradable goods sector

This is popularly known as the Balassa-Samuelson effect. This effect presupposes that productivity differences in the production of tradable goods across countries can introduce a bias into the overall real exchange rate, because productivity advances tend to be concentrated in the tradable goods sector; the possibility of such advances in the nontradable goods sector is limited. If a country experiences an increase in the productivity of the tradable goods sector, relative to its trading partners and nontradable goods sector, demand for labour in the tradable goods sector increases causing the nontradable goods sector to release labour to the tradable goods sector. Higher wages in the tradable goods sector pull labour out of the nontradable goods sector. At a given real exchange rate, the tradable goods sector, expands while the nontradable goods sector contracts. The supply of nontradable goods accordingly contracts creating excess demand in the sector and ultimately higher prices of nontradable goods. This will require a real appreciation of the exchange rate in order to restore internal balance.

At the same time, the increase in the production of tradable goods and a decline in their relative price creates an incipient trade surplus, as more of the country's tradable goods output is demanded in the world markets. As in the previous case, a real appreciation of the exchange rate is also required for the restoration of external balance. Thus, an increase in differential productivity growth in the tradable goods sector creates an appreciation of the real exchange rate (Montiel, 1999: 285, Edwards, 1994: 83 and MacDonald, 1998: 121).

Commercial policy

Commercial or trade policy is another variable that affects the real exchange in both Edwards' and Montiel's models. An increase, for example, in an import tariff can increase the domestic price of imports, which are part of tradable goods. This, in turn, shifts domestic demand towards nontradables, which will lead to an increase in their price beyond that in tradables, resulting in a real appreciation of the exchange rate. The increased demand for foreign currency, following an increase in the domestic price of imports, also appreciates the real exchange rate. An increase in export subsidies also creates a balance of payments surplus which requires an appreciation of the real exchange rate to correct (see Montiel, 1999: 288). Thus, commercial liberalisation (a more open economy) is likely to be associated with a more depreciated real exchange rate.

Monetary policy

The impact of monetary policy on the real exchange rate depends on the direction of the policy: expansionary or contractionary. An expansionary monetary policy, for example, represented by a growth of domestic credit and money supply, exerts upward pressure on domestic prices (mostly on nontradable goods) and hence an appreciation of the real exchange rate

(Edwards, 1994: 70). However, in Edwards' model monetary variables have only a short term impact on the real exchange rate.

Foreign exchange reserves

An improvement in the stock of foreign exchange reserves is theoretically expected to appreciate the real exchange rate, consistent with its role as a relatively liquid indicator of the stock of national wealth. Central bank reserves, in particular, indicate the capacity to defend the domestic currency and as such, an increase in reserves has an effect of appreciating the real exchange rate, while a decrease depreciates the real exchange rate. Higher net foreign exchange reserves induce larger expenditure on domestic goods due to the wealth effect, thus raising the price of nontradable goods relative to tradables and, in turn, appreciating the real exchange rate (Aron *et al*., 1997: 16 and MacDonald and Ricci, 2003: 6).

Nominal exchange rate policy

A change in the nominal exchange rate can affect the real exchange rate if prices are slow to respond (Joyce and Kamas, 2003: 159). Edwards included this variable in his model to capture short term fluctuations in the real exchange rate. A nominal devaluation or depreciation of the exchange rate depreciates the real exchange rate in Edwards's model. On the other hand, nominal revaluation or appreciation of the nominal exchange rate appreciates the real exchange rate. Edwards (1994: 88) finds that the coefficient of a variable representing nominal devaluation is quite large, providing evidence to support the view that nominal devaluations can indeed be a powerful tool to manage the real exchange rate.

Before attempting to estimate any of these theoretical models, a review of empirical literature may shed some more light on variables that have been empirically found to impact on the real exchange rate. A review of empirical studies on the determinants and behaviour of the real exchange rate, then, follows in the next section.

3.3 EMPIRICAL LITERATURE

Empirical works on the determinants of the real exchange rate and the effects of real exchange rate misalignment on the economy have assumed an important part in research over the past decade. However, very few studies have been conducted to explain real exchange rate behaviour in South Africa and other developing countries. In particular, there are no studies that have recently looked at the determinants and behaviour of the real exchange rate in the transformed (post-apartheid) South African economy. The existing empirical literature, in general, shows that purchasing power parity (PPP) is not an appropriate model for the determination of the equilibrium real exchange rate, because of the slow mean reversion of real exchange rates to a constant level (long run equilibrium implied by the PPP assumption). To this end, there has been a shift away from PPP-based measures of the equilibrium real exchange rate to the fundamentals frameworks, such as those by Edwards (1989) and Montiel (1999), presented in the previous section.

There are several ways of categorising empirical literature on the behaviour and determinants of the real exchange rate. These include categorisation by the type of analysis employed, for example country-by-country analysis, cross-section analysis and panel data analysis, and categorisation by countries studied, such as studies of developed countries or developing countries. The latter categorisation is followed in this review as it allows sensitivity to structural differences amongst these country groupings. This section is, therefore, divided into empirical literature from developed countries, developing and other emerging economies, and finally narrowed down to empirical literature from South Africa.

3.3.1 Empirical literature from developed countries

Literature from developed countries includes MacDonald (1998), Antonopoulos (1999) and Kempa (2005), among others.

MacDonald (1998) presents a reduced form model of the real exchange rate to re-examine the determinants of real exchange rates in a long run setting. His model features productivity differentials, terms of trade effects, fiscal balances, net foreign assets and real interest rate differentials as key fundamental determinants of the real exchange rate. Using multivariate cointegration methods, the model is implemented for the real effective exchange rates of the U.S. dollar, Yen and the Deutschmark, over the period 1974 to 1993. He finds evidence of a significant and sensible long run relationship for his model, indicating that the fundamentals mentioned above have an important and significant bearing on the determination of both long and short run real exchange rates. All the variables were found to have a positive relationship with the real exchange rate; an increase in any of them leads to an appreciation of the real exchange rate.

Antonopoulos (1999) tests the so-called “Shaikh hypothesis”, which states that the real exchange rate is fundamentally determined by the ratio of relative real unit labour costs (as a proxy for productivity differentials) of tradable goods between two countries. However, Antonopoulos’s model adds capital flows to the “Shaikh hypothesis” and employs cointegration methodology on Greece’s data covering the period 1960 – 1990. The study provides evidence that real exchange rate movements cannot be explained by the PPP hypothesis, that there is a strong role of the productivity of the export sector of Greece *vis-à-vis* that of the rest of the world, and that there is a less important role of net capital inflows. The evidence in this study suggests that an improvement in the relative productivity of Greece’s export sector and in capital inflows appreciates the country’s real exchange rate.

Kempa (2005) takes as a starting point a simple textbook version of the Dornbusch model of exchange rate determination and transforms it to obtain a decomposition of exchange rate, output and price level data of the British-U.S., German-U.S. and Japanese-U.S. bilaterals. Real exchange rates, as well as relative price levels and output movements, are decomposed into components associated with nominal shocks as well as shocks to aggregate supply and demand. In other words, Kempa (2005: 440) identifies two distinct sources driving exchange rates: one arising in financial markets and other in the real economy. Nominal shocks are measured as changes in money supply and money demand and aggregate supply shocks are measured by a series on industrial production, while the rate of domestic absorption and elasticity of the current account are used as proxies for aggregate demand shocks. The decomposition suggests that nominal shocks account for less than 33 per cent of overall real exchange rate variability, aggregate supply shocks explain less than 10 per cent of overall variability and the remaining variability is accounted for by aggregate demand shocks, particularly at longer forecast horizons. Thus, the evidence in this study suggests that exchange rate fluctuations appear to be predominantly equilibrium responses to real shocks, rather than volatility in financial markets.

3.3.2 Empirical literature from developing and other emerging market economies

The importance of the real exchange rate, particularly in developing countries, has led to several studies investigating its determinants and behaviour. These studies include Edwards (1989), Ghura and Grennes (1993), Elbadawi (1994), Obadan (1994), Mkenda (2001), Miyakoshi (2003), Joyce and Kamas (2003) and Coricelli and Jazbec (2004), among others.

As noted in the last section, Edwards (1989) pioneered the fundamentals models of the determination of real exchange rates for developing countries. Edwards started by developing a theoretical model of the real exchange rate determination and then estimating its equilibrium value for a panel of 12 developing countries (Brazil, Columbia, El Salvador, Greece, India, Israel, Malaysia, Philippines, South Africa, Sri Lanka, Thailand and Yugoslavia) using conventional cointegration tests on time series data. To analyse the relative importance of real and nominal variables in the process of real exchange rate determination in the short and long run, he uses the following partial adjustment model: RER = v(terms of trade, government consumption, capital controls, exchange controls, technical progress, domestic credit, real growth, nominal devaluation). The study finds that in the long run only real variables affect the long run equilibrium real exchange rate. In the short run, however, real exchange rate variability is explained by both real and nominal factors. More precisely, the most important factors identified in this study as affecting the equilibrium real exchange rate are the terms of trade and composition of government spending, the control of foreign exchange and the movement of goods (openness), technical progress and capital inflow. An increase in government consumption, capital inflows, terms of trade and a decrease in technological progress and openness appreciate the real exchange rate (Edwards, 1994: 86-88). Edwards further investigates the impact of real exchange rate misalignment on economic performance, and concludes that countries whose real exchange rates are closer to equilibrium outperform those with misaligned real exchange rates.

Edwards's pioneering work inspired a number of studies on not only the determinants of the real exchange rate, but also on the effects of real exchange rate misalignment, the majority of them using cointegration tests rather than classical regressions. These studies include Ghura and Grennes (1993) who use a panel of Sub-Saharan countries, excluding South Africa, to investigate the determinants of the real exchange rate and the impact of real exchange rate misalignment on economic performance. Ghura and Grennes (1993: 163) employ a classical regression methodology and find that the real exchange rate becomes appreciated with (i) an improvement in the terms of trade, (ii) a capital inflow, (iii) a decrease in openness, (iv) an increase in excess domestic credit, and (v) an improvement in technology. Nominal devaluation, the last variable in their model, depreciates the real exchange rate. With regard to the impact of real exchange rate misalignment and variability, they find that real exchange rate misalignment and variability negatively affect income growth, exports and imports, and investment and savings.

Elbadawi (1994) also develops a model of the determination of the long run equilibrium real exchange rate. The fundamental determinants of the long run equilibrium real exchange rate in this model include the terms of trade, openness (a proxy for commercial policy), the level of net capital flows relative to GDP, the share of government spending in GDP and the rate of growth of exports (a productivity measure). Elbadawi empirically estimates his model on annual data for Chile, Ghana and India. The findings of this study suggest that, in all three countries, the real exchange rate and all the fundamentals identified in the model are non-stationary and cointegrated. In addition, the qualitative signs of these fundamentals' coefficients in the cointegrating regressions are in accord with theoretical predictions.

In order to provide quantitative information on the real and policy determinants of the real exchange rate in Nigeria, Obadan (1994) formulates a simple econometric model and empirically estimates it together with a random walk model of the real exchange rate determination. Both models are estimated in log-linear forms using the two-stage least squares regression methodology and data for the period 1970 – 1988. Although this study fails to test variables for stationarity and does not estimate the equilibrium real exchange rate, it finds that both structural and short run factors are important determinants of variations in prevailing bilateral real exchange rates and multilateral real effective exchange rates. The study finds that the most important factors are international terms of trade, net capital inflows, nominal exchange rate policy and monetary policy. Obadan finds that an improvement in terms of trade, appreciation of the nominal exchange rate and net capital inflow appreciate the real exchange rate, while expansionary monetary policy depreciates the real exchange rate.

Mkenda (2001) analyses the main determinants of the real exchange rate in Zambia. The study presents an illustrative model based on the three-good production structure and employs cointegration analysis in estimating the long run determinants of the real exchange rates for imports and exports, and of the internal real exchange rate. The results of this study provide evidence that (i) a decline in the terms of trade and government consumption depreciates the real exchange rate for imports, while an increase in investment share of GDP appreciates the real exchange rate for imports; (ii) a decrease in the terms of trade, an increase in central bank reserves and trade taxes appreciate the real exchange rate for exports in the long run; (iii) in the long run, the internal real exchange rate is strengthened by a decrease in the terms of trade, an increase in investment share and the rate of growth of real GDP (a proxy for technological progress); (iv) in the short run, however, aid and openness depreciate the real exchange rate indices.

Miyakoshi (2003) re-examines three models for the determination of the real exchange rate in six East-Asian countries. The three explanations for real exchange rate behaviour examined in this study are: “the productivity bias model” (productivity differentials between nations), “real interest rates bias model” (real interest rate differentials) and the “political risk premium model”. By employing multivariate cointegration techniques, the study provides evidence that the real interest rate bias model does provide a valid explanation of the long run real exchange rate, the productivity bias model is valid for two of the six countries and there is no evidence to support the political risk premium model.

Joyce and Kamas (2003) re-investigate the factors that determine the real exchange rate in Argentina, Colombia and Mexico, distinguishing between real and nominal determinants. The study employs cointegration analysis, variance decompositions and impulse response analysis. Cointegration results establish that the real exchange rate has an equilibrium relationship with real variables (terms of trade, capital flows, productivity and government share of GDP), which excludes nominal variables (nominal exchange rate and money) and central bank intervention. In addition, an increase in all the real variables in their model appreciates the real exchange rate. Variance decompositions show that the terms of trade and productivity, among other real variables, explain much of the variation in the real exchange rates. In the short run, however, the nominal exchange rate accounts for most of the variations in the real exchange rates of all three countries. Finally, their impulse response analysis reveals that shocks to nominal variables have only transitory effects on the real exchange rate, thus consistent with theoretical predictions.

More recently, Coricelli and Jazbec (2004) analyse the phenomenon of real exchange rate appreciation that has characterised 19 transitional economies, which includes a group of nine Central and Eastern European countries, three Baltic countries and seven former Soviet Union countries. They use ordinary least squares regression to show that the real exchange rate – measured as the relative price of tradables in terms of nontradables – is affected by adverse initial conditions and structural reforms only in the first five years of the transition process. After this period, their results provide evidence that productivity differential, the share of nontradables consumption in total private consumption and real government consumption negatively affects the real exchange rate, thus contributing to the real appreciation of the currencies of these economies. However, the Balassa-Samuelson effect (productivity differentials) seems to dominate the determination of the real exchange rate in this study.

3.3.3 Empirical literature from South Africa

There are very few studies that have analysed the determination of the real exchange rate and its behaviour in South Africa. As mentioned earlier in this study, the period after the transformation of the South African economy remains largely neglected. The few studies that have investigated the determinants of the real exchange rate of the rand include the pioneering work of Edwards (1989) and later Aron *et al*. (2000) and MacDonald and Ricci (2003).

Edwards (1989) was reviewed in the previous sub-section on empirical literature from other developing and emerging markets. As noted there, the main finding in this study is that, in the long run, only real variables affect long run equilibrium real exchange rates of a panel of 12 developing countries, including South Africa, while in the short run the real exchange rate is driven by both real and nominal factors. However, since the study employed panel methods, it did not provide a specific result for South Africa.

Aron *et al*. (2000) employ a cointegration framework with single equation equilibrium error correction models to investigate the short and long run determinants of the quarterly real effective exchange rate for South Africa, over the period 1970:1 – 1995:1. They find a cointegrated equilibrium from a theoretical model characterising equilibrium as the attainment of both internal and external balance for sustainable capital flows and trade tax regimes, given terms of trade (including the price of gold) and technology. Specifically, they estimate an equation based on the following explanatory variables: RER = F(terms of trade, price of gold, tariffs, capital, official reserves, openness, nominal depreciation, government share in GDP, domestic credit, technological progress). An increase in the terms of trade, price of gold, tariffs, capital inflows, official reserves, government share in GDP, domestic credit and technological progress, all lead to an appreciation of the real exchange rate in South Africa, while an increase in openness and nominal depreciation depreciates the real exchange rate. Their finding that an increase in the terms of trade leads to an appreciation of the real exchange rate suggests that the income effect dominates the substitution effect in South Africa. However, the remaining variables (nominal depreciation and domestic credit) show only a short term impact on the real exchange rate.

Finally, MacDonald and Ricci (2003) also estimate the equilibrium real exchange rate for South Africa using the Johansen cointegration estimation procedure and data spanning from 1970:1 – 2002:1. The explanatory variables included in their model include real interest rate differential, real GDP *per capita* relative to trading partners (productivity), real commodity prices, openness, the ratio of fiscal balance to GDP and the ratio of net foreign assets of the banking system to GDP. Based on their cointegration estimation results, much of the long run behaviour of the real effective exchange rate of South Africa can be explained by real interest rate differentials, relative GDP *per capita* (productivity), real commodity prices (terms of trade), trade openness, the fiscal balance and the extent of net foreign assets. As in other empirical studies, they find that an increase in the real interest rate differential, productivity, terms of trade, fiscal balance and net foreign assets appreciate the real exchange rate in South Africa, while an increase in openness depreciates it. They further find that if the real exchange rate deviates from its equilibrium level owing to temporary factors, it can be expected to revert to equilibrium fairly quickly, in the absence of further shocks. Their study partly covers the post-apartheid period, but does not employ other analytical techniques, such as variance decompositions and impulse responses, which can provide a wealth of information on dynamic effects on the real exchange rate. Further, the study excludes some variables which other researchers have used in analysing other emerging market economies, such as monetary variables. These and other gaps that have already been mentioned will be addressed in this study.

It can be noted from the foregoing empirical literature review that there is a myriad of factors that affect the real exchange rate. Table 3.1 summarises the empirical literature and provides a quick check list for selecting variables to be tested in empirical analysis.

Table 3.1: Summary of selected empirical literature on the determinants of the real exchange rate

Study	Countries	Methodology	Determinants
Kempa (2005)	Britain, U.S., German, Japan	Variance decomposition	Nominal shocks (financial market shocks), aggregate supply and aggregate demand shocks.
Coricelli and Jazbec (2004)	19 Transitional economies	Classical regression	Productivity differential, share of nontradables consumption in total private consumption and real government consumption.
Miyakoshi (2003)	6 East-Asian countries	Multivariate cointegration	Real interest rate differential, productivity differential.
Joyce and Kamas (2003)	Argentina, Colombia, Mexico	Cointegration, variance decomposition and impulse response	Terms of trade, capital flows, productivity, government share of GDP, nominal exchange rate, broad money.
MacDonald and Ricci (2003)	South Africa	Multivariate cointegration	Real interest rate differential, productivity, terms of trade, trade openness, fiscal balance, net foreign assets.
Mkenda (2001)	Zambia	Multivariate cointegration	Terms of trade, government consumption, investment share in GDP, central bank reserves, trade taxes, technical progress, openness, aid.
Aron *et al*. (2000)	South Africa	Multivariate cointegration	Terms of trade, price of gold, tariffs, capital flows, central bank reserves, openness, nominal depreciation, domestic credit, technical progress, government expenditure.
Antonopoulos (1999)	Greece	Multivariate cointegration	Productivity differential, capital flows.
MacDonald (1998)	U.S., German, Japan	Multivariate cointegration	Productivity differential, terms of trade, fiscal balance, net foreign assets, real interest rate differential.
Elbadawi (1994)	Chile, Ghana, India	Multivariate cointegration	Terms of trade, openness, ratio of net capital inflows to GDP, share of government spending in GDP, rate of export growth (productivity).
Obadan (1994)	Nigeria	Two-stage least squares regression	Terms of trade, net capital inflow, nominal exchange rate policy, monetary policy.
Ghura and Grennes (1993)	33 Sub-Saharan African countries	Classical regression	Terms of trade, capital flows, openness, excess domestic credit, technical progress, nominal devaluation.
Edwards (1989)	12 Developing countries	Multivariate cointegration	Terms of trade, level and composition of government spending, capital flows, openness, foreign exchange control, technical progress, nominal devaluation.

3.4 CONCLUDING REMARKS

The main objective of this chapter has been to investigate the potential determinants of the real exchange rate. There are several theoretical models of the determination of the real exchange rate, let alone of its measurement, but the so-called fundamentals models have emerged as the most popular in empirical analysis on this subject. These models combine several other models to come up with potential fundamental determinants of real exchange rates. In other words, they provide a unified dynamic framework for analysing the behaviour of the real exchange rate.

It is very difficult to summarise literature on the determinants of the real exchange rate. Previous researchers have empirically estimated these fundamentals models, but only selecting variables that suit their different situations. However, it is self-defeating to come away from the vast literature covered in this chapter without more than a feeling that the main determinants of the long run real exchange rate in developing countries include changes in the terms of trade, productivity (technological progress) and real interest rate differentials *vis-à-vis* trading partner countries, fiscal policy (sectoral composition of government spending), international transfers and capital flows, commercial policies and the extent of net foreign assets. However, shocks to nominal variables, such as changes in monetary and nominal exchange rate policies, may cause the real exchange rate to deviate from its long run path, but their effects will only be transitory. Thus, the real exchange rate is determined by both real and nominal variables in the short run, while only real variables influence the real exchange rate in the long run.

With regard to the impacts of each of these variables on the real exchange rate, increases in the terms of trade and an expansionary fiscal policy have a theoretically ambiguous impact on the real exchange rate. However, the majority of empirical studies on developing economies reviewed in this study have found that both an improvement in the terms of trade and an increase in government consumption led to an appreciation of the real exchange rate. A rise in relative productivity that is biased towards tradable goods (the Balassa-

Samuelson effect), a rise in capital inflows and international transfers and in foreign exchange reserves will raise the relative price of nontradable goods and appreciate the real exchange rate. On the other hand, an increase in openness (liberalisation of commercial policy), contractionary monetary policy through decline in domestic credit and money supply, and nominal exchange rate devaluation or depreciation (when prices are sticky), will depreciate the real exchange rate. These variables and those that may emerge from the following chapter on the evolution of the exchange rate policy in South Africa will be included in the empirical model of this study in Chapter 5. However, the inclusion of these variables will be dependent on data availability, among other factors.

CHAPTER FOUR

AN OVERVIEW OF SOUTH AFRICA'S FOREIGN EXCHANGE RATE REGIMES

4.1 INTRODUCTION

The aim of this chapter is to provide a brief overview of the exchange rate regimes that South Africa has had during the study period[25] and the evolution of the real exchange rate in those different regimes. Edwards (1988: 33) shows that nominal exchange rate policy can be both a cause of and a tool for correcting misalignment in the real exchange rate. The importance of nominal exchange rate regimes that South Africa has had cannot therefore be underestimated when analysing the behaviour and determinants of its real exchange rate. In addition, knowledge of these regime shifts may assist in explaining structural breaks that may be observed in the data, thus important for modelling the real exchange rate. This chapter is thus divided into three sections. The first section covers the evolution of the South African exchange rate system during the study period. The second section turns to the evolution of the real exchange rate itself, while the last section concludes the chapter.

4.2 THE EVOLUTION OF THE SOUTH AFRICAN EXCHANGE RATE SYSTEM, 1970 – 2005

This section is further divided into four sub-sections that mirror the different foreign exchange rate regimes that characterised those periods. Until 1979, the South African exchange rate was essentially fixed, as it was pegged either to the US dollar or to the pound sterling. South Africa moved to a dual exchange rate system in 1979, which was discarded temporarily in 1983 for two years and ultimately in 1995 when the country adopted a unified and freely floating exchange rate system. These episodes of regime shifts are formally treated below.

[25] The study period actually starts in 1975 due to the unavailability of uniform time series data for some variables in the model, but this review of South Africa's exchange rate system starts in 1970 for completeness.

4.2.1 The period 1970 to 1979

This period was characterised by the demise of the Bretton Woods System and attempts by the authorities to maintain a relatively stable exchange rate of the rand. Pressures began to build up sharply from the early 1970s against the Bretton Woods System when several currencies began to float. The Reserve Bank was consequently forced to adjust the country's exchange rate regime. In 1971, the rand, which for the previous decade had been pegged to the pound sterling, was pegged to the US dollar, because the relatively underdeveloped foreign exchange market of the rand did not permit an independently floating exchange rate and most of South Africa's foreign transactions were denominated in US dollars (Van der Merwe, 1996: 2 and Aron *et al*., 1997: 2).

The peg reverted to sterling by December 1971 and as part of the general realignment of exchange rates, the rand was devalued by 12.3 per cent. In June 1972, the pound sterling started to float downward against other major currencies and the rand-sterling link was maintained in order to ensure that the recovery of the nation's balance of payments was kept on track. However, this policy lasted only four months after which the rand was once again pegged to the US dollar, at a level of R1=US$1.42, which resulted in an effective appreciation of the rand against all other major currencies of about 3 per cent. Nevertheless, the devaluation of the US dollar by 10 per cent in February 1973 was not followed by the rand, because of a sound balance of payments position and a general economic climate which was conducive to economic growth. Consequently, the rand re-valued by about 5 percent against the dollar in June 1973, to R1=US$1.49 (Aron *et al*., 1997: 3).

By 1974, the oil crisis had resulted in a global economic slowdown that impacted negatively on economic activity. In order to reflect the changes in South Africa's balance of payments and domestic economic situations and ensure macroeconomic stability, the South African Reserve Bank (SARB) announced on 21 June 1974 that a policy of independent-managed floating of the rand would be followed. This system involved a number of small but frequent adjustments to the middle market rand/dollar exchange rate. In the year from June 1974, eleven adjustments were made and the authorities, consequently, kept the nominal effective exchange rate of the rand fairly stable (Van der Merwe, 1996: 3).

The policy of independent-managed floating was sustained up to March 1975. The SARB linked the rand to the dollar again in June 1975, because of speculative pressures on the rand following the strengthening of the US dollar and the substantial weakening of the pound sterling. The authorities responded by changing their exchange rate policy in mid 1975 to keep the exchange rate between the rand and the US dollar constant for longer periods; only adjusting the rate when considered essential for the domestic and international situations. The new policy resulted in a depreciation of the rand in terms of the US dollar of about 4.76 per cent to a middle rand-dollar rate of US$1.40 per rand. The US dollar continued to strengthen against other major currencies in the following months and the effective exchange rate of the rand, which was still linked to the dollar, accordingly appreciated. Consequently, there was continued pressure on the balance of payments (deterioration of the balance of payments) forcing the SARB to devalue the rand against the dollar, in September 1975, from R1=US$1.40 to R1=US$1.15, representing a 17.9 per cent decline in the value of the rand. With the improvement in the balance of payments position and the stability of the US dollar, the link with the dollar was maintained until the beginning of 1979.

An integral part of the exchange rate regime in the years 1971 to 1979 was the controls on foreign exchange transactions. Various changes were made to the exchange control regulations, making them more restrictive or less stringent depending on domestic and international conditions at the time. This period started with stringent foreign exchange controls, which were imposed by the authorities in 1961 following the capital flight that emerged in the aftermath of the Sharpeville shootings and the consequent political upheavals (Aron *et al.*, 1997: 3). The gist of these controls was to stop capital outflows through restricting resident flows and placing the proceeds of the sale of assets by non-residents into blocked rand accounts. However, the controls were relatively relaxed for non-residents in 1976, making the previous blocked rand balances freely transferable. As a member of the sterling area, South Africa's foreign exchange rate policy and restrictive foreign exchange controls mirrored those which were applied in the United Kingdom.

4.2.2 The period 1979 to 1985

A commission of inquiry (the De Kock Commission) into the monetary system and monetary policy in South Africa was appointed in 1977 to research primarily on the exchange rate system. An interim report of this commission was published in January 1979 in which the commission reached the conclusion that South Africa's exchange rate system, which was based on "relatively fixed dollar pegging in a relatively underdeveloped foreign exchange market, was not conducive to the attainment of the optimum combination of economic growth, balance of payments equilibrium and internal economic stability" (De Kock Commission, 1979: 13). This brought the pegging of the rand to the US dollar officially to an end and a system of a managed-floating exchange rate was introduced.

The De Kock Commission recommended a fundamental reform of the foreign exchange market and policies relating to it. The long term objective was a unitary exchange rate system under which an independent and flexible rand finds its own level in well developed and competitive foreign exchange markets in South Africa. The intervention or management by the SARB would be necessary only in the form of purchases and sales of foreign currency (mainly US dollars) in order to keep the rand stable. In addition, foreign exchange controls would be temporarily imposed but abolished in the long term. To pursue this policy, greater flexibility was introduced into the foreign exchange market with a dual currency exchange rate system. A dual exchange rate system consisting of a commercial rand and a financial rand was introduced. The commercial rand was an independent-managed market determined rate, while the financial rand was a freely floating rate (De Kock Commission, 1979: 23). The financial rand replaced the old securities rand

and was introduced to separate foreign exchange transactions made by non-residents portfolio investors on the capital account from all other foreign exchange transactions. Various other measures were introduced during 1979 and 1980 to establish more flexibility into the commercial exchange rate of the rand and to improve the forward exchange market.

During the years 1981 and 1982, conditions were “not propitious to further reform the foreign exchange markets and exchange rate policy” (De Kock Commission, 1984: 123). Steps to move closer towards the long term objective, as set out by the De Kock Commission, were further implemented in 1983. Exchange controls for non-residents were lifted and this led to the demise of the dual exchange rate system; the financial rand was abolished. Controls on residents remained, but these were less stringent than in earlier years, while the blocking of emigrant assets remained. The unified currency exchange rate remained stable for a few months, but following the gold price decline in 1983, debt crisis and rising political instability in 1984, the rand depreciated sharply against all major currencies. It fell from R1=US$0.80 in early 1984 to R1=US$0.42 in January 1985, representing a 47,5 per cent depreciation. Despite the measures which were taken by the authorities to curtail speculation against the rand, the escalation of political instability and violence generated a lack of confidence in the country and a further flight of capital led to the value of the rand falling by almost 17 per cent to R1=US$0.35 by August 1985 (Aron *et al*., 1997: 3 and Bah and Amusa, 2003: 4).

4.2.3 The period 1985 to 1994

From late 1984, the socio-political situation became an important factor starting to impact on all sectors of the economy. Developments in the foreign exchange markets were hampered and the authorities were forced to revert to more direct control measures to influence the flow of capital and, in turn, manage exchange rates. Financial sanctions were imposed by the United Nations and other organisations on South Africa in 1985. Large scale withdrawal of assets and credit from the country began and the SARB was forced to revert to even tighter controls and to a dual exchange rate system.

The government responded to the sanctions by declaring a debt standstill, halting all debt payments. The financial rand was reinstated for foreigners who wanted to move capital out of the country and controls on residents were tightened. These controls were clearly a step backward in terms of the long term objectives set by the De Kock Commission (no exchange controls and a freely floating unitary exchange rate system). Because of the international isolation of the country, the authorities were unable to prevent a nominal effective depreciation of the rand of almost 19 per cent between January 1993 and the end of July 1994, despite their borrowings from the International Monetary Fund. In August 1994, the commercial rand fell to R1=US$0.28 and later to R1=US$0.18, while the discount on the financial rand was about 20 per cent reflecting the continued outflow of foreign capital (Van der Merwe, 1996: 7). The dual currency exchange rate system thereafter remained in existence until the unification of the rand in March 1995.

4.2.4 The period 1994 to 2005

This period began with a reform to political stability and developments in the foreign exchange market. The political situation in 1994 brought relief to the foreign exchange market with the first democratic elections in South Africa. The successful transformation to a new political dispensation paved the way for the normalisation and expansion of the country's international financial relations and the country became a borrower in the world financial markets again.

In pursuit of the long term objective of full financial liberalisation and integration of the country's economy into the world economy, the South African government abolished the financial rand in March 1995. The unified exchange rate system, which was adopted since then, ensures that the spot exchange rate of the rand is market determined; the currency finds its level in a relatively competitive foreign exchange market. To complement the liberalisation of the exchange rate, all but a few exchange controls over non-residents were abolished, although exchange controls over residents and emigrants were maintained. Gradual relaxation of all exchange controls was however envisaged. Significant relaxation over residents was effected in July 1997 and is still in progress. The full relaxation of all controls over residents is the long term objective and was recently advocated by the SARB Governor, Tito Mboweni. This system will allow South Africans full access to global markets, but of course with an impact on the exchange rate of the rand, as Bah and Amusa put it “the reduction in controls relating to the exchange rate market and capital flows have resulted in South Africa experiencing a significant increase in the volatility of both securities (stock and bonds) prices and the exchange rate of the rand against major world currencies” (Bah and Amusa, 2003: 5).

The free float of the rand and the relaxation of exchange control led to the currency’s exposure to both domestic and external shocks. In 1997, there was a crisis following the contagious effects from the Asian financial crisis and the decline in the price of gold[26] and other metals. Substantial amounts of capital were withdrawn all around the world from developing countries. The rand depreciated by more than 20 per cent against the dollar in response to the crisis. The SARB was forced to step in and interest rates were pushed up to indirectly influence the value of the rand. However, from the beginning of 1998, speculation due to a number of factors including the Asian crisis and mixed policy signals from the SARB concerning exchange controls, saw the rand reach a low of R6.35=US$1 in July 1998 and continued to fall (SAIFM, 2003: 13 and Bah and Amusa, 2003: 5).

Continued disturbances in other emerging market economies and non-economic disturbances in other parts of sub-Saharan Africa led to the depreciation of the nominal effective exchange rate of the rand by 17.4 per cent in 2000. A highly volatile political situation in Zimbabwe and the attacks

[26] Gold exports play a relatively huge role in South Africa’s balance of payments; sharp changes in the gold price have inevitably had a significant effect on the exchange rates of the rand with sharp declines normally leading to a depreciation of the rand (van der Merwe, 1996: 10).

on America in September 2001 further raised concerns about investments in emerging market economies and the nominal effective exchange rate of the rand declined (depreciated) by 34.4 per cent in 2001. Measured against the US dollar, the rand depreciated by 6.2 per cent in the first half of 2001 and by a further 33.3 per cent in the second half of 2001, but this was not unique to the rand. Currencies of other emerging market economies such as Brazil and Turkey also lost their ground against the US dollar (SARB, 2001: 47 and 2002: 48).

The exchange rate of the rand continued to be determined in a fairly liquid foreign exchange market following the adoption of a unified exchange rate system in 1995. Factors such as changed international sentiment towards emerging markets, South Africa in particular receiving favourable attention, eventual capital inflows, a surplus on the current account of the balance of payments and a rise in international commodity prices contributed to the recovery of the rand. The nominal effective exchange rate of the rand reflected this phenomenon by appreciating 24 per cent in 2002, 16.2 percent in 2003 and a further 8.2 per cent in the first half of 2004. Thus, this brought the appreciation of the nominal effective exchange rate of the rand from its low level at the end of 2001 to the end of June 2004 to 56.2 per cent (SARB, 2003: 46 and 2004: 40).

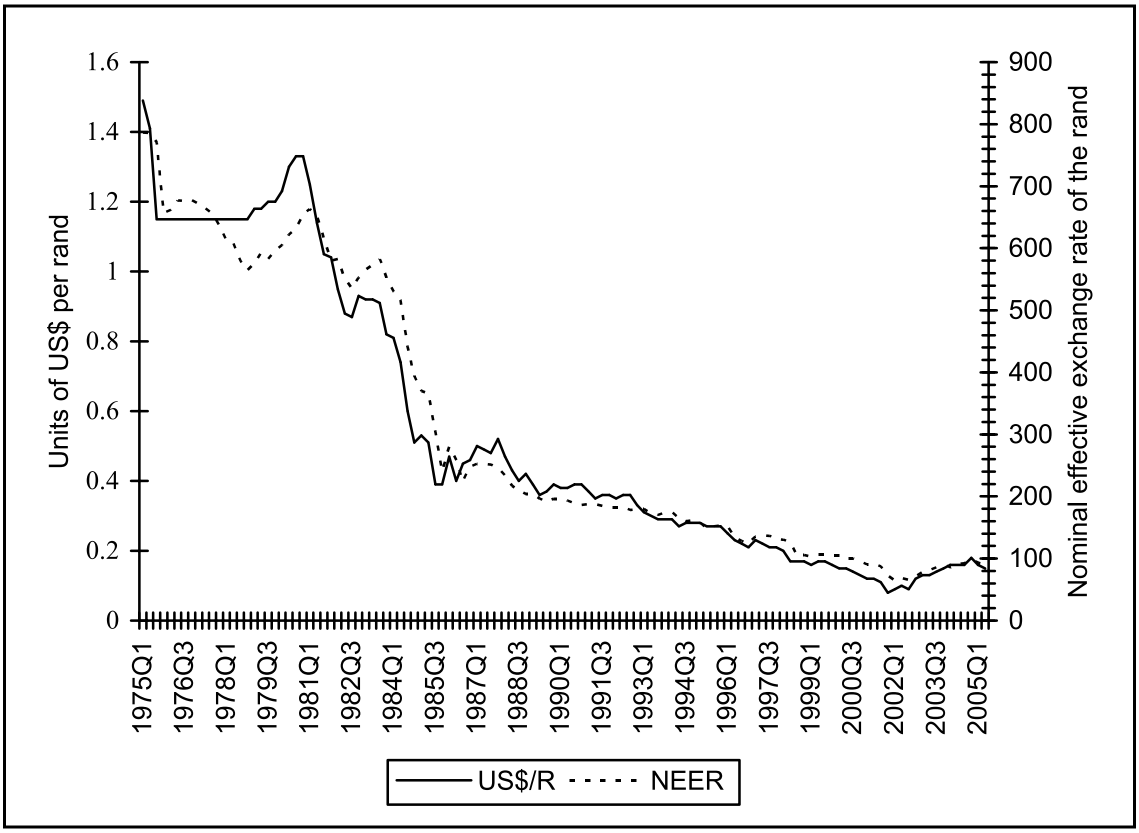
The nominal effective exchange rate of the rand, on balance, strengthened further during the second half of 2004. The strength of the rand was supported by a relatively weaker US dollar, firm commodity prices and continued positive investor sentiment towards South Africa. Consequently, the rand appreciated by 11.7 per cent in effective terms during 2004. Measured against the US dollar, the rand appreciated by 15.2 per cent from R6.64=US$1 at the beginning of 2004 to R5.63=US$1 by the end of the year. However, the nominal effective exchange rate of the rand, on balance, declined by 9 per cent during the first half of 2005. The SARB attributes this performance of the rand to the interest rate cut against the background of rising global interest rates, relatively lower international prices of key South Africa's export commodities, alongside sizeable deficits on the current account of the balance of payments (SARB, 2005: 41). Table 4.1 gives a summary of South Africa's exchange rate policy and major changes (parity changes) in the exchange rate of the rand since 1970, which was covered above.

Table 4.1: A summary of exchange rate policy and parity changes in South Africa, 1970-2005

Period	Exchange rate policy and value of the rand
1971	The demise of the Bretton Woods System and a move to a fixed exchange rate system, with rand linked either to the US dollar or to pound sterling: • the pound sterling link is abandoned for a US dollar link in August, at R1=US$1.40 • authorities decide to revert to the sterling link at R1.95=£1 in December.
1972	Fixed exchange rate regime is maintained, with rand allowed to float only against the US dollar and pound sterling: • sterling floats in June leading to the dismantling of the sterling area and the rand continues to be linked to the sterling • rand is re-linked to the US dollar in October at R1=US$1.23.
1973	Currency still pegged to the US dollar: • US dollar is devalued in February leading to a revaluation of the rand to R1=US$1.42 • rand is revalued in June to R1=US$1.49, representing a 4.98 per cent revaluation.
1974	Change of policy to a controlled-independent float, with frequent devaluations (every few weeks).
1975	Authorities decide to revert to a fixed US dollar peg: • rand is pegged, in June, at R1=US$1.40 • balance of payments deterioration, rand is devalued 17.9 per cent in September to R1=US$1.15.
1979	The US dollar link, which was maintained since 1975, is abandoned for the introduction of a dual exchange rate system: • the officially pegged rate of R1=US$1.15 is renamed the commercial rand and put on a controlled float. • a financial rand is introduced and put on a free float.
1983	The financial rand is abolished in February for the establishment of a unified, but controlled float of an effective rand.
1985	The financial rand is re-established and a return to a dual exchange rate system, following the imposition of financial sanctions on South Africa by the international community.
1995	Return to a unified exchange rate system and the implementation of gradual relaxation of exchange controls: • rand finds its level in a relatively competitive foreign exchange market (free float) • all but a few exchange controls over non-residents are abolished.
1997-1998	A significant relaxation of exchange controls over residents, the Asian financial crisis hits the world and a decline in the price of precious metals: • substantial amounts of capital withdrawn and rand depreciates by more than 20 per cent against the dollar in August 1997 • speculation on the rand leads to its reaching a period low of R6.35=US$1 in July 1998.
2001	Attacks on America and a volatile political situation in Zimbabwe are followed by substantial capital withdrawals from South Africa: • nominal effective exchange rate of the rand depreciates by 34.4 per cent • rand depreciates by more than 34 per cent against the US dollar.
2002-2005	Positive investor sentiment, a rise in international commodity prices and a relatively healthy balance of payments, all contribute to the recovery of the rand: • the nominal effective exchange rate of the rand appreciates by a cumulative 56.2 per cent between 2002 and the beginning of 2005.

Figure 4.1 displays the quarterly US dollar/rand exchange rate and the nominal effective exchange rate of the rand (2000 = base year) between 1975 and 2005. The evolution of the nominal exchange rate of the rand as described in this short history is clearly evident from the graph.

Figure 4.1: The evolution of the quarterly nominal exchange rate of the rand, 1975-2005

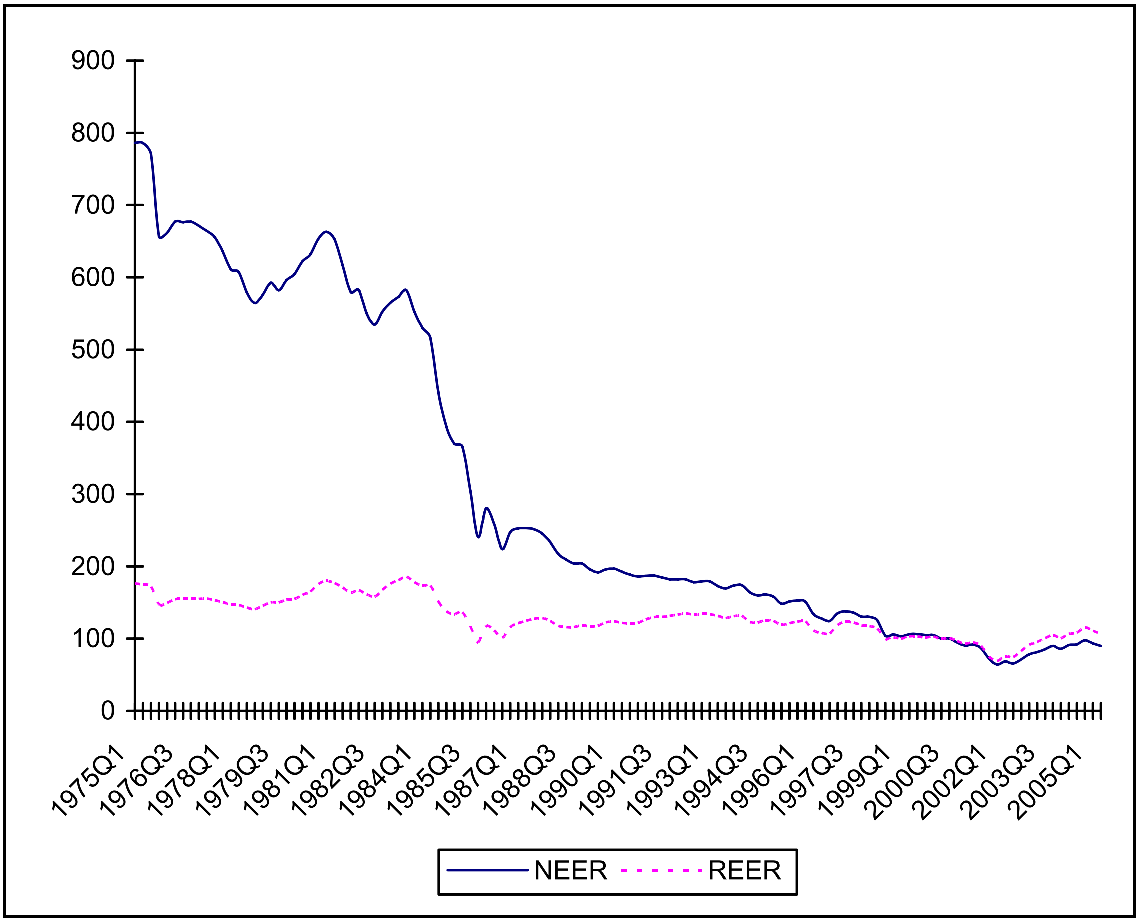


Note: An increase in both the US$/R and the NEER means an appreciation of the rand.
Source: IMF's International Financial Statistics (IFS), December 2005.

4.3 EVOLUTION OF THE REAL EXCHANGE RATE IN SOUTH AFRICA, 1975-2005

Having covered the history of exchange rate policy in South Africa and the evolution of the nominal exchange rate during the different regimes, it is also interesting to observe the behaviour of the real exchange rate itself. The real exchange rate is afforded a separate section here because factors and policies that influence the nominal exchange rate may not necessarily influence the real exchange rate in the same direction. Figure 4.2 plots the real effective exchange rate together with the nominal effective exchange rate of the rand (index, 2000 = 100 for both) in order to provide some information on the behaviour of prices in addition to the real exchange rate's response to regime shifts discussed in the previous section.

Figure 4.2: The real and nominal effective exchange rates of the rand, 1975-2005



Note: An increase in both the REER and the NEER means an appreciation of the rand.
Source: IMF's International Financial Statistics (IFS), December 2005.

As shown in Figure 4.2, movements in the nominal effective exchange rate (NEER) are reflected in the evolution of the real effective exchange rate (REER), but not with the same magnitude. The REER appears to be more stable than the NEER. Between 1975 and 1980, the REER of the rand was fairly stable, although there were wide fluctuations in the NEER. Between 1981 and 1987, the REER became volatile following the volatility in the NEER, with a huge fall (depreciation) between 1984 and 1985. As mentioned in the last section, this period was characterised by political disturbances, consequent imposition of sanctions on the country and falling international commodity prices. From 1988 to the ultimate unification of the exchange rate of the rand in 1995, both the REER and the NEER were largely stable. Aron *et al.* (1997: 4) show that although there was never any explicit policy to stabilise the real exchange rate during this period, the Reserve Bank appeared to be more active in stabilising the REER, partly out of concern for the international competitiveness of South Africa's manufacturing exports. Since the adoption of a unified exchange rate of the rand in 1995, which is market determined, both the REER and the NEER have become relatively volatile and, on balance, have tended to depreciate until the beginning of 2002. However, since 2002 both measures show some signs of recovery echoing the positive sentiment on South Africa by the international community. The REER and the NEER have appreciated by 46.2 per cent and 56.2 per cent between the beginning of 2002 and the end of 2004, respectively.

In addition, the REER and the NEER have tended to move closely together since 1988, while they were far apart prior to this period. This behaviour suggests that nominal exchange rate policy has an influence on the real exchange rate. Burda and Wyplosz (1997: 502) show that when nominal and real exchange rates move closely together, it is an indication that prices are sticky and that monetary forces play an important role in the short run determination of the real exchange rate. They further show that this situation also means that nominal exchange rate variations are not being explained by relative price levels as suggested by the purchasing power parity (PPP) theory. Thus, movements in the South African REER and NEER could be evidence that prices have become sticky or that monetary policy has gained greater influence on the behaviour of the exchange rate, coinciding with Aron *et al.*'s (1997: 4) observation, mentioned in the last paragraph. This suggests that relative prices (terms of trade) and monetary variables should enter our real exchange rate model in Chapter 5.

4.4 CONCLUDING REMARKS

This chapter reviewed the exchange rate regimes that South Africa has had during the study period and how the exchange rates have evolved in response to those regime shifts. The exchange rate system in general has changed considerably from a highly administrative to a more liberal exchange rate system. The authorities decided to move to a more liberal system in 1979, but commodity price movements and socio-political developments in the mid 1980s forced the authorities to revert to more direct control measures to manage exchange rates. However, the successful transformation to a new and stable political dispensation brought relief to the foreign exchange market and consequently South Africa has a unified exchange rate system where the exchange rate of the rand is essentially determined by market forces. Foreign exchange controls have also largely been relaxed, especially on non-residents, in order to move closer to the long term objective of financial liberalisation.

The evolution of both the nominal and real effective exchange rates of the rand suggests that prices are sticky and therefore monetary forces play an important role in the determination of the real exchange rate of the rand. In addition, the relationship between the two exchange rate measures also suggests that nominal exchange rate policy has an influence on the behaviour of the real exchange rate. This background on the exchange rate system in South Africa and the evolution of the exchange rate of the rand, together with the literature on the determinants of the real exchange rate covered in the previous chapter, guide us in developing a model for the real exchange rate in South Africa.

CHAPTER FIVE

ANALYTICAL FRAMEWORK

5.1 INTRODUCTION

The preceding review of the literature on the determinants of the real exchange rate and a background on the exchange rate system in South Africa, have both shed some light on the linkage between the real exchange rate and its potential determinants. This chapter builds on that background to set the analytical framework that is used in this study. It is divided into five sections. Section 5.2 consolidates the literature on the determinants of the real exchange rate and the background of the exchange rate system in South Africa, covered in the last two chapters, to develop a model that links the real exchange rate to its potential determinants. Definition of variables and data sources follows in section 5.3. A review of estimation techniques for the study of determinants of the real exchange rate is presented in section 5.4, while section 5.5 concludes the chapter.

5.2 MODEL SPECIFICATION

The theoretical analysis presented in Chapter 3 indicated that the real exchange rate is determined by both real and nominal variables in the short run. These variables include the terms of trade, productivity and real interest rate differentials, international transfers and capital flows, commercial policies, the extent of net foreign assets, monetary policy and nominal exchange rate policy. A review of the exchange rate policy in South Africa and the evolution of the real exchange rate also suggested that monetary policy and nominal exchange rate policy variables may have an influence on the behaviour of the real exchange rate. Based on this theoretical background and on data availability, this study estimates the following relationship:

$$LREER_t = \beta_0 + \beta_1 \overset{+/-}{LTOT}_t + \beta_2 \overset{-}{LOPEN}_t + \beta_3 \overset{+}{LDC}_t + \beta_4 \overset{+/-}{LGCON}_t + \beta_5 \overset{+}{RID}_t +$$
$$\beta_6 \overset{+}{TECHPRO}_t + \beta_7 \overset{+}{LNEER}_t + \mu_t \text{ ....(5.1)}$$

where the following notation has been used:

LREER = natural log of real effective exchange rate,

LTOT = natural log of the terms of trade,

LOPEN = natural log of an indicator of the degree of openness,

LDC = natural log of domestic credit ratio (a proxy for monetary policy),

LGCON = natural log of composition of government consumption (fiscal policy),

RID = real interest rate differential *vis-à-vis* trading partners,

TECHPRO = measure of technological progress (Balassa-Samuelson effect),

LNEER = natural log of a proxy of nominal exchange rate policy, and

μ = error term.

The impact of each of these variables on the real exchange rate has been covered in detail in Chapter 3, but we present a summary here in order to define equation (5.1). The impact of the terms of trade on the real exchange rate is theoretically ambiguous. It is dependent on the relative strengths of the income and substitution effects, as explained in Chapter 3. The expected sign for the terms of trade coefficient (β_1 in equation 5.1), therefore, can be either negative or positive. An increase in openness through trade liberalisation – tariff reduction or removal of quotas – increases imports and worsens the current account balance of payments, thus causing the real exchange rate to depreciate. A negative sign is, therefore, expected for the coefficient of openness. An increase in domestic credit is an indication of expansionary monetary policy. Generally, as mentioned in Chapter 3, an increase in this variable pushes the price of nontradable goods upwards and as a result the real exchange rate will appreciate.[27] Thus, the expected sign on domestic credit is positive as shown in equation (5.1).

[27] This transmission mechanism follows Edwards's model. However, in the classical Mundell-Fleming framework, a loose monetary policy causes a balance of payments deficit and a nominal exchange rate depreciation that, in turn, causes a depreciation of the real exchange rate if prices are sticky.

The anticipated sign on government consumption is not clear – it can either be positive or negative – because it is dependent on whether the consumption is directed towards the tradable goods sector or nontradable goods sector. If it is directed towards the nontradable goods sector, a positive sign will emerge, and vice versa. The expected sign on real interest rate differential is positive, because an increase in the real interest rate differential will cause a capital inflow which, in turn, will appreciate the real exchange rate. A rise in relative technological progress (productivity differential) is usually associated with stronger productivity in the tradable goods sector than in the nontradable goods sector. This results in an increase in both the price of nontradable goods and the volume of exports and, thus, a real exchange rate appreciation. This, therefore, suggests that the *a priori* sign for *TECHPRO* is positive. Finally, nominal devaluation or depreciation leads to a depreciation of the real exchange rate, if prices are slow to respond, while a revaluation or appreciation leads to an appreciation of the real exchange rate. It follows from this linkage that the expected sign on the coefficient of *LNEER* is positive.

The implementation of this real exchange rate model (equation 5.1) poses problems due to the unavailability of time series data for some of the real exchange rate's potential determinants. Very few theoretical determinants of the real exchange rate in equation (5.1), such as the terms of trade and the real interest rate differential, have time series data. This means that other determinants either have to be dropped from equation (5.1) or alternatively, proxies for them have to be found. Both approaches are followed in this study. We estimate real exchange rate equations under alternative specifications that either omit some variables in the model or use proxies for those that do not have data. The following section, therefore, defines the variables which are included in equation (5.1).

5.3 DEFINITION OF VARIABLES AND DATA SOURCES

As mentioned in the last section, proxies have to be found for variables without time series data. Their construction is explained below and is based on quarterly data from 1975 to the second quarter of 2005 for South Africa and its four major trading partners.[28] The variables, in level form, were obtained from the IMF's International Financial Statistics (IFS), CD-ROM, December 2005, unless indicated otherwise.

LREER: The natural logarithm of the real effective exchange rate of the rand, measured in foreign currency terms (index, 2000=100), thus an increase in this variable indicates an appreciation of the rand.

LTOT: The natural logarithm of the terms of trade, including gold, defined as the ratio of the world price of South Africa's exports to the world price of imports. Source: South African Reserve Bank (SARB)'s online data download facility.

LOPEN: This is a measure of the degree of openness. It is defined as the logarithm of the ratio of the sum of imports and exports of goods and services to GDP. Several other proxies ranging from the ratio of the tariffs to GDP to the ratio of tariff revenues to imports have been used, but this is the proxy that has been used by the majority of the studies (see Edwards, 1994: 84, Aron *et al.*, 1997: 31, Mkenda, 2001: 54 and MacDonald and Ricci, 2003: 21).

LDC: This variable indicates the stance of monetary policy and is measured as the logarithm of the ratio of total domestic credit to GDP.

LGCON: The logarithm of the ratio of government consumption to GDP, used as a proxy for the composition of government expenditure. Edwards (1994: 84) also employs this variable to proxy the ratio of government consumption on nontradables to GDP, which is the correct variable to use in equation 5.1, but no data is available for this variable.

[28] All the variables, with the exception of RID and TECHPRO, were converted to logarithms for the obvious reasons of obtaining elasticity coefficients on these variables and minimising the impact of outliers.

RID: Real Interest Differential between South Africa and its major trading partners is used as a proxy for a change in international financial conditions. We follow MacDonald (1998: 128) and MacDonald and Ricci (2003: 21) in constructing this variable. The South African real interest rate variable is calculated by subtracting consumer price inflation in the past four quarters from the 10 year bond nominal interest rate. The foreign variable is calculated in the same way for each of South Africa's four major trading partners and consolidated as a weighted average using the SARB's weights for the real effective exchange rate: Germany, a proxy for the European Union (47 per cent), United States (20 per cent), United Kingdom (20 per cent) and Japan (13 per cent). The RID variable is thus calculated as South Africa's real interest rate minus the weighted real interest rate for its four major trading partners.

TECHPRO: Technological progress data is also not readily available, so we have to find a proxy for it. We follow Edwards (1994: 84) and MacDonald (1998: 127) and use real GDP growth rate differential (all in 2000 prices) between South Africa and its major trading partners as a proxy for technological progress. The foreign variable is calculated in the same way as the RID above.

LNEER: The logarithm of the nominal effective exchange rate of the rand (index, 2000=100) is used as a proxy for nominal devaluation or depreciation (nominal exchange rate policy). Edwards (1994: 84) and Aron *et al.* (1997: 31) derive this variable in a detailed and complicated way, but for simplicity in this study, we follow Joyce and Kamas (2003: 162) in using the trade weighted nominal exchange rate. As in the case of LREER, LNEER is measured in foreign currency terms, thus an increase in this variable indicates an appreciation of the rand, while a decrease means depreciation.

Once the model that links the real exchange rate to its potential determinants has been specified and variables defined, the next step is to estimate the parameters of the specified model. There are several methods of parameter estimation that involve several steps. This is the subject of the next section.

5.4 A REVIEW OF ESTIMATION TECHNIQUES FOR THE STUDY OF DETERMINANTS OF THE REAL EXCHANGE RATE

There are several techniques available for parameter estimation, ranging from classical regression methods to cointegration based techniques. The former is based on the assumption that all the variables to be included in a regression are stationary. However, most economic series are not stationary in their levels such that estimations based on this technique will be meaningless (spurious). Differencing the variables to mechanically turn them stationary has been the preferred approach to deal with this problem, but it throws away useful long run information that may be in the data. These problems gave birth to a new generation of models based on cointegration and error correction modelling. There are also several cointegration based methods, but the majority of them suffer from numerous problems when applied to multivariate models. The technique in this category that has emerged as the most powerful and popular is the Johansen technique, which is the technique employed in this study.

The Johansen (1991, 1995) technique has become an essential tool in the estimation of models that involve time series data. This approach is preferred as it captures the underlying time series properties of the data and is a systems equation test that provides estimates of all cointegrating relationships that may exist within a vector of nonstationary variables or a mixture of stationary and nonstationary variables (Harris, 1995: 80).

The Johansen technique has several advantages over other cointegration based techniques, which will be discussed in the following sections. This technique is preferred in this study as it allows us to estimate a dynamic error correction specification, which provides estimates of both the short and the long run dynamics in our real exchange rate model (equation 5.1). There are several steps that have to be followed in implementing the Johansen methodology. Harris (1995: 76) and Seddighi *et al*. (2000: 303) both outline the eight steps that are involved in applying this methodology. Because these steps are so detailed and highly interrelated, we prefer to discuss only some of the most relevant issues in these steps. The first issue is to determine the stationarity (order of integration) of all the variables in equation (5.1), the next is performing cointegration tests in order to identify any long run relationships in the variables, a short run vector error correction model is then estimated on condition of finding cointegration in the previous step and finally, residual diagnostic checks form the last step.

We review each of these steps in the following sections with the aim of considering alternative tests that can be employed in each step and choosing those to be applied in this study. However, before we discuss these steps, it is necessary to mention that impulse response and variance decomposition analyses will also be employed if our estimated models pass the residual diagnostic tests. These analyses are therefore discussed in this chapter, as they may be used in the following chapters to provide more information on our real exchange rate model.

5.4.1 Testing for stationarity/unit root

A series is referred to as (weakly or covariance) stationary if its mean and variance are constant over time and “the value of the covariance between the two time periods depends only on the distance or lag between the two time periods, not on the time at which the covariance is calculated” (Gujarati, 2003: 797). A series that is not stationary is referred to as nonstationary. In addition, a series is said to be integrated and is denoted as I (d), where d is the order of integration. The order of integration refers to the number of unit roots in the series, or the number of differencing operations it takes to make a variable stationary.

In the classical regression model, we deal with the relationship between stationary variables, but most of the economic indicators usually follow a nonstationary path. Gujarati (2003: 806) shows that if the dependent variable is a function of a nonstationary process, the regression will produce spurious results (a nonsense regression). In other words, the dependent variable will follow the trend of its explanatory variables. In such a case, the results will be meaningless. In fact, it is likely that significant t-ratios and a high R^2 will be obtained even though the trending variables are completely unrelated. Consequently, unit root or stationarity tests should be done on all the variables before proceeding with the tests for cointegration and estimation of parameters. There are several tests for stationarity including a visual plot of the data, unit root test and those that directly test for stationarity, among others. One unit root test (augmented Dickey-Fuller) and one stationarity test (Kwiatkowski *et al.,* 1992) are considered in order to perform what Brooks (2002: 382) refers to as "confirmatory data analysis".

5.4.1.1 Dickey-Fuller and the Augmented Dickey-Fuller Tests

The stationarity of a time series can be tested directly with a unit root test. The Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) are both prominently discussed in the literature and are the most frequently used unit root tests. The DF test estimates the following equation:

$$\Delta y_t = c_1 + c_2 t + \omega y_{t-1} + v_t \quad \text{(5.2)}$$

In (5.2), y_t is the relevant time series, Δ is a first difference operator, *t* is a linear trend and v_t is the error term. The error term should satisfy the assumptions of normality, constant error variance and independent (uncorrelated) error terms. If the error terms are not independent in equation (5.2), results based on the DF test will be biased. The weakness of the DF test is that it does not take account of possible autocorrelation in the error process or term (v_t). To cater for this shortfall, the ADF can be used. The ADF test corrects for high-order serial correlation by adding a lagged differenced term on the right-hand side in the DF equation (5.2). Consequently, the ADF employs the following equation:

$$\Delta y_t = c_1 + c_2 t + \omega y_{t-1} + \sum_{i=1}^{P} d_i \Delta y_{t-i} + v_t \quad \text{(5.3)}$$

Both equations (5.2) and (5.3) can also be estimated without including a trend term (by deleting the term c_2t in the equation) and without a constant (by leaving out c_1 in the equation). The null hypothesis is that there exists a unit root in the time series (nonstationary time series), which is Ho: ω=0 against the alternative hypothesis that the time series is stationary (no unit root) or *I*(0), which is Ha: ω<0. In both tests, if the calculated statistic is less (in absolute terms) than the MacKinnon (1991, 1996) values, which are used by the E-views 5 software, the null hypothesis is accepted and will therefore mean that there is a unit root in the series. In other words, it means the time series is not stationary. The opposite is true when the calculated statistic is greater than the MacKinnon critical value.

The Dickey-Fuller test, as with other unit root tests, has its own weaknesses. Even if the test seems to give a precise answer about stationarity or non-stationarity, this is not the case. The test is weak in its ability to detect a false null hypothesis. Brooks (2002: 381) and Gujarati (2003: 819) show that unit root tests have low power if the process is stationary but with a root close to the nonstationary boundary. This lack of power means that the Dickey-Fuller test fails to detect stationarity when the series follows a stationary process (Thomas, 1997: 410). This could occur either because the null hypothesis was correct or because there is insufficient information in the sample to enable rejection.

There are several ways of solving this problem, including increasing the sample size and using a stationarity test among others. The former solution could be limited by data unavailability, while the latter could be a good alternative without changing the sample size. Brooks (2002: 382) recommends using a unit root test together with a stationarity test. We consider one such test below.

5.4.1.2 The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test

Stationarity tests, unlike unit root tests, have stationarity under the null hypothesis, thus reversing the null and alternative hypotheses under unit root tests, such as the ADF discussed above. Under stationarity tests, therefore, the data will appear stationary by default if there is little information in the sample. The KPSS (1992) is one such test and it differs from other tests in that the series is assumed to be trend-stationary under the null hypothesis. This test is based on the residuals from the ordinary least squares (OLS) regression of the dependent variable (y_t) on the explanatory variables (x_t):

$$y_t = x_t'\partial + \mu_t \text{ ......(5.4)}$$

The LM (KPSS) statistic is defined as:

$$LM = \sum_t S(t)^2 /(T^2 f_0) \text{ ......(5.5)}$$

where f_0 is an estimator of the residual spectrum at frequency zero and $S(t)$ is a cumulative residual function calculated as:

$$S(t) = \sum_{r=1}^{t} \hat{\mu}_r \text{ ......(5.6)}$$

The calculated LM statistic is compared with the KPSS (1992) critical values in order to make a conclusion about the stationarity of a series. If the calculated LM statistic is smaller than the critical values, the null hypothesis is accepted and the conclusion will be that the series is stationary. The opposite will be true for a nonstationary time series.

5.4.2 Cointegration and vector error correction modelling (VECM)

In order to proceed to this stage, all the series of interest should be integrated of the same order, preferably *I*(1). The reason for this is that if the series display level stationarity, or are *I*(0), standard regression and statistical inference could be carried out, since there would be no problem of spurious regressions. On the other hand, if they are integrated of different orders the norm used to be to difference all the variables to be included in regressions. The remaining cases of both *I*(1) or both *I*(2) variables is the case of interest here, because an estimation of regressions based on first differenced variables could result in committing a 'sin' of misspecification and loss of long run information embodied in the data. However, Harris (1995: 80) shows that it is not necessary for all the variables in the model to have the same order of integration, especially if theory *a priori* suggests that such variables should be included. Thus, a combination of *I*(0), *I*(1) and *I*(2) can be tested for cointegration.

In most cases, if two variables that are *I*(1) are linearly combined, their combination would also be *I*(1). More generally, if variables with differing orders of integration are combined, the combination would have an order of integration equal to the largest (Brooks, 2002: 387). The exception to this rule is when the series are cointegrated. Brooks shows that a linear combination of *I*(1) variables will only be *I*(0), in other words stationary, if the variables are cointegrated. Although both variables may be trending upward in a stochastic fashion, they may be trending together. As Gujarati (1995: 42) puts it "the movement resembles two dancing partners, each following a random walk, whose random walks seem to be in unison". Therefore, synchrony is intuitively the idea behind cointegrated time series. In other words, cointegration means that despite being individually nonstationary, a linear combination of two or more time series can be stationary.

Cointegration has practical economic implications. Many time series are nonstationary individually, but move together over time, that is, there are some influences in the series (for example, market forces), which imply that the two series are bound by some relationship in the long-run. Brooks further shows that a cointegrating relationship may also be seen as a long term or equilibrium phenomenon, since it is possible that cointegrating variables may deviate from the relationship in the short run, but their association would return in the long-run. This concept is particularly important in this study where we seek to identify and distinguish those variables that have a long term relationship with the real exchange rate.

There are several ways of testing for cointegration. The tests can be categorised into two broad categories: those that are residual based, such as the Engle-Granger approach and those that are based on maximum likelihood estimation on a VAR system, such as the Johansen method. The former category of the tests for cointegration suffers from numerous problems, such as the usual finite sample problem of a lack of power in unit root and cointegration tests, inability to perform any hypothesis tests about the actual cointegrating relationships and their inability to detect more than one cointegrating relationships that may exist in a model (Harris, 1995: 76 and Brooks, 2002: 394). Since our model is multivariate, there is a likelihood of having more than one cointegrating vector. Seddighi et *al*. (2000: 297) show that if there is more than one cointegrating relationships, the Engle-Granger approach would produce inconsistent estimates. Thus, in light of these problems, we prefer the Johansen methodology.

In this study, therefore, we employ vector autoregressive (VAR) based cointegration tests using the methodology developed in Johansen (1991, 1995). The purpose of these cointegration tests is to determine whether the variables in our real exchange rate model are cointegrated or not. The presence of a cointegration relation(s) forms the basis of the vector error correction model (VECM) specification. The Johansen methodology can be briefly described as follows:

Assume a vector: $X_t =$ [LREER, LTOT, LDC, LGCON, LOPEN, RID, TECHPRO, LNEER], and assume that the vector has a VAR representation of the form:

$$X_t = z + \sum_{i=1}^{p} \prod_i X_{t-i} + \varepsilon_t \qquad (5.7)$$

where *z* is a (n x 1) vector of deterministic variables, ε is a (n x 1) vector of white noise error terms and $\prod_i$ is a (n x n) matrix of coefficients. In order to use the Johansen test, the VAR (5.7) above needs to be turned into a VECM specification (Brooks, 2002: 403), which may be specified as:

$$\Delta X_t = z + \sum_{i=1}^{p-1} B_i \Delta X_{t-i} + \prod X_{t-1} + \varepsilon_t \text{ .... (5.8)}$$

Where X_t is a vector of *I*(1) variables defined above, ΔX_t are all *I*(0) variables, Δ indicates the first difference operator, B_1 is a (n x n) coefficient matrix and $\prod$ is a (n x n) matrix whose rank determines the number of cointegrating relationships. The Johansen's cointegration test is to estimate the rank of the $\prod$ matrix (r) from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of $\prod$ (Brooks, 2002: 404 and E-views 5 manual: 724). If $\prod$ is of full rank (r = n), it suggest that variables are level stationary and if it is of zero rank (r = 0), no cointegration exists among the variables. On the other hand, if $\prod$ is of reduced rank (r<n), then there exists (n x r) matrices *α* and *β* such that:

$$\prod = \alpha\beta' \text{ .... (5.9)}$$

where α represents the speed of adjustment matrix, indicating the speed with which the system responds to last period's deviations from the equilibrium relationship and *β* is a matrix of long run coefficients.

However, before one proceeds to test for the rank of $\prod$, there are two issues that have to be attended to. The first is determining the appropriate order (k) of the VAR. Brooks (2002: 404) argues that the Johansen test can be affected by the lag length employed in the VECM, thus it is crucial to attempt to select the lag length optimally. By optimally, it is meant that the chosen lag length should produce the number and form of cointegration relations that conform to all the *a priori* knowledge associated with economic theory (Seddighi *et al*., 2000: 309). On the other hand, Brooks (2002: 334) argues that economic theory will often have little to say on what an appropriate lag length is for a

VAR and how long changes in the variables should take to work through the system. Brooks recommends the use of multivariate versions of the information criteria, which includes the sequential modified likelihood ratio (LR), Akaike information criterion (AIC), Final prediction error (FPE) Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ). However, in our experience, these information criteria usually produce conflicting VAR order selections. In light of these problems, we will use both the information criteria approach and the *a priori* knowledge from economic theory to select the appropriate order of the VAR.

The second issue is related to the choice of deterministic assumptions that the Johansen test requires in testing for cointegration. Various types of VARs can be estimated based on five deterministic trend assumptions, for example, with or without a constant and trend in cointegrating term and with or without a constant in the VAR equations. E-views 5 specifically provides the following deterministic trend assumptions: Case 1 assumes no deterministic trend in the data and no intercept or trend in the VAR and in the cointegrating equation (CE); Case 2 assumes no deterministic trend in the data, but an intercept in the CE and no intercept in VAR; Case 3 assumes a linear deterministic trend in the data and an intercept in CE and test VAR; Case 4 allows for a linear deterministic trend in data, intercept and trend in CE and no trend in VAR; and Case 5 allows for a quadratic deterministic trend in data, intercept and trend in CE and linear trend in VAR. As a guide, E-views 5 recommends the use of Case 2 if none of the visual plots of the series and unit root tests show the presence of a trend in the series, Case 3 if the series have stochastic trends, Case 4 if some of the series are trend stationary, while Cases 1 and 5 are rarely used in practice (E-views 5 manual: 725). Thus, the graphical analysis of the raw data and unit root tests, together with *a priori* knowledge from economic theory, should assist in selecting the deterministic trend assumption to be used in the Johansen test for cointegration (rank of $\prod$).

Once the appropriate VAR order (k) and the deterministic trend assumption have been identified, the rank of the Π matrix can then be tested. There are two likelihood ratio (LR) test statistics for cointegration under the Johansen approach: the trace (λ_{trace}) and the maximum eigenvalue ($\lambda_{\max}$) statistics, which are specified as follows:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{N}\ln(1-\hat{\lambda}_i) \qquad \text{.........(5.10)}$$

and

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1}) \qquad \text{.........(5.11)}$$

where *r* is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value for the *i*th ordered eigenvalue from the Π matrix (equation 5.9). The trace statistic sequentially tests the null hypothesis that the number of cointegrating relations is *r* against the alternative of k cointegrating relations, where k is the number of endogenous variables. The maximum eigenvalue conducts separate tests on each eigenvalue and has as its null hypothesis that there are *r* cointegrating vectors against an alternative of *r*+1 (Brooks, 2002: 405). To determine the rank of the Π matrix the above trace and maximum eigenvalue test statistics are compared to the (non-standard) critical values from Osterwald-Lenun (1992), which differ slightly from those originally reported by Johansen and Juselius (1990).[29] For both tests, if the test statistic is greater than the critical values, the null hypothesis that there are *r* cointegrating vectors is rejected in favour of the corresponding alternative hypothesis.

However, the trace and maximum eigenvalue statistics may yield conflicting results. To deal with this problem, Johansen and Juselius (1990, in E-view 5 manual: 728) recommend the examination of the estimated cointegrating vector and basing one's choice on the interpretability of the cointegrating relations. Alternatively, Luintel and Khan (1999: 392) show that the trace test

[29] Osterwald-Lenun (1992) provides a more complete set of critical values for the Johansen test.

is more robust than the maximum eigenvalue statistic in testing for cointegration. The two approaches will be considered in this study when faced with such a problem.

Once the number of cointegrating vectors in the model has been identified, a VECM (equation 5.8) can be estimated by specifying the number of cointegrating vectors, trend assumption used in the previous step and normalising the model on the true cointegrating relation(s). Thus, a VECM is merely a restricted VAR designed for use with nonstationary series that have been found to be cointegrated. The specified cointegrating relation in the VECM restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationships, while allowing for short run adjustment dynamics. The coefficients of the VECM have already been explained and will not be repeated here. Once estimation is complete, the residuals from the VECM must be checked for normality, heteroskedacity and autocorrelation.

5.4.3 Diagnostic Checks

This stage is crucial in the analysis of the determinants of the real exchange rate because it validates the parameter estimation outcomes achieved by the estimated model. Diagnostic checks test the stochastic properties of the model, such as residual autocorrelation, heteroskedasticity and normality, among others. The multivariate extensions of the residual tests just mentioned will be applied in this study; therefore they are briefly discussed here.

5.4.3.1 Autocorrelation LM test

The Lagrange Multiplier (LM) test used in this study is a multivariate test statistic for residual serial correlation up to the specified lag order. Harris (1995: 82) argues that the lag order for this test should be the same as that of the corresponding VAR. The test statistic for the chosen lag order (m) is computed by running an auxiliary regression of the residuals (μ_t) on the original right-hand explanatory variables and the lagged residuals (μ_{t-m}). Johansen (1995: 22) presents the formula of the LM statistic and provides detail on this test. The LM statistic tests the null hypothesis of no serial correlation against an alternative of autocorrelated residuals.

5.4.3.2 White heteroskedacity test

This test is an extension of White's (1980) test to systems of equations, as extended by Kelejian (1982) and Doornik (1995, in Eviews 5: 712). It tests the null hypothesis that the errors are both homoskedastic (no heteroskedacity problem) and independent of the regressors and that there is no problem of misspecification. The test regression is run by regressing each cross product of the residuals on the cross products of the regressors and testing the joint significance of the regression. The failure of any one or more of the conditions just mentioned above could lead to a significant test statistic. Thus, under the null of no heteroskedacity and no misspecification, the test statistic should not be significant.

5.4.3.3 Residual normality test

The residual normality test used in this study is the multivariate extension of the Jarque-Bera normality test, which compares the third and fourth moments of the residuals to those from the normal distribution (for details on the construction of this test see Brooks, 2002: 180 and E-views 5 manual: 710). The preferred residual factorisation (orthogonalisation) method for the test is by Urzua (1997), which makes a small sample correction to the transformed residuals before computing the Jarque-Bera statistic. The joint test is based on the null hypothesis that residuals are normally distributed. A significant Jarque-Bera statistic, therefore, points to non-normality in the residuals. However, the absence of normality in the residuals may not render cointegration tests invalid. As Islam and Ahmed (1999: 105) put it "a more important issue in carrying out the cointegration analysis is whether the residuals are uncorrelated and homoskedastic". In addition, Johansen and Juselius (1990 and 1992, in Islam and Ahmed, 1999: 105) also observed non-normal residuals in their studies.

5.4.4 Impulse response and variance decomposition

Having identified the determinants of the real exchange rate in a well-behaved model, interesting issues that remain will be: how the real exchange rate reacts to shocks in any of those determinants, which shock is relatively the most important and how long, on average, it will take for the real exchange rate to restore its equilibrium following such shock. The usual block F-tests and an examination of causality in a VAR will show which of the variables in the model have statistically significant influences on the future values of each of the variables in the system. However, these tests will not reveal whether changes in a value of a given variable have a negative or positive influence on the other variables in the system, or how long it would take for the effect to work through the system (Brooks, 2002: 341). To provide such information, Lütkepohl and Reimers (1992) and Mellander *et al.* (1992) developed impulse response and forecast error variance decomposition analyses for a VAR process with cointegrated variables. These are briefly discussed below.

5.4.4.1 Impulse response analysis

Impulse response analysis traces out the responsiveness of the dependent variable in the VAR to shocks to each of the other variables. It shows the sign, magnitude and persistence of real and nominal shocks to the real exchange rate (in our context). A shock to a variable in a VAR not only directly affects that variable, but is also transmitted to all other endogenous variables in the system through the dynamic structure of the VAR. For each variable from the equations separately, a unit or one-time shock is applied to the forecast error and the effects upon the VAR system over time are observed. The impulse response analysis is applied on the VECM and, provided that the system is stable, the shock should gradually die away (Brooks, 2002: 341). There are several ways of performing impulse response analysis, but the Cholesky orthogonalisation approach to impulse response analysis, which is a multivariate model extension of the Cholesky factorisation technique, is preferred in this study. This approach is preferred because, unlike other approaches, it incorporates a small sample degrees of freedom adjustment when estimating the residual covariance matrix used to derive the Cholesky factor (Lütkepohl, 1991: 155-158).

5.4.4.2 Variance decomposition analysis

Further information on the linkages between the real exchange rate and its determinants can be obtained from variance decompositions, which measure the proportion of forecast error variance in a variable that is explained by innovations (impulses) in itself and the other variables. Variance decompositions performed on the VECM may provide some information on the relative importance of shocks to the determinants of the real exchange rate in explaining variations in the real exchange rate. In other words, variance decompositions give the proportion of the movements in the dependent variables that are due to their 'own' shocks (innovations), versus shocks to the other variables (Brooks, 2002: 342). Brooks also observed that own series shocks explain most of the forecast error variance of the series in a VAR. The same factorisation technique and information used in estimating impulse responses is applied in the variance decompositions.

5.5 CONCLUDING REMARKS

This chapter set an analytical framework in which the determinants of the real exchange rate are identified. Based on theory, a background on the exchange rate system in South Africa and data availability, an empirical model that links the real exchange rate to its potential determinants was specified. The potential determinants of the real exchange rate included in this model include the terms of trade, a measure of the degree of openness, ratio of domestic credit to GDP, ratio of government consumption to GDP, real interest rate differential, technological progress (relative productivity measure) and a proxy for nominal devaluation or depreciation.

The Johansen (1991, 1995) cointegration technique has been chosen as the preferred parameter estimation technique for the real exchange rate model, because of its several advantages over alternative techniques. If the estimated model passes several residual diagnostic checks, orthogonalised impulse response and variance decomposition analyses will be employed to investigate the impact and magnitude of shocks to each of the determinants on the real exchange rate and the proportion of the variance in the real exchange rate that is accounted for by each determinant over time. Having familiarised ourselves with the estimation techniques, we now apply these techniques to South African data in order to achieve the objectives of this study as set out in Chapter 1.

CHAPTER SIX
EMPIRICAL ANALYSIS AND FINDINGS

6.1 INTRODUCTION

The previous chapter set the analytical framework and reviewed the model estimation techniques to be used in this study. This chapter augments the analysis by applying that framework and the analytical techniques proposed on quarterly South African data covering the period 1975 to 2005. The results from this chapter provide answers to the questions which were raised in the first chapter of this study: what are the long and short run determinants of the real exchange rate in South Africa, which of those determinants exert the greatest impact on the real exchange rate and how long does it take for shocks in those variables to be transmitted to the real exchange rate. In pursuit of the answers to these questions, the Johansen (1991, 1995) approach is employed to provide an answer to the first question, while orthogonalised impulse response and variance decomposition analyses provide answers to the remaining questions. It proceeds in three broad sections. The next section presents the empirical findings, while the last section concludes this chapter.

6.2 EMPIRICAL FINDINGS

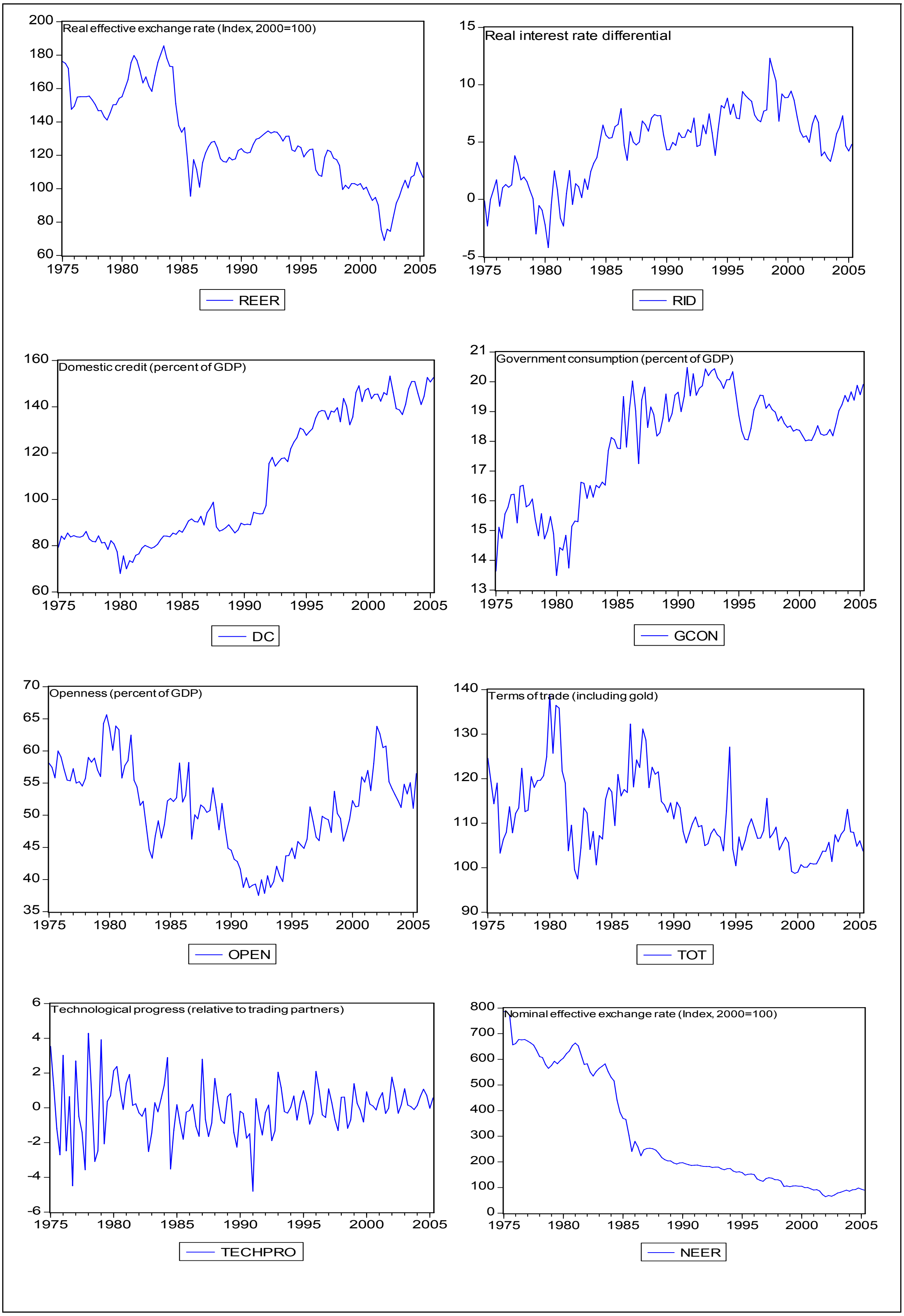
This section is divided into seven sub-sections. The first presents the results of stationarity/unit root tests, the second presents and discusses the cointegration test results, the third discusses the long run relationship, while the fourth presents the short run dynamics of the selected real exchange rate model. Diagnostic checks results are provided in the fifth sub-section, while impulse response analysis and variance decomposition results are presented in the sixth and seventh sub-sections, respectively.

6.2.1 Stationarity/unit root test results

The first step of the Johansen methodology is to determine the order of integration of the series. In this study, one informal test for stationarity and two formal tests are employed. One of the most popular informal tests for stationarity is the graphical analysis of the series. A visual plot of the series is usually the first step in the analysis of any time series before pursuing any formal tests. This preliminary examination of the data is important as it allows the detection of any data capturing errors, and structural breaks and gives an idea of the trends and stationarity of the data set. Figure 6.1 (next page) plots the eight variables of the real exchange rate model of this study against time.

The first impression that we get from the plots in Figure 6.1 is that three of the variables (RID, DC and GCON) seem to be trending upward and the other two (REER and NEER) trending downward, albeit with fluctuations. The remaining three variables (OPEN, TOT and TECHPRO) do not show any trend, but also show huge fluctuations over time (with the exception of TECHPRO). All the other variables in Figure 6.1 with the exception of OPEN, TOT and TECHPRO, have a time variant mean and variance suggesting that they are not stationary in their levels. TECHPRO clearly follows a stationary process (white noise process), as it moves closely around its mean. OPEN and TOT could be stationary or closer to the stationary boundary, as they also seem to be hovering around their means, but their variances are clearly not constant over time. Based on this analysis alone, we cannot be sure about the stationarity status of the variables, especially those that do not follow a clear trend such as OPEN and TOT in this study. Therefore, what is required here is some kind of formal hypothesis testing procedure.

Figure 6.1: Plots of the real effective exchange rate and its potential determinants, 1975-2005



The two formal tests that are employed in this study are the ADF and the KPSS, discussed in Chapter 5. These tests were applied to the data under different deterministic trend assumptions, but those that included a constant and no trend produced robust results. The option with no trend and no intercept produced 'explosive' results, while the option with both a trend and intercept made test statistics less significant. Table 6.1, therefore, shows the stationarity/unit root test results for the option with a constant only.

Table 6.1: Unit root/stationarity tests (with intercept)

	ADF Test		KPSS test	
Variables	Level	1st difference	Level	1st difference
REER	-1.832	-5.467*	1.025	0.056*
NEER	-1.041	-5.476*	1.199	0.352*
GCON	-1.678	-12.017*	0.873	0.144*
DC	-0.293	-11.815*	1.216	0.164*
TOT	-3.073	-15.340*	0.699*	0.021*
OPEN	-1.992	-14.048*	0.366*	0.128*
TECHPRO	-3.276	-19.086*	0.168*	0.161*
RID	-2.673	-10.446*	0.920	0.186*

Notes: The MacKinnon (1996) 1 % critical value = -3.485 and the KPSS (1992) 1% critical value = 0.739, thus * denotes the rejection of the hypothesis of a unit root for both tests. The lag order for the series was determined by the Schwarz information criterion and the spectral estimation method is Bartlett Kernel for ADF and KPSS, respectively.

It should be remembered here that the ADF test tests the null hypothesis of a unit root, while the KPSS has as its null hypothesis that the series is stationary. Therefore, a rejection of the null hypothesis under the ADF means the series does not have a unit root, while the rejection of the null hypothesis under the KPSS is interpreted as evidence of nonstationarity or presence of a unit root in the series. The results for the ADF tests in Table 6.1 show that none of the series is stationary in levels, since their test statistics (second column) are all smaller than the MacKinnon 1 per cent critical value of -3.485.[30] However, TOT and TECHPRO seem to be closer to the stationary boundary. When the test is applied to first differences of the series, they all become stationary suggesting that they are all *I*(1).

Results based on the KPSS deviate partly from those of the ADF. The KPSS test applied in the level variables fails to reject the null hypothesis of

[30] The 1 per cent significance level rather than the 5 per cent level is preferred in order to deal with potential small sample bias in the tests.

stationarity in TOT, OPEN and TECHPRO, while it rejects it with all the other variables. It is not surprising though that TECHPRO is level stationary because it is measured as the growth rate of real GDP in South Africa relative to trading partners, which means it has been differenced already. Those that are not stationary in levels, however, became stationary in their first differences. It seems the results from KPSS are more in line with those from the graphical analysis than the ADF results are. This could be a result of the problems associated with the ADF, which were covered in Chapter 5.

We conclude therefore that five of the series are first difference stationary *I*(1) while the other three are level stationary, *I*(0), thus the variables are not integrated of the same order. As mentioned in Chapter 5, *I*(0) and *I*(1) variables could be cointegrated, so we carry all the variables forward to cointegration tests.

6.2.2 Cointegration

Cointegration analysis is conducted using the Johansen procedure to determine whether there is a long run equilibrium relationship between the real exchange rate and its theoretical determinants. Testing for cointegration using the full real exchange rate model has always given researchers a difficult task (see for example, Edwards, 1994: 80; Aron *et al*., 1997: 20 and Mkenda, 2001: 31). In most cases, it has produced too many cointegrating relationships which are difficult if not impossible to interpret. As Juselius (1994, in Aron *et al*., 1997: 20) argues, "the main difficulty is the interpretation of cointegrating vectors which include a large number of variables". We attempted the full model (equation 5.1) and apart from degrees of freedom problems, we experienced a similar problem to the one just mentioned – we found at least five cointegrating relationships from several alternative specifications. When faced with such a problem, one option to deal with it is to estimate a simplified model with very few variables, but with the risk of an omitted variables bias (misspecification). We partially follow the approach in Aron *et al*. in estimating alternative models and using theoretical priors to achieve a parsimonious equation, but try to avoid this purely 'model-mining' exercise by using a pairwise correlation matrix to guide the variable selection exercise. Table 6.2 presents the pairwise correlations of the variables of our full real exchange rate model.

Table 6.2: Pairwise Correlation matrix

	LREER	LDC	LGCON	LNEER	LOPEN	LTOT	RID	TECHPRO
LREER	1.000	-0.776	-0.610	0.904	-0.012	0.348	-0.682	-0.002
LDC	-0.776	1.000	0.643	-0.910	-0.235	-0.584	0.691	0.083
LGCON	-0.610	0.643	1.000	-0.772	-0.651	-0.356	0.775	-0.129
LNEER	0.904	-0.910	-0.772	1.000	0.281	0.477	-0.770	-0.025
LOPEN	-0.012	-0.235	-0.651	0.281	1.000	0.270	-0.444	0.175
LTOT	0.348	-0.584	-0.356	0.477	0.270	1.000	-0.361	-0.045
RID	-0.682	0.691	0.775	-0.770	-0.444	-0.361	1.000	-0.059
TECHPRO	-0.002	0.083	-0.129	-0.025	0.175	-0.045	-0.059	1.000

By looking at the pairwise correlations in Table 6.2, the following observations can be made:

- LDC, LGCON, LNEER and RID are the only variables that are highly correlated with the LREER (column 2).
- LOPEN, LTOT and TECHPRO have very low correlations with the LREER, confirming the results from stationarity tests.
- LNEER is highly correlated with most of the variables, unlike other variables.

In order to minimize the risk of an omitted variables bias, the focus should first be on finding a model that simultaneously produces meaningful results and includes as many variables as suggested by theory. Following the observation that the LNEER is highly correlated with most variables in the model, we initially exclude it from the model, since there is a likelihood of a multicollinearity problem. This could also be the reason why we found too many cointegrating relationships in the full model. Thus, we estimate a real exchange rate model with the following explanatory variables: RID, LDC, LGCON, LOPEN, LTOT and TECHPRO.

As mentioned in Chapter 5, the Johansen cointegration technique requires us to specify the lag order and the deterministic trend assumption for the VAR.

Since our unit root tests accepted the inclusion of a constant but no trend, we choose case 3 in E-views which excludes a trend but includes a constant. As for the choice of the lag order for the VAR, the information criteria approach, augmented by theoretical priors, is used as a guide in selecting the lag order. Table 6.3 shows the lag lengths chosen by different information criteria.

Table 6.3: VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	61.79827	NA	9.02e-10	-0.961373	-0.793361	-0.893186
1	627.2154	1051.477	1.05e-13	-10.02132	-8.677225*	-9.475828*
2	683.9711	98.57579	9.25e-14	-10.15739	-7.637205	-9.134587
3	730.3864	74.91587	9.91e-14	-10.11204	-6.415774	-8.611934
4	786.9648	84.37126*	9.08e-14*	-10.24500*	-5.372642	-8.267581
5	827.2557	55.13497	1.14e-13	-10.09221	-4.043767	-7.637483
6	859.8159	40.55742	1.71e-13	-9.803787	-2.579263	-6.871758
7	904.0287	49.64241	2.21e-13	-9.719801	-1.319192	-6.310464
8	961.5735	57.54486	2.43e-13	-9.869711	-0.293016	-5.983067

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

Since the series are quarterly, the selection is drawn from a maximum of 8 lags in order to allow for adjustment in the model and the attainment of well-behaved residuals. As shown in table 6.3, the LR, FPE and the AIC select 4 lags, while the SC and the HQ choose 1 lag for the VAR. Thus, the information criteria approach produces conflicting results and no conclusion can be reached on this approach alone, as expected. Brooks (2002: 427) attributes this problem to a small sample bias. To reach a conclusion, we consider the performance of the model under the two suggested lag orders. Lag length 1 did not produce good diagnostic check results, while 4 lags resulted in well-behaved residuals. The Johansen cointegration test is therefore conducted under the assumption of no trend but a constant in the series and 4 lags for the VAR. Table 6.4 shows the cointegration test results for the real exchange rate model that we specified, based on trace and maximum eigenvalue statistics.

Table 6.4: Johansen cointegration rank test results

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.328553	148.5578	125.6154	0.0009
At most 1 *	0.286564	101.9543	95.75366	0.0175
At most 2	0.186872	62.44783	69.81889	0.1680
At most 3	0.146048	38.24444	47.85613	0.2915
At most 4	0.105091	19.77243	29.79707	0.4383
At most 5	0.041420	6.781510	15.49471	0.6032
At most 6	0.015537	1.832134	3.841466	0.1759

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.328553	46.60348	46.23142	0.0456
At most 1	0.286564	39.50648	40.07757	0.0579
At most 2	0.186872	24.20338	33.87687	0.4408
At most 3	0.146048	18.47201	27.58434	0.4564
At most 4	0.105091	12.99092	21.13162	0.4531
At most 5	0.041420	4.949376	14.26460	0.7482
At most 6	0.015537	1.832134	3.841466	0.1759

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The top part of Table 6.4 presents the Johansen cointegration test based on the trace test, while the bottom part presents the results of this test based on the maximum eigenvalue test. Starting with the trace test, the null hypothesis of no cointegrating vectors is rejected, since the test statistic of about 148.56 is greater than the 5 per cent critical value of approximately 125.62. In the same way, the null hypothesis that there are at most 1 cointegrating vectors is rejected, but the null hypothesis that there are at most 2 cointegrating vectors cannot be rejected, since the test statistic of approximately 62.45 is now less than the 5 per cent critical value of about 69.82. The trace test, therefore, indicates 2 cointegrating relationships (vectors) at the 5 per cent level of significance. The maximum eigenvalue form of the Johansen test also rejects the null hypothesis of no cointegration, but fails to reject that of at most 1 cointegrating vectors, since the test statistic of about 39.51 is now less than the 5 per cent critical value of about 40.08. The maximum eigenvalue test, therefore, suggests that there is only 1 cointegrating relationship in the real exchange rate model.

As mentioned in section 5.4.2 of Chapter 5, the trace test is more robust than the maximum eigenvalue form of the Johansen test. However, we do not take this as given, but use the results of each test and let *a priori* theoretical knowledge guide us in selecting the cointegration rank. We estimated VECMs restricted on 1 and 2 cointegrating vectors separately, as chosen by the maximum eigenvalue and trace test, respectively. Results from the estimations confirm Luintel and Khan's (1999: 392) finding that the trace test is more robust than the maximum eigenvalue test, since 1 cointegrating relationship chosen by the maximum eigenvalue test does not produce economically meaningful results. We therefore conclude that there are 2 cointegrating relationships in the real exchange rate model. The other interesting conclusion from this analysis is that there are cointegrating relationships between *I*(0) and *I*(1) variables, thus corroborating Harris's (1995: 80) finding that variables integrated of different orders may be cointegrated. What remains is to identify which 2 cointegrating vectors represent the true cointegrating relationships.

6.2.3 The long run relationship

The number of cointegrating relationships obtained in the previous step, the number of lags and the deterministic trend assumption used in the cointegration test are all used to specify a VECM. This VECM allows us to distinguish between the long and short run determinants of the real exchange rate. However, before we can interpret the results from the VECM, we need to identify the true two cointegrating relationships that have been suggested in the last section. Table 6.5 presents the results from the estimated VECM without any restrictions (except for those automatically imposed by E-views).

Table 6.5: VECM results before normalisation

Vector Error Correction Estimates
Sample (adjusted): 1976Q2 2005Q2
Included observations: 117 after adjustments
t-statistics in [ ]

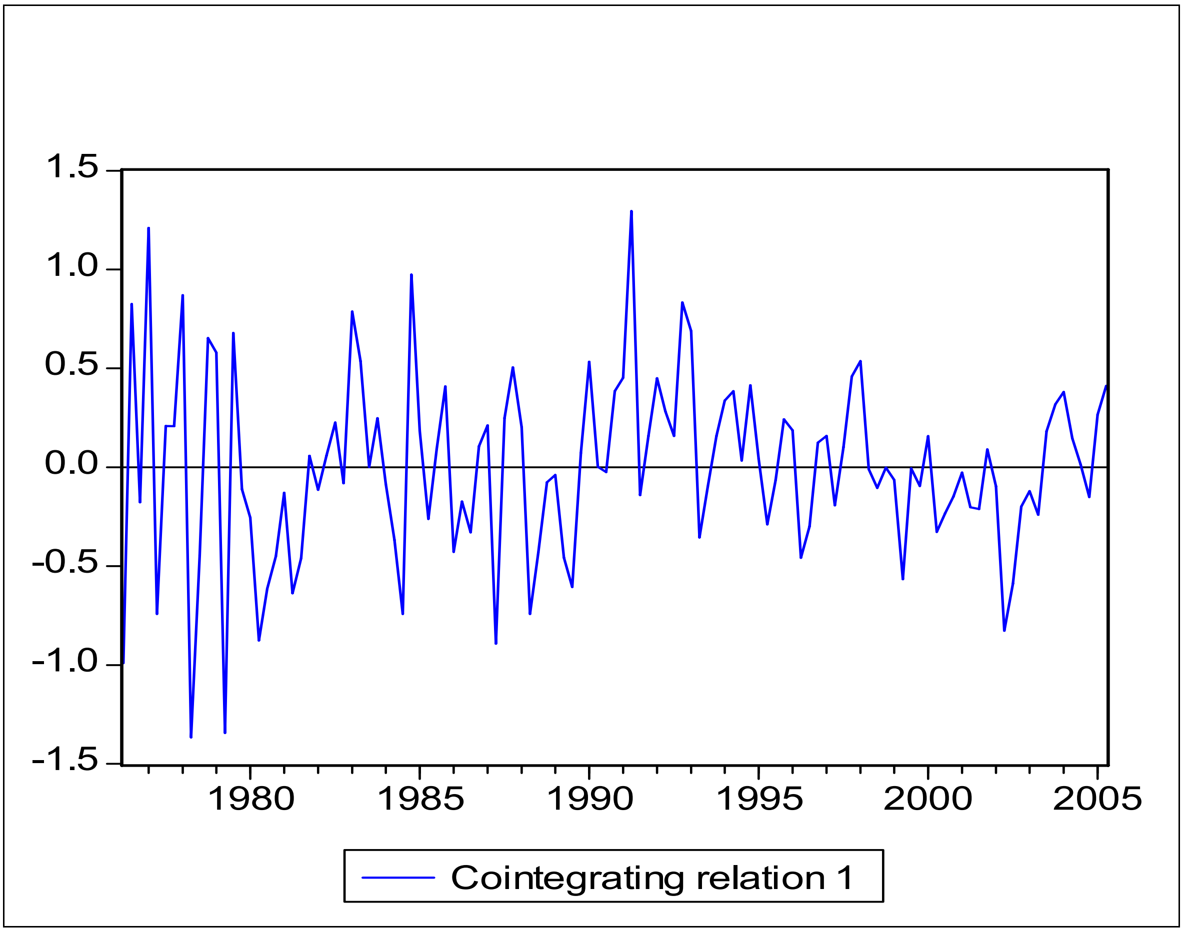
Cointegrating Eq:	CointEq1	CointEq2
LREER(-1)	1.000000	0.000000
RID(-1)	0.000000	1.000000
LDC(-1)	-0.466190	-27.78577
	[-1.36560]	[-6.73582]
LGCON(-1)	2.940650	24.10224
	[3.71565]	[2.52032]
LOPEN(-1)	1.304816	20.64026
	[2.62611]	[3.43784]
LTOT(-1)	-2.766681	-54.38967
	[-3.33201]	[-5.42089]
TECHPRO(-1)	-0.111408	3.273363
	[-1.65362]	[4.02086]
C	-3.249760	230.2924

Error Correction:	D(LREER)	D(RID)	D(LDC)	D(LGCON)	D(LOPEN)	D(LTOT)	D(TECHPRO)
CointEq1	-0.070184	1.216848	0.026143	-0.036849	-0.014418	0.088439	1.032703
	[-2.25244]	[1.51237]	[1.22398]	[-2.15078]	[-0.50657]	[3.21280]	[1.38670]
CointEq2	-0.001029	-0.165899	0.001590	0.003275	-0.004577	0.001970	-0.214020
	[-0.42930]	[-2.67925]	[0.96741]	[2.48366]	[-2.08935]	[0.92984]	[-3.73430]

We follow Arestis and Demetriades (1997: 788) in normalizing each of the vectors on the variable for which a clear evidence of error correction is found.

A comparison of the coefficients of the error correction terms (cointEq1 at the bottom of Table 6.5) for the first vector shows that LREER has the most significant coefficient, with a t-value of -2.25 and has a correct negative sign. The other variables either have a wrong sign or are less significant. This suggests that the real exchange rate equation constitutes the true cointegrating relationship in the first cointegrating vector. Our conclusion is supported by the plot in Figure 6.2 showing the first vector in the cointegration space, which appears to be stationary.

Figure 6.2: Cointegration graph for the real exchange rate equation



In the second cointegrating equation, there are three candidates for the true relationship. These are RID, LOPEN and TECHPRO, all with correctly signed adjustment coefficients and corresponding t-values of approximately -2.68, -2.09 and -3.73. The most significant variable in the second cointegrating equation, therefore, is TECHPRO, followed by RID and LOPEN. However, normalizing the vector on TECHPRO produces inconsistent estimates of the long run coefficients and positive adjustment coefficients. RID is almost equally significant and normalizing on it produces good estimates. Thus, given that LREER shows strong evidence of error correction to the first vector and RID to the second vector, the interpretation that the first and second vectors explain long run LREER and RID, respectively, is not an implausible one.

We therefore normalize on LREER and RID to obtain both the long and short run parameter estimates. However, we do not report the results for the second cointegrating vector since the relationship is not clear and our interest is in finding the determinants of the real exchange rate. Instead, two alternative models based on the pairwise correlation analysis performed in section 6.2.2 are estimated following the same steps that we applied to this first model. One of these models links the real exchange rate to those variables that displayed high correlation with it, while the other tests for a relationship between the real exchange rate and those that displayed a very low correlation with it. We also test zero restrictions on the parameters of the cointegrating vectors in order to determine their significance in those vectors. The VECM results for our main model, together with the two alternative regressions are presented in Table 6.6.

Table 6.6: Alternative single equation equilibrium correction models for the real exchange rate

Regression number	(1)	(2)	(3)
Long run terms:			
LREER (-1)	1	1	1
Constant	-12.90	-12.35	4.82*
	(0.25)	(0.31)	(0.02)
RID (-1)	-0.05*	0.03**	
	(0.02)	(0.00)	
LDC (-1)	1.06*	-1.20	
	(0.02)	(0.23)	
LGCON (-1)	1.62	0.20	
	(0.71)	(0.71)	
LOPEN (-1)	0.17		-3.62**
	(0.28)		(0.00)
LTOT (-1)	0.22**		-1.12
	(0.00)		(0.92)
TECHPRO (-1)	-0.29	0.22**	
	(0.21)	(0.00)	1.80**
			(0.00)
LNEER (-1)			
Dynamic terms:			
ΔLREER (-1)	0.22		
	[1.82]		
ΔLOPEN (-3)	-0.32		
	[-2.48]		
Speed of adjustment (α)	-0.33**	-0.04**	-0.08**
	(0.00)	(0.00)	(0.00)
Diagnostics:			
R-squared	0.34	0.21	0.11
Serial correlation LM	44.68	45.38	24.01
	{0.64}	{0.01}	{0.51}
Normality (Jarque-Bera)	291.33	105.25	3.72
	{0.53}	{0.00}	{0.59}
Heteroskedasticity	1705.80	418.93	245.76
	{0.32}	{0.02}	{0.24}

Notes: Figures within parenthesis, ( ), are marginal *P* values (marginal significance level) of likelihood ratio tests under the null hypothesis that the coefficient under construction is zero. ** and * indicate significance at 1% and 5%, respectively. Figures within [ ] are t-ratios for the significance of dynamic terms and those in { } are P values for the residual diagnostic checks under the null of no serial correlation, no heteroskedasticity and normally distributed residuals for the LM, heteroskedasticity and normality test, respectively.

The second column of Table 6.6 presents the results of the VECM regression (1), which corresponds to our main model that include all the other variables except for LNEER. Regressions (2) and (3) are the alternative specifications, with the variables included in each shown in the table. Both the long and the short run terms are presented, together with their corresponding diagnostic checks. However, only the long run parameter estimates are discussed in this section, while the other results will be explained in the sections to follow.

Real interest rate differential (RID) between South Africa and its four major trading partners has a positive long-run relationship with the real exchange rate, as indicated by the significance of its coefficient in regression (1). This means that an increase in real interest rates in South Africa relative to trading partners appreciates the real exchange rate. This result corroborates the theoretical predictions that an increase in real interest rates in South Africa, relative to trading partners, appreciates the real exchange rate.

The coefficient for LDC is negative in regression (1) while it is positive in regression (2). However, LDC is significantly different from zero in regression (1), but the hypothesis that it is zero could not be rejected in regression (2). We therefore accept the result in regression (1) and conclude that LDC has a negative long run relationship with the real exchange rate. This result is theoretically plausible as expansionary monetary policy (indicated by the growth rate in domestic credit) should increase the demand for imports and, in turn, depreciate the real exchange rate. However, this variable was not theoretically expected to have a long run relationship with the real exchange rate. This result could be due to the slow adjustment in prices, as concluded in section 4.4 of Chapter 4. Sticky prices result in an increased role of monetary variables in the determination of the real exchange rate. Thus, this result was expected in this study. Mathisen (2003: 19) found a similar result for Malawi.

The null hypothesis that LGCON is not significantly different from zero could not be rejected in both regressions (1) and (2). This result is in tandem with that found in Aron *et al*., (1997: 21). This result could be an indicator of the inadequacy of this variable as a proxy for the composition of government expenditure.

LOPEN, a measure of the degree of openness is not significant in regression (1). As mentioned earlier, this could be a result of its association with other variables that disturb or share its impact on the real exchange rate. The negative coefficient of this variable in regression (1), however, suggests that an increase in openness depreciates the real exchange rate and thus corroborates the theoretical relationship.

One of the most interesting findings in Table 6.6 is the importance of the terms of trade in determining the level of the real exchange rate in the long run. It has a negative sign in regression (1) and is significant at the 1 per cent level. The finding that it has a negative and significant estimated elasticity suggests the dominance of substitution over income effects in South Africa. An improvement in the terms of trade by 1 per cent will depreciate the real exchange rate by about 0.2 per cent. This result is in line with theoretical predictions.

As mentioned in Chapter 5, the impact of productivity growth differential on the real exchange rate is theoretically ambiguous. It can either be positive or negative depending on the sector that benefits from the technological advancement. The usual case however is that it will grow the tradable goods sector and lower their prices relative to nontradable goods, causing the real exchange rate to appreciate. TECHPRO is not significant in the first regression and carries a positive sign, while it is highly significant in regression (3). Going by the significant coefficient in regression (3), an improvement in relative technological progress depreciates the real exchange rate.

The proxy for nominal exchange rate policy (LREER) was included only in regression (2) due to the problems mentioned earlier. It is rather surprising that this variable is found to have a long term relationship with real exchange rate. Theoretically, it was expected to influence the real exchange rate only in the short run. It carries a negative significant sign suggesting that a nominal devaluation or depreciation will appreciate the real exchange rate. We cannot conclude on this relationship, however, since the model does not pass diagnostic checks, as discussed later in section 6.2.5.

6.2.4 The short run relationship

This analysis is intended to capture the short run determinants of the real exchange rate. The results for the VECM on the short run dynamics of the real exchange rate are also presented in Table 6.6. However, only results for variables with significant coefficients are reported. The short run effects of the real exchange rate determinants are generally found to be insignificant across the three alternative model specifications, with the exception of two in regression (1). As shown in Table 6.6, only the lagged first difference of the real exchange rate and the first difference of openness lagged three times, have a significant short term impact on the real exchange rate. The lagged difference LREER appreciates the real exchange rate as expected, while more openness depreciates the real exchange rate both in the short and long run. Mkenda (2001: 43) and Aron *et al*. (1997: 22) found a similar result for the openness variable in their studies on Zambia and South Africa, respectively. The dummy for regime shift in 1995, which was included in all regressions, was also not significant. A look at the plots of the series, presented in Figure 6.1, does not suggest any structural breaks hence the insignificance of the dummy could be true.

A crucial parameter to note in the estimation of VECMs is the coefficient of adjustment which, in this study, measures the speed of adjustment in the real exchange rate following a shock in the system. It can also be seen as a measure of the degree of adjustment of the actual real exchange rate with regard to its equilibrium level. As shown in Table 6.6, these are -0.33, -0.04 and -0.08 for regressions (1), (2) and (3), respectively. Since the other two regressions exclude most of the variables that aid in the adjustment process, we do not focus our attention on them. Instead, the -0.33 coefficient in regression (1), which is more complete, is interpreted. Based on this coefficient, about 33 per cent of the gap between the actual real exchange rate and its equilibrium value is eliminated every quarter. This result implies that, in the absence of further shocks, the gap would be eliminated in approximately 1 year.

This coefficient is higher than the 8 per cent and 18 per cent reported in MacDonald and Ricci (2003: 19) and Aron *et al*. (1997: 23), respectively. However, it is smaller but comparable to a 38 per cent found in Mkenda (2001: 44). As Mkenda noted, “a high disparity in the speeds of adjustment exists between countries” (Mkenda, 2001: 44). The high disparity in the coefficients of the speed of adjustment parameter in MacDonald and Ricci and Aron *et al.*, both on South Africa, also suggest that this parameter varies from one period to another in the same country. However, the speed of adjustment result in this study does not come as a surprise given the relative stability of the real exchange rate during the study period, as discussed in Chapter 4.

Since most of the short run effects from the VECM were insignificant, more information on the short run dynamics can be obtained from impulse response and variance decomposition analyses. However, before considering impulse response and variance decomposition analyses, we need to confirm that the results from the VECMs we have just reported are deriving from efficient models with well-behaved residuals. Thus, the next step is to perform diagnostic tests on the residuals from the alternative model specifications.

6.2.5 Diagnostic checks

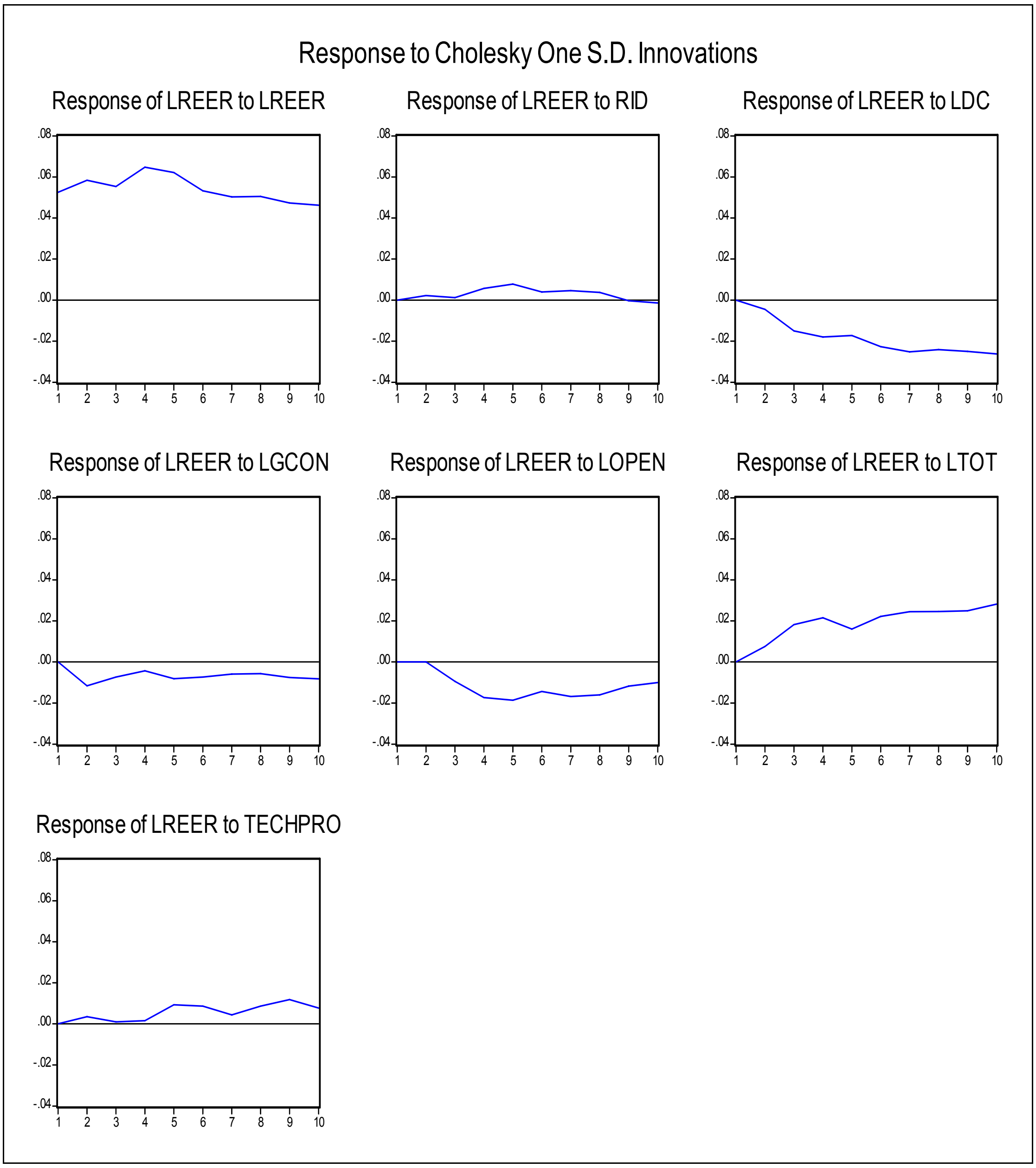
Diagnostic checks are crucial in this analysis, because if there is a problem in the residuals from the estimation of a model, it is an indication that the model is not efficient, such that parameter estimates from such a model may be biased. Results from the diagnostic tests performed in this study are presented at the bottom of Table 6.6. Of importance in this analysis are the residual diagnostic checks for serial correlation, normality and heteroskedasticity. As mentioned in Chapter 5, the three tests are based on the null hypothesis that there is no serial correlation, there is normality and there is no heteroskedasticity problem for the LM, Jarque-Bera and White heteroskedasticity tests, respectively.

Starting in regression (1), the null hypothesis of no serial correlation, residual are normally distributed and no heteroskedasticity cannot be rejected in the three tests, since the test statistics are not significant. In regression (2), all the tests significantly reject their null hypotheses, indicating that the residuals from this model are not well-behaved. Regression (3) passes all the tests, since all the tests fail to reject their null hypotheses. Thus, only regressions (1) and (3) are well-behaved and impulse response and variance decomposition analyses can be applied to these models. However, since all the variables in regression (3) are included in regression (1), the impulse response and variance decomposition analyses are performed only on regression (1).

6.2.6 Impulse response analysis

Impulse response analysis, together with variance decomposition (to be covered in the next section), reveals a wealth of information on dynamic effects that is missing in both static studies and those dynamic studies that do not employ these techniques. Figure 6.3 presents the results from the impulse response analysis performed on the VECM regression (1).

Figure 6.3: Impulse responses of the real exchange rate



Since this study focuses on the determinants of the real exchange rate, only the responses of the real exchange rate to shocks in its determinants are reported in Figure 6.3. These impulse response functions show the dynamic response of the real exchange rate to a one-period standard deviation shock to the innovations of the system and also indicate the directions and persistence of the response to each of the shocks over a 10 quarter (2.5 years) period. For the most part, the impulse response functions have the expected pattern and confirm the results from the short run relationship analysis. Shocks to three of the variables are not significantly different from zero and are transitory, while shocks to the other three variables are significant, but only two are persistent. A one-period standard deviation shock to RID and TECHPRO marginally appreciates the real exchange rate but the impact dies off quickly, on average. A shock to LGCON has a marginal depreciation effect on the real exchange rate but is also transitory. A one-period standard deviation shock to LOPEN depreciates the real exchange rate by more than 2 per cent, but also gradually levels off in about two-and-half years. Variables that have persistent and significant effects on the real exchange rate are the terms of trade and domestic credit. The response of the real exchange rate to a one-period shock to domestic credit is a continued depreciation. This result implies that expansionary monetary policy depreciates the real exchange rate in the short run.

Lastly, a shock to the terms of trade has a lasting positive impact on the real exchange rate. A one-period shock to the terms of trade appreciates the real exchange rate by over 2 per cent in a year's time and will widen the gap. Thus, only openness, domestic credit and the terms of trade have a significant impact on the real exchange rate in the short run. However, all the other variables, with the exception of domestic credit and the terms of trade, have only a transitory effect on the real exchange rate.

6.2.7 Variance decomposition analysis

As mentioned in Chapter 5, variance decomposition analysis provides a means of determining the relative importance of shocks in explaining variations in the variable of interest. In the context of this study, it therefore provides a way of determining the relative importance of shocks to each of the determinants of the real exchange rate in explaining variations in the real exchange rate. The results of the variance decomposition analysis are presented in Table 6.7 and these show the proportion of the forecast error variance in the real exchange rate explained by its own innovations and innovations in its determinants.

Table 6.7: Variance decomposition of the real exchange rate

Period	S.E.	LREER	RID	LDC	LGCON	LOPEN	LTOT	TECHPRO
1	0.052495	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.079976	96.41918	0.077018	0.321263	2.095653	4.22E-05	0.888797	0.198051
3	0.100812	90.82009	0.064352	2.433587	1.851941	0.868924	3.826772	0.134334
4	0.124501	86.61228	0.253490	3.689941	1.330056	2.506042	5.505072	0.103119
5	0.143118	84.42358	0.492489	4.230885	1.324155	3.591691	5.430471	0.506730
6	0.157092	81.57034	0.473239	5.602471	1.315363	3.816130	6.498953	0.723501
7	0.169701	78.67578	0.480574	7.013472	1.247570	4.249024	7.645334	0.688241
8	0.181428	76.58953	0.462358	7.904111	1.188268	4.496191	8.527818	0.831723

Since our interest is in the movements of the real exchange rate following shocks to itself or its determinants, we report only the variance decomposition in the real exchange rate and analyse the relative importance of each of its determinants in influencing its movements.

While the information criteria suggested that lag order 4 for the VAR was sufficient, we allow the variance decompositions for 8 quarters (2 years) in order to ascertain the effects when the variables are allowed to affect the real exchange rate for a relatively longer time. In the first quarter, all of the variance in the real exchange rate is explained by its own innovations (shocks), as suggested in Brooks (2002: 342). For the 4-quarter ahead forecast error variance, reported in column 2 of Table 6.7 under S.E., the real exchange rate itself explains about 87 per cent of its variation, while all its determinants explain only the remaining 13 per cent. Of this 13 per cent, the terms of trade explain about 5.5 per cent, domestic credit about 3.7 per cent and openness about 2.5 per cent, while the remaining variables do not significantly contribute to the variation in the real exchange rate.

However, after a period of two years, the real exchange rate explains about 77 per cent of its own variation, while its determinants explain the remaining 23 per cent. The influence of the terms of trade increases substantially to about 8.5 per cent, explaining the largest component of the 23 per cent variation in the real exchange rate that is explained by its determinants. This result is in line with Joyce and Kamas's (2003: 166) finding on their study of the determinants of the real exchange rate in Argentina, Colombia and Mexico. Domestic credit accounts for about 8 per cent and openness about 5 per cent, all with their impacts increasing over time. Thus, the terms of trade explain the largest component of the variation in the real exchange rate followed by domestic credit and openness. Shocks to the other variables continued to explain an insignificant proportion of the variation in the real exchange rate. These results, therefore, are similar to those from the impulse response analysis in that only the terms of trade, domestic credit and openness have a significant impact on the real exchange rate in the short run.

6.3 CONCLUDING REMARKS

This chapter analysed the relationship between the real exchange rate and its theoretical determinants and the dynamic adjustment of the real exchange rate following shocks to its determinants. It started by analysing the time series properties of the data employing both informal and formal tests for stationarity. The variables were found not to be integrated of the same order, as five were first difference stationary while the other three were level stationary. Johansen cointegration tests on alternative model specifications provided evidence that there is cointegration between the real exchange rate and its determinants, which were included in those models. This finding, therefore, indicates that the real exchange rate is subject to permanent changes as a result of changes in its fundamentals. Evidence of cointegration allowed the estimation of VECMs, which simultaneously provided the parameter estimates for both the long and short run relationships. The variables that have a long run relationship with the real exchange rate include the terms of trade, real interest rate differential, domestic credit, openness and technological progress. An increase in the terms of trade, real interest differential, domestic credit and technological progress all appreciate the real exchange rate in the long run, while a more open economy is associated with a real depreciation of the exchange rate. These results, therefore, corroborate the theoretical framework to a large extent.

Another interesting parameter in VECMs is the speed of adjustment coefficient which, in this study, measures the speed of adjustment in the real exchange rate following a shock in the system. The estimate of this parameter found in this study indicates that about 33 per cent of the variation in the real exchange rate from its equilibrium level is corrected within a quarter. This speed of adjustment is slightly higher than those from previous studies on South Africa, but does not present a surprise given the relative stability of the real exchange rate during the study period.

The short run dynamics from the VECMs suggested that only openness significantly affects the real exchange rate in the short run by depreciating it. However, a better picture of the short run dynamics emerged from the impulse response and variance decomposition analyses. The latter tests provided evidence that the terms of trade, domestic credit and openness have a significant impact on the real exchange rate in the short run. However, only shocks to the terms of trade and domestic credit have persistent effects on the real exchange rate. Another interesting result which emerged from this analysis and which is supported by previous research is that, among other determinants, the terms of trade explain the largest proportion of the variation in the real exchange.

CHAPTER SEVEN

CONCLUSIONS, POLICY RECOMMENDATIONS AND LIMITATIONS

7.1 SUMMARY OF THE STUDY AND CONCLUSIONS

This study analysed the behaviour of the real exchange rate, the relationship between the real exchange rate and its theoretical determinants and the dynamic adjustment of the real exchange rate following shocks to those determinants. The importance of the real exchange rate was briefly reviewed in this study and is well documented in the literature for both industrialised and developing economies. Based on an extensive review of the literature on the determinants of the real exchange rate, a background of the exchange rate system in South Africa and on data availability, an empirical model that links the real exchange rate to its potential determinants was specified. The variables included in this model as potential determinants include the terms of trade, a measure of the degree of openness, a proxy for monetary policy, a proxy for fiscal policy, real interest rate differential, technological progress and a proxy for nominal depreciation.

In order to determine both the long and short run determinants of the real exchange rate, the Johansen cointegration and error correction methodology was preferred to the other techniques, because of its several advantages over those alternative techniques. In the application of this methodology, we started by analysing the time series properties of the data employing both informal and formal tests for stationarity. The variables were found not to be integrated of the same order, as five were first difference stationary while the other three were level stationary. Johansen cointegration tests on alternative model specifications provided evidence that there is cointegration between the real exchange rate and its determinants, which were included in those models. This finding, therefore, indicates that the real exchange rate is subject to permanent changes as a result of changes in its fundamentals. Evidence of cointegration allowed the estimation of VECMs, which simultaneously provided the parameter estimates for both the long and short run relationships. The variables that have a long run relationship with the real exchange rate include the terms of trade, real interest rate differential, domestic credit, openness and technological progress. An increase in the terms of trade, real interest differential, domestic credit and technological progress all appreciate the real exchange rate in the long run, while a more open economy is associated with a real depreciation of the exchange rate. It follows from these findings that the real exchange rate is largely a function of real variables in the long run. These results therefore, for the most part, corroborate both the theoretical predictions and findings from previous research.

Another interesting parameter in VECMs is the speed of adjustment coefficient which, in this study, measures the speed of adjustment in the real exchange rate following a shock in the system. The estimate of this parameter found in this study indicates that about 33 per cent of the variation in the real exchange rate from its equilibrium level is corrected within a quarter. This speed of adjustment is slightly higher than those from previous studies on South Africa, but does not present a surprise given the relative stability of the real exchange rate during the study period.

The short run dynamics from the VECMs suggested that only openness significantly affects the real exchange rate in the short run by depreciating it. However, a better picture of the short run dynamics emerged from the impulse response and variance decomposition analyses. This study presents the first application of these techniques on the determinants of the real exchange rate in South Africa and they provide a wealth of dynamic effects that are often lacking in those studies that do not apply these techniques. The impulse response analysis provided evidence that the terms of trade, domestic credit and openness have a significant impact on the real exchange rate in the short run. However, only shocks to the terms of trade and domestic credit have persistent effects on the real exchange rate.

Results from the variance decompositions of the real exchange rate are largely similar to those from the impulse response analysis and reveal that the fundamentals explain some, but not all, of the variations of the real exchange rate. The terms of trade, domestic credit and openness are the only variables found to significantly explain the variation in the real exchange rate. The most interesting result which emerged from this analysis and which is supported by previous research is that among other determinants, the terms of trade explain the largest proportion of the variation in the real exchange. On balance, the evidence therefore suggests that real exchange rate fluctuations in quarterly data are predominantly equilibrium responses to real and monetary shocks rather than fiscal policy shocks.

7.2 POLICY IMPLICATIONS AND RECOMMENDATIONS

Taken together, the results of this study have a number of policy implications. First, the presence of long run co-movements (cointegration) between the real exchange rate and its determinants found in this study implies the effectiveness of targeting one of the variables in influencing the long run behaviour of the other variables. If this interpretation holds and given the significant long run relationship between the real exchange rate and the monetary policy variable in this study, it would justify the stance taken by the monetary authorities in South Africa of pursuing a sound monetary policy and leaving the determination of the exchange rate of the rand in the invisible hands of the economy.

Second, the real exchange rate will be shocked by factors that are outside the direct control of policy makers, such as the terms of trade which explain the greatest component of the variation in the real exchange rate in this study. The policy implication is that the authorities' ability to influence the movements in the real exchange rate is limited. The authorities may however reduce the impact of this shock, in the long run, by utilising policies to promote the diversification of traded goods and acting on other fundamentals.

Third, lliberalising trade (more openness) is one of the tools in the policy maker's arsenal to avoid overvaluation both in the short and long run. This finding further confirms the stance of the monetary authorities in South Africa of acting on the fundamentals of the real exchange rate instead of directly managing the exchange rate of the rand. A word of caution is sounded however that as the effects of shocks vary from one country to another, there is no universal solution to the problems of fluctuations in real exchange rates.

7.3 LIMITATIONS OF THE STUDY AND AREAS FOR FURTHER RESEARCH

One of the reasons for investigating the determinants of the real exchange rate is to estimate the equilibrium real exchange rate and ultimately measure the degree of misalignment in the actual real exchange rate. Having not gone to this extent, the study has obviously left some important gaps, although it has successfully achieved its objectives.

The other issue, which has also confronted previous researchers, concerns the unavailability of data, particularly in developing countries, on the actual variables suggested by the theoretical models on the determination of the real exchange rate. This means that some of the variables either have to be excluded in the empirical model, albeit with the risk of an omitted variables bias, or proxies have to be found for those variables. The risk involved in finding proxies is that they may not correctly represent the impact of the actual variables, resulting in inconsistent results. Striking this balance poses a serious challenge to empirical studies on the determinants of the real exchange rate. However, these problems seem not to have significantly affected the findings presented in this study, since they corroborate both the theoretical and empirical knowledge on the determinants of the real exchange rate.

The areas for further research that emerge from this study include covering the gap that has been left by this study of measuring the degree of misalignment in the South African real exchange rate. The other issues concern the proxies, measurement of the actual real exchange rate and the speed of adjustment parameter. Research into what proxies represent the actual real exchange rate determinants efficiently may improve the performance of the empirical real exchange rate models. The other area that remains widely debated is the measurement of the actual real exchange rate. Research into what measure constitutes the best real exchange rate policy variable is still lacking. Finally, it has been found in this and other studies that the speed of adjustment parameter varies both between countries and within the same country during different periods. It may also be important for policy purposes to research into the causes of this high variability in the speeds of adjustment.

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9.0 APPENDICES

Appendix 1: Authorised Dealers in Foreign Exchange

The offices in the Republic of the undermentioned banks are authorised to act, for the purposes of the Exchange Control Regulations, as Authorised Dealers in foreign exchange:

- **ABN AMRO Bank N.V.**
- **ABSA Bank Limited**
- **Bank of Baroda**
- **Bank of China Johannesburg Branch**
- **Bank of Taiwan South Africa Branch**
- **Barclays Bank PLC, South Africa Branch**
- **Calyon**
- **China Construction Bank, Johannesburg Branch**
- **Citibank, N.A., South Africa**
- **Commerzbank Aktiengesellschaft**
- **Deutsche Bank AG, Johannesburg Branch**
- **FirstRand Bank Limited**
- **Gensec Bank Limited**
- **Habib Overseas Bank Limited**
- **HBZ Bank Limited**
- **HSBC Bank plc - Johannesburg Branch**
- **Investec Bank Limited**
- **JPMorgan Chase Bank (Johannesburg Branch)**
- **MEEG Bank Limited**
- **Mercantile Bank Limited**
- **Nedbank Limited**
- **Rennies Bank Limited**
- **Société Générale**
- **Standard Chartered Bank - Johannesburg Branch**
- **State Bank of India**
- **The South African Bank of Athens Limited**
- **The Standard Bank of South Africa Limited**

The offices in the Republic of the undermentioned institutions are authorised to act, for the purposes of the Exchange Control Regulations, as Authorised Dealers in foreign exchange with limited authority:

- **Master Currency (Pty) Limited**
- **Nedtravel (Pty) Limited**

The offices in the Republic of the undermentioned institutions are authorised to act, for the purposes of the Exchange Control Regulations, as Authorised Dealers in foreign exchange with limited authority to operate Bureaux de Change in South Africa:

- **FxAfrica Foreign Exchange (Pty) Ltd**
- **Global Foreign Exchange (Pty) Limited**
- **Imali Express (Pty) Limited**
- **Inter Africa Bureau de Change (Pty) Limited**
- **Tower Bureau de Change (Pty) Limited**

Source: South African Reserve Bank (2005)

Appendix 2: South African Data used in the regressions

Year	LREER	LNEER	LTOT	LGCON	LDC	LOPEN	RID	TECHPRO
1975Q1	5.17	6.67	4.82	2.61	4.37	4.06	-0.12	3.5
1975Q2	5.16	6.67	4.78	2.72	4.43	4.05	-2.32	1.3
1975Q3	5.15	6.65	4.74	2.69	4.42	4.02	-0.03	-1.2
1975Q4	4.99	6.49	4.78	2.74	4.45	4.09	0.83	-2.7
1976Q1	5.01	6.49	4.64	2.76	4.43	4.08	1.71	3.0
1976Q2	5.04	6.52	4.67	2.79	4.44	4.04	-0.61	-2.5
1976Q3	5.04	6.52	4.68	2.79	4.43	4.02	1.01	0.6
1976Q4	5.04	6.52	4.73	2.73	4.43	4.01	1.29	-4.5
1977Q1	5.04	6.51	4.68	2.80	4.43	4.05	1.05	2.7
1977Q2	5.05	6.50	4.72	2.80	4.46	4.01	1.26	-0.5
1977Q3	5.03	6.49	4.73	2.76	4.42	4.01	3.80	-1.4
1977Q4	5.01	6.45	4.81	2.76	4.41	4.00	3.07	-3.6
1978Q1	4.99	6.41	4.72	2.78	4.40	4.02	1.70	4.3
1978Q2	4.99	6.41	4.73	2.73	4.43	4.08	1.94	1.0
1978Q3	4.96	6.36	4.79	2.70	4.40	4.06	1.54	-3.1
1978Q4	4.95	6.34	4.77	2.75	4.40	4.08	0.78	-2.5
1979Q1	4.98	6.36	4.78	2.69	4.36	4.04	0.06	3.9
1979Q2	5.01	6.38	4.78	2.71	4.41	4.03	-3.02	-2.1
1979Q3	5.01	6.37	4.79	2.74	4.39	4.16	-0.54	0.4
1979Q4	5.04	6.39	4.83	2.70	4.35	4.18	-0.96	0.7
1980Q1	5.04	6.40	4.93	2.60	4.22	4.15	-2.22	2.1
1980Q2	5.08	6.43	4.83	2.67	4.33	4.10	-4.21	2.4
1980Q3	5.11	6.45	4.92	2.66	4.25	4.16	-0.47	1.0
1980Q4	5.17	6.48	4.91	2.70	4.30	4.15	2.48	-0.1
1981Q1	5.19	6.50	4.80	2.62	4.29	4.02	0.84	1.4
1981Q2	5.18	6.48	4.78	2.72	4.33	4.06	-1.64	1.9
1981Q3	5.14	6.42	4.64	2.73	4.34	4.07	-2.33	0.1
1981Q4	5.10	6.36	4.70	2.73	4.37	4.13	0.50	0.2
1982Q1	5.12	6.37	4.60	2.81	4.38	4.02	2.51	-0.3
1982Q2	5.08	6.31	4.58	2.81	4.38	4.00	-0.45	-0.5
1982Q3	5.06	6.28	4.65	2.78	4.37	3.94	1.37	0.0
1982Q4	5.12	6.31	4.73	2.80	4.38	3.95	1.11	-2.5
1983Q1	5.17	6.34	4.72	2.78	4.39	3.88	0.14	-1.4
1983Q2	5.20	6.35	4.65	2.80	4.41	3.80	1.78	0.3
1983Q3	5.22	6.37	4.68	2.80	4.43	3.77	0.86	-0.2
1983Q4	5.18	6.31	4.61	2.81	4.43	3.85	2.43	0.5
1984Q1	5.16	6.27	4.67	2.81	4.43	3.89	3.15	1.3
1984Q2	5.15	6.25	4.67	2.87	4.45	3.84	3.64	2.9
1984Q3	5.02	6.09	4.75	2.90	4.44	3.88	4.99	-3.5
1984Q4	4.93	5.98	4.77	2.89	4.46	3.96	6.47	-1.3
1985Q1	4.90	5.91	4.76	2.88	4.45	3.96	5.61	0.2
1985Q2	4.92	5.90	4.70	2.88	4.48	3.95	5.32	-0.9
1985Q3	4.76	5.72	4.80	2.97	4.51	3.97	5.38	-1.8
1985Q4	4.56	5.48	4.75	2.88	4.52	4.06	6.33	-0.2
1986Q1	4.77	5.64	4.77	2.95	4.50	3.95	6.54	-0.2
1986Q2	4.71	5.56	4.76	3.00	4.50	3.97	7.91	0.2
1986Q3	4.61	5.41	4.88	2.95	4.53	4.06	4.73	-1.1
1986Q4	4.75	5.51	4.77	2.85	4.49	3.84	3.41	-1.6
1987Q1	4.80	5.53	4.82	2.96	4.55	3.91	5.91	2.8
1987Q2	4.83	5.53	4.81	2.99	4.57	3.90	4.99	-0.7
1987Q3	4.85	5.53	4.88	2.92	4.59	3.94	4.75	-1.7

1987Q4	4.85	5.50	4.86	2.95	4.48	3.94	5.00	-0.9
1988Q1	4.82	5.45	4.77	2.94	4.46	3.92	6.83	1.7
1988Q2	4.77	5.38	4.81	2.90	4.46	3.93	6.51	0.3
1988Q3	4.76	5.34	4.80	2.91	4.47	3.99	5.95	-0.7
1988Q4	4.75	5.32	4.80	2.93	4.49	3.94	7.09	-0.9
1989Q1	4.78	5.32	4.74	2.97	4.47	3.87	7.39	0.6
1989Q2	4.76	5.28	4.74	2.93	4.45	3.95	7.29	0.8
1989Q3	4.77	5.26	4.72	2.94	4.46	3.87	7.31	-1.4
1989Q4	4.81	5.28	4.74	2.97	4.50	3.80	5.61	-2.3
1990Q1	4.82	5.28	4.71	2.98	4.49	3.80	4.33	-0.2
1990Q2	4.80	5.26	4.74	2.94	4.49	3.76	4.34	-0.3
1990Q3	4.80	5.24	4.73	2.97	4.49	3.76	4.97	-1.7
1990Q4	4.80	5.23	4.68	3.02	4.55	3.73	4.70	-1.5
1991Q1	4.84	5.23	4.66	2.97	4.54	3.66	5.81	-4.8
1991Q2	4.86	5.23	4.68	3.01	4.54	3.70	5.39	0.5
1991Q3	4.87	5.22	4.70	2.97	4.54	3.66	5.42	-0.7
1991Q4	4.88	5.21	4.71	2.98	4.58	3.67	6.08	-1.6
1992Q1	4.89	5.20	4.69	2.99	4.75	3.67	5.83	-0.3
1992Q2	4.90	5.21	4.70	3.02	4.77	3.63	7.09	0.2
1992Q3	4.89	5.18	4.65	3.01	4.74	3.69	4.61	-1.9
1992Q4	4.90	5.19	4.66	3.01	4.75	3.63	4.73	-1.3
1993Q1	4.90	5.19	4.68	3.02	4.77	3.70	6.49	2.0
1993Q2	4.88	5.15	4.69	3.00	4.77	3.66	5.71	1.2
1993Q3	4.86	5.13	4.68	3.00	4.76	3.68	7.45	-0.2
1993Q4	4.88	5.16	4.67	2.98	4.80	3.74	5.81	-0.3
1994Q1	4.88	5.16	4.64	3.00	4.83	3.70	3.83	0.0
1994Q2	4.81	5.10	4.73	3.00	4.84	3.68	6.13	0.7
1994Q3	4.81	5.07	4.84	3.01	4.87	3.78	8.19	-0.7
1994Q4	4.83	5.08	4.65	2.98	4.87	3.78	7.97	0.3
1995Q1	4.83	5.06	4.61	2.94	4.85	3.80	8.83	1.0
1995Q2	4.78	5.00	4.67	2.91	4.86	3.77	7.41	0.2
1995Q3	4.80	5.02	4.64	2.89	4.87	3.83	8.31	-0.9
1995Q4	4.82	5.03	4.66	2.89	4.91	3.81	7.09	-0.3
1996Q1	4.82	5.02	4.69	2.91	4.93	3.80	7.02	2.1
1996Q2	4.71	4.90	4.71	2.95	4.93	3.83	9.40	1.0
1996Q3	4.68	4.85	4.69	2.96	4.93	3.94	9.05	-0.4
1996Q4	4.68	4.82	4.67	2.97	4.90	3.89	8.78	-0.6
1997Q1	4.78	4.90	4.67	2.97	4.93	3.84	8.54	1.1
1997Q2	4.81	4.93	4.69	2.95	4.93	3.83	7.36	0.3
1997Q3	4.81	4.91	4.75	2.96	4.94	3.91	6.93	-0.7
1997Q4	4.77	4.87	4.67	2.95	4.89	3.90	6.76	-1.3
1998Q1	4.77	4.87	4.68	2.94	4.97	3.90	7.70	0.6
1998Q2	4.74	4.83	4.69	2.93	4.94	3.86	7.80	0.6
1998Q3	4.60	4.65	4.64	2.94	4.88	3.98	12.31	-1.2
1998Q4	4.63	4.66	4.66	2.92	4.91	3.92	11.29	-0.7
1999Q1	4.61	4.64	4.67	2.92	4.99	3.90	10.34	1.4
1999Q2	4.64	4.67	4.66	2.92	5.00	3.83	6.83	0.3
1999Q3	4.64	4.67	4.60	2.91	4.96	3.86	9.20	-0.1
1999Q4	4.63	4.65	4.59	2.91	4.99	3.90	8.86	-0.8
2000Q1	4.63	4.66	4.60	2.91	5.00	3.96	8.89	0.9
2000Q2	4.60	4.60	4.61	2.90	4.97	3.94	9.44	0.2
2000Q3	4.61	4.61	4.61	2.89	4.98	3.94	8.65	0.1
2000Q4	4.57	4.55	4.61	2.89	4.98	4.02	7.19	-0.1
2001Q1	4.53	4.50	4.62	2.89	4.96	4.01	5.92	0.5

2001Q2	4.55	4.52	4.61	2.90	4.98	4.04	5.42	0.9
2001Q3	4.50	4.47	4.61	2.92	4.98	3.99	5.53	-0.3
2001Q4	4.32	4.28	4.63	2.90	5.03	4.06	4.97	0.0
2002Q1	4.24	4.16	4.64	2.90	4.98	4.16	6.56	1.8
2002Q2	4.33	4.23	4.64	2.90	4.94	4.14	7.32	0.9
2002Q3	4.31	4.19	4.66	2.91	4.93	4.10	6.71	-0.3
2002Q4	4.42	4.27	4.62	2.90	4.92	4.11	3.79	0.2
2003Q1	4.51	4.36	4.68	2.92	4.95	4.01	4.14	1.1
2003Q2	4.56	4.40	4.66	2.95	5.00	3.99	3.61	0.2
2003Q3	4.61	4.45	4.68	2.96	5.02	3.97	3.32	0.1
2003Q4	4.65	4.50	4.69	2.97	5.02	3.96	4.35	-0.1
2004Q1	4.61	4.45	4.73	2.96	4.98	3.94	5.72	0.1
2004Q2	4.67	4.51	4.68	2.98	4.95	4.00	6.31	0.7
2004Q3	4.68	4.52	4.68	2.96	4.97	3.98	7.28	1.1
2004Q4	4.75	4.58	4.65	2.99	5.03	4.01	4.67	0.7
2005Q1	4.71	4.54	4.66	2.97	5.02	3.93	4.21	0.0
2005Q2	4.67	4.50	4.64	2.99	5.03	4.03	4.81	0.6

Source: IFS and SARB