EXCHANGE RATE SHOCKS AND THE STOCK MARKET INDEX: EVIDENCE FROM THE JOHANNESBURG STOCK EXCHANGE

by

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DECLARATION

I, Paul-Francois Muzindutsi, declare that:

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DEDICATION

This dissertation is dedicated to my late friend, Samuel Rucogoza, a dear friend and a brother, who passed away on 3 October 2010.

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ABSTRACT

The foreign exchange market plays an important role in global finance, as it is considered to be among the largest financial markets in the world because of the significant amount of money involved in the foreign exchange market's transactions. Economic theories show that the exchange rate market may interact with the stock market index, but empirical studies on the interaction between the exchange rate market and the stock market index produced mixed results. Thus there is no empirical agreement regarding the interactions between the stock prices and exchange rate. This study examined the interaction between the real exchange rate and the stock market index in South Africa, with the aim of identifying the effect of exchange rate shocks on the Johannesburg Stock Exchange (JSE). It establishes the direction of causality between the stock market index and the real exchange rate; identifies the long-run and short-run relationships between the South African stock market and the exchange rate and determines the response of the South African stock market to different exchange rate regimes from 1978 to 2008. This study used different econometrics models, including descriptive statistics analysis, Engle-Granger cointegration approach, Error Correction Model and a Granger-Causality test. Variables used in this study include the real values of the JSE all share index and the real exchange rate series (the Rand/U.S. dollar exchange rate) from January 1978 to December 2008.

The stock market index responded to changes in exchange rate regimes. Although the response tended to be slightly stronger during the period of the free floating exchange rate, correlation coefficients were insignificant in both fixed and flexible exchange rate regimes. A negative long-run relationship between the real exchange rate and the stock market index was found. The short-run results established that changes in the real exchange rate have no impact on the real stock market index. Granger-Causality tests indicated that there is a bidirectional causal relationship between the South African stock market index and the Rand/U.S. dollar exchange rate.

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CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Since 1970, changes in South African policy regimes have led to the adoption of different exchange rate systems (Aron & Muellbauer, 2001:11). The adoption of different exchange rate systems may be associated with changes in foreign exchange rate risks that can affect returns to securities. These foreign exchange rate risks (or exposure) are transactions exposure, economic exposure and operating exposure (Eiteman, Stonehill and Moffett, 2007:254). Transactions exposure occurs because of gains or losses caused by the settlement of investment transactions denominated in the foreign currency. Economic exposure is caused by a change in firms' discounted cash flows when exchange rates fluctuate. Operating exposure depends on the sensitivity of the firm's value to the movements of exchange rates (Loudon, 1993). Thus, changes in the real (instead of nominal) exchange rate can affect the market position of a firm The impact of the real exchange on individual firms is eventually reflected in the aggregate share prices.

The effective real exchange rate of the South African Rand (in the first quarter of 2002) was 25% lower than the same period for the previous year and 45% lower than its average level in 1995 (MacDonald & Ricci, 2003). The South African Reserve Bank (SARB) has accumulated substantial foreign exchange reserves at a consistent rate since mid-2003 and $817 million reserves were acquired in December 2006 alone (SARB, 2007). SARB continued to purchase dollar assets despite the depreciation phase in 2006, suggesting that the SARB favoured a weaker currency. However, "…empirical evidence does not support the assertion that the SARB is not concerned about the exchange rate or is unable to influence its evolution" (Boshoff, 2008:117). It is evident that previous attempts at using exchange controls to stabilise the Rand have failed and it is argued that the attempt to manipulate the currency has increased financial market uncertainty and may have had adverse long-term consequences (Boshoff, 2008:117).

The change in the JSE's structure, such as its demutualisation in July 2005, has also attracted foreign investors. The objective of demutualisation of the JSE was to increase access to capital, enhance liquidity and, most importantly, to change the corporate governance by separating ownership rights from membership rights (Gribov, 2007:4). The positive response of foreign investors to the change in the JSE's ownership was proven by the increase in foreign investment in the South African stock market, within a two-year period after demutualisation. The JSE's 2008 annual report revealed that foreign shareholders held 45% of the JSE's issued shares at the end of 2007, while it was 18.9% a year earlier. Another significant development that affected the JSE was "…the movement by a few large companies (such as Anglo American) of their primary listing from Johannesburg to London. While in a sense this is representative of the internationalisation of South African companies, which should in the long term have benefits for the South African economy, it is sometimes perceived as a negative factor for the JSE itself" (Jefferis & Okeahalam, 2000:31). Changes in the structure of the JSE affected the flow of foreign investments in the South African stock market.

Since 1994, inflows of foreign portfolio investment in the JSE have increased "… as foreign investors have not been subjected to any exchange control regulations….and the increased importance of foreign capital flows to the JSE has increased the vulnerability of the market to international economic and financial developments" (Jefferis & Okeahalam, 2000:31). Clark & Troskie (2006:69) state that South Africa is classified as an emerging market and thus international market crises such as the collapse of the Mexican peso in 1994-1995 and the East Asian financial collapse of 1997-1998, the NASDAQ meltdown of 2000 and the Russian, Turkish and Argentinean defaults affected the South African economy. Jefferis & Okeahalam (2000:30) mention that the JSE was barely affected by the Asian crisis of 1997, which mostly affected developing countries' share markets. However, they state that the Russian/Brazilian crisis of 1998 caused a decline of 30 % in the JSE All Share Index (ALSI) during August 1998 alone. During the first half of 2008, the JSE was barely affected by the credit crunch affecting various other markets and stock exchanges, as its volumes continued to increase, while other stock markets stagnated (JSE, 2009). An

element of this is attributable to the fact that the South African equities market of the JSE comprises a large commodity component.

Previous studies, linking exchange rates and stock markets, focused on the impact of the exchange rate on the stock market's return and the use of the Arbitrage Pricing Theory (APT) in determining the pricing of the exchange rate. It has been indicated that the relationship between exchange rates and stock prices can be captured best by including other macro-variables in the APT model (Jorion, 1993:366). Studies have also shown that the relationship between equity prices and the exchange rate can be either negative or positive, depending on the nature of the stock market. Abdalla & Murinde (1997:27) assert that "…there is neither a theoretical nor an empirical consensus on the relationship between exchange rates and stock prices. Specifically, the causal direction between the two financial price variables is not resolved". Abdalla & Murinde (1997) brought together two separate developments in the area of finance, namely the Emerging Stock Markets (ESMs) and the adoption of independently floating exchange rates. They investigated the causal interactions between the leading prices in two components of emerging financial markets: exchange rates in the foreign exchange market and share prices in the stock market. Their study concludes that the causal linkage between stock markets and exchange rates in emerging economies is not standardised. This means that, in emerging economies, the causal linkage moves from exchange rate markets to stock markets in some countries, while in other countries it moves from stock markets to exchange rate markets. They emphasised that the movement in the exchange rate affects the performance of firms in domestic as well as international markets and eventually this change in performance of the firm affects its share price. Moreover, Abdalla & Murinde (1997) emphasised that the exchange rate Granger-Cause stock prices in export-oriented countries compared to import-dominant countries. Thus there are no specific expectations on the effect of exchange rate shocks on the stock market in emerging countries.

In the South African context, Barr, Kantor & Holdsworth (2007) reveal that spot exchange rate volatility has pulled the JSE ALSI in different directions (both negative

and positive), because changes in the spot exchange rate has a more immediate impact on certain stocks and a delayed or non-immediate impact on other stocks. They state that, since 2001, the JSE ALSI has responded directly to movements in the exchange rate, rising with Rand weakness and falling with Rand strength. Jefferis & Okeahalam (2000) studied the effect of the real exchange rate on the JSE with the use of the Vector Autoregressive (VAR) model. They did not identify the causal linkage between the stock market and the exchange rate market in South Africa and their sample period (from 1985 to 1995) reflects the tight control in exchange rates and the lack of openness in the South African economy because of apartheid. Although the relationship between movements in both the JSE ALSI and the exchange rate has been investigated, the causal linkage between the JSE and the exchange rate is not clearly identified. Previous studies conducted on the JSE did not test the Granger-Causality between exchange rates and stock prices.

Overall, there has been a shift to the free-floating exchange rate system around the world and this shift has increased companies' exposure to currency risks. The integration of stock markets promotes the movement of funds around the world and has increased the link between exchange rate markets and stock markets. In addition, the different level of performance between international stock markets has encouraged international portfolios as means of diversification. Since several stock markets conduct their transactions in local currencies, investors have to convert their foreign currencies into domestic currency in order to acquire stocks in local markets. This is viewed as an indirect link between the currency and stock markets and has raised concerns as to whether or not there is a causal linkage between the two markets. Researchers such as Abdalla & Murinde (1997) and Ajayi *et al.* (1998) have established that the causal linkage moves from stock market to currency markets in advanced economies, but they stressed that this linkage is not standardised in emerging economies. To the best of the present author's knowledge, there are no studies that have tested the direction of causality between the spot exchange rate and real share prices in South Africa. It is therefore important to identify the causal interactions between the foreign exchange market and the stock market in South Africa.

1.2 Objective of the Study

The objective of this study is to identify whether exchange rates shocks affected the JSE ALSI during the period 1978-2008. This will be achieved by:

i. Determining the direction of causality between the stock market index and the exchange rate;

ii. Identifying the long-run equilibrium relationship between the South African stock market and the Rand/U.S. dollar exchange rate; and

iii. Identifying the response of the South African stock market to different exchange rate regimes during the 1978-2008 period.

The outcome of this research gives an indication of the degree of the effect of exchange rate shocks on the stock market and the degree of openness in both the South African economy and the South African stock market. It indicates the level of integration of the JSE within global financial markets. This level of integration gives an indication of the accessibility to foreign investments in the South African market, the level of concentration in the JSE and its exposure to speculative and manipulative activities. These could assist investors in managing exchange rates exposure, as it provides information that may be used in enhancing international diversification and hedging strategies.

1.3 Scope and Method of the Study

This research uses different econometrics-based models to achieve its objectives. These methods include: graphical representation analysis, descriptive statistics and the Engle-Granger cointegration approach and Error Correction Model (ECM). Tests to be conducted include the test for unit root and stationarity, the Granger-Causality test, the Engle-Granger cointegration test and the parameter stability test.

Descriptive statistics analysis and graphical representation analysis are used to identify the response of the South African stock market to different exchange rate regimes. In identifying the direction of causality between the exchange rate and share prices in South Africa, the present study makes use of the model by Granger (1969), because it is simple and has been used by other researchers (in a similar context), such as Abdalla & Murinde (1997), Ajayi *et al.* (1998), Bahmani-Oskooee & Sohrabin (1992) and Freeman (1983). Stationarity and unit root are tested through the use of Dickey-Fuller and Augmented Dickey-Fuller, the Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin.

This study follows the Engle-Granger cointegration approach to establish a long-run equilibrium relationship between the South African stock market index and the real exchange rate. If the exchange rate and the stock market index are not cointegrated, a standard Granger-Causality test is used; and if both the exchange rate and the stock market are cointegrated, the Error Correction Model (ECM) is used. To avoid econometric problems, other estimations, such as the test for heteroscedasticity and the autocorrelation, are conducted. The parameter stability test is also carried out, with Chow's structural break test, to ensure that the relationship between the stock market index and the exchange rate is constant throughout the sample period.

This study uses monthly observations of the JSE ALSI and the monthly exchange rates series(R/$) from January 1978 to December 2008. The aim of setting this sample period is to measure the effect of exchange rate shocks on the JSE under both managed floating exchange rate (1978-1994) and the free-floating exchange rate (adopted since 1995) regimes. In 1978, there was an introduction of greater flexibility in the exchange rate market in South Africa, following the recommendations of the De Kock Commission of 1978 (Aron & Muellbauer, 2001:11). During 1978 there was an adoption of a floating exchange rate system (by many countries) which was formalised by the Jamaican Agreement of January 1976 (Kim & Kim, 1999:90).

1.4 Plan of the Study

The rest of this study is structured as follows:

Chapter Two builds a framework on concepts of the exchange rate market and discusses economic and financial theories relating exchange rate market to stock markets. A conceptual framework will establish basic understanding of the exchange rate market and its components such as the nominal and real exchange rates and their estimation. It contains a discussion on determinants of the exchange rate, currency risks and the management of such risks. Underlying theories focus on the discussion of financial theories linking the financial market to the exchange rate, such as the relationship between the dividend growth model and changes in the exchange rate.

Chapter Three reviews the empirical literature. The discussion on empirical literature separates international literature from South African literature. The international literature presents a comparison between studies that examined the effect of exchange rate on stock markets in developed economies such as the USA, Japan and Europe and other studies conducted on emerging Asian markets such as India, Pakistan, Hong Kong, South Korea, Taiwan, Malaysia and the Philippines. South African studies that tested the effect of the exchange rate on the JSE before 1994 and those that investigated this issue after 1994 are considered separately to allow comparisons of the effect of economic policies on the exposure of the JSE to exchange rate risks. A review of empirical literature from other African countries is also presented in this chapter.

Chapter Four analyses the movement of the South African currency, identifies different policies that affect the exchange rate and investigates whether or not the reaction of major currencies towards the Rand varies with horizon. An overview of the JSE is provided and emphasis is placed on its history, its demutualisation, its performance, its role in African and global markets and other changes in the JSE's

structure that might have changed its exposure to exchange rate risks. Finally, this chapter examines the response of the JSE to the different exchange rate regimes.

Chapter Five explains the research method, which includes discussions on the selection of data, variables to be used in the study, the sample period and the method of obtaining data. A broad description of the method used is provided, together with steps involved in developing the models. Tests to be discussed in this chapter include the test for unit root, cointegration by Engle-Granger and the use of the error correction model and the Granger-Causality test. Finally, other estimations, such as the test for heteroscedasticity and the autocorrelation and parameter stability tests, conducted to avoid econometric problems, will be presented in this chapter.

Chapter Six analyses and discusses empirical results obtained from running the model. A discussion of these results follows, to identify whether the obtained results are constant with previous studies. Chapter Seven concludes the study.

CHAPTER TWO: CONCEPTUAL FRAMEWORK AND ECONOMIC THEORIES

2.1 Introduction

There are various economic theories covering the relationship between exchange rate markets and stock markets. The review of these theories assists in establishing the effect of the exchange rate on the specific sector of the stock market or on the stock market as a whole. Madura (2003:171) states that there is a link between different exchange rates and the activities of Multi-National Companies (MNCs) because of the significant effect that the exchange rate exposures have on the value of MNCs. This effect of exchange rate movements on the value of companies can be explained with the use of the dividend growth model, which determines the value of a company based on expected cash flows in terms of dividends. It is therefore important for these concepts of the exchange rate market to be discussed in relation to economic theories that link the exchange rate market to stock markets. This will assist in establishing a basic understanding of different transactions of the currency market, the nominal and real exchange rate, determinants of the real exchange rate, exchange rate shocks and currency risks.

The rest of this chapter is organised as follows. Section Two contains a discussion of the exchange rate market and its components; economic theories at microeconomic and macroeconomic levels are discussed in Section Three; Section Four explains currency risks and the management of such risks; and concluding remarks are contained in Section Five.

2.2 Foreign Exchange Markets

The foreign exchange market is “the market in which the country’s currency is traded for another’s” (Firer, Ross, Westerfield & Jordan, 2004:670). The foreign exchange market plays an important role in global finance as it is considered to be the largest

financial market in the world (Kim & Kim, 1999:118). Thus the foreign exchange market's transactions involve a significant amount of money. For example, trading in the Rand-U.S. dollar market in February 2003 summed up to $6.8 billion (about R56 billion) (Firer *et al.*, 2004:670). Kim & Kim (1999:123) state that major participants in foreign exchange markets include exporters, governments, importers, multinational companies, tourists, foreign exchange brokers, portfolio managers, commercial banks and central banks. They explain that the currency market consists of spot trade and forward trade. In the spot trade, foreign currencies are sold and bought to be delivered within two business days, while a forward transaction involves an agreement to exchange currencies at some time in the future (Soopal, 2003:8-9). Both spot and forward markets have the same way of expressing the price of the currency, depending on the quotation used (Soopal, 2003:8). However, only measures of the exchange rate in the spot market are relevant to this study and are discussed in the following sections.

2.2.1 Nominal Exchange Rate

The price in the foreign exchange market is known as the nominal exchange rate and is defined as "the price of one country's currency expressed in terms of another country's currency" (Firer *et al.*, 2004:671). Although the two transactions, spot and forward trades, on the foreign exchange market are expressed in the same quote, they reflect two different prices. These are spot exchange rate, which is the price for spot trade, and the forward exchange rate, which is the agreed-upon price to be used in forward trade. Kim & Kim (1999:125) state that the exchange rate can be expressed as a direct quote or as an indirect quote. The direct quote is a domestic currency price per unit of a foreign currency. From a South African perspective, a direct quote between the Rand and the U.S. dollar is R7.5/$, meaning that one U.S. dollar costs 7.5 South African Rands. An indirect quote presents units of foreign currency per one unit of domestic currency. Based on the previous example, an indirect quote would be $0.1333/R, which indicates that one South African Rand costs about 13.33 U.S. cents. It is important to note that the fluctuations in the value of currencies depends on the exchange rate quotation used (Kim & Kim, 1999:125). For a direct quote, a decrease in the exchange rate reflects an appreciation of the domestic currency against the foreign currency, while an increase in the exchange rate represents the depreciation of

the domestic currency; for an indirect quote, the appreciation of a domestic currency is shown by a decrease in the exchange rate, while deprecation is shown by an increase in the exchange rate (Firer *et al.*, 2004:680).

In the currency market, the nominal exchange rates are usually quoted by foreign exchange dealers in terms of a buying (or bid) rate and a selling (or ask/offer) rate and the difference between these two rates is the dealer's profit margin (Firer *et al.*, 2004:672). Moffett, Stonehill & Eiteman (2003:126) state that a currency is always bought at a lower rate (bid) and sold at a slightly higher rate (ask), but the difference between these two quotes may not be large for currencies that have a small value. Madura (2003: 71) explains that the difference between "bid" and "ask" quotes can be normalised by measuring it as a percentage of the "ask" quote. These quotations of bid and ask may be complicated by the fact that purchasing one currency is the same as selling the opposite currency (Moffett *et al.*, 2003:127). For example, a dealer who is interested in buying South African Rands with U.S. dollars is, at the same time, offering to sell U.S. dollars for South African Rands. Consequently, a nominal exchange rate is always expressed in these two ways, the buying rate (bid) and the selling rate (ask).

2.2.2 Real Exchange Rate

Unlike the nominal exchange rate, international economics and finance do not provide one common definition of the real exchange rate. Different macroeconomic models have been used to define the real exchange rate (De Broeck & Sløk, 2006:369). Two principal definitions of the real exchange rate are: Purchasing Power Parity (PPP) and the internal relationship between the domestic price of tradable and non-tradable goods[1] (Akinboade & Makina, 2006; Odedokun, 1997 and Tembo, 1999). The PPP presents the real exchange rate as the nominal exchange rate adjusted for price

[1] Tradable goods are commodities with domestic prices because they may not be traded internationally, while tradable goods exported or imported and their prices may be in international currency (Tembo, 1999:6).

differential between countries and it is known as the external real exchange rate (Takaendesa, 2006:11). According to the PPP viewpoint, the real exchange rate is equivalent to nominal exchange rate multiplied by the ratio of the foreign price level to the domestic price level (Tembo, 1999:6). Based on Odedokun (1997:65), Tembo (1999:6) and Takaendesa (2003:12), the PPP real exchange rate is expressed as follows:

$$RER_t = \frac{NER_t * CPI_{Ft}}{CPI_{Dt}} \quad \text{.....(2.1)}$$

where:

RER_t = the direct quote of the real exchange rate;

NER_t = the direct quote of the nominal exchange rate;

CPI_{Ft} = Consumer Price Index for the foreign country; and

CPI_{Dt} = Consumer Price Index for the domestic country.

The definition of the real exchange rate within a single economy is based on the ratio of the domestic price of tradable goods to non-tradable goods and it is known as the internal real exchange rate (Tembo, 1999:6). The internal RER shows the incentives of allocating domestic resources 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" (Takaendesa, 2003:11). Based on the ratio of tradable to non-tradable goods the real exchange is:

$$RER_t = \frac{NER_t * P_{TFt}}{P_{NDt}} \quad \text{.....} \quad (2.2)$$

where:

RER_t = the direct quote of the real exchange rate;

NER_t = the direct quote of the nominal exchange rate;

P_{TFt} = foreign price of tradable goods; and

P_{NDt} = domestic price of non-tradable goods.

The common factor in both definitions of the real exchange rate is the assumption that the law of one price must hold. This means that domestic and foreign prices of both importable and exportable goods are assumed to be equal (Tembo, 1999:9). However, the choice of the real exchange's definition may be informed by different purposes to be achieved by the government or may depend on the purpose of the analysis to be conducted (Takaendesa, 2003:11). For example, the calculation of the real exchange rate based on the ratio of tradable goods to non-tradable goods is seldom used at an empirical level, because of the problem in the availability of data on tradable and non-tradable goods. Thus, the PPP-based real exchange rate is mostly used at the empirical level (Odedokun, 1997:65). The SARB calculates the real exchange rate based on the PPP (Tembo 1999:84). The PPP-based real exchange is used in this study and its calculation involves the nominal exchange rate adjusted for price differential between South Africa and the USA.

2.2.2.1 Bilateral and Multilateral Real Exchange Rates

Having identified the definitions of nominal and real exchange rates, it is important to emphasise how a country computes the exchange rate between its currency and its major trading partner. The measurement of the exchange rate can focus on one major trading partner or on more than one trading partner. The method of computing the exchange rate can either incorporate two currencies from two major trading partners (bilateral exchange rate) or more than two currencies from multiple trading partners (multilateral exchange rate) (Takaendesa, 2006:13).

The bilateral real exchange rate is simple and easy to calculate, as it only reflects the relationship between two currencies. An example of the real exchange rate can be the real exchange rate between the South African Rand and the U.S. dollar, or the real exchange rate between the South African Rand and the British pound. The bilateral real exchange rate is most usually used when a country has one dominating trade partner and it is useful when the focus is on only calculating the real exchange between two countries (Salvatore, 2004:795). This real exchange rate assists in illustrating the value of domestic currency relative to another currency of the major trading partner (Takaendesa, 2006:14). Factors that influence the bilateral real exchange rate include the trade interdependence and the movement of capital between the two countries (Devereux & Laneb, 2003:111). If a country is dealing with more than one major trading partner the bilateral real exchange rate may not be relevant, but the multilateral real exchange rate may be useful.

The multilateral real exchange or effective exchange rate of a domestic country can be defined as "…a weighted average of the exchange rates of its trading partners, with all rates being measured relative to some base year" (Black, 1976:615). The estimation of this real exchange rate involves the calculation of an index by comparing the actual exchange rate of a domestic country with the weighted average of the exchange rates of its major trading partners (Black, 1976:615). The effective exchange rate is normally used when more than two trading partners are considered and it can be estimated in nominal or real value (Levich, 2001:55). The nominal effective exchange rate is also known as the trade-weighted nominal exchange rate, as it is the trade-weighted average of the domestic exchange rate against other foreign currencies (Rahn, 2003:11).

The calculation of the trade-weighted nominal exchange rate can either use the arithmetic average approach or geometric average approach. It involves assigning the weight to each foreign currency, based on how the foreign currency changes relative to the domestic currency (Takaendesa, 2006:21). This means that a foreign currency that changes more than other currencies is given a larger weight. In other words, the weights used are generally a reflection of a domestic country's trade with another

foreign country (Black, 1976:615). The nominal effective exchange rate, using the arithmetic average, can be calculated as follows:

$$NEER = \sum_{i=1}^{n} W_i \frac{NER_{it}}{NER_{i0}} \quad \text{..... (2.3)}$$

where:

$NEER$ = the nominal effective exchange rate of the domestic country;

n = number of trading partners of the home country; and i = 1,2, …n);

W = weight assigned to foreign country i's currency;

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

NER_{it} = exchange rate of the domestic currency in terms of currency i at time t;

The effective exchange rate can also be expressed in real terms and this involves adjustment of the nominal effective exchange rate for inflation. The real effective exchange rate is the nominal effective exchange rate adjusted for the inflation differential between the domestic country and other countries included in the index's calculation (Takaendesa, 2006:18). It therefore incorporates the concepts of nominal effective exchange rate changes and the degree of difference in inflation. The real effective exchange rate can be derived from the nominal effective exchange rate, as follows:

$$REER = NEER * \frac{CPI_D}{CPI_F} \quad \text{..... (2.4)}$$

where: $REER$ = the real effective exchange rate of the domestic country;

$NEER$ = the nominal effective exchange rate of the domestic country;

CPI_D = the domestic consumer price index; and

CPI_F = the weighted average of the consumer price indices of the trading partners.

A South African example of the real effective exchange rate is the SARB's calculation of the monthly real effective exchange from 1970 to 1996, which involved the following currency and weights: the U.S. dollar (51.7%), the U.K. Pound (20.2%), the German mark (17.2%) and the Japanese yen (10.9%) (Tembo, 1999:84). Although bilateral exchange rates and multilateral exchange rates differ, it is important to note that the difference mostly exists in the short-run, as these two exchange rates tend to move together in the long-run (Ogum & Thomas, 2003). The present research will compare the movement of different bilateral exchange rates (Rand against each currency of South African major trading partners), in order to illustrate whether or not the use of one bilateral exchange rate will reflect the monthly movement between the Rand and other currencies.

2.3 Microeconomic and Macroeconomic Theories

Having explained the different methods of calculating the exchange rate, it is vital to discuss the factors that influence exchange rates. The discussion of these factors assists in establishing a linkage between the stock market index and the exchange rate. The theoretical foundations of the linkage between exchange rates and stock prices can be examined at the microeconomic or macroeconomic levels. It is essential to discuss microeconomic theories (focusing on a single company/industry) and macroeconomic theories (focusing on the overall market) separately.

2.3.1 Financial Theories at Macroeconomic Level

The link between the stock market index and the exchange rate at a macroeconomic level is explained by theories of the exchange rate determination. Moffett *et al.* (2003) mention that exchange rate determination is complex and there are different schools of thought on determinants of the exchange rate. Schools of thought on the determination of the exchange rate include parity conditions, the monetary approach to balance of payment and the asset market approach. Moffett *et al.* (2003:101) point out that these theories complement one another to capture the complexity of the currency market at a

global level[2]. Variables that influence exchange rates are related to commodity markets and asset markets and they include relative inflation rate rates, relative interest rates, relative income levels, government controls and expectations (Madura, 2003).

2.3.1.1 Parity Conditions

International parity conditions involve economic theories that determine the foreign exchange rate based on the relationship between the foreign exchange rate, money, capital and goods markets (Moffett *et al.*, 2003:68). The establishment of the relationship between these two markets suggests the set of equilibrium relationships that should hold among inflation rates, interest rates, spot rates and forward rates (Kim & Kim, 1999:132). This exchange rate equilibrium is determined by various parity relationships. There are four main parity theories: the Purchasing Power Parity (PPP), Interest Rate Parity (IRP), International Fisher Effect (IFE) and the Forward Rate Parity (FRP). A combination of these parity relationships brings together key macroeconomic factors such as interest rates, inflation and future expectations and most of these relationships depend on the efficiency of goods, capital and money markets to hold (Firer *et al.*, 2004). The extent to which the parity relationships hold in the real world is still an issue open to debate, as a market-determined exchange rate may well deviate significantly from its parity (Barr & Kantor, 2005).

Purchasing Power Parity (PPP)

The Purchasing Power Parity (PPP) is a theory linking inflation and exchange rate movements (Carbaugh, 2000:409). It is based on the law of one price, which states that identical commodities or goods must have the same price in all markets when expressed in a common currency (Firer *et al.*, 2004). Failure of the law of one price to hold would create arbitrage opportunities, whereby some entrepreneurs would buy

[2] This involves the complexities of how "… international political economy, societal and economic infrastructures, and random political, economic or social events affect the exchange rate markets" (Moffett *et al.*, 2003:93).

from the market at low prices and sell to the other market at higher prices. This would continue until the prices were equal in both markets, or the price gap became insignificant for profits to be earned from arbitrage (Shapiro, 2005:98). Even without arbitrage, Carbaugh (2000:409) reasons that rational consumers would buy from the cheaper market until prices in different markets are equal.

Firer *et al.* (2004) state that there are two forms of PPP: absolute and relative. The absolute form, according to Copeland (1994:71), amounts to the proposition that the general level of prices, when converted to a common currency, will be the same in every country. Frenkel (1976:201) states that the absolute PPP assumes that the equilibrium exchange rate is equal to the ratio of domestic to foreign prices. Absolute PPP:

$$P_{0ZAR} = P_{0USD} * S_0 \quad \text{.....(2.5)}$$

where P_0 represents the price level in South Africa and the United States, respectively; and S_0 is the spot exchange rate between the two currencies at time zero (R/$).

Carbaugh (2000:409) states that the absolute form of the PPP is very restrictive, as it can only hold if goods and financial markets are perfect and goods appear in the same proportions in each country's basket. The relative form of the PPP, on the other hand, states that in comparison to a period when exchange rates were in equilibrium, changes in the ratio of domestic to foreign prices represent the necessary adjustment to the exchange rate (Firer *et al.*, 2004:678). In other words, the relative PPP states that one country's inflation rate can only be higher (or lower) than another's to the extent that its exchange rate depreciates (or appreciates) (Copeland, 1994:74). The relative form usually means that the expected change in the exchange rate is equal to the difference between the two inflation rates and this can be formally represented as follows:

$$[E(S_t) - S_0]/S_0 = h_{SA} - h_{US} \text{ .... (2.5)}$$

where:

S_0 = current (time 0) spot exchange rate (R/$);

$E(S_t)$ = expected spot exchange rate in t periods;

h_{SA} = South African inflation rate; and,

h_{US} = U.S. inflation rate.

Rearranging Equation 2.5 gives the expected exchange rate for any time in the future:

$$[E(S_t) = S_0 * [1 + (h_{SA} - h_{US})]^t \text{ .... (2.6)}$$

Interest Rate Parity

Like the PPP, Interest Rate Parity (IRP) is based on the law of one price. Where the PPP refers to one price in the goods market, IRP refers to one price in the securities market. According to the IRP, when denominated in the same currency, identical securities must have the same price, otherwise arbitrage will occur until parity is restored (Carbaugh, 2000:407). IRP involves arbitrage conditions that must hold when international financial markets are at the equilibrium. There are two main types of IRP: covered and uncovered interest arbitrage. Covered interest arbitrage involves borrowing in one currency, selling the borrowed currency on the spot market, investing the proceeds from the sale and the purchase of the borrowed currency forward (Copeland, 1994:94). Uncovered interest arbitrage and covered arbitrage differ in one small, but important, detail; covered arbitrage locks in the exchange rate at which the foreign currency is reconverted back into the home currency, while uncovered interest arbitrage does not. With uncovered interest arbitrage, investors are, therefore, exposed to exchange rate risks.

Firer *et al.* (2004:682 explains that IRP is "the condition stating that the interest rate differential between two countries is equal to the percentage difference between the forward exchange rate and the spot exchange rate". This can be expressed as follows:

$$(F_1 - S_0)/S_0 \approx R_{SA} - R_{US} \quad \text{..... (2.7)}$$

where:

S_0 = current (time 0) spot exchange rate (R/$);

F_1 = forward exchange rate for settlement at time 1;

R_{SA} = South African nominal risk-free interest rate; and

R_{US} = U.S. nominal risk-free interest rate.

Rearranging Equation 2.7, the forward rate (with uncovered interest arbitrage) at time 1 is as:

$$F_1 = S_0 * [1 + (R_{SA} - R_{US})] \quad \text{..... (2.8)}$$

While the expected exchange at time (1), $E(S_1)$, with uncovered interest arbitrage should be:

$$E(S_1) = S_0 * [1 + (R_{SA} - R_{US})] \quad \text{..... (2.9)}$$

Unbiased Forward Rates

The unbiased forward rate (UFR) is the parity condition stating that the current forward exchange rate is an unbiased predictor of the future spot exchange rate. Firer *et al.* (2004) provide an example why it is unbiased. Should the forward rate for the U.S. dollar be consistently lower than the spot rate by 1%, then no investor would convert to U.S dollars at the forward rate, as they would receive more U.S. dollars at the spot rate. The forward rate would have to rise to attract investors. In the same way, if the forward rate was consistently higher than the spot rate, then the forward rate

would have to fall to attract investors. On average, the forward and actual future spot exchange rates should be equal to each other. Should the relationship not hold, the forward rate may be a biased predictor of the future spot rate because of unanticipated events or shocks that may occur during the period up until the date that it attempts to predict the spot rate. Transaction costs may limit the process of arbitrage, preventing traders from correcting any mispricing, allowing the bias to persist.

Fisher Effect

The International Fisher Effect (IFE) originated from Irving Fisher's work on interest rates. The Fisher Effect proposes that if the real interest rate were to remain constant, then the nominal interest rate and the inflation rate would be adjusted on a one-for-one basis (Carbaugh, 2000:407). Firer *et al.* (2004) state that the IFE posits that real interest rates are the same across all countries. This arises from the combination of the PPP, IRP and UFR. Under the IFE, the future spot rate should move in an amount equal to, but in the opposite direction from, the difference in interest rates between two countries. This arises through the notion that higher nominal interest rates reflect an expectation of higher inflation which, according to the PPP, could weaken the currency. The IFE is:

$$R_{SA} - R_{US} = h_{SA} - h_{US} \quad \text{.....2.10)}$$

where:

R_{SA} = South African nominal risk-free interest rate;

R_{US} = U.S. nominal risk-free interest rate;

h_{SA} = South African inflation rate; and

h_{US} = U.S. inflation rate.

Since the components of parity relationships (international flows of goods, services and assets) are influenced by government controls and recorded in the balance of

payment (BOP), it is essential to explore the relationship between the exchange rate and the balance of payment.

2.3.1.2 Balance of Payments Approach

The balance of payment (BOP)[3] is the measurement of all international transactions between residents of the country and foreign residents (Moffett *et al.*, 2003:45). BOP is a good indicator of pressure on a foreign exchange rate of a country (Moffett *et al.*, 2003:45). Madura (2003:114) includes government controls in the factors that influence exchange rates and emphasises that the intervention of government in the exchange rate market may lead to imbalance in BOP, especially in a country with a fixed exchange rate system. To explain the relationship between the BOP and exchange rate, Moffett *et al.*, (2003:94) presented BOP as the sum of current account balance (net export), capital account balance (net capital inflows), financial account balance (financial net inflows) and reserves balance (net reserves). The formula for the BOP is:

$$BOP = (X - M) + (CI - CO) + (FI - FO) + FXB \quad (2.11)$$

where: X = the export of goods and services, M = the import of goods and services, CI = capital inflows, CO = capital outflows, FI = financial inflows, FO = financial outflows, and FXB = official monetary reserves such as foreign exchange and gold.

Given Equation 2.11, it is important to note that exchange rate is affected by variables of BOP. These variables include foreign reserves, capital flows, productivity growth and terms of trade (Aron; Elbadawi & Kahn, 1997:10). The relationship between the BOP and foreign exchange rate depends on the exchange rate regime[4] adopted by a

[3] Components of the BOP include current account, capital account, financial account, net errors and omissions and reserves and related items (Moffett *et al.,* 2003:46 & 95).

[4] A detailed discussion on the exchange rate regimes is provided in section 3.2 of Chapter Three.

country (Copeland, 1994:22). This is due to the fact that in a fixed exchange rate regime, the government has to maintain a BOP close to zero (Moffett *et al.*, 2003:95). For instance, a negative sum of current and capital accounts is an indication of the access supply domestic currency in the currency market. To maintain the fixed exchange rate, the government has to interfere in the currency market by purchasing the domestic currency with its reserves of gold and/or foreign currency. If the sum of current and capital accounts is positive, the government often sells domestic currency for foreign currency and/or gold. Therefore, with regards to the fixed exchange rate system, the BOP is used as an indication of revaluation or devaluation[5] of the official exchange rate (Moffett *et al.*, 2003:96). Although the government does not intervene with the currency market under the floating exchange rate regime, an imbalance in BOP automatically (in theory) adjusts the exchange rate, to bring the BOP near to zero (Copeland, 1994:29). For example, a country with a net BOP deficit will have an excess supply of domestic currency which will depreciate and thus the BOP will approach zero. Managers and analysts, therefore, use BOP as a determinant of the exchange rate (Moffett *et al.*, 2003:94).

It is crucial to point out that the BOP is often criticized because it treats the capital account as a continuing flow rather than a reflection of the effort to adjust asset markets to the level desired by economic participants (Tekle, 2005:19). Researchers such as Tekle (2005:19) indicate that a new way of explaining the capital account is to consider two categories of asset market models, namely the monetary approach and the portfolio-balance approach.

2.3.1.3 Asset Market Approach

The asset market approach attaches the determination of the exchange rate to the relative interest rate, prediction for economic growth, demand and supply for securities, expectations and the level of liquidity (Moffett *et al.*, 2003:97). The asset

[5] Revaluation or devaluation is change in the fixed exchange rate, while appreciation or depreciation is a change in the floating exchange rate.

market approach reconciles the interest rate parity and unbiased expectations (discussed in 2.3.1.1), because it shows that international capital flows depend on the relative real interest rate between countries and expected international capital flows have an effect on the exchange rate. With this approach, a domestic currency is considered as a financial asset that domestic investors may want to hold (Carbaugh, 2000:421). The asset market models of the spot exchange rate include the monetary approach and the portfolio-balance approach. The monetary approach has two models, the flexible-price model and sticky-price or overshooting model (Levich, 2001:198).

2.3.1.4 The Flexible-Price Monetary Approach (FLMA)

The Flexible-Price Monetary Approach (FLMA) model suggests that prices of goods are fully flexible and that the PPP holds for both traded and non-traded goods. As a result, FLMA is centred on the income differential, interest differential and relative changes in money supply.

The FLMA model is presented by Levich (2001:1978) as follows:

If prices of a domestic and a foreign country can be related to the ratio of money supply to money demand as:

$$P = \frac{M}{L(y,i)} \quad \text{..... (2.12)}$$

and

$$P^* = \frac{M^*}{L(y^*,i^*)} \quad \text{.....(2.13)}$$

Where: P= the price level for domestic country;

P*= the price level for the foreign country;

M = money supply for domestic country;

M* = money supply for the foreign country; and

L= money demand for each country.

Considering that the PPP condition:

$$S_{(h/f)} = \frac{P}{P^*} \quad \text{(2.14)}$$

where: S(h/f) = the exchange rate in direct quote.

Thus, the PPP is:

$$S_{(h/f)} = \frac{P}{P^*} = \frac{M / L(Y,i)}{M^* / L(Y^*,i^*} \quad \text{(2.15)}$$

The common specification of money demand function is:

$$L(Y,i) = KY^{\eta}e^{-\varepsilon i}\ L(Y,i) = KY^{\eta}e^{-\varepsilon i} \quad \text{(2.16)}$$

Where: K is a constant which represents the inverse of the velocity of money, η is the income volatility of money demand and ε is the interest semi-elasticity of the money demand (Levich, 2001:198).

Making substitutions in Equation 2.15, the exchange rate is:

$$S = \frac{P}{P^*} = \frac{MK^*Y^{*\eta}e^{-\varepsilon i}}{M^*KY^{\eta}e^{\varepsilon i^*}} \quad \text{(2.17)}$$

Taking the natural logarithms of the Equation 2.17, we obtain the following:

$$\ln S_t = (m - m^*)_t + \eta(y^* - y)_t + (k^* - k)_t + \varepsilon(i - i^*)_t \quad \text{..... (2.18)}$$

Where m, k, and y represent the natural logarithm of M, K and Y and t is the time (Levich, 2001:1978).

Equation 2.18 shows that the domestic currency depreciates in response to an increase in money supply (M) and appreciates in response to an increase in domestic real income (Y) or a decrease in domestic nominal interest rates (i) (Levich, 2001:199). The FLMA assumes that good prices are flexible and the PPP holds, all the time, for both traded and non-traded goods. However, there are arguments that these assumptions of the FLMA are extreme, because the PPP may not hold continuously and prices may be flexible for tradable goods only (Levich, 2001:200).

2.3.1.5 Sticky-Price (Overshooting) Monetary Model

The overshooting/sticky-price monetary approach is also known as the Dornbusch model. This model was published by Rudiger Dornbusch in 1976 to highlight the impact of "…differential adjustment speeds in goods and asset markets. In fact, the dynamic aspects of exchange rate determination in this model arise from the assumption that exchange rates and asset markets adjust fast relative to goods market" (Dornbusch 1976: 1162). Thus, traders in financial markets respond quickly to the adjustment of money supply, by adjusting the prices of different securities and portfolio positions. Prices in commodity markets react slowly and less spontaneously to the new shock of money. This model has two features namely a short-run feature and a long-run feature. The short-run feature makes emphasises the stickiness of the prices within the product markets, whereas the long-run feature displays the characteristics of the monetary model through an adjustment process. In the context of adjustment, Dornbusch (1976) identifies the exchange rate as a critical channel for the transmission of monetary policy to aggregate demand for domestic output. Thus the

behaviour of real output affects the monetary policy on interest rates and exchange rates. The Dornbusch model is built on three basic assumptions, namely perfect capital mobility (IRP condition), slow price adjustment and perfect certainty.

The capital mobility assumption is represented as follows:

$$r = r^* + x \quad \text{.....(2.19)}$$

Where r = the domestic interest rate, r*= the given world interest rate and x = the expected rate of depreciation of the domestic currency.

If the long-run and current exchange rates are distinguished, it is assumed that

$$x = \theta(e^{-} - e) \quad \text{.....(2.20)}$$

Equation 2.19 shows that the expected depreciation of the domestic exchange rate (x) is relative to the difference between the long-run and the current spot exchange rate; where θ represents the coefficient of adjustment. Substituting Equation 2.19 into 2.20, we get:

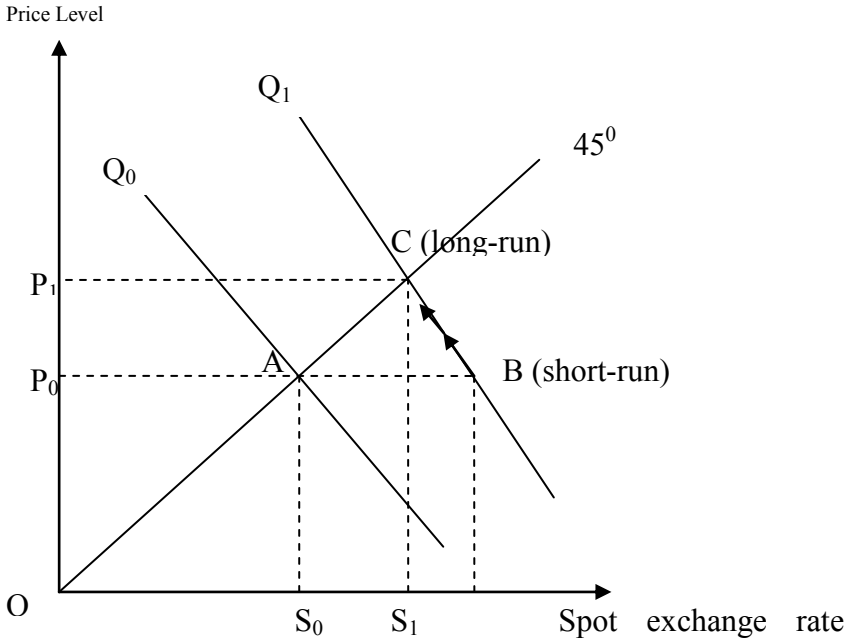
$$r - r^* = \theta(e^{-} - e)$$

Therefore, interest differences are equivalent to expected depreciation. The equation that relates macroeconomic factors, such as the quantity of money and real income and the path of exchange rate, is:

$$e_t = (m - m^*)_t + \eta(y^* - y)_t + (1/\theta)(i - i^*)_t \quad \text{.....(2.21)}$$

Where m, y and i represent money supply, real income and interest rate respectively[6] and θ is the rate at which exchange rate adjusts to equilibrium. Overshooting and the process of adjustment to the exchange equilibrium can be described by figure 2.1.

Figure 1: Expectations and Exchange Rate Dynamics



Source: Dornbusch (1976:1169)

In Figure 2.1 the initial long-run equilibrium is at Point A, where a price level is P0 and the exchange rate is S0. At this equilibrium the price level is determined by the nominal quantity of money, real income and the interest rate. The line Q0 represents asset-market equilibrium. An increase in the nominal quantity of money is expected to shift the asset-market from Q0 to Q1. The exchange rate will depreciate from S0 to S1, while the price level remains at Po and the new short-run equilibrium is achieved at point B. The new long-run equilibrium is at point C, where both goods and asset markets reflect an increase in money. However, the short-run equilibrium (point B) is below the new long-run equilibrium. The short-run depreciation of the spot exchange rate (from S0 to S2) exceeds the long-run depreciation (from S0 to S1). Thus, S2 – S1

[6] The asterisks (*) denote foreign measures.

is the amount by which the spot rate exchange rate overshot. The short-run effects of a monetary expansion are dominated by asset markets, capital mobility and expectations (Dornbusch, 1976:1169).The a djustment process fr om the short-run mar ket equilibrium (a t point B) to the long-run equilibrium (a t point C) is brought by a n increase in aggregate demand of domestic output as due to a decrease in the domestic interest. However, an increase in aggregate demand may lead to inflationary pressure instead of an increase in output. Frankel (1979) argued that the Dornbusch model c an be modified to reflect both inflation and real interest rate (Levich, 2001:202).

$$e_t = (m - m^*)_t + \eta(y^* - y)_t + (1/\theta)(r - r^*)_t + \varepsilon(\pi - \pi^*)_t \quad \text{.....(2.22)}$$

In e quation 2.22 a bove, r and r* represent domestic a nd for eign re al interest rates, whereas π and π* are domestic and foreign inflation rates. Higher real interest rates are associated with exchange rate appreciation, while higher inflation is associated with currency depreciation.

SPMA relates the time path of exchange rates to aggregate demand and output and, by implication the aggregate demand is related to stock market index. This model shows that there is an interaction stock market index and the time path of the exchange rate. The ove rshooting is probable in the c ase o f the R and/dollar rate; especially if othe r factors such as capital flows and int ernational portfolio mana gement a re considered. For example, foreign investors seeking emerging markets and commodities markets' exposure will de mand the ra nd ba sed on their expectations of risk a djusted returns across wor ldwide mar kets. In thi s light, it is vital to c onsider the expectations of market participants. A discussion of the rational expectations e xtension of the Monetary Approach is provided in the following section.

2.3.1.6 The Rational Expectations Model

Unlike the Dornbusch model,The Rational Expectations (RE) model does not consider all expectations of market participants. The RE model uses the efficient market hypothesis to explain how expectations are formed. The RE model is based on the premise that the current price is determined by current fundamentals and future expectations (Tekle, 2005:23). If investors are aware of the various factors that impact on an exchange rate in the long run, their perceptions of those factors could cause them to either buy or sell a particular currency. This continuous buying and selling of currencies contributes to the increase in the exchange rate volatility. This argument can be characterised by the following formula (Copeland; 1994:318):

$$S_{t+1}^* = 1/(1+\alpha_2)\,[M_t^* - \alpha 1 Y_t^* + \alpha_2 S_{t+2}^*] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.23)$$

Where: St_{+1}^* = the expected spot rate one period ahead;

α_1 = the income elasticity of demand;

α_2 = the semi-elasticity of the interest rate (since it is not a log value);

M_t^* = the expected real demand for money;

Y_t^* = the expected level of real national income; and,

S_{t+2}^* = the expected spot rate, two periods ahead.

From Equation 2.23, it is visible that the expected exchange rate, one period ahead (St-1) is dependent upon the expected spot rate two periods ahead (St-2). This link could potentially continue to an infinite point into the future. However, the formula is structured in such a way that the further into the future one goes the less the weighting that particular perception will have on the expected spot rate one period ahead. An important assumption of this model is that investors behave in a rational manner, as all irrational investors are not seen as players within the model (Copeland; 1994:320). Common rational expectations across all investors will be highly unlikely because

individual's perceptions are determined by intuition and subjective views. Although investors may act rationally in their own right (i.e. maximizing their wealth), there is no guarantee that these efforts will converge to the same expectations. This is vital in the context of the Rand/ U.S. dollar rate, given that there are various players, each demanding the Rand for different reasons and levels of information.

2.3.1.7 The Portfolio-Balance Approach

The portfolio-balance approach is another extension of the monetary approach of the balance of payments. It agrees with the concepts of the monetary model that exchange rates are determined by a relative supply and demand for money at home. It focuses on the excess demand of financial assets relative to their supply (Levish, 2001:203). It introduces the foreign currency as potential substitutes for money and foreign bonds as potential substitutes for bonds at home (Tekle, 2005:19). Unlike the monetary approach, the portfolio-balance approach considers domestic-currency assets as imperfect substitutes of foreign-currency securities. In this model domestic and foreign bonds are considered to imperfect substitutes by stating that the exchange rate is determined in process of balancing the demand and supply of financial securities (Levish, 2001:203). The portfolio balance approach assumes that individuals and companies hold their financial assets in combination of domestic bonds (denominated in home currency) and foreign bonds (denominated in foreign currency) (Salvatore, 2004:518). Exchange rate fluctuations affect the wealth of individuals and companies that hold assets denominated in foreign currency. Thus, changes in currency risks (as a result of exchange rate fluctuations) may lead to the adjustment of the portfolio though which firms and individuals may accumulate foreign currency assets. Although this model does not show a direct effect of exchange rate movements on the stock market index, it shows effects of exchange rate change on a company's investment activities which eventually affect the level of risk tolerance in the stock market (Tekle, 2005:20).

Overall, these models explain interactions between exchange rate and macroeconomic variables. If most of the economic variables that affect (or are affected by) the exchange rate are linked to the stock market, then this implies that there is an interaction between the exchange rate and the stock market index. The interaction between the exchange rate and the stock market at macro-level is expressed in two ways. The first theory states that changes in the exchange rate are caused by changes in the stock market index and macroeconomic variables. For example, Abdalla & Murinde (1997:26) present the relationship between aggregate stock prices and the real exchange as follows:

$$DS_t = \alpha + \beta DRS_t + cD_t + \varepsilon_t \quad \text{..... (2.24)}$$

where: DSt = changes in the real exchange rate;

DRSt = the real stock differentials (domestic minus foreign); and

Dit = interest rate differentials.

Equation 2.24 shows that the real exchange is affected by both domestic and foreign stock market indices and other macroeconomic variables. The second theory states that stock markets are affected by real exchange rates and other macroeconomic variables. Similarly, Jefferis and Okeahalam (2000:33) stated that stock market indices are affected by exchange rates and factors such as the domestic and foreign real GDPs and the domestic real interest rates. Other studies, such as those of Granger *et al.* (2000) and Aydemir & Demirhan (2009), have shown that they may be a feedback relationship between the stock market index and the real exchange rate.

Based on different schools of thought on macroeconomic theories that determine the exchange rate equilibrium, the explanation of the exchange rate seems to be simple and straightforward. Moffett *et al.* (2003:101) explain that these theories mostly hold in capital and currency markets that are large and liquid, while small and less liquid

markets tend to show a deviation from these theories. These frequent deviations in the small market partially explain the currency crisis of the 1990s in emerging markets (Moffett *et al.*, 2003:101). Short-run and long-run deviations from the equilibrium exchange rate result in exchange shocks, which may have an impact on multinational corporations. As a result, firms are exposed to exchange rate movements which are caused by different types of foreign currency risks.

2.3.2 Financial Theories at Microeconomic Level

Having explained the impact of the exchange rate on the stock market, it is essential to discuss the impact of exchange rate exposure to individual firms. Abdalla & Murinde (1997:26) explain that, at the micro level, exchange rate movements affect the value of both domestic and multinational companies; for instance, the prediction of changes in a firm's share price when exchange rates are expected to rise or fall. According to Jefferis & Okeahalam (2000:24) and Jorion (1990:364), an increase in the real exchange rate is expected to cause a decrease in the company's profit and eventually the share price may fall as well. Abdalla & Murinde (1997:26) mention that the response of domestic firms to real exchange fluctuations tends to differ from the response of multinational corporations. One may conclude that the degree of the exchange rate exposure may depend on the firm's level of foreign involvement. Furthermore, foreign exchange exposure may affect sectors of the stock market differently. Abdalla and Murinde (1997:26) emphasised that "... resource stocks (gold, other material, solid fuels, gas and oil industries) and industrials stocks (building material, chemical, banking and finance) respond differently to fluctuations in the exchange rate". The appreciation of domestic currency is associated with an improved performance in industrial stocks, while the depreciation of the domestic currency is associated with an improved performance in the resource sector (Loudon, 1993).

Soenen & Hennigar (1988) stress that share prices should reflect changes in the economic exposure, meaning that changes in the present value of a company's future cash flows may be caused by exchange rate fluctuations. "In this respect, exchange

rate fluctuations can influence even the market value of a purely domestic firm if that firm is facing international competition" (Soenen & Hennigar (1988:7). At the micro level, economic theories suggest that the effect of exchange rate risks on stock prices depends on the level of foreign involvement of a particular share or sector but, to some extent, the value of both domestic and multinational firms is affected by exchange rate fluctuations. The effect of changes in the exchange rate to the value of an individual stock or sector can be observed through the valuation of a share with the use of the Dividend Growth Model.

2.3.2.1 Exchange Rate Exposure and the Dividend Discount Model

The effect of the exchange rate movement on share prices can be explained by the Dividend Discount Model (DDM). This model indicates that the intrinsic value of a firm is equal to the present value of all expected future dividends. Bodie, Kane and Marcus (2004:419) favour the use of a constant growth Dividend Discount Model to determine the share price, with the assumption that a share price is expected to grow at the same rate as dividends. They present the calculation of the share price as follows:

$$P_t = D_{t+1} /(k - g) \quad \text{..... (2.25)}$$

where:

P_t = the stock price at time t;

D_{t+1} = dividend at time $t+1_t$;

k = cost of equity; and

g = constant growth rate for dividend.

Equation 2.25 can be extended as follows:

$$P_t = \frac{E_{t+1}(1-b)}{k-(ROE*b)} \quad \text{.....(2.26)}$$

Where E_{t+1} is expected earnings, ROE is return on equity and b is plowback ratio (reinvestment opportunities). The ROE is the total earnings over the book value of equity. The ROE is expected to increase with an increase in E_{t+1}.

Equation 2.26 shows that the increase in earnings will result in an increase in the share price, as long as b and k are held constant throughout. However, b may also be affected by changes in earnings and ROE. When the expected ROE is less than k, investors will prefer earnings to be paid out in dividends rather than reinvesting earnings at a lower rate of return. However, when ROE is greater than k, investors will prefer reinvestment over the dividend payout. On the other hand, when k = ROE investors will break even (Bodie *et al.*, 2003:430). If k < ROE, b will be expected to decrease with an increase in E_{t+1}; if k > ROE, b will be expected to increase with an increase in E_{t+1}; and if k =ROE, b may not be affected by changes in earnings (E_{t+1}). Thus changes in earnings affect both the numerator and denominator of P_0 in Equation 2.26. Since the profit (earnings) of firms that trade internationally is affected by changes in the exchange rate, P_t may also be affected by exchange rate. The profit of a company is explained by revenues and costs:

$$\text{Profit} = \text{Revenues} - \text{Costs} \quad \text{.....} \quad (2.27)$$

Export-based firms that earn their revenues in foreign currencies and incur their costs in the domestic currency will be affected by the appreciation or depreciation of the domestic currency against foreign currencies, but only on the side of revenues. The depreciation of domestic currency will increase revenues (because revenues will be converted for a high exchange rate), while costs are still constant (in domestic currency). As a result, the profit will increase and this increase will lead to an increase

in earnings and ROE and it will increase, decrease or leave b unchanged. According to Equation 2.26, if there is an increase in earnings, given that k is constant and equals to ROE, then P_t is expected to increase. Exports-based firms are expected to benefit from the depreciation of the domestic currency against foreign currencies.

The import-based firms that earn their revenues in domestic currency and incur costs in foreign currencies will be affected by domestic currency fluctuations on the costs only. The depreciation of the domestic currency will increase the level of costs (firm will get foreign currency at a high exchange rate) and leave revenues unaffected. According to Equation 2.27, this increase in costs (holding other factors constant) will lead to a decrease in profits and ROE thereafter. Equation 2.26 shows that a decrease in expected earnings (E_{t+1}), assuming that k is constant and equals to ROE, will result in a decrease in the share price (P_t). Thus, import-based firms suffer from the depreciation of the domestic currency against foreign currencies. For companies that earn some revenues in foreign currency and incur some costs in foreign currency, their exposure to changes in the exchange rate may depend on the proportion of revenues or costs that need to be converted from one currency to another. If there are equal costs and revenues to be converted, the firm will not be affected by any change in the exchange rate. This means that the appreciation or the depreciation of the domestic currency cannot affect the profit of a firm when there are equal changes in both revenues and costs of the firm. The Dividend Discount Model can be thus used to explain the impact of changes in exchange rate on the value of the company.

Although the required rate of return (k) has been held constant, it is important to acknowledge that this variable can be affected by expected changes in the exchange rate. The required rate of return (k) is expected to reflect the level of risks a firm is exposed to. Holding other factors constant, riskier firms are expected to have a higher required rate of return. Changes in the level of exchange rate risks may increase or decrease the required rate of return. If all other factors in Equation 2.26 are kept as constants, increasing the required rate of return (k) will lead to a decrease in the share price (P_t) whereas a decrease in k will lead to an increase in P_t. Thus the value of a

company is expected to decrease with an increase in the exchange rate exposure and to increase with a decrease in the exchange rate exposure. The impact of the exchange rate risks on the present value of a company depends on the exposure of such a company to currency risks.

2.4 Foreign Currency Risks

Companies whose transactions involve more than one currency are exposed to currency risks (or foreign exchange risks) and such currency risks refer to the possibility that foreign exchange rates may change unfavourably for the company that has exposure to foreign currency (Soopal, 2006:10). These changes in the foreign exchange rate have a major impact on companies' cash flows, assets and liabilities, net profit and ultimately on the value of companies' share prices (Shapiro, 2005:292). Effects on some of these variables may not be considered in assessing the exposure of the stock market to currency risks as they emerge from accounting procedures that differ from the measure of currency effects used by financial economists. Damodaran (1997:710) explains that accounting approaches are designed to measure the effect of exchange rate changes on currency income and the book values of assets and liabilities on a balance sheet, while financial economists focus on the effect of exchange rate changes on future cash flows, which are eventually reflected in the value of the firm. Kim & Kim (1992:228) state that financial economists consider three types of currency risks, namely transaction exposure, translation exposure and economic exposure.

2.4.1 Transaction Exposure

Transaction exposure is defined as the extent to which the income from a certain transaction is affected by changes in foreign exchange rates (Eiteman *et al.,* 2007:253). Transaction risks occur when cash revenue from domestic currency tends to be lower than expected, or cash payments become higher than expected (Soopal, 2006:11). Transaction exposure may result in actual cash loss (or gain) to the company as a

result of credit purchases and sales in a foreign currency and borrowing and lending in a foreign currency (Kim & Kim, 1999:230).

2.4.2 Translation Exposure

Translation exposure is a result of the consolidation of a parent company and foreign subsidiary financial statements. This exposure emerges from accounting records of a company and it does not involve any cash flows (Buckley, 1986:95). It is regarded as an accounting exposure as it arises from the translation of financial statements (that are denominated in foreign currency) into home currency of a reporting company (Soopal, 2006:11). Although translation exposure refers to paper gains and losses, Eiteman *et al.* (2007:254) emphasises that this exposure is still important in international finance. Soopal (2006:11) adds that a company's stakeholders, including investors, require that the value of the firm should be expressed in one currency, in order to understand the overall financial result and the position of the parent company. It turns out to be difficult to decide on the exchange rate to be used for translation of different accounts.

2.4.3 Economic Exposure

Economic exposure is the change in the value of a firm, as measured by the present value of its expected future cash flows, because of unexpected changes in the exchange rate in the future; it is also called operating exposure, competitive exposure, or revenue exposure (Kim & Kim, 1999:231). This exposure is concerned with the long-term real effect of currency movements on future prices, sales and costs (Eiteman *et al.*, 2007:253). It is emphasised that economic exposure focuses on unexpected movements in currency, because expected movements are already taken into consideration by product pricing, interest rates and other contracts (Shapiro, 1991:195). For example, the rapid increase in the value of the Rand on the currency market during the last month of 2004 affected the price competitiveness of many South African producers or exporters in the world market (Soopal, 2006:12). Buckley

(1986:100) expressed economic exposure based on the present value of a multinational company presented as follows:

$$PV = \sum_{t=0}^{n} \{ \frac{(CT_t - C0_t) ER_t}{(1+R)^t} \} \quad \text{..... (2.28)}$$

where:

PV = the present value of the cash flow from the foreign business in domestic currency;

CT = the estimated future incremental net cash inflows expressed in foreign currency;

$C0$ = the future incremental net cash outflows expressed in foreign currency;

ER = the expected future exchange rate (in direct quote);

R = the discount; and

t = the period for which cash flows are expected.

From Equation 2.28, economic exposure is a result of unexpected changes in the exchange rate. This causes an increase or a decrease in the present value (PV) of a multinational company.

2.4.4 Managing Currency Risks

Although foreign exchange rate exposure explains the effect of foreign exchange rate fluctuations on stock returns, some theories (such as optimal hedging theories) insist that such risks may be minimised or avoided through hedging strategies. Optimal hedging theories postulate that a firm's hedging activities have an impact on the exposure of a firm to currency fluctuations (Ng & He, 1998:741). In other words, they argue that foreign exchange rate risks can be minimised through hedging activities; thus, "… the greater the extent to which the company hedges, the lower its exposure to exchange rate risks" (Ng & He, 1998:375). These optimal hedging theories, therefore,

emphasise that firms have incentives to hedge against exchange rate risks. Gao (2000:117) states that the use of hedging strategies (such as currency options, that provide the downside protection while allowing the upside potential) is one of the explanations of the absence of empirical evidence on the effect of foreign exchange rate risks on the value of multinational companies in some studies such as those of Amihud & Levich (1994), Bodnar & Gentry (1993) and Jorion (1990). The absence of the empirical evidence on the effect of exchange rate risks on the value of a company "…is inconsistent with the common belief that exchange rate fluctuations change domestic currency revenues and costs of a multinational with foreign sales and operations, and therefore affect the value of the firm" (Gao, 2000:117). This absence of empirical evidence disagrees with the fact that the revenues and production costs are important determinants of the company's exposure to exchange rate risks (Gao, 2000:118). Besides the optimal hedging theories, there are other microeconomic theories and financial models, such as the Dividend Growth Model (DGM), that explains the effect of foreign currency risks on the value of a firm.

2.5 Concluding remarks

This chapter has provided a background to the present research, by presenting a detailed discussion of the exchange rate market and of economic or financial theories that establish the relationship between the exchange rate and the stock market. It has been shown that the foreign exchange market plays an important role in global finance, as it involves a significant amount of money. The currency market consists of two major markets, the spot and the forward markets and the difference between these two markets is the delivery time. The price used in the currency markets is the exchange rate and it can be expressed in nominal or real terms. Several definitions of both nominal and real exchange rates exist and they tend to serve different purposes.

The distinction between nominal and real exchange rates is important for analysis purposes. The nominal exchange rate is the day-to-day exchange rate in the currency market and it expresses the price of one country's currency in terms of another

country's currency. The real exchange rate can be estimated based on the PPP or on the relationship between the domestic price of tradable and non-tradable goods. The PPP-based real exchange rate is known as the external real exchange rate and it involves the nominal exchange rate adjusted for price differential between countries. The measure of the real exchange rate, based on the ratio of the domestic price of tradable goods to non-tradable goods, is known as the internal real exchange rate as it is conducted within a single economy. At an empirical level, the PPP-based real exchange rate is mostly used because of the problems of the availability of data on tradable and non-tradable goods. Another important element in computing exchange rates is the distinction between bilateral and multilateral exchange rates. A bilateral exchange rate is applicable in computing the exchange rate of only two currencies from two trading partners, while a multilateral exchange rate is employed when more than two currencies from multiple trading partners are considered.

The determination is complex and is explained by different macroeconomic theories: parity conditions, the balance of payment approach, the asset approach, the flexible-price monetary approach, the overshooting/sticky prices monetary approach, the rational expectations model and the portfolio-balance approach. These theories of determinants of the exchange rate illustrate that factors that influence exchange rates are trade-related and financial factors. Parity conditions establish the relationship between currency markets and other markets, such as the money market, the capital market and the goods market. BOP establishes the determination of the exchange rate under different exchange rate regimes. In a fixed exchange rate system, a country's BOP is adjusted by devaluation or revaluation of a country's currency, while in a floating exchange rate system a BOP adjustment is said to occur automatically with changes in the exchange rate. The asset approaches insist that the short-run determination of the exchange rate is different from the long-run determination. The short-run determination of the exchange rate is based on asset markets, interest rates and expectations of the market participants, while the long-run determination of the exchange rate is based on the commodity markets. The overshooting and adjustment of the exchange rate to the equilibrium has been shown by Dornbusch's sticky prices monetary approach. This model identifies the exchange rate as a critical channel for

the transmission of monetary policy to aggregate demand for domestic output which includes the stock market.

It has been indicated that theories of exchange rate determination do not always hold and deviation from these theories result in exchange rate disequilibrium or shocks. These theories tend to hold in the capital and currency markets of an advanced economy that are large and liquid, but small and less liquid markets tend to show a deviation from such theories. The behaviour of small markets is related to overvaluation or undervaluation of the exchange rate in these markets, because of a lack of transparency in the flow of information. It has been indicated that this behaviour of small markets explains the currency crisis of the 1990s in emerging markets.

Unanticipated fluctuations in the exchange rate have an effect on the value of multinational companies and this effect is observed through exchange rate risks (transaction exposure, translation exposure and economic exposure). In analysing the level to which such exchange rate risks can affect the value of companies, optimal hedging theories argue that currency risks may be minimised or avoided through hedging strategies; while other economic theories and financial models insist that exchange rate risks are part of systematic risks and hence cannot be eliminated. It is important to bear in mind that "…at the macro and micro levels, there is neither a theoretical nor an empirical consensus on the relationship between exchange rates and stock prices" (Abdalla & Murinde, 1997:27).

CHAPTER THREE: EMPIRICAL LITERATURE REVIEW

3.1 Introduction

Chapter two presented different financial theories on the effect of currency risks on the stock market. It now is important to review empirical evidence in order to identify whether or not expectations indicated by such theories do hold. The discussion on empirical literature includes studies that investigated the relationship between the exchange rate and the stock market. These studies used data from both advanced and emerging economies and, in most cases, findings from these two economies tend to differ because of different characteristics of stock markets in the two economies. In the different study, empirical evidence from advanced economies is separated from those of emerging economies. Although South Africa is classified as an emerging economy, it is important to view the South African literature separately, to identify whether or not there is enough evidence supporting the relationship between the currency market and stock market in the South African context. The empirical evidence on the use of different models (such as the Arbitrage Pricing Theory, Granger-Causality test, GARCH, VAR and the cointegration analysis) to investigate the relationship between the exchange rate and the stock market index is presented in this chapter. The methodology and conclusions of some empirical studies related to this study are summarised in Appendix A and a detailed discussion is given in this chapter.

The rest of this chapter is organised as follows: Section Two gives the discussion of empirical evidence supporting the use of the Granger-Causality test and cointegration techniques in testing the relationship between the stock market and exchange rates. Section Three presents a review of the empirical literature from advanced economies; Section Four provides a review of empirical literature from emerging economies; Section Five compares empirical evidence from advanced economies to the evidence from emerging economies; Sections Six and Seven review the empirical literature from South Africa and the rest of Africa, respectively; and concluding remarks are made in Section Eight.

3.2 Empirical Evidence on Methods

Different methodologies have been used to assess the relationship between the exchange rate and the stock market index. Most of the models used include the multivariable regression analysis, the Asset Pricing Theory (APT), the cointegration analysis, the Granger-Causality test, the Autoregressive Conditional Heteroscedastic (ARCH) and General ARCH (GARCH). Several studies, such as those of Adler & Dumas (1984), Aggarwal (1981) and Jorion (1990), used multivariable regression analysis to investigate the relationship between the exchange rate and stock prices. Other researchers, such as Carrieri & Majerbi (2006), Burmeister & Mcelroy (1988), Joron (1991), Linley (1992) and Reese (1993), used the APT to test the pricing of exchange rate risks in the stock market. ARCH and GARCH were used by Bah & Amusa (2003) to investigate the impact of exchange rate volatility on South African exports to its largest trading partner. The Grange-causality test has also been used in several studies on economic relationships, including the relationship between money and prices, wages and prices, exchange rates and money supply and money and income (Freeman 1983:328).

Although these models were used to identify the effect of exchange rate movements on stock markets or other related variables, some of them may not assist in achieving the objective of the present research. Bahmani-Oskooee & Sohrabin (1992) postulated that identification of the relationship between exchange rates and stock prices, by simply regressing stock prices on exchange rates, may not be effective, as there could be a two-way relationship between the two variables. Using the Granger-Causality test, combined with the error correction model, together with the Chow-test, Bahmani-Oskooee & Sohrabin (1992) found a two-way causal linkage between the effective exchange rate and stock prices. However, they failed to establish any long-run relationship between these two variables. The Granger (1969) causality test was also used in different studies to identify the causal relationship between currency and stock markets. Evidence from Ajayi *et al. (*1998), who used the Granger-Causality test to identify the causal linkage between the stock market and the exchange rate, showed that this model is effective in identifying the direction of causality. Using the Granger-

Causality test, they determined that the causal linkage between stock markets and exchange rates in advanced economies is different from the causal linkage in emerging economies. Ajayi *et al.* (1998) used this model to identify the effect of time horizon on the causal relationship and the level of integration between the two variables. They concluded that the causal relation is constant between weekly and daily data and their overall result showed that the stock market and exchange rate market are well integrated in advanced economies.

Abdalla & Murinde (1997) pointed out that Granger (1969) is useful in modelling causality. They presented this model based on the Bivariate Vector Autoregressive model (BVAR) and used it to examine the impact of exchange rate risks on emerging stock markets. They combined the Error Correction Model (ECM) and Granger-Causality test to identify the short-run dynamic behaviour and the long-run equilibrium relationship between the stock market and currency markets in Asian countries. Their findings were that the BVAR is a useful tool in identifying unconditional causality between exchange rates and stock prices and the level of integration between these two variables.

The VAR model was recommended by Jefferis & Okeahalam (2000), who attached the inconclusive evidence of some previous studies (such as those of Bennett & Kelleher, 1988 and Dwyer & Hafer, 1990) to the use of outdated methods which do not take into account recent developments in econometrics. Although they did not test for causal linkage between the exchange rate and stock market, they used the VAR model to establish the level of integration between the stock and other variables, including the exchange rate. In their cointegration analysis, they used both Augmented Dickey-Fuller (ADF) and Johansen cointegration tests and demonstrated that the Johansen test has more ability to determine the order of cointegration. The use of the Johansen multivariate test was recommended by Baillie & Bollerslev (1994), who used it to test whether or not a group of exchange rates were cointegrated. They concluded that "... the influence of shocks to the equilibrium exchange rates may only vanish at very long horizons" (Baillie & Bollerslev, 1994:737).

The use of the Granger-Causality test under the VAR model was adopted by Freeman (1983), who showed that this model was useful even in a study of political relationships, as it offers a qualitative characterisation of relationships between variables. He assessed the usefulness of this test and found that results from the Granger-Causality test are the same as those from Monte Carlo studies. He recommended the use of the Granger-Causality test because it has theoretical and practical value. He emphasised that the use of the Granger-Causality test should be guided by theoretical expectations. ARCH and GARCH models have been used to test the volatility spillovers between the exchange rate and stock market index. Adjasi, Harvey & Agyapong (2008) used these models to test the relationship between the exchange rate volatility and stock market volatility in Ghana. They found a strong negative relationship between the exchange rate volatility and stock market volatility.

3.3 Evidence From Advanced Economies

Advanced economies involve countries that have large equity markets with high levels of liquidity. These markets are characterised by large equity market capitalization and have a significant proportion of the world GDP. For example, the advanced market countries had about 80% of the world GDP and about 90% of the world's equity market capitalization in 2000 (Lofthouse, 2001:390). There is a large body of literature from advanced economies that focuses on the impact of the exchange rate on the stock market's return. These studies discuss the effect of currency movements on different stocks or industries, the overall exposure of the stock to the foreign exchange risk, the stability of the exchange rate, the pricing of exchange rate risk on the stock market and the causal linkage between the stock market index and the exchange rate. Most of these studies investigated the relationship between stock markets and exchange rate markets at a microeconomic level, by distinguishing the stocks or industries that respond positively to the exchange rate exposure from those that respond negatively to exchange rate exposure. Studies from advanced economies mostly used data from Australia, the USA, Canada, Japan and Europe.

3.3.1 Empirical Evidence From Australia

Adler & Dumas (1984) generated a definition for the exchange rate exposure in the case of Australian shares. They revealed that even domestic firms with no direct dealings in the foreign exchange market can be exposed to an exchange rate risk through exposure of their clients. Loudon (1993) studied the difference in reaction between resources and industrials to exchange rate fluctuations in the Australian companies and found a significant difference in their behaviour over the period 1984-1989. Loundon's study concluded that listed Australian resource companies benefited from the exchange rate depreciation, while industrials benefited from exchange rate appreciation. These results are supported by Gao (2000) and Barr *et al.* (2007), who associated exchange rate risks with companies' activities and emphasised that the depreciation of a domestic currency has a positive effect on companies with foreign sales. Adler & Dumas (1984) suggest that Australian resource companies generate their revenue in foreign currency and incur their costs in domestic currency, while Australian industrial companies mostly incur costs in foreign currency and generate their revenue in domestic currency.

Di Lorio & Faff (2001) conducted a study on the stability of exchange rate exposure in the Australian market, using both daily and monthly data, from 1988 to 1996. Their results (from the augmented market model) showed that the use of daily data yields evidence of the foreign exchange exposure (the asymmetric nature of the exposure). However, the level of significance of coefficients was considerably weak in monthly observations. This means that daily data produced better results, as one would expect data of high frequency to yield results that are relatively more significant than those of low frequency. Di Lorio & Faff (2001) point out that some sectors are not exposed to exchange rate risks as they have no foreign dealings. Their general conclusion indicates that there was evidence of the exposure of the Australian stock market to exchange rate risks.

In addition to Australian studies with significant results, there are some other Australian studies that produced inconclusive results or found no evidence of the exposure of the stock market (or industries) to exchange rate risks. Khoo (1994) investigated the foreign exchange exposure of mining companies in Australia from January 1980 to March 1987, using single equation and multivariate regression on individual stocks and portfolios of stocks. His results revealed that the sensitivity of share returns to exchange rate fluctuations was very small in Australia and that, in general, share returns were not sensitive to exchange rates. The absence of significant results may be attributed to spurious regressions, since a stationarity test was not conducted. Benson & Faff (2003) conducted a study on exchange rate exposure of Australian international equity trusts over the period 1989-1999 (using the APT). Although their results were mixed, they discovered that there was weak evidence of the exchange rate exposure on managed funds. They associated these insignificant results to hedging activities that might minimise the effect of exchange rate risks on hedged funds.

3.3.2 Empirical Evidence From the USA, Canada and Japan

There are a number of studies that tested the relationship between the exchange rate and the stock market, using data from the USA, Canada and Japan. Jorion (1990) showed that differences in exposure to the exchange rate occurred between U.S. multinationals and stated that this exposure was related to the level of foreign sales, as he used a sample of value-weighted industry portfolios with different exposure to the foreign exchange rate. Using the augmented market model, he indicated that export-oriented industries respond positively to the depreciation of the U.S. dollar. This means that their share prices have a tendency to increase when the U.S. dollar falls (Jorion, 1990:364). For import-oriented companies, Jorion (1990) explained that their share prices tend to decrease as the U.S. dollar depreciates. His study on monthly stock returns of U.S international firms from 1971 to 1987 concluded that the nominal exchange rate movements have an insignificant impact on stock returns and this impact depends on the nature of the industry.

The topic of exposures of certain industries to exchange rate risks was also examined by Bodnar & Gentry (1993), who used a sample from advanced countries: Canada, Japan and the USA. They categorised industries based on their mode of operation, such as exporters, importers and foreign investors. Using APT, they found that categorised industries are exposed to exchange risks in all three countries and indicated that exchange rates risks have an effect on industry returns. They stressed that exchange rate risks are systematically associated with the industries' activities and point out that the high level of exposure is observed in industry with international status, with investment in international assets and holding foreign sales.

In addition to studies that focused on the effect of exchange rate on different industries, there are studies from advanced economies that investigated the exposure of stock's returns to exchange rate risks, comparing different time horizons (frequency). Chow, Lee & Solt (1997:122) stated that the real exchange rate plays an important role in explaining the short-term variation in the stock and bond returns and that all assets are exposed to exchange rate risks. They continued that the response of bonds to exchange fluctuations tend to differ from that of stocks, as bonds respond to both long-run and short-run variations in the real exchange rate. They pointed out that the exposure of stock returns to exchange rate risks reflects both interest rate and cash flow effects, while bonds reflect the interest effect only. Using a sample from 65 industry stock portfolios from Standard and Poor's, Chow *et al.* (1997) demonstrated that the effect of unanticipated exchange rate fluctuations on stocks is negative in short horizons but positive in long horizons. They justified their result with the fact that the two effects (interest rate and cash flow), shown by exchange rate risks, offset one another in the short-run, while they are complementary during the long-run.

Given that many firms allocate significant resources to the management of foreign exchange exposure, Jorion (1991) deemed it important to test whether or not such exposure should be considered as a source of risk that can be actively hedged away. He stated that hedging can be valuable to investors only if foreign exchange risk is priced in the stock market and if some sort of market segmentation occurs. He warned

that currency hedging could change the cost of capital for the firm when foreign exchange risks are priced in the stock market, but not in the foreign exchange rate market. He explained that purely domestic firms might be affected by exchange rate fluctuations through effects on aggregate demand on the costs of traded inputs or on competing imported goods. His studies on the pricing of exchange rate risks in the U.S. stock market, using the APT model, found little evidence of pricing of the exchange, as he also demonstrated that U.S. companies earned a risk premium of 0.2% per annum for being the foreign exchange risks. Such premium was statistically and economically insignificant. Jorion (1991) concluded that exchange rate risk appears to be diversifiable. His results are supported by Hamao (1988). Although these results go against the notion that the exchange rate risk is a systematic risk that cannot be diversified, it is important to consider that the impact of the foreign exchange rate risk differs across industries or companies. A balanced stock market may thus not reflect much exposure on exchange rate risks. Studies may conclude differently on the pricing of exchange rate risks, because the industries used in the samples may respond to exchange rate fluctuations in opposite ways. For example, appreciation of domestic currency may be a risk in a sample dominated by resource stocks, while it may not necessarily be a risk within the sample dominated by the industrial stocks.

In addition to the use of the APT (by Jorion 1991) to test the pricing of exchange rate risks, the study of Bahmani-Oskooee & Sohrabin (1992) tested whether or not there is a causal linkage between the stock market index and the exchange rate in the USA. They used Granger-Causality and Cointegration techniques to investigate interactions between stock prices (measured by S&P 500) and the effective exchange rate of the dollar, using monthly observations from July 1973 to December 1988. Their empirical results revealed that there is bi-directional causality between the exchange rate and stock prices in the short-run. However, their cointegration analysis found that there is no long-run relationship between the S&P 500 stock prices and the effective exchange rate of the U.S. dollar.

3.3.3 Empirical Evidence From Europe

Studies from Europe investigated the effect of exchange rate risks on stock markets, both before and after the introduction of the single currency (the Euro) within European countries. Miller & Verschoor (2006) studied the exposure of the European multinational firms to the foreign currencies and concluded that a depreciation (or appreciation) of the Euro against foreign currencies has a net negative (or positive) impact on European stock returns in the long term. Bartram & Karolyi (2006) analysed whether or not major changes in stock return volatility, market risk and foreign exchange rate risk exposures took place around the launch of the Euro in 1999. Their study examined weekly returns for 3 220 non-financial firms from 18 European countries, the United States and Japan. They discovered that the launch of the common currency (Euro) was linked to an increase in total stock return volatility and that a considerable reduction in market risk exposures arose for non-financial firms, both inside and outside of Europe. They demonstrated that the introduction of the Euro resulted in a net absolute decrease in the foreign exchange rate exposure of non-financial firms, but these changes were statistically and economically small. Their conclusion was that the foreign exchange rate risk is, in part, a source of non-diversifiable risk.

In addition to the studies conducted in Europe during the use of a single currency, there are other European studies conducted before the introduction of the Euro. Martin (2000) used weekly data from 1994 to1996 to assess exchange rate exposure for the key foreign exchange institutions and for a mixture of portfolios from eleven countries (mostly from Europe). The aim of this study was to examine differences in exposure across countries and to review exchange rate exposure for the key financial institutions that comprise the inter-bank foreign exchange market. The conclusion on the exposure of financial institutions indicated that 40% of them were exposed to fluctuations in the value of their home currency and the other 60% were considerably exposed to fluctuations in the value of the U.S. dollar. She stated that the foreign exchange institutions have equal capability of managing exchange rate exposure. She emphasised "…differences in exposure across institutions may be attributed to

differences in the desire to accept more risk for higher expected returns" (Martin 2000:281). On the level of the exposure across countries, she found that European portfolios, such as those of the U.K. and Switzerland, are exposed to exchange rate risks compared to U.S. portfolios, which are not exposed to these risks. Her results indicated that currency exposure does not exist from a global portfolio perspective. She explained that "…the vast majority of currency trading is conducted among the financial institutions included in the portfolio, exposure is expected to be insignificant as gains accrued by one institution would be offset by losses incurred by another institution" (Martin 2000:267). Contrary to Miller & Verschoor (2006), Martin (2000) concluded that European countries and their institutions tend to be exposed to currency risks, but these risks can be minimised through global diversification.

3.3.4 Empirical Evidence From Different Countries with Advanced Economies

There are studies that combined different countries of advanced economies, regardless of their geographical locations. From 1975 to 1997, Griffin & Stulz (2001) investigated the effect of exchange rate shocks on industry returns within countries with well-established stock markets. Their study used weekly, monthly, quarterly and annual data from six advanced economies (USA, Japan, France, UK, Germany and Canada). Their empirical analysis concluded that exchange rates shocks have an almost insignificant impact on the industry returns and on stock markets across the world. They supported their finding with the idea of hedging, as they highlighted that firms may have competent instruments to minimize the effect of exchange rates on their value. Another supporting point could be that "…the stock market fails in taking exchange rate shocks into account, so that exchange rates are important but their impact is irrationally ignored by the stock market" (Griffin & Stulz, 2001:239). They add that the alternative reason could be the ability of stock markets to incorporate exchange rate shocks on stock prices. Griffin & Stulz (2001) confirmed that the effect of exchange rate shocks on the stock market varies with time horizon, as their monthly data produced better results compared to weekly data. Despite their insignificant results on the role of exchange rate shocks on stock returns, they acknowledged that exchange shocks are important to investors.

In addition to the work of Griffin & Stulz (2001), there are other studies (such as that of Ajayi *et al.*, 1988) that examined the effect of exchange rates shocks on the overall stock market within advanced economies. Ajayi *et al.* (1988) investigated the causal relations between stock returns and changes in exchange rates, using the Granger-Causality test. Their objective was to determine the uni-directional causality, bi-directional causality and simultaneous adjustments between stock returns and changes in exchange rates. They conducted a comparison among seven (Canada, Germany, France, Italy, Japan, UK and USA) advanced markets and eight countries with emerging markets. They addressed the issue of time horizon as they used daily and weekly data from April 1985 to August 1991. Their empirical results on daily data indicated that there is significant (at a level of one per cent) unidirectional causality from stock returns to differentials to changes in exchange rates in all six advanced market of their sample; and insignificant unidirectional causality from currency markets to stock markets in each advanced market. The simultaneous effect was found significant (at one per cent) in most of the advanced economies (six out of seven countries). The results for analysis revealed a significant unidirectional causality from stock returns to exchange rates in all developed economies, but the instantaneous effect was significant in three markets only.

3.4 Evidence From Emerging Economies

Emerging economies are developing countries with small equity markets. In 2000, emerging market countries had about 10% of the world's equity market capitalization and about 20% of the world GDP (Lofthouse, 2001:391). Equity markets from emerging economies are often characterised by a domestic ownership, because they sometimes have restrictions on the number of shares owned by foreigners in a company (Lofthouse, 2001:391). There is a large empirical literature on the relationship between the stock market and the currency market in emerging economies, with the focus on Asian and Latin American countries. The common factor in the literature from emerging markets is that there is no standardised conclusion on the effect of exchange rate shocks on the stock market. Some studies from emerging economies found evidence supporting the relationship between the exchange rate

movements and the stock market, while others failed to provide significant results on this issue.

Ajayi *et al.* (1988) investigated the relationship between the stock and currency markets, using daily and weekly data (April 1985 to August 1991) from eight emerging Asian markets (Taiwan, Korea, the Philippines, Malaysia, Singapore, Hong Kong, Indonesia and Thailand). Their results for daily data were different for emerging economies, as the unidirectional causality was significant (at one per cent) in three of the eight countries under study; and it runs from stock market to currency market in two countries (Thailand and Malaysia) and from currency market to stock market in one country (Korea). In terms of bidirectional (two-way) causality, it was found to be statistically significant in Taiwan and statistically insignificant in the other four countries (Hong Kong, Singapore, Thailand and Malaysia). The instantaneous effects between these two variables in emerging countries were significant only in three of the eight counties. Results from weekly data for emerging economies show a significant unidirectional causality from the stock market to the currency market in two countries only and an instantaneous adjustment in one country. They concluded that causal relations between stock market and currency market in emerging economies is not established, as their evidence produced mixed results on this direction of causal relations. The reason behind such mixed results may be different levels of economic structure in these countries, as some of these countries may be export-oriented, while others have import-dominant economies.

Abdalla & Murinde (1997) examined the impact of exchange rate risks on emerging stock markets, using monthly observations (January 1985 to July 1994) from India, Korea, Pakistan and the Philippines. They used the Bivariate Vector Autoregressive model (BVAR) to investigate the interactions between exchange rates and stock prices in these countries. Their findings demonstrated unconditional causality from exchange rates to stock prices in India, Korea and Pakistan, but the causality moves from stock prices to the exchange rate in the Philippines. They found that the causal influence that moves from exchange rates to stock markets is strong in export-oriented economies.

They explained that in export-dominant economies the effects of exchange rates' movements on stock markets start from companies' exports, continue though profits and values of such companies and eventually affect the overall stock. Consequently, one would expect the export-oriented countries to reflect the causal relationship that moves from the currency market to the stock market.

Granger *et al.* (2000) used daily data (January 3, 1986-June 16, 1998) to explore short-term dynamic relations between stock prices and exchange rates in the Asian markets (South Korea, Philippines, Hong Kong, Malaysia, Singapore, Thailand, Taiwan, Indonesia and Japan). They concluded that most of the markets revealed either changes in stock prices, leading to changes in exchange rates, or the exchange rate took the lead (feedback interaction). In South Korea, exchange rates led stock prices, while in the Philippines stock prices led exchange rates, with a negative correlation. Hong Kong, Malaysia, Singapore, Thailand and Taiwan showed strong feedback interactions, while Indonesia and Japan did not reveal any identifiable pattern (Granger *et al.*, 2000). Although some studies concluded otherwise, there is enough evidence supporting the theory that exchange rate exposure of the stock market to this effect is not standardised in emerging economies.

Muller & Verschoor (2006) used Engle-Granger cointegration approach to test whether or not the exposure of sector-specific companies to exchange risks has any pattern and whether or not such exposure increases with time horizons. Their study was conducted on 3 634 Asian internationally active companies, with a data set of weekly stock returns and exchange rate movements from January 1993 to January 2003. They found that: "…about 25 percent of Asian firms experienced economically significant exposure effects to the US dollar and 22.5 percent to the Japanese yen for the period January 1993 to January 2003" (Muller & Verschoor, 2006:16). Their results also indicated that a depreciation of the Asian currency against foreign currencies has a net negative impact on stock returns, while an appreciation has a positive impact. "The extent to which firms are exposed to exchange rate fluctuations varies with return horizons; short-term exposure seems to be relatively well hedged,

where considerable evidence of long-term exposure is found" (Muller & Verschoor, 2006:16).

Complementary to the study of Muller & Verschoor (2006), Chue & Cook (2008) focused on emerging economies, but they extended the sample size to include emerging markets from Asia, Latin America and Africa. They estimated the exposure of emerging market companies to movements in their domestic currencies, using data from 15 emerging markets (Brazil, Chile, Colombia, India, Indonesia, Korea, Mexico, Morocco, Pakistan, the Philippines, South Africa, Taiwan, Thailand, Turkey and Venezuela). Their sample period was from the beginning of January 1999 to the end of June 2006. It was divided into two sub-periods (1999-2002 and 2002-2006), to investigate whether or not such exchange rate exposures were constant throughout the time. They used an instrumental variables approach in order to determine the total exposure of a firm to exchange rate fluctuations without capturing the influence of other macroeconomic shocks. Their findings show that the depreciation of the domestic currency resulted in a negative effect on share returns in emerging economies during the first sub-period (1999-2002), while this effect mainly disappeared in the second sub-period (2002-2006). Their overall conclusion was that exchange rate risks affect companies in emerging economies, but these effects are not constant over time. This conclusion put more emphasis on results from others studies (discussed in the present research), which indicated that it is difficult to standardise effects of currency risks on emerging stock markets.

3.5 Comparison Between Advanced and Emerging Economies

Having reviewed empirical evidence from advanced and emerging economies separately, it is important to compare these studies in order to identify whether or not they present similar findings. The comparison between findings from advanced and emerging economies shows that the relationship between the currency market and the stock market in these two economies tends to differ. Ajayi *et al.* (1988) stated that stock and currency markets are well integrated in advanced economies, with the

direction of causality mostly moving from stock returns to exchanges rates, while such direction of causality is not constant in emerging economies. The inconstancy of causal relations may imply that there is a low level of integration between stock and currency markets in some emerging economies. Ajayi *et al.* (1988) emphasise that the distinction between the findings from advanced and emerging economies is linked to the differences in the structure and characteristics of financial markets between the two economies. Thus "…emerging markets are much smaller in size, less accessible to foreign investors, more concentrated and may be subject to speculative and manipulative activities. Therefore, the emerging stock markets may be less reflective of broad economic activities as documented in the advanced markets" (Ajayi *et al.*, 1988:248). Moreover, the exchange rate markets in emerging economies might not be as independently floating as those in the advanced economies because of the difference in structure and the high level of government intervention in emerging economies.

Mixed results on the causal linkage between currency markets and stock markets in emerging economies were obtained by Abdalla & Murinde (1997) and Granger *et al.* (2000), who attached such inconstancy to the different economic orientations of developing countries. They observed that results from emerging economies may not be standardised, as some countries of this economy tend to be more export-oriented, while others have import-oriented economies. Both studies established that the causal linkage between the currency market and stock markets tends to be standardised in advanced economies, while results from emerging economies are mixed.

Other studies did not reveal any differences between the effect of exchange rate risks on the stock market in advanced and emerging economies. Dominguez & Tesar (2001) observed the relationship between exchange rate fluctuations and companies' values using companies from eight (non-US) advanced and emerging markets from 1980 to 1999. They found that changes in the exchange rate have an effect on a considerable fraction of the companies and that the direction of exposure depends on the nature of the company and the specific currency and this direction changes over time. They discovered that the response of companies' share returns to exchange rate

fluctuations was not consistent throughout the period. Dominguez & Tesar (2001:188) declared that "… the exchange rate exposure is correlated with firm size, multinational status, foreign sales, international assets, and competitiveness and trade at the industry level". Dominguez & Tesar (2001) concluded that the exchange rate exposure is more common in small companies than large or medium sized companies. This may indicate that medium and large companies have more ability to minimise the exchange rate exposure than small companies. They also found that companies involved in international activities (in both advanced and emerging economies) portray more evidence of the exchange rate exposure than companies with domestic activities only.

3.6 Evidence From South Africa

In South Africa, previous studies that tested the relationship between the exchange rate and the stock market focused either on the exposure of the JSE to currency movements or the exposure of specific firms or specific industries. These studies demonstrate that South African investors have been concerned with exchange rate risks even before the adoption of the free-floating exchange rate in South Africa in 1995. Studies that tested the effect of the exchange rate on the JSE before 1995 are separated from those that investigated this issue after 1995. This separation will allow the present study to specify whether or not changes in economic policies (post-apartheid) have increased the exposure of the JSE to exchange rate risks. This will highlight the general effect of different exchange rate regimes on specific firms or on the stock market as a whole.

3.6.1 South African Literature: Before 1995

Reese (1993) included the exchange rate in her study of the effect of pre-specified factors on share prices on the JSE, using monthly observation, for 10 years (from 1 January 1980 to 31 December 1989). She explains the effect of the exchange rate on the stock market by emphasising that the exchange rate fluctuations cause changes in the cost of imports and the selling prices of exports. She pointed out that the weakening of the South African currency should cause the cost of imported goods to

increase, whilst also increasing the revenue derived from exports. She stated that unanticipated movements in exchange rates should lead to unanticipated movements in share prices. Her conclusion was that there was a significant negative relationship between the exchange rate and industrial share returns and a positive relationship between mining share returns and the foreign exchange rate. She established that the depreciation of the Rand would affect industrial share returns negatively, while it would have a positive effect on mining share returns. Reese (1993) discussed the study of Westwell (1987), which established that the exchange rate appears to be a priced factor, particularly in the shares that are sensitive to foreign exchange risks. These tradable shares are described by Westwell (in Reese 1993:41) as "traditional Rand hedges on the JSE". Westwell postulated that foreign exchange rates may be one of the factors that affect stock markets, even though this could not be determined with certainty.

Aron *et al.* (1997) define the equilibrium real exchange rate based on a macroeconomic approach focusing on variables such as taxes, terms of trade, trade policy, capital flows and technology. They state that the exchange rate shocks are the result of deviation of the real exchange rate from the equilibrium level because of short-run changes in economic variables that affect the level of capital flows. They examined determinants of the short-run and long-run equilibrium in the quarterly real exchange rate, from of 1970:1 to 1995:1. Their conclusion was that foreign direct and portfolio investments are part of fundamental variables that influence the real exchange rate in South Africa and they stressed that "…exchange rate is not constant over time, but responds to changes in a range of fundamentals and shocks to the economy" (Aron *et al.,* 1997:26). These findings are in line with the theories of exchange rate determination, discussed in Chapter Two.

Jefferis & Okeahalam (2000) used cointegration and error correction techniques to investigate the impact of economic fundamentals on stock markets in Botswana, South Africa and Zimbabwe. Their economic variables included the real exchange. Their analysis was conducted using quarterly observations from 1985 to 1995. Their results

on South Africa show that there is a positive relationship between the South African stock market and the real exchange rate and that the impact of the exchange rate on South African stock market was identified as more indirect than direct. Findings on Zimbabwe showed that the real exchange rate has no impact on the real stock market index. Jefferis & Okeahalam (2000) linked these results to the relatively closed nature of the Zimbabwean economy during the sample period. They found that changes in stock prices indexes and economic fundamentals are closely linked only over longer periods. They stated that "changes in variables such as exchange rates or interest rates cannot be interpreted as changes in fundamentals at the high frequencies represented by daily price changes" (Jefferis & Okeahalam, 2000:25). Their justification for these expectations is that the daily or weekly changes in stock market indexes may well be largely influenced by investors' psychology. Their overall conclusion was that there is a positive relationship between the JSE and the real exchange rate and that international influences on the JSE are transmitted through the exchange rate.

3.6.2 South African Literature: After 1995

Bah & Amusa (2003) used ARCH and GARCH models with quarterly data to examine the impact of exchange rate volatility on South Africa's exports to the United States, over the period 1990–2001. They inferred that, after 1994, South Africa's reintegration into the world economy proved to be beneficial to exports and, therefore, to the domestic economy. This is a result of the liberalisation of exchange controls and relaxation of capital flows within the financial system. "As an emerging market economy with a well developed financial sector, the reduction in controls relating to the exchange rate market and capital flows has 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 & Amusa, 2003:5). These authors found that there is a correlation between the volatility of the stock market and the exchange rate and they recommended ways of reducing the volatility of the Rand as a way of stabilising the stock market and exports. Based on their findings, one would expect changes in the exchange rate market to cause changes in stock markets.

Using the exponential Generalised Autoregressive Conditional Heteroscedasticity (EGARCH) model and cointegration and ECM, Takaendesa, Tsheole and Aziakpono (2006) tested for the impact of the exchange rate volatility on exports in South Africa. Their findings show that the exchange volatility has a negative effect on the real exports in South Africa.

Barr & Kantor (2006) examined the relationship between the foreign exchange rate (R/U. S. $) and the JSE during 2000-2003. They established an important assumption that there they should be a close relationship between the stock market (JSE in this case) and the foreign exchange rate, given the fact that both are affected by South African inflation at the same time. They showed that the JSE and the R/US$ exchange rate have been showing a negatively related movement, with fairly long-run constant values, over the sample period. At the end of 2002 "…the JSE was about 20% higher in dollars than in the early eighties. Since the real exchange rate in dollars has declined about 20% over the same period this means that the JSE has barely kept up with inflation over the period examined" (Barr & Kantor, 2006:81). Although some of the JSE's sectors responded differently to the overall tendency, Barr & Kantor (2006) concluded that the JSE ALSI has responded very directly to the exchange rate movements; meaning that it increased with Rand depreciation and declined with Rand appreciation.

Barr, Kantor & Holdsworth (2007) used a GARCH adjusted regression analysis to identify the relationship between the returns of the ALSI Top40 companies and changes in the Rand-U.S. dollar exchange rate from February 1999 to August 2005. They grouped these companies according to their global positioning in relation to income and costs into four main categories: Rand-hedge, Rand-leverage, Rand-play and mixed. They stressed that this ranking allows investors to construct customised portfolios according to their expectation of future exchange rate movements and to understand more fully the exchange rate risk that their current portfolio may have. Their division of Top40 companies, based on the company's dependency on the South African and global economy, is as follows:

Rand-plays/non-tradable

Barr *et al.* (2007:57) explained that companies (listed on the JSE) whose operations are almost completely South African-based are defined as Rand-plays. These include retailers and banks (such as FirstRand), with almost all their revenues generated and costs incurred in the South African Rand. They indicate that Rand-play dividend is proportional to the profit at time t.

$$\Pr of_t = R(\mathrm{Re}v_t - Cost_t) \quad \text{.....} \quad (3.1)$$

where:

$\Pr of_t$ = Profit at time t;

$\mathrm{Re}v_t$ = Revenue at time t; and,

$Cost_t$ = Cost at time t.

From Equation (3.1), these firms earn their profit by generating revenues and incurring Rand costs in the domestic currency (Rand). Barr *et al.* (2007:46) state that the local market can be vital for some JSE-listed resources companies, such as Sasol, as these companies have the ability to charge their domestic customers world market prices, U.S. $-related import parity prices, because of the absence of local competition. Thus they depend on the strength of the South African economy and world economies, as well as on the foreign exchange value of the Rand itself for their bottom line. Generally, these companies are negatively related to the R/$ exchange rate; as a result they benefit with appreciation of the Rand and lose with depreciation of the Rand (Barr & Kantor, 2006:95).

Rand-hedge stocks

For Rand-hedge stocks, Barr *et al.* (2007:57) pointed out that these are "companies listed on the JSE that are almost completely foreign-based, generating only foreign „hard' currency income and incurring only foreign costs". Examples of these are Liberty International and Richemont. In this category, the dividend is proportional to the profit at time (t) denominated in foreign currency (U.S. dollar, in this case) and then is converted into the local currency (Rand) to provide:

$$\Pr of_t = \frac{R}{\$}(\$\mathrm{Re}v_t - \$(Cost_t) \quad \text{..... (3.2)}$$

Equation (3.2) indicates that Rand-hedge firms have both revenues and costs in foreign currency (U.S. dollar in this case), but their profits are denominated in domestic currency (Rand, in this case). Barr *et al.* (2007:57) therefore conclude that "the profits of a Rand-hedge company in dollars will be directly affected by the Rand/U.S.$ exchange rate; a weaker exchange rate will increase the dividend flow in Rand for any given profit in dollars" (Barr *et al.*, 2007:57).

Rand-leverage stocks

This category includes companies that are South African-based and incur costs in local currency, but sell their products in foreign currency. Mining and resources companies, close to 50% of the JSE's market value, respond very differently to Rand weakness or strength. "They tend to lose Rand value when the Rand appreciates and gain Rand and U.S.$ value when the Rand depreciates. This is because they earn almost all their revenue from the minerals and metals they produce that are priced in U.S.$ from mostly offshore customers and their costs are predominantly in Rands" (Barr *et al.*, 2007:46). Hence, their dividend is proportional dollar profit at time t, denominated in dollars and then converted into Rands. The expectation is supported by Barr & Kontor (2006), who concluded that Rand-hedge companies, mostly resource producers, are

positively related to the exchange rate. It means that they benefit from the depreciation of the Rand and lose if the Rand appreciates.

$$Profit_t = [\frac{R}{\$} * (\$Rev_t)] - R(Cost_t) \text{ .....(3.3)}$$

Equation (3.3) indicates that Rand-leverage companies earn revenues in Rand and incur costs in U.S. dollars and eventually profits have to be converted from U.S dollars to Rands.

Mixed stocks

Even if a large number of companies fall quite clearly into one of these three groups, some diversified industrial stocks, holding companies and companies, whose business is primarily but not exclusively based overseas, are not so easily classified. Barr *et al.* (2007:47) assert that some of the firms (such as Remgro, Investec and Old Mutual) that have equal mixed earnings from South African and offshore assets, may be classified as Rand neutral. They emphasised that other firms (such as SAB-Miller and Barloworld), that have the characteristics of both Rand-hedge and Rand-play, should be classified into a new category of mixed companies. Companies under this group may therefore not be affected by currency movements, as profits and losses from currency fluctuations offset one another.

Barr *et al.* (2007) revealed that the effect of the exchange rate on individual companies corresponds to the market's expectations of how these exchange rate movements would affect company operating profits and dividend flows. The manner in which companies' profitability is affected explains the magnitude of exchange rate fluctuations on the firm's share price. This is similar to the use of the dividend discount model in explaining the effect of exchange rate movements on the company's share price, as shown in Section 2.3.2.1 of Chapter Two.

Aron & Muellbauer (2001) examined the effect of South African monetary policy regimes on output, using quarterly observation, over the period 1963-2000. They pointed out that South Africa has been characterised by unstable developments on the international front because of significant changes in regime. Most of these changes in regime affected the volatility of the exchange rate. They stated that "…South Africa has become more responsive to the real exchange rate as its economy became more open during the 1990s, especially after 1994" (Aron & Muellbauer, 2001:26). This was a result of the removal of control capital movement on non-residents and the lenient attitude toward direct investment abroad by South African residents. They stated that the intervention of the SARB in both spot and forward foreign exchange markets affected the exchange rate, even though the level of intervention is limited by low reserves. Their results demonstrated that the openness of the South African economy resulted in a structural break and emphasised that this is mostly caused by the increase in international capital flows.

3.7 Empirical Evidence From the Rest of Africa

Having discussed the empirical evidence from South Africa, it is important to consider studies from other African countries besides South Africa. The main focus of such studies has been on the exchange rate management, the impact of exchange rate volatility on investment, the effect of exchange rate policy on different sectors and the reviews of African stock markets.

Jefferis & Okeahalam (2000) examined the effect of domestic and foreign economic factors (including real exchange rate) on real stock market returns in three southern African stock markets (South Africa, Zimbabwe and Botswana), from 1985 to 1995, and provided a review of African stock markets. They explained that African markets are illiquid by global standards and such presence of illiquidity may limit overall portfolio capital flows into Africa. This has been the case in many African countries, especially in countries in which controls on foreign ownership of shares exist (Jefferis & Okeahalam, 2000: 28). Their results on Zimbwabwe showed that is that there is no

relationship between the real exchange rate and the real stock market index. They linked the absence of such a relationship to the relatively closed nature of the Zimbabwean economy, characterised by strict exchange control regulations, especially during the period of the study (Jefferis & Okeahalam, 2000:46). It was concluded that there is a positive relationship between the real stock market in Botswana and the real exchange rate. South African results have been discussed in the previous section.

Sekkat & Varoudakis (1998) reviewed exchange rate regimes in Africa and conducted an assessment of the impact of exchange-rate policy on manufactured exports in sub-Saharan countries. Their study examined the relationship between exchange rate policy and manufactured export at sector level, focusing on how manufactured export is affected by effective real exchange rate changes, exchange rate volatility and exchange rate misalignment (Sekkat & Varoudakis, 1998:12). Their study (from 1970 to 1992) involved eleven sub-Saharan countries, six countries with fixed exchanges rates and five countries with more flexible exchange rates. They conducted a detailed analysis by examining the effect of exchange rate fluctuations on three categories of manufactured exports (textile products, chemicals and metal products). Their results showed that exchange rate fluctuations have an effect on textile and metal products, but not on chemical products. Sekkat & Varoudakis (1998) indicated that the exchange rate misalignment has a negative impact on manufactured export performance within sub-Saharan countries with flexible exchange rate regimes. They emphasised that countries with fixed exchanges rate regimes portrayed the opposite pattern to the countries with flexible exchange rate regimes.

Their overall conclusion was that exchange-rate mismanagement in sub-Saharan Africa has decreased the incentives for exporters and that the response of sub-Saharan Africa exporters to real exchange rate incentives appears to be less than the response of other developing countries' exporters (Sekkat & Varoudakis, 1998:45). The reason behind such a difference might be the increase in real exchange rate volatility in sub-Saharan countries, because of inconsistencies in internal macroeconomic policies, which failed to provide stable economic conditions (Sekkat & Varoudakis, 1998:22).

Bleaney & Greenaway (2001) studied sub-Saharan countries and examined the effects of terms of trade and real exchange rate volatility on investment and growth from 1980 to 1995. Their study was conducted within fourteen sub-Saharan African countries[7]. Their review indicated that all countries in the sample had shown a significant real exchange rate depreciation of more than 4% per annum, on average, during the sample period (Bleaney & Greenaway, 2001:498). Their overall findings on sub-Saharan Africa were that real exchange rate fluctuations appeared to have a strong negative impact on investment and growth. Such findings concur with those Sekkat & Varoudakis (1998). The reason behind such negative effects may be the inconsistencies in internal macroeconomic policies within these countries. Adjasi, Harvey and Agyapong, (2008) used the Exponential Generalised Autoregressive Conditional Heteroskedascity (EGARCH) model to test for the relationship between exchange rate volatility and the stock market volatility in Ghana, from 1995 to 2005. Their results revealed that exchange rate volatility had a negative effect on the stock market in Ghana.

The study of Reinhar (2000) shifted the focus from sub-Saharan Africa to northern Africa, as he combined Egypt with countries from other continents. He used data from 36 countries from different continents to investigate the mirage of floating exchange rates, from January 1970 to April 1999. He grouped countries into four types of exchange rate regimes: peg, limited flexibility, managed floating and freely floating. The aim of such classification was to identify groups that are exposed to exchange rate fluctuations. Egypt was classified within the group of countries with a managed floating exchange rate. Empirical results showed that there was no evidence on the exposure to exchange rate fluctuations in Egypt during the sample period (Reinhar, 2000:67). However, some of the other countries were exposed to the exchange movements and there was a relationship between such exposure and exchange rate regimes adopted during the sample period. The absence of empirical evidence in Egypt may thus be allocated to the exchange rate system (managed floating exchange rate) that allows the intervention of government in the currency market.

[7] These countries were Botswana, Burkina Faso, Cameroon, Côte d'Ivoire, The Gambia, Ghana, Kenya, Malawi, Mauritius, Niger, Senegal, Tanzania, Togo and Zimbabwe.

3.8 Concluding Remarks

Chapter Three has shown that there is empirical literature supporting the relationship between the stock market and the exchange rate market. It has been revealed that the interaction between these two markets may be influenced by the nature of the economy of a country. Most of the studies tested the effects of exchange rate changes on the specific share or the overall stock market using different models, such as the APT, the Granger-Causality test, GARCH, Cointegration techniques and the simple descriptive statistics analysis. In most cases, these studies showed that results from countries with advanced economies tend to differ from those from developing countries.

The review of the literature has, however, left a few questions without specific answers. It has been revealed that the relationship between stock markets and currency markets is not standardized within emerging economies and there is no general consensus on whether or not exchange rates affect the stock market positively or negatively. Most studies, such as those of Jorion (1991), Goldberg (1993), Risse (1993) and McDermott (2008), have established that firms that are export-based (mostly in resources and mining) benefit from their domestic currency's depreciation (or suffer from its appreciation), while firms that mostly import their input tend to suffer from their currency depreciation (or benefit from its appreciation). However, the overall effect of exchange rate risks on the stock market may depend on the nature and the structure of the stock market. Moreover, the issue of causal linkage between stock markets and currency markets in an emerging economy is not established, as empirical evidence produced mixed results on this issue. Most importantly, this relationship has not yet been tested in South Africa, as most previous studies established the assumption that the exchange rate market affects the stock market.

The literature presents two arguments as far as the time horizon is concerned. Firstly, Chamberlain *et al.* (1997) showed that daily data produce better empirical evidence on the sensitivity of stock markets to foreign exchange rate risks than monthly data.

Chow *et al.* (1997) indicated that it is difficult to detect exchange rate exposure in the long-term, while Jefferis & Okeahalam (2000) reasoned that short-term (daily or weekly) changes in the stock market indexes are linked to the investor's psychology instead of an economic variable such as the exchange rate. Ajayi *et al.* (1998) revealed that results for weekly data are different from those for daily observations, especially in emerging economies. This implies that results are still different, even in the short-run.

The issue of the time horizon is attached to different responses of major currencies towards changes in the Rand. Major currencies tend to respond differently in the short-run, but the response becomes the same as the time horizon increases (Ogum & Thomas, 2003). This raises a concern about short-run shocks that may persist longer in some currencies relative to others, but become common in the long run. Short-term results may not be generalised across different currencies as exchange rate shocks may differ even in the short run. The present research will use monthly observations, as Jefferies & Okeahalam (2000) showed how previous studies using short-run horizon (daily and weekly) could not produce sufficient evidence on the effect of the real exchange rate on the stock market. Most importantly, the monthly movements of the Rand against major currencies will be examined to establish whether or not these currencies tend to take the same direction. The causal linkage between these two variables in South Africa will be established using the Granger-Causality test.

CHAPTER FOUR: EXCHANGE RATE REGIMES AND THE JSE

4.1 Introduction

Recent global economic and financial crises, such as the sub-prime crisis, have affected different countries because of the increase in the level of global financial integration (Schindler, 2009). This integrated global economy has increased the involvement of firms, both large and small, in international trade and investment. The involvement of companies in cross-border trade and investment requires the conversion of the money from the firm's domestic currency into foreign currency and *vice versa* (Soopal, 2006:1). This means that economic and financial instabilities that affect companies may have an impact on the stability of the exchange rate market. Furthermore, the stability of the exchange rate may be affected by changes in exchange rate regimes, as some of the exchange rate regimes may increase the volatility of the value of the currency. For example, developing countries that adopt the pegged exchange rate regimes were highly affected by the 1998 financial crisis (Fischer, 2001:3). A country with flexible exchange rate regimes, such as South Africa, was affected by the September 11, 2001 incident and the 2008 economic crisis in Zimbabwe. These international crises manifest in foreign exchange rate movement. Since changes in exchange rate regimes have an impact on the exchange rate volatility and the exchange rate volatility affects the stock market[8], changes in foreign exchange rate regimes may also affect the stock market. Thus the effect of the international crisis on a country may depend on the exchange rate regime adopted by the country. In the South African context, companies respond differently to currency movements, but the overall effect of the fluctuation of the Rand can be observed through the analysis of the response of the JSE to different exchange rate regimes.

Chapter Four provides a detailed discussion on different exchange rate regimes and the effect of such regimes on the South African stock market. The remainder of this

[8] The review of the empirical literature in Chapter Three revealed that exchange rate fluctuations and changes in the stock market index are linked.

chapter is divided into four sections, presented as follows: section 4.2 provides the overview of the foreign exchange rate regimes and the implementation of these regimes in South Africa; the overview of the JSE is presented in section 4.3; section 4.4 conducts an analysis of the response of the JSE towards different exchange rate regimes and section 4.5 provides a conclusive summary to the chapter.

4.2 Foreign Exchange Rate Regimes and Their Implementation in South Africa

Most companies are involved in activities that result in the exchange of one currency for another in order to make payments. Since exchange rates change over time, the cash flows needed in making payments also change accordingly. As a result, the number of units of companies' domestic currency required to pay for foreign supplies can change, even though the suppliers may have not modified their prices (Madura, 2003:18). These unexpected movements in exchange rates are the source of currency exposures that affect multinational corporations. Currency exposures may be linked to exchange rate regimes adopted through the economic policies of a certain country. Another question on currency risk is whether or not they may change with the horizon. This section presents the general background on exchange rate regimes[9], discusses the movement of the South African currency, identifies different policies that affected the South African currency and investigates whether or not the reaction of major currencies towards the Rand changed with horizon.

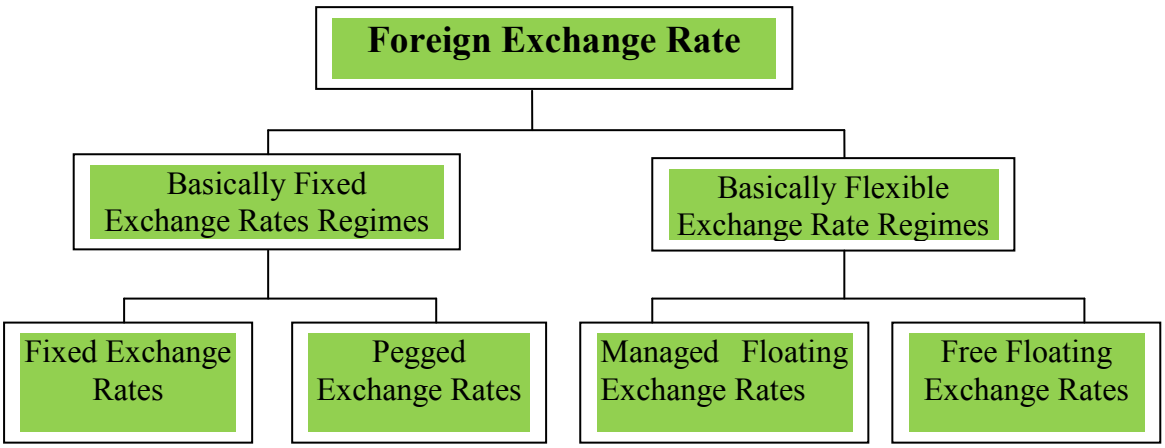
4.2.1 Exchange Rate Regimes

Countries use different exchange rate regimes (systems) in an attempt to control the stability of their currency. Parkin, Powell & Matthews (2008:774) provide a detailed discussion on three possible ways of intervening in the currency market, including the adoption of a free floating exchange rate, a fixed exchange rate and a managed floating exchange rate. A free floating exchange is identified by the market forces without the

[9] Exchange rate regimes and exchange rate systems are used interchangeably in this dissertation.

intervention of the central bank; a fixed exchange rate is determined by the central bank through actions of buying and selling of the domestic currency in the foreign exchange market; and a managed floating exchange rate, called "crawling peg", is a fluctuating exchange rate with intervention of the central bank to maintain a moderate fluctuation (Parkin *et al.*, 2008:774). Madura (2003:170) explains a pegged exchange rate system as an exchange rate system through which the value of a domestic currency is linked (pegged) to another currency, or to some valuable commodity such as gold. Thus, in a pegged exchange rate regime, fluctuations in the domestic currency depend on changes in the value of a foreign currency (or a commodity) to which the home currency is pegged. Tembo (1999:32) summarises exchange rate regimes by placing them in two main categories: basically fixed exchange rate regimes, which include fixed and all categories of pegged exchange rates and basically flexible exchange rate regimes, which include managed floating and free floating exchange rates. These foreign exchange rate regimes are presented in Figure 2.

Figure 2: A Framework of Foreign Exchange Rate Regimes



Source: Tembo (1999:32)

Figure 2 shows that exchange rate regimes can be classified into two basic categories, each category being divided into two sub-categories. This figure indicates that the overall structure of exchange rate regimes involves four categories. The present research discusses details of these four categories in the following sections.

4.2.1.1 Fixed Exchange Rate System

The fixed exchange rate was first introduced by the international monetary conference that took place in 1944 at Bretton Woods in the United States of America (Giovannini, 1998). The goal of this meeting was to stabilise the world financial system after the crisis caused by the Second World War. At that meeting, the promotion of exchange rate stability was adopted as one of the ways in which to achieve stability in the financial system, globally. The fixed exchange rate regime was thus established and was named the Bretton Woods exchange rate (Madura, 2003:67). The Bretton Woods fixed exchange rate system worked well in avoiding significant fluctuations in exchange rate markets, but it collapsed in 1971, when exposure of countries to exchange rate fluctuations increased because of unexpected events such as the oil crisis that affected the international monetary order (Kim & Kim, 1999:90). Kim & Kim (1999:92) stated that the Bretton Woods exchange rate system officially ended in 1976. However, it is important to understand whether or not countries benefitted from adopting the Bretton Woods fixed exchange rate regime. According to Madura (2003:171), the benefit from using a fixed exchange rate system is that it allows multinational companies to engage in international transactions without worrying about changes in the future exchange rate. He points out that there is still a possibility of risk in the fixed exchange rate system, when a government devalues or revalues its currency.

4.2.1.2 Pegged Exchange Rate System

In a pegged exchange rate arrangement, domestic currency is attached to foreign currency, to a currency basket or to some unit of account. This means that the value of the home currency is fixed in terms of foreign currency (or unit of account) to which it is pegged (also known as base currency), while it moves in line with that base currency against other currencies (Klein & Shambaugh, 2008). In this exchange rate system, fluctuations in the domestic currency depend on changes in the value of a foreign currency to which the home currency is pegged. As a result, pegged currencies are affected by economic forces, such as the interest rates and inflation, of the base country (Shambaugh, 2004:1). However, a country can minimise such effect of the

base country's economic force by pegging its currency to a single currency or a currency basket within narrow margins in a pre-set-up margin (Tembo, 1999:32). This allows the country to peg its currency to a new currency when the base currency goes beyond the pre-established margin.

Madura (2003:175) states the best-known pegged exchange rate system was adopted by European countries in 1972. In this arrangement, known as the "snake", European currencies were kept within established limits of each other. It was difficult for European countries to maintain such an agreement, as some countries moved outside of established limits because of market pressure (Madura, 2003:175). In a southern African context, countries such as Namibia, Lesotho and Swaziland peg their currency to the South African Rand (Guillaume & Stasavage, 2000:5). Consequently, these currencies fluctuate with the Rand.

4.2.1.3 Managed Floating Exchange Rate System

The period between 1971 and 1977 was characterised by the dirty floating exchange rate system, also known as the managed floating exchange rate system (Kim & Kim, 1999:90). A managed floating exchange rate system possesses the characteristics of both fixed and freely floating exchange rate systems. In this exchange rate system, the exchange rate fluctuates on a daily basis without any official boundaries; however, government can sometimes intervene to prevent extreme fluctuations in the currency market (Kim & Kim, 1999:90). This means that authorities adjust their exchange rates regularly, based on changes in variables such as reserves and the position of the balance of payment[10] (Tembo, 1999:32). A practical example of a managed floating exchange rate system is the development and implementation of a group of floating exchange rates in 1972, by European countries, with intervention of governments to maintain the level of the exchange rate desirable for their economic policy (Klein & Shambaugh, 2008:70). One of the criticisms of a managed floating exchange rate

[10] The relationship between the exchange rate and the balance of payment has been discussed in section 2.3.1.2 of Chapter Two.

system is that it permits a government to influence exchange rates to the benefit of its own country, at the expense of other countries (Madura, 2003:174).

4.2.1.4 Free Floating Exchange Rate System

Since 1973, the intervention of central banks in exchange rate markets decreased gradually and countries started adopting a flexible exchange rate; as a result, the exchange rate values were determined by market forces, such as inflation and interest (Madura, 2003:172). The low level of government intervention in the exchange rate market was the beginning of a new exchange rate regime with flexible exchange rates. This system of a freely floating exchange rate was formalised by the Jamaican Agreement of January 1976, but it was broadly adopted from 1978 (Kim & Kim, 1999:90). The motive behind the shift toward the flexible exchange rate regime is explained by Broda (2004:31), who pointed out that "…an advantage often attributed to flexible exchange rate regimes over fixed regimes is their ability to insulate more effectively the economy against real shocks". Countries thus adopted a freely floating exchange rate to minimise the effect of exchange rate shocks (Berger; Sturm & Haan, 2004:1). Whether or not the flexible exchange rate achieved this motive, of minimizing the effect of exchange rate shocks, is still a subject for debate. The present research therefore investigates this issue in the South African context by conducting an analysis of the effect of exchange rate regimes on the South African Rand and the effect of these regimes on the JSE.

Overall, it appears difficult to implement a single exchange rate regime, as these exchange rate systems tend to be linked, to some extent. Klein & Shambaugh, (2008:70) state that fixed rates are not fully fixed (in most cases) and estimate that countries could not manage to maintain the fixed exchange rate regime for a period of five years or more. With freely floating exchange rates, Calvo & Reinhart (2002) explain that floating rates do not really move independently; rather governments that claim to permit market forces to decide on the value of their currencies take action to minimize exchange rate movements. Tembo (1999:32) explains that the Bretton

Woods fixed exchange rate system was characterised by fixed but adjustable pegs. Although these exchange rate systems may be interlinked, they have a significant effect on international trade, on the economic growth rate, on the volatility of the currency market and on the movement of capital flows (Klein & Shambaugh, 2008:71). The responsibility of the government and private sectors towards the currency market may change with exchange rate systems. For example, the adoption of a flexible exchange rate system has increased the responsibility of the private sectors to manage currency risks (Soopal, 2006:56). As a result, the shift in economic policy towards the adoption of a freely floating exchange rate regime may have led to an increase in the exposure of companies and stock markets to currency risks.

4.2.2 South African Exchange Rate Regimes

Having discussed the development of different exchange rate regimes in the global economic system, it is important to discuss their implementation in South Africa. Since the 1970s, the Rand has been affected by the adoption of different exchange rate regimes. These exchange rate regimes, implemented by the South African Reserve Bank (SARB), changed from a highly controlled exchange rate system to a more liberal exchange rate system (Takaendesa 2006:71). South Africa adopted the blocked Rand system through the Bretton Woods fixed exchange rate regime; this was followed by the decision to peg the Rand to different currencies and eventually the adoption of a free-floating exchange rate, from March 1995 (Tembo, 1999:62-3 and Schaling, 2009:506). These stages of different exchange rate regimes in South Africa reflected global developments in the exchange rate policies (Aron & Muellbauer, 2006:11) and it can be divided into two major parts. The first part is based on fixed exchange rate regimes and includes the Bretton Woods fixed exchange rate regimes and pegged exchange rate regimes. The second part is based on floating exchange rate regimes and includes managed floating exchange rates and free floating exchange rates.

In 1961, the South African government took the measure of using the blocked Rand system to impose strict controls on capital transfers from the country (Schaling, 2009:507). This was a policy responding to debt crisis situations in order to protect foreign reserves. Schaling (2009:507) points out that the blocked Rand system was introduced to restrict the repatriation of funds previously invested in South Africa by foreigners, as well as prohibiting South Africans from transferring funds to foreign countries. Foreign investors could sell local securities on the JSE, but the proceeds from such sales were deposited into blocked Rand accounts at commercial banks. Such funds deposited at the bank in the name of foreign investors were named "blocked Rands". This system interrupted the demand for foreign currency and the supply of Rands in the currency market, while it protected the Rand from selling pressures that would have emerged from the selling of South African assets by foreign investors (Schaling, 2009:507).

In the early 1970s, several currencies started to float and this floating of currencies forced several countries to find a replacement for the Bretton Woods fixed exchange rate system (Van der Merwe, 2003:1). The SARB adjusted the exchange rate regime by adopting a new policy of pegging the Rand either to the U.S. dollar or to the British pound (Takaendesa 2006:72). In August 1971, the Rand was pegged to the United States dollar, because most of the country's foreign transactions were denominated in the U.S dollar (Van der Merwe, 2003:2). Four months later, during December 1971, the Rand was pegged to the British Pound (Takaendesa, 2006:72). Van der Merwe (2003:3) mentions that in June 1972 the British pound started to depreciate against other major currencies, but the Rand continued to be linked to the British pound in order to sustain a recovery in the South African balance of payments account. This depreciation of the British pound did not go well with South African economic goals and, as a result, the Rand was again pegged to the U.S. dollar in October 1972. Tembo (1999:62) states that the Rand continued to be pegged to the U.S. dollar throughout the year of 1973. Takaendesa (2006:72) stressed that the Rand did not track the devaluation of the US dollar in February 1973 and the Rand was revalued in June 1973 (Takaendesa, 2006:72).

The 1974 oil crisis led to a slowdown in global economic activities and, as a result, the SARB announced the independent managed floating exchange rate system on 21 June 1974 (Tembo, 1999:62). This independent managed floating exchange rate system involved frequent adjustment of the exchange rate, with devaluation every few weeks, until June 1975, when the Authority announced that the Rand would be held constant for long periods and only be changed when deemed necessary (Van der Merwe, 2003:4). This process allowed the Rand to be pegged to the U.S. dollar for a long period, with few adjustments. However, a major adjustment was made in September 1975, when the Rand was devaluated by 17.9% because of the decline in the balance of payments (Takaendesa, 2006:73). Although the Rand was pegged to the U.S. dollar for such a long period (1972-1979), Tembo (1999:62) records that there was an introduction of the securities Rand[11] in February 1976. The aim of the securities Rand was to relax the controls of capital outflows for non-residents (such controls were promoted by the blocked Rand system of 1961). From 1976 the South African exchange rate system was characterised by a "variable Rand-dollar peg", combined with the securities Rand, characterised by a high level of control in capital outflows (Schaling, 2009:518). This system continued until the beginning of 1979.

In January 1979 an interim report of the De Kock Commission of Inquiry (Commission appointed in 1977 to look into the monetary system and monetary policy in South Africa, focusing primarily on the exchange rate system) concluded that the policy of pegging the Rand to the U. S. dollar for long periods had not been conducive to the achievement of targeted economic objectives (Van der Merwe, 2003:6). These economic objectives included optimal combination of economic growth, balance of payments equilibrium and domestic economic stability (Takaendesa, 2006:74). This policy of pegging the Rand to the U. S. dollar failed to achieve these economic objectives, because it allowed the adjustment of the exchange rate without taking domestic economic activities into consideration (Van der Merwe, 2003:6). To attend to this shortfall of the pegged exchange rate regime, the SARB reintroduced the

[11] "A security rand is a mark in blocked balances directly transferrable between non-residents. The balances could only be used to buy certain shares and certain government securities and semi-gilts, often a large discount relative to the commercial Rand" (Tembo 1999: 63).

independent managed floating exchange rate in January 1979 (Aron & Muellbauer, 2006:12). This regime involved the intervention of the South African Reserve Bank (through the purchasing and selling of foreign currency) to maintain the stability of the Rand (Takaendesa, 2006:74). Aron & Muellbauer (2006:12) reveal that such intervention of the SARB was sometimes limited by low reserves.

Another recommendation of the interim De Kock Commission was the promotion of the flexibility of the exchange rate (Aron & Muellbauer, 2006:11). To achieve this flexibility, a dual-currency exchange rate system, with a commercial Rand and a financial Rand, was introduced in 1979 (Takaendesa, 2006:74). The commercial exchange rate was determined daily, based on market factors, while the financial exchange rate was a free-floating rate applicable to foreign exchange transactions made by non-resident portfolio investors (Aron & Muellbauer, 2006:11). The financial exchange rate replaced the securities Rand and it was lower than the official exchange rate, so that foreign investors could be encouraged to keep assets in South Africa (Schaling, 2009:520). Thus, foreign investors who received proceeds (from selling their South African assets) in Rands would be less willing to exchange these proceeds into foreign currency at a lower exchange rate. This financial exchange rate increased the cost of taking capital out of the country and improved flexibility by reducing the level of control on foreign exchange transactions made by non-residents. These strategies of improving flexibility were maintained during 1981 and 1982 (Takaendesa, 2006:75).

In 1983, the dual exchange rate system ended because of the abolishment of the financial Rand in February 1983 and the total removal of capital movement controls for non-residents (Tembo, 1999:63). As a result, a unified floating exchange rate (a commercial Rand determined by the market) was adopted in August 1983, but it was subject to SARB intervention (Aron & Muellbauer, 2006:11). This unified exchange rate stayed stable for a few months and then started to depreciate because of the decrease in gold price in 1983, the debt crisis and increasing political insecurity in 1984 (Takaendesa, 2006:75). Financial sanctions were imposed on South Africa by

global organisations in 1985 and the unified exchange rate dropped even further (Aron & Muellbauer, 2006:12). To respond to this situation, the SARB reintroduced a dual exchange rate system in September 1985 and this system continued until March 1995, when the exchange rate was reunified again (Tembo, 1999:63).

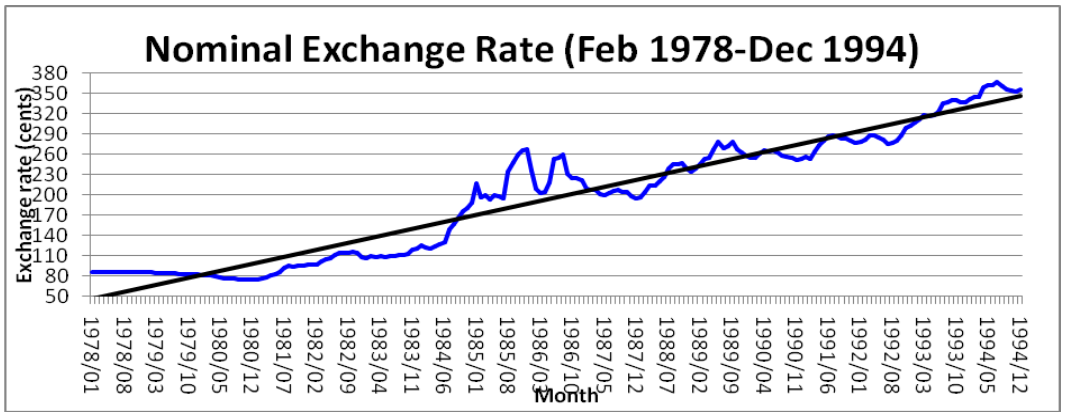
In March 1995 the financial Rand was abolished and further relaxation of exchange rate controls was introduced. From 13 March 1995 "…non-residents (foreigners) were able to introduce and repatriate funds, and transfer current and capital gains, without restriction" (Schaling, 2009:522). Relaxation of control in capital outflows allowed domestic companies and private individuals to make direct investment in foreign countries. From 1 July 1994, private individuals over 18 years of age were allowed to invest abroad a limit of R200 000 per person and this limit increased to R750 000 per person from 23 February 2000 (Schaling, 2009:522). The relaxation of capital controls on outflows and the low level of control on the exchange rate led to a free-floating exchange rate system, through which the exchange rate is determined by market factors (Tembo, 1999: 63).

The adoption of the free floating exchange rate system has exposed the Rand to both domestic and external shocks, such as the Asian crisis, the decrease in the gold price in 1997, the September 2001 attack on America and the volatile political situation in Zimbabwe (Takaendesa, 2006:77). Although a free-floating exchange rate has been maintained (since 1995), there have been concerns over the intervention of the SARB to indirectly influence the value of the Rand (Takaendesa, 2006:77). Aron & Muellbauer (2006:12) indicate that this intervention was expected to be at a minimal level, since the exchange rate management was not expected to be the main concern of the SARB under the inflation targeting policy.

4.2.2.1 The Rand and Different Monetary Policies

South Africa adopted both fixed and flexible exchange rate regimes. Such adoption of different exchange rate regimes reflects volatile developments of exchange rate systems at the global level. However, the free-floating exchange was adopted in 1995 because of the change in South African economic policies after 1994. The movement of the exchange rate prior to 1995 is shown in Figure 3, while exchange movement for the period 1995-2008 is presented in Figure 4. Percentage changes for these two periods are presented in Figures 5 and 6. In addition to graphical representation, descriptive statistics (such as mean, standard deviation and coefficient of correlation) are used to identify the magnitude of the exchange rate volatility during these two periods.

Figure 3: Nominal Exchange Rate from January 1978 to December 1994



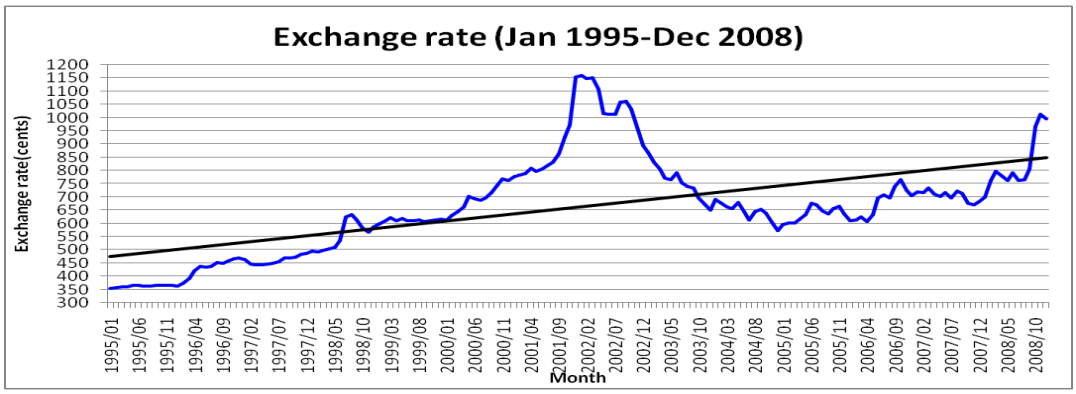
Source: SARB (2009)

From January 1978 until December 1994 (Figure 3), the exchange rate (ZAR/USD) experienced upward movement. During this period the exchange rate does not deviate from the trend line and this indicates that the exchange rate was relatively stable. The relative stability of the nominal exchange rate is attached to monetary policies that adopted both fixed exchange and managed floating exchange rate systems during this period (Tembo, 1999:68). This means that the government intervened to minimise fluctuations of the Rand. From November 1984 to December 1986 the Rand stayed

above the trend line and sharp fluctuations are observed in1985.This indicates that the Rand was weak and volatile during this period. Barr & Kantor (2005:78) state that the exchange rate was subject to severe nominal shock in August 1985 because of the failure of the government to adopt democratic rules at that time. They further explain that this failure of the government disappointed foreign investors, who withdrew a large amount of foreign capital from the South African financial market and, as a result, the foreign exchange rate was put under pressure. Cross (2002:2) and Tembo (1999:70), however, associate the instability of the Rand (for the period 1984-1986) to the debt crisis of 1985 and the recession of 1984-1986.

The period 1988 -1994 was characterised by smooth fluctuations compared to the previous period. Tembo (1999:72) attaches the stable exchange rate to changes in the direction of the monetary and exchange rate policies as the SARB continued to pursue a managed floating exchange rate policy. Such change in economic policies caused an increase in the level of liquidity, index value level and the number of registered firms in the JSE during this period (JSE, 2009).

Figure 4: Nominal Exchange Rate from January 1995 to December 2008



Source: SARB (2009)

Figure 4 presents nominal exchange rate from 1995 to 2008, which was characterised by the free-floating exchange rate regime. The upward trend is observed and the exchange rate tends to deviate from the trend line. For this period the exchange rate

seems to be more volatile compared to the previous period. Tembo (1999:72) states that the persuasion of a freely floating exchange rate introduced a relative stable movement in the early 1990s. However, the end of apartheid sanctions contributed to the increase in exchange rate shocks because of the immense pressure of foreign capital on the exchange rate (Barr & Kantor, 2005:78). From January 2000 to January 2004, the South African currency was weak, as the exchange rate stayed above the trend line. The shock of the high magnitude for this period occurred in November and December 2001, as the Rand depreciated sharply. This depreciation was caused by "…a panic demand for foreign exchange from wealthy individuals with newly found access to hard-currency assets made available through assets swap mechanism…We describe this panic demand for U.S. dollars as one of the unintended effects of partial exchange control reform" (Barr & Kantor, 2005:78). Another movement of the Rand above the trend line was observed in the year 2008, when the exchange rate depreciated significantly. In this year, the Rand depreciated by 20% in October and reached double digits at the end of November (above R 10/$). The main cause of this exchange rate depreciation in 2008 is the international financial crisis caused by the lack of liquidity in the international financial system as a result of the sub-prime crisis and the credit crisis[12.]

In general, there appears to be an inverse relationship between fluctuations in the exchange rate and the volatility of the JSE ALSI, especially in the period of the free floating exchange rate regime. This means that the depreciation of the Rand is accompanied by a decline in value of the JSE ALSI, while the appreciation of the Rand goes with an increase in the JSE ALSI. Since exchange rate policies have an impact on the exchange rate fluctuations, it is important to discuss changes in the exchange rate based on exchange rate regimes.

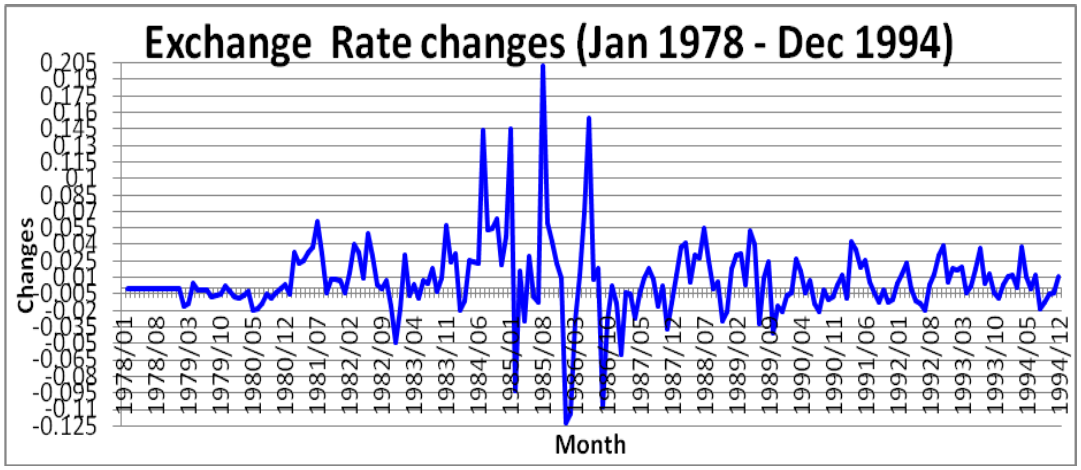
[12] The subprime crisis was caused by a collapse in the value of mortgage-backed securities in 2007 and was characterised by severe global illiquidity and the credit crunch in the banking sector (Blackburn, 2008 and Ryan, 2008).

4.2.2.2 Exchange Rate Changes Prior To and After 1994

Movements in the exchange rate for the period prior to 1994 are expected to be different from those of the period after 1994. Cross (2002:9) stated that the two periods are different in terms of total market size and international exposure. He emphasised that prior to 1995, South Africa was mostly isolated from dealings and non-residents could not trade in the domestic currency market easily. It is vital to conduct a descriptive statistics and graphical representation analysis in order to assess whether or not exchange rate fluctuations during these two periods were different. For example, in August 1998, the Rand depreciated by 16%, while the JSE ALSI level decreased by 29.87%. The Rand appreciated by 8% in May 2002, while the JSE ALSI level increased by 2%. The weakness of the Rand and the appearance of shocks of high magnitude over the period 2000-2004 affected the JSE negatively. The depreciation of the Rand in 2008 was accompanied by a decline of 25.25% in the annual market capitalisation on the JSE. The negative relationship between the exchange rate and the JSE is shown by a high volatility in the index value level (JSE, 2009), a change in the number of registered firms and fluctuations in market capitalisation and the level of liquidity (World Federation of Exchanges, 2009).

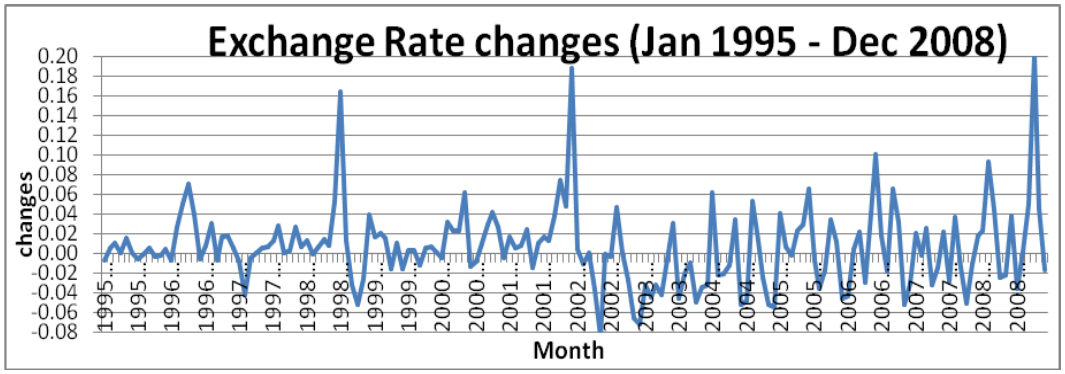
Changes in the exchange rate for the periods 1978-1994 and 1995-2008 are shown in Figures 5 and 6, respectively, and the estimated descriptive statistics for these two periods are presented in Table 1. Both figures show that the exchange rate had been volatile, but the volatility of higher magnitude is observed in Figure 6. The last period (1995-2008) is characterised by a high level of exchange rate shocks. The first period (1978-1994) has a high average percentage change of 0.76%, compared to 0.69% for the period 1995-2008. The standard deviation is 0.03476 for the first period and 0.0397 for the second period. Based on the standard deviation, the second period had a high volatility. This implies that the adoption of the free-floating exchange rate policy increased the level of fluctuation in the exchange rate.

Figure 5: Changes in Nominal ER from January 1978 to December 1994



Source: SARB (2009)

Figure 6: Changes in Nominal ER from January 1995 to December 2008



Source: SARB (2009)

Table 1: Descriptive Statistics for Changes in ER

Period	1978 - 1994	1995- 2008
Mean	0.76%	0.69%
Maximum	20.26%	20.18%
Minimum	-12.19%	-8.42%
Variance	0.12	0.16
Standard Deviation	3.48	3.97

Source: Estimated by the current author

The effect of the free-floating exchange rate regime on the JSE is shown by the increase in the fluctuation of the liquidity level and a decline in the number of registered firms on the JSE. However, the market capitalisation and index value level, over the period of the free-floating exchange rate regime, have been increasing. This

increase is caused by the "… large inflow from the purchase of bonds or shares by non-residents" (Cross, 2002:4), because the adoption of the free floating exchange rate increased total market size and international exposure. However, it is not yet clear whether or not these effects start from the Rand market or from the JSE. The present research will conduct a further analysis, in Chapter five, to identify the causal relationship between these two markets.

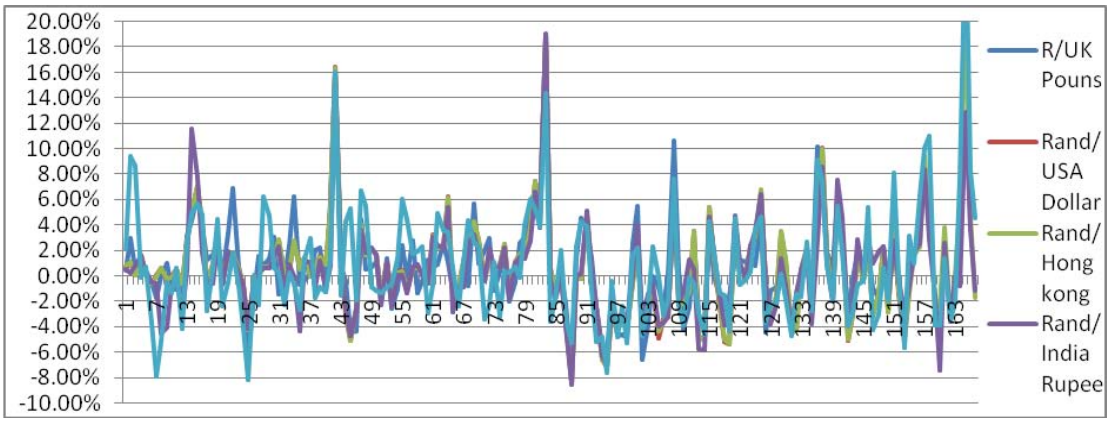
4.2.3 The Response of the Rand to Major Currencies

Having identified the response of the Rand to the US dollar, it is important to determine whether or not this response is constant for other major currencies. In order to identify the response of major currencies to the movements in the Rand, South Africa's major trading partners are used. According to the Department of Trade and Industry (DTI) (2009), South Africa's top five trading partners (in their ranking orders) are the USA, Germany, the UK, Japan and the Netherlands. South Africa also has a global trade partnership with developing countries such as China, India, Malaysia, South Korea and Brazil. The bilateral exchange rates between the Rand and some of these countries' currencies are presented in Figure 7. This will assist in identifying the impact of trading partnerships on the interactions between the Rand and the major currencies and in determining whether or not the use of a bilateral exchange rate will reflect the general behaviour of the South African exchange rate market.

Figure 7 shows the percentage changes between the Rand and the U.K. pound, U.S. dollars, Japanese yen, Indian rupee and Hong Kong dollar. The movement of these currencies shows a similar trend over the sample period and percentage changes tend to move in the same direction. This is in line with the findings of Ogum & Thomas (2003), who found that major currencies tend to respond differently in the short-run (daily and weekly), but the response becomes the same as the time horizon increases. Thus, on a monthly basis, major currencies have a similar response towards the South

African currency and shocks in the South African currency market tend be the same across major currencies.

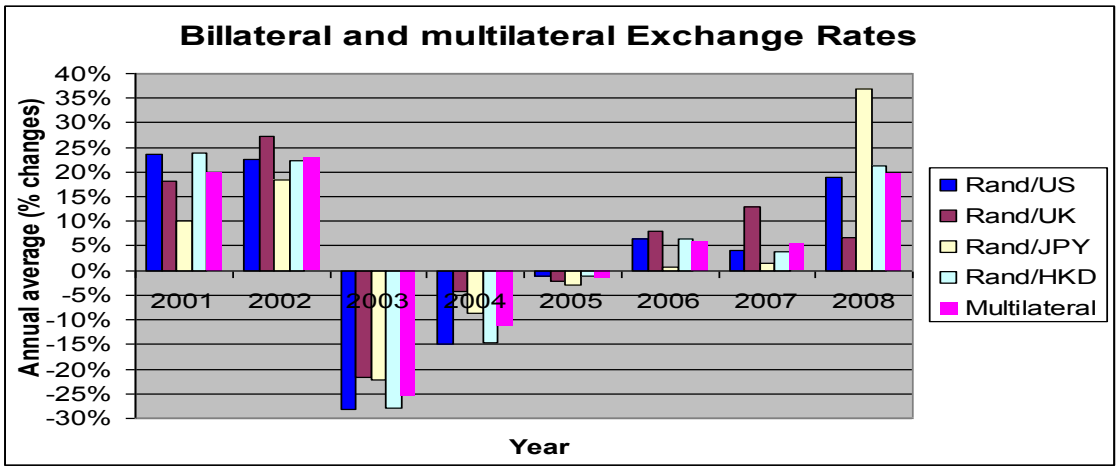
Figure 7: Percentage Change in the Rand and Major Currencies



Source: SARB (2009)

It is important to identify whether or not this trend between the Rand and other major currencies stays the same even in longer periods (on an annual basis) and whether or not the multilateral exchange rate (based on these major trading partners) takes the direction of the bilateral exchange rate of the Rand against the U.S. dollar. Figure 8 shows the annual movement of the Rand against major currencies, together with the multilateral exchange rate.

Figure 8: Bilateral and Multilateral Annual Movements of the Rand



Source: SARB (2009)

Figure 8 presents the annual percentage change of bilateral and multilateral exchange rates between the Rand and other major currencies. The estimation of the multilateral exchange rate is based on the SARB (Tembo, 1999) weighting, adjusted to match the weighting of the current trading partnership between South Africa and its top five trading partners (DTI, 2009). The weighting is as follows: USA (53%), UK (22%), Japan (18%) and Hong Kong (7%). From Figure 8 it is evident that bilateral exchange rates move in the same direction, but the magnitude of the movement tends to be different. There is not much difference between the multilateral exchange rate (pink) and the bilateral exchange rate between the Rand and the U.S dollar (blue). This means that the trading of the U.S. dominates the transactions of the South African currency market. This is linked to the fact that the U.S dollar is widely used as a currency of reference. The conclusion on the effect of exchange rate shocks based on the exchange rate between the Rand and the U.S. dollar may apply to exchange rates between the Rand and other major currencies.

4.3 Overview of the JSE

Having discussed exchange rate regimes and exchange rate shocks in South Africa, it is important to discuss the characteristics of the JSE in order to evaluate the impact of these exchange rate regimes on the South African market. The JSE is the only stock exchange currently operating in South Africa. Since its formation, the JSE went through significant changes, including numerous changes in premises utilisation, trading systems, management, ownership and modification of rules (Mabhunu, 2004:13). These changes are discussed in the next section, but emphasis is placed on changes that are believed to have affected the exchange rate movements and the flow of foreign portfolio investment into South Africa. The main focus will be on the history of the JSE, its demutualisation, its performance, its liquidity, its role in Africa and global markets and other changes in the JSE's structure that might have changed its exposure to exchange rate risks.

4.3.1 History of the JSE

The JSE was established in 1887 (by Benjamin Woollan), shortly after the discovery of gold on the Witwatersrand. It is the oldest stock market in Africa. Jefferis & Okeahalam (2000:30) record that most of the capital needed for the development of gold mines, in the early years, was raised overseas, primarily in London, and that the contribution of the JSE in raising capital was limited, since it was characterised by speculative behaviour, with frequent booms and crashes. They explain that the JSE had grown steadily and become more diversified, but remained heavily influenced by the fortunes of the mining sector because of the absence of other shares, such as industrial shares, due to the lack of industrial development in the country at that stage. Mabhunu (2004:13) adds that the JSE was accepted as a member of the Federation International Bourses de Valeurs (FIBV) in 1963 and became an active member of the African Stock Exchange in 1994. From the establishment of the JSE to 8 November 1993 there was a limitation on foreign brokers, as all stockbrokers were required to be South African citizens.

The political changes that took place in South Africa, particularly the lifting of formal and informal financial sanctions against the country, caused the JSE to experience a major set of reforms in late 1995 (Jefferis & Okeahalam, 2000:30). These modifications include an authorising corporate membership on the JSE for the first time; the introduction of regulations covering the protection of investors and members; the introduction of electronic trading, replacing the old open-outcry system; and the permitting of negotiable brokerage fees (JSE, 2009). The ending of apartheid and the lifting of sanctions in 1994 increased inflows of foreign portfolio investment to the JSE. Since the abolition of the dual exchange rate regime foreign investors have not been subject to any exchange control regulations (Jefferis & Okeahalam, 2000:31-32). From October 1995 foreign investors have been exempted from paying withholding tax on dividends (JSE, 2009). These changes and others, such as demutualisation and the increased importance of foreign capital flows to the JSE, have promoted the vulnerability of the market to shocks resulting from international economic and financial developments.

4.3.2 Demutualisation of the JSE

Over a period of 100 years, before the 1990s, stock exchanges across the world were organised as mutual firms and mutual stock exchanges were member-owned co-operatives (Gribov, 2007:1). These members (owners) are broker-dealers with "seats" on the exchange and have all the voting rights given by ownership (JSE, 2009). Recently, stock exchanges have gone through a process of demutualisation. Aggarwal (2002:106) mentions that demutualisation is the method of converting a non-profit, mutually owned organization-for-profit, investor-owned corporation. He explains that the conversion ownership structure to a common-stock form has affected the vast majority of world market capitalisation and small exchanges remain organised as mutual firms. The JSE changed its structure as it went into a process of demutualisation on 1 July 2005 and it was registered through an Initial Public Offer (IPO), an issue of new share capital by a company that had not previously traded on the market. Thus the JSE became listed on itself. Having the JSE listed on a stock exchange "…improves the value of stock exchanges, as exchanges are urged to create value for their own shareholders through improvement of their structure to operate more efficiently" (Serifsoy, 2005:2). Demutualisation allows a stock market to maximise its potential market capitalisation and shareholders' value, as it increases the ability of stock exchanges to deal with the level of competition (Serifsoy & Tyrell, 2006:35).

Objective of Demutualisation

Stock exchanges have different motives for demutualisation, but this section will focus on the objective that affected the JSE. According to Gribov (2007:17), demutualisation allows stock exchanges to better adapt to changing industry conditions by giving them strategic and operational freedom, which is very important in the case of competition. Serifsoy (2005:20) explains that demutualisation is not linked to the flexibility but to the mixed interests of members. Most stock markets undergo a process of demutualisation because of strategic flexibility, access to capital, improved liquidity and development of the market (Gribov, 2007:7).

The demutualisation of the JSE was motivated by access to capital and improved liquidity. The achievement of objectives of demutualisation is observed through the positive response of foreign investors to the change in the JSE's structure. According to the JSE's 2008 annual report, foreign shareholders held 45% of the JSE's issued shares at the end of 2007. This manifests a great increase from 2006, when foreign ownership of the JSE was 18.9%. Thus the process of demutualisation has contributed to the increase of foreign investments in the JSE and the increase in inflow of foreign investment has had an impact on the exchange rate.

4.3.3 Size of the JSE

The size of the market can be measured through the market capitalization, the number of listed companies, turnover value and liquidity of the market. According to the World Federation of Exchanges (2009), the JSE had 411 listed companies, with a total market capitalisation of R4 514 billion at the end of 2008. It was ranked as the eighteenth largest stock market in the world in terms of market capitalisation, one of the top five emerging markets and the first in Africa, accounting for 75 per cent of the total capitalisation of African stock markets. The market capitalization, the number of listed companies, turnover value and liquidity of the JSE from 1995 to 2008 appear in Table 2.

Table 2: Summary of Market Size and Trading

Year	Market capitalization R(bn)	Number of companies	Turnover value R(bn)	Liquidity (%)
1995	1022	638	64.25	6.3
1999	1616	668	448.38	34.6
2001	1771	542	606.14	38.5
2002	1584	472	808.66	39.1
2003	1 741	443	752.25	35.8
2004	2 493	389	1 031.21	47.2
2005	3 484	373	1 278.69	48.9
2006	5 015	389	2 121.50	52.5
2007	5 660	411	2 980.11	30
2008	4 514	411	3 264.07	36.6

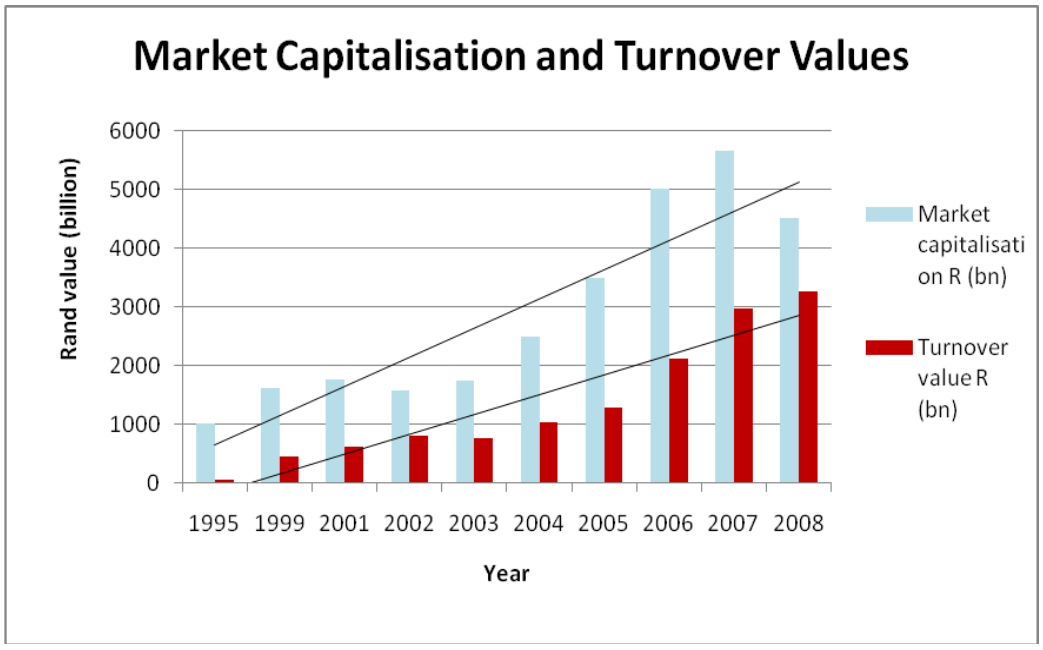
Source: World Federation of Exchanges (2009)

Table 2 is discussed through a breakdown based on the market capitalisation and the value turnover (shown in Figure 9), the level of liquidity (shown in Figure 10) and the number of registered companies (shown in Figure 11).

4.3.4 Market Capitalisation and the Value Turnover

Figure 9 shows an upward trend for both the market capitalisation and the turnover value. This is an indication of the overall increase in these factors. The market capitalisation has been increasing, except for the decrease in 2002. The highest market capitalisation of R 5 660 billion was achieved in 2007, while the lowest market capitalisation for this period was in 1995, with 1 022 billion. Turnover value has been increasing unceasingly and it has increased by 500% as it moved from R6.3 billion in 1995 to R3 264.07 billion by the end of 2008. This increase in turnover is associated with an improvement of the trading system in the JSE and the high level of integration between the JSE and other stock markets. Furthermore, The increase in the market capitalization can be linked to the high level of GDP growth experienced by South Africa from 2006 to 2008 (Stats SA, 2010).

Figure 9: Market Capitalisation and Turnover Values

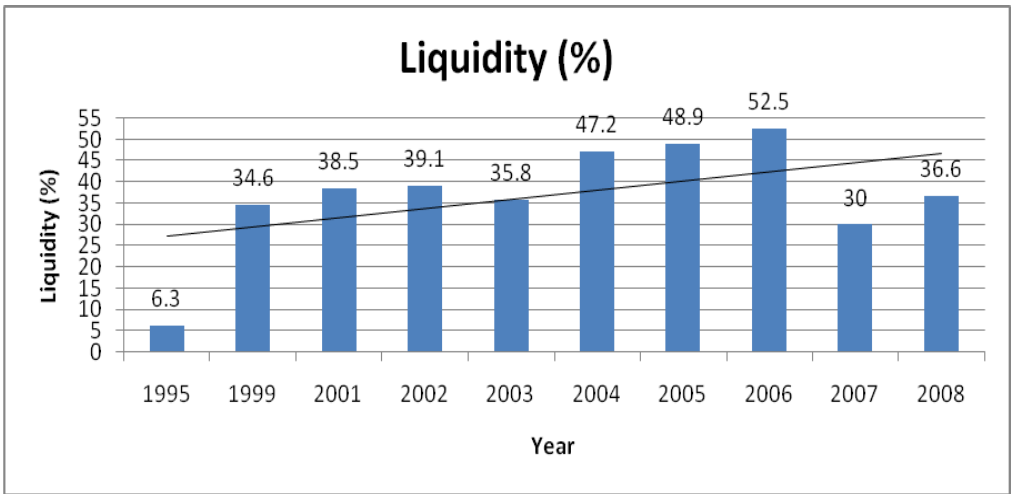


Source: World Federation of Exchanges (2009)

4.3.5 The Level of Liquidity

Table 2 and Figure 10 show a significant increase in liquidity, from a mere 6.3% in 1995 to 34.6% in 1999 and 36.6% by the end of 2008. The highest level of liquidity (of 52.5%) was achieved by the end of 2006. From 1999 to the end of 2008 liquidity has been moving around its average of 36.95 % and it never went below 30%. However, there is a large increase of 28.3% from 1995 (the lowest level of liquidity) to the end of 1999. The trend line is upward-sloping and this supports the increase in liquidity over this period.

Figure 10: Liquidity of the JSE



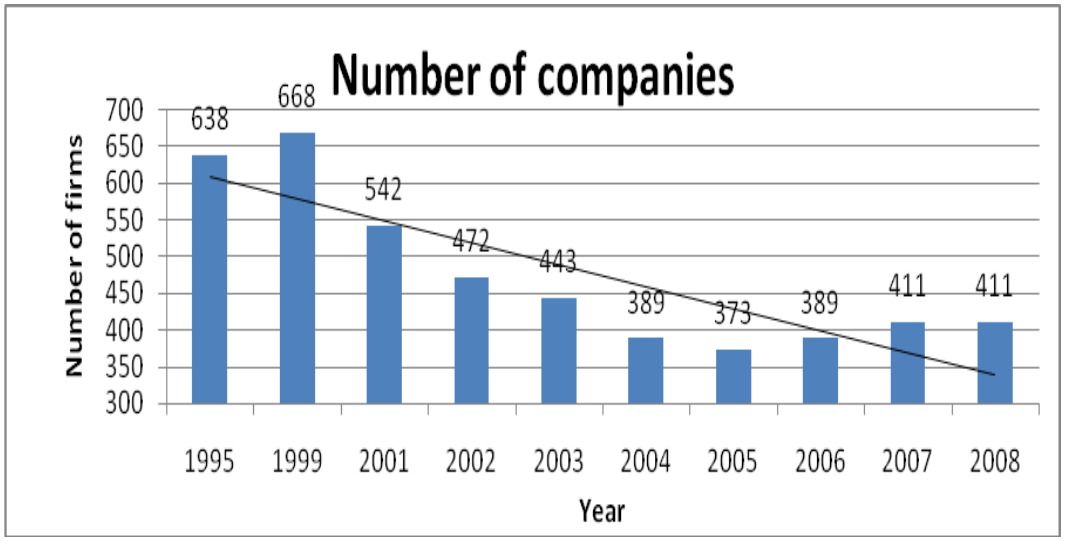
Source: World Federation of Exchanges (2009)

4.3.6 Number of Registered Companies

Figure 11 shows a downward trend, indicating that the number of companies has been decreasing. The highest number of registered companies during this period is 668 companies (in 1999) and the lowest number is 373 companies (in 2005). The highest number of companies in 1999 can be linked to the process of privatisation in South Africa. Smith, Jefferis & Ryoo (2002:477) explain that " … privatisation programmes in several countries have involved the listing of shares in formerly nationalized firms, which are often very large in relation to the size of national economies, thus providing a supply of new shares and a further boost to stock market development". The process

of privatisation in South Africa after 1994 contributed to the high number of registered companies on the JSE in 1999.

Figure 11: The Number of Registered Companies on the JSE



Source: World Federation of Exchanges (2009)

From 2001 to the end of 2005 the number of listed companies had been decreasing. This decline can be linked to the increase in mergers and acquisition among South African companies, which is a result of strict exchange controls on the capital account that had limited South African companies from exporting capital and encouraged them to take over other domestic firms (Smith *et al.*, 2002:477). From 2006 the number of registered companies increased and it reached 411 companies by the end of 2008. This increase can be linked to the high level of economic growth (Stats SA, 2010) during the period 2006-2008.

4.3.7 The Ranking of the JSE

Table 3 shows the ranking of the JSE within the world and within emerging markets, based on market capitalisation, turnover value and liquidity. Market capitalisation gives the JSE a good ranking compared to the turnover value and the liquidity

rankings. Thus the JSE has a good market capitalisation within global markets. In 1995 the JSE was ranked number 12 in the world and number one in emerging countries (based on the market capitalisation) and these were the highest rankings for the whole period. In 1995, the global ranking based on the turnover value and the level of liquidity puts the JSE at position 30 and position 38, respectively. During the same year the JSE was in second position within emerging markets, based on both the turnover value and the level of liquidity. The worst rank (highest rank), based on market capitalisation, is 19 in world ranking and six in the ranking of emerging markets. The worst positions, based on turnover values, were 30 (in 1995) within the world and 10 within emerging markets (in 2007); while good positions were 19 in world ranking (in 2002) and second in the emerging market ranking (in 1995). In liquidity ranking, the best position within the world was 24 (in 2004) with a second position (in 1995) within emerging markets, while the worst positions were 38 within the world (1995) and 12 within emerging markets (in 2007).

It is evident that the JSE has a good ranking based on market capitalisation. In terms of liquidity, there is a difference between the performance of advanced markets and emerging markets. For example, in 1995 the JSE performed well among the emerging markets but this performance seems to be weak among the world markets. Advanced markets have a high level of liquidity compared to emerging markets. Turnover values seem to be very high in the stock markets of advanced economies compared to the stock exchanges of emerging economies. The justification of these differences may be the differences in the size of stock markets within these two economies and the level of the technological advancement that facilitates information accessibility in advanced economies (Ajayi *et al.,* 1988:248).

Table 3: Ranking of the JSE

Year	Market	Market capitalisation	Turnover value	Liquidity (%)
1995	World	12	30	38
	Emerging markets	1	2	2
1999	World	19	24	38
	Emerging markets	3	5	5
2001	World	17	22	26
	Emerging markets	4	3	3
2002	World	14	19	26
	Emerging markets	4	4	6
2003	World	18	24	31
	Emerging markets	6	7	6
2004	World	13	22	24
	Emerging markets	2	8	7
2005	World	16	21	29
	Emerging markets	4	7	10
2006	World	18	21	30
	Emerging markets	4	7	10
2007	World	19	26	33
	Emerging markets	6	10	12
2008	World	18	26	30
	Emerging markets	5	9	11

Source: Mabhunu (2004: 16) & World Federation of Exchanges (2009)

4.3.8 The JSE and Other Stock Markets

By international standards, the JSE is a very large market and it makes use of fully automatic electronic trading on the JET System (Johannesburg Equities Trading). The System is an order-driven automated trading system acquired from the Chicago Stock Exchange, which has successfully installed the system at several other exchanges around the world (Mabhunu, 2004:14). The JSE functions as part of a relatively sophisticated financial sector, characterised by a wide range of financial institutions, markets and information flows which, in many respects, is more representative of a developed than a developing country (Page & Rayneke, 1997:1404). According to Clark & Troskie (2006:69), the JSE is linked to other stock markets; thus, international market crises such as the collapse of the Mexican peso in 1994-1995 and the East Asian financial collapse of 1997-1998, the Nasdaq meltdown of 2000 and the Russian, Turkish and Argentinean defaults all had negative impacts on the South African economy.

Jefferis & Okeahalam (2000:30) state that the JSE was not badly affected by the Asian crisis of 1997, which mostly affected the markets of other developing countries. However, they point out that the Russian/Brazilian crisis of 1998 caused a decline of 30% in the JSE overalls during August 1998 alone. During the first half of 2008, the JSE did not feel a noticeable impact from the credit crunch affecting various other markets and stock exchanges, as its volumes continued to climb while other stock markets stagnated. An element of this is attributable to the fact that the South African equities market of the JSE comprises a large commodity component (JSE, 2009). According to Jefferis & Okeahalam (2000:31), another important development affecting the JSE in recent years has been the movement of the primary listing from Johannesburg to London by few large companies (such as Anglo American). While, in a sense, this is representative of the internationalisation of South African companies, which should in the long term have benefits for the South African economy, it is sometimes perceived as a negative factor for the JSE itself.

4.3.9 The Response of the JSE to Different Exchange Rate Regimes

Section 4.2.2 showed that the South African economy has been characterised by different exchange rate policies. Tembo (2002) stated that exchange rate movements tend to change with these policies, as some policies have resulted in the increase in exchange rate fluctuations, while others reduced currency movements. This section will show a link between exchange rate movements and changes in prices of the JSE ALSI, focusing on the response of this index to different exchange rate regimes. The relationship between the JSE and the exchange rate during the period 1978-1995 is compared to the one during the period 1995-2008; since these two periods have different exchange rate regimes.

4.3.9.1 The JSE and the Managed Floating Exchange Rate Regime

The period prior to 1995 (January 1979 to March 1995) was characterised by managed floating exchange rate regimes. It can be divided into three sub-periods, based on

changes of exchange regimes. The first sub-period runs from January 1979 to February 1983 and was characterised by a dual floating exchange rate regime. The second sub-period, characterised by a unified floating exchange rate, runs from March 1983 to September 1985. The last sub-period started with the reintroduction of the dual floating exchange rate regime in October 1985 and ended in February 1995. The response of the JSE to these different regimes is conducted though a graphical analysis of percentages in the exchange and the JSE ALSI, shown in Figures 12, 13 and 14.

4.3.9.2 The JSE and the Dual Floating Exchange Rate Regime

Figure 12 presents the relationship between the nominal changes in the JSE and the exchange rate under a dual managed floating exchange rate regime from January 1979 to February 1983. This figure shows a weak relationship between the JSE and the exchange rate during this period, as the JSE tended to fluctuate more than the nominal exchange rate. This may be a result of government intervention (in the foreign exchange market) that minimised fluctuations in the exchange rate. A strong relationship is observed between 1981 and 1982 and it tends to be negative. During this period of dual managed floating exchange rate regimes, the JSE ALSI increased by 2.3%, on average, while the exchange rate depreciated by 0.49%. The coefficient of correlation between the two variables is -0.3480 and it is significant at the 5% level of significance (P-value is smaller than 5%). Thus there is statistical evidence supporting a negative correlation between the two variables. During this sub-period, the depreciation in the nominal exchange rate was accompanied by a decrease in the JSE ALSI.

4.3.9.3 The JSE and a Unified Floating Exchange Rate Regime

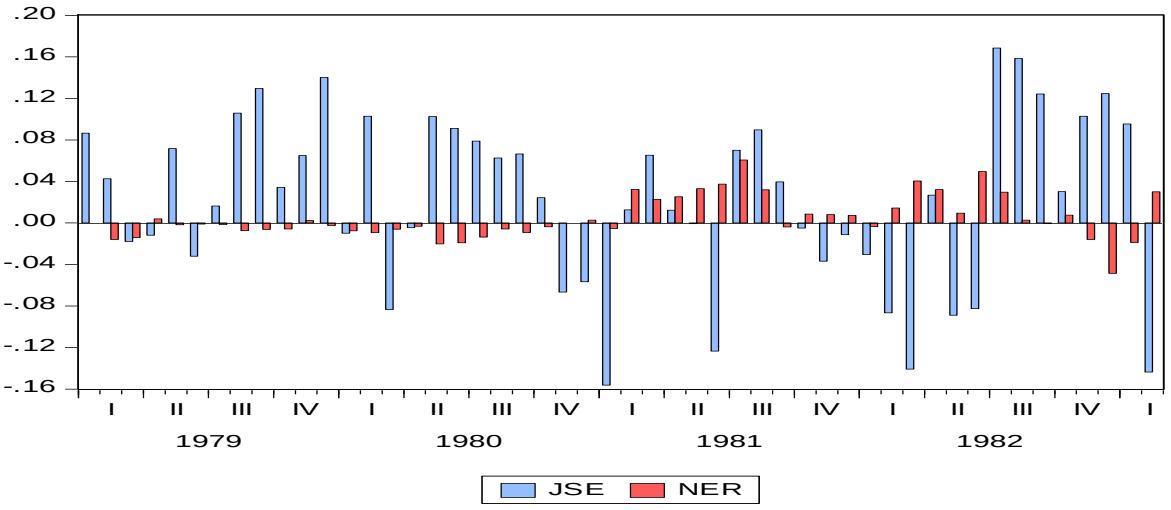
Between March 1983 and September 1985, a managed float exchange rate regime was maintained, but the dual exchange rate was replaced by a unified exchange rate. The relationship between the JSE and the exchange rate under this unified managed floating exchange rate regime is shown in Figure 13. According to this figure, in 1983,

small changes in the exchange rate were accompanied by major changes in the JSE ALSI, but in the opposite direction. In October 1983 for example, the exchange rate depreciated by 0.93%, while the JSE ALSI decreased by 11.19%. The magnitude of fluctuations has increased during 1984 and 1985 because of credit crises and the relationship between the exchange rate and the JSE became strong. In July 1984, the JSE ALSI decreased by 10.17%, while the exchange rate depreciated by 14.35%. The highest change in the Rand for the whole period is a depreciation of 20.26% in August 1985, while the highest changes in the JSE ALSI was a decrease of 11.19% in October 1983. The average change for the entire period of a unified managed float exchange rate regime reveals that the exchange rate depreciated by 2.82%, while the JSE increased by 1.34%. The coefficient of correlation (-0.042) between these two variables is still negative, but weaker than the coefficient of correlation for the period of the dual exchange rate regime. A high P-value (0.822) indicates that Pearson's coefficient of correction is statistically insignificant, even at the 10% level of significance.

4.3.9.4 The JSE and a Dual Floating Exchange Rate Regime

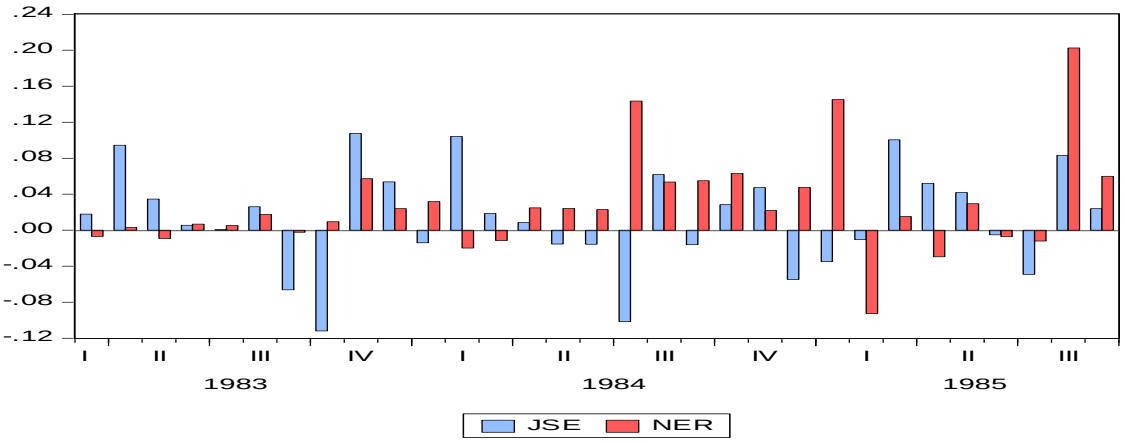
In October 1985 South Africa reintroduced a dual exchange rate. The relationship between the JSE and the exchange rate, during this period, is presented in Figure 4.13. The second period of dual exchange was associated with increase in fluctuation of both variables, especially between 1985 and 1987. The highest change in the exchange rate was the depreciation of 15.53% in June 1986, while the highest change in JSE was a decrease of 23.76 % in October 1987. On average, the exchange rate depreciated by 0.37% (during this period) while the JSE increased by 1.49%. The coefficient of correlation of 0.095 shows a weak positive relationship between these two variables. However, a P-value of 0.316 shows that this coefficient of correlation is statistically insignificant, even at the 10% level of significance.

Figure 12: The JSE and Exchange Rate (Jan 1979–Feb 1983)



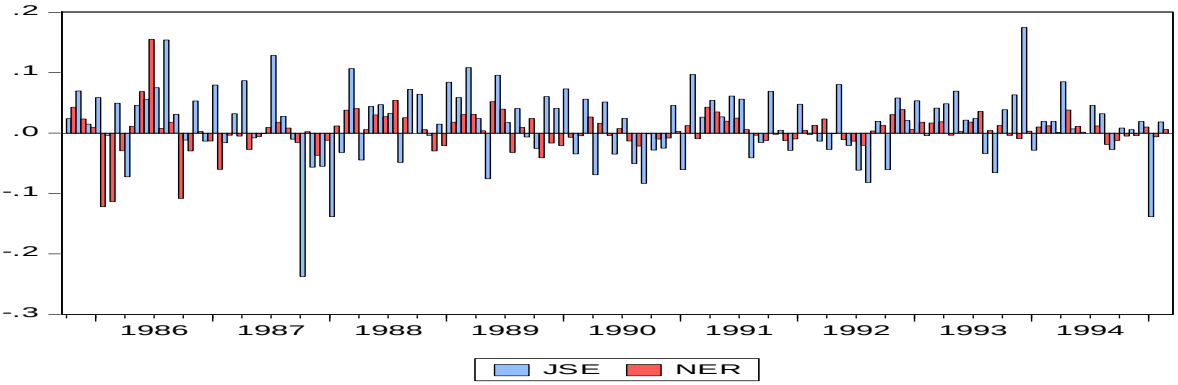
Source: JSE (2009) & SARB (2009)

Figure 13: The JSE and Exchange Rate Regime (March 1983-Sept 1985)



Source: JSE (2009) & SARB (2009)

Figure 14: JSE and Exchange Rate (Oct 1985–Feb 1995)



Source: JSE (2009) & SARB (2009)

Table 4: Descriptive Statistics on Managed Floating ER Regimes

ER policy	Dual floating (Jan 79-Feb 83)		Unified floating (Mar 83-Sept 85)		Dual floating (Oct 85-Feb 95)	
Variable	JSE	NER	JSE	NER	JSE	NER
Mean	2.30%	0.49%	1.34%	2.82%	1.49%	0.37%
Standard Deviation	0.0823	0.0205	0.0563	0.0556	0.0599	0.0320
Pearson correlation P-values (by SPSS)	-0.3480 (0.013)		-0.0418 (0.822)		0.0952 (0.316)	

Source: Estimated by the current author

Generally, the exchange rate depreciation was associated with a decrease in the JSE ALSI, while the exchange rate appreciation was associated with an increase in the JSE ALSI. According to descriptive statistics in Table 4, the relationship between the JSE and the exchange rate tended to be strong in the first period of the dual exchange rate system. This means that the dual exchange rate system increased inflow of foreign investment to the JSE as this exchange rate regime encouraged foreign investors to keep assets in South Africa (Schaling, 2009:520). Under a unified exchange rate system, exchange rate fluctuations increased, while fluctuations in the JSE ALSI decreased. This may be linked to the total removal of capital movement controls for foreigners (Tembo, 1999:63), political insecurity and financial sanctions imposed on South Africa that caused the unified exchange rate to drop (Takaendesa, 2006:75). Under the flexible exchange rate system, the response of the JSE to currency fluctuations is not constant. It appears to be changing with changes in exchange rate regimes.

4.3.10 The JSE and the Free Floating Exchange Rate Regime

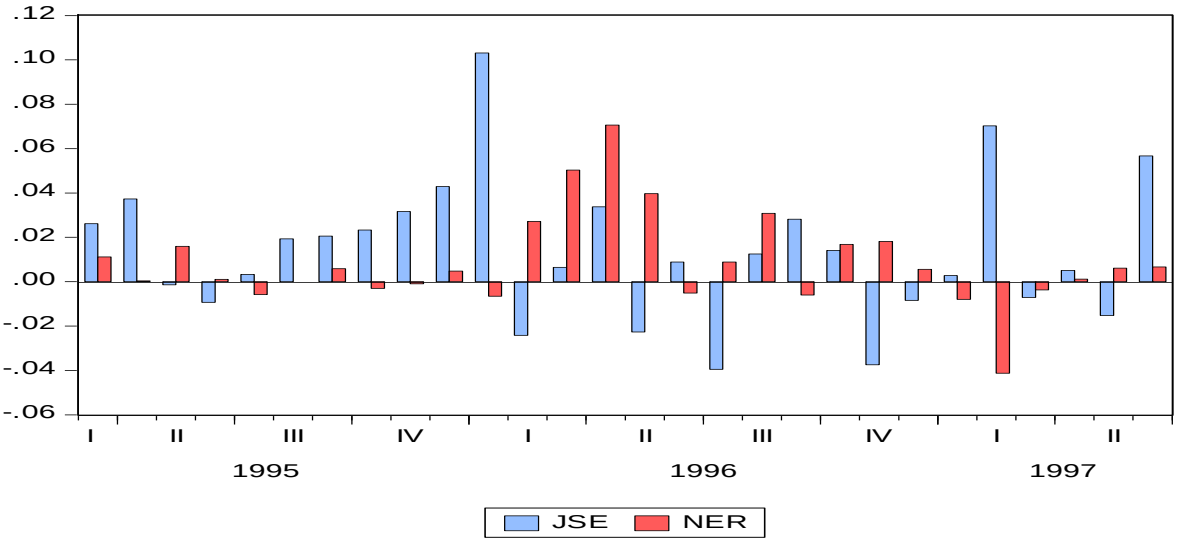
Having identified the response of the JSE to the managed float exchange regime, it is vital to discuss the effect of the adoption of a free floating exchange system on the JSE. The period of free float (March 1995–December 2008) may be divided into three sub-periods, based on the level of intervention of the SARB in the currency market and other regulations that limited the flexibility of the exchange rate market. A graphical representation of the relationship between the exchange rate and JSE during

different sub-periods is presented in Figures 15, 16 and 17, while a summary of descriptive statistics is shown in Table 5.

4.3.10.1 Early Free Floating Exchange Rate

Figure 15 presents the percentage change in the JSE ALSI and the nominal exchange rate from March 1995 to June 1997. This period marked the introduction of the free floating exchange rate and the establishment of a relatively competitive foreign exchange market in South Africa (Takaendesa, 2003:80), but there was still a low level of government intervention. This period is characterised by a great magnitude of changes in both variables, especially in 1996, when the JSE increased by 10.32% in January and the exchange rate depreciated by 7.06% in April. Average changes for the whole period show an overall increase of 1.36% in the JSE and an exchange rate depreciation of 0.86%. The standard deviations for this period are 0.032 and 0.021 for the JSE ALSI and the exchange rate, respectively. This means that fluctuations in the JSE ALSI were slightly higher than the exchange rate fluctuations. This shows that the relationship between the two variables tended to increase during this first period of free floating exchange rate. The Pearson's coefficient of correlation (-0.313) confirms a negative relationship. The P-value of 0.105 is close to the 10% level of significance. It appears that the adoption of a free floating exchange rate regime increased the exposure of the JSE to exchange rate fluctuations.

Figure 15: The JSE and Exchange Rate (March 1995-June 1997)

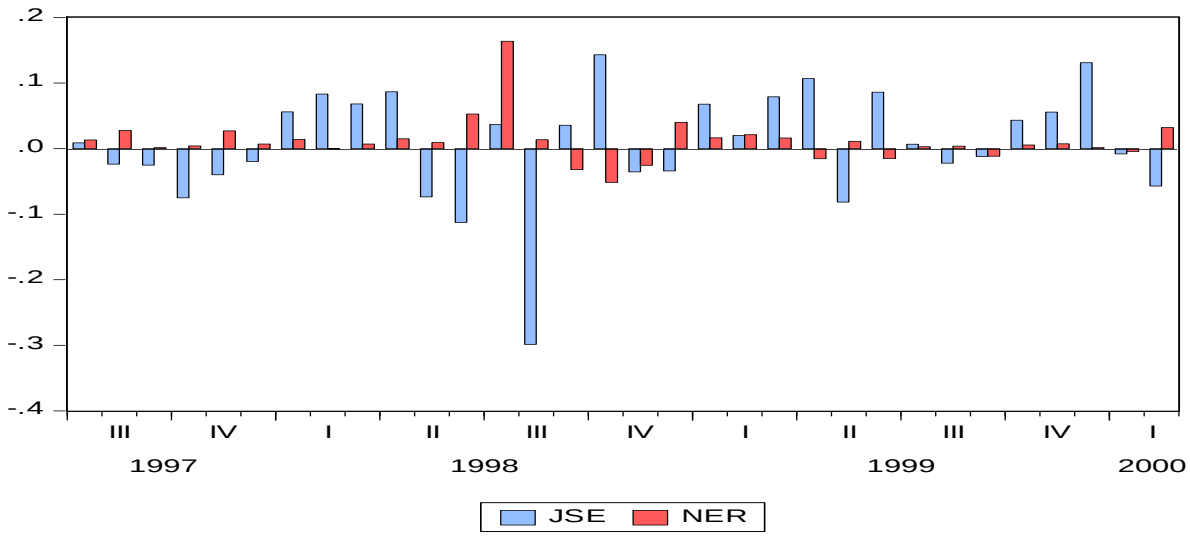


Source: JSE (2009) & SARB (2009)

4.3.10.2 Free Floating Exchange Rate With Less Control

Figure 16 presents the percentage change in the JSE ALSI and exchange rate series from July 1997 to February 2000, a period characterised by considerable relaxation of exchange controls over residents and non-residents. This period is associated with an increase in volatility in markets, the stock market and the exchange rate market. The value of the Rand fell significantly, with a depreciation of about 16.5% in July 1998, followed by a major decline in the JSE ALSI of about 30%. These major declines in both markets may be explained by the Asian financial crisis and the decrease in the price of precious metals that affected the world during this period (Takaendesa, 2006:80). The average change in the exchange rate was 1.12% per period, while the average movement in the JSE was 0.062% per period. Standard deviations of 0.0853 and 0.0345 for the JSE and the exchange rate, respectively, show that the JSE experienced higher volatility. The common trend during this period is that changes in the exchange rate tended to be followed by changes of high magnitude in the JSE. Thus the relaxation of exchange control promoted high financial integration and increased the link between the JSE and the exchange rate. The Pearson coefficient of correlation is negative and is statistically insignificant, even at the 10% level of significance. There is thus no evidence of a strong correlation between the two variables during this sub-period.

Figure 16: The JSE and Exchange Rate (Jul 1997 -Feb 2000)

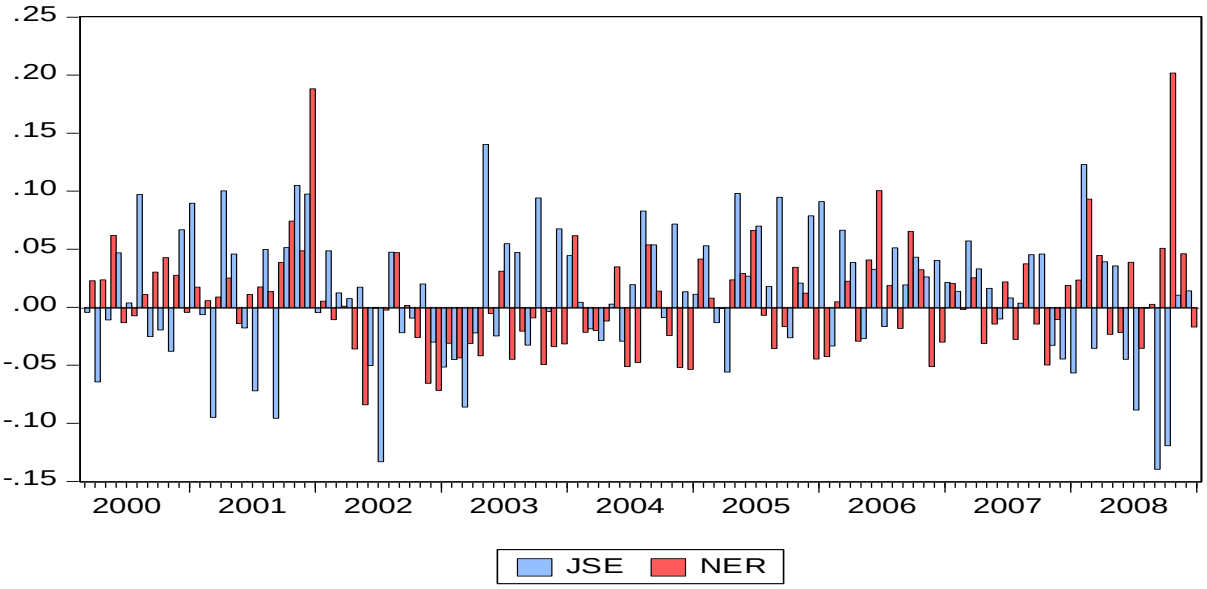


Source: JSE (2009) & SARB (2009)

4.3.10.3 Free Floating Exchange Rate with High Level of Flexibility

Figure 17 presents the relationship between the exchange rate and the JSE from March 2000 to December 2008. This was a period of free floating exchange rate, with a high level of flexibility, without any direct intervention of government in the exchange rate market. This period was characterised by high levels of volatility in both markets and this volatility tended to be in both directions.

Figure 17: The JSE and Exchange Rate (Mar 2000-Dec 2008)



Source: JSE (2009) & SARB (2009)

Table 5: Descriptive Statistics on Free Float ER Regimes

ER Policy	Free floating (Marc 95-Jun97)		Free floating (Jul 97-Feb 00)		Free floating (Marc 00-Dec 08)	
Variable	JSE	NER	JSE	NER	JSE	NER
Mean	1.36%	0.86%	0.62%	1.12%	1.09%	0.53%
Standard Deviation	0.0315	0.0210	0.0853	0.0345	0.0553	0.0450
Pearson correlation	-0.3130		-0.1892		-0.0552	
P-value (by SPSS)	(0,105)		(0.30)		(0.574)	

Source: Estimated by the current author

The period of free floating increased the exposure of the JSE to currency fluctuations, especially in the last sub-period, where movements of high magnitude are observed. All standard deviations tended to be high for the JSE, indicating that the stock market fluctuated more than the exchange rate market. The negative coefficients of correlation for all three sub-periods support the inverse relationship between the variables, but these correlation coefficients are not statistically significant. However, the first sub-period of free floating exchange rate tends to be significant at the 10% level of significance. This supports the idea that the end of sanctions in 1994 and the abolition of the dual exchange rate in March 1995 have led to the increased foreign investment portfolio in the JSE (Jefferis & Okeahalam (2000:29-31). The analysis conducted on the sub-periods from both managed floating and free floating exchange rate regimes (separately) has revealed that there may be a relationship between the JSE and the exchange rate under both regimes. Correlation coefficients appear to be significant in the first sub-periods of both regimes. It is still relevant to compare the response of the JSE in both regimes, however.

4.3.11 The JSE and Two Major Exchange Rate Regimes

The two previous sections discussed the relationship between the JSE and the exchange rate separating the period of managed floating exchange rates (1978-1995) from the period of free floating exchange rates (1995-2008). Although a negative relationship between the two variables was observed in both periods, this relationship tends to be strong in the period of free floating exchange rates. The combination of descriptive statistics (shown in Table 6) supports a weak inverse relationship between the JSE and the exchange rate, but Pearson's coefficients of correlation are insignificant in both periods.

Table 6 shows a negative coefficient of correlation between exchange rate and the JSE for both periods. For the period 1978-1994, the Pearson correlation is -0.0376. This implies that there was a weak negative relationship between the JSE and the exchange rate during this period. The coefficient of correlation for the period of free floating

exchange rate (1995-2008) is -0.0906. This is an indication of a weak negative relationship. This period has a higher coefficient correlation than the previous period (more than double the previous period's correlation), but it is still statistically insignificant, even at the 10% level of significance.

Table 6: Descriptive Statistics 1978 to 2008

	Feb 1978-Dec 1994		Jan 1995-Dec 2008		Feb 1978–Dec 2008	
	JSE	ER	JSE	ER	JSE	ER
Min	-24.76%	-12.19%	-29.87%	-8.42%	-29.87%	-12.19%
Max	17.50%	20.26%	14.31%	20.18%	17.50%	20.26%
Mean	1.79%	0.76%	0.96%	0.69%	1.41%	0.72%
Variance	0.0042	0.0012	0.0036	0.0016	0.0039	0.0014
Covariance	-0.0001		-0.0002		-0.0001	
Pearson correlation	-0.0376		-0.0906		-0.0612	
P-values (by SPSS)	(0.606)		(0.241)		(0.24)	

Source: estimated by the current author

The average percentage changes for the JSE and the exchange rate during the period 1978-1994 are 1.79% and 0.76%, respectively. During the period 1995-2008, the average percentage changes are 0.96% for the JSE and 0.69% for the exchange rate. During the period of managed floating exchange rate systems (1978-1994) there was a big difference between percentage changes in the JSE and percentage changes in the exchange rate. However, average percentage changes are relatively closer during the period of free floating exchange rate (1995-2008), suggesting that these two variables tended to be more related during the period of the free floating exchange rate. The difference between variances of these two variables seem to be low during the last period (1995-2008), meaning that the volatility tended to be lower in the last period.

Overall, a negative relationship between the JSE and the exchange has been found. This implies that the depreciation of the Rand is associated with a decrease in the share price of the JSE ALSI. Barr & Kantor (2005:81) found that the JSE tracked the exchange rate (ZAR/USD) closely from 1980 to 2002, in the opposite direction. For

the last period of the present study, from 1995 to 2008, the JSE increased by 0.96%, on average, while the Rand depreciated by 0.69%, on average. These results are supported by Jefferis & Okeahalam (2000), who concluded that the JSE's returns increase with the appreciation of the Rand and decrease with the depreciation of the Rand. However, Pearson coefficients of correction tend to be insignificant for both periods, but the sub-periods characterised by capital controls appear to have significant coefficients of correlation.

4.4 Concluding Remarks

It has been shown that countries use different exchange rate regimes in an attempt to control the stability of their currency. Exchange rate regimes include a flexible exchange rate system, a fixed exchange rate system, a managed exchange rate system and a pegged exchange rate system. Changes in these exchange rate systems affect international trade, the economic growth rate, the volatility of the currency market and the level of international investment. The overview of the exchange rate in South Africa revealed that South Africa has been characterised by different exchange rate regimes, but these regimes can be condensed into two categories: fixed and free-floating exchange rate systems. The analysis of the history of the exchange rate in South Africa showed that the flexibility was introduced in 1979, but the exchange rate shocks of great magnitude appeared during the period of the free-floating exchange rate system (1995-2008).

The overview of the stock market in South Africa revealed that the JSE has undergone different changes in terms of its structure and such changes have increased the exposure of the JSE to exchange rate risks. The JSE is integrated with other stock markets and, as a result, it had been affected by some of the economic crises. The position of the South African stock market in the ranking within global and emerging markets showed that the JSE has a competitive advantage in market capitalisation compared with liquidity and turnover values. It has been explained that the relationship between the JSE and the exchange rate has been increased during the

period of the free floating exchange rate and that the exposure of the JSE to currency risks increased during the period 1995-2008. The JSE's return decreases with the depreciation of the Rand and increases with the appreciation of the Rand. However, Pearson's coefficients of correlation appeared to be insignificant during both periods. Results from this chapter suggest that the JSE ALSI responded to change in exchange rate regimes, but the response was not consistent throughout the sub-periods of the two exchange rate regimes. Further estimations are thus needed to confirm these results.

CHAPTER FIVE: RESEARCH METHOD

5.1 Introduction

The theoretical analysis presented in Chapter Two shows that the exchange rate market and the stock market interact; and that the causal linkage between these two markets varies from country to country. A review of South African exchange rate regimes indicated that exchange rate shocks may vary with exchange rate systems and that changes in the exchange rate policies have an effect on the JSE. Although one of the objectives of the present study (identifying the response of the JSE to different exchange rate regimes) has been achieved in the previous chapter, the other two objectives (determining the direction of causality between the stock returns and the exchange rate in South Africa and identifying the long-run equilibrium relationship between the South African stock market and the exchange rate) have not been achieved. The motivation behind this chapter is to discuss the methodology to be used in achieving the other two objectives of this study.

Chapter Five discusses data and models used in the study. Section 5.2 explains the selection of the data, variables and sample period used in the study, as well as the way in which the data was obtained. Section 5.3 explains the methodology, together with the steps involved in developing the model used in testing the causal linkage between the real exchange rate and the real stock market and the use of the error correction model to estimate short-run dynamics and long-run equilibrium between the variables. Tests conducted are the test for unit root, Engle-Granger and Augmented Engle-Granger cointegration tests, and the Granger-Causality test. Section 5.4 discusses diagnostic tests, such as tests for heteroscedasticity, serial autocorrelation and parameter stability. Section 5.5 concludes this chapter.

5.2 Data Selection

The data set used in this study consists of monthly observations of the JSE ALSI and the monthly South African Rand (ZAR) to U.S. dollar (USD) exchange rate series. The ZAR/USD exchange rate series (S_t) were provided by the SARB. The historical stock market indices were obtained from McGregor BFA library and the JSE. Both stock market indices (P_t) and exchange rate series (S_t) will be adjusted for inflation to obtain real stock indices (RP_t) and real exchange rate series (RS_t). Monthly inflation rates (calculated as the change in the consumer price index, CPI) for South Africa were obtained from the Statistics South Africa (STATS SA) website, while monthly inflation rates for the USA were taken from the USA Bureau of Labour Statistics. The natural logarithm of both variables will be used. Thus the natural logarithm of the real stock indices is LRP_t and the natural logarithm of real exchange rate series is LRS_t.

The sample period starts in January 1978 and ends in December 2008. The year 1978 was characterised by a shift in South African exchange rate regimes, as the fixed exchange rate regime was replaced by the managed floating exchange rate regime. This means that the year 1978 marked the official end of the Bretton Woods fixed exchange rate regime and the introduction of flexibility in the South African exchange rate. This flexibility resulted from the reformation of the foreign exchange market and exchange rate policies in South Africa, recommended in the De Kock Commission interim report of 1978 (Aron & Muellbauer, 2001:11). Worldwide, the year 1978 was characterised by a broad adoption of a floating exchange rate system, formalised by the Jamaican Agreement of January 1976 (Kim & Kim, 1999:90). In other words, the year 1978 marked the end of the Bretton Woods fixed exchange rate system in South Africa and many other countries. The reason for starting the sample period in 1978 was to capture the introduction of flexibility in the South African exchange rate market. December 2008 was selected as the end of the sample period because it corresponds to the last available full year at the time the study was begun. In addition to the use of the full period, sub-periods will be constructed based on changes in exchange rate policies, discussed in Chapter Three. These sub-periods will assist in conducting parameter stability tests. Two phases have been identified. The first phase

covers the period of the managed floating exchange rate (with high level of government intervention) and starts from January 1978 to December 1994; while the second phase includes the period of free floating exchange rate, January 1995 to December 2008. This second phase coincides with the incorporation of South Africa into the International Finance Corporation's (IFC) emerging market index since the beginning of 1995.

5.2.1 Adjusting For Inflation

Having indicated that this study uses real values, it is vital to explain the difference between nominal rates and real rates and the process of adjusting the data from nominal to real terms. Firer *et al.* (2008:213) state that nominal rates are rates of return or interest rates that have not been adjusted for price changes, while real rates are rates of return or interest rates that have been adjusted for inflation. The real exchange rate can be defined as the nominal exchange rate adjusted for price differentials between countries (Takaendesa, 2006:11). Using the Fisher effect[13], the relationship between nominal returns, real returns and inflation can be presented as follows:

$$1+R=(1+r)\times(1+h) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.1)$$

Where: R = the nominal return;

r = the real return; and

h = inflation rate.

Solving for the real return (r)

$$[(1+R)\div(1+h)]-1=r \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.2)$$

[13] The Fisher effect is the relationship between nominal returns, real returns and inflation proposed by the economist Irving Fisher (Firer *et al.*, 2008:214).

The real return on a stock index (RRP_t) for each month can be calculated as follows:

$$RRP_t = \left(\frac{1 + NP_t}{1 + h} \right) - 1 \quad \text{.....(5.3)}$$

Equation 5.3 pr ovides guidelines on how to obtain the real return on a stock index given the nomi nal return on the stock index. However, the p resent research uses the real stock index (RP_t) instead of the real return on stock index (RRP_t) . The e quation to be used in adjusting nominal stock prices for inflation is:

$$RP_t \equiv \frac{NP_t}{(1 + h_{t\,SA})} \quad \text{..... (5.4)}$$

where: RP_t = real stock prices;

NP_t = nominal stock prices; and

$h_{t\,SA}$ = monthly changes in consumer price index from South Africa.

Nominal e xchange r ates are a djusted for infla tion to obtain re al exchange ra tes. Following Takaendesa, Tsheole & Aziakpono (2006:85) and Tembo (1999:6), the monthly S outh African and US CPI a re us ed to convert monthly nomi nal exchange rates into real exchange rates:

$$RS_t == \frac{NS_t * CPI_{tUS}}{(CPI_{t\,SA})} \quad \text{..... (5.5)}$$

where: RS_t = monthly real exchange rates;

NS_t = monthly nominal exchange rates;

$CPI_{t\,US}$ = monthly CPI from the USA; and

$CPI_{t\,SA}$ = monthly CPI from South Africa.

5.3 Model Specification

This study uses different methods to achieve its objectives. According to the literature, the real stock price may not just be related to its own lagged values, but also to those of the real exchange rate; similarly, the real exchange rate may be related to its own lagged values and those of the real stock price (Kaseeram, 2003:89). The Engle-Granger cointegration approach and error correction model are used to establish the long-run and short-run relationships. Other tests conducted include tests for causality (Granger-Causality test), stationarity, heterocedasticity, autocorrelation and parameter stability.

5.3.1 Granger-Causality Test

In analysing the relationship between the exchange rate series and stock prices in South Africa, it is important to establish a statistical causation test that determines whether or not there is a causal relationship between the two variables. Although there may be different ways of modelling causality, this study makes use of the Granger (1969) model as it is simple, straightforward and has been recommended by other researchers, such as Abdalla & Murinde (1997) and Ajayi *et al.* (1998). A variable Y is said to *Granger-Cause* another variable Z, if Z can better be predicted from the past of Y and Z together than the past of Z alone, with the consideration of other information in such a prediction (Freeman, 1983:328). According to Abdalla & Murinde (1997:27) and Charemza & Deadman (1997:167), the Granger-Causality test for this study can be established as follows:

$$LRS_t = \sum_{j=1}^{m} \alpha_j LRS_{t-j} + \sum_{j=1}^{n} \beta_j LRP_{t-j} + E_t \quad \text{.....} (5.6)$$

$$LRP_t = \sum_{j=1}^{m} c_j LRS_{t-j} + \sum_{j-1}^{n} d_j LRP_{t-j} + u_t \quad \text{.....} (5.7)$$

where: LRSt = the natural logarithm of the real exchange rate variable;

LRPt = the natural logarithm of the real stock price variable; and

E_t and u_t are error terms.

If the errors E_t and u_t are contemporaneously correlated, a shock to one of the equations would have a ripple effect on the other equation (Patterson, 2000:537). Hence, each equation is assumed to have serially independent residuals, with zero mean and constant variance. In other words, both equations are assumed to be serially independent, with zero mean and a finite covariance matrix. If Equations 5.6 and 5.7 meet these assumptions then the causality analysis would be based on the following hypothesis tests.

For Equation 5.6:

H_0: $\sum \beta_j = 0$, LRP_t does not cause LRS_t

H_1: $\sum \beta_j \neq 0$, LRP_t cause LRS_t

For Equation 5.7:

H_0: $\sum C_j = 0$, LRS_t does not cause LRP_t

H_1: $\sum C_j \neq 0$, LRS_t cause LRP_t

Patterson (2000:537) states that there can be four possible outcomes from a causality test: one-way causation from real stock prices to the real exchange rate; one-way causation from the real exchange rate to the real stock price; mutual causation and causal relationship between the real exchange rate and the real stock price.

5.3.2 The Concept of Stationarity and Unit Root Testing

It is important to determine whether or not a series is stationary, as a non-stationary series can have a strong influence on its behaviour and properties. The use of non-stationary data can lead to spurious regressions[14], which yield uninterpretable t-statistics and F-statistics (Brooks, 200:230). There are two definitions of stationarity: these include a strictly stationary process and a weakly stationary process (Kaseeran, 2003:73). A series is said to be strictly stationary if the distribution of its values stays constant as time progresses; meaning that the probability that a variable (y) "… falls within a particular interval is the same now as at any time in the past or the future" (Brooks, 2002:230). Hendry (1995 :42), Jefferis & Okeahalam (2000) and Brooks (2002:231) state that a series is said to be weakly stationary when it satisfies the following three conditions:

i. $E(y_t) = \mu$ ……..….(5.8)

ii. $E(y_t - \mu)(y_t - \mu) = \sigma^2 < \infty$ ……..….(5.9)

iii. $E(y_{t1} - \mu)(y_{t2} - \mu) = \gamma_{t2-t12} \quad \forall t_1, t_2$ ……(5.10)

According to the above equations, a weakly stationary process should have a constant mean (Equation 5.8); a constant variance (Equation 5.9) and a constant autocovariance structure (Equation 5.10). These autocovariances identify the relationship between y and its previous values and "…for a stationary series they depend on the difference between t_1 and t_2, so that the covariance between y_t and y_{t-1} is the same as covariance between y_{t-10} and y_{t-11}, etc" (Brooks, 2002:231). If a series does not meet the above conditions of stationarity it is said to be non-stationary.

[14] **Spurious regression**: a regression with the end result that looks good but under standard measures (significant coefficients estimates and high R^2), but which is really valueless (Brooks, 2002:368).

5.3.2.1 Two Types of Non-Stationarity

Brooks (2002:369), Kaseeram (2003:75-78) and Enders (2004:157-161) state that non-stationarity is frequently characterised by two models, the *Rand*om walk[15] with drift and the trend stationary process. The *Rand*om walk with drift is expressed as follows:

$$y_t = u + y_{t-1} + u_t \quad \text{..... (5.11)}$$

The trend stationary process (TPS), which is stationary around a trend, can either be a deterministic[16] trend or a stochastic[17] trend:

$$y_t = \alpha + \beta t + u_t \quad \text{..... (5.12)}$$

where: u_t is a white noise disturbance term in the Equation 5.11 and Equation 5.12.

Brooks (2002:370) indicates that Equation 5.11 can be generalised in a case where y_t is an explosive process:

$$y_t = u + \Phi y_{t-1} + u_t \quad \text{..... (5.13)}$$

Where there may be three possible cases for a non-stationary time series:

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[15] " A random walk is an example of a non-stationary time series, where, as a variable grows from its base it is accompanied by a stochastic distance μ at time t, if the variable continues to grow indefinitely it will drift further and further away from its base" (Kaseeram, 2003:75). For example, today's stock price is yesterday's price plus a random shock.

[16] A deterministic trend is perfectly predictable and displays no variability.

[17] Stochastic trends are different over different time period lengths; such trends could be at variable rates and/or directions.

i. $\Phi < 1$ thus shocks to the systems gradually dissipate (this is the stationary case).

ii. $\Phi = 1$ thus shocks persist in the system and never dissipate. As a result, the following equation is obtained:

$$y_t = y_0 + \sum_{t=0}^{\infty} u \quad \text{..... (5.14)}$$

This indicates that the current value of y is an infinite sum of past shocks, plus some initial value of y_o (Kaseeram, 2003:77).

iii. $\Phi > 1$ thus shocks become more influential as time passes. This does not characterise many financial and economic time series; as a result, this research focuses on the second case ($\Phi = 1$) to describe non-stationarity (Brooks, 2002:371).

5.3.2.2 Testing for a unit root

Cheremza & Deadman (1992:128) state that the level of integration explains whether data are stationary or not and this level of integration is presented as follows:

$$X_t \approx I(d)$$

where d stands for the order of integration.

This 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. When d = 0, a series

(X_t) is integrated of order zero (I[0]) and is stationary. However, when $d \geq 1$, a series is integrated of order 1 (I[1]), or higher, and is non-stationary.

There are various ways of testing for stationarity, including informal tests such as graphical analysis and correlogram test; and formal tests such Dickey-Fuller (DF) unit root test, Augmented Dickey-Fuller (ADF) unit root test and the Phillips-Perron (PP) unit root test (Brooks, 2008:327-331 and Gujarati, 2003:814-820). Unit root tests (such as ADF and PP) tend to produce similar results, but they are criticised because they have low power and are sensitive to size that they may lead to a poor decision in small sample sizes (Brooks 2008:330-331 and Gujarati 2003:818-819). As a way of dealing with this problem of selecting the appropriate unit root test, Brooks (2003:382) insists that results of the KPSS stationarity test should be compared to ADF and PP to check whether or not they produce the same conclusion.

The equation for DF, ADF and PP tests, based on a standard regression with a constant and time-trend, is expressed by Abdalla & Murinde (1997:28) as follows:

$$\Delta LRP_t = \alpha_0 + \beta_1 T + \lambda_1 RP_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta LRP_{t-1} + \varepsilon_{1t} \quad \text{..... (5.15)}$$

$$\Delta LRS_t = \alpha_0 + \beta_1 T + \lambda_2 LRS_{t-1} + \sum_{i=1}^{p} \phi_i \Delta LRS_{t-1} + \varepsilon_{2t} \quad \text{..... (5.16)}$$

Where: Δ = the first difference operator: thus, $\Delta LRP_t = LRP_t - LRP_{t-1}$ and

$\Delta LRS_t = LRS_t - LRS_{t-1}$;

α_0, β_1, β_2, λ_1, λ_2, α_i, and φ_i are the coefficients;

T = time trend; and,

ε_1 and, ε_2 are white noise errors.

The hypothesis tests for unit root (DF, ADF and PP) are:

- The null hypothesis (Ho): $\lambda_1 = \lambda_2 = 1$ then RP_t and RS_t have a unit root, I(1);
- Alternative hypothesis (H_1): λ_1 and $\lambda 2 < 1$ then RP_t and RS_t are stationary, I(0).

The KPSS test follows a different format[18] (LM statistics) and the KPSS hypothesis tests for stationary are:

- The null hypothesis (Ho): LRP_t and LRS_t are stationary, I(0);
- Alternative hypothesis (H_1): LRP_t and LRS_t have a unit root, I(1).

Thus, the combination of stationarity and unit root test, known as "*confirmatory data analysis"* (Brooks 2008:331), would yield four possible conclusions:

1. Reject Ho and do not reject Ho
2. Do not reject Ho and reject Ho
3. Reject Ho and reject Ho
4. Do not reject Ho and do not reject Ho

This means that the first and second conclusions produce constant results, while the third and fourth outcomes produce conflicting results.

Where time series are found to be non-stationary, they can be made stationary through differencing. This means that the first difference of a series with a unit root I(1) are

[18] For a detailed discussion of the format of the KPSS LM test, see Kwiatkowski, Philips, Schmidt & Shin (1992)

stationary[19] (Gujarati, 2003:820). Once the time series are found to be stationary or have been transformed through differencing, cointegration tests will be conducted.

5.3.3 Testing for Cointegration

Having indicated that financial variables contain one unit root and are I(1), it is important to emphasise that non-stationary variables may move together over time. Such variables are said to be cointegrated if a linear combination of them can be stationary (Brooks, 2002:388). This implies that two non-stationary series may be bound by some relationship in the long-run. The cointegrating relationship is, therefore, considered as a long-run or equilibrium phenomenon of variables that might deviate from a short-run relationship (or may have no tendency to move together in the short run) but return their association in the long run (Patterson, 2000:15). This research uses the Engle-Granger and Augmented Engle-Granger cointegration test to identify whether trends in stock prices and exchange rates that contain a unit root have a long-run relationship. Engle and Granger (EG) cointegration techniques use the EG critical values to test for the cointegrating relationship between the variables. The EG cointegration of two variables is presented by Charemza (1997:125) as follows:

Two non-stationary series Xt and Yt are said to be cointegrated of order d, b where $d \geq b \geq 0$, written as: $Xt,Yt \approx CI(d,b)$. If both series are integrated of order d, there exists a linear combination of these variables, such as $\alpha 1Xt + \alpha 2Yt$, which is integrated of order d-b (Charemza, 1997:125). Thus the vector [α1, α2] is called a cointegrating vector, vt . If vt is a n x 1 vector of series, with the components of vt integrated of order (d,b), then each variable of vt is I(d) and there is at least one vector of coefficients α, such that $\alpha' vt \approx I(d-b)$. Thus, if d= b =1, then variables contain a unit root (Brooks, 2002:388).

[19] A time series that has two unit roots, I(2), has to be differenced twice and a series that is I(*d)* will be differenced *d* times (Gujarati, 2003:820).

5.3.3.1 The Engle-Granger Cointegration test

Suppose that the natural logarithm of the real stock market index (LRP_t) and natural logarithm the real exchange rate (LRS_t) are both I(1) and the relationship between them is given by:

$$LRP_t = \alpha_1 + \alpha_2 LRS_t + u_t \quad \text{.....(5.17)}$$

Where u_t is the error term and it has to be I(0) for the two variables to be integrated. Thus the DF and ADF tests are used to assess whether the error term, u_t, is stationary. The DF cointegration test is based on the following regression:

$$u_t = \phi u_{t-1} + \varepsilon_t \quad \text{.....(5.18)}$$

with $\phi = 1$ indicating non-cointegration and $-1 < \phi < 1$ indicating cointegration.

For ADF use augmented regression that by p lagged values of Δu_t to ensure that the estimated ε_t are serially independent (Patterson, 2000:331). Thus, the estimated regression is:

$$\Delta u_t = \lambda u_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta u_{t-1} + \varepsilon_t \quad \text{..... (5.19)}$$

where $\lambda = \phi - 1$.

However, the test on residual of model does not use DF and ADF critical values. New critical values tabulated by Engle and Granger (1987) are used to conduct the EG cointegration test. EG critical values are more negative (larger in absolute value) than

the DF critical values (Brooks, 2002:392). The hypothesis testing for residuals is set as follows:

H_0: $u_t \approx I(1)$ ($\lambda = 0$)

H_1: $u_t \approx I(0)$ ($\lambda < 0$)

If the estimated value is smaller than the EG critical value, the H_0 is not rejected. This will show that there is unit root in the residuals and it will be concluded that variables are not cointegrated. However, if the estimated value is smaller than the EG critical value, the H_0 is rejected. It will, therefore, be concluded that residuals are stationary and that variables are cointegrated.

5.3.4 Error Correction Model or Granger-Causality

The estimation of the short-run dynamic behaviour of the model and the long-run equilibrium relationship depends on the results from the cointegration analysis (Abdalla & Murinde, 1997:29). If both the exchange rate and the stock market are not cointegrated, a standard Granger-Causality test is used. However, if both the exchange rate and the stock market are cointegrated, the Error Correction Model (ECM) is used.

Abdalla & Murinde (1997:29) explain that the use of the ECM in cointegrated variables avoids the misspecification that occurs when the Granger-Causality test is used in a standard model to obtain differenced data for cointegrated variables. This has been confirmed by other researchers, such as Lyons & Murinde (1994), MacDonald & Kearney (1987) and Miller & Russek (1990). If previous tests show that the real exchange rate and the real stock market are I(1) and are cointegrated, the ECM is used. According to Gujarati (2003:825), the ECM is presented as follows:

$$\Delta LRP_t = \delta_1 + \delta_2 \Delta LRS_t + \delta_3 u_{t-1} + \varepsilon_t \quad \text{...............................(5.20)}$$

where: Δ is the first difference operator;

ε_t is a random error term, and

$u_{t-1} = (LRP_{t-1} - \alpha_1 - \alpha_2 LRS_{t-1})$, the one-period lagged value of the error from the cointegrating regression 5.17).

Equation (5.20) shows that changes in the real stock price (ΔLRP_t) depend on changes in the real exchange rate (ΔLRS_t) and the equilibrium error term (δ_3). The absolute value of the error correction coefficients (δ_3) shows the speed of adjustment to the equilibrium and the short-run dynamics of the model are captured by ΔLRS_{t-i}. If δ_3 is zero, it means that LRPt adjusts to changes in LRSt in the same time period. If δ_3 is not zero, the model is not at equilibrium and RSt will increase or decrease to correct the equilibrium error.

5.4 Diagnostic tests

Diagnostic tests check whether or not the stochastic properties of the model (ECM) are met in order to avoid conventional econometrics problems which result in the violation of the assumptions of the classical linear regression model. These stochastic properties of the model include residual autocorrelation, heteroscedasticity and parameter stability, among others (Takaendesa, 2006:100). The heteroscedasticity test indicates whether or not the residuals of a model have a common variance and the autocorrelation test determines if error terms are uncorrelated to one another, over time. In conducting tests for heteroscedasticity and autocorrelation, the Lagrange Multiplier (LM) test is used, since this test can identify both heteroscedasticity and autocorrelation. The stability of the regression coefficients is tested using Chow's structural break test.

5.4.1 Testing for Heteroscedasticity

One critical assumption to hypothesis testing is that the variance of the errors is constant, σ^2 (Patterson, 2000:161). This assumption of constant conditional variance is known as *homoscedasticity* and when errors do not have a constant variance they are said to be *heteroscedastic*. According to Brooks (2002:150), the presence of heteroscedasticity in the error terms leads to unbiased coefficient estimates, but they will not possess a minimum variance among the class of unbiased estimators. According to Gujarati (2003), there are various ways of detecting heteroscedasticity. these are: the graphical method, park test, Glejser test, Spearman's rank correlation test, Goldfeld-Quandt test, Breusch-Pagan-Godfrey test, Koenker-Basssett test and White's general heteroscedasticity test. The level of simplicity among these tests may differ, as they are based on several different assumptions[20]. White's general heteroscedasticity test is commonly used because it is simple and easy to implement (Gujarati, 2003:415) and it depends on assumptions about the possible form of the heteroscedasticity (Brooks, 2003:148). This research will, therefore, use White's general heteroscedasticity test to examine the presence of heteroscedasticity. According to Brooks (2002 :148-151) and Gujarati (2003:413), White's test is conducted using the LM test. The test is as follows:

Consider the following regression:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + u_t \quad (5.32)$$

To test for var $(u_t) = \sigma^2$, the auxiliary regression from Equation 5.32 is obtained

$$\hat{u}_t^2 = \alpha_1 + \alpha_2 x_{2t} + \alpha_3 x_{3t} + \alpha_4 x_{2t}^2 + \alpha_5 x_{3t}^2 + \alpha_6 x_{2t} x_{3t} + v_t \quad (5.33)$$

[20] For a detailed discussion on various heteroscedasticity tests see Gujarati (2003:403- 415).

Where: v_t is a normally distributed disturbance term independent from u_t.

The LM test for heteroscedasticity uses R^2 from the auxiliary regression (5.33) multiplied by the number of observations (T). The product of the two is then compared to the critical values from the Chi-squared (χ^2) distribution:

$$T R^2 \sim \chi^2 (m)$$

Where: m is the number of regressors in the auxiliary regression (excluding the constant term).

The joint Hypothesis test:

H_o: $\alpha_2 = 0$, and $\alpha_3 = 0$, and $\alpha_4 = 0$, and $\alpha_5 = 0$, and $\alpha_6 = 0$ (Homoscedastic)

$H_1 = \alpha_2 \# _0$, or $\alpha_3 \# 0$, or $\alpha_4 \# 0$, or $\alpha_5 \# 0$, or $\alpha_6 \# 0$ (Heteroscedastic)

If the χ^2 test ($T R^2$) is greater than critical values from the statistical table then H_0 is rejected and it will be concluded that the errors are heteroscedastic.

5.4.2 Testing for Autocorrelation

According to Brooks (2002), there are various ways of detecting autocorrelation, including graphical methods, the runs test, the Durbin Watson test, the Breusch-Godfrey test and the LM test. However, Brooks (2002:165) and Gujarati (2003:473) are of the opinion that a more general test for autocorrelation is the Breusch-Godfrey test, which is similar to the LM test, presented as follows:

Consider the following regression:

$$Y_t = \beta_1 + \beta_2 X_t + u_t \quad \text{..... (5.21)}$$

With assumption that the error term is as follows:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + ... + \rho_n u_{t-n} + \varepsilon_t \quad \text{..... (5.22)}$$

Where: ε_t is normally distributed and X includes lagged dependent variables.

According to Charemza & De adman (1997:74), the null h ypothesis and a lternative tests for autocorrelation are set as follows:

H_o: $\rho_1 = \rho_2 = \rho_3 = \rho_n = 0$ (no autocorrelation)

H_1: $\rho_1 \neq 0$, or $\rho_2 \neq 0$, or $\rho_3 \neq 0$, or …, or $\rho_n \neq 0$ (autocorrelation)

By obtaining R^2 from the auxiliary regression, the test statistic is given by:

$$(T\text{-}n)R^2 \sim \chi^2_n$$

If the calculated value, $(T\text{-}n)R^2$, is greater than critical value, $\sim \chi^2_n$, we reject H_0 and conclude that there is autocorrelation (Brooks, 2002:166).

5.4.3 Parameter Stability Test

Testing for pa rameter stability test is carried out using Chow's structural break test. This is done to e nsure that the relationship be tween the real stock price and the real

exchange rate, over the sample period, holds. This test enhances the assumption of the regression model that the regression coefficients are constant for the entire sample, for both the entire period (t=1) and any sub-periods (T_n) (Patterson, 2000:185). The parameter stability test involves splitting the data into two sub-periods and estimating up to three models (one for each sub-period and the entire period) in order to compare the Residual Sum of Squares (RSS) of the different models (Brooks, 2002:199).

Chow's Test

There are two tests for constancy of the regression coefficients, namely the Chow's Analysis of Variance (CAO) test, or Chow's first test, and predictive failure tests (Patterson, 2000:185). The present study uses Chow's test, which is conducted through the following steps (Brooks (2002:199):

i. *Splitting the data into sub-periods*: the sample is divided into two sub-periods, in order to obtain sub-samples. Three regressions, one each for the entire sample period and two sub-periods, are estimated to get RSS for each regression.

ii. *Restriction in the model:* the F-test is formed with a restricted regression for the whole period and two unrestricted regressions from sub-samples (Charemza & Deadman, 1997:31).

$$\text{Test statistic} = \frac{RSS - (RSS_1 + RSS_2)}{RSS_1 + RSS_2} \times \frac{T - 2k}{k} \quad \text{.....(5.23)}$$

where: RSS = residual sum of squares for the entire sample;

RSS_1 = residual sum of squares for the sub-sample 1;

RSS_2 = residual sum of squares for the sub-sample 2;

T = number of observations;

2k = number of regressors in the unrestricted regression (in two parts); and,

k = number of regressors in each unrestricted regression.

The restriction imposed on the sample period model is that coefficients are equal across the sub-sample. Hence, the test is on whether or not the RSS for the entire sample is bigger than the RSS for two periods ($RSS_1 + RSS_2$). The difference may not be very large if coefficients are constant throughout the samples (Brooks, 2002:200).

iii. Setting the test: The hypotheses are:

H_0 = the parameters are stable over the time

H_1 = the parameters are not stable over the time

If the value of test statistics (obtained in Equation 5.36) is less than the critical value from the F-distribution, which is F (k, T – 2k), then the H_0 is not rejected, with the conclusion that parameters are stable over time. If evidence of instability is found, then one sub-period will be used for the sample size.

5.4.4 Selection of the Lag Length

The problem with the lag length is that too few lags mean that regression residuals do not behave like a white-noise process, while the inclusion of too many lags reduces the power of the test to detect a unit root (this means that the increase in the number of lags requires the estimation of additional parameters and a loss of degrees of freedom) (Enders, 2004:191). To ensure that the appropriate number of lags is selected, the present study makes use of information criteria to identify the lag length. According to

Brooks (2002:257), types of information criteria include Akaike's (1974) Information Criterion (AIC); Schwarz's (1978) Bayesian Information Criterion (SBIC); and The Hannan-Quinn Information Criterion (HQIC).

The conjunction of these three methods of information criteria is used to check if they do not produce conflicting results. Abdalla and Murinde (1997:30) pointed out that the adjusted R^2 can also be viewed as an information criterion when these techniques suggest different lag lengths. The adjusted R^2 may be used in case the above techniques produce conflicting results, as long as the lag structure follows the basis of financial theories (Seddighi; Lawler & Katos, 2000:125).

5.5 Concluding Remarks

The main purpose of this chapter was to discuss the selection of data and the statistical techniques and to specify the model to be employed in the next chapter. The discussion on methodology presented the steps involved in developing models to be used in determining the causal linkage and long-run and short-run relationships between the stock market and the exchange rate market.

Chapter Five started with a discussion of the selection of variables to be used in the study. These include the monthly observation of exchange rates and the JSE ALSI; the sample period from January 1978 to December 2008 and the sources of data, which are the SARB, STATS SA, McGregor BFA library, the JSE and the USA Bureau of Labor Statistics. The main reason for selecting this sample period is to observe the effect of exchange rate shocks on the JSE during periods of managed floating and free floating exchange rate systems. In addition to the identification of the full period, sub-periods have been constructed based on changes in exchange rate policies in South Africa.

Intensive discussion of the different tests to be conducted has been presented. These tests include the Granger-Causality test, the unit root test, Engle-Granger cointegration approach, the Error Correction Model (ECM), the Lagrange Multiplier (LM) test to detect heteroscedasticity and serial autocorrelation on ECM and Chow's structural break test to check the stability of parameters. Most importantly, the emphasis has been placed on how to utilise these estimation techniques on South African data, in order to achieve the objectives of this research, which were outlined in Chapter One.

CHAPTER SIX: RESULTS

6.1 Introduction

The previous chapter presented a discussion of the data and models to be used in this study to achieve the remaining objectives (identifying the long-run equilibrium relationship between the stock market index and the exchange rate in South Africa and the causal linkage between these two variables). Chapter Six continues with the analysis of results obtained from applying the analytical techniques discussed in Chapter Five. A discussion of these results identifies whether or not the results obtained match the expected outcome considered in the literature. Outcomes from Chapter Six assist in determining the direction of causality between the stock market and the exchange rate market in South Africa and in identifying the short-run dynamics and the long-run equilibrium relationship between these two markets. The Granger-Causality test establishes the direction of causality; while the Engle-Granger cointegration technique and ECM identify long-run equilibrium between stock and exchange rate markets. This rest of this chapter is divided into two main sections. Section Two presents a discussion of empirical results, while Section Three contains remarks concluding the chapter.

6.2 Results Analysis

This section discusses all the steps taken to arrive at the final results. It is divided into four sub-sections. Sub-sections one and two present the results from unit root/non-stationary and cointegration tests, respectively. Sub-section three conducts diagnostic tests on the ECM and uses the results of the ECM to determine short-run and long-run relationships. Sub-section four discusses the Granger-Causality results.

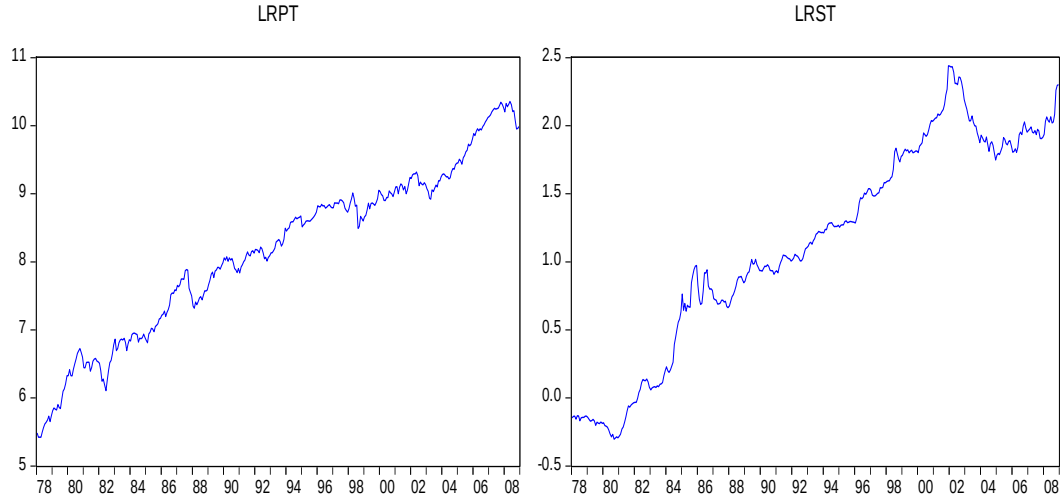
6.2.1 Unit Root/Non-Stationarity

In order to conduct any cointegration test, it is important to test for unit root and the order of integration of the variables. Before conducting formal unit root tests, preliminary investigations of stationarity are conducted. This preliminary investigation involves the use of informal tests such the graphical representation. Other tests, such as Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS), are used as formal tests.

Preliminary investigation

The graphical analysis and the correlogram test or ACF allow the researcher to conduct a preliminary investigation of the data and assist in identifying data capturing errors, structural breaks and trends in the data set (Takaendesa, 2003:106). Figure 18 presents the graphs for logs of the real exchange rate series and the JSE ALSI against time.

Figure 18: Plots Of the Real Exchange Rate and the JSE ALSI



Source: Estimated by the current author with the use of Eviews

Figure 18 shows that both variables tend to have an upward trend with a low level of fluctuation. Both variables have a time changing mean and variance and do not move

closely around their mean. This suggests that LRPt and LRSt may not follow a stationary process or white noise process. Therefore the graphical analysis indicates that variables tend to be non-stationary in their levels and they seem to be trading upward.

Sample Correlogram

The sample correlogram or ACF for both variables is reported in Appendix B. Appendix B (1) and (2) show the autocorrelation coefficient for log values of the real exchange rate (LRSt) and log values of the JSE ALSI (LRPt), respectively, up to thirty six lags. For the series to be stationary, autocorrelation coefficients should fluctuate around zero (shown by the line with dots on the left hand side). Autocorrelation coefficients for both variables have very high positive values. At lag 1, the autocorrelation coefficients are 0.992 and 0.989 for LRSt and LRPt, respectively. These coefficients decline very slowly and they are still high even at lag 36. Both variables do not fluctuate around zero and this suggests they are expected to be nonstationary. Although both informal tests indicate that series are nonstationary, it is still vital to conduct a formal test in order to confirm these results.

Formal Tests for Unit Root Tests

It has been indicated (in section 5.3.2.2 of Chapter Five) that DF, ADF and PP tests assist in testing for a unit root, while the KPSS test is set to check whether or not a series is stationary. As a result, these four tests are used in testing for stationarity of the variables in the levels, in natural logarithm form and in first differences. The results of these four tests, with a trend and intercept, are reported in Table 7. In this table, LRPt is the natural logarithm of stock market index; LRSt is the natural logarithm of the real exchange rate series; and ΔLRPt and ΔLRSt are first differences of the natural logarithm of stock market index and exchange rate series, respectively.

DF, ADF and PP tests test the null hypothesis of a unit root, while KPSS tests the null hypothesis which states that the series is stationary. A rejection of the null hypothesis under the DF, ADF and PP means there is no presence of a unit root in the series, while the rejection of the null hypothesis under the KPSS means that the series are not stationary or have a unit root.

Table 7: Unit Roots/Stationarity Tests

Variables / Test	Natural Logarithm		First Difference		Test Critical Values[21]		
	LRPt	LRSt	ΔLRPt	ΔLRSt	1% level	5% level	10% level
DF	-1.543	-2.130	-6.934	-14.519	-2.571	-1.942	-1.616
ADF	-3.069	-2.114	-17.511	-14.507	-3.983	-3.422	-3.134
PP	-3.220	-1.955	17.502	-14.418	-3.983	-3.422	-3.134
KPSS	0.3098	0.2643	0.0325	0.0594	0.216	0.146	0.119

Source: Estimated by the current author with the use of Eviews

According to Table 7, the absolute value of the estimated DF value for LRP_t is larger than the absolute value of DF critical value at 5% and 10% levels of significance. This means that LRS_t is stationary at the 5% level of significance. However, the absolute values of estimated values for LRP_t are smaller than the absolute value of DF critical values, even at the 10% level of significance. LRP_t has a unit root in levels at the 10% level of significance. DF unit root test, without intercept and trend, shows that only one variable (LRS_t) is stationary in their level.

ADF test is used to introduce the intercept and the trend. In the level, the ADF estimated values are less negative than critical values, even at the 10% level of significance. Thus the ADF fails to reject the null hypothesis (for both variables) at the 10% level of significance. Based on ADF, it is concluded that variables are not

[21] Critical values based on MacKinnon (1996) and KPSS (1992) are shown in the last three columns and the lag order for the series was determined by the Schwarz information criterion, automatically set by Eviews software.

stationary in level. The PP test reveals that only one variable (LRP_t) is stationary at the 10% significance level.

Under the KPSS test, the null hypothesis is rejected, for both variables, because the LM-statistics are greater than the 1%, 5% and 10% critical values. This indicates that the series are not stationary in their level. These two sets of formal tests reach the same conclusion, that the natural logarithm of exchange rate series and the natural logarithm of the stock market index (either with or without the intercept and trend) are not stationary in levels. This is similar to the conclusion of the preliminary investigations.

Based on the first difference, the DF, ADF and PP test statistics are more negative than critical values at 10%, 5% and 1% levels of significance. Thus all three tests support the rejection of the null hypothesis. This means that there is strong evidence supporting the presence of the stationarity. The LM-statistics for the KPSS test are smaller than critical values at 10%, 5% and 1% levels of significance; this means that the null hypothesis for stationarity is not rejected. The stationary test concludes that both variables are stationary in their first difference. The results for confirmatory data analysis[22] are robust, because both stationary and unit root tests conclude that the first differences of the exchange rate series and stock market index are stationary at 10%, 5% and 1% levels of significance. This means that variables are I(1) and might be cointegrated. Due to this, it is therefore important to continue with a cointegration test.

6.3 Cointegration Test

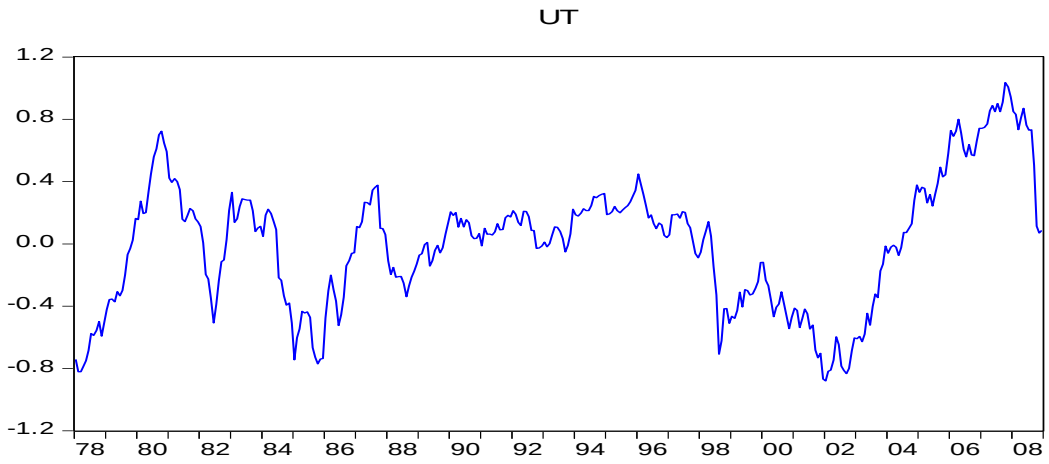
The EG cointegration test is conducted without a constant and a trend. Equation (6.1) is estimated and the error term is tested for stationarity.

$$LRP_t = \alpha_2 LRS_t + u_t \quad \text{..(6.1)}$$

[22] This is the combination of stationary and unit root tests, discussed in Chapter Five, in 5.3.2.2.

Before conducting any formal test, it is important to conduct a visual inspection on the plotting of residuals from Equation 6.1, presented in Figure 19.

Figure 19: Residuals Plot



Source: Estimated by the current author with the use of Eviews

Figure 19 shows that residuals from Equation 6.1, have not moved away from the mean, as they tend to fluctuate around zero. They seem to be stationary, but a formal test is needed for confirmation of the stationary process.

Table 8: EG Stationary Test in Residuals

Estimated value		-3.041
Test critical values for EG:	1% level	-4.00
	5% level	-3.37
	10% level	-3.02

Source: Estimated by the current author with the use of Eviews

Table 8 shows that the absolute value of the test statistics is greater than the absolute value of the EG critical values at the 10% significance level. Thus, H_0 of a unit root is rejected at the 10% significance level and it is concluded that the error term is stationary. It is therefore established that there are cointegrating relationships between the real exchange rate and the real JSE ALSI at the 10% significance level. Since these

two variables are found to be I(1) and cointegrated, there is an error correction representation. This study proceeds with ECM to identify the long-run and short-run relationships between the real exchange rate series and the real stock market index.

6.4 Error Correction Model and Diagnostic Tests

Having identified that the stock market index and the exchange rate are I(1) and cointegrated, the two variables are expected to be generated by the ECMs presented in the Equation 6.2.

$$\Delta LRP_t = \delta_1 + \delta_2 \Delta LRS_t + \delta_3 u_{t-1} + \varepsilon_t \quad \text{.....(6.2)}$$

The results from Equation 6.2 are used to test for the short-run and long-run relationships between these two variables. This means that the error-correction terms are included in order to initiate additional channels through which equilibrium could be restored in the event of shocks to the stock market index (Abdalla & Murinde, 1997:32). The results from the ECMs identify the short-run dynamics and the long-run relationship between the stock market index and foreign exchange market in South Africa. If there is disequilibrium in the short run, the ECM assists in estimating the speed of adjustment to equilibrium. It is, however, important to conduct basic diagnostic tests on the ECM, before interpreting its results, in order to avoid basic econometric problems (Abdalla & Murinde, 1997:32).

6.4.1 Diagnostic Test

Basic diagnostic tests assist in identifying the efficiency, unbiasness, the normality in residuals and the consistency of the specification. This analysis involves the residual diagnostic tests for serial correlation and heteroscedasticity and the test for structural break in the parameters. As mentioned in Section 5.4 of Chapter Five, diagnostic tests

conducted include the LM test for serial correlation, the White heteroscedasticity test and the Chow structural break test.

Testing for Structural Break

The Chow structural break test sample was divided into two equal sub-samples. The first sub-sample runs from January 1978 to May 1993, while the second runs from June 1993 to December 2008. Results of the Chow structural break test obtained using Eviews software are presented in Table 9. This table reports test statistics of 2.26 that is lower than the critical values from F-distribution ($F_{3, 365}$), which is 2.6 at the 5% significance level. This is confirmed by P-values which are greater than 5%. The null hypothesis of no breaks is therefore accepted. This means that there is significant evidence that there are no structural breaks in the parameters at the 5% and 1% levels of significance.

Table 9: Chow Structural Break Test

Chow Breakpoint Test: 1993M05			
Null Hypothesis: No breaks at specified breakpoints			
Equation Sample: 1978M02 2008M12			
F-statistic	2.551747	Prob. F(3,365)	0.0554
Log likelihood ratio	7.700607	Prob. Chi-Square(3)	0.0526
Wald Statistic	7.655242	Prob. Chi-Square(3)	0.0537

Source: Estimated by the current author with the use of Eviews

Testing for Serial Correlation

The LM test for serial correlation is conducted on ECM with 12 lags. Results are presented in Table 10. This table reports F-statistic of 1.07, which is lower than the critical value ($F_{12, 356}$) of 1.75 at the 5% level of significance. Probabilities are greater

than 5% for all lags. Thus the null hypothesis of no serial correlation is accepted. It is concluded that there is no serial correlation at the 5% and 1% levels of significance.

Table 10: ECM Residual Serial Correlation LM Tests

F-statistic	1.070434	Prob. F(12,356)		0.3841
Obs*R-squared	12.92025	Prob. Chi-Square(12)		0.3749
Dependent Variable: RESID				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000184	0.003338	-0.055139	0.9561
D(LRST)	0.029588	0.092360	0.320356	0.7489
UT(-1)	-0.003690	0.010025	-0.368104	0.7130
RESID(-1)	0.097189	0.054225	1.792330	0.0739
RESID(-2)	0.009478	0.054310	0.174513	0.8616
RESID(-3)	0.077628	0.054422	1.426406	0.1546
RESID(-4)	0.001640	0.054940	0.029843	0.9762
RESID(-5)	-0.089867	0.054915	-1.636476	0.1026
RESID(-6)	-0.003259	0.055209	-0.059037	0.9530
RESID(-7)	-0.055494	0.055123	-1.006736	0.3147
RESID(-8)	0.054532	0.054825	0.994656	0.3206
RESID(-9)	0.047572	0.054932	0.866009	0.3871
RESID(-10)	-0.046601	0.055060	-0.846375	0.3979
RESID(-11)	0.053859	0.055296	0.974018	0.3307
RESID(-12)	0.014573	0.055452	0.262812	0.7928

Source: Estimated by the current author with the use of Eviews

Testing for Heteroscedasticity

Results of the heteroscedasticity test, shown in Table 11, indicate that the joint test has a low F-test of 0.7002 and a P-value of 0.6236. These results suggest that the null hypothesis of homoscedastic errors is accepted; meaning that there is significant evidence of no heteroscedasticity and there is no problem of misspecification in ECM. The next step is to discuss the short- and the long-run relationships based on the results from ECM.

Table 11: ECM White Heteroscedasticity Test

F-statistic	0.700189	Prob. F(5,365)	0.6236
Obs*R-squared	3.524688	Prob. Chi-Square(5)	0.6197
Scaled explained SS	9.037787	Prob. Chi-Square(5)	0.1076

Dependent Variable: RESID^2
Method: Least Squares
Sample: 1978M02 2008M12
Included observations: 371

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003943	0.000613	6.431446	0.0000
D(LRST)	0.025778	0.015290	1.685953	0.0927
(D(LRST))^2	-0.058634	0.143670	-0.408116	0.6834
(D(LRST))*UT(-1)	0.018630	0.027666	0.673381	0.5011
UT(-1)	-0.001011	0.001175	-0.860078	0.3903
UT(-1)^2	-0.000533	0.002204	-0.241860	0.8090

Source: Estimated by the current author with the use of Eviews

6.4.2 The Long-run and Short-run Relationships

These results assist in identifying both long-run and short-run relationships between the exchange rate and stock market index, together with the speed of adjustment to the equilibrium. ECM results are reported in Table 12.

Table 12: ECM Results

Dependent Variable: D(LRPT)
Included observations: 371 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.012640	0.003334	3.790954	0.0002
D(LRST)	-0.076605	0.090491	-0.846548	0.3978
UT(-1)	-0.017443	0.007970	-2.188664	0.0292

Source: Estimated by the current author with the use of Eviews

Table 12 shows that the error correction term's coefficient is negative and statistically significant at the 5% level of significance. The magnitude of the error correction term shows the change in real stock market index per month that is attributed to the disequilibrium between the actual and equilibrium levels. Error correction coefficient shows that 0.017443 of the discrepancy between the real stock market index and the real exchange rate is eliminated each month. This implies that an adjustment speed of 1.744% takes place in one month. The short-run relationship between the real stock market index and the real exchange rate is negative, but it is insignificant, even at the 10% level of significance. Thus short-run changes in real exchange have no effect on short-run changes in the real stock market index. Since the coefficient of ΔLRSt is insignificant and the coefficient of u_{t-1} is negative and significant, the ΔLRPt is above the equilibrium value (Gujarati 2003: 825). Thus, the real stock market index will fall during each month to restore equilibrium.

In the long run, the depreciation of the real exchange rate is associated with the increase in the JSE ALSI. These confirm the results from graphical analysis and descriptive statistics discussed in Chapter Four. These findings are similar to the results found by Chow, Lee & Solt (1997:122) and Jefferis & Okeahalam (2000). Muller & Verschoor (2006) obtained similar results and stated that the absence of the short-run effect may suggest that the short-term currency exposure appears to be reasonably well hedged.

6.5 Granger-Causality Test

Having established the response of the JSE to the exchange rate regimes and identified the short-run dynamic and the long-run equilibrium between the stock market index and the exchange rate, it is important to determine the direction of causality between the two variables. The causality is conducted based on standard Granger-Causality tests estimated by Eviews, with two lags. Results in Table 13 show that the null hypothesises for no causality in both variables are rejected. Thus there is bidirectional causality between the stock market index and the real exchange rate in South Africa.

Table 13: Pair-wise Granger-Causality

Sample: 1978M01 2008M12

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D(LRST) does not Granger Cause D(LRPT)	369	3.34396	0.0364
D(LRPT) does not Granger Cause D(LRST)		3.37581	0.0353

Source: Estimated by the current author with the use of Eviews

Ramasamy & Yeung (2005) state that the results of the Granger-Causality test can change with the period of study. They emphasised the use of dynamic error correction as a way of supplementing the standard Granger-Causality test. Thus an ECM Granger-Causality test is conducted to confirm results from pair-wise Granger-Causality tests. Equations 6.3 and 6.4 (with error corrections) are estimated and an F-test is conducted.

$$\Delta LRP_t = \phi + \sum_{i-1}^{m} \beta_i \Delta LRP_{t-i} \sum \alpha_i \Delta LRS_{t-i} + u_{t-1} + \varepsilon_t \quad \text{..... (6.3)}$$

$$\Delta LRS_t = \lambda + \sum_{j-1}^{m} \lambda_j \Delta LRP_{t-i} + \sum_{j}^{n} \delta_j \Delta LRS_{t-j} + u_{t-1} + \varepsilon_t \quad \text{..... (6.4)}$$

Although the information criteria were considered in the selection of the lag length in each equation, conflicting results were obtained. The R^2 criterion was used to determine the optimum number of lags. For Equation 6.3, one lag was selected for LRP_t and three lags for LRS_t whereas for equation 6.4 one lag was selected for each variable. The time lag identified seems to be short but "...in a financial world where information flow is near perfect, the time lag would be fairly short as investors react almost immediately to fluctuations in the market" (Ramasamy & Yeung, 2005:165). In their studies, Ajayi *et al.* (1998) and Granger *et al.* (2000) suggested a one-day lag for daily observation. One or two lags for monthly observations seem to be fine, because the causality between the two variables can be observed from a shorter period

perspective in order to obtain reasonable implications (Ramasamy & Yeung, 2005:165).

Equation 6.3 is used to test for the causality relationship from LRS_t to LRP_t. Firstly, $\Delta LRPt$ is regressed on lagged ΔLRP_t without ΔLRS_t lagged variables. Since this is a restricted equation, the restricted residuals sum of squares (RRSS) of 1.493475 is obtained. Secondly, the unrestricted regression is estimated with lagged values of both LRP_t and LRS_t. The unrestricted residual sum of squares (URSS) of 1.455416 is obtained. The test hypotheses for Equation 6.3 are:

H_0: $\sum \alpha_i = 0$ (LRSt does not cause LRPt)

H_1: $\sum \alpha_i \neq 0$ (LRSt does cause LRPt)

The following F-test is used to test these hypotheses:

$$F = \frac{(RRSS - URSS)/m}{URSS/(n-k)} \quad \text{..... (6.5)}$$

Where n is the number of observations, m is equal to the number of lagged ΔLRP_t terms and k is the number of parameters estimated in unrestricted regression. This test follows an F distribution with m and n-k (Fm, n-k).

$$F = \frac{(1.493475 - 1.455416)/1}{1.455416/(368-5)} = 9.6232$$

The critical F-value (for 1 and 363df) at the 5% level of significance is 3.84. The estimated F-value (9.6232) is greater than the critical F-value. Therefore, the H_0 is rejected. This means that there is a causal relationship from the real exchange rate to the real stock market index.

The test hypotheses for Equation 6.4 are:

H_0: $\sum \lambda_i = 0$ (LRP_t does not cause LRS_t)

H_1: $\sum \lambda_i \neq 0$ (LRP_t does cause LRS_t)

Similar steps are followed in estimating both restricted and unrestricted equations.

RRSS=0.457953, URSS=0.452875, m= 1, k= 3 and n= 370

$$F = \frac{(0.457953 - 0.452875)/1}{0.452875/(370-3)} = 4.1151$$

The critical F-value ($F_{1, 367}$) at the 5% significance level is 3.84 and it is lower than the estimated F -value of 4. 1151. Thus H_0 is re jected. T his suggests that, a t the 5% significance level, the real stock market index Granger-Cause the real exchange rate.

Granger-Causality tests on ECM reveal that there is a bilateral causality between the real exchange rate and the South African stock market index. These results are similar to the re sults obtained with the use of a pair-wise Gr anger-Causality test. The se findings agree with other results from emerging markets. For example, Granger *et al.* (2000) found feedback causality for Malaysia, Singapore, Thailand and Taiwan. Using monthly obse rvations, Ramasamy & Yeung (200 5) a lso found bidi rectional causality between thes e two va riables in Hong Kon g. Using a similar model, Abdalla & Murinde (1997) found instantaneous bidirectional causality between the Korean stock market index a nd the real exchange r ate. Using c ommon c ycle exhibit analysis, Morley & P entecost (2000) concluded that ther e wa s a c o-dependence b etween the stock market index and the e xchange rates in some Eur opean countries. Aydemir & Demirhan (2009) found bidi rectional causality between the exchange rate and the stock market indices in Tur key. However, bidi rectional causality suggests that bot h

variables affect each other in the short run, but the ECM showed that the real stock index is not affected by the real exchange rate in the short run.

6.6 Concluding Remarks

This chapter presented the empirical results and conducted the analysis with the aim of identifying the causal linkage and the long-run relationship between the real stock market index and the real exchange rate. It started with the assessment of the time series characteristics of data using both formal and informal assessments. It was indicated that both variables are non-stationary in their levels, but they were stationary at the first difference. This means that both variables are integrated of order 1, I(1). After identifying the order of integration of the variables, the Engle-Granger cointegration test was conducted. The cointegration test illustrated that there is cointegration between the real stock market index and the real exchange rate. Since variables were found to be cointegrated, the ECM was used to estimate the long- and short-run relationships between the variables.

Diagnostics tests were conducted to ensure that the ECM is free from econometrics problems. The model passed all tests. Results of ECM indicated that there is a negative long-run relationship between the real exchange rate and the real stock market index. In the short run, the relationship is insignificant. The causality test on ECM and the pair-wise Granger-Causality test have been used to establish the causal linkage between the real exchange rate and the stock market index. These two tests produced similar results, namely that there is a bidirectional causal relationship between the real exchange rate and the real stock market index in South Africa. This suggests that there is a short-run effect between the two variables, but the ECM shows that there is no short-run effect from the real exchange rate to the stock market. These conflicting results may be attributed to the high level of capital control and different rate regimes adopted during the period of this study.

Chapter Six concluded that there is a negative long-run relationship between the real exchange rate and the real stock market index in South Africa. The short-run results established that changes in the real exchange rate have no impact on the real stock market index, but Granger-Causality tests suggest that changes in the stock market index may affect the real exchange rate in the short run. These findings may explain the reason why some of the previous attempts (by the SARB) of using exchange controls to stabilise the currency failed (Boshoff, 2008:117), because the stock market index and other variables, which are not directly controlled by the SARB, may have a significant effect on the exchange rate.

CHAPTER SEVEN: CONCLUSIONS

The present research examined the interaction between the real exchange rate and stock market index in South Africa, with the aim of identifying the effect of exchange rate shocks on the Johannesburg Stock Exchange (JSE). The main objectives of this study were to: (i) establish the direction of causality between the stock market index and the real exchange rate; (ii) identify the long-run and short-run relationships between the South African stock market index and the real exchange rate; and (iii) determine the response of the South African stock market to different exchange rate regimes from 1978 to 2008. To achieve these objectives the study used different econometrics models; these included the Granger-Causality test, the Engle-Granger cointegration test and the ECM and descriptive statistics analysis and graphical representation. Variables used in this study include real values of the JSE ALSI and the real exchange rate series from January 1978 to December 2008.

In providing the background to the study, a framework on concepts of the exchange rate market has been established. Financial theories relating exchange rate markets to stock markets have been discussed in detail. Underlying financial theories linking the stock market to the exchange rate explained how the dividend growth model reflects the impact of changes in the exchange rate on the share prices of companies. Financial theories provided an understanding of exchange rate determinants, currency risks and the management of such currency risks. It was pointed out that factors that influence exchange rates are trade-related and financial factors. These financial theories tend to hold in the advanced capital and currency markets that are large and liquid, while small and less liquid markets tend to show a deviation from these theories. The study explained the difference between the use of bilateral and multilateral exchange rates in estimating the exchange rate and revealed a distinction between nominal and real exchange rates.

The review of the empirical literature separately covered international literature, South African literature and literature from other African countries. The separation permits this study to compare the empirical evidence from the advanced economies to those of emerging economies. Comparison of the findings from these two economies showed that the relationship between the exchange rate market and the stock market tends to be affected by the nature of the economy. It was shown that, in most well-integrated and advanced economies, the direction of causality moves from stock market to the exchange rate, while in emerging economies such direction of causality is not constant. The inconsistency of causal relations may imply that there is a low level of integration between stock and currency markets in some of the emerging economies. The empirical literature revealed that the relationship between the stock market index and the exchange rate may change with the time horizon.

It was shown that South Africa had adopted different exchange rate regimes since the 1970s and these regimes had different impacts on the JSE. Analysis revealed that the link between the JSE ALSI and the real exchange rate tends to increase during a period of free floating exchange rate regime. The period of a managed floating exchange rate was characterised by mixed responses of the JSE to the exchange rate regimes. The relationship between the JSE and the real exchange rate tended to be strong in a dual exchange rate system, but it became weak during the period of a unified exchange rate. The reason for these different responses was the political insecurity and financial sanctions imposed on South Africa during the period of the unified exchange rate. Generally, a negative relationship between the JSE ALSI and the real exchange rate was found. This implies that the depreciation of the Rand is associated with a decrease in the JSE ALSI. Pearson correction coefficients revealed that the correlation between the variables was not significant in both fixed and flexible exchange rate systems. This correlation appears to be significant in early sub-periods of both fixed and flexible exchange rate regimes.

In order to identify the long-run and short-run relationships between the real exchange rate and the stock market index, this study used the Engle-Granger cointegration

approach and error correction mechanism. It used both formal and informal tests to assess the time series characteristics of the data. Both variables were found to be non-stationary in their levels, but they were stationary at the first difference. This means that they are integrated of order 1, I(1). The Engle-Granger cointegration test concluded that there is a cointegrating relationship between the real stock market index and the real exchange rate. The presence of a cointegrating relationship led to the use of the ECM to estimate the long-run and short-run relationships between the variables.

A negative long-run relationship between the real exchange rate and the stock market index was found. About 1.744% of deviation from equilibrium is eliminated every month. The short-run results established that short-run changes in the real exchange rate have no impact on the short-run changes in the real stock market index. The ECM causality test and the pair-wise Granger-Causality test were used to establish the causal linkage between the real exchange rate and the real stock market index. These two tests showed that there is bidirectional causal linkage between the stock market index and the real exchange rate in South Africa.

The results of this study may assist investors and policy-makers in different ways. The existence of the long-run relationship between the exchange rate and the stock market index indicates that changes in one variable have an influence on the long-run movement of the other variable. The intervention of government in the currency market is not recommended. For example, the 2010 consideration (by the South African government) of weakening the Rand may not be encouraged, as this might have a negative impact on the JSE in the long run. The shor-run behaviour of the JSE showed that the JSE tends to have the characteristics of an advanced market rather than that of an emerging market. Investors and traders should, therefore, consider the JSE as an emerging market that tends to be advanced.

Limitations of this study may emerge from unresolved issues identified from the review of the empirical literature. It has been reasoned that the frequency of collecting data may have an impact on the relationship between the exchange rate and the stock market index. Some researchers recommend the use of low frequency data (quarterly or annual observations), while others argued that the use of high frequency data (daily or weekly observations) may produce more accurate results. Monthly observations used in the present study may be considered as long periods by those who strongly favour shorter periods. On the other hand, these observations may be considered as short periods by those who strongly prefer longer periods. However, *monthly* observations have a practical implication to policy-makers, financial institutions, multinational corporations and individual investors who may be interested in the relationship between the stock market and the real exchange rate.

The causal linkage between the two variables changes from one economy to another and it may be influenced by the length of the period selected and/or the frequency of data collection, econometric models used and economic policies of countries (Ramasamy & Yeung, 2005:116 and Aydemir & Demirhan, 2009). This study may have been exposed to changes in economic policies, because the period selected involved the adoption of different exchange rate regimes and the JSE may respond to each of these exchange rate regimes differently. Linking the interpretation of error correction dynamics to the Granger-Causality test was another way of attending to the flaws of the Granger-Causality test, as suggested by Ramasamy & Yeung (2005). Since South Africa has been exposed to different exchange rate regimes, the way forward may be to separately identify the causal relationship between the real stock market index and the real exchange rate in each exchange rate regime.

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APPENDICES

APPENDIX A: Summary of empirical studies

Author(s)	Economy	Topic	Model	Results
Adler & Dumas (1984)	Advanced (Australia, France & USA)	Relationship between the exchange rate resources and industrials sectors	Multi-regression analysis	Significant
Jorion (1991)	Advanced (USA)	Pricing of the exchange rate risk in the stock market	APT	Insignificant
Bahmani-Oskooee & Sohrabian (1992)	Advanced (USA)	Causality between the exchange rate and the stock market	Granger-Causality test	Mixed
Reese (1993)	South Africa	An empirical study of the effect of pre-specified risk factors on share prices of the JSE	APT	Significant
Khoo (1994	Advanced (Australia)	Foreign exchange exposure of mining companies in Australia	Multivariate regression	Insignificant
Baillie & Bollerslev (1994)	Advanced (Europe, Japan & USA)	Cointegration, fraction cointegration and exchange rate dynamics	Johansen cointegration approach	Significant
Abdalla & Murinde (1997)	Emerging (Asia)	Exchange rate and stock market interactions	Granger with BVAR and ECM	Mixed
Ajayi *et al.* (1998)	Emerging and advanced	Causality between the exchange rate and the stock market	Granger-Causality test	Mixed in emerging
Jefferis & Okeahalam (2000)	Emerging: Southern Africa	Economic fundamentals and the stock market	VECM	Significant
Granger *et al.* (2000)	Emerging (Asia)	Causality between the exchange rate and the stock market	Granger-Causality test	Mixed
Di Lorio & Faff (2001)	Advanced Economy	An analysis of asymmetry in foreign currency exposure of the Australian equities market	Augmented market approach (similar to the APT)	Significant
Freeman (2001)	Advanced (USA)	Granger-Causality and the Time Series Analysis of Political Relationship	Granger-causality test with VAR	Significant

Benson & Faff (2003)	Advanced (Australia)	Exchange rate sensitivity of Australian international equity funds	APT	Mixed
Bah & Amusa (2003)	South Africa	Real exchange rate volatility and foreign trade	ARCH and GARCH models	Significant
Takaendesa, (2006)	South Africa	Determinant of the real exchange rate	VECM	Significant
Takaendesa *et al.* (2006)	South Africa	Real exchange rate volatility and its effect on trade flows: new evidence from South Africa	EGARCH & VECM	Significant
Muller & Verschoor (2006)	Mixed (Europe, Asia & USA)	European foreign exchange risk exposure	Engle-Granger cointegration	Significant
Barr, *et al.* (2007)	South Africa	Effect of exchange rate on TOP40	GARCH adjusted regression analysis	Significant
Adjasi *et al.*(2008)	Emerging (Africa)	Effect of exchange rate volatility on the Ghana stock exchange	EGARCH	Significant
Sundaram (2009)	Emerging (India)	Relationship between exchange rate and FII	Granger-causality & EG Cointegration tests	Insignificant

APPENDIX B: Sample Correlograms

1: Sample Correlogram of LRSt

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.992	0.992	369.14	0.000
.|*******	.|. |	2	0.984	-0.040	733.02	0.000
.|*******	.|. |	3	0.975	-0.008	1091.6	0.000
.|*******	.|. |	4	0.967	0.042	1445.5	0.000
.|*******	.|. |	5	0.960	0.027	1795.0	0.000
.|*******	.|. |	6	0.953	0.009	2140.4	0.000
.|*******	.|. |	7	0.946	-0.022	2481.4	0.000
.|*******	.|. |	8	0.939	0.009	2818.3	0.000
.|*******	.|. |	9	0.931	-0.037	3150.5	0.000
.|*******	.|. |	10	0.923	-0.031	3477.8	0.000
.|*******	.|. |	11	0.915	-0.002	3800.2	0.000
.|*******	.|. |	12	0.907	0.009	4118.0	0.000
.|******|	.|. |	13	0.899	-0.018	4431.0	0.000
.|******|	.|. |	14	0.891	-0.008	4739.3	0.000
.|******|	.|. |	15	0.882	-0.012	5042.7	0.000
.|******|	.|. |	16	0.874	-0.019	5341.2	0.000
.|******|	.|. |	17	0.866	0.005	5634.8	0.000
.|******|	.|. |	18	0.857	0.007	5923.7	0.000
.|******|	.|. |	19	0.849	-0.009	6207.9	0.000
.|******|	.|. |	20	0.841	0.004	6487.5	0.000
.|******|	.|. |	21	0.833	-0.010	6762.5	0.000
.|******|	.|. |	22	0.824	-0.030	7032.6	0.000
.|******|	.|. |	23	0.816	0.001	7297.9	0.000
.|******|	.|. |	24	0.807	-0.009	7558.4	0.000
.|******|	.|. |	25	0.799	0.003	7814.1	0.000
.|******|	.|. |	26	0.790	-0.029	8065.0	0.000
.|******|	.|. |	27	0.781	-0.019	8310.8	0.000
.|******|	.|. |	28	0.772	0.012	8551.9	0.000
.|******|	.|. |	29	0.763	0.004	8788.3	0.000
.|***** |	.|. |	30	0.754	-0.027	9019.8	0.000
.|***** |	.|. |	31	0.746	-0.001	9246.6	0.000
.|***** |	.|. |	32	0.737	0.033	9469.0	0.000
.|***** |	.|. |	33	0.729	-0.013	9686.9	0.000
.|***** |	.|. |	34	0.720	-0.022	9900.4	0.000
.|***** |	.|. |	35	0.711	0.004	10109.	0.000
.|***** |	.|. |	36	0.703	-0.002	10314.	0.000

Source: estimated by the author with the use of Eviews

2: Sample Correlogram of LRPt

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.989	0.989	367.09	0.000
.|*******	.|. |	2	0.978	-0.032	726.90	0.000
.|*******	.|. |	3	0.967	-0.009	1079.4	0.000
.|*******	.|. |	4	0.955	-0.037	1424.3	0.000
.|*******	.|. |	5	0.943	-0.013	1761.3	0.000
.|*******	.|. |	6	0.931	0.018	2091.0	0.000
.|*******	.|. |	7	0.920	-0.011	2413.4	0.000
.|*******	.|. |	8	0.908	-0.004	2728.5	0.000
.|******|	.|. |	9	0.896	-0.001	3036.4	0.000
.|******|	.|. |	10	0.885	0.003	3337.5	0.000
.|******|	.|. |	11	0.873	-0.030	3631.4	0.000
.|******|	.|. |	12	0.862	0.023	3918.5	0.000
.|******|	.|. |	13	0.851	-0.008	4198.9	0.000
.|******|	.|. |	14	0.840	-0.000	4472.8	0.000
.|******|	.|. |	15	0.828	-0.016	4740.1	0.000
.|******|	.|. |	16	0.817	-0.004	5001.0	0.000
.|******|	.|. |	17	0.806	0.012	5255.6	0.000
.|******|	.|. |	18	0.795	-0.017	5503.9	0.000
.|******|	.|. |	19	0.784	-0.005	5746.0	0.000
.|******|	.|. |	20	0.773	0.019	5982.3	0.000
.|******|	.|. |	21	0.763	0.026	6213.2	0.000
.|***** |	.|. |	22	0.754	0.003	6439.0	0.000
.|***** |	.|. |	23	0.744	0.015	6660.0	0.000
.|***** |	.|. |	24	0.736	0.022	6876.5	0.000
.|***** |	.|. |	25	0.727	-0.005	7088.7	0.000
.|***** |	.|. |	26	0.719	0.018	7296.8	0.000
.|***** |	.|. |	27	0.711	-0.030	7500.7	0.000
.|***** |	.|. |	28	0.703	-0.002	7700.3	0.000
.|***** |	.|. |	29	0.695	0.013	7896.0	0.000
.|***** |	.|. |	30	0.687	0.023	8088.0	0.000
.|***** |	.|. |	31	0.680	0.009	8276.6	0.000
.|***** |	.|. |	32	0.673	0.017	8462.0	0.000
.|***** |	.|. |	33	0.666	-0.009	8644.3	0.000
.|***** |	.|. |	34	0.660	-0.002	8823.4	0.000
.|***** |	.|. |	35	0.653	-0.019	8999.3	0.000
.|***** |	.|. |	36	0.645	-0.038	9171.6	0.000

Source: estimated by the author with the use of Eviews

APPENDIX C: Data

	Nominal values		Monthly changes in CPI		Real values		Natural logarithm	
Month	NPt	NPt	SA	USA	RPt	RSt	LRPt	LRSt
1978-01	243.90	0.87	1.27%	0.60%	240.85	0.86	5.484	-0.146
1978-02	226.30	0.87	0.00%	0.50%	226.30	0.87	5.422	-0.135
1978-03	226.60	0.87	0.00%	0.60%	226.60	0.87	5.423	-0.134
1978-04	232.30	0.87	2.50%	0.80%	226.63	0.86	5.423	-0.156
1978-05	244.30	0.87	0.00%	0.90%	244.30	0.88	5.498	-0.131
1978-06	260.60	0.87	0.00%	0.80%	260.60	0.88	5.563	-0.132
1978-07	285.40	0.87	3.66%	0.80%	275.33	0.85	5.618	-0.168
1978-08	284.70	0.87	1.18%	0.60%	281.39	0.86	5.640	-0.145
1978-09	295.30	0.87	1.16%	0.90%	291.91	0.87	5.676	-0.142
1978-10	312.30	0.87	1.15%	0.90%	308.75	0.87	5.733	-0.142
1978-11	284.80	0.87	0.00%	0.60%	284.80	0.87	5.652	-0.134
1978-12	310.70	0.87	0.00%	0.60%	310.70	0.87	5.739	-0.134
1979- 01	337.60	0.87	1.14%	0.90%	333.81	0.87	5.811	-0.142
1979- 02	352.00	0.86	1.12%	1.00%	348.09	0.85	5.852	-0.157
1979- 03	345.70	0.84	1.11%	1.00%	341.90	0.84	5.835	-0.171
1979- 04	341.60	0.85	1.10%	1.00%	337.89	0.85	5.823	-0.167
1979- 05	366.10	0.85	0.00%	1.10%	366.10	0.85	5.903	-0.157
1979- 06	354.40	0.84	1.09%	1.10%	350.59	0.84	5.860	-0.169
1979- 07	360.20	0.84	4.30%	1.10%	345.35	0.82	5.845	-0.201
1979- 08	398.30	0.84	1.03%	1.00%	394.24	0.84	5.977	-0.178
1979- 09	449.90	0.83	1.02%	0.90%	445.36	0.83	6.099	-0.185
1979- 10	465.30	0.83	1.01%	1.10%	460.65	0.83	6.133	-0.188
1979- 11	495.50	0.83	0.00%	1.10%	495.50	0.84	6.206	-0.176
1979- 12	565.00	0.83	1.00%	1.20%	559.41	0.83	6.327	-0.187
1980- 01	559.40	0.82	0.00%	1.40%	559.40	0.83	6.327	-0.183
1980- 02	616.90	0.81	0.99%	1.30%	610.85	0.82	6.415	-0.203
1980- 03	565.50	0.81	0.98%	1.40%	560.01	0.81	6.328	-0.208
1980- 04	562.90	0.81	0.97%	1.00%	557.49	0.81	6.323	-0.215
1980- 05	620.60	0.79	0.96%	1.00%	614.69	0.79	6.421	-0.235
1980- 06	677.20	0.78	1.90%	1.00%	664.54	0.77	6.499	-0.264
1980- 07	730.60	0.76	1.87%	0.10%	717.19	0.75	6.575	-0.286
1980- 08	776.30	0.76	0.00%	0.70%	776.30	0.77	6.655	-0.267
1980- 09	827.90	0.75	2.75%	0.80%	805.72	0.74	6.692	-0.303
1980- 10	848.10	0.75	1.79%	1.00%	833.22	0.74	6.725	-0.295
1980- 11	791.70	0.75	0.88%	1.10%	784.82	0.75	6.665	-0.285
1980- 12	746.80	0.75	1.74%	0.90%	734.03	0.75	6.599	-0.293
1981- 01	630.10	0.75	0.00%	0.90%	630.10	0.76	6.446	-0.281
1981- 02	638.10	0.77	1.71%	0.90%	627.38	0.77	6.442	-0.266
1981- 03	679.70	0.79	0.00%	0.70%	679.70	0.80	6.522	-0.228
1981- 04	688.00	0.81	0.84%	0.60%	682.27	0.81	6.525	-0.213

1981- 05	687.50	0.84	0.83%	0.70%	681.82	0.84	6.525	-0.179
1981- 06	602.60	0.87	0.83%	0.90%	597.66	0.87	6.393	-0.141
1981- 07	644.80	0.92	2.46%	1.10%	629.32	0.91	6.445	-0.096
1981- 08	702.60	0.95	1.60%	0.80%	691.54	0.94	6.539	-0.059
1981- 09	730.40	0.95	2.36%	1.00%	713.54	0.93	6.570	-0.068
1981- 10	726.80	0.95	0.77%	0.30%	721.25	0.95	6.581	-0.051
1981- 11	700.10	0.96	0.76%	0.40%	694.80	0.96	6.544	-0.042
1981- 12	692.20	0.97	0.76%	0.30%	687.00	0.96	6.532	-0.036
1982- 01	671.10	0.97	0.00%	0.30%	671.10	0.97	6.509	-0.031
1982- 02	613.00	0.98	1.50%	0.30%	603.92	0.97	6.403	-0.032
1982- 03	526.70	1.02	2.22%	0.00%	515.25	1.00	6.245	-0.003
1982- 04	540.80	1.05	1.45%	0.30%	533.07	1.04	6.279	0.040
1982- 05	492.70	1.06	0.71%	0.90%	489.21	1.06	6.193	0.062
1982- 06	452.10	1.11	0.71%	1.10%	448.92	1.12	6.107	0.113
1982- 07	528.30	1.15	0.70%	0.50%	524.61	1.15	6.263	0.136
1982- 08	612.00	1.15	1.40%	0.20%	603.56	1.14	6.403	0.129
1982- 09	688.10	1.15	1.38%	0.00%	678.74	1.13	6.520	0.127
1982- 10	708.90	1.16	1.36%	0.40%	699.38	1.15	6.550	0.138
1982- 11	781.80	1.14	1.34%	-0.10%	771.45	1.12	6.648	0.117
1982- 12	879.20	1.09	0.00%	-0.30%	879.20	1.08	6.779	0.079
1983-01	963.10	1.07	0.66%	0.20%	956.76	1.06	6.864	0.059
1983-02	824.70	1.10	1.97%	0.10%	808.74	1.08	6.695	0.074
1983-03	839.50	1.09	0.65%	0.10%	834.12	1.08	6.726	0.080
1983-04	918.80	1.09	1.28%	0.70%	907.17	1.09	6.810	0.083
1983-05	950.60	1.08	0.63%	0.40%	944.62	1.08	6.851	0.077
1983-06	955.90	1.09	0.00%	0.20%	955.90	1.09	6.863	0.089
1983-07	956.50	1.10	1.26%	0.40%	944.62	1.09	6.851	0.083
1983-08	981.40	1.12	1.24%	0.30%	969.36	1.10	6.877	0.100
1983-09	916.40	1.11	0.61%	0.30%	910.81	1.11	6.814	0.104
1983-10	813.90	1.12	0.61%	0.40%	808.97	1.12	6.696	0.114
1983-11	901.50	1.19	1.21%	0.30%	890.70	1.18	6.792	0.163
1983-12	950.00	1.22	0.00%	0.30%	950.00	1.22	6.856	0.199
1984-01	936.80	1.25	0.60%	0.70%	931.22	1.26	6.836	0.228
1984-02	1034.40	1.23	1.19%	0.50%	1022.23	1.22	6.930	0.200
1984-03	1053.60	1.22	1.18%	0.30%	1041.35	1.21	6.948	0.187
1984-04	1062.60	1.25	1.74%	0.40%	1044.38	1.23	6.951	0.207
1984-05	1046.20	1.28	1.14%	0.20%	1034.38	1.26	6.942	0.235
1984-06	1029.90	1.31	0.56%	0.20%	1024.11	1.30	6.932	0.263
1984-07	925.20	1.49	1.12%	0.40%	914.92	1.48	6.819	0.393
1984-08	982.50	1.57	1.11%	0.30%	971.70	1.56	6.879	0.445
1984-09	966.70	1.66	0.55%	0.30%	961.42	1.66	6.868	0.504
1984-10	994.10	1.76	1.64%	0.40%	978.07	1.74	6.886	0.555
1984-11	1041.10	1.80	1.08%	0.20%	1030.02	1.79	6.937	0.581
1984-12	984.20	1.89	0.53%	0.20%	978.99	1.88	6.887	0.633
1985-01	949.80	2.16	1.06%	0.20%	939.85	2.14	6.846	0.763
1985-02	939.90	1.96	3.66%	0.60%	906.67	1.90	6.810	0.644

1985-03	1034.40	1.99	0.00%	0.50%	1034.40	2.00	6.942	0.694
1985-04	1088.30	1.93	2.53%	0.20%	1061.49	1.89	6.967	0.636
1985-05	1133.90	1.99	0.99%	0.20%	1122.84	1.97	7.024	0.681
1985-06	1128.20	1.98	1.46%	0.30%	1111.93	1.95	7.014	0.669
1985-07	1072.90	1.95	0.48%	0.20%	1067.77	1.95	6.973	0.666
1985-08	1162.10	2.35	0.96%	0.20%	1151.08	2.33	7.048	0.846
1985-09	1189.90	2.49	1.42%	0.20%	1173.22	2.46	7.068	0.899
1985-10	1218.50	2.59	1.40%	0.40%	1201.65	2.57	7.091	0.944
1985-11	1303.40	2.66	1.38%	0.50%	1285.63	2.63	7.159	0.968
1985-12	1322.80	2.68	1.82%	0.50%	1299.18	2.64	7.169	0.973
1986-01	1400.70	2.35	3.13%	0.40%	1358.25	2.29	7.214	0.829
1986-02	1395.30	2.09	0.87%	-0.20%	1383.32	2.06	7.232	0.725
1986-03	1464.50	2.02	1.29%	-0.50%	1445.88	1.99	7.276	0.688
1986-04	1358.60	2.05	1.69%	-0.40%	1335.96	2.01	7.197	0.696
1986-05	1420.80	2.19	0.00%	0.30%	1420.80	2.20	7.259	0.786
1986-06	1500.30	2.53	1.25%	0.40%	1481.78	2.51	7.301	0.919
1986-07	1613.10	2.55	2.06%	0.10%	1580.58	2.50	7.366	0.916
1986-08	1862.00	2.59	1.21%	0.10%	1839.75	2.57	7.517	0.942
1986-09	1920.00	2.31	1.99%	0.40%	1882.50	2.28	7.540	0.823
1986-10	1898.00	2.25	1.17%	0.20%	1876.02	2.22	7.537	0.799
1986-11	1999.00	2.25	1.16%	0.20%	1976.11	2.23	7.589	0.802
1986-12	1972.70	2.22	1.15%	0.40%	1950.37	2.20	7.576	0.791
1987-01	2130.00	2.09	1.13%	0.50%	2106.16	2.07	7.653	0.730
1987-02	2096.00	2.08	1.49%	0.40%	2065.18	2.06	7.633	0.722
1987-03	2163.00	2.07	1.47%	0.40%	2131.65	2.05	7.665	0.717
1987-04	2350.60	2.01	1.45%	0.40%	2317.02	1.99	7.748	0.690
1987-05	2332.00	2.00	0.71%	0.30%	2315.46	1.99	7.747	0.691
1987-06	2331.00	2.02	1.06%	0.40%	2306.46	2.01	7.743	0.698
1987-07	2631.00	2.06	0.70%	0.30%	2612.67	2.05	7.868	0.718
1987-08	2704.00	2.08	1.74%	0.40%	2657.70	2.05	7.885	0.717
1987-09	2677.00	2.04	1.37%	0.30%	2640.82	2.02	7.879	0.704
1987-10	2041.00	2.05	1.01%	0.30%	2020.52	2.03	7.611	0.710
1987-11	1926.00	1.97	1.00%	0.30%	1906.87	1.96	7.553	0.673
1987-12	1820.00	1.95	0.66%	0.20%	1808.03	1.94	7.500	0.663
1988-01	1568.00	1.97	0.66%	0.30%	1557.75	1.97	7.351	0.676
1988-02	1518.00	2.05	0.65%	0.20%	1508.14	2.04	7.319	0.712
1988-03	1680.00	2.13	1.62%	0.30%	1653.16	2.10	7.410	0.744
1988-04	1605.00	2.14	0.96%	0.60%	1589.76	2.14	7.371	0.759
1988-05	1676.00	2.21	0.95%	0.30%	1660.24	2.19	7.415	0.786
1988-06	1755.00	2.27	0.31%	0.40%	1749.52	2.27	7.467	0.820
1988-07	1812.00	2.39	1.25%	0.40%	1789.63	2.37	7.490	0.863
1988-08	1724.00	2.45	1.23%	0.40%	1702.98	2.43	7.440	0.889
1988-09	1849.00	2.45	1.22%	0.40%	1826.72	2.43	7.510	0.889
1988-10	1968.00	2.47	1.20%	0.30%	1944.57	2.44	7.573	0.894
1988-11	1961.00	2.39	0.89%	0.30%	1943.65	2.38	7.572	0.867
1988-12	1990.00	2.34	0.88%	0.30%	1972.54	2.33	7.587	0.846

1989-01	2158.00	2.39	1.46%	0.40%	2126.90	2.36	7.662	0.859
1989-02	2285.00	2.46	0.86%	0.30%	2265.41	2.45	7.726	0.894
1989-03	2533.00	2.54	1.71%	0.50%	2490.31	2.51	7.820	0.919
1989-04	2594.00	2.55	1.40%	0.70%	2558.07	2.53	7.847	0.927
1989-05	2398.00	2.68	1.39%	0.50%	2365.24	2.65	7.769	0.976
1989-06	2628.00	2.78	1.09%	0.30%	2599.59	2.76	7.863	1.016
1989-07	2675.00	2.70	1.08%	0.30%	2646.39	2.67	7.881	0.984
1989-08	2784.00	2.72	1.34%	0.00%	2747.27	2.68	7.918	0.987
1989-09	2766.00	2.79	0.79%	0.20%	2744.28	2.77	7.917	1.019
1989-10	2696.00	2.67	0.79%	0.50%	2674.99	2.66	7.892	0.980
1989-11	2859.00	2.63	1.30%	0.40%	2822.35	2.60	7.945	0.957
1989-12	2976.00	2.57	1.28%	0.30%	2938.33	2.55	7.986	0.936
1990-01	3194.00	2.56	1.27%	1.00%	3154.08	2.55	8.056	0.936
1990-02	3084.00	2.55	0.75%	0.40%	3061.04	2.54	8.027	0.931
1990-03	3257.00	2.61	1.49%	0.50%	3209.22	2.59	8.074	0.951
1990-04	3032.00	2.66	0.98%	0.20%	3002.63	2.63	8.007	0.969
1990-05	3188.00	2.64	0.97%	0.20%	3157.42	2.62	8.058	0.965
1990-06	3077.00	2.66	0.72%	0.60%	3055.02	2.66	8.025	0.979
1990-07	3152.00	2.63	0.71%	0.50%	3129.65	2.62	8.049	0.965
1990-08	2993.00	2.57	1.65%	0.80%	2944.28	2.55	7.988	0.937
1990-09	2744.00	2.57	1.63%	0.70%	2700.05	2.55	7.901	0.935
1990-10	2667.00	2.54	0.69%	0.70%	2648.82	2.54	7.882	0.934
1990-11	2601.00	2.52	2.05%	0.20%	2548.86	2.48	7.843	0.908
1990-12	2720.00	2.53	0.67%	0.40%	2701.95	2.52	7.902	0.926
1991-01	2555.50	2.56	1.11%	0.40%	2527.54	2.54	7.835	0.934
1991-02	2803.40	2.54	1.31%	0.10%	2767.07	2.51	7.926	0.920
1991-03	2877.10	2.65	0.86%	0.00%	2852.46	2.62	7.956	0.965
1991-04	3033.10	2.74	1.50%	0.20%	2988.31	2.71	8.002	0.995
1991-05	3114.80	2.79	1.48%	0.40%	3069.47	2.77	8.029	1.017
1991-06	3305.90	2.86	0.62%	0.30%	3285.41	2.86	8.097	1.049
1991-07	3491.40	2.88	1.24%	0.10%	3448.65	2.85	8.146	1.047
1991-08	3348.60	2.87	1.43%	0.30%	3301.44	2.84	8.102	1.044
1991-09	3297.00	2.84	1.41%	0.30%	3251.21	2.81	8.087	1.031
1991-10	3525.50	2.83	1.79%	0.10%	3463.65	2.78	8.150	1.024
1991-11	3541.80	2.79	0.97%	0.40%	3507.61	2.78	8.163	1.022
1991-12	3440.30	2.77	1.54%	0.30%	3387.98	2.73	8.128	1.006
1992-01	3604.70	2.78	0.95%	0.10%	3570.76	2.76	8.181	1.014
1992-02	3597.10	2.82	0.94%	0.20%	3563.54	2.79	8.179	1.028
1992-03	3549.60	2.88	0.75%	0.40%	3523.31	2.87	8.167	1.055
1992-04	3453.80	2.88	1.30%	0.20%	3409.60	2.85	8.134	1.046
1992-05	3731.70	2.85	0.73%	0.20%	3704.61	2.83	8.217	1.041
1992-06	3655.10	2.81	1.09%	0.30%	3615.73	2.79	8.193	1.025
1992-07	3431.00	2.75	0.90%	0.30%	3400.48	2.74	8.132	1.007
1992-08	3150.10	2.76	1.07%	0.20%	3116.82	2.74	8.045	1.008
1992-09	3211.40	2.80	0.70%	0.20%	3188.94	2.78	8.067	1.024
1992-10	3016.70	2.88	0.17%	0.40%	3011.44	2.89	8.010	1.061

1992-11	3192.20	3.00	0.52%	0.30%	3175.57	2.99	8.063	1.095
1992-12	3258.80	3.01	0.00%	0.10%	3258.80	3.02	8.089	1.104
1993-01	3432.81	3.07	1.04%	0.40%	3397.42	3.05	8.131	1.115
1993-02	3418.14	3.12	0.34%	0.20%	3406.44	3.12	8.133	1.136
1993-03	3559.97	3.18	1.37%	0.10%	3511.87	3.14	8.164	1.144
1993-04	3732.99	3.17	2.70%	0.30%	3634.75	3.09	8.198	1.129
1993-05	3992.49	3.18	0.33%	0.30%	3979.40	3.17	8.289	1.155
1993-06	4077.93	3.23	0.49%	0.10%	4057.98	3.22	8.308	1.170
1993-07	4176.67	3.35	0.82%	0.10%	4142.87	3.33	8.329	1.202
1993-08	4034.32	3.36	0.49%	0.20%	4014.84	3.36	8.298	1.210
1993-09	3770.39	3.41	0.32%	0.10%	3758.29	3.40	8.232	1.224
1993-10	3916.23	3.40	0.80%	0.40%	3885.05	3.38	8.265	1.218
1993-11	4164.27	3.36	0.16%	0.30%	4157.65	3.37	8.333	1.215
1993-12	4892.99	3.38	0.32%	0.20%	4877.48	3.37	8.492	1.215
1994-01	4754.56	3.41	1.43%	0.00%	4687.70	3.36	8.453	1.212
1994-02	4845.74	3.45	0.31%	0.30%	4830.65	3.45	8.483	1.238
1994-03	4939.09	3.45	0.62%	0.30%	4908.51	3.44	8.499	1.236
1994-04	5359.13	3.59	0.62%	0.10%	5326.15	3.57	8.580	1.272
1994-05	5396.10	3.63	0.62%	0.20%	5363.10	3.61	8.587	1.284
1994-06	5404.12	3.63	0.61%	0.30%	5371.27	3.61	8.589	1.285
1994-07	5651.89	3.67	1.52%	0.30%	5567.28	3.62	8.625	1.288
1994-08	5833.76	3.60	1.50%	0.40%	5747.71	3.56	8.657	1.270
1994-09	5676.11	3.56	1.18%	0.20%	5609.92	3.52	8.632	1.259
1994-10	5723.97	3.54	0.44%	0.10%	5699.05	3.53	8.648	1.260
1994-11	5756.26	3.52	0.29%	0.30%	5739.60	3.52	8.655	1.260
1994-12	5866.91	3.56	0.29%	0.20%	5849.98	3.56	8.674	1.269
1995-01	5054.12	3.54	1.30%	0.30%	4989.33	3.50	8.515	1.254
1995-02	5147.08	3.56	0.43%	0.30%	5125.18	3.55	8.542	1.268
1995-03	5281.87	3.60	1.13%	0.20%	5222.60	3.57	8.561	1.271
1995-04	5479.06	3.60	1.26%	0.40%	5410.77	3.57	8.596	1.273
1995-05	5471.41	3.66	0.42%	0.20%	5448.77	3.65	8.603	1.295
1995-06	5420.67	3.66	-0.14%	0.20%	5428.15	3.67	8.599	1.301
1995-07	5438.46	3.64	0.55%	0.10%	5408.57	3.62	8.596	1.288
1995-08	5543.38	3.64	0.27%	0.20%	5528.19	3.64	8.618	1.291
1995-09	5657.25	3.66	0.14%	0.10%	5649.51	3.66	8.639	1.298
1995-10	5789.14	3.65	0.27%	0.30%	5773.34	3.65	8.661	1.295
1995-11	5972.10	3.65	0.27%	0.10%	5955.85	3.64	8.692	1.292
1995-12	6228.42	3.67	0.82%	0.10%	6177.99	3.64	8.729	1.292
1996-01	6870.89	3.64	1.21%	0.50%	6788.44	3.62	8.823	1.285
1996-02	6705.10	3.74	0.13%	0.20%	6696.17	3.74	8.809	1.320
1996-03	6748.60	3.93	0.80%	0.30%	6695.11	3.91	8.809	1.363
1996-04	6976.29	4.21	0.66%	0.40%	6930.51	4.19	8.844	1.434
1996-05	6818.49	4.37	0.66%	0.20%	6774.04	4.35	8.821	1.471
1996-06	6878.72	4.35	0.91%	0.20%	6816.51	4.32	8.827	1.463
1996-07	6606.90	4.39	0.78%	0.20%	6556.08	4.36	8.788	1.473
1996-08	6689.36	4.52	0.51%	0.10%	6655.23	4.51	8.803	1.505

1996-09	6878.04	4.50	1.02%	0.30%	6808.56	4.46	8.826	1.496
1996-10	6975.26	4.57	0.88%	0.30%	6914.15	4.55	8.841	1.514
1996-11	6713.93	4.66	0.38%	0.30%	6688.82	4.65	8.808	1.537
1996-12	6657.53	4.68	1.00%	0.30%	6591.77	4.65	8.794	1.537
1997-01	6676.06	4.64	1.23%	0.20%	6594.64	4.60	8.794	1.525
1997-02	7145.17	4.45	0.61%	0.20%	7101.87	4.43	8.868	1.489
1997-03	7094.76	4.44	0.61%	0.10%	7052.02	4.41	8.861	1.485
1997-04	7130.51	4.44	0.84%	0.10%	7070.88	4.41	8.864	1.484
1997-05	7021.73	4.47	0.36%	0.00%	6996.65	4.45	8.853	1.493
1997-06	7419.98	4.50	0.24%	0.20%	7402.35	4.50	8.910	1.503
1997-07	7484.52	4.56	1.07%	0.10%	7405.36	4.51	8.910	1.507
1997-08	7306.98	4.68	0.12%	0.20%	7298.40	4.69	8.895	1.545
1997-09	7123.38	4.69	0.47%	0.20%	7090.10	4.68	8.866	1.543
1997-10	6589.12	4.71	0.47%	0.20%	6558.47	4.70	8.789	1.547
1997-11	6326.26	4.84	-0.35%	0.10%	6348.41	4.86	8.756	1.581
1997-12	6202.31	4.87	0.35%	0.10%	6180.67	4.86	8.729	1.581
1998-01	6550.28	4.94	0.81%	0.10%	6497.40	4.90	8.779	1.590
1998-02	7095.70	4.94	0.23%	0.00%	7079.37	4.92	8.865	1.594
1998-03	7578.88	4.97	0.69%	0.00%	7526.91	4.94	8.926	1.597
1998-04	8235.50	5.05	0.46%	0.10%	8198.02	5.03	9.012	1.615
1998-05	7629.56	5.09	0.46%	0.20%	7595.00	5.08	8.935	1.625
1998-06	6771.61	5.36	0.34%	0.10%	6748.68	5.35	8.817	1.677
1998-07	7020.43	6.24	2.37%	0.20%	6857.88	6.11	8.833	1.809
1998-08	4923.35	6.32	1.10%	0.10%	4869.66	6.26	8.491	1.834
1998-09	5098.60	6.12	1.74%	0.10%	5011.16	6.02	8.519	1.796
1998-10	5828.32	5.81	0.43%	0.20%	5803.44	5.79	8.666	1.757
1998-11	5620.86	5.66	0.00%	0.10%	5620.86	5.67	8.634	1.734
1998-12	5430.48	5.89	0.00%	0.20%	5430.48	5.90	8.600	1.775
1999-01	5799.13	5.98	0.75%	0.20%	5756.12	5.95	8.658	1.784
1999-02	5914.63	6.11	0.00%	0.00%	5914.63	6.11	8.685	1.810
1999-03	6382.54	6.21	0.00%	0.10%	6382.54	6.22	8.761	1.827
1999-04	7064.69	6.11	0.21%	0.70%	7049.76	6.14	8.861	1.815
1999-05	6488.78	6.18	-0.11%	0.10%	6495.65	6.19	8.779	1.824
1999-06	7047.96	6.09	0.53%	0.00%	7010.87	6.06	8.855	1.801
1999-07	7095.91	6.11	0.11%	0.40%	7088.45	6.12	8.866	1.812
1999-08	6938.11	6.13	-0.42%	0.20%	6967.42	6.17	8.849	1.819
1999-09	6855.50	6.06	0.42%	0.40%	6826.66	6.06	8.829	1.801
1999-10	7153.13	6.09	0.21%	0.20%	7138.12	6.09	8.873	1.807
1999-11	7552.63	6.14	0.21%	0.20%	7536.81	6.14	8.928	1.814
1999-12	8542.79	6.15	0.31%	0.20%	8516.03	6.14	9.050	1.815
2000-01	8475.34	6.12	1.15%	0.30%	8379.12	6.07	9.033	1.803
2000-02	7992.36	6.32	-0.31%	0.40%	8017.18	6.36	8.989	1.850
2000-03	7957.23	6.46	1.04%	0.60%	7875.70	6.43	8.972	1.861
2000-04	7445.10	6.61	1.33%	-0.10%	7347.24	6.52	8.902	1.875
2000-05	7364.17	7.02	0.40%	0.20%	7334.51	7.01	8.900	1.947
2000-06	7709.67	6.93	0.60%	0.60%	7663.36	6.93	8.944	1.935

2000-07	7737.57	6.88	0.90%	0.30%	7668.48	6.84	8.945	1.922
2000-08	8489.06	6.95	0.40%	0.00%	8455.50	6.92	9.043	1.935
2000-09	8274.23	7.16	0.49%	0.50%	8233.55	7.16	9.016	1.969
2000-10	8111.47	7.47	0.29%	0.20%	8087.61	7.46	8.998	2.010
2000-11	7804.54	7.67	0.20%	0.20%	7789.27	7.67	8.961	2.038
2000-12	8326.19	7.64	0.29%	0.20%	8301.82	7.63	9.024	2.032
2001- 01	9071.84	7.77	1.27%	0.60%	8958.22	7.72	9.100	2.044
2001- 02	9013.42	7.82	0.29%	0.20%	8987.44	7.81	9.104	2.055
2001- 03	8158.86	7.88	0.67%	0.10%	8104.36	7.84	9.000	2.059
2001- 04	8977.67	8.08	0.48%	0.20%	8935.04	8.06	9.098	2.087
2001- 05	9389.64	7.97	0.38%	0.50%	9354.10	7.98	9.144	2.077
2001- 06	9222.63	8.06	0.47%	0.20%	9179.21	8.03	9.125	2.084
2001- 07	8559.04	8.20	-0.09%	-0.20%	8567.10	8.19	9.056	2.103
2001- 08	8985.70	8.31	-0.19%	0.00%	9002.67	8.32	9.105	2.119
2001- 09	8126.11	8.63	0.28%	0.40%	8103.16	8.64	9.000	2.156
2001- 10	8543.23	9.27	-0.09%	-0.30%	8551.28	9.25	9.054	2.225
2001- 11	9440.75	9.72	0.47%	-0.10%	9396.47	9.66	9.148	2.268
2001- 12	10361.28	11.55	0.56%	-0.10%	10303.28	11.47	9.240	2.440
2002- 01	10313.87	11.61	1.68%	0.20%	10143.55	11.44	9.225	2.437
2002- 02	10814.63	11.48	1.10%	0.20%	10696.86	11.38	9.278	2.432
2002- 03	10948.68	11.49	1.00%	0.30%	10840.47	11.41	9.291	2.435
2002- 04	11029.71	11.08	1.62%	0.40%	10854.17	10.95	9.292	2.393
2002- 05	11219.26	10.15	0.71%	0.10%	11140.46	10.09	9.318	2.311
2002- 06	10657.73	10.14	0.70%	0.10%	10583.40	10.08	9.267	2.310
2002- 07	9239.02	10.11	1.39%	0.20%	9111.91	9.99	9.117	2.302
2002- 08	9677.26	10.59	0.52%	0.30%	9627.59	10.57	9.172	2.358
2002- 09	9465.33	10.60	1.03%	0.20%	9369.15	10.52	9.145	2.353
2002- 10	9376.23	10.33	1.52%	0.20%	9235.47	10.19	9.131	2.322
2002- 11	9563.74	9.65	0.33%	0.20%	9531.94	9.64	9.162	2.266
2002- 12	9277.22	8.96	0.17%	0.20%	9261.82	8.96	9.134	2.193
2003- 01	8798.35	8.68	0.91%	0.40%	8718.76	8.64	9.073	2.156
2003- 02	8402.09	8.30	-0.08%	0.50%	8409.01	8.35	9.037	2.122
2003- 03	7679.88	8.04	0.99%	0.20%	7604.77	7.98	8.937	2.077
2003- 04	7510.40	7.71	0.33%	-0.40%	7486.00	7.65	8.921	2.035
2003- 05	8564.33	7.67	-0.24%	-0.20%	8585.25	7.67	9.058	2.037
2003- 06	8352.20	7.90	-0.33%	0.10%	8379.49	7.94	9.034	2.071
2003- 07	8809.63	7.55	0.00%	0.30%	8809.63	7.57	9.084	2.024
2003- 08	9226.20	7.39	0.41%	0.40%	9188.66	7.39	9.126	2.000
2003- 09	8925.69	7.32	-0.33%	0.30%	8954.84	7.37	9.100	1.997
2003- 10	9765.30	6.96	-0.65%	-0.10%	9829.49	7.00	9.193	1.946
2003- 11	9729.60	6.73	-0.74%	0.10%	9802.09	6.79	9.190	1.915
2003- 12	10387.22	6.52	0.08%	0.30%	10378.63	6.53	9.248	1.876
2004- 01	10849.25	6.92	0.74%	0.40%	10769.08	6.89	9.284	1.931
2004- 02	10895.86	6.77	0.49%	0.20%	10842.45	6.75	9.291	1.909
2004- 03	10692.56	6.63	0.65%	0.20%	10623.13	6.60	9.271	1.888
2004- 04	10385.80	6.55	0.16%	0.20%	10368.97	6.56	9.247	1.880

2004- 05	10413.81	6.78	0.08%	0.40%	10405.38	6.80	9.250	1.917
2004- 06	10108.61	6.44	0.32%	0.40%	10075.98	6.44	9.218	1.863
2004- 07	10305.89	6.13	0.32%	0.10%	10272.73	6.12	9.237	1.811
2004- 08	11160.44	6.46	-0.16%	0.10%	11178.43	6.47	9.322	1.868
2004- 09	11761.00	6.55	0.00%	0.30%	11761.00	6.57	9.373	1.882
2004- 10	11655.31	6.39	0.40%	0.50%	11608.54	6.39	9.359	1.855
2004- 11	12490.79	6.06	0.56%	0.50%	12421.01	6.05	9.427	1.800
2004- 12	12656.86	5.73	-0.24%	0.00%	12687.24	5.75	9.448	1.749
2005- 01	12798.55	5.97	0.32%	-0.10%	12757.73	5.94	9.454	1.783
2005- 02	13476.59	6.02	0.16%	0.40%	13455.13	6.03	9.507	1.797
2005- 03	13298.58	6.01	1.04%	0.40%	13162.35	5.97	9.485	1.787
2005- 04	12555.96	6.15	0.55%	0.30%	12487.08	6.14	9.432	1.814
2005- 05	13787.02	6.33	0.00%	-0.10%	13787.02	6.33	9.531	1.845
2005- 06	14154.73	6.75	-0.16%	0.10%	14176.95	6.77	9.559	1.912
2005- 07	15143.64	6.70	0.86%	0.60%	15014.01	6.69	9.617	1.900
2005- 08	15414.01	6.47	0.39%	0.60%	15354.27	6.48	9.639	1.869
2005- 09	16875.65	6.36	0.39%	1.40%	16810.49	6.42	9.730	1.860
2005- 10	16433.10	6.58	0.08%	0.20%	16420.42	6.58	9.706	1.885
2005- 11	16774.54	6.66	-0.08%	-0.50%	16787.49	6.63	9.728	1.891
2005- 12	18096.54	6.36	0.00%	0.00%	18096.54	6.36	9.803	1.850
2006- 01	19745.16	6.09	0.69%	0.60%	19608.88	6.08	9.884	1.806
2006- 02	19085.35	6.12	0.08%	0.10%	19070.73	6.12	9.856	1.811
2006- 03	20351.74	6.25	0.54%	0.20%	20243.16	6.23	9.916	1.830
2006- 04	21135.51	6.07	0.46%	0.50%	21039.29	6.07	9.954	1.804
2006- 05	20565.46	6.32	0.61%	0.40%	20441.38	6.31	9.925	1.842
2006- 06	21237.87	6.95	0.75%	0.20%	21078.90	6.92	9.956	1.934
2006- 07	20885.57	7.08	0.97%	0.50%	20684.30	7.05	9.937	1.953
2006- 08	21953.80	6.96	0.82%	0.40%	21776.23	6.93	9.989	1.935
2006- 09	22374.58	7.41	0.22%	-0.40%	22325.33	7.36	10.013	1.997
2006- 10	23338.16	7.65	0.22%	-0.50%	23286.90	7.59	10.056	2.027
2006- 11	23949.95	7.26	-0.07%	0.10%	23967.50	7.27	10.084	1.984
2006- 12	24915.20	7.04	0.37%	0.50%	24824.27	7.05	10.120	1.953
2007- 01	25447.73	7.18	0.88%	0.10%	25226.77	7.13	10.136	1.964
2007- 02	25795.99	7.17	-0.14%	0.40%	25833.38	7.21	10.159	1.975
2007- 03	27267.24	7.35	0.87%	0.50%	27032.18	7.32	10.205	1.991
2007- 04	28170.60	7.12	1.29%	0.30%	27810.98	7.05	10.233	1.953
2007- 05	28627.79	7.02	0.57%	0.40%	28466.28	7.01	10.256	1.947
2007- 06	28337.20	7.17	0.85%	0.20%	28099.41	7.13	10.244	1.964
2007- 07	28561.81	6.97	0.98%	0.20%	28284.89	6.92	10.250	1.934
2007- 08	28660.35	7.23	0.48%	0.00%	28522.09	7.20	10.258	1.974
2007- 09	29959.19	7.13	0.69%	0.40%	29754.13	7.11	10.301	1.961
2007- 10	31334.24	6.77	0.89%	0.30%	31057.89	6.73	10.344	1.907
2007- 11	30307.80	6.70	0.41%	0.80%	30184.93	6.73	10.315	1.906
2007- 12	28957.97	6.83	0.88%	0.30%	28705.82	6.79	10.265	1.915
2008- 01	27317.14	6.99	1.14%	0.40%	27009.60	6.94	10.204	1.937
2008- 02	30673.74	7.64	0.33%	0.20%	30572.51	7.63	10.328	2.032

2008- 03	29587.51	7.98	1.58%	0.40%	29126.11	7.89	10.279	2.065
2008- 04	30743.49	7.79	1.75%	0.30%	30213.43	7.68	10.316	2.039
2008- 05	31841.27	7.62	1.15%	0.60%	31479.44	7.58	10.357	2.026
2008- 06	30413.43	7.92	1.26%	0.90%	30034.21	7.89	10.310	2.066
2008- 07	27719.67	7.64	2.12%	0.80%	27144.29	7.54	10.209	2.020
2008- 08	27702.06	7.66	0.73%	-0.10%	27500.59	7.59	10.222	2.027
2008- 09	23835.97	8.05	0.18%	0.00%	23792.71	8.03	10.077	2.084
2008- 10	20991.72	9.67	0.00%	-0.90%	20991.72	9.58	9.952	2.260
2008- 11	21209.49	10.12	0.06%	-1.80%	21196.67	9.93	9.962	2.296
2008- 12	21509.20	9.95	-1.15%	-0.70%	21759.15	9.99	9.988	2.302