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FINAL DRAFT

HEDGING CURRENCY FUTURES BASIS RISK: A SADC UNIFORM CURRENCY PERSPECTIVE

FelipéYvann Jordaan

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Supervisor:
Prof. J.H.van Rooyen

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**DEPARTMENT OF BUSINESS MANAGEMENT
UNIVERSITY OF STELLENBOSCH**

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LIST OF ABBREVIATIONS, ACRONYMS AND KEY PHRASES

Gordon (1975); Ethier & Svensson (1986:21); Frankel (1999); Duma (2001) and Masson & Patillo (2005), provided the following abbreviations and acronyms when considering the monetary geography of Africa:

Managed Float (also referred to as a Dirty Peg) - Intervention is allowed by the Central Bank to protect certain parity.

Adjustment Peg- This is similar to the managed float exchange rate regime, but countries were allowed to realign their own exchange rates. An example is the Bretton Woods exchange rate regime.

Asymmetric Shocks - Economic shifts resulting in different effects in various monetary unions.

Base Currency -Example: 1 USD = 7 ZAR. In this example, the USD is referred to as the base currency and the ZAR is referred to as the local currency units.

ECU - The European Currency Unit was used as an “artificial” currency basket comprising of the European member states currencies. The ECU was the predecessor of the Euro and was replaced by the Euro on a one-to-one basis.

Basket Peg - This is the method used to compute the ECU which is discussed later and is also the method followed in this study. It comprises local currency units which are weighted in terms of one base currency and is mostly used when the trade is geographically diversified. An example is shown in Table 2.2.

Basis Spread - Basis spread refers to the difference between the futures price and the spot price before the futures contract maturity. On maturity the basis is zero as the spot and futures price converge on maturity.

Basis Spread Risk - Basis risk or basis spread risk can be defined as a numerical value attributable to the variability of the basis spread.

CFA franc – The name of the exchange rates used in Central and Western Africa.

CAEMC - It can be defined as the “Central African Economic and Monetary Community”. The countries comprising of this monetary community are: Cameroon, the Central African Republic, Chad, the republic of the Congo, Equatorial Guinea, and lastly, Gabon.

WAEMU – West African Economic and Monetary Union. The countries comprising of this monetary community are: Benin, Burkina Faso, Côte d’Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo.

CFA Franc Zone - This is an optimal currency area in which the CFA franc is pegged to the Euro. The African member countries included are classified according to two groups: (1) CAEMC and (2) WAEMU.

Crawling Peg- This regime is used by countries which have a high inflation environment. This strategy involves the moving of a country from its own inflation cycle by setting the crawl at a lower rate than the rate forecasted for inflation.

Currency Union¹- One common currency circulates among members. The first example is the Eastern Caribbean with the Dollar as the common currency. The second example is the EMU with members using both fiscal as well as monetary policies to monitor the policy of the exchange rate.

¹ Masson (2007:1) states that two forms are present, the first is a multilateral monetary union and the second is dollarization.

Currency Board- Three factors cause a currency board to differ from a currency union. These factors are:

- (a) The exchange rate is set by the law and not based on a policy.
- (b) Reserve requirements must be set in terms of foreign reserves.
- (c) There is a mechanism for the “balance of payments” which is self-regulating.

CMA - A common monetary union which comprises South Africa, Lesotho, Namibia and Swaziland.

Convergence Criteria - Criteria those African countries must adhere to in order to form part of the new central SADC currency. The euro uses a stability and growth pact discussed in chapter three. The assumption underlying this paper is that the SADC REC will reach monetary union status in the future.

Common Currency -A central currency used by a specific domain or region, e.g.the USD or euro. This study will use the SADCdollar as the common currency for the SADC region.

Direct Quote - Quoting foreign currency in terms of the domestic currency. This domestic currency is also referred to as the base currency. Two quoting conventions are used. The first is “/” which is pronounced as foreign currency per domestic currency units. The second convention is “:” which is pronounced as foreign currency relative to domestic currency (foreign:domestic).

Economic Renaissance -Theupliftment of poor African countries due to a means of centralization.

WAMZ – It is the West African Monetary Zone. The countries comprising of this monetary zone are: Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone.

ECOWAS - Economic community of West African states comprising WAEMU and WAMZ countries.

EMU - European Economic and Monetary Union.

EMS -The European monetary system which ultimately lead to the EMU creation.

EU - European Union, which comprised the grouping of fifteen countries of which twelve formed part of the EMU.

Factor Mobility -The ability to move the factors of production to a different location.

FDI - Foreign direct investment. There are two forms of foreign direct investment, namely inflow and outflow. This study only considers the implications from the inflow of foreign direct investment into a region.

Free Float - No intervention is allowed by the Central Bank, thus only the forces of Supply and Demand are allowed to help an exchange rate. An example is the exchange rate of the USA.

Managed Float (also referred to as a Dirty Peg) - Intervention is allowed by the Central Bank to protect certain parity.

NEPAD - NEPAD can be defined as the “new partnership for African development.”

OCA - An optimal currency area. An OCA answers the question of whether countries should adopt a fixed or floating exchange rate regime.

REC - Regional economic community. The five REC’s proposed for Africa are: AMU, COMESA, ECCAS, ECOWAS and SADC. This study focuses on the SADC REC.

SADC - Southern African Development Community comprising: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

“SADCdollar” Exchange Rate -The nominal exchange rate denomination used in the SADC region.

SADCIX -A foreign SADC exchange rate index, including the ZAR index.

SADCEX - A foreign SADC exchange rate index, excluding the ZAR index.

Symmetric Shocks -Economic shifts resulting in similar effects in various monetary unions.

“Truly Fixed” Exchange Rate - This involves a fixing principle, where countries use a stronger currency as their exchange rate. Examples include: Central and Western African currency is fixed via the French Franc.

Target Zone or Band - Intervention occurs when an exchange rate reaches margins which were pre-announced. The ERM in the EMS, which was used from 1979 until 1999, is an example.

Wage/Price Rigidities -The ability of wage rates or prices to adjust as a result of excess supply or demand in the market.

ZARN-The South African rand nominal exchange rate

ZARC-The South African rand with the nominal exchange rate calculated on a ZAR currency index.

AN EXAMPLE OF HOW THE SADC DOLLAR FICTITIOUS CURRENCY NOTES MAY LOOK




SADC BILLS

Source: Pazar (2008); Silver (2008); Shahmiri (2010)

ABSTRACT

The implementation or adaption of a common currency by a group of countries has managerial as well as risk management implications for these emerging market multinational corporations (EMNC'S). This study sets out to examine these business management implications and the computation of a fictitious uniform currency for the SADC region, "SADC dollar" to derive its optimality should the SADC dollar replace the ZAR. This optimality was determined by comparing the basis risk of currency futures hedge positions using both the USD/ZAR on a ZAR currency index and USD/SADC dollar on a SADC currency index as the respective underlings.

Findings indicated that the basis risk and currency risk declined over a time-series analysis which implied better business management decisions, increased profit margins, larger firm value and more effective hedged positions for the companies in South Africa that may adopt this new currency.

ABSTRAK

Die implementering of aanvaarding van 'n gemene wisselkoers deur 'n groep SADC-lande het besigheidsbestuurs- asook risikobestuursimplikasies vir SADC multinasionale maatskapye. Hierdie studie beoog om die implikasies vir bestuur te ondersoek en te bepaal hoe die skep van 'n fiktiewe eenvormige wisselkoers vir die SADC-streek gebruik kan word, dit is, sou die "SADC dollar" die ZAR vervang. Hierdie optimaliteit is bereken deur die basisrisiko van verskeie valutatermykontrakte te vergelyk. Die instrument onderliggend aan die verskillende valutatermykontrakte was die VSA dollar/rand wisselkoers wat op 'n Suid-Afrikaanse rand (ZAR) valutaindeks gemodelleer is en die VSA dollar/SADC dollar wat op 'n SADC valutaindeks gemodelleer was.

Die resultate van die navorsing op die gekose tydreeks dui daarop dat die basisrisiko sowel as die valutarisiko moontlik sal afneem. Die implikasie hiervan is moontlik beter besigheidsbestuursbesluite, toename in winsmarges, toenames in maatskapywaardes en meer effektiewe skansposisies vir maatskapye in Suid-Afrika wat hierdie eenvormige wisselkoers sou implementeer.

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“That man is a success who has lived well, laughed often and loved much; who has gained the respect of intelligent men and the love of children; who has filled his niche and accomplished his task; who leaves the world better than he found it, whether by an improved poppy, a perfect poem or a rescued soul; who never lacked appreciation of earth’s beauty or failed to express it; who looked for the best in others and gave the best he had.”

~ Robert Louis Stevenson ~

“Whom do I call educated? First, those who manage well the circumstances they encounter day by day... Next, those who are decent and honourable in the intercourse with all men, bearing easily and good naturedly what is offensive in others and being as agreeable and reasonable to the associates as is humanly possible to be...”

~ Socrates ~

“Never give in, never give in, never, never, never- in nothing, great or small, large or petty - never give in except to convictions of honour and good sense.”

~ Winston Churchill ~

“You may never know what results come from your action. But if you do nothing, there will be no results.”

~ Mahatma Gandhi ~

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SUMMARY OF NOTATIONS:

Table 0.1: Summaries of Notations

Notation	Description	Name
ZAR	South African Rand currency unit	rand
€	European currency unit	euro
\$	American currency unit	US dollar
SADCD	South African development community currency unit	SADC dollar

Source: Own Compilation

SUMMARY OF EQUATIONS:

The following equations were used to calculate the ultimate basis risk spread of two different currency futures hedge positions:

The model to determine currency futures prices using discrete interest with the South African Rand as the underlying is the following:

$$f_0(T) = [S_{i,j,t} \times (1 + r_d)^T] / (1 + r_f)^T \quad (1)$$

$f_0(T)$ = At time 0 (now or today), it is the price of the futures contract that expires at time T (Quarterly).

$S_{i,j,t}$ = Spot price of the USD currency i relative to the Rand foreign currency j at time t today (direct quote).

r_d = Simple domestic risk free interest rate.

r_f = Simple foreign risk free interest rate

T = The time to expiration of a futures contract. A day count convention will be used (365 days per year).

Currency futures price using continuously compounded interest with the South African Rand as the underlying:

$$f_0(\mathbf{T}) = (S_{i,j,t} e^{-r^{fc}t}) e^{r^d t} \quad (2)$$

$e^{-r^{fc}t}$	=	Foreign country risk-free rate discount factor
$e^{r^d t}$	=	Compounding factor for domestic (base) country risk-free rate
r^{fc}	=	$\ln(1 + r^f)$
r^d	=	$\ln(1 + r_d)$

Currency futures using discrete interest with the uniform SADC dollar currency as the underlying:

$$f_0(\mathbf{T}) = [\text{SADC dollar } a_{j,t} \times (1 + r_d)^T] / (1 + r_f)^T \quad (3)$$

Computation of the SADC dollar:

$$\text{SADC – dollar exchange rate } a_{j,t} = \exp\left(\sum_{i=1}^{12} w_{it} \log_{10} S_{i,j,t}\right)^2 \quad (4)$$

Where:

w_{it}	=	A weighting measure, namely GDP or size of the financial market for country i at time t .
$S_{i,j,t}$	=	Exchange rate in base year, 2005 in terms of the USD.
$\log_{10} S_{i,j,t}$	=	Log-normal distribution of the SADC countries exchange rates with a common base of 10.
Exp	=	Exponential function of $(\sum_{i=1}^{10} w_{it} \log_{10} S_{i,j,t})$.
SADC dollar $a_{j,t}$	=	SADC dollar spot exchange rate of SADC region (a) relative to currency j at time t .

² This is the formula used in the Euro region and is provided by Antweiler (2001) with a few amendments. Note that the scaling factor has been excluded as the value of the SADC-dollar currency unit is not known. The SADC monetary union, comprises a different number of African countries.

Currency futures using continuously compounded interest (SADC dollar as the foreign currency underlying):

$$f_0(T) = (\text{SADC dollar } a, j, t e^{-r \text{ffct}}) e^{rct} \quad (5)$$

Basis spread for financial futures with the South African rand as the foreign currency underlying:

$$\text{Basis spread} = f_0(T) - S_{i, j}(T-t) \quad (6)^3$$

Where:

$f_0(T)$ = Futures price calculated in equation (1)

$S_{i, j, T-t}$ = Will be represented by the USD/ZAR moving to contract maturity.

Basis spread for financial futures with the SADC dollar as the foreign currency underlying:

$$\text{Basis spread} = f_0(T) - \text{SADC dollar } a, j(T-t) \quad (7)$$

Where:

$f_0(T)$ = Calculated in equation (3)

SADC dollar $a, j, T-t$ = Calculated in equation (1). Calculated as the spot exchange rates move to contract maturity at time T-t.

Basis risk (Variance of the Basis) with the South African rand as the foreign currency underlying:

$$\text{Basis risk: } \sigma_{F(h)-S}^2 = \sigma_{F(h)}^2 + \sigma_S^2 - 2 \rho \sigma_{F(h)} \sigma_S \quad (8)$$

³ Note the inverse as opposed to commodity futures, with $S_0(T) - f_0(T)$, as stated by Hull (2006).

Where:

$\sigma^2_{F(h)-S}$	=	Basis risk is the variance of the basis.
$\sigma^2_{F(h)}$	=	Variance of the futures price multiplied by a hedge ratio.
S	=	Spot price of the ZAR foreign currency.
F	=	Futures price
σ^2_S	=	Variance of the spot price.
h	=	Hedge ratio ⁴ , assumed to be 1 in this study
ρ	=	Correlation of the spot and futures prices
σ_F	=	Futures price volatility
σ_S	=	ZAR Spot price volatility
$2 \rho \sigma_{F(h)} \sigma_S$	=	Twice the correlation of the futures and spot volatility

Basis risk (Variance of the Basis) with the SADC dollar as the foreign currency underlying:

$$\text{Basis Risk: } \sigma^2_{F(h)-\text{SADC dollar}} = \sigma^2_{F(h)} + \sigma^2_{\text{SADC dollar}} - 2 \rho \sigma_{F(h)} \sigma_{\text{SADC dollar}} \quad (9)$$

Where:

$\sigma^2_{F(h)-\text{SADC dollar}}$	=	Basis risk is the variance of the basis
$\sigma^2_{F(h)}$	=	Variance of the futures price multiplied by the hedge ratio
SADC dollar	=	SADC dollar as underlying spot price
$\sigma^2_{\text{SADC dollar}}$	=	Variance of the spot price
h	=	Hedge ratio, assumed to be 1 in this study
ρ	=	Correlation of the spot and futures prices
σ_F	=	Futures price volatility
$\sigma_{\text{SADC dollar}}$	=	SADC Spot price volatility
$2 \rho \sigma_{F(h)} \sigma_{\text{SADC dollar}}$	=	Twice the correlation of the futures and spot volatility

$$\text{Hedging Effectiveness (HE)} = h^2 \frac{\sigma^2_F}{\sigma^2_S} \quad (10)$$

⁴ $h = \rho * (\sigma_S / \sigma_F)$ (Hull, 2006:57).

Where:

h (hedge ratio)	=	$\rho \frac{\sigma^2_S}{\sigma^2_F}$
ρ	=	Correlation of the spot and futures prices
	=	Hedge ratio, assumed to be 1 in this study
σ^2_F	=	Futures price variance
σ^2_S	=	Underlying spot price variance

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION AND PROBLEM STATEMENT

Barroso (2010:7), president of the European Union, stated that the implementation of the Euro currency has resulted in the growth of emerging markets, the upliftment of millions out of poverty, increased use of investment opportunities and prosperity. This clearly means that introducing such a “common currency” may also be beneficial in the South African context should a SADC dollarcurrency be implemented. Furthermore, in an earlier study conducted by Dutta (2005:352) he argued that the implementation is only beneficial if the new “common currency” shares a large part of the world economic output.

One of the features of the SADC region which stands out from the rest of the world is the vast amount of untapped resources in this region. This provides the premise that SADC can clearly become a prominent global force pertaining to its share of economic output which supports the argument held by Dutta (2005). In an earlier argument, Wyplosz (1997:3) provided three factors that give rise to the need to introduce the Euro, namely:

- Sustained high inflation
- Unemployment
- Negative economic effects of drastic oil price changes

These three factors are primary properties shown by most if not all African countries over the last decade, which may support the premise that the implementation of a “common currency” in the SADC region may be desirable. Although this study is about the business management benefits, it must be kept in mind that a change to a uniform currency will also support social and economic renaissance influences. This includes the upliftment of extremely poor countries, which will be carried or assisted by the stronger African economies.

Multinational corporations in South Africa may be leaders in Africa, and even in the world. However, due to the geographical positioning in a third world country, these corporations are prone to substantial exchange rate volatility risk. In this instance, the exchange rate risk is due to the fluctuations of the South African Rand against the euro or other major currencies.

This results in a demise of a company's profit margins and could even result in more stringent business management decisions.

One method provided to counter this risk by enterprises on a minimal scale is to enter into hedges with currency future contracts provided on the SAFEX division of the JSE Securities Exchange. This serves as a means of protection against financial risk for a company, mostly used by companies directly affected by foreign currency fluctuations.

Although hedging appears to be the optimal way to cope with currency risk, it seems that limited research has been done on the creation and implementation of a fictitious uniform SADC dollar currency and the effect that this could have on companies wishing to hedge this exchange rate risk in S.A. Similar post-euro studies were done on French firms in Europe after the implementation of the euro. Studies by Nguyen, Faff and Marschall (2007: 563) demonstrated that French firms that implemented the euro showed a reduction in exposure to exchange rate risk and they found that the "absolute size of this exposure decreased". This provides the premise that a similar situation in the South African derivatives market may exist. Capstaff, Marshall and Hutton (2007:1) also found that companies conducting sales inside the euro area experienced greater declines in the use of foreign currency derivatives in contrast to firms importing goods from outside the euro area. Another finding was that the decline in hedging was not directly linked to the exact decline in foreign currency exposure. This implied that the euro was hedged more effectively than the French Franc. Thus, in conclusion derivatives contracts intended to hedge were implemented more effectively post-euro as opposed to pre-euro. This was similar to the findings of Simpson and Dania (2006:42)⁵.

Another reason for introducing a common currency to a region is the removal of intra-country exchange rate risk in the SADC region. Hardouvelis, Malliaropoulos and Priestley (2006:366) found that this was the situation post- euro introduction in Europe and concluded that a single common currency reduces intra-Europe country exchange rate risk up to the extent that European stocks exhibit less currency risk. This has implications for investors post-euro and

⁵ Simpson and Dania (2006) found that the newly introduced euro exchange rate had a higher correlation than the French franc or German mark relative to other world currencies. This implied greater hedging benefits for investors post-euro as opposed to pre-euro. This finding together with numerous authors entices the question of the hedging benefits that the SADC dollar nominal exchange rate will hold for investors opposed to only trading the South African rand or the Botswana pula.

post-SADC dollar introduction. Investors will demand lower required returns on stocks due to the foreign currency risk component being removed.

Risk management in an African business environment with numerous currencies is subject to fluctuations in the exchange rates. Should a central SADC dollar currency be introduced, businesses in Africa may benefit by improving currency and basis risk management.

The information about such a currency will be used to evaluate its impact on basis risk and currency risk management. This could lead to improved company profit margins, as well as better risk management decisions. In improving the hedging decision, the secondary objectives will be met.

1.2. OBJECTIVES OF THIS STUDY

The objectives of the study may be briefly set out as follows:

1.2.1 The Primary Objective of the Research

The primary objectives of this study are as follows:

- The creation of a fictitious uniform SADC dollar currency based on the euro principles for the sake of modeling.
- To develop a model that will be used to test and evaluate the impact of the fictitious implementation of such a uniform currency on basis risk and spreads in the South African currency futures derivatives market.

1.2.2 The Secondary Objectives of the Research

The Secondary objectives will be to provide a literature review of:

- Survey of currency futures pricing and factors that affect basis risk and spreads.⁶

⁶ This will be represented as a number of basis points.

- Survey of theory as it relates to currency modeling.
- Currency indices currently in use on financial exchanges.
- Considering the implementation of the central SADC dollar currency into alternative derivative contracts such as currency reference warrants.

1.3. IMPORTANCE OF THE STUDY

By carrying out the two primary stated objectives, a foundation can be established on which evaluations can be made for businesses in South Africa that are subject to exchange rate volatility. It may offer the background that South African enterprises may evaluate, should they have questions about the implementation of a central SADC dollar currency monetary unit in place of the South African rand, in order to minimize currency risk.

This study may have implications for business management decisions. These may include:

- The ability of companies to better hedge against exchange-rate volatility
- The improvement of profits of import and export enterprises
- Improved investment decisions in terms of managing the basis

1.4. SCOPE AND LIMITATIONS OF THE STUDY

This study examines the financial risk and hedging implications from the use of a common currency as opposed to a single local currency. Only one currency instrument is considered, but allows for the extension to cross currency futures⁷, currency options⁸ or currency reference warrants. Preliminary assumptions were made for the variables affecting the new uniform SADC dollar currency and currency futures contracts with maturities of up to one year were used.⁹

⁷ See Chang and Wong (2003) for with cross-currency futures with currency options.

⁸ Lien and Tse (2001:159) investigated the hedging effectiveness of both currency futures and currency options. The underlying foreign currencies they included were the British pound, the Japanese yen and the Deutsche mark. They found that currency futures are a more effective hedging instrument than currency options.

⁹ Kaufold & Smirlock (1986:71) state that the futures markets are inactive for maturities longer than this period.

Hedged positions where the monetary value in currency terms is identical to the monetary value of assets being hedged, were used. This excludes studies conducted by Broll, Kit & Zilcha (1999) and Karagozoglu (1999) that considered hedging using cross-currency futures contracts.

Only one hedged currency futures price will be computed at contract maturity. Any marking-to-market on the currency futures prices for three, six, nine or twelve month contracts will not be considered. Thus, the basis risk is only an approximation of the currency futures price. The hedge ratio being used is one. Assumptions were made that this is also the optimal hedge ratio. Hence, research done by Chakraborty and Barkoulas (1999) and Ku, Chen and Chen (2007) that consider “time-varying optimal hedge ratios”, fall outside the scope of this research.

Data were used for the period of 1999 until 2006. The results are thus reflective of an economic up cycle and could be extended over a full economic business cycle which includes the recent financial crisis in 2008. Only long hedged positions were used when applying currency futures, with both the South African Rand and SADC dollar as the respective underlying currencies.

1.5. METHODOLOGY

1.5.1 Research Design

In this study a partly exploratory approach will be used. The effect of spreads and pricing over time using the SADC dollar will be considered. This research will also follow a causal approach. The effect of changing various variables in futures derivative positions will be evaluated. These instruments include the currency of South Africa (ZAR) and the fictitious SADC dollar currency. The methodology will broadly comprise a number of steps:

Firstly, the spot exchange rates for the rand against the USD exchange rates will be obtained or computed for twelve consecutive monthly intervals over the course of one year.

Secondly, the currency futures price of the USD/rand will be computed for three month periods compounded on each interval over the course of twelve months; thereby yielding four currency futures prices over the period of one year.

Thirdly, to get an indication of how the basis spreads move over time, they will be calculated at each of the futures price intervals, namely for three, six, nine and twelve months. For each of the currency futures price values, the monthly spot price values available up to that point will be subtracted.

Fourthly, the basis spread risk will be computed using equations 8 and 9 (refer to summary of equations) for the same time intervals specified in step three. Hereafter, the new fictitious uniform African currency (USD/SADC dollar) will be computed with reference to the principles used to compute the Euro.¹⁰ This will be used to repeat step one. The composition of the weights in the uniform SADC dollar currency will be computed using one of the following magnitudes:

- Cash reserves¹¹
- Gold reserves
- GDP of each country
- GNP of each country excluding exports
- Foreign exchange reserves

These weighting methods will be specific to the Monetary Union being considered. Each of the alternate approaches above will be computed in terms of each country (examples: SA, Botswana) relative to the SADC region. These weights will then be multiplied with the spot exchange rate of each country relative to the USD.

Lastly, steps two, three and four will be repeated in exactly the same manner for the USD/SADC dollar and comparisons will be drawn between the basis risk spread. Steps one to

¹⁰ Refer to equations 4-9.

¹¹ Cash reserves have been included to remove the bias for SADC member states not containing natural resources.

four will be repeated using currency futures contracts with compound interest.¹² The reason for this is to test for two ways to evaluate prices in line with the business environment.

1.6. DATA COLLECTION

1.6.1 Research Method

The focus in the computation of a central SADC currency is to include only those countries that Masson and Patillo (2004) listed in the SADC monetary union. The reason for only using the SADC monetary union is its predominant role in Africa as the strongest monetary union. Another reason is the lack of data on the other monetary unions. While the euro had a set of criteria, known as convergence criteria or Maastricht criteria, these criteria are too stringent in the African context and thus were not considered. All data to be used in the calculation of the weights of the alternate countries will be supplied via Quantec, World Bank (2010) and the IMF (n.d).

In this study secondary data will also be used. Exchange rates relative to the USD will be obtained from InetBridge. The risk-free interest rates for South Africa will be the three, six, nine and twelve month Johannesburg interbank agreed rate (JIBAR) and for the foreign countries (namely the USD), the three six, nine and twelve month T-bill rates. The spot exchange rates of the various SADC countries will be obtained from Quantec, as well as from the World Bank (2010).

Futures prices and basis risk spreads with the ZAR as the underlying will be computed for the periods:

- 01/01/2009 until 01/04/2009
- 01/01/2009 until 01/07/2009
- 01/01/2009 until 01/10/2009
- 01/01/2009 until 01/01/2010

¹² See equation 10.

Futures prices and basis risk spreads with the “SADC dollar” as the underlying will be computed for the periods:

- 01/01/2009 until 01/04/2009
- 01/01/2009 until 01/07/2009
- 01/01/2009 until 01/10/2009
- 01/01/2009 until 01/01/2010

1.7. ORIENTATION OF THE STUDY

The remainder of this study was structured as follows:

Chapter 2 summarizes the literature on the USD/Euro development, the role of the Euro on companies and the foreign exchange market in a pre- and post- context.

Chapter 3 provides an overview of the literature on currency futures. It considers the modeling of futures prices in alternative financial markets, hedged spreads as well as using currency futures as a hedging device.

Chapter 4 describes the research methodology used in this study.

Chapter 5 will provide an overview of the empirical research results and a detailed discussion thereof.

Lastly, chapter 6 puts forth all the findings, conclusions and managerial implications from Chapter 5 with some recommendations for further research.

CHAPTER 2: THE PRINCIPLES USED TO CREATE THE EURO: APPLICATION IN SADC

2.1 INTRODUCTION

When countries give up their exchange rates and adopt a common currency they stand to lose parity, becoming susceptible to up and down turns in the economy and could fall into disequilibrium due to the removal of their balance of payments. The question then arises as to why these countries would choose to do so (Coffey, 2002:3). This is the question which is addressed throughout this chapter. One way to address this is to examine the development and implementation of the most recent and seemingly successful¹³ common currency, the euro currency. Its effect on corporations and investors is discussed with greater emphasis on the business management aspects and, in passing, certain economic principles that are relevant, are briefly discussed.

2.2 DEVELOPMENT OF THE EURO-DOLLAR EXCHANGE RATES

In this section a brief history is given that led to the introduction of the euro in Europe. It is not intended to be an economic evaluation of the important factors to consider from an economic perspective, but more of a highlighting of the important aspects to consider when compiling the SADC foreign currency index, for the sake of this study. This approach is considered from a business management and financial risk management perspective. Table 2.2.1 below provides a summary of the events which lead upto the implementation of the euro nominal exchange rate.

¹³ Based on the time period in which this study was conducted.

Table 2.1.1: Summary of the USD/euro History

Date	A summary of the history that led to the development of the USD/euro exchange rate
1970	Nominal and real exchange rate volatility saw European countries moving away from a floating to a managed exchange rate system ¹⁴ .
Early 1970's	Basket currencies were created due to the Bretton Woods ¹⁵ exchange rate system that collapsed. The first basket of currencies created was the European currency unit (EURCO ¹⁶), which was mainly used by private corporations to protect clients against any fluctuations in the exchange rate. Special Drawing Rights ¹⁷ (SDR) were linked to EURCO and were introduced to: (1) create liquidity internationally and (2) solve the credibility problems of the US dollar.
Late 1970's	The second basket of currencies was the EAU, which represented fixed amounts of the same currencies used and had the value of 1 SDR when created.
1979	The European Monetary System (EMS) was established. This was aided by the third and final currency basket, the ECU replacing the EAU. In theory these weights initially used in the ECU were not arbitrary, but reflective of GDP, intra-regional trade and share in the short-term financial support mechanism. The EMS was introduced with the following aims: the member states participating had to demonstrate greater economic convergence; all states had to adopt the same public policy; stabilization of exchange rates; the European currency units' (ECU's) central role had to be promoted with the intention that a large degree of integration would occur among the member states
1980's	A managed exchange rate system was reflected using an exchange-rate mechanism (ERM). Countries wishing to adopt or enter this monetary union had to comply with bilateral exchange rates or bands ¹⁸ put forth by the ERM.
Early 1990's	There were speculative attacks on EMU countries.
1992	Maastricht Treaty was introduced.
1997	Stability and Growth Pact was introduced to aid the Maastricht Criteria.
1999	The USD/euro exchange-rate was introduced which replaced the ECU on a 1:1 basis. The ERM2 was implemented which replaced the ERM1.

Source: (Summarized from Cuthbertson and Nitzsche, 2001:449); (Coffey, 2002:16); ((Cobbold, 1994:185) cited in (Johnson and Collignon, 1994)); ((Moon, Rhee & Yoon,2006:1); (Temperton, 1999:3); (Padoa-Schioppa, 2004:405); (Posen, 2008:53)

¹⁴ This is referred to as a target zone or a band (Duma, 2001:1).

¹⁵ See Levy-Yeyati and Sturzenegger (2005) for a complete discussion of the Deeds versus Woods exchange rate regimes. Also see Cyr (2003:986) for the unraveling of the Bretton Woods fixed exchange rate regime.

¹⁶ This is the first European currency unit and differs from the ECU that is used today.

¹⁷ Special Drawing Rights can be defined as a foreign exchange rate reserve or asset used internationally (Williamson, 2009:3)

¹⁸ These bands were $\pm 6\%$ wide and $\pm 2.5\%$ narrow (Coffey, 2002:22). Bands in this context refer to the amount that a currency may deviate from its fundamental value.

As shown above in the development of the euro, the ECU basket of currencies plays an integral part and can be seen as the backbone of the euro exchange rate. It is thus crucial that investors trading or hedging the euro as a foreign currency must have an understanding of the ECU as it has a direct effect on the euro exchange rate. To allow for a better understanding of the ECU, a few characteristics are provided, complemented with a practical example. When the first currency basket was introduced, the European currency unit's (ECU's) central role had to be promoted with the intention that a larger degree of integration would occur among the member states (Coffey, 2002:16). Another characteristic of the ECU was to use the Deutsche Mark as the anchor currency in the ECU¹⁹ as well as the introduction and replacement²⁰ of national targets with those of the German monetary policy (Cuthbertson & Nitzsche, 2001:450). Cobbold (1994:185), cited in Johnson and Collignon (1994), provided the following reasons for establishing the ECU: (1) Being a basket of defined quantities of member currencies, it allowed market participants to compose and decompose this basket. (2) It allowed for a real interest rate to be computed by weighting the interest rates of the different member countries. (3) The creation of a European currency, which could be classified as neutral. (4) The creation of a "unit of account" which could be used for accounting or the settlement between corporations and governments.

As the ECU is a currency basket, comprising of different weighted currencies, using a specific weighting approach, a change in the weight may cause a change in the value of the ECU and ultimately change the value of the euro exchange rate. Investors must thus understand how these weights can change in practice. The method used to re-examine the weights used in the ECU was twofold. The first method occurred six months post the creation of the basket of currencies when the currency was rebalanced. The latter was placed upon request, due to the fluctuation of the currencies in the basket, thus the weights of the ECU currency basket were rebalanced when there was a deviation of approximately twenty-five percent per annum (Moon et al., 2006:1).

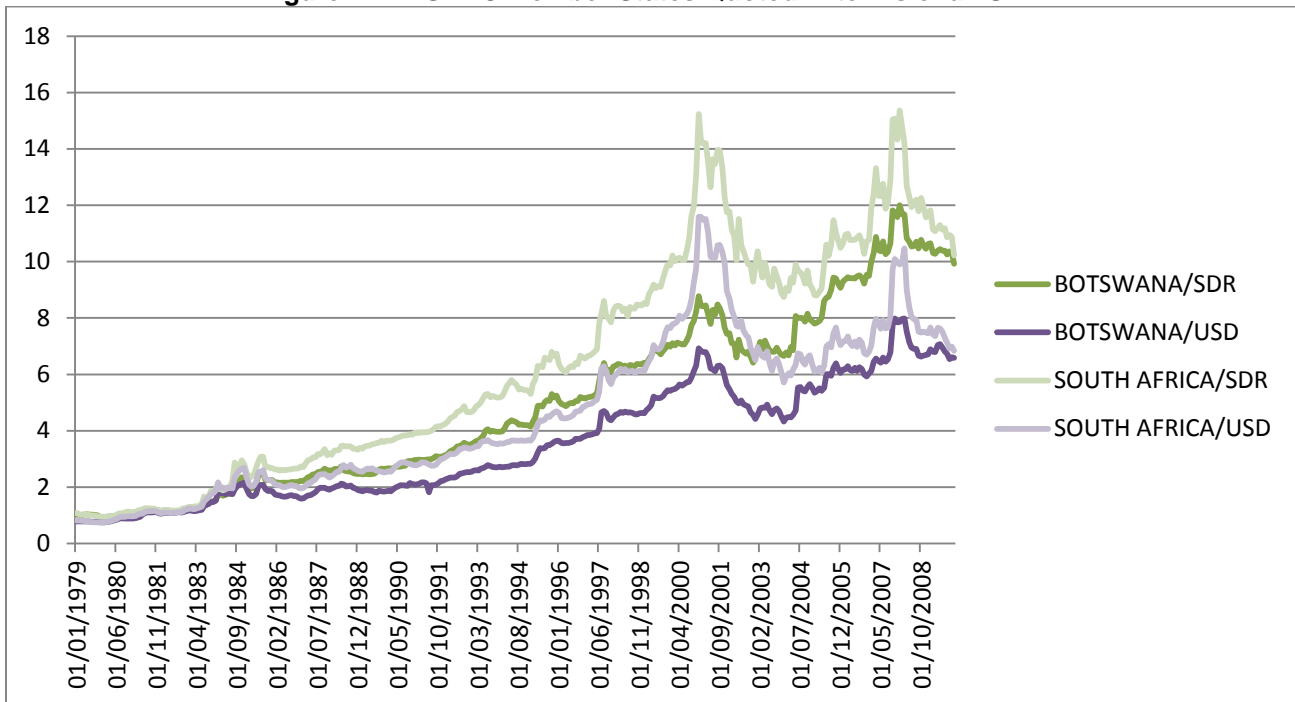
The currency baskets that led up to the implementation of the USD/euro were all affected by the changing value of a SDR to which they were pegged. This invokes the premise that

¹⁹ Coffey (2002:22) argues that the ECU is a model of stability due to the way that it is composed.

²⁰ Replacement in this context was implemented to reduce inflation.

before the SADC dollar is introduced a currency basket should be formed for the SADC region and pegged or linked to the value of 1 SDR. This approach is shown below for the two stronger member states of SADC.

Figure 2.2.1: SADC Member States Quoted in terms of an SDR



Source: Own Compilation: Adapted from Quantec

The figure above indicates that when the SADC member states exchange rates are quoted in terms of a SDR, there is an upward bias in contrast to quoting in terms of the USD. A possible reason for this phenomenon is that a SDR is reflective of a basket of currencies and not reflective of the trading weights given to the SADC member countries. Therefore the claim on the basket of currencies is greater than the claim on USD nominal value. It is thus more appropriate to quote SADC member states in terms of the USD to eliminate this bias.

Now that the general characteristics of the ECU have been provided, a practical example of a proposed currency basket is that of the Asian Currency Unit(ACU), created due to the Asian exchange rate crisis²¹ (Moon et al., 2006:1). Although Moon et al. (2006:1) considered the creation of a regional currency unit (RCU), also referred to as an Asian Currency Unit

²¹ Coudert and Couharde (2008:7) provided exchange rate regimes that resulted in currency misalignments. They provided a crawling peg example for Asian currencies with a peg relative to the USD on a de facto basis.

(ACU)²², Ogawa and Shimizu (2006) considered using this RCU as a deviation indicator. This clearly shows that those currency baskets can also be used as a means to control or counter exchange rate volatility and prevent currency crises. As demonstrated by Ogawa and Shimizu (2006), currency baskets can also be used by investors to compare a basket of currencies with individual currencies. This allows for any deviations to be identified and profits to be made. This computation of the RCU against the US dollar is shown in tables 2.2.2 and 2.2.3 below:

Table 2.2.2: Weights and Amounts of the Three Northeast Asian Currencies in the RCU

	Currency weight (%)				US dollar Rates	Currency amount (units)			
	PPP-GDP	Nom-GDP	Intra-trade	CMI-swap		PPP-GDP	Nom-GDP	Intra-trade	CMI-swap
Korea	8.09 (7.39)	8.08 (10.77)	22.41 (20.75)	(26.67)	1130.60 ²³ (1024.13) ²⁴	91.45 (75.69)	91.31 ²⁵ (110.30)	253.38 (237.29)	(273.10)
Japan	37.30 (29.97)	74.87 (65.17)	48.61 (40.20)	(47.62)	107.80 (110.25)	40.21 (33.04)	80.71 (71.85)	52.40 (43.49)	(52.50)
China	54.61 (62.64)	17.05 (39.05)	28.98 (39.05)	(25.71)	8.30 (8.1922)	4.53 (5.13)	1.42 (1.97)	2.41 (3.24)	(2.11)

Source: Moon et al. (2006:24)

Table 2.2.3: Value of the RCU in USD and National Currencies, 2005

	PPP-GDP	Nom-GDP	Intra-trade	CMI-swap
\$/RCU rate	1.0073	0.9940 ²⁶	1.0163	1.0179
RCU/\$ rate	0.9927	1.0060	0.9839	0.9824
Won/RCU rate	1031.61	1017.99	1040.83	1042.51
Yen/RCU	111.06	109.59	112.05	112.23
Yuan/RCU	8.2521	8.1431	8.3258	8.3392

Source: Moon et al. (2006:14)

²² Moon et al. (2006:12) proposed the following method to compute the weights, namely: (1) relative weight of GDP to PPP of member country, (2) relative weight of nominal GDP of member country, (3) relative weight of intra-regional trade of member country, (4) relative weight of bilateral swap arrangement of the CMI and (5) combination of above.

²³ These values are for 2000.

²⁴ Values in brackets are for 2005.

²⁵ Spot exchange rates used are \$1 = 107.80 Japanese Yen, \$1 = 8.30 Chinese Yuan, \$1 = 1130.60 Korean Won. Thus, RCU 1 = 80.71 currency units (107.80*74.87%) + 1.42 currency units (8.30*17.05%) + 91.31 currency units (1130.60*8.08%).

²⁶ \$/RCU = [80.71*(1/107.80)] + [1.42*(1/8.30)] + [91.31*(1/1130.60)] = 0.9077836 for 2000 and 0.9940 for 2005 (Moon et al., 2006:14).

One advantage of the ERM mentioned by Cuthbertson and Nitzsche (2001:449) is that it had the ability and facility to realign the exchange rates of countries, provided there was a fundamental misalignment²⁷. In the 1990's, the ERM was put under considerable strain due to the increasing mobility of capital and the removal of exchange rate controls in the relevant countries. This resulted in speculative attacks²⁸ on the Italian lira, French franc and pound sterling on 16 September 1992²⁹. A speculative attack is one of the important variables which cause currency crises in developing economies³⁰. A year later, the ERM system was the centre of speculative attacks and resulted in governments extending the ERM currency bands from $\pm 2.25\%$ to $\pm 15\%$, thus resulting in the Deutsche Mark depreciating (Henderson, 2006:188).

Cuthbertson and Nitzsche (2001:450) also highlighted an important factor in the euro composition, namely the criteria of the Maastricht Treaty³¹, which determined if a country was allowed permission into the European Monetary Union and included:

- (1) "The inflation rate should be within *1.5 percentage points* of the average rate of inflation in the three European Union countries with the lowest inflation rates".
- (2) "Long-term interest rates must be within *2 percentage points* of the average rate of the three European Union states with the lowest interest rates".
- (3) "The national budget deficit must be below *3% of GDP* at market prices".
- (4) "The national debt must not exceed *60% of GDP*"³².
- (5) "The national currency must have remained within the *2.25% fluctuations margin* in the *currency band of the European Monetary System (EMS)* and must not have been devalued for *two years*".

²⁷ Provides inflation reduction, the volatility of the exchange rate declined and encouraged the policy of co-ordinate interventions (Cuthbertson & Nitzsche, 2001:450).

²⁸ Eichengreen et al. (1994:2) defines a speculative attack as: "Large movements in exchange rates, interest rates or international reserves."

²⁹ 16 September 1992 was later known as "Black Wednesday".

³⁰ See Frankel and Rose (1996) on a detailed discussion on the variables causing currency crashes.

³¹ This is also referred to as the Maastricht criteria, was signed in December 1991 but only came into force on 1 November 1993 (Vierk and Park, 2003:1).

³² See Prskawetz, Feichtinger & Luptàčik (1998) on an analysis of the Maastricht Treaty criteria. For countries exceeding this ratio, they provide an optimal path using optimal path theory and discuss methods for countries to obtain additional revenue with a decline in inflation.

The Maastricht Treaty was supported by a “Stability and Growth Pact in 1997³³” to ensure that fiscal as well as economic policies were upheld once a common currency was introduced (Baskaran, 2009:331). The *first* and *fifth* criteria are the most important and were used to ensure countries wishing to enter the European Monetary Union were not having an adverse effect on prices. This would cause reductions in that country’s output³⁴ after entry into the Euro zone (Cuthbertson & Nitzsche, 2001:450). These two criteria in the treaty also prevented investors from switching their financial capital between countries in and out of the EMU. This put downward pressure on the euro-dollar exchange rates. To analyze each criterion falls outside the scope of this study³⁵, while the total effect of the Maastricht Treaty has been dealt with in this section.

Afxentiou (2000:248) refers to the importance of the Maastricht Treaty during the USD/euro implementation and argues that the criteria of this treaty did adhere to the principles of OCA theory which were later supported by Coffey (2002:36). Alternatively, Wyplosz (2008:63) found that these criteria were unrelated to OCA theory³⁶ as the decision to implement a common currency was only political, which reinforced an original argument put forth by Baun (1995:605). Over the years many currency unions and exchange rate regimes have been created and ultimately all have failed, unless they were reinforced by means of policy unification (Baimbridge & Whyman, 2003:8). Baskaran (2009:331) recently conducted a study that explored the impact that the Maastricht Treaty had on the macro economy and the investment climate of European Union (EU) countries. He found that neither did the Maastricht Treaty provide a sustained improvement on macroeconomic stability, nor did it improve the investment climate. Due to all the criticism against the Maastricht criteria in the literature surveyed, these criteria have not been applied to determine which countries may join the SADC region.

³³ Soukiazis and Castro (2005:386) state that the Stability Pact of 1997, was introduced to ensure a level of price stability and a degree of sustainable growth. Their study however provided mixed results of its effective implementation.

³⁴ This is also referred to as the PPP which has been discussed in Chapter 3 in the section on modeling of currency futures.

³⁵ See Szapary (2001:1) and Ozkan, Sibert & Sutherland (2004:649) on the dilemma presented from applying the inflation criteria to accession countries in the EMU and remedies that could be used to overcome this dilemma. Also see Cuthbertson and Nitsche (2001:450) on the fourth criterium which covers the issue of debt of each accession country. They find that the 60% ratio is used as an arbitrary rate which prevents a specific country from funding this deficit from issuing bonds.

³⁶ Durlauf and Blume (2008:63) state that OCA considers both the costs as well as benefits when a country enters a Monetary Union and how this company deals with asymmetric shocks without impacting the exchange rate. Also refer to chapter 1 on the steps in the development of OCA principles using the foundation provided by Mundell (1961).

The final stage of the EMU began with the introduction of the euro, which replaced the ECU on a 1€:1ECU basis, on 1 January 1999³⁷. Using this date as the event, all financial market and business implications prior will be referred to as ex ante otherwise ex post. Also on that date, the economic and financial council (ECOFIN) determined that the irrevocable conversion rates to be used in the euro would be identical to the ECU value, which was expressed in units. This was based on the participating currencies on 31 December 1998 (Coffey, 2002:56). Thus the following irrevocable rates³⁸ were fixed for the member states participating in the EU. These rates are shown in table 2.2.4 below. The method used to calculate these irrevocable exchange rates are shown in table 2.2.5.

Table 2.2.4: Irrevocable Exchange Rates Used in the ECU

Euro Exchange Rate: 1 €	
	= 13.7603 Austrian Schilling
	= 40.3399 Belgian Franc
	= 2.20371 Dutch Guilder
	= 5.94573 Finnish Markka
	= 6.55957 French Franc
	= 1.95583 German Mark
	= 0.787564 Irish Pound
	= 1936.27 Italian Lira
	= 40.3399 Luxembourg Franc
	= 200.482 Portuguese Escudo
	= 166.386 Spanish Peseta

Source: Coffey (2002:56)

Coffey (2002:206) suggests that no announcement of the irrevocable conversion rates could be made prior to the 1998 year end. On the other hand, however, bilateral exchange rates of the currencies comprising the ECU on 31 December 1998 could be announced. These bilateral rates contributed to the development of the euro conversion rates which were fixed or irrevocable for the different countries in the euro area.

³⁷ The eleven member countries participating in the EU included: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and lastly Spain (Temperton, 1998:3).

³⁸ These rates are in accordance with Article 1091 (4) of the Treaty (Coffey, 2002:56).

Table 2.2.5: Calculation of the ECU Member Countries Exchange Rates against the US Dollar

Step 1 ³⁹		Step 2 ⁴⁰		Step 3 ⁴¹
Amount of National Currency Units in the ECU Basket (a)	USD Exchange Rate on 31 December 1997 (b)	Equivalent of Dollars of National Currency Amount (c) = (a):(b)	ECU Exchange Rates (d) = (USD/ECU) ⁴²	
DEM	0.6242	1.7898	0.3487541	1.9763200
BEF	3.301	36.92	0.0894095	40.7675349
LUF	0.130	36.92	0.0035211	40.7675349
NLG	0.2198	2.0172	0.1089629	2.2274180
DKK	0.1976	6.8175	0.0289842	7.5279705
GRD	1.440	282.59	0.0050957	312.039
ITL	151.80	1758.75	0.0863113	1942.03
ESP	6.885	151.59	0.0454186	167.3876115
PTE	1.393	183.06	0.0076095	202.1371869
FRF	1.332	5.9881	0.2224412	6.6121364
GBP⁴³	0.08784	1.6561	0.1454718⁴⁴	0.666755
IEP	0.008552	1.4304	0.0122328	0.771961
			USD/ECU 1.1042128⁴⁵	
FIM	---	5.4222	---	5.98726
ATS	---	12.59	---	13.9020
SEK	---	7.9082	---	8.732134

Source: Coffey (2002:209)

The ERM underlying the EMS at the start of the euro development was used until the beginning of stage three, or 1 January 1999, and was referred to as ERM 1 and hereafter replaced by ERM 2. The ERM 2 would be the centre of the EMS, which used central rates

³⁹ Step 1 comprises EU banks, including those not comprising the ECU to disclose their exchange rates of their currencies relative to the dollar at 11:30 CET using a “daily concentration procedure”. This procedure requires the spot exchange rates to be recorded at their discrete values, which are those rates that are at the mid-points of their bid-ask spreads and containing seven digits (Coffey, 2002:207).

⁴⁰ Step 2 involves obtaining the official value of the ECU against the USD.

⁴¹ Step 3 in contrast to step 2 computes the value of the ECU relative to the countries participating in the EU.

⁴² Note that these fixed irrevocable exchange rates differ from the rates proposed in Table 2.5 due to the spot exchange rates used in (b) are for 1997 as opposed to 31/12/1998 as in the Euro.

⁴³ See Mulhearn and Vane (2006) for discussion on the GBP and Euro.

⁴⁴ For GBP as well as IEP, (c) reflects (a)*(b) due to quotation convention used of dollars relative to currency unit.

⁴⁵ This represents the value of the USD relative to the ECU by summing the equivalent of dollars of national currency amounts.

and had wide currency bands similar to that of ERM 1. When exchange rates included in the ERM 2 reached their predetermined margins, intervention was automatic and short-term financing which was made available was used. The ERM 2 allows for voluntary membership of countries in contrast to ERM 1 which was compulsory and required policy co-ordination (Coffey, 2002:148). After considering the variables and events that led to the euro introduction on 1 January 1999 and before a common currency similar to the euro composition can be developed for the SADC region, the theory of optimal⁴⁶ currency areas (OCA's) must be surveyed and considered in order to determine how this theory can contribute in a SADC context, or to a monetary union proposed for this region⁴⁷.

2.3 OPTIMAL CURRENCY AREA (OCA) THEORY

OCA theory originated from arguments over an optimal exchange rate regime, namely fixed versus floating⁴⁸. The theory on OCA was developed⁴⁹ by the seminal contributions of Mundell (1961), McKinnon (1963) and Kenen (1969), which was surveyed by Ishiyama (1975), cited in Melitz (1995), and later by Tower and Willett (1976). Kim and Chow (2003:297) defined an optimal currency area as: "a region or a domain where countries would be better off with a common currency or tightly fixed currency than with floating exchange rates among themselves". Kiss (2004) later considered the practicality of OCA principles. Next, the authors that made valuable contributions in establishing the OCA principles are discussed.

Mundell (1961) who can be regarded as the founder of OCA considered factor mobility⁵⁰ as a replacement for wage-price flexibility⁵¹ to determine if a domain or region could be perceived as an OCA. Ghatak & Sanchez-Fung (2007:190) considered the seminal paper presented by Mundell (1961) in a developing/emerging markets context and held that the main argument

⁴⁶ A distinction must be made between optimal and feasible, while it may not be optimal it may be feasible depending on the country's transition period for the full integration (Corden, 2003:18).

⁴⁷ Refer to Appendix C. These proposed monetary unions serve as the last stage from the imposing of regional economic communities which will result in the integration of Africa.

⁴⁸ See list of abbreviations, acronyms and key phrases for definitions.

⁴⁹ For review with regard to OCA: see Tavlas (1993); Tavlas (2004); de Grauwe and Mongelli (2005).

⁵⁰ For definition see List of Abbreviations, Acronyms and Key Phrases.

⁵¹ For definition see the List of Abbreviations.

was the reduction in transaction costs with the loss of monetary dependence the primary disadvantage.

McKinnon (1963) provided an argument for the “openness of the economy”⁵² and the more open an economy to trade, the greater the argument for a fixed exchange rate regime. This was similar to the argument already made by Mundell (1961) that the smaller the region or country, the less chance it has of it being an OCA (Corden, 2003:22).

Kenen (1969) was the last seminal paper that contributed to the theory of OCA by providing a competing principle, which supplemented both Mundel (1961) and McKinnon (1965) instead of contradicting them. He mentions that a diversified economy, with regard to exports, will suffer less from adverse shocks (Corden, 2003:22). Thus, Corden (2003:22) concluded that the larger the area of a country, the less this country is prone to shocks.

When considering the Mudell-McKinnon argument put forth above, a smaller country could not be defined as an OCA based on wage illusion or the size of open economy. However, when considering ‘the Kenen principle’ also introduced above, the smaller the country the more likely it is of being an OCA due to the diversification aspect. Although these two schools of thought contradict one another, Kenen (1969) can be thought of as the more applicable paradigm in the context of developing⁵³ countries opposed to developed countries. Mongelli (2002) has incorporated the original factors proposed to build a four stage factor model which has become known in research literature as the “new view” of OCA theory. His work is not without its limitations and includes the following four stages:

2.3.1 Pioneering Stage

This stage was begun by the contribution made by Mundell (1961) who put forward the idea that a domain should comprise fixed exchange rates as opposed to floating exchange rates. Other authors characterized this stage of OCA as the minimum requirements or criteria stage. The pioneering stage had one major shortcoming, namely it illustrated that most of these

⁵² This is the ratio of tradables to non-tradables.

⁵³ Corden (2003:22) argues that less developed countries are less diversified, thus should make use of a full floating exchange rate regime.

criteria were too ambiguous and required a lot of resources (Robson, 1987, cited in Mongelli, 2002). Tavlas (1994) supported this argument and referred to the problem as “the problem of inconclusiveness” and found that it was difficult to derive the direction of an OCA property.

2.3.2 Cost-Benefit Stage

This stage was characterized by the redefining and the assessment of the OCA principles. This assessment comprises the costs and benefits of OCA principles. The two major fundamental variables identified that affect a domain, are price flexibility and wage flexibility. This stage saw the redefining of the OCA principles in order of importance. One drawback from this stage was primarily the lack of structure (Mongelli, 2002). The reason for this lack of structure was due to the subjective definition provided by the alternate OCA principles. An important study of this stage is by Fratzscher (2002) who investigates the financial market integration and the effect that this has had on European stock markets. Schiavo (2007) also considers financial market integration, but extends these studies to the GDP correlation of European member states.

2.3.3 The Reassessment Stage

Buiter, cited in Mongelli (2002), refers to this stage as the “fine tuning fallacy”. Primary characteristics of this stage were the elimination of the exchange rates of countries that wished to adopt a single currency. Countries were also assessed with regard to money integration. Observations stemming from this stage:

- In deeming if Europe should only implement a single currency, the OCA principles or theory failed. Tavlas (1993) argues that, once the OCA principles failed, it was no longer an OCA question but rather an EMU question. He concludes that the OCA principles were posing too many limitations.
- The determination of optimum economic and monetary competencies of a geographical domain is a complex task.

This illustrated the fact that the OCA principles, as well as the EMU, must be used as complements, not in isolation.

2.3.4 Empirical Stage

During this stage Mongelli (2002:1) considered four empirical studies which overlapped. All of the studies he conducted were mutually exclusive, namely:

- Broad-based studies
- Shocking studies of OCA studies
- Studies investigating the endogeneity of OCA
- Studies of regional developments

Babetskii, Boone and Maurel (2004:218) provided a study that considered OCA literature in the context of exchange rate regimes as well as shock⁵⁴ asymmetry for accession countries into the EU. They assessed the business cycle similarities between countries to determine if fluctuations existed. They concluded that the closer these business cycle fluctuations among a basket of countries, the greater the benefits from the use of a common policy. This was later confirmed by Garcia-Solanes and Maria-Dolores (2008). These new views of OCA and alternate studies on OCA literature all have a developed country focus. In order to apply these principles to Africa, the criteria must be considered in a developing country context. Ghatak & Sanchez-Fung (2007:190) recently provided criteria to determine if developing countries meet the criteria laid down in the literature of OCA. These include:

- Business cycle synchronization,
- The degree of labour, capital and factor mobility within the recommended currency union,
- Derive the macroeconomic convergence by considering fiscal policy and exchange rate variables, and
- If links exist, examples include links among financial and trade transactions.

⁵⁴ Babetskii et al. (2004) considered both demand and supply shocks. Demand shocks reflect business cycles and are only temporary, while supply shocks reflect structural aspects such as financial system changes.

2.4 BENEFITS OF A SHARED MONETARY UNION

Frankel and Rose (2002:437) studied the possibility of countries obtaining certain gains from joining a monetary union. They found that over a twenty year term, every one percent increase in GDP due to increase in trade, would cause an increase to the income per capita. Benefits that arose from the introduction of a single uniform currency include: (1) an increase in the stability of the nominal exchange rate; (2) risk reduction to investors and corporations as exchange rate volatility is reduced (reducing the need for hedging); (3) trade and investment activity is stimulated; (4) in the long term there is higher growth as well as more employment; (5) the business environment is improved which leads to a reduction in transaction costs and improved price transparency; (6) competition among the European firms is increased which results in conforming pressure to subordinate prices and (7) the central bank is responsible for implementing policies. An example of policy implementation would be a low inflation climate together with price stability (Baimbridge & Whyman, 2003:1).

Due to the lack of formality in OCA as well as the subjectively defined principles, some authors refer to OCA as a “dead-end problem” (Johnson, 1969:395). However, this statement is based on out-dated research. Other authors support this initial statement by Johnson (1969), but also point out the irrelevancy of OCA theory. While OCA theory is under a lot of criticism, it is the only theory that exists that provides the framework for the adoption of a new common currency (Pomfret, 2005). The ‘new’ views provided by Mongelli (2002) and criteria laid down by Ghatak & Sanchez-Fung (2007:190) provide the foundation on which OCA theory can be applied to a SADC context and whether these proposed limitations would hold in SADC can be tested. Next the establishment of a monetary union in SADC will briefly be discussed.

2.5 ESTABLISHMENT OF A SADC MONETARY UNION

It is important to gain an understanding of monetary unions in Africa. If the two monetary unions which currently exist in Africa are extended to the proposed five, this could have a detrimental impact on corporations/investors and stock exchanges in these alternative regions.

At present two regional monetary unions are present in Africa, the first is the CFA franc zone and the second is the CMA. The CFA franc zone can be broken up into the West African economic and monetary union as well as the central African economic and monetary union (Masson & Patillo, 2004:11). Masson and Patillo (2004) provide an article where they extended these original two monetary unions into five proposed monetary unions, also referred to as regional economic communities (REC's). These regional economic communities include the AMU, COMESA, ECCAS, ECOWAS and the SADC.

In order for the SADC regional economic community to be considered as monetary union⁵⁵, it must comply with the criteria put forth in the literature of OCA. Duma (2001:89) found that using the model put forth by Holden, Holden and Suss (1979)⁵⁶, the SADC does not comply with the OCA criteria and cannot be regarded as a monetary union. The criteria used by Duma (2001:89) to assess the OCA theory were (1) openness in the economy, (2) mobility of trade, (3) geographical concentration of trade, (4) level of economic development, (5) inflation differential and (6) the diversification of the external sector. Khamfula and Huizinga (2004:699) later investigated the desirability of a monetary union for SADC members using a GARCH model. They supported the results of Duma (2001) that the costs exceed the benefits to SADC members and concluded that a monetary union was not desirable. Tavlas (2007:26) on the other hand conducted a survey on all of the existing literature which studied the feasibility of a monetary union for the SADC region. Some problems he encountered when comparing studies included different (a) types of methodologies implemented, (b) types of countries considered, (c) sample periods chosen, (d) interpretations for similar empirical results and (e) cross-references with authors in alternate studies. Tavlas (2007:26) thus made the following conclusions: (1) Many SADC member countries have asymmetric shocks, thus as an inference about a common currency may not be optimal. (2) Similar research suggests that only a few euro member countries would benefit, but have been functioning satisfactorily for numerous years, which supports the SADC argument. (3) Countries in the SADC with high intra-trade shares tend to have similar business cycle trends. (4) Two principles should be enforced in the SADC creation of a monetary union, namely gradualism and conditionality. (5)

⁵⁵ A monetary union is the most stringent form of integration in an area which imposes a relationship which is fixed and eliminates any exchange controls that may exist (Lundahl & Peterson, 1994:271, cited in Duma, 2001:21).

⁵⁶ Holden et al. (1979) provided a model to determine if a regional area should use a fixed or floating exchange rate regime.

South Africa would serve as the anchor currency with the CMA as the core in the monetary union.

A survey on the literature of the other four RECs falls outside the scope of this study⁵⁷. These RECs have only been mentioned to provide a holistic view of the SADC region in relation to the other RECs in Africa. The table below shows the process that the African union is following at present to establish a single currency for Africa. From this table it can be seen that the SADC wishes to achieve monetary union status by 2016 with implications for emerging market investors in the near future.

Table 2.5.1: Composition of REC's and the African Union Status

Grouping	Countries	Monetary union Status
Arab Maghreb Union (AMU)	Algeria, Libya, Mauritania, Morocco and Tunisia	No project
Common Market for Eastern and Southern Africa (COMESA)	Angola, Burundi, Comoros, DRC, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe.	Target date: 2025
Economic Community of Central African States (ECCAS)	CEMAC (Cameroon, C. Afr. Rep., Chad, Equatorial Guinea, Gabon, Rep. Congo) plus Burundi, D.R. Congo, Rwanda, S. Tome and prince.	CEMAC countries are members of CFA franc zone; the non WEAMU countries aim to form a monetary union in 2009; ECOWAS to achieve a full monetary union at some future date.
Economic Community of West African States (ECOWAS)	WAEMU (Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, Togo) plus Cape Verde, the Gambia, Ghana, Guinea, Liberia, Nigeria, Sierra Leone.	CMA constitutes an exchange rate union; SADC aims to achieve full monetary union by 2016.
SADC (South African Development Community)	CMA (Lesotho, Namibia, South Africa, Swaziland) plus Angola, Botswana, D.R. Congo, Malawi, Mauritius, Mozambique, Tanzania, Zambia and Zimbabwe	CMA constitutes an exchange rate union; SADC aims to achieve full monetary union by 2016.
African Union	All the above member of regional economic communities	Single African currency by 2028

Source: Masson (2007:4)

⁵⁷ For studies on these four REC's see Testas (1999:108) on the AMU; Camignani (2006:242) and Musila (2005:135) on COMESA; Rose (2000); Rose, Lockwood and Quah (2000) and Rose and Van Wincoop (2001) and Masson (2007) on the impact that monetary union status can have on trade for African countries from EMU experience and lastly; Masson (2008:539) and McCarthy (2008:1) on the advantages and disadvantages from the joining of all RECs resulting in full integration and ultimately a single currency for Africa.

The section that follows takes a closer look at the SADC region. Aspects of this region are highlighted from the euro experience such as the development of the financial system, the changing of exchange rate regimes and implications for investors.

2.6 SOUTHERN AFRICAN DEVELOPMENT COMMUNITIES (SADC)

2.6.1 Introduction

Some of the reasons for choosing this REC in Africa are firstly, the fact that it is the strongest monetary union with the earliest target date and therefore a relevant topic at the moment, and secondly to examine the ways that businesses in a REC can combat globalization. Thus, it is the most appropriate REC to use in Africa to replicate the USD/euro exchange rate. However, due to the lack of literature as well as diversified countries in the SADC region, newspapers from 1978 and financial publications since 2001 were researched. This was done to obtain a general understanding of the business environment in SADC and implications for foreign investors outside this region.

In 1979, the first Southern African Co-ordination Conference (SADCC) was created in Arusha, Tanzania by people and governments in Southern Africa. In 1992, the “Summit of Heads of State Government” of the SADCC approved and signed a Declaration and Treaty to transform and fully integrate this organization. This Declaration and Treaty, which was signed in Windhoek, Namibia, created the SADC and replaced the SADCC. In 1994, South Africa, Seychelles and Mauritius became members of the SADC which strengthened the integration among these countries (Allen and Gandiya, 2004:226). At present there are fifteen SADC member countries, namely: Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe⁵⁸. The major goal set by the Summit of Heads of State Government is to create a SADC monetary union by 2016, with one central bank (Masson & Patillo, 2004; Masson, 2007; Kröhne, 2006:IV; SADC, 2008). This one central bank will have an effect on the (1) banking sector, (2) business sector as well as the

⁵⁸ See section 2.7.4.

(3) financial market of countries in SADC⁵⁹. This effect on the different sectors is known in the literature as a “ripple effect.” Mishkin and Schmidt-Hebbel(2001:454) list the following main functions of the new SADC central bank, namely: (1) the responsibility of issuing coins and notes, (2) the banking for other banks, (3) the banking for the government, (4) responsibility for foreign reserves and (5) responsibility for the maintaining of stable financial markets. Another important component of a central bank is its discount rate used in the financial market. This discount rate can be seen as the interest rate that the central bank uses when it lends to commercial banks (Kröhne, 2006:36). With the process towards the establishment of this SADC central bank, monetary policies and discount rates should converge and would ultimately lead to the replacement of a single SADC dollar exchange rate. This process of convergence is reflected in the exchange rate regimes of member countries and is shown on 31 December 1991 in Table 2.6.1 and on 31 December 1999 in Table 2.6.2 below:

Table 2.6.1: SADC Countries Grouped by their Individual Exchange Rate Regime

Exchange Rate Regime ⁶⁰	Countries
NS/CBA	DRC, Namibia
FP	Angola, Botswana, Lesotho, Malawi, Mauritius, The Seychelles, Swaziland, Tanzania, Zimbabwe
HB	Nil
CP	Nil
MF	Mozambique, South Africa, Zambia
IF	Nil

Source: Allen and Gandiya (2004:48)

Table 2.6.2: SADC Countries Grouped by their Individual Exchange Rate Regime Cont.

Exchange Rate Regime	Countries
NS/CBA	Nil
FP	Botswana, Lesotho, Namibia, The Seychelles, Swaziland and Zimbabwe
HB	Nil
CP	Nil
MF	Malawi

⁵⁹ See Tyandela and Biekpe (2001:59) on the construction of the SADC stock market index.

⁶⁰ Abbreviations for exchange rate regimes: NS = Arrangement with no separate legal tender; CBA = Currency Board; FP = other conventional fixed pegs; HB = Pegged rate in horizontal bank; CP = Crawling Peg; MF = Managed float with no pre-announced exchange rate path; IF = independently floating.

IF	Angola, DRC, Mozambique, South Africa, Zambia
----	---

Source: Allen and Gandiya (2004:49)

The tables above show that over a period of 10 years most of the countries in the SADC have started moving towards pegged exchange rates and independent floating exchange rate regimes. All of the countries in the pegged exchange rate regime class are pegged to one of the countries in the floating regime class. This is known as a dual exchange rate system and is advantageous as it protects the current account from political risk. In a dual exchange rate system there are two rates, a financial rate and a commercial rate. When the financial rate is applied to the South African rand (ZAR) it is applicable to non-residents making direct investments or portfolio investments. The commercial rate on the other hand was applicable to foreign trade transactions with the current account as well as foreign credits and loans (Allen and Gandiya, 2004:50). Dornbusch and Kuenzler (1993:120) found that the commercial rate always remains stable in a dual exchange rate system, while the financial rate reflects the expectations of portfolio managers with regard to capital flows. Jefferis (2003:15) provides a summary of the monetary integration process below.

Table 2.6.3: Summary of Integration Process

Policy Choices	Degree of Monetary Integration			
	None	Weak	Strong	Full
Exchange Rate	Floating	Constrained float/crawling Peg	Fixed Peg	Single Currency
Capital Market	Exchange (capital) Controls Possible	Progressive Removal of Capital Controls Equal treatment across Jurisdictions		
Other		Removal of Controls on Labor Mobility Stricter limits on fiscal deficits and public debt Trade Liberalization Stabilization of Financial Sector and Strengthening of Supervision		
Monetary Policy Implications	Unconstrained	Constrained by exchange rate targets and capital movements	Co-ordinate movements in interest rates	Single Central Bank and Benchmark interest rate

Source: Jefferis (2003:15)

As shown above, exchange rates that are managed/constrained floating or fixed pegged are in the process of changing towards full monetary integration. The exchange rate regimes of the SADC member states currently in use are provided below for the periods 2005 and 2008. A discussion is provided below on the development of these exchange rate regimes over time and their link to current monetary integration.

Table 2.6.4: SADC Exchange Rate Regimes, 2005 and 2008

Country	Exchange Rate Regime	
	2005	2008
Angola	Fixed Peg	Fixed Peg
Botswana	Fixed Peg	Fixed Peg
DRC	Independent Float	<i>Independent Float</i>
Lesotho	Fixed Peg	Fixed Peg
Madagascar	Independent Float	Managed Floating
Malawi	Managed Float	Fixed Peg
Mauritius	Managed Float	Managed Float
Mozambique	Managed Float	Managed Float
Namibia	Fixed Peg	Fixed Peg
Seychelles	Fixed Peg	Fixed Peg
South Africa	Independent Float	<i>Independent Float</i>
Swaziland	Fixed Peg	Fixed Peg
Tanzania	Independent Float	Managed Float
Zambia	Managed Float	<i>Independent Float</i>
Zimbabwe	Managed Float	Fixed Peg

Source: IMF (n.d), Simwaka (2010:7)

Tables 2.6.1 and 2.6.2 demonstrate the exchange rate regimes of SADC member states until the euro was introduced in 1999. Table 2.6.4 provides a picture of the exchange rate regimes currently in use by the SADC member states. From the table above, eight of the 15 countries have adopted fixed peg exchange rate regimes with the ZAR (as an independent floating exchange rate regime) being used as the major anchor currency for these pegs. Thus, most of the countries are in a strong form of monetary integration with SADC based on Table 2.6.3. The first country's exchange regime to be pegged is Angola. Angola and Botswana are the only two member states of SADC with fixed-peg exchange rate regimes which have been discussed due to their predominant roles in SADC. Angola's role is to stimulate or increase

trade and is the second largest exporter of oil in Southern Africa. Although it is a strong export nation, it has been under considerable strain over the last century. Only in 1999 did the Angolan kwanza become a free floating exchange rate regime as shown in Table 2.6.2. A lot of reforms were put in place to strengthen this exchange rate via the improvement of transparent pricing, tax reforms and increased public finances. The Angolan economy has reaped the benefits with the adoption of a fixed peg exchange rate regime in 2005 as shown in Table 2.6.4. Angola is currently in a strong degree of monetary integration with SADC, providing the role of a 'strengthening relationship' in the future.

Botswana is the second fixed peg exchange rate regime and strongest foreign currency in SADC, with the pula being pegged to the ZAR and a special drawing right (SDR). This SDR is a basket of currencies comprising the Chinese yuan (¥), British pound (£) and the euro (€). Possible reasons for this type of pegging are the pula's use of SDR's during the Bretton Woods exchange rate system, which collapsed, as well as the shift to ZAR as opposed to Zimbabwe dollar. When SADC Investor Survey (2000) described Zimbabwe in SADC they used the phrase "investment anorexia". Zimbabwe was "thin" due to no foreign direct investment (FDI)⁶¹ inflows into the country by foreign investors. Zimbabwe is excluded from the SADC region in this study due to data restrictions as well as the political unrest in the country. Of the 15 member countries, three use independent floating exchange rate regimes. These countries are the Democratic Republic of Congo (DRC), South Africa and Zambia. The DRC faced some major challenges prior to 2000. These included (1) political unrest and (2) hyperinflation due to extravagant government spending. In 2002, the political situation changed with a new president being elected which would bring a greater extent of political stability to the region. The effect of this stability is shown in Table 2.6.4 when the DRC moved from an exchange rate arrangement with no legal tender to an independent floating exchange rate regime. While the DRC is still using this exchange rate regime today, this period of recovery will most likely take a great number of years. Investors can thus conclude that the inclusion of DRC in SADC will initially pull down the region. However, over a long period of time it should have a strengthening effect. South Africa as an independent floating exchange rate regime together with its role as an anchor currency is discussed in the next section. The next independent floating exchange rate regime to be discussed is Zambia. Over an 18 year

⁶¹ See section 2.7.5 on the FDI influence during the integration of the financial system in SADC.

period, Zambia has been moving back and forth among exchange rate regimes. Table 2.6.4 shows that the country recently went from a managed and weak form of monetary integration to a floating exchange rate regime. Problems that are faced by Zambia include: (1) high inflation and (2) high debt obligations. To combat these problems Zambia adjusted the foreign exchange rate policies and reduced the workforce of the public sector. Despite all the efforts to combat these problems, Zambia still experiences high inflation (double digits) levels due to increases in money supply and currency devaluations. Thus, it is still a long process before it can integrate with SADC member states and adopt a single SADC currency. From Table 2.6.4 it is evident that there are four SADC member states using managed floating exchange rate regimes. These states are Madagascar, Mauritius, Mozambique and Tanzania. Characteristics of these countries that stand out are their moderate economic growth rates with stable economies, which serve as a “stabilization effect” in SADC with greater integration prospects in the future (Allen and Gandiya, 2004; Jefferis, 2003; IMF, n.d). The type of classification of income countries in SADC also has an effect on the choice of exchange regime chosen

In analyzing the most appropriate exchange rate regime choices for SADC countries, countries classified as low per capita countries should adopt a conventional/fixed peg exchange rate regime. This conventional/fixed peg exchange rate regime will also allow for a strong form of integration in the future. Middle-income SADC countries, such as South Africa (ZAR) should adopt a floating or managed exchange rate regime. Another variable which influences the choice of exchange rate regime is the extent to which the capital markets are developed. A capital market integrating with global capital markets should adopt either a floating or fixed exchange rate regime (Simwaka, 2010:5).

Now that the dual exchange rate system that currently exists in SADC has been discussed together with the countries’ level of integration, the impact that a common currency has on the anchor currencies can be addressed.

2.6.2 SADC dollar on Anchor Currencies: ZAR and Botswana pula

As mentioned previously in the dual exchange rate system, SADC countries' exchange rates are pegged to the anchor currencies' floating exchange rates⁶². This is a situation which would only occur for the South African rand (ZAR) and the Botswana pula. If the SADC dollar had to replace the dual exchange rate system currently in place, it would have the following effects on the anchor countries' exchange rates:

- 1.) Rise in both short- and long-term interest rates and could result in SADC having an additional risk premium for investors.
- 2.) This risk premium would cause the ZAR and the Botswana pula to devalue relative to other major currencies (Kröhne, 2006:36).

While this could be considered as a disadvantage, it may have many advantages. Firstly, the competitive environment is improved with an increase in exports by South Africa and Botswana. Secondly, investment spending by companies in South Africa and Botswana would increase. This may be due to corporations in these countries wishing to gear and prepare for the SADC dollars introduction. While Botswana is the strongest economy with the strongest currency in the SADC region, SADC investor survey (2001) listed numerous challenges in the investment environment for Botswana. This has resulted in the ZAR being chosen as the anchor currency. The challenges faced by Botswana include:

- (1) In the short to medium term Botswana would have strong fundamentals (macroeconomic). However, in the longterm social issues must be dealt with and industrial activity diversified. This may limit foreign direct investment (FDI) inflow by investors into Botswana.
- (2) A large regional shift has occurred from Zimbabwe to South Africa.
- (3) Public sector operations have been relatively slow.
- (4) Botswana's major source of wealth is the resource sector. In order to stay an economic force in Africa it must diversify into the services sector as well as the industrial sector.

⁶² See Meissner and Oomes (2008) on the determinants that countries use when choosing which country to use as their anchor currency.

(5) HIV/AIDS is a major factor impacting the employment figures in Botswana and ultimately the productivity of these corporations.

Another reasons for choosing the ZAR as the anchor currency besides all the challenges faced by Botswana are its large cross-border investment activity with the other SADC member countries. Other reasons for South Africa's role as anchor currency include its moderate business cycle synchronization, largest GDP in the region with SADC and very high correlation with the G-7 countries (Kabundi & Loots, 2006:1). Although South Africa can be regarded as "the Germany of the EMU", there are still some key areas to develop in this investment environment, namely: (1) achieving macroeconomic as well as political stability; (2) focusing on promoting investments by considering the perceptions of investors on a broader level and (3) by promoting FDI (SADC investor survey, 2001). This is dealt with in section 2.7.5. By separating South Africa from the SADC region, an analysis can be done of the implications for investors (domestic and foreign).

2.6.3 An Analysis of South Africa with the SADC Region

Even though South Africa is positively viewed by foreign investors as a result of the (1) sophisticated infrastructure, (2) industrialized local market and a (3) fiscal and monetary policy which is well controlled, there is still a lot of pressure exerted on South Africa to be an anchor currency in the SADC region (SADC investor survey, 2001). SADC investor survey (2001) found that in the South African economy medium-sized enterprises are the main inhibitors of growth. The constraints which ultimately affected business growth were (1) low demand for SMME's, (2) high cost of capital due to high interest rates and (3) infrastructure constraints. The impact that SMME's have had on South Africa is highly relevant to investors. While numerous authors mention macroeconomic variables which affect business, SMME's react more adversely than large multinational corporations or micro-companies. Thus it is crucial that foreign investors understand. Kabundi and Loots (2006:4) list an investment measure that foreign investors can use in their analysis of the SADC itself or SADC member states with reference to the anchor currency, namely:

$$\frac{\text{Investments}}{\text{GDP (USD)}}$$

This ratio, when equal or greater than twenty five percent, results in an acceleration of economic growth. If many of the countries in the SADC have an investment/GDP ratio equal to or greater than 25% of the anchor currency (ZAR), the region could expect a form of sustainable growth.

Next, the single SADC central bank is compared to the central bank of the EMU.

2.6.4 SADC Central Bank versus EMU Central Bank

At euro introduction in 1999, the three main sectors of the money market were the swap market, the repo market and the unsecured deposit market. The unsecured deposit market was the largest sector of the money market contributing to about 53 percent (Reszat, 2003:27). The reason for explaining the money markets effects at euro introduction are due to a similar situation resulting for some SADC member states. The introduction of the “SADC dollar” will cause the money markets to change leaving only three evident sectors remaining. This effect on the money market will have an indirect⁶³ effect on the interbank market which will ultimately result in derivative instruments being valued differently in this single SADC market.

The interbank market provided smooth integration and an efficient distribution of liquidity leading up to the introduction of a new common currency in the EMU. With a few months remaining until the formal introduction of the new single currency, there was a lot of uncertainty on the reference yield curve which was going to represent the European money market. This money market deposit rate or EURIBOR was competing against the EURO LIBOR rate calculated by the British Bankers Association (BBA) in London. Market participants were more in favour of the EURIBOR rate and removed all their derivative products from the EURO LIBOR rate using the EURIBOR as the preferable rate. There was also a rise in interbank market activity and in claims that European banks had post-euro introduction. Prior to euro introduction, the claim was on average \$650 billion, with a substantial rise to approximately \$1000 billion post euro (Galati & Tsatsaronis, 2003:168).

⁶³ See European Central Bank (1999:12); European Central Bank (2001:20)

The table below shows the indirect measure of integration with the average bid-asks spreads decreasing for the EMU region post 1999 to an 8.5 bid-ask spread, whilst Germany, France and Italy had bid-ask spreads of 8.8 with constant standard deviations of 3.1 percent. Although there was an increase in the bid-ask spread post-euro introduction for the EMU region, this increase was still lower than the bid-ask spreads of the individual EMU member states. There was also a decrease in standard deviations post euro introduction for the EMU region from 3.1 percent to 1.8 percent. An international comparison of the EMU with the United States of America and Japan demonstrates that on average, the EMU has better bid-ask spreads post euro introduction. Another interesting observation from the table below is that the longer the euro exchange rate circulates, the lower the deviation among the bid-ask spreads and for the individual member states. Consider 1999 where the standard deviation in the euro area was 3.1 percent while in 2002 it was 1.8% percent.

Table 2.6.5: 3 Month Bid-Ask Spreads

	1996	1997	1998	1999	2000	2001	2002
Euro area average (Stand. dev.)	14.4 (3.0)	12.4 (3.5)	9.7 (1.8)	8.9 (3.1)	8.5 (3.1)	9.2 (2.7)	9.2 (1.8)
United States average (Stand. dev.)	12.5 (3.0)	11.3 (5.3)	8.8 (4.0)	9.0 (2.9)	10.3 (2.5)	10.0 (2.5)	9.5 (1.7)
Japan average (Stand. dev.)	12.0 (2.0)	9.7 (3.7)	11.9 (3.3)	10.5 (5.9)	10.0 (1.5)	9.8 (1.50)	8.6 (2.0)
Germany average (Stand. dev.)	16.5 (6.3)	15.1 (7.6)	8.2 (2.9)	9.2 (4.1)	8.8 (3.1)	9.2 (2.7)	9.8 (1.2)
France average (Stand. dev.)	14.1 (4.6)	11.2 (2.7)	11.3 (3.0)	8.7 (2.8)	8.8 (3.1)	9.2 (2.7)	9.8 (1.20)
Italy average (Stand. dev.)	11.3 (2.3)	9.3 (2.4)	10.1 (2.8)	9.0 (2.6)	8.8 (3.1)	9.2 (2.7)	9.8 (1.2)

Source: Galati and Tsatsaronis, 2003:168

From the table above, the establishment of the EMU has caused a significant reduction in the bid-ask spreads among EMU member states. On average it has resulted in lower bid-ask spreads for the region. It can thus be argued that a similar situation would result for the SADC region. However, the extent of this reduction would depend on the characteristics, shortcomings and the level of integration of the region in the future.

2.6.5 Review of the SADC Region

The combined GDP in the SADC is approximately \$176 billion with a population of 190 million in 2004 (Allen & Gandiya, 2004:31). Thus, on a GDP per capita basis SADC is one of the largest untapped markets with some of the largest gains to be made by investors in the world. Before investors would fund the developments of such a region or invest in corporations in SADC, the aims, characteristics and shortcomings must be understood. Table 2.6.6 below provides a summary of the SADC Region.

Table 2.6.6: Overview of SADC

Major Aims	Key Characteristics	Shortcomings of the Region
<ul style="list-style-type: none"> Economic Harmonization 	<ul style="list-style-type: none"> Large Amounts of Energy Resources 	<ul style="list-style-type: none"> Violence
<ul style="list-style-type: none"> Free Trade 	<ul style="list-style-type: none"> Diversified and Rich Minerals 	<ul style="list-style-type: none"> HIV/AIDS
<ul style="list-style-type: none"> Single Currency 	<ul style="list-style-type: none"> Booming Agricultural Sector 	<ul style="list-style-type: none"> Adverse Regulations on FDC
<ul style="list-style-type: none"> Democracy with Human Rights 	<ul style="list-style-type: none"> Sufficient Human Resources 	<ul style="list-style-type: none"> Resource Inflow Declining
	<ul style="list-style-type: none"> Good Infrastructure 	<ul style="list-style-type: none"> Large Debt Burden
	<ul style="list-style-type: none"> Developing Industrial Sector 	<ul style="list-style-type: none"> Credit Risk
	<ul style="list-style-type: none"> Large Tourism Industry 	<ul style="list-style-type: none"> Different Production Structures Among Member States

Source: Allen and Gandiya (2004:31)

If these key characteristics are managed correctly during the integration process and until the SADC dollar is introduced in 2016, this region can become one of the most influential forces in the world with good profits/returns for investors. Investors must however take note of the shortcomings in the SADC with emphasis being placed on the large debt burden and differing production structures among the SADC countries. Allen and Gandiya (2004:31) list reasons for this large debt burden carried by SADC member states: (1) Failed projects; (2) corruption⁶⁴; (3) natural disasters and (4) corruption resulting in trade practices which are not just. The different production structures in the various SADC member states can be regarded as a major shortcoming. Investors should realize that at the moment there is a large gap among these member states with endless investment opportunities. The closer to the date

⁶⁴ The World Bank publishes a corruption index that investors could use.

when the SADC dollar exchange rate is introduced or until the SADC reaches monetary union status, the smaller these investment opportunities will become. Now that some generalizations have been made about the region, the development of the financial system of SADC is discussed from a broader perspective.

2.6.6 SADC Financial System Development

Research was done on different aspects of the financial system in a Sub-Saharan African (SSA) context. Although SADC is only a REC or region in SSA, deduction and conclusions were made for the financial system of SADC. Only the most recent articles on SSA were used due to very old articles having no value in an emerging market context. This showed that banks are integrating in SADC member states and answers some of the questions listed above.

Ncube (2008:30) considers how financial systems have operated during the evolution of a monetary policy in SSA. He defines the financial system as comprising a banking system, corporations involved with banking and lastly capital markets. Firstly, the banking sector in SSA and SADC was considered. When analyzing the banking sector in these regions, a number of questions arise. Questions such as would banks in SADC integrate, how would it be measured over a time series, would extensions of CMA into SADC be an optimal approach from a financial perspective, main reasons for banking crises in emerging markets, are banks efficient and lastly, what determines the profitability of commercial banks in SSA? Aziakpono, Kleimeier and Sander (2007:28) conducted a study on a few of these questions and found that the interest rates of the different banks in SADC were unilaterally set using convergence clubs in the integration process. They also found that extending the CMA to SADC would be an optimal approach provided it is aided by financial policies on development.

Banking crises in SSA were heavily influenced by variables which also caused banking crises worldwide. These variables listed by Daumont et al. (2004:41) were (1) macroeconomic shocks; (2) involvement of the government and (3) a less stringent legal framework. According to Daumont, Le Gall and Leroux (2004:42), the major effect of banking crises in the

SSA countries were due to the intervention of the government which occurred along three channels, namely:

- The environment that banks operated in on macroeconomic and legal level,
- The structure of the market and
- The general operations of the bank which consisted of the granting of debt.

Thus, ways to prevent future banking crises would be to put in place more stringent laws and provisions that limit the intervention of the government in the financial system. Although the article by Daumont et al. (2004) provides a good framework for the prevention of banking crises, it can be criticized for the small sample size of only 10 countries and for the fact that only one of these countries, Tanzania, falls within the SADC region⁶⁵. This makes it difficult to draw conclusions for the SADC region.

Kablan (2010:18) answers the question whether banks in SSA are efficient. He links this efficiency to the level of financial development of the financial sector. A summary is provided below.

Table 2.6.7: Summary of Bank Efficiency in SSA

	Banking Efficiency in SSA	Level of Financial Development in SSA
Model used	Stochastic Frontier Analysis (SFA) with one step process.	Generalized Method of Movement Systems (GMM)
Definition	Efficiency is the potential of banks to produce the greatest output with the least amount of resources.	Financial development is the growth of all sectors of the financial system or since a country receives independence.
Description of Models	Plots a cost efficient frontier which is stochastic in nature.	Form of M2 (credit)/GDP.
Advantages of Models	<ul style="list-style-type: none"> • SFA is not sensitive to any outliers. • The random error terms are separated from an inefficient production unit. 	<ul style="list-style-type: none"> • Ignores the openness of the economy⁶⁶. • Takes into account competitiveness. • Looks at the extent of public borrowings.
Negative Factors	<ul style="list-style-type: none"> • Regulatory Environment • Credit Environment 	<ul style="list-style-type: none"> • Inflation • Political and economic Environment

⁶⁵ According to the article by Daumont et al. (2004), Tanzania lost 10% of its GDP during the banking crisis of 1987-1990 which is relatively small and insignificant in comparison to the 49% lost by South Africa during the sub-prime crisis in 2007/2008.

⁶⁶ Less requirements than OCA.

	<ul style="list-style-type: none"> • Non-performing Loans (NPL's) • Capitalization • GDP per capita 	<ul style="list-style-type: none"> • Corruption • Foreign bank penetration
Conclusion	Banks are cost efficient with a rating of 76% (Efficiency scores are used: Calculates the optimal amount of factors of production used to generate short-term and long-term loans). Banks are, however, constrained by the factors listed above.	There is a low level of development in the SSA region.

Source: Kablan (2010)

From the table above it is evident that banks are cost efficient with a 76% efficiency rating with a low level of financial development presently due to the negative effect of foreign bank penetration. If the banking sector is fully representative of the financial system, a banking sector which is more efficient would cause an increase in the level of financial development. Some aspects which should be improved in SADC countries for this to occur are: (1) sounder legal support for banks and clients and a (2) credit environment which is more sound (Kablan, 2010:20). As mentioned previously, banks are cost efficient. This efficiency has not been able to further the level of financial development in the region due to certain constraints. The major constraints hindering this development are the credit environment and the penetration of banks owned by foreign corporations in the region. Under the credit environment constraint, Flamini, McDonald and Schumacher (2009:1) found that commercial banks in SSA had larger profits and on a micro level had larger return on assets (ROA's). By ignoring credit risk⁶⁷ these ROA's were primarily a function of the size of the bank, the type of ownership and the diversification of the banks' activities. Another factor that they found that caused these high commercial bank profits were macroeconomic variables. These macroeconomic variables promoted inflation levels which were low and boosted the expansion of credit together with output growth. Under the second constraint, of banks owned by foreign institutions in SSA, these banks may offer many advantages to a region, such as an increase in banking efficiency. They do not necessarily have an impact on commercial banking profitability. A reason is that banks owned by foreign corporations are subject to the

⁶⁷ Flamini et al. (2009:7) measured credit risk as the ratio of loans/deposits. Another approach that is used in academic literature to measure credit risk is loan loss provisions. They hold that the latter is not often used as it forms part of the revenue component which complicates matters.

same conditions as local banks. One way to increase the profitability of these commercial banks in the region is to enforce policies which entice greater capital requirements (Flaimin et al., 2009:16). Now that the financial sector of the financial system has been discussed, the funding of these banks via the capital markets is considered.

Capital markets in the SADC were also considered. The creation of the derivatives market in South Africa has provided additional capital inflows (FDI), enabling market participants to diversify, transfer and value risk. This has all been possible with stringent laws and regulatory mechanisms. Using South Africa as an example for the SADC, the SADC could establish a regional exchange with a derivatives market. Some advantages include: (1) Allowing countries in the SADC to use derivatives from the regional exchange to protect against volatile capital flows from foreign investors into the SADC region. (2) As the majority of SADC countries are large producers of wheat and seasonal products, seasonal risk can be removed or managed using commodity derivatives on the regional exchange. (3) Establishing a regional exchange for the SADC will allow smaller SADC member states to trade their local securities. (4) Greater price discovery with smaller SADC member states generating a lot of financing. This establishment of a regional exchange with a derivatives market must be aided by stringent laws and regulators which reinforce the premise put forth to prevent banking crises in SADC member states (Adelegan, 2009:18).

The establishment of a single capital market in the SADC or the transition to a regional currency, "SADC dollar" may attract foreign direct investment. Some authors regard this as a negative consequence as it entices speculators into the SADC market, which results in short-term currency devaluations and later causes currency misalignments. Other academics argue that the additional capital flow over the long term may be advantageous to a new currency serving as a stabilization effect. Due to literature providing mixed results, only FDI as it relates to SADC economies have been discussed. Figure 2 below shows the FDI inflow into the different SADC member states and average for the region from 1987 until 2000.

Figure 2.6.1: Average growth of FDI inflow into SADC

	1987 -1992	1993	1994	1995	1996	1997	1998	1999	2000
	Annual average								
Angola	178	302	170	472	181	412	1 114	2 471	1 800
Botswana	-29	-287	-14	70	71	100	96	37	30
DRC	-11	7	-2	1	2	1	1	1	1
Lesotho	11	15	19	275	286	269	262	136	223
Malawi	12	11	9	25	44	22	70	60	51
Mauritius	25	15	20	19	37	55	12	49	277
Mozambique	12	32	35	45	73	64	213	382	139
Namibia	44	55	98	153	129	84	77	111	124
Seychelles	19	4	15	40	30	54	55	60	56
South Africa	-24	-17	334	1 241	818	3 817	561	1 502	877
Swaziland	62	72	63	33	-62	-48	165	90	-37
Tanzania	3	20	50	150	149	158	172	183	193
Zambia	102	2	40	97	117	207	198	163	200
Zimbabwe	-8	38	41	118	81	135	444	59	30
TOTAL	396	269	878	2 739	1 956	5 330	3 320	5 304	3 964

Source: Muradzikwa (2002:5)

According to this figure, Angola and South Africa had the largest FDI inflow from foreign investors on average. The DRC on the other hand had the lowest FDI inflow over a 10 year period. When considering the SADC as a region, there was a considerable increase from 1998 to 1999. There was also a considerable decrease in 2000. One reason is that 1999 was approximately the time when the euro was introduced and another reason is to the fact that Angola carried the SADC during 1999 due to the Angola kwanza changing to a free-floating exchange rate during this time period.

2.7 ROLE OF EURO INTRODUCTION ON EMU CORPORATIONS

Understanding the role that the introduction of the euro exchange rate has had on corporations in and outside of the euro area, will allow investors (1) to understand the impact that foreign currency has had on multinational corporations (investments, capital structure, cross-border mergers and firm value to corporations in a common currency); (2) to make better risk management decisions and (3) to understand the different components of firm specific risk.

Prior to the euro introduction, the EMU's role with regards to corporations and financial markets was discussed by seminal papers presented by the IMF, Prati & Schinasi (1997) as

well as work presented by Temperton (1999). Temperton (1999:354) drew two conclusions from the euro introduction in an ex ante context. The first conclusion was highlighted by three factors which included, amongst others, increased pressure shown by traditional banks, only one market and newly introduced technology. The second conclusion was the growth from euro denominated issues. Financial institutions in Europe are extremely sensitive to minor variations in the environment they operate in. The exchange rate or interest rate change could result in totally new markets, thus resulting in new risk management tools. Volatility, regulatory concerns, information technologies and transaction costs comprise an environment overlay which is used in business strategy by financial corporations. Thus, the development and introduction of the euro is the largest change in the business environment and therefore is related to financial corporations' strategies (Walter & Smith, 2000:3).

Next, aspects of corporations are discussed from the introduction of the Euro.

2.7.1 Euro's Effect on Foreign Exchange Exposure and Firm value

Before the effect of the euro's introduction on firms and corporations in the EMU can be discussed, direct and indirect foreign exchange exposure must be explained.

Holding all other factors equal, it is generally presumed that firms in open economies trade more, thus being prone to more direct exchange rate exposure (Hutson & Stevenson, 2010:107). Other studies by Miller and Reuer (1998) demonstrate that there is no relationship between export intensity and the level of exchange exposure rate felt by firms. This is later confirmed by Dominguez and Tesar (2001). Counter arguments are for firms in open economies using risk management to deal with direct transaction exposure⁶⁸. Other arguments are in favor of firms using swaps, foreign currency borrowings or operational hedges to manage direct exchange rate exposure (Hutson & Stevenson, 2010:107). Miller and Reuer (1998) examined the use of foreign direct investment (FDI) to manage foreign exchange exposure and found that FDI reduces foreign exchange rate exposure.

The above factors illustrate the method to deal with the direct foreign exposure, namely the use of hedging techniques and foreign direct investment. The exposure after hedging will

⁶⁸ See Wong (2003).

allow for the identification of other foreign factors having an impact on firm value. Prior studies identified two such factors, also referred to as indirect exchange exposure. The first was the mark-ups in both the import and export markets. The second was a “pass-through pricing” in both imports as well as exports markets (Bodnar, Dumas & Marston, 2002; Allayannis & Ihrig, 2001).

There is a lot of controversy around the effect that the openness of the economy has had on foreign exposure with mixed results in the literature. Hutson and Stevenson (2010:118) found that the greater the level of openness experienced, the greater the direct foreign exchange exposure on the firm. While they were able to measure and quantify the direct factors which influenced a firm’s foreign exchange exposure, it was, however, not possible for the indirect factors as it “requires a sophisticated understanding of the firm’s international competitive environment”. They were able to support this statement by finding that the openness of the economy was significantly related to the firm’s international competition. To measure the effect of foreign exposure on firm value, Bris, Koskinen and Nilsson (2002:5) used the following Tobins Q⁶⁹ equation as an approximation for firm value as shown below:

$$\begin{aligned} \frac{A_t - A_{t-1}}{A_{t-1}} &= \frac{(D_t + D_t + RE_t) - (D_{t-1} + E_{t-1} + RE_{t-1})}{A_{t-1}} \\ &= \frac{D_t - D_{t-1}}{A_{t-1}} + \frac{E_t - E_{t-1}}{A_{t-1}} + \frac{\Delta RE_t}{A_{t-1}} \end{aligned}$$

They found, using data on a corporate level, that ten⁷⁰ countries in the EMU that gave up their domestic currencies and started to use the euro common currency, had a 7.9% per annum increase in firm-valuations, in comparison to the countries outside of the EMU. They also found that firms which were influenced more by the adoption of the euro were those that:

- were heavily exposed to currency crises which persisted throughout the nineties;
- experienced large declines in firm value when the euro depreciated relative to other major world currencies; and
- were large firms in contrast to small firms.

⁶⁹ Where A, D, E and RE denoted the firm’s assets, debt, equity as well as its retained earnings.

⁷⁰ Note that 10 countries were used. Greece was excluded due to data restrictions.

In conclusion, the biggest factors that played a role in the increase in firm value were the lowering of firms' cost of capital, together with the change in monetary policy. This was primarily due to the fact that the intra-currency exchange rate risk between the member countries had been eliminated. Other factors which also contributed were (1) greater financial investments in the EMU; (2) increased cross-border mergers and lastly (3) the large amount of integration towards the adoption of the euro common currency (Bris et al., 2002:23). These findings were also supported by Bartram, Karolyi and Kleimeier (2002). Karlinger (2002:15) and De Nardis and Vicarelli (2003) later provided studies considering the impact that a common currency's introduction had on the cost of businesses in a post-euro context. It was found that these costs tend to be low to moderate in both the services as well as the banking industry. All of these above-mentioned factors depend on the level of cross-border trade between countries. If there is no cross-border trade, there will be little benefits.

Vierk and Park(2003:15) listed some implications for corporations' post-euro introduction. The introduction of a single currency removed the restriction that the assets of insurance and pension companies must be invested in the liabilities of the same currency. Together with the reduction in the risks and transaction costs of foreign exchange, it resulted in these savings being used to stimulate the risk of liquid, larger European bond and stock markets. This is also supported by Cyr (2003:992). The introduction of the euro has also resulted in a subdivision of the bond market increasing, namely junk bonds. The rise of all of these new efficient markets had given ready available financing, thus banks were put under considerable pressure to provide new and alternate financing to corporations, resulting in a low cost of capital. The growing bond market in Europe resulted in banks being susceptible to greater competition; the discipline in the market improved; capital costs declined; companies' finances are more transparent to the public; more European countries are rated by Standard and Poor's and lastly more European citizens invested in equity. Galati and Tsatsaronis (2003:166) confirmed these arguments and highlighted some other general consequences for corporations from post-euro introduction, namely:

- The elimination of the risk of foreign exchange.
- Constraints with regard to technical, psychological and regulatory aspects that resulted in market segmentation being relaxed.

- Introduction of new possibilities for lenders and borrowers, which ultimately led to financial strategies that could be diversified.
- Foreign exchange markets resemble that of the anchor currency in light of four characteristics: (a) percentage share of trading in global markets, (b) width of spreads, (c) volatility in terms of \$ relative to ¥ and (d) the anchor currency role.
- Lower barriers to entry, thus increased competition which supports the argument initially put forth by Holder (1999).
- The euro currency helped identify problems with institutional structures already in place and helped to eliminate excess competition of businesses so that optimality and full benefits could be achieved.

Bartram and Karolyi (2003:35) extended the research by Galati and Tsatsaronis (2003:166) to provide several more implications for corporations in the EMU suffering from foreign exchange rate exposures, namely: (1) Euro introduction caused the “volatility of trade-weighted exchange rates” for countries to decline. (2) Firms in Europe eliminated exchange rate risk and promoted intra-trade among one another. (3) Firms⁷¹situated in the euro zone and outside are subject to less market risk after the euro introduction. This reduction in beta results in

- (a) a change in the required return;
- (b) firmbeing able to withstand more business risk;
- (c) the weighted average cost of capital (WACC) declining;
- (d) anincrease in firms’ valuationdue to the decline in WACC; and
- (e) market risk declining which causes a change in the financial leverage of the firm.

(4) As argued previously, a fixed versus floating exchange rate regime was dependent on OCA theory.

⁷¹ Bartram and Karolyi (2003:35) refer to firms in this context as multinationals, which conduct their operations outside of Europe and argue that these businesses benefit more than firms without foreign business.

Bartram and Karolyi (2003:35) stated that such a transition to corporations was solely dependent on “foreign exchange rate exposure⁷²” resulting in a decline in market risk, which was consistent with research by Bartov, Bondnar and Kaul (1996) and in contrast to OCA theory. On the other hand Engel and Rogers (2004:348) also conducted studies considering the impact that product market integration had on corporations’ post-euro implementation. Engel and Rogers (2004:376), however, found that no relationship existed for corporations and foreign exchange rate exposure. They provided two possible reasons, namely: (1) It was too early to draw any conclusions; (2) Integration from the 1990’s up until 1999 provided greater benefits to corporations than the introduction of the euro in 1999, possibly from the monetary policy being harmonized. The Chancellor of the Exchequer (2003) provided three channels that the euro used in order to promote integration:

- 1.) Transaction costs declined for consumers and corporations. This decline estimate is around 0.20% of GDP.
- 2.) Exchange rate volatility declines, which allows both small and large companies exporting goods to benefit.
- 3.) Trade across borders increases which stimulates growth and commerce.⁷³

There has been limited success in identifying the effect of changes in exchange rate exposures on non-financial firm value (Bodnar & Wong, 2003; Griffin & Stulz, 2001; He & Ng, 1998; Bartov et al., 1996; Prasad & Rajan, 1995; Bartov & Bodnar, 1994). Finance theory on the other hand provides a hypothesis denoting the fact that the foreign exchange rate risk should have a detrimental impact on the value of the firm (Dufey, 1972; Shapiro, 1974; Levi, 1994; Bartram, 2008). This resulted in a large gap between the empirical evidence over the years and the theoretical hypothesis (Bartram & Karolyi, 2006:519). Bartram and Karolyi (2006:521) thus published a second paper to examine this phenomenon and provided four important conclusions on this large gap. Firstly, the research of Bodnar and Wong (2003) was used to divide the volatility of the total stock market into a systematic and a diversifiable

⁷² There are several problems in the measurement. The first is a short time horizon may bias results, the second is the type of benchmark chosen by firms and lastly the macroeconomic/capital market effects are usually not chosen (Bartram & Karolyi, 2003:36).

⁷³ Supports the argument initially put forth by Rose (2000).

component. With the market risk declining for nonfinancial firms⁷⁴ from the introduction of the euro, the foreign exchange rate was left as the largest part of the systematic risk. Secondly, this market risk reduction was much greater for multinational firms than domestic firms. Thirdly, market beta's declined more for multinational corporations which were inside the euro region than those outside the euro region. Lastly, they concluded that the introduction of the euro resulted in a "net absolute decrease" in foreign exchange rate exposure of nonfinancial firms of approximately 10%. This will, however, be discussed in more detail in the next section.

As mentioned previously, and stated by various authors, the adoption of a common currency has advantages for companies in a common currency region. Eichengreen (1990) listed a few of these advantages from adopting a common currency, namely (1) exchange rate risk⁷⁵ declined, (2) any uncertainty from operating among national borders was removed and (3) intra-zone trading together with investment was enhanced. The first advantage listed by Eichengreen (1990), the decline in foreign exchange exposure, was also cited in policy documents of the EU⁷⁶. While all literature pointed to exchange exposure declining after the introduction of the euro, Hutson and O'Driscoll (2010:468) found that the exchange exposure of firms in the euro zone was greater in comparison to firms outside the euro zone. This finding was in contrast to the work presented by Bartram and Karolyi (2006) and other authors. One possible reason for this difference in results could be the fact that Bartram and Karolyi (2006) used a dataset which extended from 1990 up to the end of 2001. Thus, if they had used more data post 2001, they may have obtained different results. In order to measure this foreign exposure at firm level, Hutson and O'Driscoll (2010:468) used the model initially used and developed by Jorion (1990)⁷⁷, which was superior to most other models determining foreign exchange rate exposure and is regarded in the literature as the model most widely used today. This model by Jorion (1990) together with the firm level exposure coefficients is presented below.

⁷⁴ These nonfinancial firms are domiciled in the euro as well as in the non-euro area, but with assets or foreign sales being made in Europe.

⁷⁵ Note that in this article exchange exposure is put on firms regardless and is the measurement of exchange rate risk.

⁷⁶ See European Union (1995) and European Commission (2007).

⁷⁷ For prior models see Adler and Dumas' (1984).

$$r_t^{ij} = \alpha_0^i + \alpha_1^i R_t^i + \alpha_2^i s_t^j + \varepsilon_t^i$$

Where: r_t^{ij} = stock i return from country j at time t (log difference returns).
 R_t^i = country j's stock index return at time t
 s_t^j = country j's change in trade-weighted currency index.
 α_2^i = firm i idiosyncratic exchange exposure.

Jorion (1990) included the market index in his model to control for macroeconomic effects, for example the movement of exchange rates. The fact that exchange rates and stock prices fluctuate together may be due to the fact that both are affected by similar external or internal shocks. From the table below it is evident that the firm-level exposure increased pre and post the introduction of the euro. In order to measure the extent of this increase in firm-level exposure, the median absolute value was used. There was no significant decline in absolute median exchange exposure in the euro zone after implementation. Although there was a decline for Belgium and Netherlands, this decline was not significant. The Norway firms outside the euro zone had a decline in exchange rate exposure, which was significant at the 5% level. In general the entire sample exhibited greater exchange rate exposure, which was significant even at the 1% level.

Table 2.7.1: Firm-Level Exchange Exposure Coefficients

	Pre-euro period							Post-euro period							Post-pre-euro median	p-Value
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]		
	N	No. neg	No. signif	% Signif	Sig pos	Sig neg	Median abs	No. neg	No. signif	% Signif	Sig pos	Sig neg	Median abs			
Eurozone firms																
Belgium	38	26	6	15.8	3	3	0.85	10	4	10.5	4	0	0.78	-0.07	0.70	
France	174	91	12	6.9	6	6	0.79	73	15	8.6	15	0	0.83	0.04	0.83	
Germany	256	149	14	5.5	3	11	0.54	113	23	9.0	17	6	0.79	0.25	0.00	
Italy	88	42	8	9.1	5	3	0.30	42	8	9.1	5	3	0.57	0.27	0.00	
Netherlands	68	41	12	17.6	3	9	0.83	30	7	10.3	3	4	0.78	-0.05	0.89	
Portugal	34	16	3	8.8	2	1	0.77	15	3	8.8	2	1	2.42	1.65	0.01	
Spain	44	17	4	9.1	2	2	0.56	20	4	9.1	3	1	0.88	0.32	0.02	
Eurozone total	702	382	59	8.4	24	35	0.58	303	64	9.1	49	15	0.80	0.22	0.00	
Non-Eurozone firms																
Norway	29	14	3	10.3	1	2	1.00	18	5	17.2	0	5	0.61	-0.39	0.05	
Sweden	63	27	5	7.9	2	3	0.46	43	3	4.8	0	3	0.46	0.00	0.73	
Switzerland	98	96	32	32.7	2	30	1.02	79	26	26.5	0	26	1.20	0.18	0.06	
UK	262	87	22	8.4	18	4	0.32	73	24	9.2	22	2	0.66	0.34	0.00	
Non-Eurozone total	452	224	62	13.7	23	39	0.46	213	58	12.8	22	36	0.66	0.20	0.00	
Sample overall	1154	606	121	10.5	47	74	0.53	516	122	10.6	71	51	0.72	0.19	0.00	

Source: Hutson and O'Driscoll (2010:470)

Previously the firm level foreign exchange exposure was calculated, controlling for the market exposure. In order to account for the market-level exchange rate exposure, the following equation was used:

$$R_t^j = \beta_0^j + \beta_1^j s_t^j + \varepsilon_t^j$$

Where: R_t^j = the trade-weighted exchange rate index of country j. The index value is then regressed on country j stock market index, resulting in β_1^j measuring this exposure. From the table below it can be seen that pre and post euro introduction the market exposure decreased for all the countries inside the euro zone. This was more significant for countries inside the euro zone than outside the euro zone. Hutson and O'Driscoll (2010:477) thus had to refine their first conclusion, namely that although euro zone firms' exchange rate exposure declined, this was attributable to the decline in market exposure.

Table 2.7.2: Market Exposure

	Pre-euro period					Post-euro period				
	β_1^j	p-Value	R^2	Var s_t^j	Covar	β_1^j	p-Value	R^2	Var s_t^j	Covar
Belgium	-2.459	0.00	0.15	0.61	-1.49	0.641	0.31	0.01	0.45	0.29
France	-2.843	0.00	0.14	0.61	-1.72	-1.015	0.19	0.02	0.47	-0.47
Germany	-1.957	0.00	0.11	0.87	-1.68	-0.991	0.22	0.02	0.68	-0.67
Italy	0.655	0.02	0.03	3.38	2.19	-0.729	0.26	0.01	0.54	-0.39
Netherlands	-3.027	0.00	0.20	0.57	-1.72	-0.956	0.19	0.01	0.53	-0.50
Portugal	-1.016	0.06	0.02	0.86	-0.87	-0.853	0.34	0.01	0.18	-0.15
Spain	-0.295	0.63	0.00	1.32	-0.39	-1.794	0.11	0.03	0.24	-0.43
Norway	-0.359	0.67	0.00	0.99	-0.35	-0.051	0.88	0.00	2.03	-0.10
Sweden	-0.548	0.32	0.02	3.07	-1.67	0.411	0.30	0.01	1.65	0.67
Switzerland	-0.628	0.10	0.03	1.93	-1.20	-1.252	0.01	0.09	1.35	-0.17
UK	-0.120	0.71	0.00	3.05	-0.36	-0.126	0.65	0.00	0.97	-1.20

Source: Hutson and O'Driscoll (2010:472)

Lastly, they tried to determine why the firms inside the euro zone and firms outside the euro zone differed with regard to their foreign exchange rate exposure. They found that firms outside the euro zone were larger, had given special rights to creditors and had also paid out fewer dividends. Once controlling for these country and firm specific factors, they found that the exposures between firms in the euro zone and firms outside the euro zone had been the same increase in foreign exposure post-euro introduction. This had many implications for managers and strategies implemented by the firms that are involved with import and export decisions, namely:

- The increased foreign exchange rate exposure was the result of extra trade and flow of direct investment into the euro zone.

- The hedging of economic exposure was more important than transaction hedging. Transaction hedging was seen as a coincidental outcome by firms.⁷⁸
- Oxelheim and Wihlborg (2005) stress that managers of firms, large corporations or multinational corporations should be aware of the fact that the exposure of foreign exchange rates is a broader concept than what it was in the past. This is the result of international competition, direct investment, capital flow and increased openness. They conclude by reinforcing the premise that exchange rate exposure must be managed at every level: tactical, strategic as well as at operational level.

A better approach would be to see if the firm values of corporations in the EMU have changed post euro introduction. One factor that influences firm values, namely foreign exchange exposure has already been discussed. Other factors that affect firm exposure are discussed in more detail in the sections that follow.

2.7.2 Euro's Effect on Cross-Border Mergers

The first factor which contributed to the change in firm value due to the removal of intra-currency risk in the EMU was cross-border mergers. Bris et al. (2002:13) used two approaches to measure the level of merger activity:

$$1.) \text{ Level of Merger Activity} = \frac{\text{Number of cross-border mergers of firms}_{(it)}}{\text{Total number of listed firms } (i)}$$

$$2.) \text{ Level of Merger Activity} = \frac{\text{Number of cross-border mergers of firms}_{(it)}}{\text{Total number of listed firms } (i)}$$

where i is the i^{th} firm in each country being measured at a specific time period t . They found that the cross-border mergers were greater for small/weak firms within the EMU and concluded that the decline in WACC had a larger impact on firm valuations in the EMU than the amount of cross-border mergers taking place post-euro adoption. Cross-border mergers were merely the result from the long period of financial integration prior to the Euro's

⁷⁸ See studies by Miller and Reuer (1998) as well as Dominguez and Tesar (2001). Miller and Reuer (1998) found that the level of export intensity did not have an impact on "firm-level exchange rate exposure". Dominguez and Tesar (2001) found that an inverse relationship existed between the firm industries trade and the firm level exchange exposure.

implementation. Where WACC⁷⁹ is defined below as the weighted average cost of debt (K_d) plus the cost of equity (K_e) plus the cost of preferred stock (K_p). The cost of equity may be determined with the CAPM as follows:

$$\text{Cost of Equity: } K_e = r_f + \beta_e (R_m - r_f)$$

Bris et al. (2008:3174) list two possible methods which could have resulted in the EMU corporations lowering their WACC post-euro adoption. Firstly, it results in a decline in the risk-free rate (r_f). Secondly, the cost of equity contains a market risk premium component. This market risk component comprises a number of risks, one of which is currency risk. The removal of intra-currency risk among EMU companies results in a decline of the market risk premium. This means that in order to earn the same return on equity as before, more risk has to be attracted. These two factors combined generally result in a decline in the cost of equity which results in a decline in the WACC. Since companies then discount their expected cash flows by a lower WACC, it means that the corporate valuations increase.

2.7.3 Euro's Effect on Financial Investments

The second factor that influenced EMU corporations' firm values post euro adoption was that of financial investments. One of the first findings of financial investment opportunities and firm value (Tobin's Q ⁸⁰), was that there was a positive correlation (McConnell & Servaes, 1990). The greater the degree of financial integration before the euro's implementation, the greater the reduction in the cost of capital and the more investments increased. One reason for the rise in financial investments was due to more acceptable projects being presented. Once hurdle rates changed, it impacted marginal investments⁸¹. Thus, the impact on marginal Q would be ambiguous and would ultimately result in the average Q increasing. It can thus be concluded that there may be a general rise in the level of financial investments due to implementation of a common currency (Bekaert & Harvey, 1995). The degree of financial integration had a tremendous and differential impact on the size of firms in the euro zone, with

⁷⁹ WACC is an acronym for the weighted average cost of capital.

⁸⁰ Q denotes firm value throughout.

⁸¹ See Hayashi (1982) on a detailed discussion on marginal investments.

larger firms being affected more than similar small firms. One reason for this phenomenon is foreign investors being willing to make more investments in larger firms due to lower risk (Kang & Stultz, 1997; Dahlquist & Robertson, 2001; Bris et al., 2006).

The effects of the euro's adoption on the investments of EMU corporations have been studied in a wide range of literature on sector, corporate as well as on the macroeconomic level. Studies on the impact on the macroeconomic level have not been considered in this study as it falls outside of the scope of the study. On the industry or sectoral level, Dvorak (2006:15) found that the euro's introduction resulted in an increase of 5 percent in the level of investments in 1999. This gradually decreased until the end of 2003. He also found that:

- The extent to which financial development has taken place does not have an effect on the amount of financial investment.
- The effect is more evident in industries that rely on a source of foreign financing.
- The euro's adoption had no or little impact on capital allocation (example: the financial markets of the EMU countries have become more competitive resulting in the financing of only those investment opportunities that are most productive).

Some criticism with regards to Dvorak's research may be mentioned. Output, productivity or growth measures used do not capture the marginal product of capital, thus not properly reflecting the impact on capital allocation. On the corporate level Bris et al. (2006:1) expressed that (1) firms in EMU countries which had weak exchange rates demonstrated an increase in their level of financial investments, (2) firms in EMU countries which experienced financial stress also demonstrated an increase in the level of financial investments and (3) the opposite effect was shown by firms in EMU countries with strong currencies which were financially more sound. The study by Bris et al. (2006) reinforced the importance of firms in countries with weak currencies entering a common currency area. They also used a single shock approach, instead of testing the impact of multiple shocks on investments⁸². The euro's adoptions by countries in the EMU have also had an impact on their capital structure.

⁸² See Love (2004) for study on the impact of multiple shocks on financial investments.

2.7.4 Euro's Effect on Capital Structure

The capital structure of a business has implications for prospective and existing investors and managers. This is especially important if the capital structure changes after a common currency is used by companies in a specific region.

Previously, it was pointed out that the integration towards the adoption of a common currency resulted in the cost of capital declining and the longer the period of integration, or size of the firm, the greater the value of the firm will be. This larger firm value raises a question about the capital structure which should be implemented. Bris et al. (2002:16) tested three hypotheses around this question. These hypotheses are:

a.) H_0 : Euro adoption = Optimal trade-off effect

The optimal trade-off hypothesis states that due to the larger firm value, the capital structure as it relates to debt and equity must change to create a new optimal capital structure (Welch, 2002).

b.) H_0 : Euro adoption = Debt-capacity effect

As mentioned previously, the introduction of the euro resulted in firms facing less currency risk inside a specific currency area. This decline in risk implied a lower financial distress risk, causing the value of the firm to rise and eventually resulted in more corporate leverage (Bradley, Jarrel & Kim, 1984). This is known as the debt-capacity effect from introducing the euro.

c.) H_0 : Euro adoption = Strategic-leverage effect

In section 2.7.1 reference was made to the type of corporations that were adversely affected by the introduction of a common currency. These corporations should not structure any of their policies around an introduction of a new common currency. This is known as the strategic-leverage effect (Bris et al., 2002:17). Bris et al. (2002) concluded that the effect of debt capacity hypothesis was the only hypothesis that was not rejected. The reason for this

was the fact that post euro introduction firms were willing to issue more debt due to lowered risk levels. The effect of trade-off and strategic leverage hypotheses were both rejected as having effects on the capital structure once the euro was adopted.

2.8 IMPACT OF EURO ON FOREIGN EXCHANGE MARKETS

The euro's implementation caused many problems in the foreign exchange markets, one such problem worth mentioning is the fact that exchange rates fluctuated more. Another factor which complicated the analysis is the stochastic nature of the volatility of the exchange rates.

In order to determine the impact of the euro, the variables causing the exchange rate to fluctuate randomly must be isolated. These variables include the level of globalization; the behavior patterns of entrants into the market consisting of both institutions and private clients; the relaxation of regulations globally; monetary policy changes; central bank intervention and lastly geographical risks such as inflation. While all these factors give rise to problems, the following conclusions could be drawn using five exchange rate series. The first conclusion is that the volatility process contained asymmetry, with the JPY appreciating and both the AUD and NZD depreciating. Secondly, in a post euro context, the volatility of exchange rate series increased and the correlation among exchange rate series also strengthened. Lastly, inverse correlations were present between the euro and other currencies, demonstrating that the euro is a predominant second-world currency (Zhentao & Asako, 2009:1804). Karlinger (2002:15) also discovered that it caused the foreign exchange market to shrink and a decline of the intra-European currency risk which is presented in Table 2.8.1. This was also later confirmed by research done by Galati and Tsatsaronis (2003:166).

Table 2.8.1 below shows the shrinking of the foreign exchange market post euro's adoption. The average daily turnover of the euro against its EMU currencies declined from 201.10 USD billions to 125.10 USD billions. Against the ECU it declined to 5.6 USD billion in 1998 and totally disappeared in 1999. This shrinking of the foreign exchange market has brought about considerable economic gains. The best method to analyze these economic gains is to observe the revenue lost on arbitrage and currency exchange activity. Through his literature reviewed, Karlinger (2002:17) found that the foreign exchange market was expected to

decline by approximately 10-15%. Thus, the banking system would lose plus minus one percent revenue. He also found that the removal of local EMU currencies resulted in businesses conducting arbitrage strategies losing a large portion of their bond and swap market. The economic gain from these scenarios was that all the costs, which were put into these foreign currencies by banks and companies, could now be used to invest in more productive alternatives.

Table 2.8.1: Foreign Exchange Exposure after Euro Introduction

	Average daily turnover in 1995 (US \$billions)			Average daily turnover in 1998 (US \$ billions)			Average daily turnover in 2001	
	Total US\$	Versus EMU	Versus currencies	Total US\$	Versus EMU	Versus currencies	Total US\$	Versus EMU
US \$		1,313.40	-		1,741.00	-	1,472.70	-
EMU currencies	869.80	551.40	201.10	968.40	709.10	125.10	611.80	498.0
ECU	36.20	25.20	10.90	28.20	22.70	5.60		
Japanese yen	371.40	329.90		407.20	63.30		369.57	325.46
British pound	139.70	102.80		211.90	59.40		207.40	170.01 ⁸³
Canadian dollar	50.35	49.15		68.65	66.63		72.52	70.38
Total	1,571.80	1,313.40		1,981.60	1,741.00		1,617.90	1,472.70

Source: Danthine, Giavazzi & Thadden. (2000:50); Karlinger (2002:16)

2.8 CONCLUSIONS

The introduction of the euro exchange rate has been one of the greatest events or social experiments over the last half century. It was criticized a lot due to the weak macroeconomic performance of countries participating in the EMU. Some of these problems included the fact that the Maastricht Criteria did not promote macroeconomic stability or improve the fiscal balance of countries. Counter arguments are that the euro is still a young currency with a developing framework with results still pending. The creation of the EMU and eventually the

⁸³ Refer to the GBP as well as the CAD, in both of these circumstances the adoption of a common currency (euro) in the trading volume of these currencies to increase.

euro which replaced the ECU occurred over a substantial period of time which went collectively with a long period of financial integration among the EMU countries. The SADC is also currently in a long period of integration and wishes to obtain monetary union status by 2016 as shown in Table 2.5.1 and the figure in Appendix B.

In order for the SADC region to obtain monetary union status it had to adhere to the OCA principles laid down previously. The reason for not regarding the principles in OCA as a fundamental requirement for the adoption of a common currency is due to numerous authors providing arguments that the EMU, in comparison, is still not an optimal currency area. The variable of detrimental importance is the length of integration until a common currency is adopted by a group of countries. While it is difficult to measure the exact impact of the euro's implementation, it is an appropriate approach to provide a thorough analysis on corporate valuations of the companies in the EMU, pre and post euro adoption. This allows investors and managers of corporations to make deductions with regard to how SADC companies would be affected by the adoption of a common currency. Some of the deductions from the literature surveyed can be summarized as follows. Firstly, the change in exchange rates or interest rates will result in one market with new risk management tools for investors. Secondly, the removal of intra-currency risk among EMU countries resulted in large firm valuations with three factors contributing to these large firm valuations, namely: (1) the decline in cost of capital; (2) increase in cross-border mergers and (3) increased investments. The cost of capital factor was shown to be the greatest contributor to increased firm valuations. This change in firm value also had implications for the capital structure. Numerous hypotheses were tested with only one not being rejected, namely the effect of debt-capacity hypothesis. This hypothesis showed that firms in the euro area were willing to issue more debt due to the reduction in the cost of capital. This implies that a similar situation will exist for the companies of the SADC member states.

Lastly, the impact of the euro's introduction on the foreign exchange market was reviewed. The foreign exchange market declined in size, but had favorable benefits for investors. Another interesting finding was the increase in daily currency trading volume for the USD, British pound and the Canadian dollar.

Regardless of currency risk advantages from the adoption of a single currency, there is still mixed results in the literature on the impact that the financial sectors in different regions can experience. It is therefore appropriate to conclude this chapter with an argument held by Mundell (1961:661):

“In the real world, of course, currencies are mainly an expression of national sovereignty, so the actual currency reorganization would be feasible only if it were accompanied by profound political changes”.

CHAPTER 3: CURRENCY FUTURES

3.1 HEDGING USING CURRENCY FUTURES

3.1.1 Introduction

Currency futures are the preferable instrument to test whether a fictitious SADC foreign currency which replaces the ZAR, is an optimal decision. This decision is analyzed over time by considering the basis risk of currency futures hedged positions.

3.1.2 History and development of currency futures

On all global exchanges, the use of interest rate derivatives forms a large portion of the market as well as the contribution to the operation of a healthy market. This was, however, not the case on the JSE prior to 2007. Numerous market participants put forth the idea of a central environment for the trading of interest rate derivatives and this was seen by many as a “one-stop-yield shop”. After careful consideration, the JSE decided to implement the idea of an interest rate central trading environment and consequently an electronic platform that matches orders referred to as the Yield X⁸⁴ was born (JSE, n.d.a).

In the budget speech of 2007, Trevor Manuel, the former South African minister of finance gave the JSE Securities Exchange, or Yield X, permission to trade currency derivatives. This was launched on 18 June 2007, with the USD/Rand or \$/ZAR the first currency being traded and since inception numerous other currencies are being traded.⁸⁵ Trading currencies provides market participants with the following advantages:

- Currency risk can be hedged; and
- Diversification internationally is possible (JSE, n.d.a).

The launch of currency futures on the JSE, with currency exchange rates as the underlying, has resulted in the relaxation of exchange controls internationally. JSE (2009a:1) defines

⁸⁴ Its functioning is explained in section 3.1.8.

⁸⁵ Other currency pairs include the Euro/ZAR, Pound/ZAR and the Yen/ZAR.

currency futures as “[a] contract that allows market participants to trade the underlying exchange rate for a period of time in the future”. The JSE(2009a:1) considers two counterparties that transact. One of these counterparties will buy (long⁸⁶) an underlying which is foreign currency while the other will sell (short) the underlying which is also a foreign currency. The exchange rates for the two different currencies is specified or locked in today for trading at a future determinable date. Chance (2003:102) mentions a few characteristics of currency futures:

- Investors may only trade on a limited number of currencies, one of these being the Euro. This supports the premise that the “SADC dollar currency” will also be used as an underlying.
- Currency futures contracts have a preset size and are quoted by a “quotation unit.”
- Currency futures contracts expire every three months.

Birkner (2008:56) later listed two benefits of using currency futures as opposed to foreign exchange, namely:

- Currency futures eliminate credit risk. This contributes to putting all market participants on an equal playing field.
- Regardless of the size, all market participants have equal market access.

One limitation of the amount of trading in currency futures⁸⁷ is its dependence on the relative⁸⁷ strength of the rand (ZAR). A stronger rand (ZAR) demonstrates a reduced demand to hedge by investors, thus resulting in less trading and less open interest. The reason for this reduction in trading is due to less currency risk⁸⁸ which will be discussed later. On the other hand, the converse is true when the rand (ZAR) weakens (Bonorchis, 2007).

Due to the strong correlation between interest rates and the level of exchange rates, the establishment of the Yield X division of the JSE Securities Exchange serves as the appropriate platform for the trading of currency and interest rate derivatives. Over the years

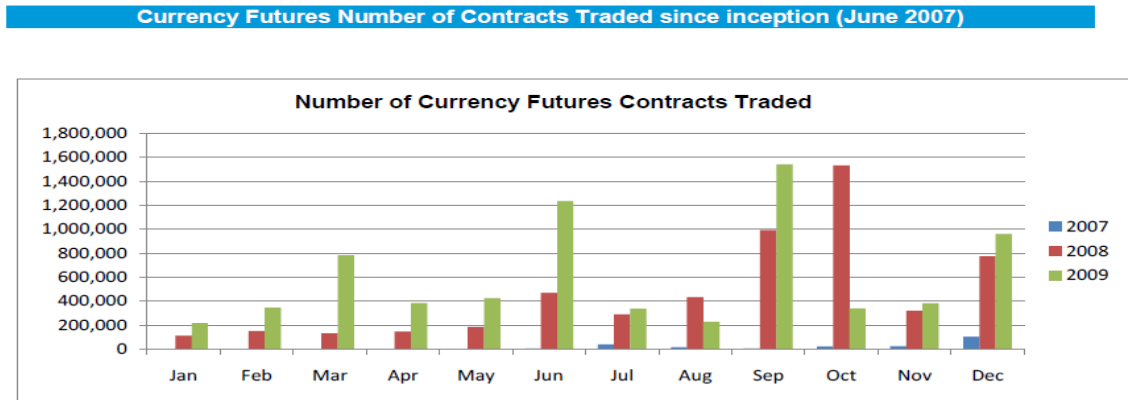
⁸⁶ Buy is a synonym for long, while sell is a synonym for short used in the futures market.

⁸⁷ Relative in this context is in terms of the other four currencies against which currency futures contracts are traded.

⁸⁸ There is less opportunity to speculate and generate returns.

the currency futures market has increased substantially due to the number of currency futures contracts traded. The diagram below shows the number of traded contracts over a period of three years, from 2007 until 2009.

Figure 3.1.1: The Number of Currency Futures Contracts since Inception



Source: JSE (2009b); JSE (2010c)

From the diagram above it is evident that over a period of three years the volume of currency futures traded, increased from under 200,000 in January 2007 to approximately 1,000,000 in 2009. Next, currency futures traded on the JSE, namely Yield X will be discussed together with related concepts and complemented with a news brief from January 2010

A strengthening or gain of the rand (ZAR) allows the retail sector to trade in the currency futures market demonstrated in an article by Bonorchis (2007). In order to support her view, three investors or market participants were interviewed. The first, Saville (cited in Bonorchis 2007), stated that “Liberation would work in favor of the currency”. The second, Du Bois (cited in Bonorchis 2007), stated that the opening of this market would result in (1) greater liquidity, (2) improved stability and (3) sentiment in the market that can be more clearly indicated. Lastly, Giddy (cited in Bonorchis 2007) provided arguments of using currency futures in the South African derivatives market for improved price discovery: corporations would have better access to alternate hedging mechanisms and the size of the currency futures market could also be used as a growth indicator for the local market (Bonorchis, 2007).

Due to the volatility of the rand exchange rate, this risk is borne by the investor. An understanding of currency risk is thus fundamental to the understanding and use of currency futures contracts.

3.1.3 Currency risk

Currency risk is a synonym for foreign exchange rate exposure. Saunders⁸⁹ (2000:311) provides a formula to measure foreign exchange rate exposure:

Dollar loss/gain in currency_i

= [Net exposure in foreign currency _i measured in US Dollars] X {shock (volatility) to the \$/foreign currency _i exchange rate}

Basically currency risk can be seen as any negative change in the exchange rate which results in a loss of income⁹⁰ for a multinational corporation. Although the definition of currency risk differs in the academic literature, a practical explanation could be the impact that unexpected exchange rate changes have on the value of a corporation (Henderson, 2006:139). While, theoretically, currency risk can be defined as comprising of the following four components, namely

(1) Transaction exposure (exposure due to engagement in normal business transactions)

The first component of currency risk is transaction exposure and can be seen as a synonym for a form of cash flow risk. It is mostly present when a firm pays or receives a specific amount in a foreign currency due to engagement in business transactions. Thus, any change in the exchange rate results in an alteration to the firm's specific cash flow (JSE, 2009a: 1). Kolb (2000:273) simplistically stated that transaction exposure had to do with the exchange of one currency for another.

⁸⁹ She stated that the greater the net exposure to the foreign currency or volatility shock, the greater the risk of potential future earnings would be.

⁹⁰ Income in this context refers to the cash flow received and discounted by WACC to obtain the value of the firm.

(2) Translation exposure or balance sheet exposure⁹¹

The second component of currency risk is that of translation exposure and is also referred to as accounting exposure. Translation exposure reflects the extent that the fluctuations in the exchange rate has on the book value of the parent company that uses the home currency to consolidate its financial statements (JSE, 2009a:1). Kolb (2000:273) considers this to be a restating risk.

(3) Economic exposure or operating exposure

This risk is used to determine the variation in the firm's "operating cash flows" as well as market value. The major problem with this risk is the loss of market share which has a vast effect on the firm's competitive position (JSE, 2009a:1). One factor of currency risk mentioned by the JSE (2009a) and ignored in most literature is that of political exposure. This is discussed briefly below.

(4) Political exposure

The last risk inherent in currency risk is political exposure and is determined by the country's government. Two examples include:

- Tax laws and
- The mechanism for exchange control (JSE, 2009a:1).

Doukas, Hall and Lang (1999:1) considered currency risk in the Japanese equity market. They found a significant effect, showing that foreign currency exposure in the Japanese MNC's and high exporting companies should contain a risk premium. They concluded that the currency risk factor is greater for large exporting Japanese corporations than smaller exporting corporations.

Loderer and Pichler (2000:317) also conducted a study on currency risk. They conducted the survey to determine the extent that firms know their currency risk exposure. Their sample consisted of Swiss industrial companies. They found that these industrial corporations do not know their currency risk exposure for the following two reasons: (1) "On-balance-sheet"

⁹¹ Today it is also referred to as statement of financial position exposure.

instruments are used in both pre and post scenarios when exchange rates reach extreme and troublesome rates. (2) These industrial corporations use currency derivatives for short term fluctuations. This was problematic as transaction exposure was not estimated and thus not known. Currency risk has a significant effect on the value of a corporation. This has briefly been discussed in section 2.1.2. Once the EMU was created, currency risk in this monetary union was also affected and its relevance is discussed in the next chapter.

In contrast to considering currency risk in different financial markets, Srinivasan and Yongren (2003) provide a way to measure currency risk⁹². They consider and compare the foreign and local asset market returns. This difference is called a currency effect. They argue that by holding the exchange rate constant, it would result in a currency risk equal to zero. Later AIMR⁹³(cited in Srinivasan & Yongren 2003) argued that when considering the impact of currency risk, using the change in the underlying sport price or ΔS_0 , would not provide a true representation. They concluded by separating the currency effect into two components, namely (1) expected (known) effect and an (2) unexpected (surprise) effect. This surprise component is defined by the AIMR as:

Figure 3.1.2: The Computation of a Currency Surprise

$$\text{Currency surprise}_t = \frac{(\text{Foreign currency spot rate}) - (\text{foreign currency forward rate}_{(t-1)})}{\text{Foreign currency spot rate}_{(t-1)}}$$

Source: AIMR (cited in Srinivasan & Younger 2003)

De Santis and Gerard (1998:375) test the size of the currency risk premium component of the total risk premium for accepting currency risk and consider how this changes over time in different financial markets. They test this using an international capital asset pricing model (ICAPM). This is aided with parametric methods and a GARCH process⁹⁴. They argue that the total risk premium contains an equity risk premium component and a currency risk premium component and they demonstrate the sizes of these components over time in the

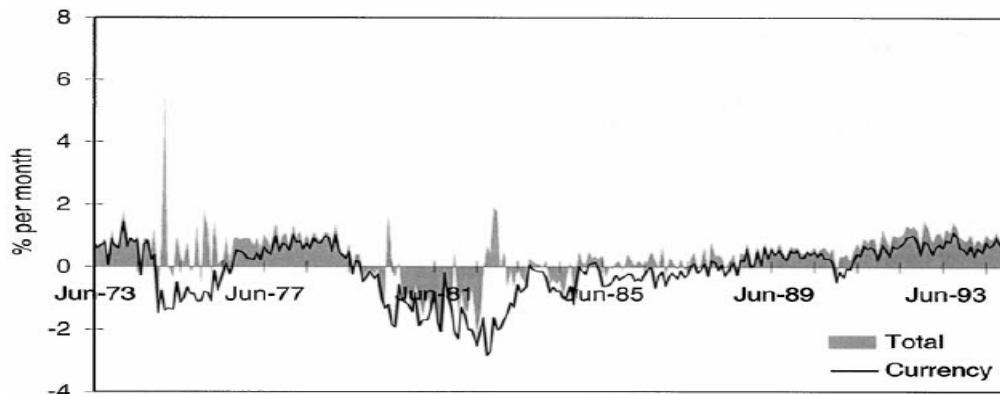
⁹² Henderson (2006:144) applies a contrary Value at risk (VaR) approach, however implements operational limits together with the VaR limits in order to obtain measurable results.

⁹³ Abbreviation used represents "the Association of Investment Management Research".

⁹⁴ ARCH/GARCH models have been discussed in the section under basis and basis risk.

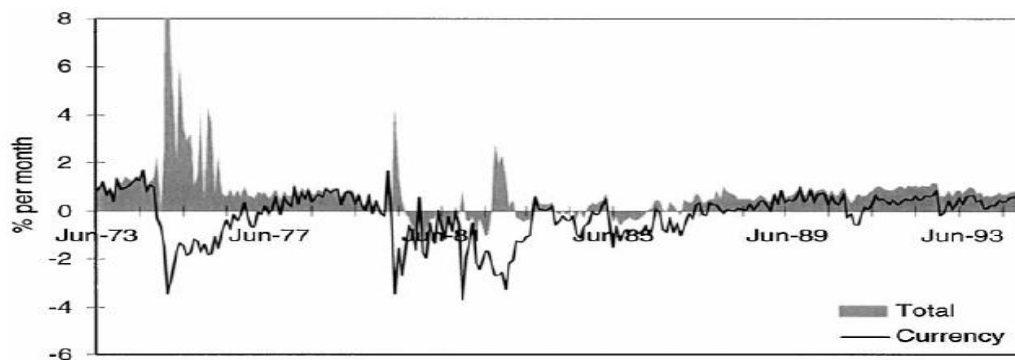
diagrams below, using the data from two financial markets, namely Germany and the United Kingdom.

Figure 3.1.3: Currency Risk premium: German equity



Source: De Santis and Gerard (1998:403)

Figure 3.1.4: Currency Risk premium: U.K. equity



Source: De Santis and Gerard (1998:403)

The diagrams indicate that the total risk premiums for June 1973 until June 1975, June 1977 until June 1979 and June 1989 until June 1994, January 1975 until June 1975 and 1980 until 1984 for Germany and the U.K., are positive values and are primarily driven by a currency risk component. One reason for this negative currency risk component is due to the violation of uncovered interest parity (UIF)⁹⁵(De Santis & Gerard, 1998:375). Although outdated, it may be concluded that if violation of UIF occurs, it results in a negative currency risk premium component. Thus, the total risk premium is predominantly explained by the market risk premium component during these time periods (De Santis & Gerard, 1998:375).

⁹⁵ This is discussed in the section of modeling of currency futures.

3.1.4 Factors that affect exchange rates

JSE (2009a:1) and Pruitt and Wei (1992:456) identify five factors that influence exchange rates, namely:

- The supply and demand for a currency⁹⁶;
- Net imports and exports, also known as the merchandise trade balance;
- Flow of funds (F-O-F) to bonds and stock markets which are also affected by an interest rate differential;
- Balance of Payments (BOP's); and
- The level of relative interest rates. (The level of relative interest rates is present in an economy when the money growth is greater than the growth in real GDP).

Another important concept with exchange rates is the purchasing power parity (PPP). The JSE (2009:2) states that the exchange rate will adjust over the long term to illustrate the differential that exists between price levels. According to Kolb (1997:336), the “purchasing power parity or PPP asserts that the exchange rates between two currencies must be proportional to the price level of traded goods in the two currencies”. He states that the PPP is linked to the interest rate parity, and any violations that occur result in arbitrage, also called Croissant Arbitrage. This will be discussed in more detail in the section dealing with modeling and the pricing comparison of currency futures. Now that the variables influencing exchange rates have been addressed, currency futures will be discussed.

3.1.5 The relationship between currency futures and exchange rates

Studies that consider the relationship between futures contracts and exchange rate variability include Bessembinder and Seguin (1992), Bessembinder and Seguin (1993), Chen, Cuny and Haugen (1995), Chang, Chou and Nelling (2000) and Gulen and Mayhew (2000). McCarthy and Najand (1993) used the deviation in the futures rates in contrast to those of the exchange rates. Adrangi and Chatrath (1998) examined the trading activity of futures in relation to disaggregated open interest.

⁹⁶ When a direct quote of an exchange rate is provided, it is referred to as the spot exchange rate and reflects both supply and demand for that currency.

A more recent study by Bhargava and Malhotra (2007:95) examined if a relationship existed between the trading activity of currency futures and the level of exchange rate volatility. Due to the market containing different market groups, they used open interest⁹⁷ of the currency futures with trading volume to distinguish between day traders or speculators and hedgers in the market⁹⁸. Bhargava and Malhotra (2007:95) used three different forms of volatility, namely:

(1) An intra-day volatility⁹⁹ measure which can be defined as:

$$\sigma_{HL,t}^2 = 0.3607 \left[\ln \left(\frac{H_t}{L_t} \right) \right]^2$$

This model was initially proposed by Parkinson (cited in Bhargava & Malhotra 2007:98). He defined H_t as the highest price for the currency futures contract on day t . L_t can be defined as the lowest price of the currency futures contract on day t . The 0.3607 can be defined as a constant term.

(2) A historical volatility measure which is defined as:

$$\text{HSD} = \sqrt{\frac{\sum_{i=1}^T (R_t - R)^2}{T-1}}$$

$$\text{Where } R_t = \ln \left(\frac{F_t}{F_{t-1}} \right), R = \sum_{i=1}^T \frac{R_t}{T}$$

(3) A conditional volatility measure using a GARCH (1, 1) model.

$$\begin{aligned} R_t &= \mu_{t-1} + \varepsilon_{t-1} \\ \varepsilon_t | I_{t-1} &\approx N(0, \sigma_t^2) \\ \sigma_t^2 &= \alpha_0 + \alpha_1 \varepsilon_{t-1} + \alpha_2 \sigma_{t-1}^2 \end{aligned}$$

Where μ_{t-1} can be defined as the mean denoted as R_t which is also conditioned on prior information. This is demonstrated by the error term, ε being conditioned on normality from the

⁹⁷ See section 3.1.11.

⁹⁸ The different groups of market participants in the currency futures market have been addressed in section 2.1.7.

⁹⁹ Bhargava and Malhotra (2007:95) stated that this volatility measure accounted for both day traders and speculators.

variance of the error terms. The variance at time t (σ_t^2) is a function of the error term and variance in the previous period.

They concluded that day traders as well as speculators are responsible for the destabilization of the currency futures market. While the impact of hedgers in the currency futures market provide mixed results depending on the volatility measure chosen, they also found that if the foreign exchange rate volatility increases, speculators' demand for the use of currency futures declines. This was later confirmed by the research of Arbaeus and Kaziouw (2007). They used Euro currency futures contracts which were not done prior to their study. As mentioned previously, a variable influencing exchange rates is the relative level of interest rates.

When considering alternate financial markets with differing currency areas¹⁰⁰, the development of exchange rates are primarily driven by interest rate differentials¹⁰¹ between these currency areas. The reasons for these differing interest rate differentials include:

- (1) Investors in global markets borrowing capital from countries with low interest rates and
- (2) Investing this capital in countries with high interest rates.

The two reasons provided above do not occur in a systematic fashion, resulting in a complex measurement. One way to reduce this complex measurement is to allow the trading of currency futures on financial exchanges. Currency futures provide the advantages of matching their returns with the returns of carry trades as well as the assessment of how the international financial markets have developed. This is done solely using the "covered interest parity (CIP)" (Deutsche Bank, 2007:30) relationship. They define the CIP as:

$$S_{t+k} - f_{t,t+k} = S_t + i^*_{t,t+k} - i_{t,t+k}$$

Where S_{t+k} is the spot foreign currency at time $t+k$; $f_{t,t+k}$ is the futures price at time t as well as time $t+k$. S_t is the spot price at time t ; $i_{t,t+k}$ is the domestic interest rate at time t as well as $t+k$. $i^*_{t,t+k}$ is the foreign interest rate at time t as well as $t+k$.

Deutsche Bank (2007:30) stated that the left-hand term can be seen as the return on the futures position; while the term on the right-hand side can be regarded as the return on the

¹⁰⁰ Currency areas and optimal currency areas will be discussed in detail in Chapter two.

¹⁰¹ See section four of this chapter.

cost of carry. They state that in international finance these terms are regarded as equal and present similar risk/return characteristics.

Figure 3.1.5: Relationship between Currency Futures and Exchange rates



Source: Deutsche Bank (2007:28)

From the diagram above it can be shown that there are net long positions¹⁰² when the CHF1 = 0.84USD and round about 0.78USD. This is also the scenario when the Yen100 = 0.97USD till about 0.88USD.

3.1.6 Currency futures dispensations

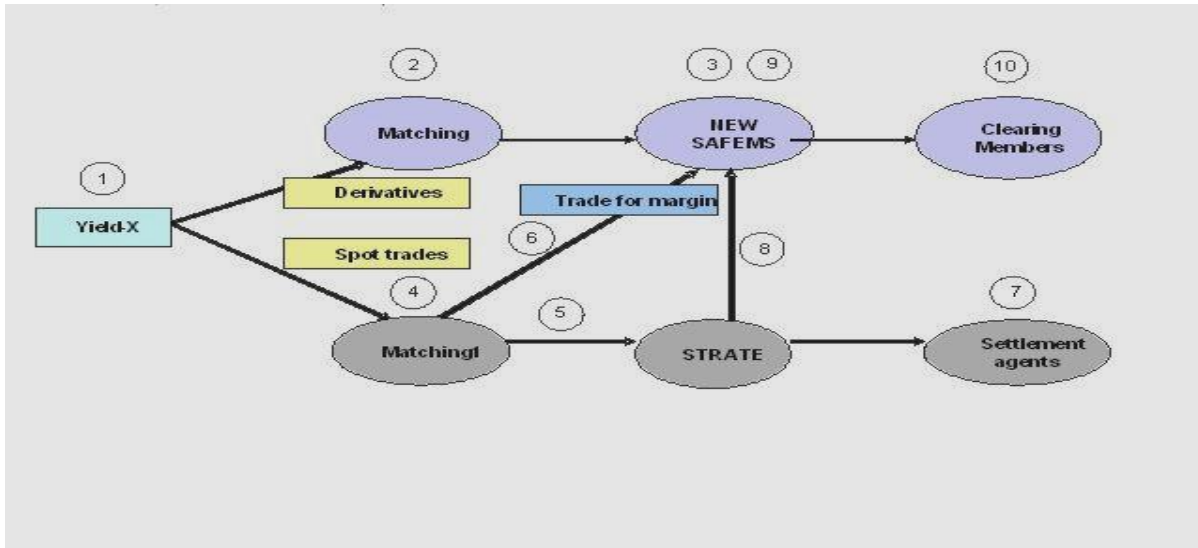
In 2007, the South African minister of finance allowed private individuals to trade above their R2 million foreign threshold, which was also allowed by the South African Reserve Bank (SARB). Thus, individuals had no limits to the amounts they could trade with currency futures. In 2008, the minister of finance allowed all corporate firms to use currency futures. No approval by the Reserve Bank was required and the companies did not have to report these trades (JSE, n.d.a:1).

¹⁰² Net long positions refer to a surplus of long positions when both long and short positions have been offset against each other.

3.1.7 Infrastructure and Market Participants in the Currency Derivatives Market

The currency derivatives market contains the following infrastructure illustrated in the figure below:

Figure 3.1.6: Currency Derivatives Market Infrastructure



Source: JSE(2009:d)

The different nodes or phases as regards the trading of currency derivatives as set out in figure 9 above may be explained as follows:

1. "The derivatives trader enters an order on the front end at the dealing desk.
2. Derivatives trades are matched on a special program regarded as a derivatives automated matching engine.
3. Derivatives are cleared and risk managed by the clearing system through to expiry
4. Spot bonds are matched on a spot bond automated trading engine.
5. Spot bonds are sent to STRATE¹⁰³ for settlement on a T+3 rolling contractual settlement basis.
6. Spot bonds are reported on the clearing engine for clearing and risk management purposes until settlement of the spot bond.
7. Delivery versus payment of securities and cash is handled by the settlement agents.
8. The status of spot bonds is monitored.

¹⁰³ Defined by Bloomberg (2009) as a: "share transactions totally electronic".

9. On final settlement spot bonds are removed from the clearing system and margins are returned to the clearing members.
10. Margin requirements are sent by and collected from the clearing members". (JSE, 2009d).

The market participants¹⁰⁴ in the currency futures market can be classified into four categories:

(1) Arbitrageurs

In general, arbitrage can be seen as the profiting from the pricing discrepancy of an identical underlying instrument that exists on alternate exchanges or financial markets. This general definition is supported by De Beer (2008:15). Jarrow and Turnbull (cited in De Beer 2008:15) state that no cash outlay is required when implementing an arbitrage strategy and one primary characteristic is that of no loss if implemented correctly. Miyazaki (cited in De Beer 2008:15) provides an argument in contrast to Jarrow and Turnbull (cited in De Beer 2008:15), stating that an arbitrage position undertaken was not risk free. Regardless of the amount of risk undertaken, one property of these market participants is the manipulation of prices in alternative markets. One example of this type of price manipulation is the differential that exists between the spot and futures markets (JSE, 2009a:3). Another example of an arbitrage strategy in the foreign exchange market is triangular arbitrage. In this strategy, the triangular arbitrage is achieved from the interaction of three foreign currencies. This interaction is as a result of two properties of log-normally distributed exchange rates. The first is sharp peaks and the second is flat tails (Aiba, Hatano, Takayasu, Marumo, & Shimizu, 2002:478). While arbitrage can be considered as a negative outcome, this study uses log-normal exchange rates, with arbitrage removing any price discrepancies that may exist among the foreign exchange rates.

(2) Hedgers

¹⁰⁴ These groups have been introduced as they may cause temporary distortions in the pricing of currency futures.

This group of market participants uses currency futures as a risk management tool, thus seeking to minimize risk and protect the business from any sudden changes in the exchange rate (JSE, 2009a:3).

(3) Investors

Investors have a long term horizon and use currency futures to generate a greater return from a portfolio comprised of assets only (JSE, 2009b:3).

(4) Speculators¹⁰⁵

Kearns and Manners (2004:21) state that by definition speculators have a predominant role in the currency futures market and only trade to generate profits, not on any fundamentals or on hedging applications. Speculators focus on short-term fluctuations in the exchange rate prices in order to generate profits. Their primary concern is the anticipation in the movement or trend in the exchange rate of the underlying currencies. A healthy market should show characteristics of sufficient liquidity and depth and should contain a balance of the above-mentioned groups of market participants (JSE, 2009a:3). Hereafter, these groups of market participants can choose to trade currency forwards or currency futures.

3.1.8 Forwards versus Futures

Reilly and Brown (2006:852) classify forward contracts and futures contracts into one type of class. Futures differ from forward contracts with regard to three primary characteristics. These characteristics are design flexibility, liquidity risk and credit risk. With the design flexibility characteristic, futures are standardized contracts. Futures are traded on an exchange, while forward contracts can be customized. With the credit risk characteristic, futures have a clearing house, while forward contracts have counterparty risk. This is also referred to as an “over-the-counter (OTC) risk”. With liquidity risk, futures contracts are dependent on trading. Forward contracts can be negotiated into an exit position prior to the expiration (Reilly & Brown, 2006:852). The JSE (2009a: 3) provides the following comparison of forwards and futures contracts and states that both can be used as a hedging mechanism.

¹⁰⁵ See Chatrath, Liang & Song(1997:730) on the role that speculators have on hedgers.

Table 3.1.1: Comparison of Forwards and Futures Contracts

Forwards ¹⁰⁶	Futures
Trading is OTC	Trading is via a formalized exchange
Contract tailored according to individual needs of parties involved.	Standardized with regard to: <ul style="list-style-type: none"> • Quantity • Quotation method • Expiry date • The underlying value
Reservation placed for large corporations	No reservation placed

Source: Adapted from JSE (2009a:3); PSG Prime (Pty) Limited (2009:3).

3.1.9 Yield X

The criteria used to match orders¹⁰⁷ of market participants are price and time priority which results in a currency futures market with transparent pricing. The Yield X also approves trades ex ante instead of using a post checking system. This has the advantage of limiting only those currency market participants that are qualified to trade in this market (JSE, 2009b:3; Adelegan, 2009:5; JSE, n.d.a). Institutional investors are limited with an investment ceiling in the currency futures market. This investment ceiling is a percentage that they may allocate offshore. The first two types of institutional investors, insurance companies and pension funds have 15% investment ceilings while asset managers and investment schemes are constraint to 25% investment ceilings. On the other hand, local market participants and foreign investors from other exchanges have no limits to the amount of contracts that they may enter into in the currency futures market. The only requirement that must be met by local and foreign market participants is that the contract value must be at least USD1 000 (Adelegan, 2009:5).

The JSE (2009a:3) identifies two characteristics of the Yield X division of the JSE, firstly that the performance is guaranteed using a Safeguard command¹⁰⁸. Safcom is the clearinghouse used by the JSE for the Yield X division. The second characteristic is that the contracts are standardized. Two advantages of using standardized contracts are that default risk is reduced and the instruments are more liquid.

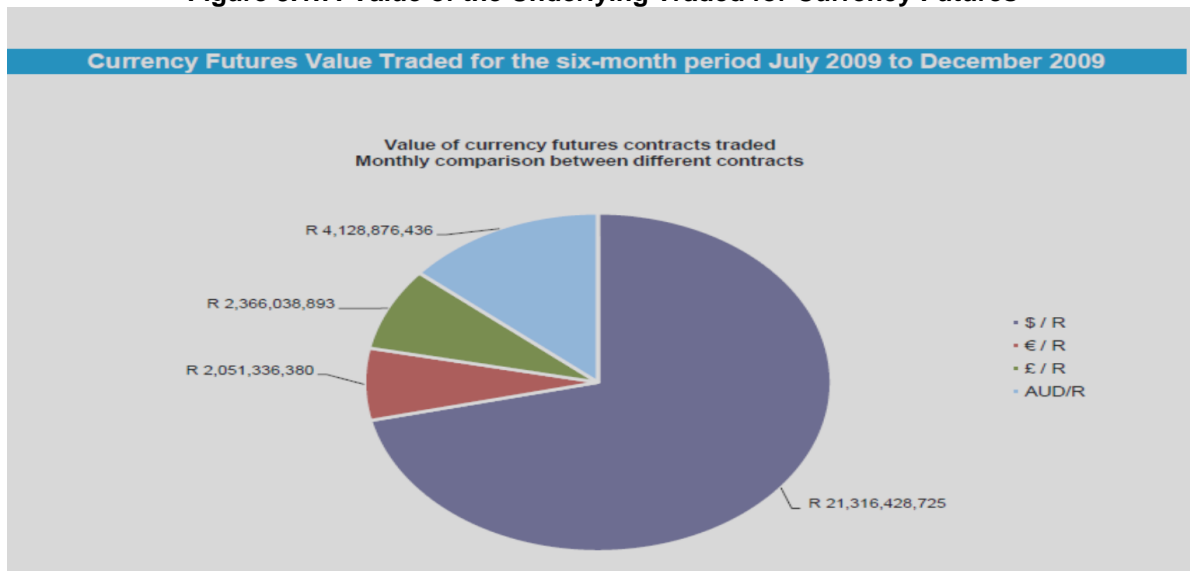
¹⁰⁶ Currency forwards will be used as a synonym to currency futures contracts.

¹⁰⁷ Buy and sell orders from market participants are matched.

¹⁰⁸ Safeguard command is the clearinghouse of SAFEX and the acronym used is Safcom.

The Yield X division of the JSE is also responsible for the modeling of currency futures prices. While three foreign currencies are traded as the underlings in the currency futures market, the USD/rand with currency pairs are used to calculate the different theoretical futures prices. The reason for this is that the euro/ZAR and GBP/ZAR are illiquid contracts (Adelegan, 2009:5). This argument of high liquidity is supported for the USD/ZAR currency futures in the diagram below which is provided by JSE (2009b) for the period of six months. All other futures contracts traded on the other currencies are less liquid.

Figure 3.1.7: Value of the Underlying Traded for Currency Futures



Source: JSE (2009b:4)

The above diagram shows the most actively traded currency futures is the \$/R with R21,316,428,725 contracts executed. This study therefore only focuses on the \$/R as well as the new fictitious currency proposed for this research, namely the USD/SADC dollar that will be introduced for the purpose of modeling. Based on the underlying instruments, futures may be classified into two broad categories, namely commodity and financial futures. This study considers only financial futures and in particular, currency futures. Winstone (1995:118) defines currency futures as a binding obligation to buy or sell a particular currency against another at a designated rate of exchange on a specified later date. Similarly, as it relates to futures contracts, the only variable is the price or the exchange rate in this case. Chance (2003:102) mentions a few characteristics of currency futures:

- Currency futures contracts have a predetermined size and are quoted in units of the base currency.
- Currency futures contracts expire every three months.

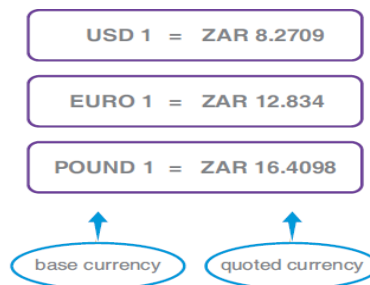
The JSE (2009a:3) provides two advantages of using currency futures, namely:

- All market participants have equal access to favourable rates. No reservation can be placed on these rates for large corporations as stated previously.
- Traders can take a view or expectation of the futures market. This is not possible when using forward contracts.

Before the modeling of currency futures can be understood, the quoting convention and the variables which influence this quotation should be discussed. These factors include marking-to-market, open interest and basis.

The JSE (2009a:3) provides the diagram below on the quotation of currency futures. The foreign currency is referred to as the base currency. When this base currency is quoted in terms of the local or domestic currency, it is referred to as the quoted currency or a direct quote.

Figure 3.1.8: Example of Quotations used



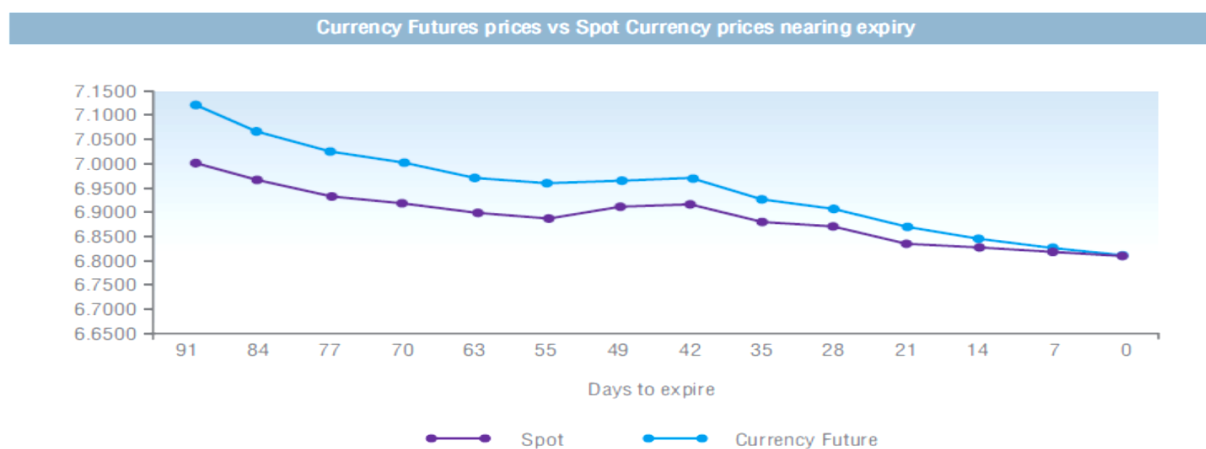
Source: JSE (2009a:3)

Basis spread is an important concept when using currency futures for hedging, speculating, investing or implementing an arbitrage strategy. The basis spread can be defined as the difference between the underlying assets' spot price and the futures price of this underlying asset.¹⁰⁹ According to the JSE (2009a:3), the basis reflects numerous factors called carrying costs. They state that such an example of a carrying cost is an interest rate differential of the

¹⁰⁹Refer to section 2.2 for complete definition from numerous authors.

domestic risk-free interest rate and the foreign risk-free interest rate. As the futures contract reaches maturity, i.e. the days to expiry decline, the basis narrows (it is used up) until the basis spread is zero at contract maturity. If the basis is not zero at contract maturity, then the futures and asset prices have not converged, with Pennings and Meulenberg (1997) arguing that in this situation, the difference would be arbitrated away provided that the costs are not too large. They provide some reasons for the variability in the hedgers' basis which include: market to market factors; tax treatment for both spot as well as futures prices and arbitration difficulty. This is illustrated in the diagram below and will be discussed in more detail in the section on basis and basis risk of currency futures as evident in time series analysis.

Figure 3.1.9: Basis of a Currency Futures Contract over Time



Source: JSE(2009a:4)

The JSE (2009a:5) states that the expiration prices of foreign currency futures contracts are computed from the arithmetic average of spot prices. The spot prices referred to in the figure are for sixty seconds and for the time interval between 12:01 to 13:40. This is done on the basis of one hundred iterations. One hundred iterations must be accumulated in order to compute the expiry price. However, if this is not the case, the process is postponed and the expiry price will only be calculated when one hundred iterations have been accumulated (JSE, 2009a:5).

3.1.10 Market to market of currency futures

As mentioned previously, futures contracts are exchange traded instruments of which the performance of the other party in the transaction is guaranteed. This results in the debiting (crediting) of losses (profits) to each party as a daily price settlement and is also called marking to market (JSE, 2009a:5). This is supported by Rendleman (2002) who states that the advantage of this system is the settlement of profits and losses today as opposed to contract maturity, which could result high credit risk and increased probability of the parties defaulting. The JSE (2009a:5) states that Safcom enters into the counterparty position and thus ensures that there is a buyer and a seller for each position. They provide two measures that are used by Safcom to ensure that in the currency futures market, performance always takes place, namely:

(1) Initial margin

In the currency futures market, the initial margin is deposited in the broker's account by the investor. This is done immediately when the currency futures position is entered into. When this currency futures position is exited the amount of the initial margin is refunded by the broker to the investor. The amount of the initial margin is dependent on the type of the underlying in the currency futures contract (JSE, 2009a:5; Hull, 2006:50; Chance, 2003:87).

(2) Variation margin or additional margin

The variation margin must be compared to the initial margin and not the maintenance margin. The market price used by Safcom is calculated using the exchange rate prices from 16:55 to 17:00 to compute an arithmetic average and this average represents the market price used. When determining the amount that must be debited or credited to investors, the change in today's market price and yesterday's market price is considered. The payment made to these parties is called the variation margin (JSE, 2009a:5; Chance, 2003:85; Hull, 2006:50). Although other concepts are also applicable to the marking to market process, namely price limits which includes (a) limit up, (b) limit down and (c) lock limit, these aspects do not play a predominant role in the currency futures market and will not be considered further.

3.1.11 Currency futures and open interest

Open interest is a crucial variable in currency futures markets with the modeling of currency futures being done throughout this study. By understanding open interest, investors will be able to better understand how currency returns are driven in certain periods together with an analysis of the basis spread. Open interest in futures contracts can be seen as a liquidity measure in the derivatives markets and is representative of both the long as well as short future contracts in the month of delivery (De Beer, 2008:17).

In contrast to a liquidity tool, open interest can also be used as a forecasting tool. Open interest is pro-cyclical and it can more accurately predict the fluctuations in asset prices in comparison to other variables (Hong & Yogo, 2011:1). They built a model to predict currency futures returns with several explanatory variables, namely the: (1) short rate; (2) yield spread; (3) currency basis¹¹⁰; (4) currency market interest; (5) currency returns; (6) currency market imbalance and (7) Chicago Federal Index.

When the currency basis is added as an explanatory predictor, a 1% increase in standard deviation causes the currency returns on average to decrease by 0.35% on a monthly basis. According to the covered interest parity, the currency basis is reflective of the interest rate differential. However, the currency basis has a negative t-statistic on average when added to the model. Thus, the covered interest parity does not hold in the model and is rather reflective of the forward discount factor. Using a rule of thumb of 2 for the t-statistic in academic literature, all explanatory variables in the model are excluded for not being statistically significant except for the currency market interest. This explanatory variable has a t-statistic of 2.3 on average and can be seen as the best predictor of currency returns. When open interest increases in the currency futures markets, it predicts that foreign currencies are going to appreciate relative to the USD. Open interest also provides more information on the economic activity to take place in the future as well as on inflation. This ability to predict additional information is dependent on (1) the demand for hedging and (2) demand curves in currency futures markets which are downward sloping (Hong and Yogo, 2011:1). The decision that a

¹¹⁰ Currency Basis_{i,t,T} is defined by Hong and Yogo (2011 :8) as $= (F_{i,t,T}/S_{i,t})^{1/T-t} - 1$.

foreign multinational corporation makes to hedge exchange rate risk using currency futures, has certain value implications for a multinational corporation and is addressed below.

3.2 CORPORATE HEDGING

Hedging is usually necessary to counter the possibility that market changes may have a negative effect on certain magnitudes in the business. Companies may be exposed to currency risk, not because it is its core business, but because the transactions in which it engages, are coincidental. These exposures may have implications for the value of the enterprise. These aspects are briefly considered in the sections that follow.

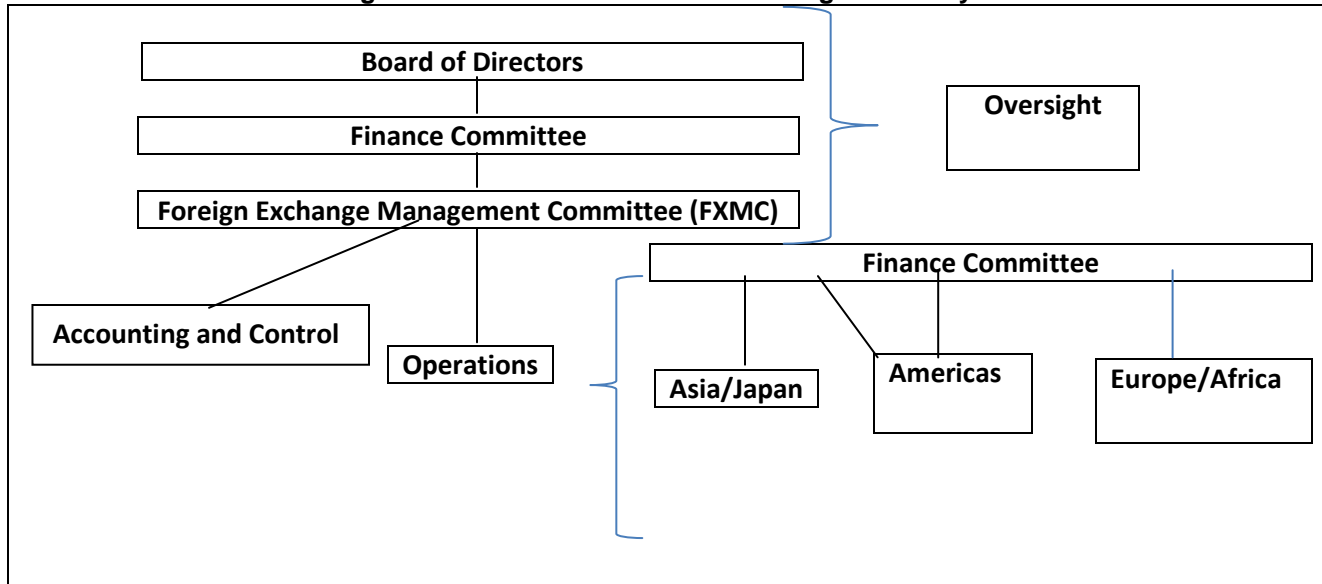
3.2.1 Corporate hedging and company value implications

Modigliani and Miller (MM) (1958)¹¹¹ provided the first theoretical models and theories on optimal capital structure. They argued that risk management¹¹² by the corporation would not cause an increase in the value of the firm. The reason for this was due to private investors or shareholders being able to implement their own and similar¹¹³ risk management strategies as the corporation. Later, the models provided by MM were adjusted for tax as well as external financing. This resulted in risk management later being shown as a value enhancing strategy (Allayannis and Weston, 2001:243). Brown (2001:401) considers two questions when firms implement hedges. The first is the question of how firms hedge and the second question is related to how a firm implements a hedge.

¹¹¹ MM are the founders of optimal capital structure theory and their work is based on numerous assumptions, one of which is that risk management would not increase the value of the firm and we assume this assumption holds relevant to this argument (Brigham & Daves, 2007:519).

¹¹² Risk management and hedging in this context will be used as synonyms.

¹¹³ Similar in this context refers to “perfect substitutes” as put forth originally by Sercu & Uppal (1995:459).

Figure 3.2.1: Process Followed to Hedge Currency Risk

Source: Brown (2001:407)

When considering how firms hedge, the diagram above provided by Brown (2001:407) illustrates the structure of a general U.S. multinational corporation and illustrates the three main operations when hedging currency risk. These operations comprise of (1) operations, (2) accounting and control, together with (3) oversight. The first question of how centers around the hedge exchange rate used in dealing with currency risk. This hedge exchange rate can be defined as a FOREX rate determined by the hedging group of the Foreign Exchange Management Committee of the corporation and can be seen as an ex-ante rate, thus being used for (1) the future estimation of sales budgets; (2) sales targets and (3) strategic decisions (Brown, 2001:403).

The first question of how firms hedge also depends on several factors. The factors that influence how firms hedge are dependent on the cross-sectional differences exhibited between currencies; the unique properties of the different derivative positions undertaken and lastly, the derivative contracts chosen. The second question of why firms hedge is dependent on the asymmetries which result from inadequate information; the different internal contracts that can be facilitated; if pricing was done competitively and lastly, if gains were efficient (Brown, 2001:403). Hagelin (2003:55) considered the question of why currency derivatives were used to hedge firm value using both translation and transaction exposure. His data comprised of survey data complemented with secondary data. The use of survey data

allowed for the differentiation between the hedging of (1) Translation exposure and (2) “Committed and anticipated transaction exposure”.

Hagelin (2003:67) concluded that corporations using currency derivatives to hedge “committed transaction exposure” contain two primary characteristics, namely (i) they have more human capital than other companies and (ii) the amount of institutional ownership declines. He also concluded that transaction exposure that was anticipated after it was hedged would (i) increase with the large human capital that was invested and (ii) decrease by the amount of institutional ownership and lastly (iii) increase the market-to-book value ratio. These variables are, however, unrelated to translation exposure. This supports the premise that corporations using currency derivatives to hedge transaction exposure cause an increase in firm value, while no evidence supports the use of currency derivatives to hedge translation exposure.

In contrast to Brown (2001) and Hagelin (2003) who only considered how and why firms hedge, Allayannis and Weston (2001:243) provided evidence that the use of foreign currency derivatives (FCD) may influence the market value of the firm. In their study the market value of the firm was approximated using a Tobin’s Q proxy¹¹⁴. They showed a 4.87% higher market value for a firm using currency derivatives than a firm not using derivatives to hedge currency risk. Makar and Huffman (2001:421) provided a counter argument stating that the current market values of companies using currency derivatives to hedge contain a downward bias due to the lagged firm value/exchange rate relationship. They concluded that the effect of this lag effect on firm value was significant among low foreign exchange rate users regardless of the particular size of the company using these derivative instruments. The study by Allayannis and Weston (2001:243) was later supported by Aretz, Bartram and Dufey (2007)¹¹⁵ and Campello, Lin, Ma & Zou (2010).

¹¹⁴ Tobin’s Q can be seen as an approximation of firm value. Chung and Pruitt (1994:70) define Tobin’s Q as: “ratio of the market value of a firm to the replacement cost of its assets”. Most financial analysts do not use Tobin’s Q, due to no accurate comparable measures as well as the difficulty in the approximation. While there are limitations in the use of Tobin’s Q, Chung and Pruitt (1994:70) provided a study showing that q still provides the best approximation of firm value even though there are no suitable measures of comparison.

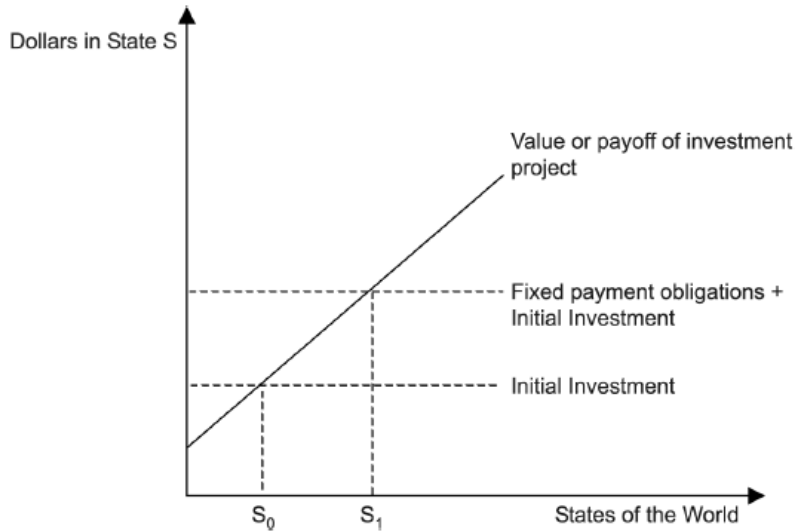
¹¹⁵ Their study is considered as it incorporates the research of numerous authors and due to recency can be seen as a relevant study when dealing with foreign currency exposure as is the case in this study. However, it must be stressed that currency exposure is but one aspect of many aspects that may affect company value. For counter arguments on the use of foreign exchange derivatives and firm value, see Magee (2008).

Campello et al. (2010:20) focus on value implications from the hedging decision. One such implication is the inverse relation between hedging and a corporation's cost of capital. An increase in hedging activities results in a lower cost of capital on loans and vice versa. When corporations hedge a number of advantages are evident. These advantages include: (1) The number of expected cash flows to be realized are limited, thus resulting in companies obtaining external financing more easily; (2) As mentioned previously, cost of capitals is reduced which is indirectly reflected in higher firm valuations; (3) Creditors favour hedging which translates into corporate stakeholders receiving gains. All these advantages allow corporate managers and analysts to obtain a better understanding for the use of derivatives in the corporation (Campello et al., 2010:20). Aretz et al. (2007) focus on the second advantage mentioned by Campello et al. (2010) and show that hedging causes an increase in the value of the firm using multiple scenarios which will briefly be discussed next.

First, they show that imperfections in the capital markets will increase the shareholder value when hedging is implemented. The examples they provide of these imperfections that may impact on company value include (1) agency costs, (2) transaction costs, (3) bankruptcy, (4) the costs involved with financial distress, (5) taxes and (6) risk management in a corporate setting. Secondly, they show that corporate hedging can reduce the underinvestment problem. They state that this occurs due to the stabilization of the cash flows and results in any gain received by the company on the project hardly ever falling below the initial investment value (I_0) and FBO (fixed benefit obligation).

The underinvestment region is shown in the diagram below between S_0 and S_1 . They extended the underinvestment problem from the research provided by Froot, Scharfstein and Stein (1993). The third scenario considered by Aretz et al. (2007:437) is that corporate hedging solves the asset substitution problem, thus preventing any decline in the value of the firm. The fourth scenario they consider is that agency conflicts could be reduced by implementing a corporate hedging strategy. This results in the prevention of investments that are below optimal levels and in assets that were perceived as risky.

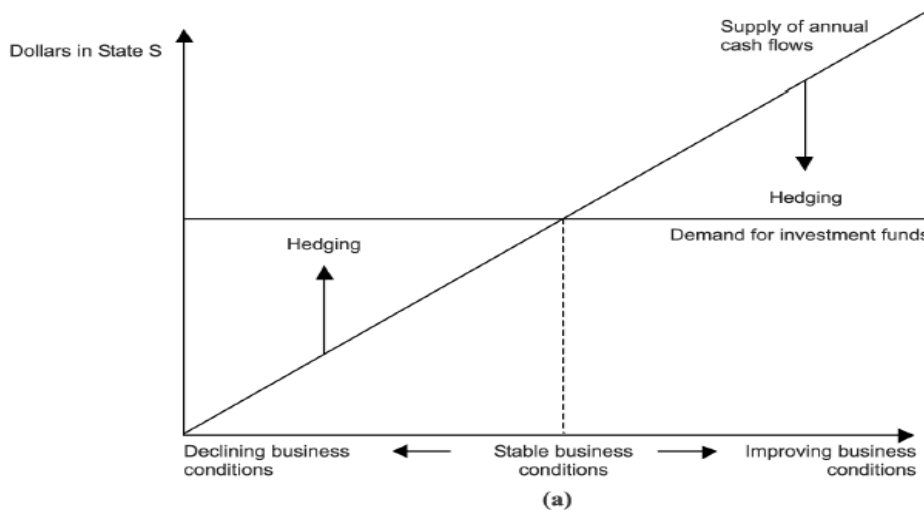
Figure 3.2.2: Impact that Hedging has on Financing and Investing Policies



Source: Aretz, Bartram and Dufey (2007:434)

The fifth scenario provided by Aretz et al. (2007:438) states that corporate hedging provides a stronger relationship between the managerial performance and the quoted market price of the company. They say this coincides with or allows for the more accurate identification of those managers that are efficient and those that are not.¹¹⁶ The diagram below illustrates the impact that corporate hedging has on the matching of both the financing as well as the investing policies of the company.

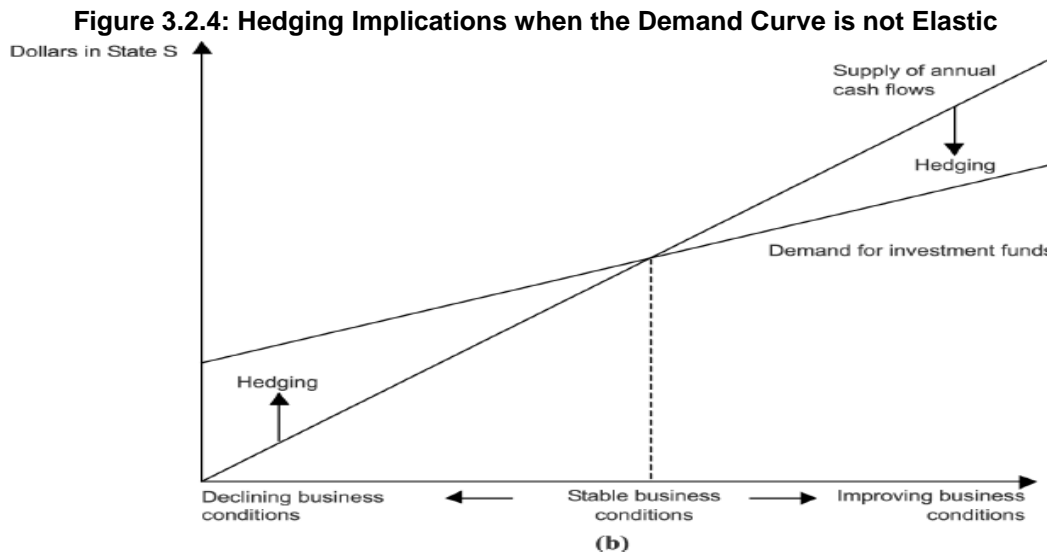
Figure 3.2.3: Hedging Impact: Both Financing and Investing Policies of the Company



Source: Aretz et al. (2007:440)

¹¹⁶ In a manner, this case can be seen as the reduction or possible elimination of any agency conflicts that may exist.

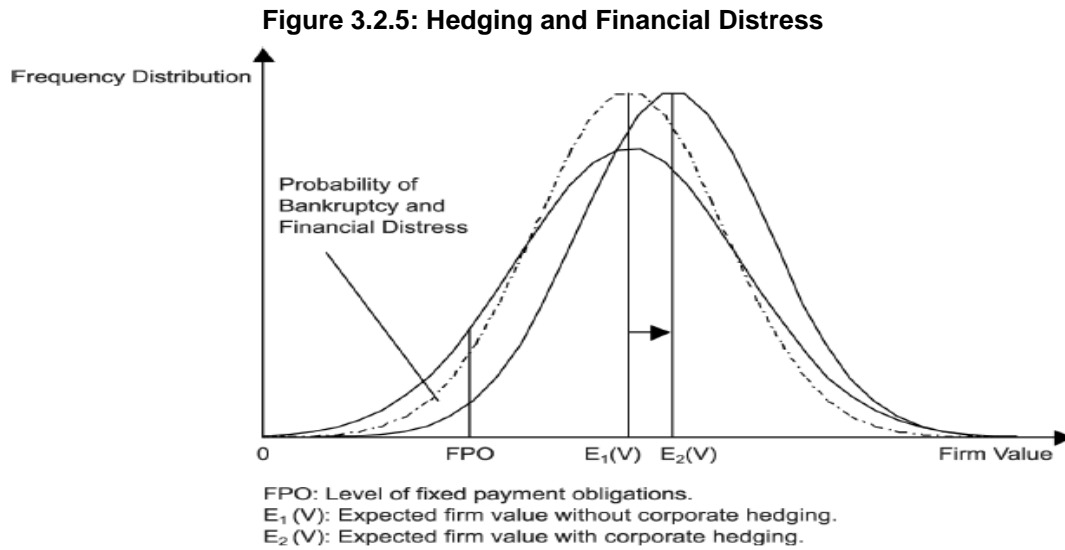
Figure 3.2.3 (a) above illustrates the demand for investment funds, which is elastic, and the supply of annual cash flows. Implementing a corporate hedging strategy will result in a reduction of cash flow surplus (when the cash flow > investment expenditure) or cash shortage (when cash flow < investment expenditure). The end result of corporate hedging is the better alignment of the demand for investment funds and the supply of cash available for investment (Aretz et al., 2007:438).



Source: Aretz et al. (2007:440)

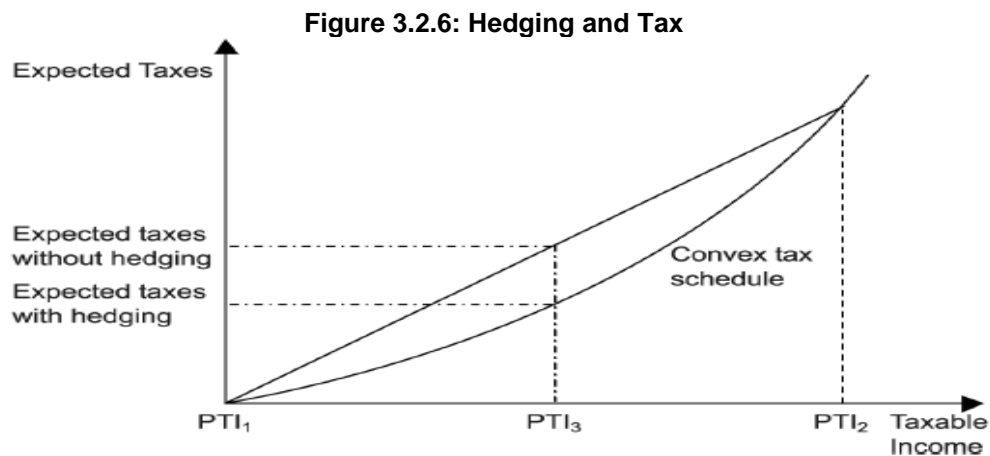
Aretz et al. also provide a scenario where the demand curve is not elastic as shown in Figure 3.2.4 (b) above. They reason that this was due to the partial offsetting of the demand for investment funds with the supply of cash, thus not requiring a complete or full hedge. In this instance, they state that the cash flow is dependent upon the market price. If the market price of the company rises, it results in an increase in the value of investing and thus ultimately causes the internal cash flow to increase. The second-last scenario that is mentioned where corporate hedging could increase shareholder value is where there is a reduction of financial distress costs which may result in an increase of the value of the firm. This is illustrated in Figure 3.2.5 below (Aretz et al., 2007:438). They illustrate that from the implementation of a corporate hedge, the firm value stabilized and ensured a decrease in the probability of the cash flow (CF) declining more than the fixed payment obligation (FPO). This

results in an increase in the value of the firm. This is shown in the diagram below from $E_1(V)$ to $E_2(V)$.



Source: Aretz et al. (2007:442)

Aretz et al. (2007:438) provide the last value implication that hedging has on a corporation, namely that it may help with the reduction in the tax liability which results, once again, in an increase in the firm's value. This is demonstrated in Figure 3.2.6 below.



Source: Aretz et al. (2007:443)

Note in the figure, the tax schedule represents a convex shape. This occurs due to a (1) marginal tax structure and (2) special tax provisions. Implementing a corporate hedge results in the expected tax or $E(\text{tax})$ without hedging being larger than $E(\text{tax})$ with hedging. This is illustrated on the vertical axis in pre-income tax year three (Aretz et al., 2007:443).

While numerous authors support the idea that the implementation of a hedging strategy may result in an increase in the value of the corporation, Nguyen, Faff and Marshall (2007) demonstrate a contrasting view. They argue that this was not the case in an Australian setting as the use of derivatives to hedge a firm's currency exposure resulted in a decline in the market value of the firm. An argument against their findings may be that the time interval of their study was too short. Thus, it can be concluded that generally hedging may result in an increase in firm value.

Next the benefits and cost of hedging must briefly be discussed.

3.2.2 Benefits and Cost of Hedging

Hill and Schneeweis (1984:34) provide a definition of hedging. They define hedging as the offsetting of gains and losses in the futures as well as spot market. Where the underlying in the spot market that is being hedged is identical to the futures price, this is referred to as a perfect hedge. In practice, a perfect hedge hardly ever occurs due to the fact that the value of the underlying and futures contracts available rarely offset each other. Cuthbertson and Nitzsche (2001:622) support the argument that a perfect hedge is hardly ever possible in practice. Reilly and Brown (2006:853) also use the word "offset" in their definition of hedging as opposed to "eliminate". This merely means that any exposure that is deemed to remain on the balance sheet is neutralized with some counter action. Cuthbertson and Nitzsche (2001:622) also argue that a perfect hedge is hardly ever possible in practice. Hull (2006:48) identifies two types of hedges, namely a short and a long positioned hedge. Winstone (1995:118) states that "A long is locked into the higher futures price relative to spot and will therefore lose". The short makes a loss when the exchange rate rises and obtains a profit when the exchange rate falls. The long exhibits a net gain when the exchange rate (local currency for foreign currency) rises and loses when it declines.

A long (short) hedge position is entered with currency futures based on the speculating on the local currency that will depreciate (appreciate) in the future (JSE, 2009b:7). Several hedging theories are put forward below:

- (1) A naïve hedging strategy. In this strategy, two positions are entered into by the investor. The first is long (short) in the spot market with a short (long) position in the futures market. Due to a similar underlying in both markets, this is seen as a perfect hedge (Kroner & Sultan, 1993:536).
- (2) A conventional hedging strategy. This strategy results from those hedges where the underlying in the spot market varies relative to the futures position of that underlying (Kroner & Sultan, 1993:536).
- (3) The hedging from an error correction model, also called a conditional hedge.
- (4) This strategy considers a relationship that is co-integrated in the long-run and the assets dynamic distribution.
- (5) Hedgers act as speculators. Pennings and Meulenberg (1997:600) provide an additional hedging strategy, namely that hedgers could act as speculators. These hedgers only focus on the relative prices instead of the absolute prices. In an earlier article on hedging by Hill and Schneeweis (1984:34), their results illustrate the reduction of foreign currency fluctuations when using currency futures. This compared the standard deviations of hedged as well as un-hedged positions.

In the first three traditional hedge strategies above, the BP, DC, DM, JY and SF were used as the foreign currencies. Prior to hedgers acting as speculators, the conventional hedge strategy outperformed the naïve and conditional hedging strategy (Kroner & Sultan, 1993:536).

3.2.3 Hedging using Currency Futures

Although the research is outdated, it purports the premise that hedging may have been an optimal approach used by corporations to deal with currency fluctuations over numerous years. Table 3.2.1 illustrates the reduction in spot price changes when hedging.

Table 3.2.1: Currency Hedging Effectiveness

Currency	1974–1977		1978–1980 Standard Deviation of Monthly Price Changes		
	R^2	HR*	Unhedged	HR = 1.0	HR*
British Pound	0.770	0.783	0.0406	0.0250	0.0291
German Mark	0.689	0.632	0.0113	0.0057	0.0067
Swiss Franc	0.805	0.939	0.0171	0.0107	0.0129
Canadian Dollar	0.796	0.782	0.0078	0.0063	0.0075
Japanese Yen	0.157	0.244	0.0137	0.0083	0.0088

Source: Hill and Schneeweis (1984:34)

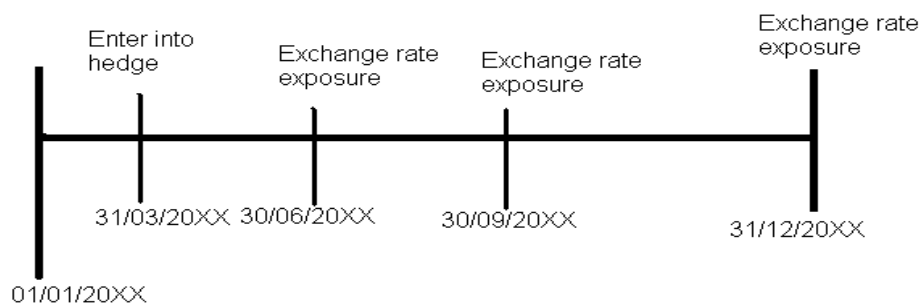
The arguments Hull (2006:48) proposes for hedging is that a company could avoid any sudden surprises in the change in an exchange rate. This is also an argument put forth by Platt (2001:43) and allows companies to focus primarily on their main or core business activities. Birkner (2008:56) lists two benefits of using foreign currency futures as opposed to foreign exchange, namely:

- Currency futures (because they are exchange traded) eliminate credit risk. This contributes to putting all market participants on an equal playing field. This argument is supported by Hull (2006:352) that the clearing house provided on the futures exchange removes any default risk, which is an aspect of credit risk.
- Regardless of the size, all market participants have equal market access.

According to Hull (2006:50) there are arguments against hedging. One argument is that the type of business must be considered when hedging. Manufacturing, retailing, wholesaling or enterprises that provide a service and are subject to variables in the economy over which they have little control should be hedged away. Once these variables or risks have been reduced or neutralized, companies have more time to focus primarily on their core business and eventually their bottom line. Hull (2006:50) also provides an argument against the negative impact that hedging can have on a company's profit margins. If a company hedges, it has fluctuating profit margins, while a company not implementing a hedge, illustrates a constant profit margin. Thus, in this instance hedging risks may not be an optimal approach. He also places a lot of emphasis on the type of hedge implemented and general variables influencing this hedge are provided below:

- There are considerable brokerage fees.
- A variation margin is present. The size is dependent on the general state of the economy, in which interest rates play a predominant role. The greater the level of interest rates, the greater the variation margin.
- There is a variation margin risk. This is dependent on the size of the futures position in contrast to the size of the capital base.
- Large administration costs. Administration costs are more inherent in commodity futures in comparison to financial futures. Examples include storage, transportation and handling costs.

Figure 3.2.7: Different Time to Maturities of a Long Currency Futures Position



Source: Adapted from Kawaller (1993:79)

An investor or company facing currency exchange rate exposure may wish to hedge this exposure. However, a problem remains of implementing the correct hedge with the correct time to maturity. An investor or company facing currency exchange rate exposure may wish to hedge this exposure. Kawaller (1993:79) provides a comparison of two currency futures hedges using different expiration dates. In Figure 3.2.7 above, the year from 01/01/20XX to 31/12/20XX is illustrated with exchange rate exposures which started on 31/03/20XX and expired every three months, namely June, September and December. The hedger considered entering in two hedges, namely:

1. A long hedge for the period 01/03/20XX to 31/12/20XX. This hedge is for the period of one year. This only occurs if the derivative instruments used in the hedge are able to match the exact size of the currency exchange rate exposure.

2. A short hedge beginning on 01/03/20XX and expiring at the end of every three months. At the end of the first three months, namely 30/06/20XX, the position is re-entered with the last hedge expiring on 31/12/20XX. This is also referred to as “rolling over of the hedge position¹¹⁷”.

Kawaller (1993:79) mentions that the primary decision between these alternative approaches should be based on market factors. He also states that when using the longer term hedge, the hedger is able to “lock in the exchange rate”. However, two primary conditions must hold, namely:

- (a) The correct hedge ratio must be used. This is found by dividing the exposure size by the number of marks per contract.
- (b) The futures price should converge to the spot price over time. When the futures position is exited at maturity, it is referred to as “liquidating the position”.

The only way the long hedge position would be improved is if an additional condition is imposed and met:

- (c) Calendar spreads over a six month interval, from 31/09/20XX to 31/12/20XX.

Winstone (1995:284) defines a calendar spread with futures as the simultaneous buying of one futures contract in the shortest month until delivery together with selling one futures contract in the month that follows. When considering the second alternative with shorter time to maturities, additional commissions in the contracts must be taken into account. These include:

- consolidated spreads
- dollar commissions must be converted into spread points.

Huffman, Makar and Beyer (2010:1) provide a recent article on the analysis of foreign exchange rate exposure under a three factor model proposed by Fama and French (1993). While prior research by Adler and Dumas (1984), Jorion (1990), Choi and Prasad (1995), Ihrig (2001) and lastly Dominguez and Tesar (2006) use a market model method in the analysis of foreign exchange rate exposure, Huffman, Makar and Beyer (2010:1) provide a new approach by reconciling the equity return with the foreign exchange rate exposure, which

¹¹⁷ See Hull (2006) for an explanation of “rolling over of the hedge position.”

can be seen as superior to the traditional market model approach. They provide the following three conclusions as it relates to hedging of foreign exchange rate exposure:

- (1) Non-hedging corporations are more prone to foreign exchange rate exposure than hedging corporations under the assumption of effective hedging.
- (2) By using a three-factor model, the key factors used in the description of high foreign exchange rate exposure are more statistically as well as economically significant.
- (3) Lastly, the size of the corporation plays an important role in the level of foreign exchange rate exposure.

Kawaller (1993:79) concludes that traders that enter hedges with long currency futures positions prefer the first alternative, while hedges that enter into a short currency futures position prefer the second or “rolling alternative”. However, both alternatives are still based on market expectations. Thus, the long hedge provides the advantage of certainty, while the short-term hedge provides incremental benefits, namely the rolling into subsequent periods. Any traders that set up hedges are aware of the fact that the effectiveness of hedges can vary widely. It is therefore appropriate that this aspect is briefly considered.

3.2.4 Hedging Effectiveness

Howard and D’Antonio (1984) provided the first early models on hedging effectiveness (HE) shown below:

$$HE = \left[\frac{\theta_H}{\left(\frac{R_p - R_i}{\sigma_s} \right)} \right], \text{ Where } \theta_H = \left[\frac{R_p - R_i}{(\sigma_p)} \right]$$

With r_s as the expected spot market return over one period i ; i denotes the risk-free rate; σ_s is the standard deviation of the returns in the spot market; R_p denotes the expected return from a portfolio comprising futures and spot contracts and σ_p is the standard deviation of this portfolio. Chang and Shanker (1986:289) list two problems with the model presented by Howard and D’Antonio (1984). These problems stem from the difference between r_s and r_i . When $r_s - r_i$ is small or close to zero it results in a large HE. The other problem is that when $r_s -$

r_i is negative the HE provides confusing results. Howard and D’Antonio (1987) later produced another article to rectify these problems of their original model. They put forth a new model known as HBS which calculated the “hedging benefit per unit of risk” as shown below:

$$HBS = \frac{i + \theta_H \sigma_S - r_S}{\sigma_S}$$

With $\theta_H = HE$ and $\theta_C = \frac{R_S - R_i}{\sigma_S}$.

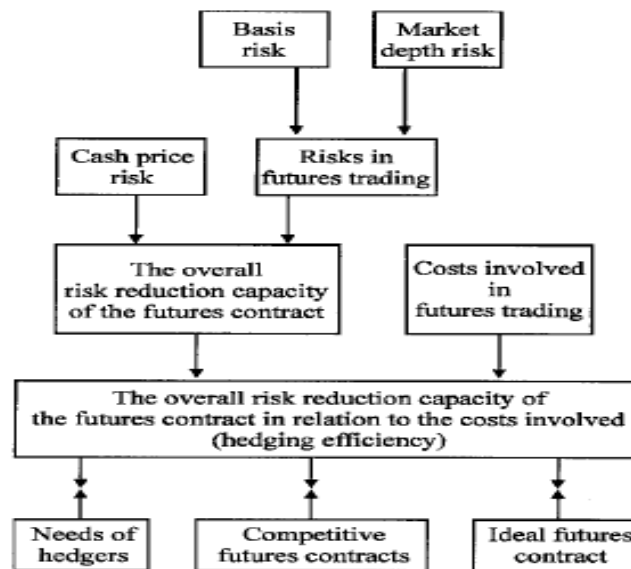
Advantages of this model are that:

- it can be applied to market data;
- it solves the $R_S - R_i$ problem; and
- it is easy to compare to other risk measures that calculate returns per units of risk (Van Niekerk, 2004:6).

Pennings and Meulenberg (1997:605) later provided research on hedging effectiveness. They found that this effectiveness is dependent on the type of measurement together with a “hedge utility function”. The total amount of risk reduction using a currency futures contract depends on:

- basis and
- market depth risks (Pennings & Meulenberg, 1997:605).

Figure 3.2.8: Hedging Effectiveness



Source: Pennings and Meulenberg (1997:650)

Pennings and Meulenberg (1997:605) illustrate in the diagram above that when considering the effectiveness of a hedge implemented, the distance is obtained between a perfect hedge and the proposed hedge¹¹⁸. They conclude that this distance can then be broken into a systematic component and a random component, while the systematic component is manageable, the latter is beyond control.

Later studies by Kawaller (2001) used “interest-rate swaps” to test the effect that these instruments using accounting rules exhibited in the market. Kawaller concludes that the hedging effectiveness was dependent on the swap contract being exactly equal to the debt to be hedged. Studies by Kawaller and Koch (2000) investigated hedging effectiveness tests. They found that regressions could be used to explain hedging effectiveness, but only if an appropriate data set was used. They provide two remarks regarding the correlation coefficient used in these tests. Firstly, it is a biased indicator for the performance of a hedge. Secondly, it is related to the optimal hedge. The last study conducted recently by Bodurtha (2005) considers the hedging effectiveness when “diverging interest-rate risk” is evident. He considers this under the conditions of financial accounting standard (FAS) 133 as well as international accounting standard (IAS) 39 and puts forth alternative remedies. From a corporation’s perspective advantages and disadvantages are provided below together with an approach to analyze the effectiveness of hedging. The variables underlying the approach that investors use to analyze hedging positions in the market are the basis and basis risk discussed below.

3.3 THE BASIS AND BASIS RISK SPREAD VARIANCE OVER TIME

3.3.1 Introduction

Basis or basis spread is the first integral concept which should be understood by multinational corporations using financial risk management instruments. Basis is an excellent indicator of causality. The second concept is basis risk or basis spread risk, which is the deviation in the basis spread. By analyzing the basis spread risk over a time series, investors will be able to

¹¹⁸ Note that in the text, the word “distance” has been used. This distance could also be seen as the deviation in monetary terms.

make more accurate predictions and have simpler comparisons of their investments in the future. Basis spread risk is also an important measure to determine how interest rates will behave. Lastly, investors will be able to analyze and forecast their investments risk reduction in percentage terms. It must be noted that on maturity, basis risk does not exist since on maturity date the spot and futures prices are the same.

3.3.2 The Basis¹¹⁹

Understanding basis spread is an imperative feature when hedging with currency futures. Rinehimer (1986:9-11) argues that “the most important concept in understanding the application of futures hedging price risk is basis...” Kruger (1991:18) defines basis as an asset which differs in price in both the spot and futures markets, regardless of having the same characteristics and being purchased in the same time period. Schumann (2000) on the other hand defines basis as the futures price less the spot price at any one point on a time line, and uses the notation of $F^{120} - S^{121}$ on the same underlying. This definition is held consistent by Hull (2006) and numerous other authors.

Schumann (2000) deduces that the basis spread can be used to indicate or explain causality between the spot and futures markets, which supports the argument originally provided by Kruger (1991:18). Rothstein and Little (1984:750) argue that a complete understanding of basis spread is necessary for investors as well as financial managers in order to understand: (1) the futures market pricing structure and (2) the fundamentals when implementing speculative deals and hedging strategies. This will be discussed in more detail in section 3.3.3. Inci and Lu (2007:180) provide a more recent study on the predictability of the currency futures basis spread. Their findings are summarized in the table below:

¹¹⁹ Basis and basis spread were used interchangeably in this section of the chapter.

¹²⁰ F = Futures price at contract maturity or the futures price at which the futures contract expires.

¹²¹ S = Spot price at contract maturity or the spot price of the underlying asset when the futures contract expires.

Table 3.3.1: Long Term and Short Term Comparison of the Basis Spread

Basis spread in a currency futures contract with a long time to maturity	Basis spread in a currency futures contract with a short time to maturity
Spot exchange rates deviations between contract entry and maturity cannot be predicted.	Spot exchange rates deviations between contract entry and maturity can be predicted.
The uncovered interest rate parity is rejected.	The uncovered interest rate parity is not rejected.
Currency futures returns due to risk premium can be predicted.	Currency futures returns due to risk premium cannot be predicted.
Validated using the following currencies: <ul style="list-style-type: none"> • Japanese Yen • British Pound • Swiss Franc • German Euro 	Validated using the following currencies: <ul style="list-style-type: none"> • Japanese Yen • British Pound • Swiss Franc • German Euro
Expectations hypothesis for the short term interest rates does not hold.	Expectations hypothesis for the short term interest rates does hold.

Source: Inci and Lu (2007:180)

When analyzing the basis spread, two variables should be highlighted. These variables include the spot market prices and future market prices. Keynes (1930) used two concepts or scenarios to illustrate the movements of the spot as well as futures markets as the expiration of these futures contracts approached. Firstly, backwardation is the firm scenario used to illustrate a negative basis spread. This occurs when the spot price at time t , or S_t , is greater than the futures price at time t , or when $S_t > F_t$. When the spot price increases above the futures price, it is termed as “a strengthening of the basis spread” due to the sudden increase in the basis. In contrast, when the futures price increases above the spot price, it results in a sudden decrease in the basis and is termed as “a weakening of the basis” (Hull, 2006:53). Table 3.3.2 provides an analysis of the basis indicating whether it weakens and strengthens for a short and a long hedge position. It also includes the effects that the direction of the basis will have on the weakening and strengthening basis.

The second scenario that Keynes (1930) identified was that of a contango. This is used to describe a positive basis. This occurs when the futures price at time t is greater than the spot

price at time t , or $F_t > S_t$. Lastly the third scenario, termed normal backwardation, is similar to backwardation but takes into account an expected term for the spot price (Keynes, 1930).

Table 3.3.2: The Effect of Weakening and Strengthening of the Basis

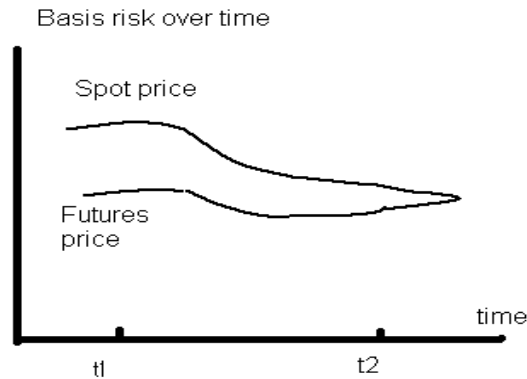
Basis Movement		Effect			
Basis = $P_c^{122} - P_f^{123}$ hedge	Price Movements	Type of	Type of basis	Direction of	Return
	basis				
“Weakens”	P_c increases less or falls more than	Short	$P_c - P_f > 0$	Narrows	Negative
			$P_c - P_f < 0$	Widens	Negative
	Long	$P_c - P_f > 0$	Narrows	Positive	
		$P_c - P_f < 0$	Widens	Positive	
“Strengthens”	P_c increases more or falls less than	Short	$P_c - P_f > 0$	Widens	Positive
			$P_c - P_f < 0$	Narrows	Positive
	Long	$P_c - P_f > 0$	Widens	Negative	
		$P_c - P_f < 0$	Narrows	Negative	

Source: Schumann (2000:150)

In order to determine the magnitude of the basis, Hull (2006:53) uses the following variables and notations: S_1 : Spot price at time t_1 ; S_2 : Spot price at time t_2 ; F_1 : Futures price at time t_1 ; F_2 : Futures price at time t_2 ; b_1 : Basis at time t_1 and b_2 : Basis at time t_2 . According to Hull the basis (b) at t_1 and t_2 can be expressed respectively as: $b_1 = S_1 - F_1$ and $b_2 = S_2 - F_2$.

¹²² The spot price of the underlying asset.

¹²³ The price of the futures contract.

Figure 3.3.1: The Basis Spread over Time

Source: Adapted from Hull (2006:54)

Various researchers argue that the main goal of a hedge is to predict how the basis behaves over time. How this basis behaves or moves over time ultimately determines the hedge portfolio's return and after the hedge position is put into effect, the trend provided by the basis will surpass the market price's movement. Futures traders wishing to hedge, use futures contracts to shift adverse price risk¹²⁴ from the spot to the futures markets to protect their portfolios from any adverse market changes.

When considering the basis, two hedged positions can be set up, namely a long and a short hedge as stated before (Hill & Schneeweis, 1984:34). The most effective hedge, either long or short in terms of the basis spread, will depend on how well the basis changes can be accurately forecast. If this prediction is accurate it will result in a realization of a profit and the minimization of price risk (Schumann, 2000:82). When hedging the purchase of an asset in the future, a long hedge position will be used and will result in the cost of an asset = $S_2 - (F_2 - F_1) = F_1 + \text{Basis}$ up to period 2. When hedging the loss of the sale of an asset in the future, a short hedge position will be used. The price of this asset realized = $S_2 + (F_1 - F_2) = F_1 + \text{Basis}$ (Hull, 2006:54). The basis is represented by the term, b_2 . If spot and futures prices are known at time t_1 , b_2 will be a perfect hedge and the basis will be equal to zero. If either spot or futures prices are not known, a basis term must be added in both the long as well as short hedge positions to account for this risk. Although hedging appears to be an optimal approach, one risk remains which is a portion of the total volatility which cannot be eliminated by means of diversification. Thus, from an alternate point of departure, it can be considered as the

¹²⁴ Price risk in this instance is the risk that the spot exchange rate that will fluctuate in an adverse way.

difference between the futures price that would have existed when the position was reversed or exited and the futures price exhibited in a perfect hedge. It can also be seen as the loss in the spot market that is not exactly offset in the futures market or vice versa (Miffre, 2004:1043).

Bailey and Chan (1993) provided the first research that suggested that the basis contained a time-varying risk premium (TVRP) using commodities. Baum and Barkoulas (1996:753) later confirmed these results using foreign currency futures and showed that a TVRP exists in the basis. From an econometric perspective, they modeled the basis of a currency futures contracts as: $F_t - S_t = \{F_t - E_t[S_{t+1} | \Omega_t]\} + \{E_t[S_{t+1} - S_t | \Omega_t]\}$ ¹²⁵. Where E_t is an operator representing future expectations; F_t is the currency futures price at time t ; S_t is the underlying spot exchange rate; $F_t - S_t$ is the basis spread; Ω_t is the amount of information given at time t and S_{t+1} is the spot exchange rate at time $t + 1$. In the model above, two terms are reflective of the basis, the expected premium shown as $\{F_t - E_t[S_{t+1} | \Omega_t]\}$ and the expected forecast error shown as $\{E_t[S_{t+1} - S_t | \Omega_t]\}$. To account for the systematic variables influencing the expected premium of the basis, an ARMAX-GARCH (1, 1) time series regression was used with the following formula: $100 \cdot (F_{i,t} - S_{i,t}) / S_{i,t} = \alpha_{i0} + \alpha_{i1}DY_{t-1} + \alpha_{i2}DEF_{t-1} + \alpha_{i3}TERM_{t-1} + \varepsilon_{i,t}$. Where DY is the dividend yield in the equity market; DEF is the default spread in the bond market and $TERM$ is the term spread in the bond market. To test whether a TVRP exists in the expected forecast error component, the futures price was substituted with the spot exchange rate for currency i at time t . A similar regression was then run for the expected forecast error of the basis as: $100 \cdot (S_{i,t} - S_{i,t}) / S_{i,t} = \vartheta_{i0} + \vartheta_{i1}DY_{t-1} + \vartheta_{i2}DEF_{t-1} + \vartheta_{i3}TERM_{t-1} + \eta_{i,t}$.

Baum and Barkoulas (1996:737) found that the coefficients were statistically insignificant under the expected forecast error component. This proved that the latter approach could be rejected resulting in a TVRP only existing in the expected premium of the currency futures basis. It is important to note that under the expected premium of the basis, a futures contract is available that provides a risk premium from the risk in the equity and bond markets. This has value implications for this study. They found that the basis is ultimately positively affected when there is more risk in the equity market and the basis is adversely affected when there is more risk in the bond market. This finding prevents this study from choosing a sample period

¹²⁵ This is a relative basis spread model as both sides of the equation have been scaled in terms of S_t .

that is not characterized by a stable business cycle. Reasons include the basis and basis risk comparisons being affected by a time varying risk premium if they are not made during a stable steady state economy.

From the results mentioned previously, Baum and Barkoulas (1996:737) found that the basis can be forecast using three economic variables. These variables include (1) the dividend yield, (2) the default spread and (3) the term spread. The two spread variables are linked negatively to the basis of currency futures, while the dividend yield is positively linked. The most appropriate method used by Baum and Barkoulas (1996:737) to test the existence of a time-varying risk premium across currencies is to make use of the “covered interest parity (CIP)” principle. The CIP in the basis of foreign currency futures is determined relative to the domestic and foreign interest rates. They restated this condition as: $F_t - S_t = R_t - R^*$, where F = log (futures price) at delivery time $t+1$ observed today (t); S_t = log (Spot rate); R_t = log (simple domestic interest-rate for one period); R^* = log (simple foreign interest-rate for one period). The CIP is used to obtain a “no arbitrage future price” when hedging exchange rates and will be discussed in more detail in the section on the modeling of currency futures prices (Baum and Barkoulas, 1996:737).

To test whether the basis contains a TVRP, an alternative approach used by Miffre (2004:1044) was to decompose the basis into a (1) TVRP and (2) an expected deviation or alteration in the spot price. Miffre (2004:1044) followed a two-step approach. The first step involved the regressing of the basis risk on predictors that represented the systematic risk that exist in an economy. The second step involved repeating the first step, but using spot prices. Once these steps were completed, the predictability of the first and second steps differed and no attributes could be made, thus illustrating the presence of a “time – varying premium in the bases” (Miffre, 2004:1044).

From the literature it can be concluded that the basis of currency futures used from SAFEX could contain a time-varying risk premium. Baum and Barkoulas (1996) put forth that this time-varying risk premium in the basis has a strong correlation with macroeconomic variables and illustrates trends in the basis that are positively linked with interest rates which is

confirmed by Miffre (2004). Miffre (2004) found that the basis of currency futures contracts increases over time. The risk premium that forms part of the basis is subject to:

- Conditional risk and
- Systematic risk from conditional prices in the market.

Although the increase in basis risk is attributable to the increase in risk premium in order to compensate for the risk, Miffre (2004) notes other factors that can cause the basis to increase, but does not empirically test them. These include:

- Market imperfections. Examples include transaction costs and numerous trade restrictions on investors.
- “Segmentation between spot and futures markets” (Bessembinder & Chan, 1992:191).

These two restrictions force arbitrageurs into the spot or futures market, and result in a basis which is stochastic and changes randomly over time. By not empirically testing alternative factors that may cause the basis to change, it invokes grounds for further research. These factors provided by Benhamou (n.d), Hull (2006:53) and Miffre (2004:1043) allow for the interpretation of the size of the basis risk spread should a new fictitious SADC dollar currency be considered.

Kruger (1991:55) decomposes the basis over a time-series analysis in the South African market and this allows for the following conclusion to be drawn, namely:

- A narrowing basis over time is illustrated and diagrams that took the shape of a cone are used.
- a consistent cyclical pattern exists and
- an irregular cyclical component exists.

Although Kruger (1991) mentions the presence of a cyclical pattern and an irregular cyclical component in the basis, he is unable to state the cause for this cyclicity due to a lack of information. Schumann (2000:137) extends this research of Kruger (1991) and confirms a strong negative correlation that exists between “daily interest rates and the basis”. He also states that the cyclical patterns as well as the irregular component in the trend can be explained by incorporating political aspect into the data of the study. The reason for

incorporating the political aspects is due to the political aspects being positively linked to interest rates.

Although the variables in the basis can be analyzed over time, these variables that comprise the basis can also be considered as a whole. The basis of a futures position has forecast ability. Rinehimer (1986:9-14) states in an early article that the computation of the correlation between the futures and spot market prices is an excellent indicator of the type of variation in the basis that can be expected. He also argues that the higher this correlation, the more stable this basis will be. This variation in the basis is known as the basis risk and is affected by different variables. This is discussed in the next section.

3.3.3 Basis Spread Risk

The basis risk is an appropriate measure to use for comparative purposes. Reasons are that there is a chance that the currency futures provided in the SADC market will not match the underlying SADC dollar foreign currency perfectly. Another reason is that basis risk captures variables such as the: interest rate differential among countries, degree of market segmentation, risk of rolling futures contracts forward and lastly a conservative forecast of future short term volatility.

Schumann (2000:85) defines basis risk as the numerical value of the variation in the basis, or also stated as σ^2_{S-F} . He uses the following equation to compute the basis risk¹²⁶:

$$\sigma^2_{S-F} = \sigma^2_S + \sigma^2_F - 2 \rho \sigma_{S,F} \text{ or } \sigma^2_{F-S} = \sigma^2_F + \sigma^2_S - 2 \rho \sigma_{F,S}$$

He puts forth an argument that if the spot and futures market prices show a strong positive correlation, the variance of basis risk will be smaller than the risk attributable to either the stock or futures prices, thus:

$$\text{If } \rho_{S-F} > 0.60^{127}, \text{ then } \sigma^2_{S-F} < \sigma^2_F \text{ or } \sigma^2_S$$

¹²⁶ Garcia and Sanders (1996:422) state that basis risk is generalized in the context of *ex ante*.

¹²⁷ In academic literature, a $\rho=0.60$ is significant indicating a strong correlation.

$$\sigma_{S-F} < \sigma_F \text{ OR } \sigma_S$$

In practice, the spot price converges to the futures price as the futures contract expiration date nears. This allows for the assumption that there will be a strong correlation between the spot and futures price. This argument is supported by Schumann (2000:85) who concludes that due to this high positive correlation, the basis risk is much less than the pure risk exhibited when not entering into a hedged position that is an un-hedged or open position. Redhead (1994:4) also states this is the case, provided that the instrument that needs to be hedged does not differ too much from the futures instrument.

According to Hull (2006:55), a perfect hedge strategy occurs when the hedger knows the exact date when the underlying will be purchased or sold. In this instance the hedger would be able to remove any risk from the position due to the offsetting positions in the spot and futures markets. However, this is mostly not the case in practice (Hill & Schneeweis, 1984:34; Cuthbertson & Nitzsche, 2001:622). Hull (2006:53) mentions that basis risk exists when an investor is unable to identify the exact date of purchase or sale of an underlying in a futures contract. Some other reasons why basis spread risk exists are due to:

- The asset underlying the spot market is not identical to the asset underlying the futures contract.
- The date of purchase or sale may not be known with precision in the future.
- The hedged position may be required to be exited prior to maturity.

On the other hand basis risk may directly focus to the risk of the underlying asset's price that does not correlate perfectly in the spot (cash) market with the futures market (Kruger, 1991:49; Schumann, 2000:60). On the other hand, if the spot and futures markets do not support a perfect correlation the resulting basis risk would be higher (Kruger, 1991:35). Hull (2006:53) argues that the basis risk spread may be negative or positive prior to the expiration of a futures contract. He further states that the spot and futures price will be equal when short time to maturity future contracts are used, as opposed to long time to maturity futures contracts.

Castelino, Francis, & Wolf (1991) highlight two dimensions of basis risk, namely: (1) whether or not convergence can be predicted between prices and (2) days to expiration until the hedge is removed or exited. Hull (2006:55) further identifies a factor that has an effect on the size of the basis risk. This factor is the choice of contract used by the hedger for hedging. According to Hull (2006:55) this choice of contract can be simplified into two parts, namely: (1) the type of underlying used in the futures contract and (2) the delivery month. The first part is relatively simple. However, if the underlying asset and futures price differs, a complex analysis must be done. This analysis may include the determination of the most closely correlated asset price and futures price in order to do a meaningful comparison. The second part, namely the delivery month of the futures contract, is influenced by numerous factors. When the time to maturity is identical to the delivery month of a futures contract, the later delivery month must always be chosen. As futures contracts are standardized, it is not always possible, in practice, to obtain contracts that coincide with the required delivery date. According to Hull (2006:55) the reason for this choice of later delivery is due to futures prices being erratic in the month of delivery in the United States. This may also be the case in South Africa. Another influence is that a hedger in a long hedge position is exposed to the risk of non-delivery of the physical asset, provided the futures contract was still held in the month of delivery. The end result is that the delivery of the asset is: (1) more expensive and (2) more inconvenient. Thus, as a general principle, the basis risk will increase with an increase in the difference between the hedge expiration month and the delivery month. A general rule can thus be imposed namely, to only use a delivery month that is as close as possible to, but does not exceed the hedge expiration date. Applying this general rule, an assumption is made that there will be enough liquidity to meet the requirements of the hedger. Shorter future contracts have greater liquidity than comparable longer term future contracts (Hull, 2006:55). Liquidity is also dependent on the underlying instrument. To optimize the use of liquidity, the hedger may use shorter time to maturity contracts and roll these contracts forward to extend the maturities. This was, however, discussed in the section dealing with currency futures hedging. Considering the relationship between spot (cash) price risk, futures price risk and basis risk, the following two conclusions can be drawn (Kruger, 1991:49):

- Spot price risk and futures price risk are larger than basis risk.

- Both spot as well as futures markets stabilize at one hundred days prior to contract maturity. This results in the causality between these markets increasing and a more stable basis. In effect this more stable basis results in a reduction in the basis risk.

Redhead (1994:21) considers the impact that the shape of the yield curve has on basis risk. He states that in an “upward sloping yield curve”, the futures price will be less than the spot (market) prices. The futures price can thus be seen as a discount relative to the spot prices and the converse is also true for a downward-sloping yield curve. It can be concluded from the article provided by Redhead (1994:21) that any changes in the market that cause alterations to the slope of the yield curve results in the change in the basis and can be seen as a form of basis risk. Another way that this basis risk is minimized is to decide at what numerical value the basis of the hedge will be exited or closed out. Rinehimer (1986:9) refers to this numerical value as the “forward or futures basis”.

Fama and French (1987) and Bailey and Chan (1993) also provided studies that highlighted the magnitude of the basis when hedging a commodity position or exposure as opposed to a financial position. They state that the primary disadvantage in this type of hedging is that the underlying commodity in the futures contract differs from the commodity in the spot market. This presents several problems. Futures contracts are generally quoted with expirations of three months. Thus, when hedging a commodity underlying using futures, only a limited number of observations are possible. One method they use to counter this problem is to make use of extended maturities, also referred to as proxy maturities. Miffre (2004:1049) advanced prior research and was able to identify three advantages when the underlying in the futures contract and spot market are identical when using financial futures. Firstly, all cross hedging implications could be ignored. Secondly, it allows for observations of the bases over a much longer interval. Lastly, the results are also supported by asymptotic properties.

An important advantage of futures across financial markets is that they allow investors/hedgers to transfer risk to another party willing to accept it. This transfer occurs between hedgers and speculators and the primary risk found during this transfer is a price risk. At contract expiration, the hedge position is removed or lifted¹²⁸. At this point in time,

¹²⁸ Removed/lifted in this context refers to the futures contract expiring and thus being closed out, which results in the offsetting of risk among the spot and futures market.

namely contract expiration, the spot price will be equal to the futures price.¹²⁹ In this instance basis risk is equal to zero. If the hedge is closed out prior to futures contract expiration¹³⁰, the hedger is said to be entering a transaction for the exchange of risks. There are two risk types being exchanged in this instance, namely price risk and basis risk, of which the primary risk found during this transfer, is that of a price risk. Hedgers enter into contrasting positions in the futures and spot markets. These contrasting positions allow for a considerable reduction in volatility (Miffre, 2004:1044).

3.3.4. Applications of Basis and Basis risk

Schumann (2000:175) provides the following results of basis and basis risk and what this implies:

- The trends of basis risk are not shown in immature future market contracts.
- In mature future market contracts there is a clear correlation between the basis and basis risk.
- Strong correlation is found between the basis and (1) daily interest and (2) opportunity loss. This implies that market participants have knowledge of the basis as it allows for the determination of future contracts' fair value.

3.4 MODELLING OF CURRENCY FUTURES PRICES

This section briefly describes how currency risk exposure may be modeled in an emerging market context, as this study focuses primarily on the SADC region. Variables affecting these futures prices in their respective markets are also identified. Firstly, the models used to compute currency futures prices are presented and discussed. Thereafter, aspects relevant for emerging and developed markets will be identified and contrasted.

3.4.1 Models Used to Compute Currency Futures Prices

Winstone (1995:122) provides one of the earlier generic methods to model currency futures prices:

¹²⁹ Refer to Figure 20 at time t_2 and post.

¹³⁰ Refer to time t_1 in Figure 20 adapted from Hull (2006:53).

$$F_{t,T}(DC/FC)^{131} = S_t (DC/FC) \times [1+(R_{DC} - R_{FC}) \times T-t/360^{132}]]^{133}$$

$F_{t,T}(DC/FC)$ is the currency futures price that expires at time T, provided it is now time t. $S_t (DC/FC)$ is the spot exchange rate at time t. R_{DC} is the domestic risk-free rate, R_{FC} is the foreign country risk-free rate. Sequeira, McAleer and Chow (2001:271¹³⁴) provide two alternate methods of modeling Australian currency futures prices that are listed on the international monetary market (IMM) division of the Chicago Board Options Exchange (CBOE). These two models are presented below.

(1) The unbiased expectations hypothesis (UEH)¹³⁵

The unbiased expectations hypothesis in the foreign exchange market states that future exchange rates at a specified date are unbiased predictors of future spot rates at that date. Sequeira et al. (2001:271) used this model to investigate the variability shown in the risk premium as well as to account for the depreciation in the exchange rates that occur in the foreign exchange market. This model to price currency futures in the Australian market differs from the model developed by Winstone (1995:122) as it is unbiased and accounts for the depreciation of the currency underlying the futures contract. The model is presented below as:

$F_{t+k|t} = E_t (S_{t+k}) + \pi_{t+k|t}$, with the variables defined as: $F_{t+k|t}$ is the price of a futures contract with k periods, provided it is currently in period t. $E_t (S_{t+k})$ is the spot price that is expected at time $t+k$. $\pi_{t+k|t}$ is the expected log risk premium at time $t+k$.

(2) The cost of carry hypothesis (COCH)

The second model is provided by Sequeira et al. (2001:272) and is developed on the argument of no arbitrage, provided that the futures contract is held until contract maturity. It

¹³¹ $F_{t,T}(DC/FC)$ is referred to as the theoretical rate and may differ from the rate quoted in the market. If these rates differ, there are arbitrage opportunities (Winstone, 1995:122). Note that this futures price is calculated as the domestic currency (DC) relative to the foreign currency (FC).

¹³² Note 360 days was used for the domestic country, while 365 days will be used for South Africa.

¹³³ All models to compute the currency futures price are derived on the principles of no arbitrage, except EUH.

¹³⁴ Model was formed using the research of Sequeira, McAleer and Chow (1999) as the foundation.

¹³⁵ This hypothesis was developed from the risk premiums hypothesis.

incorporates an additional term, $\theta_{t+k|t}$, which accounts for the marking to market process which is not incorporated in the other models. They provide the following equation:

$$F_{t+k|t} = S_t \cdot [(p^f_{t+k|t}) / (p^d_{t+k|t})] \cdot \exp \theta_{t+k|t},^{136}$$

where $F_{t+k|t}$ is the price of a futures contract with k periods, provided it is currently in period t . S_t is the spot price at time t . $p^f_{t+k|t}$ can be defined as the foreign risk-free interest rate with k periods given at time t . $p^d_{t+k|t}$ can be defined as the domestic risk-free interest rate with k periods given at time t . $\theta_{t+k|t}$ is representative of the marking to market process of futures with k periods, provided it is currently in period t .

Sequeira et al. (2001:282) found that when comparing the UEH and COCH models, the COCH is the superior model on the basis of no restrictions. They concluded this result accounting for the number of relationships which co-integrated. If the COCH holds in practice, then Bessembinder, Coughenour, Seguin & Smoller (1995:375) could use the term structure of futures to study the ability of the underlying spot prices to revert to their mean. They provide two conditions under which this reversion is possible. The second condition is more applicable to the currency futures market and occurs when the interest rate differential is negatively correlated to the futures prices. In this instance the term structure of futures prices is negatively correlated with the spot prices. They provide practical applications in the fields of capital budgeting and the pricing of derivative securities. Chance (2003:135) provides a simplified form of Winstone's (1995) earlier generic model to price currency futures, namely:

$$f_0(T)^{137} = \left(\frac{S_0 \cdot (1+r_d)^{\frac{T}{360}}}{(1+r_f)^{\frac{T}{360}}} \right)$$

The numerator compounds the spot exchange rate today by the domestic interest rate for a $t/360$ period. This numerator is then discounted by the foreign interest rate denominator for a $t/360$ period. This formula provided by Chance (2003) can also be referred to as the covered

¹³⁶ Derived from the research of Amin and Jarrow (1991) and using the framework presented by Heath, Jarrow & Morton (1992).

¹³⁷ This is also the model that will be used throughout the rest of the research when computing the price of the ZAR as the underlying in the futures contract and later the SADC dollar as the underlying currencies. The reason for use is due to less confounding variables which eliminate any biases that may be created with too many variables.

interest parity and contrasts the uncovered interest parity as the preferable formula to model futures prices on different foreign currencies. Schweser (2009) provides the following characteristics of the covered interest parity:

- The currency risk from changes in the foreign currency relative to the domestic currency is covered using a futures contract.
- Arbitrage is not present in this model which forces the futures price on the exchange rate equal to the expected future spot exchange rate.
- There are capital flows under this model.

The uncovered interest parity model is applicable when no cash flows are available, as illustrated in this diagram by Schweser (2009):

$$E(S_1)/S_0 = \frac{\text{Expected spot exchange rate at } t=1}{\text{Spot exchange rate}} = \frac{1 + R_{\text{domestic}}}{1 + R_{\text{foreign}}}$$

Where S is the direct quote on the exchange rate (foreign/domestic) and R is the nominal exchange rate. When considering the models provided by Winstone (1995), Sequeira et al. (2001) and Chance (2003) above, these models provide no-arbitrage futures prices, except the EUH. Henderson (2006:2) argues that exchange rates underlying currency futures contracts are based on equilibrium models¹³⁸, which purport an ideal/equilibrium level that exchange rates revert to. He states that these exchange rate models are classified based on the approach they follow to forecast exchange rates, as well as the commodity they use for their relative pricing. The approaches followed include¹³⁹: (1) *purchasing power parity (PPP)*, (2) monetary approach, (3) interest rate approach and (4) balance of payments approach. These approaches are discussed below.

¹³⁸ One limitation of an exchange rate model is that the equilibrium exchange rate changes or moves over time due to “cause and effect pressures”. The movement causes constant increases (reductions) and thus results in the present exchange rates being over (undervalued) (Henderson, 2006:3).

¹³⁹ An explanation on the portfolio balance approach has been excluded from this study due to it having no effect on exchange rates.

(1) *PPP*¹⁴⁰.

Kolb (2000:266) provides a general definition of the PPP. There is PPP if the exchange rate of two countries reflects the relative level and value of goods traded, between the two relevant countries. Cuthbertson and Nitzsche (2001:492) present two forms of the PPP, the strong and weak form. They define the strong form PPP as: $P_d = S \times P_f$, where P_d refers to the domestic price index, P_f refers to the foreign price index and S is the long run equilibrium exchange rate. They define the weak form PPP as the domestic countries inflation rate less foreign country's inflation rate, thus $S = P_{domestic} - P_{foreign}$.

(2) *The monetary approach*

Monetary approach is vastly impacted by the change in the money supply. This results in (i) changes in the price, which alters the exchange rate or (ii) changes in the interest rate, which results in the change in the exchange rate (Henderson, 2006:25). He concludes that the monetary approach is not useful in the short run, but is useful in providing insights into exchange rate events, for example the de-pegging and devaluation of the "fixed-exchange rate regime".

(3) *The interest rate approach*¹⁴¹

This approach provides an analysis of interest rate differentials which considers a number of principles, where the first principle involves the interest rate parity (IRP) theory and states that: "an exchange rate's forward percentage premium or discount reflects its interest rate differential" (Henderson, 2006:32). Henderson (2006:32) states that if this relationship does not hold in practice, then risk-free profits could be made by arbitrageurs, which is known as covered interest rate arbitrage. The implied repo rate can be used as an alternative to derive if arbitration is possible (Winstone, 1995). Winstone (1995) puts forth an argument that if the implied repo rate is larger than the cost of borrowing by investors, then covered interest arbitrage is possible. He defines the implied repo rate as:

¹⁴⁰ Henderson (2006:17) defines the PPP as: "The law of one price".

¹⁴¹ This is an interest rate version of the PPP and provides mixed results in literature (Henderson, 2006:32).

$$IRR = [360(f_{tT}) - 360(S_t) + F_{t-T}] / (T-t).St.$$

Rendleman (2002:298) considers the IRP to be a theoretical exchange rate. Winstone (1995:123) defines the IRP as “a currency futures price that is an exchange rate which must differ from the prevailing spot rate by an amount which reflects the interest rate differential between two currencies”. According to Winstone (1995:123) this difference can be considered a swap, which can be defined as the currency futures price less the prevailing spot price, in other words $Swap = S_0 \times (\text{Interest-rate}_d - \text{interest-rate}_f) \times (\text{days to contract maturity}/360)$.

The relationship between these two models rests on the relationship between interest rates and inflation rates (Kolb, 2000:267). Kolb (2000:267) defines this relationship as:

$(1+r_n) = (1+r^*)[1+E(I)]$, where r_n is the nominal risk-free rate, r^* is the real risk-free rate and $E(I)$ is the expected inflation.

(4) Balance of payments approach

Henderson (2006:34) provides the following identity¹⁴² when considering how exchange rates are related to exchange rates: $S - I = Y - E = X - M$. The balance of payments approach also is dependent on the type of exchange rate regime implemented. The difference between $X - M$ also has an impact on a country's exchange rate and is referred to as the “terms of trade”. Any change in the terms of trade results in a change in the country's currency account balance which ultimately causes a change in a country's real exchange rate to restore equilibrium (Henderson, 2006:39).

Fang, Lai and Lai (1994) consider an aspect of modeling currency futures in various markets under a fractural structure¹⁴³. They use a “non-parametric spectral method” for the following underlying currencies: BP, DM, JY and the SF. Their results are important as they call into effect the adequacy of the Martingale hypothesis when modeling currency futures price

¹⁴² S denotes savings; I denotes investments; y denotes income; E denotes expenditure; X represents exports and lastly M is the amount of imports.

¹⁴³ A fractural structure is a form of dynamics that contains characteristics of: (1) Cyclical fluctuations that are irregular patterns and (2) have a dependence that is long-term in nature.

behaviour, and allow for currency futures prices that comprise fractal dynamics. These results are later confirmed by Barkoulas, Labys and Onochie (1999:98) who provide implications for the existence of fractal dynamics in the returns of currency futures. Barkoulas et al. (1999:98) argue that non-linear models should be proposed in contrast to linear models to price currency futures as this will take into consideration the fractal behaviour of these returns. They state that the presence of a fractal structure allows for arguments on market rationality of market participants and price efficiency in currency futures to be considered.

When modeling the prices of currency futures, as stated previously, numerous variables have a direct effect on the price, however the three main variables will be highlighted, namely the distribution, volatility and news released into the market. Many studies on the pricing of currency futures prices are dependent on the type of distribution chosen. Some studies assume that the futures prices are normally distributed, while others drop this assumption and use a leptokurtic distribution. A leptokurtic distribution refers to a distribution that exhibits a tendency to having many extreme observations in contrast to a normal distribution (Kolb, 2000:80). Pan, Chan and Fok (1995) state that the choice of distribution used in modeling currency futures in various markets may alter the results. They argue that a superior way to model currency futures is to use a two-piece mixture of normal distributions (TPN) approach to describing the stochastic process to model asset returns.

Volatility is another important variable in any sort of financial modeling, especially as it relates to currency futures. Two hypotheses are introduced when considering the volatility of futures prices. The first is the Samuelson hypothesis and the second is the Martingale hypothesis. The Samuelson hypothesis is built on the premise that as the futures contract approaches expiry, the volatility of the futures price is expected to increase (Kolb, 2000:81). The Martingale hypothesis is defined by Kolb (2000:81) as “a price process in which the expected value of the next price equals the current price”, thus $E(\Delta^{144}) = 0$.

Another detrimental variable that affects the modeling reliability/success and ultimately the futures price is the release of financial news in the financial markets. Christie-David and

¹⁴⁴ Delta represents a change.

Chaudhry (2000:109) conducted a study investigating this variable. They used the following underlying currencies in their study, namely: BP, DC, DM, JY and the SF. They concur that all these currencies are affected by macroeconomic events and provide the following examples of these events: (1) Employment report, (2) Trade deficit, (3) Industrial production and (4) Capacity utilization.

In contrast to the above variables that have an impact on the modeling of currencies futures prices, studies were also conducted that investigated two anomalies which occurred in the market and could influence currency futures prices. The first anomaly is known as the preholiday effect. This was investigated by Liano (1995:299) who used the following underlying currencies in the currency futures contracts: BP, DM and SF. He found that no preholiday effect exists in the currency futures derivatives markets, thus only being applicable in the equity markets of alternate exchanges. The second anomaly, known as the turn on market effect, was investigated by Liano and Kelly (1995:6) using the following underlying currencies in the futures contracts: BP, DM, JY and the SF. Their study was conducted over a seven-year period to examine what effect the turn of the month had on future contracts prices and found that the effect only prevailed for the SF. This implied that investors could profit from the turn-of-the-month effect using SF. However, an old data set was used by Liano and Kelly (1995:6). It could be that this effect could be prevalent in more currencies if more recent data are used.

Next, currency futures in both emerging and developed markets are discussed.

3.4.2 Emerging and Developed Derivatives Markets

Emerging derivatives markets have frequently been the subject of research over the past years (Lien & Zhang, 2008:39). In the 1980s and 1990s financial derivatives markets were established in Hong Kong, Japan, Brazil and in Western Europe (Lien & Zhang, 2008:40). On each derivatives exchange two broad classes of spot underlyings are traded. The first is commodities, while the second can be classified as financial¹⁴⁵. Financial derivatives serve

¹⁴⁵ This study will only consider the financial aspect of emerging and developed derivative exchanges. The reason is because currency futures are a sub-division of the financial class.

two primary goals; the first is to manage risk and the second is to facilitate the flows of capital into other (developed or emerging) markets (Lien & Zhang, 2008:40). Dodd (2003:8) found that using derivatives can be used to misreport the balance of payments of emerging and developed markets. According to Lien and Zhang (2008:48) emerging derivatives markets may serve three functions, namely it may be used as a means to reduce risk¹⁴⁶; as a means of price discovery and as a means of price stabilization.

When considering the second function, Lien and Zhang (2008:48) highlight the small transaction costs in the futures markets in contrast to the high transaction costs in the spot market. They conclude that the futures market also contains information with regard to future demand, which can be used in future decisions on production. Sequeira, Chiat and McAleer (2004) consider the causal relationship between spot and futures market returns which relates to price discovery in both developed and emerging markets. Their research confirms that in emerging markets, the future returns are responsible for explaining the spot returns. In developed markets, the converse holds, namely that the spot returns explain the future returns. The method they used to compare returns was conditional volatility. When comparing the influence of the domestic and foreign risk-free rate on developed and emerging markets, they used conditional variance. They also found that the most influential variable that may be used to compute a currency futures price is the foreign risk-free interest rate and concluded that the domestic risk-free interest rate cannot explain the spot or futures price regardless of the economic cycle.

Puri, Elayasiyani and Westbrook (2002:18) conducted a study considering the return predictability of currency futures. They found that two regularities existed. Firstly, they used a variance ratio test. This illustrated that currency futures prices move away from fundamental value. They used the spot exchange rate as proxy to represent this fundamental value. Puri et.al (2002:18) concluded that the basis had return predictability, but this diminished as the length of the contract increased. Min and Najand (1999) conducted a similar study to that of Sequeira, Chiat & McAleer (2004), but only considered the lead and lag relationship of spot and futures prices in the Korean market. They found that the Korean futures prices had a lead effect relative to the Korean spot market. A study in South Africa on price discovery by

¹⁴⁶ Refer to Section 2.3.

Beelders and Massey (2002) considered all three sectors of the JSE, together with their corresponding futures prices for each sector. They found that both the spot and futures market reacted quicker to shocks from within the country than to shocks outside the country. Where the futures market is used for price discovery in emerging and developed markets, the cash¹⁴⁷ market contains information on sovereign risk (Lien & Zhang, 2008:53).

When considering the function of price stabilization, Mayhew (2000) states that in an imperfect market, the introduction of futures may result in the volatility in the spot market increasing. Although a lot of research has been done on this topic, the general consensus is that the introduction of futures does not destabilize the underlying in the spot market (Lien & Zhang, 2008:48). Jochum and Kodres (1998:486) conducted a similar study with currency futures. They used the Mexican peso, the Brazilian real and the Hungarian forint as the underlying currencies in the spot market. They employed a SWARCH¹⁴⁸ model and showed that the futures volatility did not affect the spot market volatility. Their study extended over a period of 22 months. They concluded that around the arrival of news into the markets, it can help investors to devise strategies to trade from and determine if the market is efficient. Elyasiani and Kocagil (2001) examined currency futures markets to determine if any long run relationships existed. The currencies used as underlying for the futures contracts in their research included the British pound, Deutsche mark, Swiss franc, Australian dollar, Canadian dollar, and the Japanese yen. Their test results illustrated that currency markets follow an unstable pattern. All currency futures markets, however, are affected similarly by the following variables: world events; monetary policy changes and regime shifts.

This illustrates the fact that currency futures are price sensitive to structural changes and are event driven. They also found that developed countries with currency futures markets reacted quickly to new information and constantly moved towards long-term equilibrium. Wang, Yang and Simpson (2008:169) support these arguments. Their study considered the effect of United States monetary policy surprises on currency futures markets. These currencies included the British pound, Deutsche mark and the Japanese yen. They found that the various currency prices are strongly influenced by positive surprises, but unaffected by the

¹⁴⁷ Cash and spot will be used throughout as synonyms.

¹⁴⁸ This is an abbreviation for switching autoregressive conditional heteroskedasticity model which is used to compute the volatility.

announcement of a negative surprise. Sequeira (1996:673) conducted a study showing that in the Singapore market currency futures performed better than the random walk model. He thus concluded that currency futures prices in Singapore challenge the EMH.

In order to obtain a better understanding of the role that currency derivatives had on a developed financial market, the USD was used as the respective underlying. Some conclusions conceded that firstly derivatives promote speculation in the market, secondly they remove regulations in financial markets, thirdly liquidity risk is introduced via the swap market and lastly systematic risk is introduced (Dodd, 2005:14).

According to Dodd (2003) the FOREX derivatives market adds risk to the following negative consequences in a fixed exchange rate country, namely:

- (1) The transaction costs are higher with large gearing possibilities.
- (2) More responsibilities are given to the central bank, namely the pegging of the exchange rate in alternate markets.
- (3) Although price discovery is evident, it often results in the devaluation of futures.
- (4) If the demand is high for a specific country, the market makers of a foreign currency will offer those foreign currencies that are trading at a market premium.
- (5) Forward rates are used as an indicator for greater rate depreciation.

3.4.3 Volatility Models

This section provides a summary on the existing literature on (1) historical volatility and (2) estimating future volatility. Models that can be used for estimating volatility include: (a) exponentially weighted moving average (EWMA), (b) autoregressive conditional heteroscedasticity (ARCH) and generalised autoregressive conditional heteroscedasticity (GARCH¹⁴⁹). The last part of this section (3) considers foreign exchange rate volatility models in emerging markets.

¹⁴⁹ For recent studies on the GARCH (1, 1) process see Mikosch and Stărică (2000).

Kalotychou and Staikouras (2009:5) argue that volatility in financial markets is a function of: (1) fundamentals, (2) information dissemination as well as (3) the expectations of market participants.

1 Historical Volatility Measures

Kalotychou and Staikouras (2009:5) proposed two historical volatility measures. Firstly, the random walk concept was introduced. This is the most unreliable volatility measure as it assumes that the best measure of today's volatility is to consider the value which was realised yesterday. Secondly, they introduced the moving average which ignores prior data assuming that all historical observations carry the same weight. Next, the assumption of constant weights was dropped leading to a better model with which to forecast volatility, namely the EWMA model.

2 (a) Exponentially Weighted Moving Average (EWMA)

The exponentially weighted moving average is a volatility model which contains weights which decrease exponentially when moving backwards from past observations through time (JP Morgan, 1996). Hull (2003:375) also lists some advantages of using this model to estimate volatility, which includes:

- Only a small amount of data needs to be stored; and
- Any alterations in the volatility are tracked over time.

(b) Generalised Autoregressive Conditional Heteroscedasity (ARCH/GARCH) Models

The ARCH/GARCH models were first put forth by Engle (1995) and Bollerslev, Engle and Nelson (1995). Kalotychou and Staikouras (2009:33) stated that "One of the major breakthroughs in financial economics is the modelling of non-constant variances." This is also referred to as conditional heteroscedasity. GARCH volatility models accounted for the previous period's forecast error as well as the volatility of the previous period's volatility in determining the current period's volatility. When an ARCH volatility model has too many terms

it is more preferable to use a GARCH volatility model. Numerous forms of the GARCH volatility models exist and will be discussed briefly. These include: (i) IGARCH, (ii) EGARCH, (iii) TGARCH, (iv) FIGARCH, (v) MGARCH, (vi) COGARCH and (vii) ECOGARCH. Kalotychou and Staikouras (2009:14) define the most general specification of the GARCH volatility model as:

$$r_t = \mu + \varepsilon_t, \text{ with } \varepsilon_t \sim N(0, \delta_t^2);$$

$$\delta_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \delta_{t-1}^2$$

α_1 in the general specification of the GARCH model above can be seen as the short-term shock today which will filter into the volatility estimate of tomorrow. Thus, it can be regarded as a short-term volatility estimate. On the other hand β can be regarded as an older shock which will contribute to the long run volatility estimate (Kalotychou and Staikouras, 2009:14).

When α_1 and β have a constraint which limits to 1, this form of the GARCH model is known as the integrated or IGARCH volatility model. Using this process, the shock will be permanently reflected in the future volatility estimate. One version of the IGARCH process is the EWMA, but only when EWMA forecasts volatility for a short period. Over a longer period EWMA is not a function of IGARCH as EWMA is not mean reverting (Kalotychou and Staikouras (2009:15).

Campbell and Hentschel (1992) were among the first authors to suggest that volatility feedback is one of the justifications responsible for volatility asymmetries. The phenomenon has also been supported later at the “aggregate market level” by Chiang and Doong (2001). In order to account for these asymmetries in the volatility estimates, Nelson (1991) suggested an exponential GARCH volatility model or EGARCH. On the other hand Glosten, Jagannathan and Runkel (1994:1779) and Zakoian (1994) suggested a threshold or TGARCH volatility model.

When considering “high-frequency data”, volatility alterations occur much slower and shocks are also disseminated much slower. A fractionally integrated or FIGARCH model has been created by Baillie, Bollerslev and Mikkelsen (1996) to model hyperbolic in contrast to the normal exponential shocks.

In some financial markets volatility spillovers are evident. These spillovers endorse a multivariate GARCH or MGARCH volatility forecasting model. These specifications in the MGARCH volatility model account for asset interdependence. It also accounts for the volatility dynamics and correlation/covariance (Kalotychou and Staikouras, 2009:16).

Until recently, most of the stochastic modeling of volatility was under the assumption of discrete time. However, today access to continuous “high frequency data” with irregular time intervals call for the stochastic modeling of volatility using continuous time (Kalotychou and Staikouras, 2009:34). Nelson (1990) developed the first such model. It had one shortcoming, however, namely a limit function. This limit function did not contain a feedback mechanism, resulting in bursts in higher volatility. In order to overcome this shortfall Klüppelberg, Linder and Maller (2004) provided an extension to the COGARCH model which accounts for a “single background driving (continuous-time GARCH) Levy process”. This preserves some stationary as well as Markovian properties.

3 Choosing between the Models

The most distinctive feature underlying these various volatility models is their recognition that both correlations as well as volatilities are not constant (Hull, 2003:373). Akgiray (1989) concludes that the GARCH (1, 1) is the most appropriate volatility model to account for volatility clustering. He also states that it is the best alternative to MA, HA, MA and EWMA. This argument is supported by Hull (2003) and Taylor (2008). Solakoglu, Demir and Orhan (2009:522) provided a study which considered the importance of macroeconomic variables in stock market volatility. They considered six foreign exchange rate models, listed below, which have been used in emerging markets.

1. Rolling variance of monthly returns (12 months) (V1)

$$h_t = \left\{ \left[\sum_{j=t-12}^t (r_j - \mu^b)^2 \right] / 11 \right\}$$

2. GARCH (1, 1)

$$h_t = \mu + \alpha e_{t-1}^2 + \beta h_{t-1}$$

3. Recursive variance estimate with $w_t = 1$

$$h_t = (w_{jt}r_j^2)/(t - 1)$$
4. Nonparametric estimate of conditional variance

$$h_t = (w_{jt}r_j^2)$$
5. Exponentially weighted moving average (EWMA)

$$h_t = (1 - \lambda) \sum_{j=0}^{\infty} \lambda^{j-1} (r_{t-j} - \mu)^2$$
6. Downside risk (semi variance)

$$h_t = \frac{1}{T} \sum_{t=1}^T \min((r_t - \mu), 0)^2$$

Where r is the monthly returns, h is the volatility estimates and μ is the mean form the series returns. These different volatility formulas in international financial markets can be applied to alternative derivative securities that hedge or manage currency risk.

3.5 AN ALTERNATIVE DERIVATIVE INSTRUMENT TO HEDGE CURRENCY FLUCTUATIONS

This is a brief overview of currency reference warrants that trade in the South African derivatives market. The reason for considering this type of recently introduced derivative instrument is that they can also be used to deal with currency risk.

3.5.1 Currency Reference warrants (CRWs)

Currency reference warrants (CRWs) are derivative instruments that were launched recently due to popularity from the increased trading of currencies by investors to protect themselves against any adverse movements which may occur in exchange rates. These instruments were first issued by Standard Bank and are now widely traded on the SAFEX division of the JSE.

CRWs can be defined as derivative instruments of which the value is derived from an underlying asset, where this asset is foreign currency¹⁵⁰. A CRW can be classified as either a call or put. In contrast to the futures discussed previously, the holder of a CRW has the right, not an obligation to buy or sell the rand (ZAR) against a specified foreign currency¹⁵¹ at a rate that has been determined¹⁵² at date of origination¹⁵³ (Standard Bank, 2009).

3.5.2 Currency Reference Call Warrants (CRCW's)

This derivative instrument is used by investors when they perceive the ZAR to weaken or depreciate relative to a foreign currency as it approaches contract maturity. These investors will follow two approaches. Firstly they will buy the foreign currency as they expect it to appreciate and sell the ZAR as they expect it to weaken or depreciate and vice versa. The intrinsic value can be computed as: $\text{Intrinsic value}^{154} = (E^{155} - K)/CR^{156}$ (Standard Bank, 2009; DeutscheSecurities Asia Limited, 2005).

3.5.3 Currency Reference Put Warrants (CRPW's)

This derivative instrument (an options contract) is used by investors when they perceive the ZAR to appreciate or strengthen relative to a foreign currency, as it approaches contract maturity. These investors will follow two approaches. Firstly they will sell the foreign currency when they expect it to depreciate and buy the ZAR when they expect it to strengthen or appreciate. Secondly, they purchase foreign currency when they expect the foreign currency to appreciate and sell ZAR when they expect it weaken or depreciate. The intrinsic value can be computed as: $\text{Intrinsic value} = (K - E)/CR^{157}$ (Standard Bank, 2009). Table 3.5.1 below provides an example of a currency reference warrants with three underlying currency pairs, codes as well as other financial information.

¹⁵⁰ The change in the ZAR relative to a specific foreign currency.

¹⁵¹ An example is the euro.

¹⁵² Referred to as the Strike rate (denoted by K or X).

¹⁵³ Also called the maturity or expiry date.

¹⁵⁴ The intrinsic value = 0 at the maturity of the contract and the maximum loss that the holder of this contract can lose is the premium.

¹⁵⁵ E is used to denote the exchange rate at contract maturity.

¹⁵⁶ This abbreviation stands for the conversion ratio and represents "the number of currency reference warrants that have to be converted in contrast to the rand price of one unit of foreign currency" (Standard Bank, 2009).

¹⁵⁷ Note the inverse of the put relative to the call. Warrants can never obtain an intrinsic value that is negative.

Table 3.5.1: CRW's with Different Underlings

Underlying Currency	Warrant Code	Strike Price	Expiry	Option Type	Exposure Ratio ¹⁵⁸	Effective Gearing ¹⁵⁹
EUR/ZAR ¹⁶⁰	EURSCA ¹⁶¹	11.00	08-Sep-10	European ¹⁶² call	3.00	11.23
EUR/ZAR	EURSCP	10.50	08-Sep-10	European put	2.00	6.86
GBP/ZAR	GDPSCA	12.25	08-Sep-10	European call	4.00	10.33
GBP/ZAR	GDPSCB	11.50	08-Sep-10	European call	2.00	8.66
GBP/ZAR	GDPSCP	11.75	08-Sep-10	European put	2.00	7.50
USD/ZAR	USDSCA	8.00	10-June-10	European call	2.00	14.86
USD/ZAR	USDSCB	7.50	08-Sep-10	European call	2.00	8.46
USD/ZAR	USDSCP	7.00	10-June-10	European put	1.00	16.03

Source: Adapted from Standard Bank (2009)

Currency reference warrants have an onscreen market maker¹⁶³ which provides a narrow double every few seconds. This results in currency reference warrants having a high volatility, thus a very large premium in contrast to other currency derivatives¹⁶⁴. This allows investors to move in and out of warrant positions very quickly. Another important aspect when trading currency reference warrants is that holders may never be on the short side of the position, but only on the long side. Hence, investors may only long currency reference warrants and not short them (Boardman, 2009; Kotze, 2009).

¹⁵⁸ Exposure ratio of 2 represents a R50 000 warrant contract being exposed to R100 000 in the market.

¹⁵⁹ Effective gearing = Delta x leverage (Gearing). Delta indicates the deviation or change in the theoretical value of a warrant, providing for a one unit change in the underlying. Leverage = underlying price/ (Warrant price today x CR) (Deutsche Bank, 2005:9).

¹⁶⁰ Underlying currency in CRW contracts.

¹⁶¹ Short name used.

¹⁶² European warrants can only be exercised at contract maturity, while American warrants can be exercised at any time prior to contract maturity.

¹⁶³ This is a market maker, which provides additional liquidity of a few cents every few seconds.

¹⁶⁴ An example is currency options which are quoted on futures on the SAFEX division of the JSE.

3.5.4 Maxi Currency Futures

On the 15th of November 2010, the JSE listed a new type of currency derivative instrument, the USD/ZAR maxi currency futures contract. This is similar to the original currency futures contracts traded in the market, but with a \$100 000 nominal value. This is greater than the standard \$1 000 currency futures contracts originally traded. The reasons for this increase in nominal size are increased demand and the encouragement of foreign investors to trade via the JSE's platform rather than to use their own foreign platforms (JSE, 2010d).

The minimum contract sizes of the maxi currency futures contract is \$201 000 or in old currency futures terms 201 contracts¹⁶⁵. Another minimum requirement is at least three contracts must be traded. This maxi currency future is only on the USD/ZAR foreign currency as the underlying. This is due to the ZAR being the most liquid relative to €/rand, £/rand and AUD/randas previously shown in Table 2.6.4. Next, an alternative type of currency derivative contract with multiple underlyings is discussed (JSE, 2010d).

3.6 INDICES AND CURRENCY FUTURES INDICES

3.6.1 Indices

This section provides a general definition of an index, the types of indices, some problems associated with using indices and the advantages of using indices by investors.

An index number is defined by Mohr (1998:94) as: "the level of a single or composite variable in relation to its level at another time, during another period, at another place and so on." She also states that an index number can be defined as: "the ratio between the value of a variable or group of variables at a given time or during a specified period and its value at a base time or during a base period, the latter being normally taken as 100." Two main groups of indices are presented in most literature. These groups of indices include (1) specified index and a (2) general index. The major difference between these indices is in their method of computation. The specified index only comprises one variable, where the general index comprises multiple

¹⁶⁵ This number of currency futures is set by the JSE.

variables or components and is the type of index used in this study. This index is calculated on the basis of a trade-weighted average of imports and exports.

Mohr (1998:101) mentions the following problems of indices: The first problem is the fact that an upward bias is created when fixed weights have been used. The second problem is that of custom-made goods and the difficulty in measuring these products. The third problem is new products entering the export and import market and the seasonality effect that these products have on the index. The fourth and last problem is that indices are generally representative of an average, thus conceal instead of reveal. In light of these above-mentioned shortcomings of indices, currency index futures and their recent introduction in the market have been addressed.

3.6.2 Currency Index Futures

The recent introduction of these new instruments in the market allow managers and investors to speculate on the index together with exposure which is magnified by the number of currencies underlying this index.

3.6.3 Pricing of ZAR Currency Index (RAIN)

On 8 November 2010, the SAFEX division of the JSE Securities Exchange launched the ZAR currency index (also known as RAIN index). RAIN is an index which arithmetically averages five trading partners' currencies (the euro, the Japanese yen, the Chinese yuan and the UK pound). Reasons for the creation of this index by the JSE Securities Exchange were:

- To consider how competitive South African goods are in foreign markets;
- To summarize the appreciation as well as the depreciation of the South African rand among its trading partners;
- To allow the South African rand to be tracked against a basket of currencies; and
- To allow market participants and investors with another risk management tool and increased participation in the currency market (JSE, 2010a; JSE, 2010b; JSE, 2010d).

The RAIN index is similar to a trade-weighted index calculated by the South African Reserve Bank (SARB) and only includes five trading partners as the weighting of the other trading partners is too small to include in the index. As shown below, the currency index calculated by SAFEX is inversely related to the ZAR. When the ZAR appreciates relative to the other currencies, the index declines and the opposite is true when the ZAR depreciates.

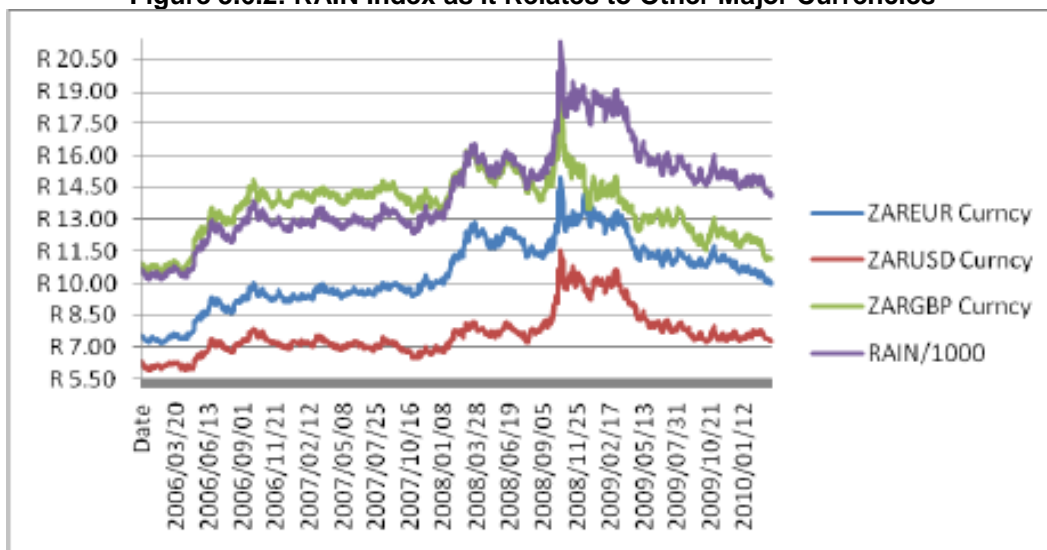
Figure 3.6.1: ZAR Inversely Related to RAIN Index

Date	€ / R	\$/ R	CNY / R	£ / R	¥ / R	RAIN
2006/01/02	R 7.5013	R 6.3422	R 0.7859	R 10.9109	R 0.0538	10,680.33
2006/02/17	R 7.1670	R 6.0225	R 0.7483	R 10.4848	R 0.0510	10,182.03
<i>ZAR strengthens against all 5 currencies and the index goes down</i>						
2008/10/22	R 14.9784	R 11.5650	R 1.7046	R 18.9508	R 0.1193	21,339.82
<i>ZAR weakens against all 5 currencies and the index goes up</i>						

Source: JSE (2010b)

The base date used by the JSE is January 2006 with the base year index set equal to 10 000 with constant weights used to determine the RAIN index using imports and exports of the different trading partners. Figures 3.6.2 and 3.6.3 below show the RAIN index at time t in relation to the individual currencies in the RAIN index. The RAIN index is divided by 1000 (the contract sizes) when shown relative to the EUR, USD and GBP. According to currency derivative specialists at the JSE smaller contract sizes are used for more liquid foreign currencies.

Figure 3.6.2: RAIN Index as it Relates to Other Major Currencies



Source: JSE (2010b)

Figure 3.6.3: RAIN Index as it Relates to Other Major Currencies Cont.



Source: JSE (2010b)

In figure 3.6.3 above, the RAIN index is divided by 10 000 for comparison to the ZAR/CNY. The reason for this division and contract size is due to the CNY being a less traded currency in the currency derivatives market. It is also less often hedged than other major foreign currencies. This is also the situation in figure 3.6.4 when dealing with the JPY where a 100 000 contract size is used.

Figure 3.6.4: RAIN Index as it Relates to the JPY



Source: JSE (2010b)

According to the JSE, the following formula is used to calculate the RAIN currency index at time t:

Figure 3.6.5: Formula to Calculate RAIN Currency Index

$$RAIN_t = \sum_{i=1}^N SX_{i,t} \times ContZ_i \times NCont_i$$

Source: JSE (2010b)

Where $RAIN_t$ is the level of the index at time t ; $SX_{i,t}$ is the number of ZARs per foreign currency; N can be defined as the number of currencies in the currency basket; $ContZ_i$ can be seen as the notional value or contract size of the specific foreign currency. It could alternatively be seen as the number of foreign currency units to purchase one futures contract. These amounts of the specific foreign currency are set fixed on the listing day.

Examples of one contract include:

- 1000 euros,
- 1000 USDs,
- 10 000 Chinese yuan,
- 1000 British pounds and
- 100 000 Japanese yen

Figure 3.6.6: Number of Futures Contracts on the RAIN Index

$$NCont_i = \frac{(RAIN_T \times W_{i,T})}{SX_{i,T} \times ContZ_i}$$

Source: JSE (2010b)

$NCont_i$ in the calculation of the Rain index is the number of fixed futures contracts on currency _{i} . These fixed contracts which comprise the currency weights are calculated at the rebalancing date which usually occurs one day after the futures contract on currency _{i} has been closed out. The formula above is used with $w_{i,t}$ as the weight of currency _{i} in the currency basket on the rebalancing date with the sum of the weights¹⁶⁶ equaling one.

¹⁶⁶ Note that these weights are fixed and rebalanced per annum on a trade-weighted basis.

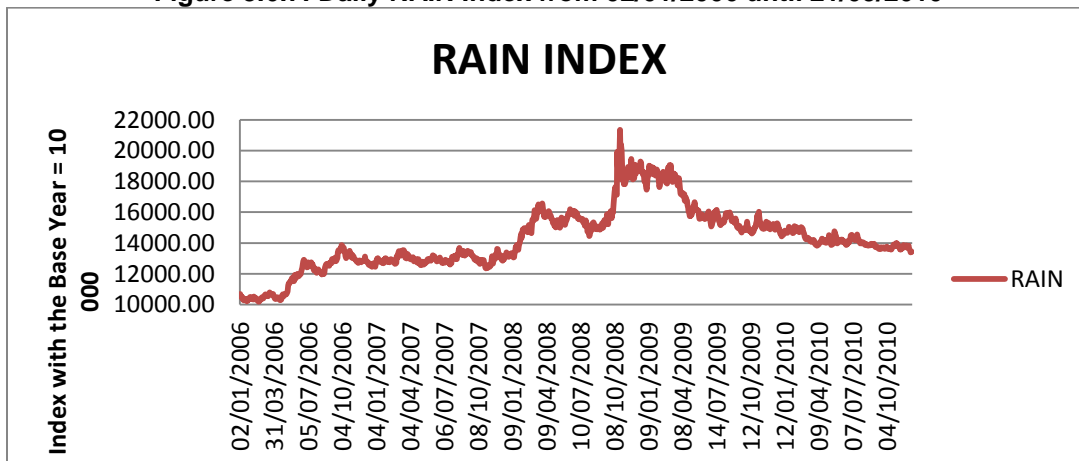
Table 3.6.1: Calculation of RAIN Index with the Number of Futures Contracts

Exchange Rate	Spot rate	Contract Size	Contract Value	Fixed Contract	Capitalisation	Weight
ZAREUR Currency	R 9.6963	1000	R 9,696.30	6.0292	R 58,460.83	42.09%
ZARUSD Currency	R 6.9749	1000	R 6,974.90	2.9994	R 20,920.68	15.06%
ZARCN¥ Currency	R 1.0432	10000	R 10,432.00	2.9929	R 31,222.16	22.48%
ZARGBP Currency	R 11.1900	1000	R 11,190.00	1.0985	R 12,292.25	8.85%
ZARJP¥ Currency	R 0.0866	100000	R 8,660.00	1.8490	R 16,012.58	11.53%
Total Cap					R 138,908.50	100.00%
(R/p)					10	
Index Level					13,890.85	

Source: JSE (2010b)

The table above provides a clear example of how the rain index is calculated at time t with the corresponding weights of each currency in this index. This is also shown graphically in the diagram below. The spot exchange rates are multiplied with their contract size to obtain the total contract value. Futures contracts are then entered into on each contract value. The number of fixed futures contracts is then multiplied with each country’s contract value to obtain the capitalization and ultimately the weights of each currency based on their specific capitalization. Note that the total capitalization is R138 908.50. To obtain the index level of 13 890.85, 10 is used. R10 is the rand value of a 1 point change in the index. The cap therefore has to be divided by R10 to get the actual index value. It ensures that any depreciation or appreciation of the underlying currency is clearly reflected in this RAIN index. Figure 3.6.7 reflects the RAIN index over a daily time-series analysis for the period 2006 until 2010.

Figure 3.6.7: Daily RAIN Index from 02/01/2006 until 21/09/2010



Source: JSE (n.d.b)

In order to calculate the number of fixed futures contracts on the contract value, the formula below is used. The ZAR/EUR and ZAR/USD are used as examples. Note that in order to determine the number of futures for hedging purposes, the figure is rounded off as fractions of futures cannot be used. The numbers of euro and USD futures contracts are shown below:

$$NCont_{EUR} = \frac{RAIN_T \times W_i}{SX_{i,T} \times ContZ_i}$$

$$NCont_{EUR} = \frac{138\,908.50 \times 42.09\%}{R9.6930 \times 1000} = 6.0292 \approx 6 \text{ contracts.}$$

$$NCont_{USD} = \frac{138\,908.50 \times 15.06\%}{R6.9749 \times 1000} = 2.9994 \approx 3 \text{ contracts.}$$

Source: JSE (2010b)

3.6.4 Using the RAIN Index for Hedging Purposes

As currency index futures contracts fall within the Yield X class of the JSE, it is analyzed and broken up in the market of currency futures. Both forward rates as well as spot rates which are used in the currency futures market are used to compute the RAIN future contract price. In table 3.6.2 below, the individual currency futures contracts are shown relative to the RAIN futures. The individual currency futures contracts prices making up the RAIN index are computed using the formula provided by Chance (2003) and are presented below.

Table 3.6.2: Currency Futures Prices and RAIN Futures Prices

Date	€ / R Future	\$/ R Future	CNY / R Future	£ / R Future	¥ / R Future	RAIN Future
2010/01/29	R 10.7735	R 7.7454	R 1.1171	R 12.4157	R 0.0854	14,825.49
2010/02/26	R 10.6735	R 7.8553	R 1.1303	R 11.9128	R 0.0883	14,861.57
2010/03/31	R 10.0523	R 7.4328	R 1.0658	R 11.2568	R 0.0796	13,906.50
2010/04/30	R 9.8576	R 7.4102	R 1.0956	R 11.3401	R 0.0788	13,826.83
2010/05/31	R 9.4666	R 7.7075	R 1.1385	R 11.1964	R 0.0845	13,923.85
2010/06/14	R 9.3593	R 7.6469	R 1.1427	R 11.2715	R 0.0832	13,819.28

Source: JSE (2010b)

The formula used to compute the futures price on the RAIN index is the same as that discussed by Chance (2003). However, the JSE replaces the SX_t in the RAIN index formula with FX_t as set out below:

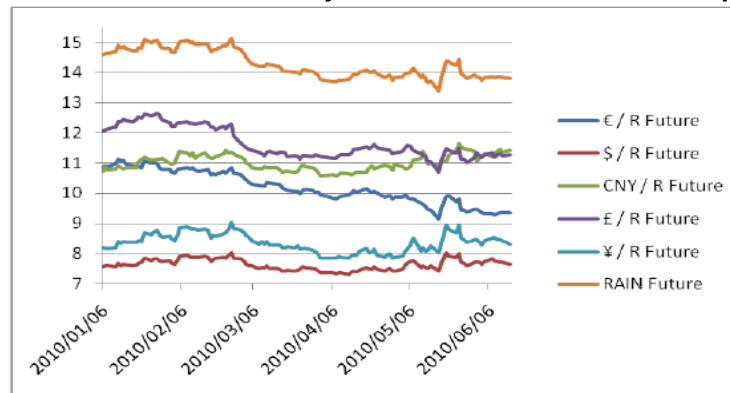
Figure 3.6.8: Adjusting the RAIN Index formula

$$RAIN_t = \sum_{i=1}^N FX_{i,t} \times ContZ_i \times NCont_i$$

Source: JSE (2010b)

Where $FX_{i,t}$ is the futures price of the foreign currency i at time t . The futures prices of the foreign currencies and the RAIN indices are provided graphically below.

Figure 3.6.9: RAIN and Currency Futures Prices Presented Graphically

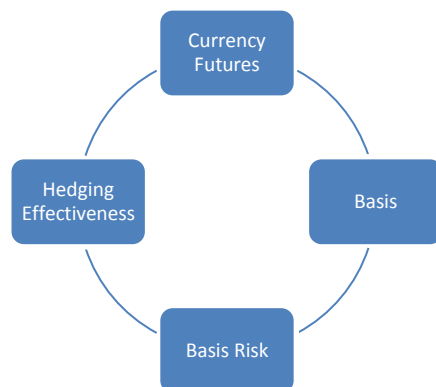


Source: JSE (2010b)

Investors in the market can consider the individual currency futures contracts comprising of the index as a hedging tool or may use the index to assess the international competitive environment and may take futures positions with the index as underlying.

3.7 CONCLUSION

This first section of this chapter describes the launch of currency futures in the South African market. On an individual level, the primary uses of currency futures by market participants are the removal of volatility and generation of profits from changing currency exposures of the ZAR relative to other major foreign currencies. On a corporate level, this change in foreign currency exposures induces currency risk which has firm value implications. Currency futures limit this risk resulting in higher firm values. Other sections dealt with in this chapter were the characteristics of currency futures, namely basis and basis risk which have an impact on the hedging effectiveness. This is graphically shown below.

Figure 3.7.1: A Summary of the Characteristics of Currency Futures on Hedging Effectiveness

Source: Own Compilation

As the characteristics of currency futures are market dependent, a section on the pricing comparison of currency futures in both a developed and developing market context were provided. Currency futures are only one of the many instruments to manage currency exposures, alternative instruments were also discussed such as currency reference warrants. The last section provides literature on a currency index approach that deals with multiple currency exposures and a possible method for modeling a fictitious uniform SADC currency over a time-series.

Currency futures are the most frequent instruments used to hedge against short-term foreign exchange rates fluctuations. One advantage of using currency futures in a financial market is the ability that it gives to gauge the economic development of that particular market. Thus, in this regard, it is the appropriate instrument to use within the SADC region, as will be explained later in this study. In order to use these instruments, assumptions of CIP conditions must be used over a time-series analysis of which the largest carrying cost would be the interest rate differential. Another factor influencing this CIP condition is the underlying spot exchange rates. Bhargava and Malhotra (2007:95) concluded that if the volatility of a foreign exchange rate goes up, speculators' demand for the use of currency futures declines. This also puts additional pressure on exchange rates.

Most firms are unaware of their currency risk exposure and the impact that the change in foreign currency exchange rates may have on their operations (Loderer & Pichler, 2000:317). In order to remedy this major shortcoming they show that corporations wishing to hedge

currency risk can follow guidelines described below. For demonstration purposes Brown (2001:407) used a general U.S. multinational corporation (MNC) with three levels of management in place to manage currency risk exposure. These levels include operations, accounting and control, and lastly oversight. The operations comprise the treasury foreign exchange group which accounts and hedges numerous currencies. These operations are then accounted for and lastly oversight is provided by top management. If these guidelines are followed, corporations will be able to implement effective hedges and ultimately increase the firm value. Aretz et al. (2007) showed these increases in firm value under multiple currency exposure hedging scenarios.

In order to compute these efficient hedges, companies must be aware of the correct currency futures pricing method to use depending on the type of market. Sequeira et al. (2001:271) provided two alternative currency futures models which differed from the traditional model originally proposed by Winstone (2001:122). The first currency futures model was absent from a bias and also accounted for the depreciation of the underlying exchange rate. The second model used by Sequeira et al. (2001:271) is less applicable in the South African market as it is based on the assumption of no-arbitrage. If investors or managers choose these models instead of the traditional models it may affect their analysis of the basis of the futures position. When consulting market participants, it was stressed that the basis spread is used as a forecasting tool.

An alternate measure used by market participants is the analysis of the deviation of the basis over time, also called the basis risk. Kruger (1991) provides a study of basis risk in the South African context, which was later extended by Schumann (2000). One criticism of these studies is the use of equity futures instead of currency futures. Currency futures may yield different results for the basis risk over a time series analysis. Another criticism is that the sample used was too small and the information was inconclusive to explain the phenomenon that existed. Although these are two strong criticisms, the studies they conducted were able to confirm that the characteristics that existed in the international markets were also applicable in the South African futures market and spot market. Their studies could also provide a foundation of the variables which could impact the basis and basis risk over time. More variables have an impact on the basis risk of commodity futures as opposed to financial

futures. Miffre (2004) provides the most recent research on the bases over time and what this implies for basis risk. He confirmed the results of Bailey and Chan (1993) as well as Baum and Barkoulas (1996) that the bases contained a time-varying risk premium using foreign currency instruments. Another finding is that the bases inherent in these contracts were priced rationally in an efficient market.

The literature survey was conducted on the modeling of currency futures prices over a time-series analysis in both developed and emerging markets. The following characteristics inherent in currency futures prices can be put forth. In the pricing of currency futures, two assumptions are generally made about the distribution. The first is the use of a normal distribution, while the other is a leptokurtic distribution. This study makes use of the normal distribution with currency futures prices. The Samuelson hypothesis should also be taken note of when pricing currency futures. This hypothesis states that futures prices are more volatile in periods prior to maturity, with a decline in volatility closer to maturity of the futures contract. Other characteristics of currency futures prices are that these prices move away from their fundamental value with unstable patterns. A possible reason for this phenomenon is that the underlying foreign currencies are non-linear and stochastic. The market prices of currency futures are affected by three factors, namely: (1) world events; (2) monetary policy changes (changes in interest rates) and (3) regime shifts. Lastly the volatility of currency futures does not affect spot market volatility in contrast to other types of futures contracts.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter two highlighted the variables in the development and eventual implementation of the USD/euro currency basket exchange rate. Studies that analyze the changes that occurred in both the financial sector and foreign exchange markets of the countries in the EMU region were surveyed. Chapter three focused more on detailed business management considerations as it relates to futures and hedging. Basis and the basis risk were considered and the introduction of a proposed currency for the SADC region was also briefly discussed.

This chapter briefly describes the methodology that was used to model the possible effect that the introduction of a uniform currency will have on currency futures hedging by corporations in the SADC region. This effect on hedging was obtained from studying hedging positions with different underlying foreign currencies. These foreign currencies include the USD/ZARN and USD/ZARC (see List of Abbreviations) in relation to the USD/SADC. The methodology used to model the effect that the implementation of the fictitious SADC currency may have on risk management with futures is described below.

4.2 RESEARCH DESIGN¹⁶⁷

In chapter 1 it was mentioned that a research design consists of three approaches. In terms of the USD/SADC dollar exchange rate index development and the basis risk comparison over time, a partly exploratory approach was followed. The reasons for following this approach is because to date no empirical studies have been conducted on this topic. The variables in these futures derivative positions were altered, thus also following a causal approach. Finally, a secondary research design approach was followed which included the analysis of existing data. The research design consists of the following steps:

¹⁶⁷ A summary of the research design is provided in appendix C.

Firstly, the spot exchange rates of the ZAR relative to one dollar were obtained for twelve consecutive monthly intervals for the period 31/12/1999 to 31/12/2006. These monthly intervals provide thirteen¹⁶⁸ spot rates.

Secondly, the currency futures prices were computed using the USD/ZAR nominal spot exchange rate on 31 December each year obtained in step one and substituted into equation one (see Summary of Equations), the covered interest parity formula. These futures prices were compounded every three months (ending March, June, September and December). This is similar to the method used by the SAFEX division of the JSE and yields four futures prices over one year.

Thirdly, the basis spread of the different hedge positions will be computed at each of the futures price intervals, namely three, six, nine and 12 months. The basis spread is computed using equation six in the summary of equations by subtracting the monthly USD/ZAR spot exchange rates up to that point from the futures prices, thus yielding the basis spreads over the period of one year.

The above approach uses an absolute basis spread. The reason for using the absolute value is to allow for the computation of the variability in the basis. Equations eight and nine have been used to calculate the variability of the basis spread. Next, a USD/ZAR foreign currency index will be created. This approach which is identical to the approach used for the SADC countries is discussed in more detail in section 4.4.2 below. The basis spread risk is then calculated for the USD/ZAR nominal exchange rate as well as for the USD/ZAR currency index. These steps are then repeated for the USD/SADC dollar and comparisons drawn. The countries comprising of the SADC region are shown in table 4.1 below:

¹⁶⁸ This includes the spot exchange rate on 31/12/1999.

Table 4.1: Countries Comprising of SADC

Countries in SADC	Spot exchange Rates
	1 US Dollar =
Angola	Angolan kwanza
Botswana	Botswana pula
Democratic Republic of Congo	Congolese franc
Lesotho	Lesotho loti
Malawi	Malawian kwacha
Mauritius	Mauritian rupee
Mozambique	Mozambican metical
Namibia	Namibian dollar
Seychelles	Seychelles rupee
South Africa	South African rand
Swaziland	Lilangeni
Tanzania	Tanzanian shilling
Zambia	Zambian kwacha
Zimbabwe	Zimbabwe US dollar

When computing the futures prices for the USD/ZARN and USD/ZARC on the ZAR currency index, different interest or interbank rates were used. For the SADC region the following equation was used to calculate an equivalent to an interbank rate:

$$R_{d(SADC)t} = \sum_j^n CB_{it}^* g_{it},$$

where CB_{it} is the central bank discount rate for a three, six, nine or 12 month period and g_{it} is the GDP weighting measure of country i at time t .

To calculate a fictitious nominal currency for the grouping of the SADC member states listed above in the base year of 2005, the Democratic Republic of Congo and Zimbabwe were excluded due to the lack of currency exchange rate data. Zimbabwe was excluded from SADC because of the following reasons: (1) Only recently did they convert/peg the Zimbabwean Dollar to the USD; (2) Political unrest in the country causes large central bank

discount rates to induce a bias in the futures prices; and (3) Macroeconomic indicators must first improve before they can be allowed into this monetary union, thus serving as a renaissance effect. Other reasons for later considering the exclusion of Angola from the study is due to (1) Angola having a crawling exchange rate and (2) a very large central bank discount rate (120 to 150%).

While the basis risk is calculated for the USD/ZAR nominal exchange rate as well as this exchange rate modeled on the ZAR currency index, no nominal exchange rate exists for SADC. To obtain accurate comparisons, a nominal exchange rate for the SADC region is calculated using equation 4 in chapter 1 and modeled pre and post the 2005 base year of the SADC currency index. The USD/SADC dollar nominal exchange rates are modeled using the equation presented below:

$$\text{SADC dollar exchange rate}_{a, j, t} = 100 * \left(\frac{S_t}{100} \right),$$

Where 100 denotes the value of the base year in 2005 and S_t is the exchange rate at time t .

4.3 DATA COLLECTION

This stage deals with the actual collection of data. Two types of data are available. Collis and Hussey (2009:73) define primary data as: “data generated from an original source, such as your own experiments, surveys, interviews or focus groups.” They also define secondary research as: “data collected from an existing source, such as publications, databases and internal records.” Based on these definitions, this study used secondary data from existing sources and transformed this data into a usable format. All spot exchange rates have been obtained from the Inet-Bridge database and the OANDA Corporation (2010a,b,c) exchange rate website, complemented with currency converters and solving for exchange rates as the unknown variable using currency pairs where data were missing. These exchange rates have been quoted in terms of the US dollar (\$) foreign currency, not the euro. This was done for the following reasons:

- Liquidity. As discussed in chapter 2¹⁶⁹, currency futures contracts with the dollar as the underlying are more actively traded than the euro, which improves price discovery.
- Foreign trade. Countries in the SADC monetary region are more dependent on the dollar as opposed to the euro.

All central bank discount rates for countries that are part of SADC and for the ZAR were obtained from the Quantec database. Different interbank rates were used as the foreign interest rates. For the USD, the T-bill rates were used which were obtained from Quantec and websites related or linked to the US Federal Treasury. GDP and CPI data were obtained from the McGregor (2005), World Bank (2010) as well as the IMF (n.d) databases.

4.4 DATA ANALYSIS PLAN

The purpose of this section is to explain the various statistical methods that were applied to the data in order to develop the model. Firstly, the interpolation method will be explained followed by the method to create a currency index. Secondly, the development of a currency index is explained. Lastly, descriptive and inferential statistics are discussed with hypothesis tests complemented by time-series multiple linear regressions. The method for quantifying seasonality is then explained.

4.4.1 Linear Interpolation

A simple linear interpolation method was used in cases where monthly or quarterly data were not available. The following equation was used:

$$Z_s^{170} = \frac{(T_1 - T_s)}{(T_2 - T_1)} * Z_1 + \frac{(T_s - T_1)}{(T_2 - T_1)} * Z_2,$$

Microsoft Excel contains a “FORECAST” function based on the above equation that was utilized to interpolate the large datasets in the study. Since only six month, nine month and

¹⁶⁹ Refer to Figure 7.

¹⁷⁰ T_1 = date at time 1; T_s = date at which the value is to be determined; T_2 = date at time 2; Z_1 = given value at T_1 ; Z_2 = given value at T_2 ; Z_s = value to be determined.

one year data are available, the data were converted to monthly data using the FORECAST function.

4.4.2 Development of a Foreign Currency Index¹⁷¹

The development of a currency index comprises three steps. The first step involves obtaining the exchange rates of the SADC countries for the period 31/12/1999 until 31/12/2006 at month-end intervals. Once these exchange rates had been obtained, they were indexed using 2005 as base year.

The second step involves obtaining the weight of the trading partners for these countries. These weights can be expressed as $(p^{x/m}_{ijt} = w_{jt} / \sum_j^n w_{jt})$, where $p^{x/m}_{ijt}$ is the weight of the export/imports of country i in SADC relative to trading partner j at time t and can be normalized by dividing trading partner j 's weight by the sum of the normalized weight of trading partner j at time t . This is due to $\sum_j^n < 1$. Next the trade-weighted averages of country i in SADC relative to trading partner j is calculated using the equations listed below:

$$w_{ijt} = (X_{ijt}^{172} + M_{ijt}^{173}) / TT_{it}^{174}, \text{ where}$$

$$X_{ijt} = p^x_{ijt} * \sum_i^n X_{it};$$

$$M_{ijt} = p^m_{ijt} * \sum_i^n M_{it} \text{ and}$$

$$TT_{it} = \sum_i^n X_{ijt} + \sum_i^n M_{ijt}$$

Step three involves calculating the currency index value for SADC and each country's value in this index. Each country's index value in SADC can be expressed using the equation below:

$$(N_{it}) = \sum_i^n S_{ijt} * W_{ijt}$$

¹⁷¹ Refer to Appendix A for a definition of the variables.

¹⁷² X denotes exports.

¹⁷³ M represents imports.

¹⁷⁴ TT = total trade.

where S_{ijt} is the spot exchange rates of country i relative to country j at time t , as mentioned in step one. After N_{it} is obtained for each individual SADC member's foreign trading partners, the N_{it} factor must be indexed using the base year of 2005. To calculate the final indexed value, a GDP weighting factor is used. This weighting factor accounts for each SADC member's contribution in the total SADC index. This GDP weighting factors used is:

$$\text{GDP weight}_{\text{SADC-member}} = \frac{\text{GDP}_{it}}{\sum_{i=1}^n \text{GDP}_{it}}$$

While the use of the GDP is not without its limitations, it is the only appropriate approximation method that takes the economic activity into consideration. This approach can also be justified from an investment perspective. Reasons include: An increase in GDP is a signal of economic growth to investors. Economic growth implies companies and financial markets are increasing, thus more profitable returns can be made by investors, *ceteris paribus*. Z_t is the final factor, or spot exchange rate index value for the SADC region as demonstrated below:

$$\begin{aligned} Z_t &= \sum_i^n N_{it} * g_{it} \\ &= (\sum_i^n S_{ijt} * W_{ijt}) * g_{it} \end{aligned}$$

The SADC currency index for a specific date can therefore be calculated as the sum of Z_t as shown below:

$$\text{SADC currency index}_t = \sum_{i=1}^n Z_t$$

4.5 DESCRIPTIVE STATISTICS

Blumberg, Cooper and Schindler (2008:714) state that descriptive statistics are used to obtain knowledge from the data collected with regard to the characteristics of location, shape, spread and the distribution. They argue that small problems that could occur in the data are magnified using descriptive statistics. Descriptive statistics in this study were used to obtain the standard deviation, type of distributions, skewness and kurtosis of the SADC countries' exchange rates. Descriptive statistics will demonstrate the distribution and feasibility of this

approach or whether an index would rather be best suited in contrast to the nominal exchange rate value for the SADC region.

4.5.1 Standard Deviation

The standard deviation is the deviation of the variance (Collis & Hussey, 2010:225; O'Leary, 2005:243). In this study the standard deviation is used to calculate the currency risk of the ZAR on the ZAR currency index and the SADC dollar on the SADC currency index.

4.5.2 Skewness and Kurtosis

When a distribution is non-normal, it is skewed. If the skewness of distribution is positive, then it is skewed to the right otherwise it is skewed to the left. The kurtosis measures how flat or how the data peaked around the mean. If the kurtosis is positive then the data are peaked, otherwise if the kurtosis is negative then the data have a flatter distribution (O'Leary, 2005:241). The skewness and kurtosis give an indication of the normality of the time-series data which provides meaningful information to the type of standard deviation estimate that can be used to compute the basis risk.

4.6 INFERENCE STATISTICS

Inferential statistics are statistical methods which are used to make generalizations from a sample set chosen to a population, thus making inferences about a population. The data used are conditioned to some sort of variation, for example:

- Observation error
- Sampling error (Collis & Hussey, 2009:222; O'Leary, 2005:243)

4.6.1 Hypothesis Tests

Two sets of hypotheses were tested in the research design:

1.) H_0 : Ceteris Paribus, $\sigma^2_{ZARN/USD} = \sigma^2_{USD/SADC\ dollar}$

H_A : Ceteris Paribus, $\sigma^2 \text{ZARN/USD} \neq \sigma^2 \text{USD/SADC dollar}$

2.) H_0 : Ceteris Paribus, $\sigma^2 \text{ZARC/USD} = \sigma^2 \text{USD/SADC dollar}$

H_A : Ceteris Paribus, $\sigma^2 \text{ZARC/USD} \neq \sigma^2 \text{USD/SADC dollar}$

The null hypothesis is not rejected in favour of the alternate hypothesis when the p-value is less than 0.05. This 0.05 represents a five percent level of significance, thus demonstrating that the volatility of the basis spread risks have declined for the different SADC hedged positions in comparison to the ZAR hedged positions.

In order to compare the variance calculated of the different hedge positions, the F-statistic was used for the index values as well as the nominal exchange rate values. The F-statistic can be defined with the equation being provided below:

$$\text{F-statistic} = \frac{\text{Max variance}}{\text{Min variance}}$$

The F-statistic is calculated by dividing the maximum variance by the minimum variance or volatility of the different hedged positions for the SADC dollar and ZARN/ZARC. The same is done for the minimum volatility. In other words a comparison is made between the maximum basis risk and the minimum basis risk of the different currency futures hedge positions. This approach is used under the assumption that the data sets provided are normal with the basis risk being calculated using the standard deviation equation of the currency futures basis spreads.

4.6.2 Multiple Linear Regressions: ARIMA (1, 1, 0)

To analyze the currency risk of the various sets of exchange rate data, the assumption of a normal distribution must be dropped and a model must be found that fits all of the data sets. Once a model is found, the currency risk of the various exchange rate data sets can be calculated in the form of mean squared errors (MSE). In order to find a model that fits the data used in this study, various forms of the autoregressive integrated moving average, ARIMA (p, d, q) models are tested. The variables comprising the ARIMA (p, d, q) are:

- p = represents the total number of autoregressive terms used,
- d = non-seasonal differences used, and
- q = the number of lagged forecast errors

One of the more general models is the ARIMA (1, 1, 0) model with 1 autoregressive term, 1 non-seasonal difference and no lagged forecast errors which can be defined as:

$$\hat{Y}(t) = \mu + Y(t-1) + \Phi(Y(t-1) - Y(t-2))$$

Where: μ = a constant due to the error terms of the regression being correlated; Φ = auto correlative coefficient. Once a model is found that fits, then both ARCH and GARCH (1, 1) models can be run on the error terms of the different data sets. The ARCH/GARCH models have the advantages of being able to quantify and demonstrate the effects of seasonality. Another advantage of ARCH and GARCH (1, 1) models is the ability to calculate and forecast short-run and long-run volatility estimates for each quarterly currency futures hedge position allowing for comparisons to be drawn (Box and Pierce, 1970; Nau, 2005).

4.7 SAMPLING

Blumberg et al. (2008:235) identify two broad categories of sampling, namely probability and non-probability sampling. They state that probability sampling deals with the choice of selecting data at random, while non-probability sampling is subjective and non-random.

This study followed the non-probability sampling approach. The non-probability sampling approach was applied to the spot exchange rates chosen. While probability sampling is more simple and accurate than non-probability sampling, non-probability sampling was chosen due to (1) Data on the spot exchange rates of countries and weights were chosen in a non-random fashion and (2) The scales of the different variables which influence this study are not known to precision. This study is more interested in the type of effect, namely positive or negative, than the actual accuracy of the effect.

4.8 CONCLUSION

This Chapter identified the variables from the literature reviewed in the previous Chapters to develop a foreign currency index model. This foreign currency index model is used to model the effect of a fictitious nominal exchange rate for the SADC region in comparison to the ZAR. This Chapter concludes by explaining where all the data was obtained and summarizing the various statistical procedures which complement the above mentioned model. In the Chapter that follows, the procedure of applying the model to data is described. Thereafter, finding and conclusions have been made in the final Chapter as well as recommendations for further research.

CHAPTER FIVE: OVERVIEW OF EMPIRICAL RESEARCH

5.1 INTRODUCTION

This chapter contains the empirical results of the model developed and as described in chapter 4. It illustrates the various outcomes of the calculations of the indices, SADC exchange rate, and analyses of the indices using various descriptive statistics.

Two approaches are used to compare the basis (basis risk) and volatility of different foreign currency underlings¹⁷⁵ in currency futures contracts. The first approach employs a standard deviation formula, while the second approach applies time series regressions.

5.2 APPROACH ONE

5.2.1 USD/ZARN basis and basis risk spread

This section describes the calculation of the USD/ZARN currency futures basis risk and the variables that were used or considered in the futures price calculations. The currency futures basis risk of the USD/SADC dollar is calculated in section 5.2.4 with sections 5.2.2 and 5.2.3 establishing the SADC foreign currency index and the SADC domestic interest rate.

The monthly USD/ZAR spot exchange rates were obtained for the period 31/12/1999 to 31/12/2006 (see Table 5.2.1). These spot exchange rates on 31 December each year (starting at 31/12/1999) were used to calculate the alternative three, six, nine and 12 month currency futures prices (see section 4.2). Hereafter, the monthly spot exchange rates were subtracted each year from these futures prices to obtain the absolute basis spreads of the quarterly currency futures hedged positions.

¹⁷⁵ The first underlying is the USD/ZAR nominal exchange rate (ZARN) as quoted in the South African market. The second underlying is the USD/SADC-dollar on the SADC currency index. The last underlying is the USD/ZARN on a ZAR currency index (ZARC).

Table 5.2.1: Monthly USD/ZARN Spot exchange Rates

Date	Spot	1 month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	12 months
2000	6.16	6.34	6.29	6.58	6.79	7.00	6.82	6.96	6.96	7.31	7.57	7.79	7.63
2001	7.63	7.79	7.71	8.04	7.98	8.00	8.05	8.23	8.39	9.01	9.42	10.27	11.55
2002	11.55	11.44	11.44	11.33	10.61	9.71	10.36	10.16	10.51	10.56	10.09	9.27	8.94
2003	8.94	8.65	8.29	8.04	7.64	7.60	7.85	7.53	7.36	7.31	6.96	6.71	6.52
2004	6.52	6.89	6.74	6.61	6.50	6.79	6.41	6.10	6.43	6.52	6.36	6.02	5.71
2005	5.71	5.95	5.82	6.29	6.09	6.65	6.67	6.58	6.54	6.36	6.71	6.52	6.36
2006	6.36	6.08	6.10	6.24	6.07	6.34	6.94	7.07	6.93	7.39	7.60	7.23	7.03

Source: McGregor (2005)

In this study three rates were considered as the domestic interest rates to be used when pricing currency futures with the USD/ZARN as the underlying foreign currency. The first interest rate, the JIBAR, is the domestic interest rate used by traders in the pricing of alternative interest rate derivatives contracts and various other financial instruments (JSE, 2010c) in SA.

The second interest rate considered is the Yield X curve rate, which is used to price all interest rate derivatives in the South African market. As currency futures instruments are a form of an interest rate derivative, SAFEX prices these contracts on the the Yield X yield curve after consulting market participants. One problem when pricing historical currency futures contracts with this Yield X curve rate is the difficulty of constructing and matching these yield curves. Currency futures were only launched in the South African derivatives market during 2001 and traded by market participants from June 2001. This results in limitations of currency futures data prior to 2001 and affects the time period chosen in this study. As the SADC has no interbank market, no accurate comparisons can be made between SADC and South Africa hedged positions when pricing currency futures using an interbank rate as the domestic interest rate. For this reason, the JIBAR and Yield X yield curve rates cannot be used.

Due to reasons mentioned above, the third rate considered and used in this study is the central bank discount rate. Other reasons for choosing central bank discount rates for SADC member states are its affiliation with a credible central bank as opposed to a JIBAR rate that is calculated between commercial banks and not countries. A central bank discount rate is

calculated on a country basis and may be more reflective of that country's economic climate. As this study assumes the establishment of a regional monetary union in future, the use of one central bank discount rate could be more appropriate to use in this sense. For this reason the central bank discount rates were used to compute both SADC and ZAR currency futures contracts. The first approach to calculate the domestic central bank discount rates for three, six, nine and 12 months was to weight them arithmetically which led to unrealistic results. The second approach which followed was based on the assumption that the ZAR and the SADC will contain an upward sloping yield curve in the long term. The longer the term of the futures contract, the higher the yield. Investors wish to be compensated with a higher yield for taking on the additional risk of more uncertainty with a longer term. For that reason the central bank discount rate has been used for the ZAR and SADC region to easily validate comparisons in contrast to different yield curves being used as the domestic interest rate. The annual central bank discount rates are partitioned into their quarterly weights as demonstrated in the table below.

Table 5.2.2: ZAR Central Bank Discount Rates

Date	3 month	6 month	9 month	12 month
01/01/2000	1.030	1.060	1.090	1.120
01/01/2001	1.024	1.048	1.071	1.095
01/01/2002	1.034	1.068	1.101	1.135
01/01/2003	1.020	1.040	1.060	1.080
01/01/2004	1.019	1.038	1.056	1.075
01/01/2005	1.018	1.035	1.053	1.070
01/01/2006	1.023	1.045	1.068	1.090

Source: Qunatec database

The foreign interest rates used to hedge the United States dollar (\$) is the T-bill rate at¹⁷⁶ presented in Table 5.2.3 below.

¹⁷⁶ The underlying foreign currencies in the currency futures contracts have only been priced relative to the USD, because the USD is the most liquid contract in the South African market and stimulates trade in the South African retail sector. Based on prior literature, it is assumed that this will also be the case for SADC.

Table 5.2.3: Foreign Risk-free Interest Rates (USD T-Bill)

Date	3 months	6 months	9 months	1 year
12/31/1999	1.0574	1.0598	1.0611	1.0624
01/02/2001	1.0587	1.0558	1.15856	1.0511
01/02/2002	1.0174	1.0185	1.02065	1.0228
01/02/2003	1.0122	1.0125	1.01335	1.0142
01/02/2004	1.0093	1.0102	1.01165	1.0131
01/03/2005	1.0232	1.0263	1.0271	1.0279
01/03/2006	1.0416	1.044	1.0439	1.0438

Source: N.A (2010a); N.A (2010b); N.A (2010c); N.A (2010d); N.A (2010e); N.A (2010f); N.A (2010g)

The currency futures prices were calculated using the domestic and foreign interest rates provided in Table 5.2.3 in the format of $1 + (i^{177})$, where i is the central bank discount rate expressed as a percentage. Note that the futures prices in 2002 are considerably larger than any other year's futures prices. One reason for this is the high domestic rate of 3.4% and the extremely low foreign interest rate of 1.74%. This resulted in a large compounding factor and a low discounting factor. The equation used to calculate the currency futures prices is as follows (see equation 1 and section 4.2):

$$F_0(T)^{178} = [S_{i,j,t} \times (1 + r_d)^T] / (1 + r_f)^T$$

One limitation in the use of the currency futures equation above is that the prices computed by this model are only theoretical prices inducing modeling risk. Prices in practice can still deviate from these theoretical prices computed due to daily supply and demand issues and other financial information entering the market. The currency futures formula with compounding interest proposed in Chapter 1 is not used in practice when consulting market participants (also refer to SAFEX). Thus, the simple interest formula was chosen and used in this study. For the sake of this study, it is assumed that a SADC dollar future will be available and will be traded when the currency index is introduced in the SADC region. One of the reasons for including futures/forwards is that these contracts are highly likely to be traded and be available on the SADC dollar foreign currency. These derivative contracts are included because it is assumed that futures/forwards will be traded when the currency index is opened in the SADC market. This would cover a significant amount of currency risk that would exist.

¹⁷⁷ Where (i) is representative of the nominal central bank discount rate.

¹⁷⁸ An advantage from using this formula is that it forces the covered interest parity relationship to hold in the future.

An alternative reason for using the covered interest parity formula is the fact that the uncovered interest parity relationship assumes that the real exchange rate holds among countries. This is however not the case for exchange rates of SADC member states which is discussed later.

Table 5.2.4: Quarterly Currency Futures Prices Using Simple Interest

Date	3 month futures price	6 month futures price	9 month futures price	12 month futures price
2000	6.00	6.16	6.33	6.49
2001	7.38	7.57	7.05	7.95
2002	11.74	11.58	12.46	12.82
2003	7.47	8.96	9.35	9.52
2004	6.58	6.70	6.81	7.02
2005	5.68	5.76	5.76	5.95
2006	6.24	6.37	6.51	6.64

Source: Own Compilation

Once the currency futures prices have been calculated, the absolute basis spread and basis spread risk are calculated for quarterly intervals by subtracting the end of month initial spot exchange rates using the equation provided below:

$$\text{Basis spread} = \text{ABS} [f_0(T) - S_{ij}(T-t)]$$

Equation 8 in chapter 1 was the recommended approach used by Kruger (1991) and Schumann (2000) when calculating the basis spread risk of equity index futures. One major shortcoming in calculating the basis spread risk in the currency futures market is the lack of available monthly central bank discount rates. In order to compute the basis spread risk (volatility) from the basis spreads, an ARCH/GARCH model was chosen as the alternative models to be used. The ARCH/GARCH models can compute both short run (α) and long run volatilities (β). However, this approach best suits a time series regression and has been discussed in more detail in the second modeling approach. Apart from the above, the standard deviation was also determined in order to quantify the volatility:

$$\sigma^2 = \sqrt{\sigma^2} = \sigma_{\text{Basis spread}} = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2}$$

The basis spread is presented in Table 5.2.5 as the 3-month hedge price (H_3) less the initial spot exchange rate (S_0), compounded at the risk-free rate for the life of the future. After three months the 3 month currency futures contract expires, thus resulting in the basis spread after this point being equal to zero. It is the delivered or sold underlying currency at the agreed upon exchange rate (contract price). This approach occurs for quarterly intervals.

Table 5.2.5: Basis Spread of USD/ZARN Hedged Positions

Date	$H_3 - S_0$	$H_3 - S_1$	$H_3 - S_2$	$H_3 - S_3$	$H_3 - S_4$	$H_3 - S_5$	$H_3 - S_6$	$H_3 - S_7$	$H_3 - S_8$	$H_3 - S_9$	$H_3 - S_{10}$	$H_3 - S_{11}$	$H_3 - S_{12}$	ZAR S/D	ZAR S/D	ZAR S/D	ZAR S/D
2000-3 month	0.16	0.34	0.29	0.58										0.18			
2000-6 month	0.00	0.18	0.13	0.42	0.63	0.84	0.66								0.31		
2000-9 month	0.2	0.0	0.0	0.3	0.5	0.7	0.5	0.6	0.6	1.0						0.3	
2000-12 month	0.33	0.15	0.21	0.09	0.30	0.50	0.33	0.47	0.47	0.82	1.08	1.30	1.14				0.40

Source: Own Computation

5.2.2 Calculation of the SADC nominal exchange rate and currency index

In order to calculate the basis risk as described in section 4.2, the SADC nominal exchange rate and the SADC dollar exchange rate index is needed. This section details the calculation of the needed magnitudes. Results are shown in table extracts and annexures where applicable.

One method proposed in this study (section 4.4.2) to create a nominal exchange rate for the SADC region was to follow the USD/Euro approach and to create a currency basket of the SADC countries currencies. A problem with this approach is that a large number of the SADC countries currencies are linked to the ZAR. Another method to overcome this problem was to model SADC countries' exchange rates when they are at their equilibrium levels. Equilibrium

levels can more easily be modeled when real exchange rates are used. A simple way of calculating the real exchange rates is shown below as:

$$S_{ijt} \text{ (real)} = S_{ijt} \text{ (nominal)} \times \frac{CPI \text{ (Domestic)}}{CPI \text{ (Foreign)}}^{179}$$

Where S_{ijt} (real) is the real exchange rate calculated by multiplying the nominal exchange rate of each SADC member state by the difference between local and foreign consumer price indices (CPI's). CPI's are used as an approximation for inflation in this calculation. One major problem with this approach is that these SADC currencies are never in equilibrium, even when using real effective exchange rates. The problems described above were circumvented by developing a foreign currency index for the SADC region. By using this currency index, SADC countries' trading partners could be grouped together in terms of a common base year. This also made sense from an investment perspective. The currency index for the SADC region was therefore calculated for the following reasons:

- Due to the SADC countries being structurally different from one another, the only way to group these countries over time is to use a currency index. The euro exchange rate was able to sum the weighted EMU countries' exchange rates daily as these economies had already undergone a considerably long period of integration.
- Investors look at their return on an asset they hold or wish to hedge against a currency index for the SADC region.
- No nominal exchange rate exists for the SADC region.
- A central nominal currency from a basket of currencies can be applied to the base year of the currency index.
- It allows pre and post nominal exchange rates to be calculated using the currency index.
- Investors use currency futures to hedge import and export prices. As these are two of the fundamentals that affect exchange rates, their inclusion in the currency index¹⁸⁰ make sense from both an economic and investment perspective.

¹⁷⁹ Not that both end of period CPI and closing monthly exchange rates have been used.

¹⁸⁰ Note the term currency index has been used throughout. This is similar to an effective exchange rate index, however, an effective exchange rates only accounts for trade weights. With this study suggesting other weights that investors should include to obtain more accurate results or forecasts, the term currency index is the more appropriate alternative to use in this study.

- Investors can extend these indices to account for other fundamental variable weights that they feel may affect exchange rates, for example: speculation¹⁸¹, FDI¹⁸², capital flows or any other relevant macro-economic variable.
- Allows for the analyses to be done of SADC in relation to other regions moving towards monetary union status.
- Investors can decompose the SADC foreign currency index and calculate inverse geometric trade weighted indices for each of the SADC member states with financial exchanges.
- Derivative products can be extended onto this inverse geometric trade weighted indices of the SADC member states and the SADC region.
- Investors can compare volatilities of the foreign SADC currency index to export and import index volatilities.
- Currency indices account for multiple currency exposures.
- Clyman, Allen and Jaycobs (1997) suggest that currency indices deal better with currency exposure than other risk management techniques and currency indices are more liquid due to risk arbitragers entering the market.
- Shin and Soenen (1999) use trade-weighted indices to analyze the change that foreigntax exposure has on multinational corporations. Multinational corporations may find that hedging effectiveness increases in relation to only hedging one currency exposure(Bhargava & Clark, 2003:572).
- Investors could use these foreign currency indices with one, three and twelve month trend lines. This would be an indication of long term foreign currency exposure.
- Investors could hedge the adverse effects of the USD on the ZARC, SADC region or SADC member states but still generate profits on the underlying currencies or foreign trading partners comprising the SADC currency index.

In order to compile the SADC currency index, all members of the SADC are included in the index. As stated before, each of these members are included based on a weight determined on the basis of their trade (imports and exports) with certain trading partners. However,

¹⁸¹An approach that could be used to include this variable in a currency index is discussed in the section under exchange rate modelling.

¹⁸² FDI is an abbreviation for foreign direct investment.

including the members in the index using exchange rates relative to each other gives rise to distorted unusable values as these values are too large relative to the base year of 2005. Quoting them in terms of a universal well traded currency such as the USD, solves the problem. This is illustrated below.

5.2.3 Development of a SADC foreign currency index

Assumptions underlying the creation of this currency futures index include:

1. From the point of investors wishing to hedge, effective exchange rates are better than bilateral exchange rates.
2. Hedgers look at the strength of the ZAR relative to other major currencies which influence their export and import volumes; thus using trade-weighted indices when making hedging decisions.
3. Exchange rates are fully reflective of all macro-economic variables.
4. GDP is an appropriate measure to estimate the size of local currency units to include in the SADC basket.
5. Exchange rates of the SADC countries will meet the criteria of a lognormal distribution in future, which is similar to the euro or developed market currencies.
6. Multinational corporations use currency derivatives to hedge both export/import deviations in the price, thus imports and exports have been used to calculate the effect of trade by countries in the SADC regional economic community.
7. Foreign currency indices are only applicable in stable state economies.

For each of the countries comprising the SADC, the following data and indexation method has been followed as demonstrated using Botswana as an example below. Table 5.2.6 is an illustration of the inclusion of the trading partner exchange rates for the calculation of the SADC foreign currency index.

Table 5.2.6: Local Currency Units of SADC Trading Partners Relative to 1 USD for Botswana

Date	1 USD relative to trading partners currencies (Conversion ratio's)			
	1 USD	China	EU	SA
31/12/1999	1.00	1.480	0.996	6.1578
31/01/2000	1.00	1.505	1.023	6.3400
28/02/2000	1.00	1.483	1.026	6.2850
31/03/2000	1.00	1.478	1.040	6.5784
30/04/2000	1.00	1.477	1.097	6.7900
31/05/2000	1.00	1.500	1.076	6.9950
30/06/2000	1.00	1.531	1.051	6.8225
31/07/2000	1.00	1.543	1.082	6.9625
31/08/2000	1.00	1.498	1.119	6.9587
30/09/2000	1.00	1.503	1.137	7.3071
31/10/2000	1.00	1.529	1.189	7.5675
30/11/2000	1.00	1.576	1.166	7.7870
31/12/2000	1.00	1.542	1.062	7.6288

Source: McGregor (2005); I-Net Bridge database

The exchange rates were obtained from McGregor (2005) for 1 USD relative to Botswana's¹⁸³ three foreign trading partners, namely China, the European Union and South Africa. The extract is for the period 31/12/1999 until 31/12/2000. All countries in the SADC are expressed in similar fashion using 1 USD relative to their trading partners' currencies, in contrast to their own domestic or local currency units. The reasons for doing this include:

- Currency indices created relative to SADC member states' local currency units are too large in comparison with the base year of 2005. Quoting the local exchange rates relative to USD exchange rates balances the relative levels when compared to the exchange rate of a developed economy. In other words there were vast changes in the currency indices of the SADC region when SADC member states' local currencies only were used due to large fundamental and economic disparities.
- By using 1 USD, Botswana's foreign trading partners can be expressed in terms of this base currency using the indexation approach below. While this approach may be subject to criticism, another way of seeing this approach is to weigh the amount of foreign trade of Botswana with their foreign trading partners. As a local currency for

¹⁸³ In this study, indexation of all SADC member states, has been done in a similar fashion to Botswana.

the SADC region is implemented in the base year, the base currency of 1 USD serves to match both Botswana's foreign and domestic environments. As to these foreign currencies being representative of different economic climates, they must first be indexed to remove the bias. This is a problem because the economic environments of the SADC member countries are not fully integrated at present.

Next, the exchange rates of the trading partners were indexed using the base year of 2005 with the equations presented below and demonstrated with data in table form:

$$S_{tb}^{184} = \left(\frac{S_{tb}}{S_{tb}}\right) * 100,$$

Where: S_{tb} is the exchange rate in the base year at time t.

$$S_t^{185} = \left(\frac{S_t}{S_{tb}}\right) * 100$$

Table 5.2.7: Botswana's Trading Partner Exchange Rates after Indexation

Date	Exchange Rates Indexed		
	China	European Union (EU)	South Africa
31/12/1999	124.59	117.91	96.80
31/01/2000	124.04	121.19	99.66
28/02/2000	124.30	121.52	98.80
31/03/2000	124.76	123.22	103.41
30/04/2000	126.98	129.87	106.74
31/05/2000	129.13	127.38	109.96
30/06/2000	127.24	124.45	107.25
31/07/2000	126.77	128.18	109.45
31/08/2000	126.71	132.56	109.39
30/09/2000	128.70	134.69	114.86
31/10/2000	131.33	140.81	118.96
30/11/2000	132.34	138.08	122.41

Source: Own compilation

¹⁸⁴ Exchange rate indexed in base year.

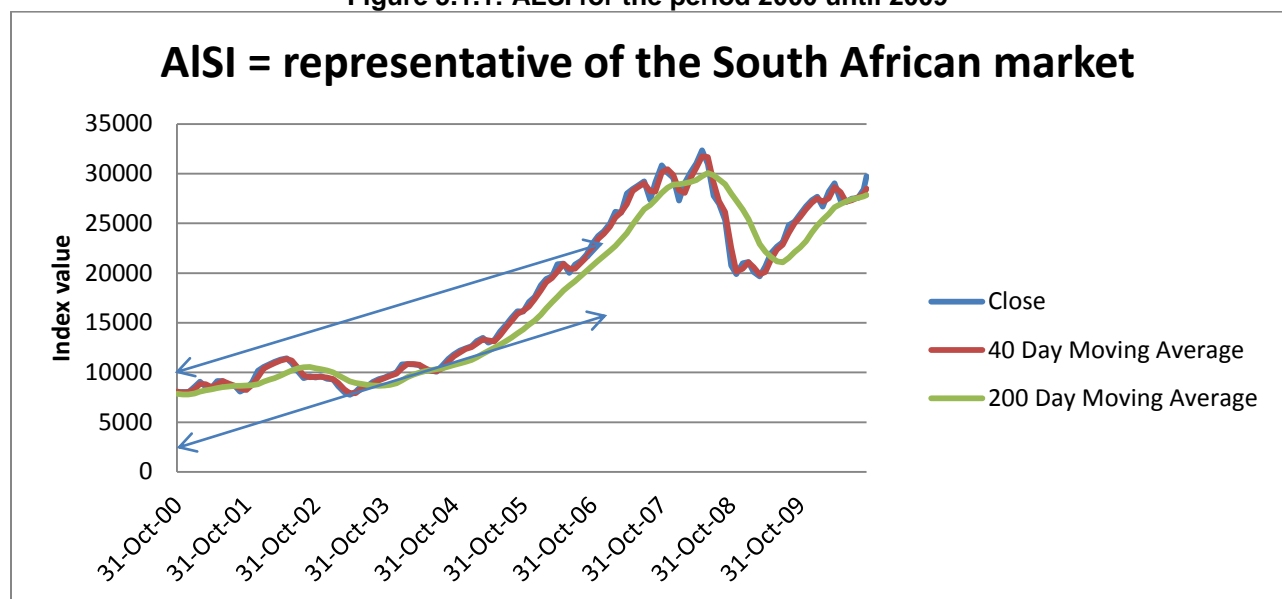
¹⁸⁵ The exchange rate at time t.

For indexation, a stable base year was sought. After inspecting the ALSI share index, 2005 was identified as a suitable starting point or base year due to it being a “normal” year with low variability. See Figure 5.1.1 below.

The ALSI was also chosen as proxy for market activity from an investment perspective because

- it is reflective of the South African market and possibly the SADC region; and
- it is one figure that is computed on a daily basis, easily obtainable and representative of a return and market activity.

Figure 5.1.1: ALSI for the period 2000 until 2009



Source: McGregor (2005) database

From the figure above, the period of 2000 until end of 2005 was relatively stable, with the ALSI entering into a steep bull market from the period 2006 until the end of 2007. Thus, 2005 served as a reasonable period from which comparisons maybe drawn. Other reasons for choosing 31/12/2005 as the base year included:

- The RAIN index calculated by the JSE used 01/01/2006 as the base year with the base year equal to 10 000.

- Market participants consulted indicated that when the ALSI has a value of 25 000 points, it can be regarded as in equilibrium. Note that this measure is not based on any empirical research and is only used as a “rule-of-thumb”.
- The IMF (n.d) and World Bank (2010) calculate trade-weighted indices using the base year of 2005.

Before a trade-weight could be determined, the weights of exports/imports of each trading partner with each SADC country were obtained and normalized. Imports and exports were chosen as these are two of the variables which have a significant effect on a country’s exchange rate.¹⁸⁶The trade-partner weights are normalized¹⁸⁷with the following equation and then demonstrated with data in Table 5.2.8:

$$(p^{x/m}_{ijt} = w_{jt} / \sum_j^n w_{jt})$$

Table 5.2.8: Normalizing of Import and Export Weights for Botswana

Botswana’s Currency Index				
Broad Trading Partners	Export (%)	Normalizing Export Weight (%)	Import (%)	Normalizing Import Weight (%)
China	4.90	5.72	2.80	3.05
EU	60.40	70.56	10.40	11.33
South Africa	20.30	23.71	78.60	85.62
Other	14.40		8.20	
Total	100.00	100.00	100.00	100.00
Total Without Other	85.60		91.80	

Source: Own Compilation: 2010 (h)

As GDP (USD) is quoted on a per annum basis and currency futures contracts expire at month end, the GDP (USD¹⁸⁸)was interpolated to obtain monthly GDP (USD) data using the formula provided below:

¹⁸⁶ JSE (2009 b: 1) lists that the net trade balance (X-M), also known as merchandise trade balance of a country, is one of the influential variables that affects exchange rates.

¹⁸⁷ The weights are normalised because not all of the trading partners are known. Only the main trading partners are known, thus their sum must equal to one.

¹⁸⁸ Note all economic data has been expressed in comparable USD terms.

$$Z_s = \frac{(T_1 - T_s)}{(T_2 - T_1)} * Z_1 + \frac{(T_s - T_1)}{(T_2 - T_1)} * Z_2$$

An extract is provided below of Botswana's exports (USD) and imports (USD) from annual data into monthly data:

Table 5.2.9: Extract of Interpolation: Imports and Exports

Growth rate per period		1999	2000
		1999 till 2000	2000 till 2001
Exports (USD) per annum		2743315889.00	3248238772.00
Exports (USD) per month		228609657.40	270686564.35
Exports:	Holding period	0.1841	-0.0085
	Nominal interest	0.1701	
	Nom per period	0.0142	
Imports (USD) per annum		827272750.50	920289873.60
Imports (USD) per month		68939395.88	76690822.80
Imports:	Holding period	0.1124	0.05474
	Nominal interest	0.1070	0.05341
	Nom per period	0.0089	0.00445

Source: Own Compilation

This allows trade-weighted currency indices to be calculated on a monthly basis. The export-trade weight (X_{ijt}) is obtained using the equation below and shown with an extract of data (see table 5.2.10):

$$X_{ijt} = p^x_{ijt} * \sum_i^n X_{it};$$

Table 5.2.10 Calculating Export Weights of SADC Trading Partners

Date	Weight of Botswana Trading Partners			
	China	EU	South Africa	Total
	Exports (USD)	Exports (USD)	Exports (USD)	Exports (USD)
31/12/1999	13086300	161308683	54214673	228609657
31/01/2000	13271842	163595777	54983349	231850969
28/02/2000	13460016	165915299	55762923	235138238
31/03/2000	13650857	168267707	56553550	238472115
30/04/2000	13844403	170653469	57355387	241853261
31/05/2000	14040695	173073057	58168593	245282346

Source: Own Compilation: IMF (n.d)

An import-trade weight (M_{ijt}) is obtained using the equation below and shown with data (see table 5.2.11):

$$M_{ijt} = p_{ijt}^m * \sum_i^n M_{it} \text{ and}$$

Table 5.2.11: Calculating Import Weights of SADC Trading Partners

Date	Weight of Botswana's trading partners (2008 average economic indicator)			
	China	EU	South Africa	Total
	Imports (USD)	Imports (USD)	Imports (USD)	Imports (USD)
31/12/1999	2102726.672	7810127.638	59026541.57	68939395.88
31/01/2000	2121481.019	7879786.642	59553002.89	69554270.55
28/02/2000	2140402.638	7950066.939	60084159.75	70174629.33
31/03/2000	2159493.019	8020974.071	60620054.04	70800521.13
30/04/2000	2178753.669	8092513.627	61160727.99	71431995.29
31/05/2000	2198186.106	8164691.25	61706224.25	72069101.61

Source: Own Compilation: IMF (n.d)

The total trade is obtained by summing the exports and imports with country i in SADC and is shown with the equation below and in table form.

$$TT_{it} = \sum_i^n X_{ijt} + \sum_i^n M_{ijt}$$

Ultimately the total trade-weight at time t is found by dividing the exports and imports at time t with the total trade in time t .

$$w_{ijt} = (X_{ijt}^{189} + M_{ijt}^{190}) / TT_{it}^{191}$$

¹⁸⁹X denotes exports.

¹⁹⁰M represents imports.

¹⁹¹TT = total trade.

Table 5.2.12: Trade-weights of SADC Member States for Botswana

Date	Trade Weighted Average of the Different Countries relative to the Total Trade between Partners				
	China W_{ijt}	EU W_{ijt}	South Africa W_{ijt}	Total weight (100%)	Total trade TT_{it}
31/12/1999	0.0510	0.5684	0.3806	1.000	297549053.278
31/01/2000	0.0511	0.5689	0.3800	1.000	301405240.300
28/02/2000	0.0511	0.5695	0.3794	1.000	305312867.954
31/03/2000	0.0511	0.5700	0.3789	1.000	309272636.740
30/04/2000	0.0511	0.5706	0.3783	1.000	313285256.835
31/05/2000	0.0512	0.5711	0.3777	1.000	317351448.226
30/06/2000	0.0512	0.5716	0.3772	1.000	321471940.844
31/07/2000	0.0512	0.5722	0.3766	1.000	325647474.708
31/08/2000	0.0512	0.5727	0.3760	1.000	329878800.059
30/09/2000	0.0513	0.5732	0.3755	1.000	334166677.510
31/10/2000	0.0513	0.5738	0.3749	1.000	338511878.186
30/11/2000	0.0513	0.5743	0.3744	1.000	342915183.869
31/12/2000	0.0513	0.5748	0.3738	1.000	347377387.152

Source: Own Compilation

Once the trade-weight has been calculated (w_{ijt}), this weight is multiplied with the trading partner index values to obtain the total index value of Botswana with its trading partners shown in table 38 below.

$$(N_{it}) = \sum_i^n S_{ijt} * W_{ijt}$$

Table 5.2.13: Decomposing SADC Member States' Indices: Trading Partners

Date	Trading partners trading weights in the Botswana's index								
	China index	China weight	China weight in Index $\sum_i^n S_{ijt} * W_{ijt}$	EU index	EU weight	EU weight in index $\sum_i^n S_{ijt} * W_{ijt}$	South Africa index	South Africa weight	South Africa weight in index $\sum_i^n S_{ijt} * W_{ijt}$
31/12/1999	124.5906	0.05105	6.3600	117.91	0.5684	67.019	96.7971	0.3806	36.839
31/01/2000	124.0408	0.05107	6.3350	121.19	0.5689	68.950	99.6620	0.3800	37.872
28/02/2000	124.3024	0.05110	6.3514	121.52	0.5695	69.204	98.7975	0.3794	37.487
31/03/2000	124.7587	0.05112	6.3778	123.22	0.5700	70.236	103.4102	0.3789	39.179
30/04/2000	126.9805	0.05115	6.4945	129.87	0.5706	74.098	106.7358	0.3783	40.378
31/05/2000	129.1310	0.05117	6.6076	127.38	0.5711	72.749	109.9583	0.3777	41.535
30/06/2000	127.2378	0.05119	6.5139	124.45	0.5716	71.140	107.2467	0.3772	40.450
31/07/2000	126.7660	0.05122	6.4928	128.18	0.5722	73.341	109.4475	0.3766	41.219
31/08/2000	126.7085	0.05124	6.4929	132.56	0.5727	75.920	109.3877	0.3760	41.135
30/09/2000	128.7021	0.05127	6.5982	134.69	0.5732	77.208	114.8636	0.3755	43.130
31/10/2000	131.3304	0.05129	6.7361	140.81	0.5738	80.792	118.9578	0.3749	44.601
30/11/2000	132.3417	0.05132	6.7911	138.08	0.5743	79.302	122.4082	0.3744	45.827
31/12/2000	128.5245	0.05134	6.5983	125.75	0.5748	72.285	119.9214	0.3738	44.829

Source: Own Compilation

Each SADC member state has an index value within the SADC currency index, Z_{it} . For each member state this Z_{it} is an expression of that country's monthly trading partners' weights and its relative importance for the overall SADC index. These weights change monthly to provide updated monthly foreign trade-weights for each SADC member state. This approach provides the advantage of taking the foreign trade relationship into account and factoring in the global context into each SADC member state's index value. One question that arises with this approach is that the local exchange rates of SADC member states are not taken into consideration. To allow for this, Z_{it} indices are created in terms of a base year which allows a nominal USD/SADC dollar exchange rate to be applied to this total SADC currency index in the base year. By factoring into account the foreign situation and considering the domestic situation, a "matching principle" has been used. Another advantage that arises from this approach is the removal of each SADC member state's foreign and local deviation with the USD (as all exchange rates are quoted in terms of 1 USD). This can also be seen in the

domestic setting as the removal of intra-currency exchange rate exposure. In order to calculate each SADC member state's index, the following formula has been used:

$$\begin{aligned} Z_t &= \sum_i^n N_{it} * g_{it} \\ &= (\sum_i^n S_{ijt} * W_{ijt}) * g_{it} \end{aligned}$$

where S_{ijt} is the spot exchange rates of country i relative to country j at time t . To calculate each SADC member state's contribution in the SADC index (Z_t), a weighting measure must be used. The first weighting measure considered was the size of the financial sector of each SADC member state relative to the total SADC region. A limitation of this approach is that not all SADC member states had financial markets. A second and more appropriate approach was to use a GDP weighting measure (g_{it}) to calculate an index value (Z_t) for each SADC member state. An example of this index calculation is shown in Table 5.2.14.

Table 5.2.14: Total Index Value of each SADC Member State

Total index value of Botswana in SADC								
Date	China weight in Index	EU weight in index	South Africa weight in index	Total N_{it}	GDP weight in SADC index (with ZAR) g_{it}	GDP weight in the SADC index (without ZAR) g_{it}	Botswana in SADC Z_t	Botswana in SADC (without ZAR) Z_t
31/12/1999	6.360	67.019	36.839	110.218	0.032	0.1296	3.50958	14.28
31/01/2000	6.335	68.950	37.872	113.157	0.032	0.1295	3.62478	14.66
28/02/2000	6.351	69.204	37.487	113.043	0.032	0.1295	3.64266	14.63
31/03/2000	6.378	70.236	39.179	115.792	0.032	0.1294	3.75330	14.98
30/04/2000	6.494	74.098	40.378	120.971	0.033	0.1293	3.94414	15.64
31/05/2000	6.608	72.749	41.535	120.892	0.033	0.1292	3.96447	15.62
30/06/2000	6.514	71.140	40.450	118.104	0.033	0.1291	3.89540	15.25
31/07/2000	6.493	73.341	41.219	121.053	0.033	0.1290	4.01547	15.61
31/08/2000	6.493	75.920	41.135	123.548	0.033	0.1288	4.12145	15.91
30/09/2000	6.598	77.208	43.130	126.936	0.034	0.1286	4.25825	16.33
31/10/2000	6.736	80.792	44.601	132.129	0.034	0.1284	4.45711	16.97
30/11/2000	6.791	79.302	45.827	131.920	0.034	0.1282	4.47454	16.92
31/12/2000	6.598	72.285	44.829	123.712	0.035	0.1489	4.38268	18.42

Source: World Bank Database (2010); IMF (n.d)

Once an index value has been computed for each country in the SADC region using the equation provided above, the total value of the SADC index can be calculated by taking the sum of Z_t shown below:

$$\text{SADC foreign currency index} = \sum_i^n Z_{t_i}^{192}$$

This approach has been repeated for the following indexes:

- 1 USD to ZAR
- 1 USD to SADC (with ZAR)
- 1 USD to SADC (without ZAR)

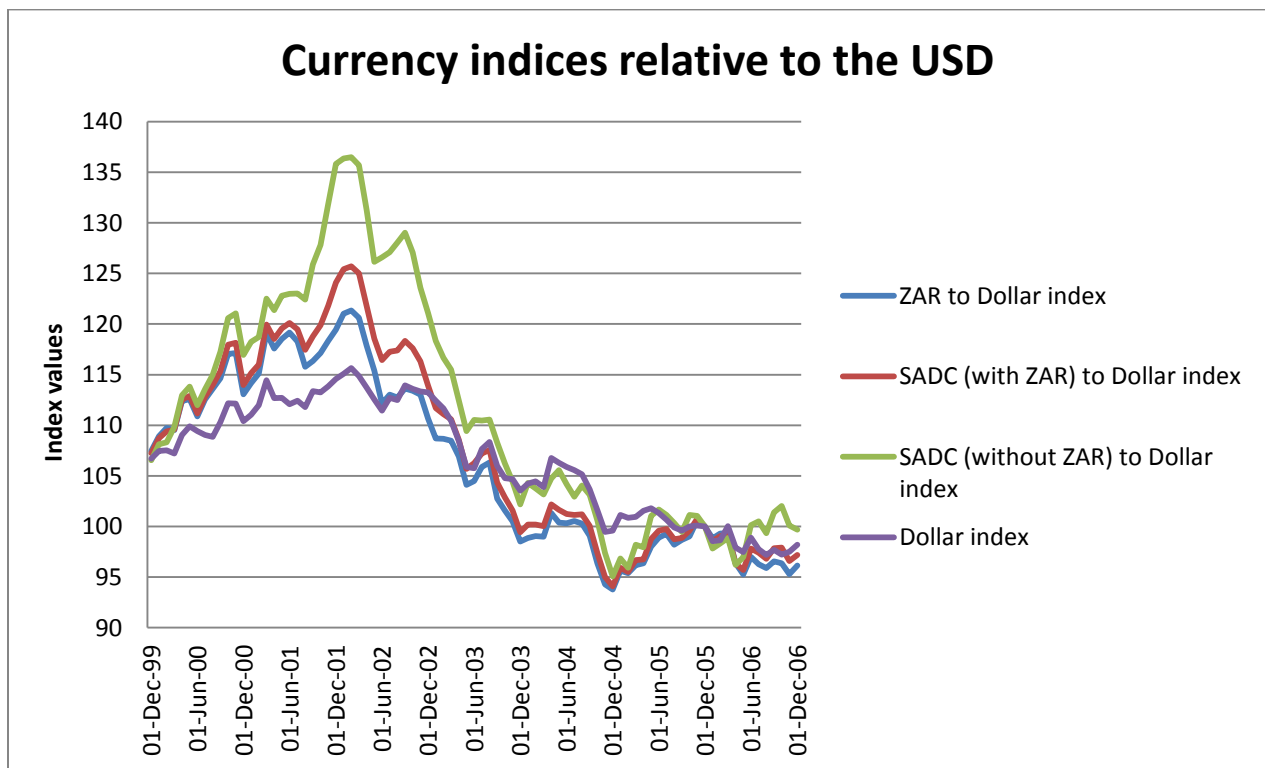
In order to limit the size of this study, the annexures with extracts, on the computation of the ZAR index as well as the SADC including ZAR and the SADC excluding ZAR have not been

¹⁹²A measure to check if the currency index model is correct is that each SADC country's portion in this index should sum to 100 in the base year.

included in this study. The reason for this exclusion of their computation was their similarity in computation to the Botswana index shown above. An alternative reason for calculating the SADC (with and without) the ZAR was to allow for the validity of results by removing any biases of comparisons made with the SADC region to the ZAR.

All these indexes were computed in terms of the USD. However, using alternative exchange rates allowed these indexes to be converted into euro or pound equivalents as presented in the figures below:

Figure 5.2.1: Currency Indices relative to the USD



Source: Own Compilation

Removing the ZAR from the index gives rise to a large SADC to Dollar index, a large deviation was experienced for the period of 2001 until the end of 2003. The SADC (without ZAR) index is always greater than SADC (with ZAR) index. Thus, the SADC to dollar index should include the ZAR. Note that all these indices tend to converge until the end of 2006 except for the SADC (without ZAR) to dollar index. Data post 2006 was not considered due to the all share index (ALSI) being in a bear market cycleduring a financial crisis (seeFigure

5.2.1). This would induce the presence of a time varying risk premium in the basis making realistic comparisons of hedged positions difficult.

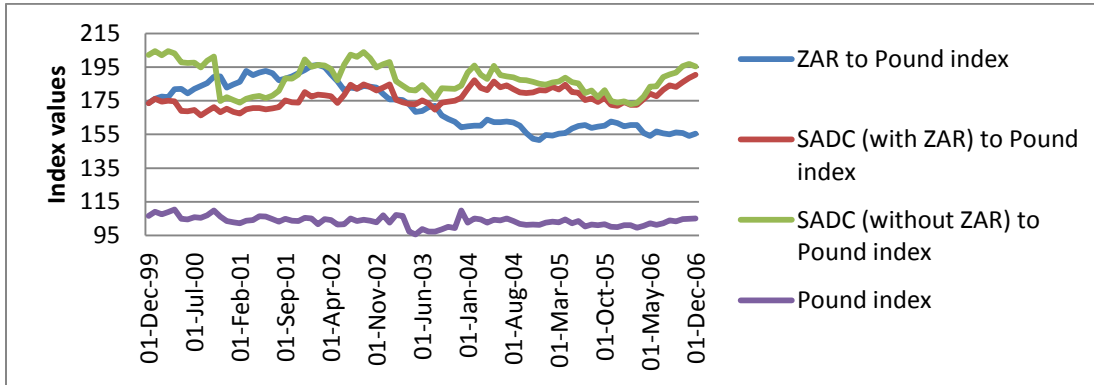
Once these indexes have been created, they can be expressed in any currency. In this research these indexes have been expressed in both pound and euro equivalents. Note that according to Figure 5.2.2 there is a large deviation of the Pound index to the SADC

- with ZAR to pound index and
- without ZAR to pound index.
- with ZAR to euro index and
- without ZAR to euro index.

One limitation of expressing these indexes in pound and euro terms is that the pound is one of the constituents in the euro basket. This means that a bias is created. Investors in the market commented that the pound influences most world currencies opposed to the euro. An explanation for the foreign currency index of the SADC not converging to each other when expressed in euro and pound equivalents is possibly due to the fact that both imports and exports have been expressed in USD dollar equivalents in calculating these trade-weights. It would be more feasible to re-calculate import and export values in pound and euro terms and then to recalculate the trade-weights. Interesting observations that may be noted from the foreign SADC currency index when expressed in euro and pound equivalents are:

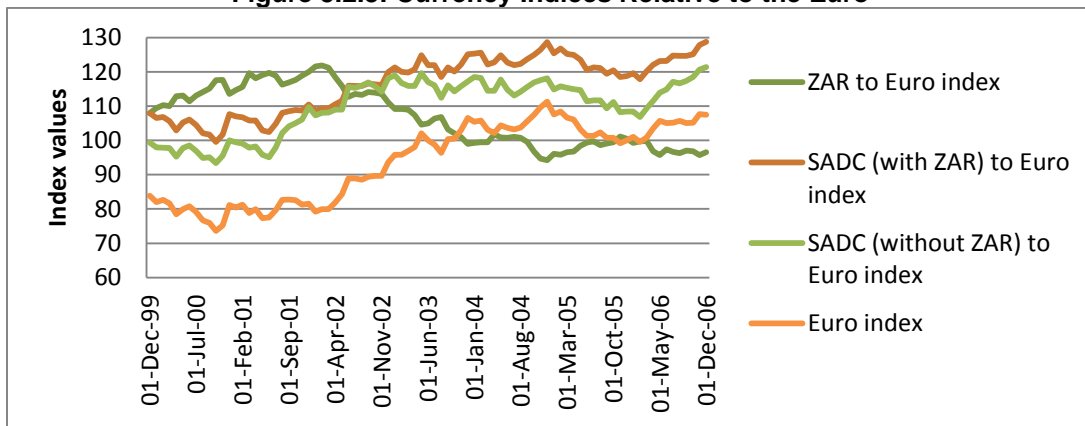
- SADC (with ZAR) to Pound foreign currency index > SADC (with ZAR) to Euro foreign currency index > SADC (with ZAR) to USD foreign currency index.
- The foreign currency indices of the pound, euro and USD are more stable than the SADC foreign currency index. This is to be expected as the pound, euro and USD are the currencies of developed economies.

Figure 5.2.2: Currency Indices Relative to the Pound



Source: Own Compilation

Figure 5.2.3: Currency Indices Relative to the Euro



Source: Own Compilation

The computation of the SADC interest rate, which was briefly mentioned in section 5.2.2, will next be discussed.

5.2.4 Computation of the SADC Domestic Interest Rate:

An interest rate for the SADC area was calculated using the central bank discount rates and once again they wereweighted by a GDP factor. This was done using the equation presented below:

$$R_{d(SADC)t} = \sum_j^n CB_{it}^* g_{it},$$

where

CB_{it} = the central bank discount rate for a three, six, nine or 12 month period; and

g_{it} = GDP weighting measure of country i at time t .

While the central bank discount rates quoted on Quantec are nominal rates, a real interest rate was calculated for the SADC region. This was done using the following formula:

$$n(i) = [1+R(i).(1+h)]+e(i)$$

$$n(i) - e(i) = (1+R)(1+h)$$

$$R = [n(i) - e(i)/ (1+h)]-1$$

Where: $n(i)$ denotes the nominal interest rate; $R(i)$ denotes the real interest rate; h is the historic/current inflation rate; $e(i)$ denotes an expected inflation rate.

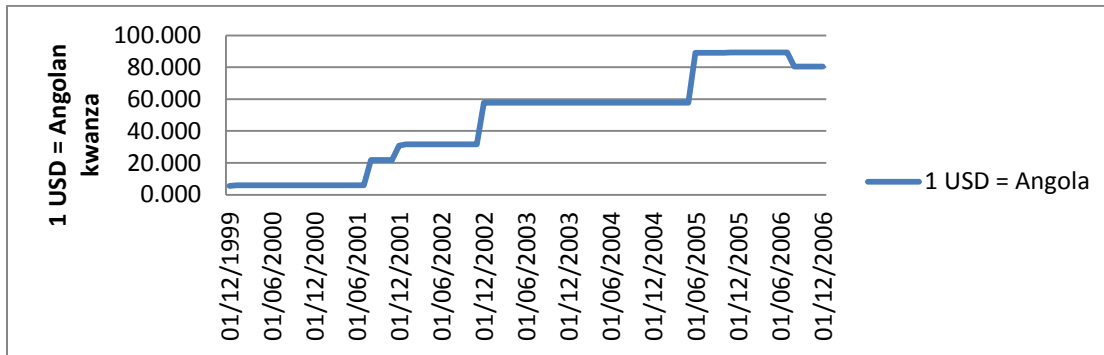
The above formula takes the Fisher effect on real interest rates into account, which has been expressed in the form of a regression. Some problems or limitations with this approach are:

- The real interest rates of the SADC countries quoted on the World Bank (2010) could be handpicked or an average could be used, thus influencing the results.
- Using the real interest rate excludes the inflation component as demonstrated above and would serve as a more accurate measure when comparing African countries. African countries tend to have a large inflation bias.
- Hedgers wishing to hedge the price of exports/imports of their foreign national business do not hedge real exchange rates, thus a real interest rate will not be used in practice.

According to market participants, other approaches that could be used for a SADC central interest rate is to use the average interest rate of three, six, nine and 12 month periods for the G7 or G20 countries. Based on limitations mentioned above, an interest rate for the G7 or G20 countries is not fully reflective of the SADC region. Thus, the nominal interest rate is the proposed method to be used.

One country which had a significant impact on the SADC interest/discount rate is Angola. Two reasons may be mentioned for the exclusion of the country from the calculation of the central bank interest rate. The first reason is its crawling peg exchange rate regime which is shown in the figure below.

Figure 5.2.4: Angolan Exchange Rate

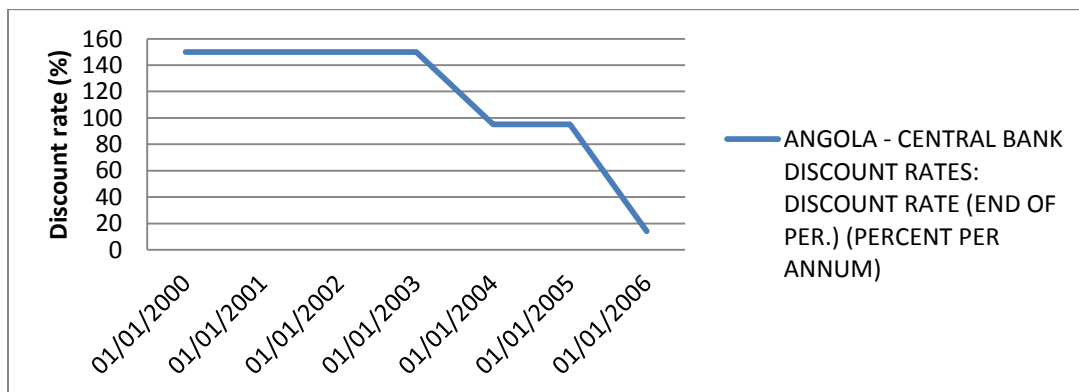


Source: Quantec Database

This exchange rate has depreciated over time relative to 1 USD. The Angolan kwanza depreciated towards 90 Angolan kwanza in 2005 and then appreciated to 80 Angolan Kwanza in 2006.

The second proposed reason for the exclusion of Angola from the SADC central bank discount rate calculation is due to the high level of central bank discount rate. As demonstrated below, the central bank discount rate is 150% in 2000 and decreased to 18% at the end of 2006. These extremes distort the rate that would be reflective of the region with reasonable stability.

Figure 5.2.5: Angola - Central Bank Discount Rate (End of Period Expressed as PercentagePerAnnum)



Source: Quantec Database

Basis spread risk in a currency futures hedge position is primarily a function of:

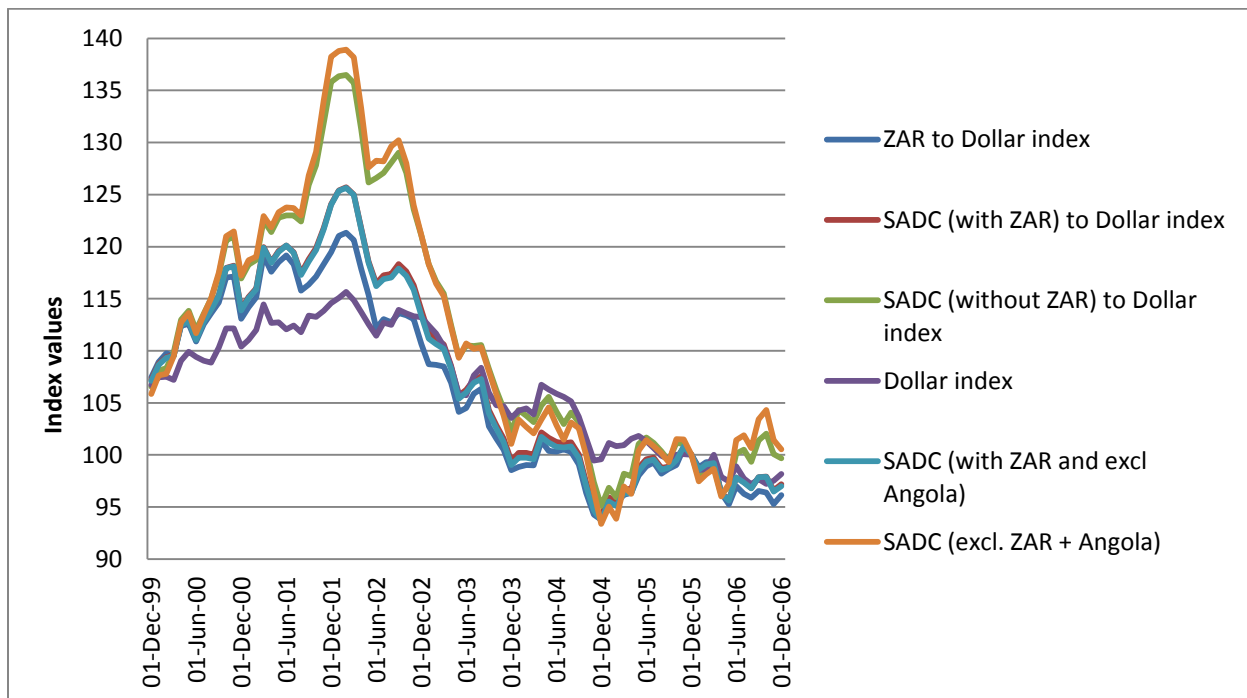
- Supply and Demand,
- Future spot price and (influenced by supply and demand)

- Interest rates, both foreign and domestic.

If Angola has a very high central bank discount rate, holding the GDP weighting factor constant, it results in a very large central bank discount rate for the SADC region. This very large domestic interest rate will cause the currency futures price to increase as it is compounded with this rate and ultimately leads to a larger currency futures spread and larger basis spread risk which may not be reasonable.

In the Figure 5.2.6 below, the SADC (with ZAR and excluding Angola) moves together over time as the SADC (with ZAR and including Angola) to Dollar index. When Angola is excluded, the SADC (excluding ZAR and Angola) increases to almost 140, which is a 40% deviation from the base year of 100 in 2005. All these indices tend to converge at the end of 2006. However, this is not the case when the ZAR or ZAR and Angola are excluded from the SADC currency index. For this reason, Angola is included as it may lead to a better representation of the region.

Figure 5.2.6: Scenario's of Currency Indices relative to the USD

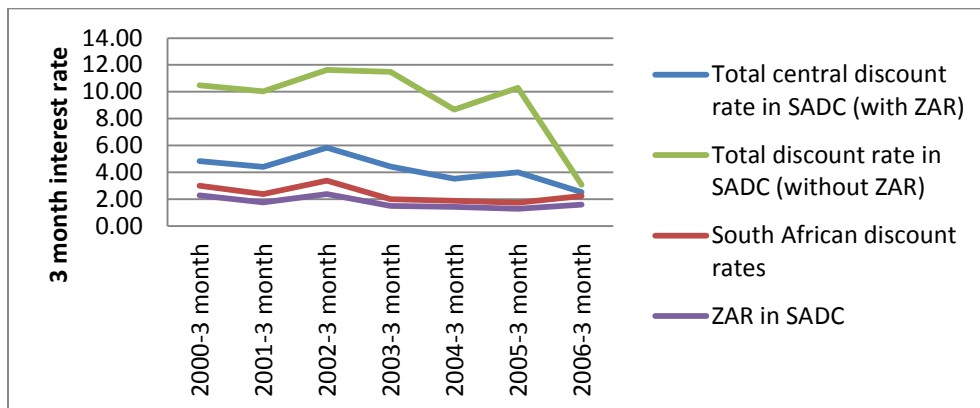


Source: Own Compilation

Figures 5.2.7 to 5.2.10 depict the quarterly domestic discount/interest rates calculated for the SADC region using the equation mentioned previously in the beginning of Section 5.2.4.

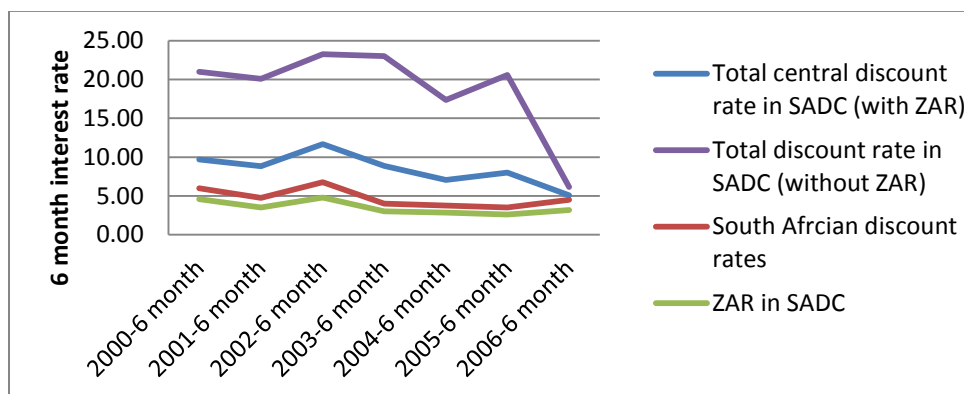
These interest rates are calculated from the central bank discount rates of the countries comprising SADC. These graphs depict the total quarterly SADC discount rate when South Africa is included in SADC, the total quarterly SADC discount rate when South Africa is excluded, the South African discount rate in isolation and lastly, the proportion of South Africa's discount rate to the total quarterly discount rate in SADC. Recall that the ultimate goal of this study is to examine the changes in the basis spread risk of the currency futures hedged positions with the ZAR as well as the SADC dollar as the respective underlyings. To obtain uniform comparisons, similar variables are required under both approaches. The foreign risk-free rate in both sets of comparisons is the US T-bill rate, and the SADC central bank discount rate as the domestic interest rate used in the currency futures contracts.

Figure 5.2.7: Interest Rate for SADC: Three month Currency Futures



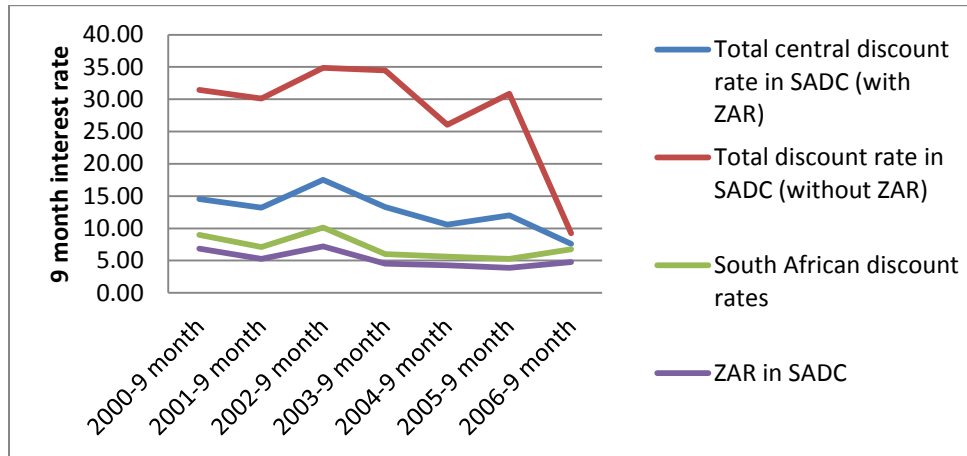
Source: Own Compilation

Figure 5.2.8: Interest Rate for SADC: Six month Currency Futures



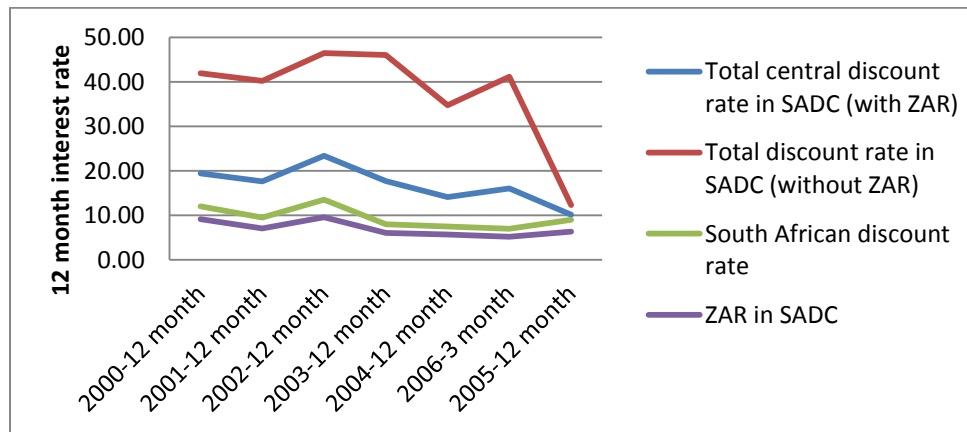
Source: Own Compilation

Figure 5.2.9: Interest Rate for SADC: Nine month Currency Futures



Source: Own Compilation

Figure 5.2.10: Interest Rate for SADC: 12 month Currency Futures



Source: Own Compilation

From the graphs above it is clear that the longer the term of the currency futures contract, the higher the central bank discount rate. This is based on the assumption mentioned previously. In all four contracts, when the ZAR is excluded from the SADC region, Angola's GDP weighting becomes larger, implying a much larger discount rate. The reason for the large decline presented in these diagrams is due to Angola's large decline in the central bank discount rate from 150% to 18% in 2006. When the ZAR is included in SADC, investors hedging foreign currency movements would use a lower domestic interest rate. This is supported for all four contracts. If the foreign interest rate is held constant, it would theoretically result in lower futures prices, which would lead to lower basis spreads and ultimately lower basis spread risks. This is under the assumption of no marking-to-market. If a

SADC dollar currency was not implemented, South African investors would use a higher domestic interest rate compared to when included in SADC.

Some problems with the indices need to be highlighted here. Hedgers do not use currency futures indices when hedging import and export exposures affected by currency fluctuations. While this research was in progress, the JSE introduced the RAIN currency index as a tool that may be used to hedge these import and export changes. This was achieved by calculating the RAIN currency index from the rebalancing date as an inverse arithmetic average of South Africa's main trading partners. This currency index provided investors with an efficient as well as easy way to hedge against an entire basket of currencies. Investors are now able to simultaneously hedge multiple currency exposures by entering into futures positions on the RAIN currency index and its underlying foreign currencies. The eventual hedging benefits which arose were the result of the zero static futures hedge value. The profits/losses of the futures contracts on the underlying foreign currencies are netted out against the profits/losses from the futures contract entered into on the RAIN currency index (JSE, 2010f).

The RAIN currency index solves the problem of hedging individual currency indices using currency futures contracts. The RAIN currency index provides a method to calculate an index for a specific country in relation to its main trading partners. This index, however, does not provide an approach to calculate currency indices for countries also adopting the same fictitious exchange rate.

Another problem with the indices is that this study focuses on the basis risk spread of a fictitious grouping of currencies for the SADC region. A foreign currency index makes it possible to compute the volatility for this region in comparison to that of South Africa and can be extended to make possible comparisons with other regions. The main advantage of using these currency indices is that it allows for the creation of a nominal exchange rate for the SADC region to be applied to the SADC currency index in the base year. This fictitious nominal exchange rate can thus be computed ex ante and ex post the base year as the foreign currency index changes. The calculation of this fictitious exchange rate used by the SADC countries is discussed and illustrated in section 5.2.5 below.

5.2.5 SADC Basis Spread and Basis Spread Risk: Nominal Exchange Rate in 2005

A nominal exchange rate has been computed for the SADC region in the base year (2005) using the equation provided below.

$$\text{SADC}_{(\text{dollar exchange rate}, j, t)} = \exp \left(\sum_{i=1}^{10} w_{it} \log_{10} S_{i,j,t} \right)$$

There are two important variables underlying the equation above. The first is the log-normal distribution of the exchange rates. Reasons for the assumption that SADC countries exchange rates will adhere to log-normally distribution criteria in the future are:

- It allows this study to circumvent the problems associated with Siegel's paradox. Siegel's paradox in international finance refers to the inability of the expectation of the future exchange rate of the domestic currency relative to foreign currency to be expressed as a reciprocal when lognormal exchange rates are not used (Sarno & Taylor, 2002:36).
- The USD/ZARC and USD/ZARC descriptive statistics suggest that the data are skewed positively to the right. This is one of the properties of a log-normal distribution. By using this assumption of a log-normal distribution for the SADC dollar it allows accurate comparisons to be made with the ZAR.
- A GDP weighting factor which has been linearly interpolated monthly can be applied to the log-normal distribution of the SADC countries exchange rates in the short term.

The second variable is an exponential function of $(\sum_{i=1}^{13} w_{it} \log_{10} S_{i,j,t})$. The use of this variable provides an unbiased comparison by using exponential smoothing of the exchange rates. In other words it captures the variables of SADC countries' economies that have an exponential effect on their local exchange rates. It also accounts for the compounding effect of exchange rates overtime. Numerous authors suggest that annual GDP contains exponential and uneven growth; the exponential function seems the most appropriate to use in this case to capture long-term changes in GDP. More advanced models to determine a fundamental value of a currency basket may be used: this approach only provides the framework that investors can use to derive the implications of adopting a new currencies and the effect that this may have

on risk management practices. The calculation of this exchange rate in 2005 is shown in table 5.2.15 below:

Table 5.2.15: Calculation of USD/SADC_{dollar} Nominal Exchange Rate: 2005

	Angola	Botswana	Lesotho	Malawi	Mauritius	Mozambique	Namibia	Swaziland	ZAR	Seychelles	Tanzania	Zambia
Spot exchange rates: 2005	89.23	5.50	6.35	125.50	30.55	23.67	6.32	6.35	6.36	5.42	1136.00	3280.00
log function	1.95	0.74	0.80	2.10	1.49	1.37	0.80	0.80	0.80	0.73	3.06	3.52
GDP weights (2005)	0.09	0.03	0.00	0.01	0.02	0.01	0.02	0.01	0.74	0.00	0.04	0.02
log * weights	0.18	0.02	0.00	0.02	0.03	0.01	0.02	0.01	0.59	0.00	0.13	0.08
Exponential function	1.20	1.02	1.00	1.02	1.03	1.01	1.02	1.01	1.81	1.00	1.14	1.08
Sum	13.34											

Source: IMF (n.d); OANDA database; World Bank (2010) database

The exchange rates of the SADC foreign trading partners have been indexed with weighting factors and summed to create a foreign currency index for the SADC region. The monthly exchange rates of the SADC member states in the base year of the currency index should reflect the changes of imports and exports of the SADC currency index over time. The SADC currency index can thus be regarded as the foreign market, with the nominal exchange rate created in the base year as the domestic setting. This change of the foreign trading partners thus has a direct effect on the domestic SADC market. As the base value of the foreign currency index is equal to 100, the value of the domestic exchange rate of the SADC currency basket should also be equal to 100. To better match both foreign SADC currency index and domestic currency basket, both markets are expressed in terms of 1 USD. The SADC domestic currency basket, if introduced in 2005, will be affected over time by supply and demand in as well as by the change in trade of trading partners. To account for this change in international trade, the nominal value of the SADC currency is modelled on the currency index pre and post the base year. Using the equation provided above and the data in the

table5.2.15, the nominal exchange rate in 2005 from a currency basket for the SADC region is calculated at 13.4 SADC dollars relative to 1 USD. For the nominal exchange rate pre and post the base year, the following equation is used:

$$\text{SADC}_{(\text{dollar exchange rate}, j, t)} = 100 * \left(\frac{S_t}{100} \right)$$

The diagram below illustrates the ZAR to dollar nominal exchange rate and the SADC dollar nominal exchange rate as well as the SADC dollar/ZAR exchange rate.

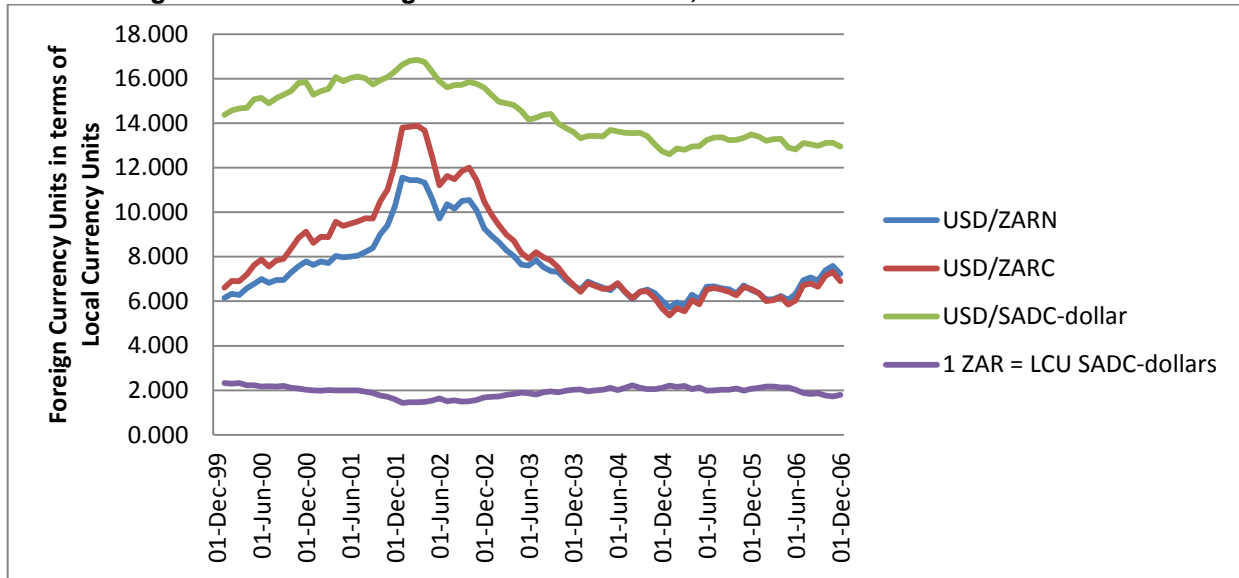
$$1 \text{ USD} = 6.362 \text{ ZAR}$$

$$1 \text{ USD} = 13.40 \text{ SADC dollar, Thus}$$

$$1 \text{ ZAR} = 13.40/6.362 \text{ SADC dollar} \\ = 2.11 \text{ SADC dollar}$$

From the graph below it is apparent that the nominal exchange rates of the USD/SADC dollar are less volatile than the USD/ZARN and USD/ZARC. There is also a large deviation during 2001 and 2002 experienced by the USD/ZARN and USD/ZARC. Another observation from the figure above is that the value of the USD/ZARC is magnified during this period in contrast to the ZARN. A reason for this increase in ZARC is the Rand currency index increasing from 2000 until the end of 2002. This was as a result of the foreign trading partners indices (Z_{it}) increasing together with a depreciating ZAR relative to the USD.

Figure 5.2.11: Exchange Rates of USD/ZARN; USD/ZARC and USD/SADC dollar



Source: Own Compilation

The standard deviations for the USD/ZARN and USD/SADC dollar are presented below in table 5.2.16.

Table 5.2.16: Comparison of USD/ZARN and USD/SADC dollar volatility(standard deviations)

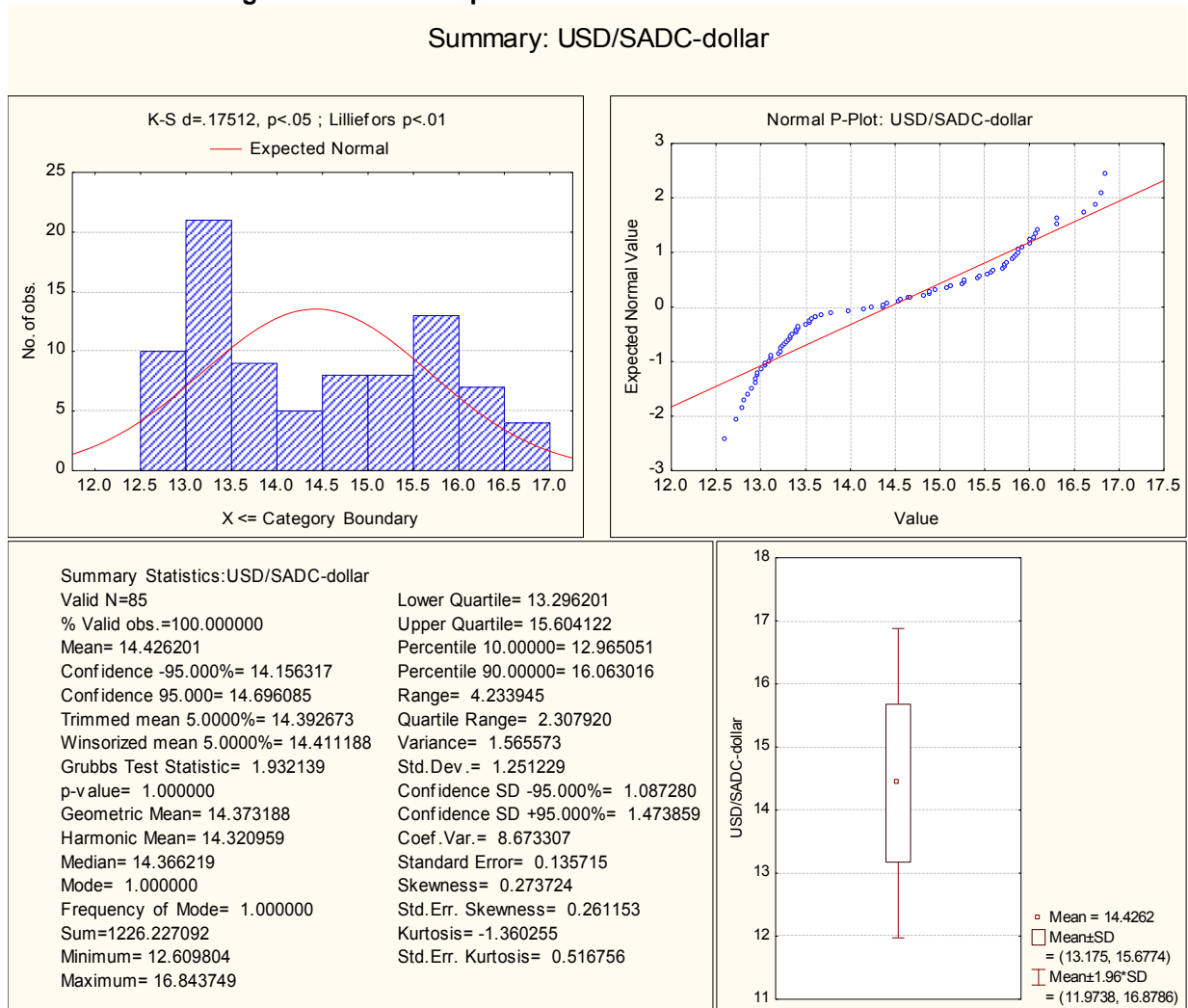
Date	ZARN/USD on Nominal currency	SADC dollar/USD Nominal Currency value on index	% Deviation of ZAR Index relative to theSADC Index	Basis Points (bps.)
2000	0.524	0.452	0.072	7.204
2001	1.176	0.321	0.855	85.471
2002	0.806	0.534	0.272	27.193
2003	0.626	0.517	0.109	10.911
2004	0.341	0.351	-0.010	-1.036
2005	0.293	0.233	0.060	5.960
2006	0.554	0.145	0.409	40.923
average deviation:			0.252	25.23

Source: Own Compilation

The standard deviation on a yearly basis is presented above for the period 2000 until 2006 for the USD/ZARN on the nominal currency value and the USD/SADC dollar nominal exchange rate value on the currency index. The percentage deviation is also given between these foreign currencies and expressed as basis points (bps). The deviation of the USD/SADC dollar is on average 25.23% lower than the USD/ZARN deviation. The largest decline of

85.47bps was in 2001 and a small increase in currency risk for 2004 of 1.04 bps. The development of a SADC dollar currency basket is based on the assumption that the SADC countries' exchange rates will present a lognormal distribution in the future. In order to analyze this assumption at present, descriptive statistics have been applied to the exchange rates below in figure 5.2.12:

Figure 5.2.12: Descriptive Statistics of the USD/SADC dollar¹⁹³



Source: Own Compilation

Figure 5.2.12 illustrates the skewness, kurtosis of the errors terms of the USD/SADC dollar nominal exchanges rate. From this figure, the skewness is positive which adheres to the assumption of a lognormal distribution. The kurtosis which is complemented by the expected

¹⁹³A detailed discussion of the USD/ZARN, USD/SADC-dollar and USD/ZARC is provided in Approach 2. However, please note that the skewness is positive for all three data sets. USD/ZARN and USD/ZARC is shown in Appendix H.

normal histogram and normality p-plot show that the error terms are not normally distributed. In order to calculate the basis spread risk for the SADC region, the following spot exchange rates (Table 5.2.17) and domestic (Table 5.2.18) and foreign (Table 5.2.19) interest rates were used:

Table 5.2.17: Spot Exchange Rates of SADC Region

Date	Spot	1 month	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months	10 months	11 months	12 months
2000	14.37	14.57	14.66	14.69	15.08	15.13	14.90	15.12	15.27	15.46	15.81	15.83	15.27
2001	15.27	15.43	15.54	16.07	15.88	16.02	16.09	16.01	15.74	15.92	16.06	16.32	16.63
2002	16.63	16.80	16.84	16.75	16.32	15.89	15.60	15.71	15.73	15.86	15.76	15.59	15.26
2003	15.26	14.97	14.89	14.82	14.55	14.16	14.24	14.37	14.41	13.98	13.79	13.61	13.32
2004	13.32	13.43	13.43	13.40	13.69	13.62	13.57	13.55	13.56	13.41	13.05	12.73	12.61
2005	12.61	12.86	12.80	12.95	12.97	13.24	13.35	13.37	13.23	13.25	13.34	13.50	13.40
2006	13.40	13.21	13.27	13.30	12.91	12.83	13.11	13.05	12.97	13.11	13.12	12.95	13.02

Source: Own Compilation

The short term central bank discount rates discussed in section 5.2.4 used are shown in table 5.2.18 below:

Table 5.2.18: Domestic Interest Rate applicable to the SADC region

Date	3 month	6 month	9 month	12 month
01/01/2000	1.048	1.097	1.145	1.194
01/01/2001	1.044	1.088	1.132	1.176
01/01/2002	1.058	1.117	1.175	1.234
01/01/2003	1.044	1.089	1.133	1.177
01/01/2004	1.035	1.071	1.106	1.141
01/01/2005	1.040	1.080	1.120	1.160
01/01/2006	1.025	1.051	1.076	1.101

Source: World Bank (2010) Database; Quantec database

The following foreign interest rates are provided in table 5.2.19 below:

Table 5.2.19: United States T-Bill Rate

Date	3 months	6 months	9 months	1 year
12/31/1999	1.0574	1.0598	1.0611	1.0624
01/02/2001	1.0587	1.0558	1.15856	1.0511
01/02/2002	1.0174	1.0185	1.02065	1.0228
01/02/2003	1.0122	1.0125	1.01335	1.0142
01/02/2004	1.0093	1.0102	1.01165	1.0131
01/03/2005	1.0232	1.0263	1.0271	1.0279
01/03/2006	1.0416	1.044	1.0439	1.0438

Source: N.A (2010a)

Equation seven (shown below) was used to calculate the USD/ SADC dollar currency futures prices (see Table 5.2.20). It was also used to calculate the USD/ZAR currency futures prices.

$$f_0(T) = [\text{SADC dollar}_{a,j,t} \times (1 + r_d)^T] / (1+r_f)^T$$

Table 5.2.20: Futures Prices using SADC dollar/USD as the Underlying Currency

Date	3 month futures price	6 month futures price	9 month futures price	12 month futures price
2000	14.25	14.87	15.51	16.15
2001	15.06	15.74	14.93	17.09
2002	17.30	16.66	19.15	20.06
2003	13.07	15.67	17.06	17.72
2004	13.67	14.12	14.56	14.48
2005	12.82	13.27	13.53	14.23
2006	13.19	13.48	13.81	14.14

Source: Own Compilation

The basis spread and basis risk spreads have been computed (see Table 5.2.21) using the equation listed below.

$$\text{Basis spread} = f_0(T) - \text{SADC dollar}_{a,j,t}(T-t)$$

Table 5.2.21: Basis Spread and Basis Spread Risk of SADC region

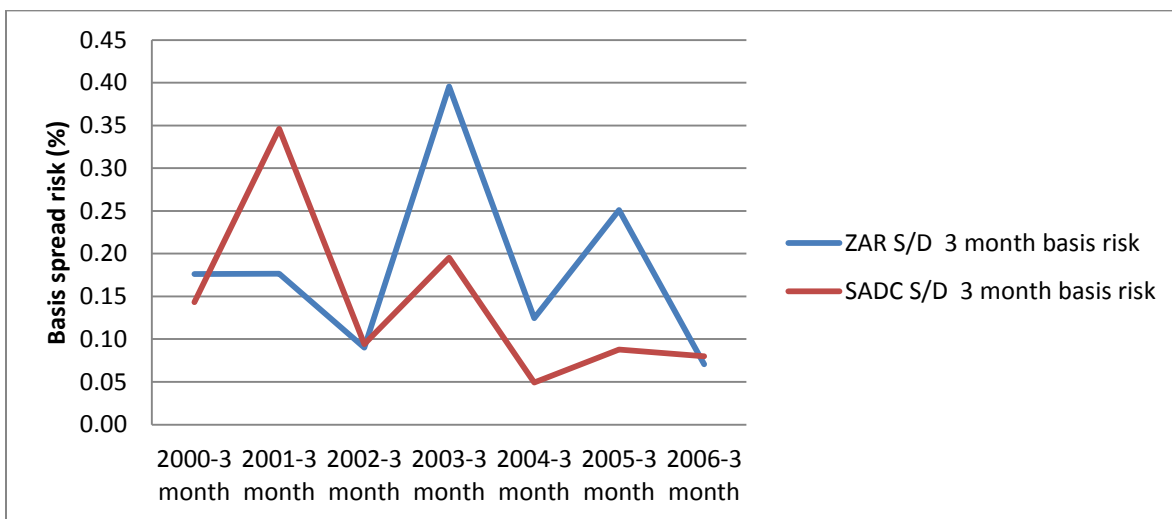
Date	H ₃ – S ₀	H ₃ – S ₁	H ₃ – S ₂	H ₃ – S ₃	H ₃ – S ₄	H ₃ – S ₅	H ₃ – S ₆	H ₃ – S ₇	H ₃ – S ₈	H ₃ – S ₉	H ₃ – S ₁₀	H ₃ – S ₁₁	H ₃ – S ₁₂	SAD C S/D	SAD C S/D	SAD C S/D	SADCS/D
2000-3 month	0.16	0.34	0.29	0.58										0.18			
2000-6 month	0.00	0.18	0.13	0.42	0.63	0.84	0.66								0.31		
2000-9 month	0.2	0.0	0.0	0.3	0.5	0.7	0.5	0.6	0.6	1.0						0.3	
2000-12 month	0.33	0.15	0.21	0.09	0.30	0.50	0.33	0.47	0.47	0.82	1.08	1.30	1.14				0.40

Source: Own Compilation

5.2.6 Comparison: ZARN/USD and USD/SADC dollarBasis Spread Risk

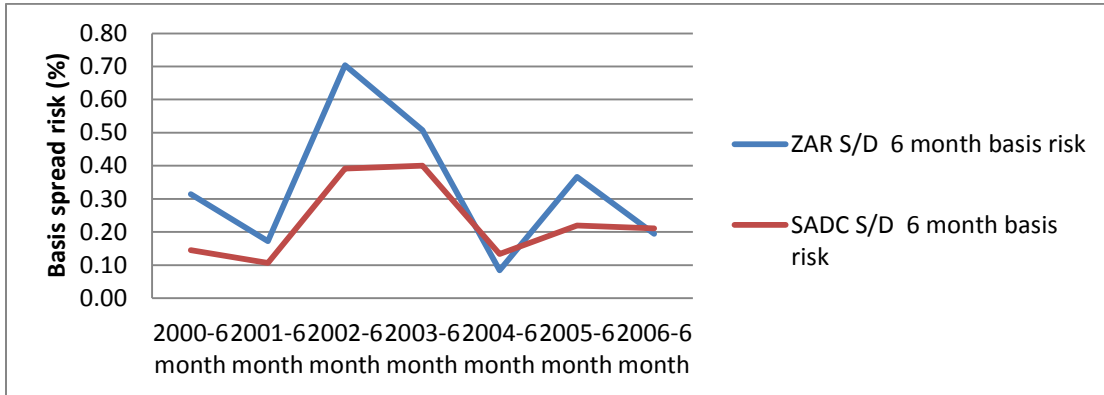
The ZAR and SADC dollar basis spread risk relative to the USD are compared graphically in the diagrams below:

Figure 5.2.22: Three Month Basis Risk Comparisons of USD/ZARN and USD/SADC dollar



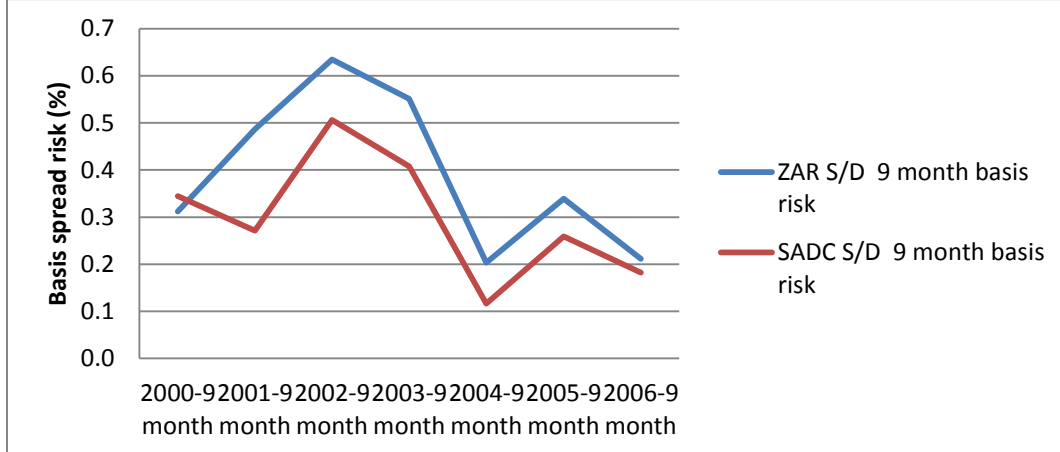
Source: Own Compilation

Figure 5.2.23: Six Month Basis Risk Comparisons of USD/ZARN and USD/SADC dollar



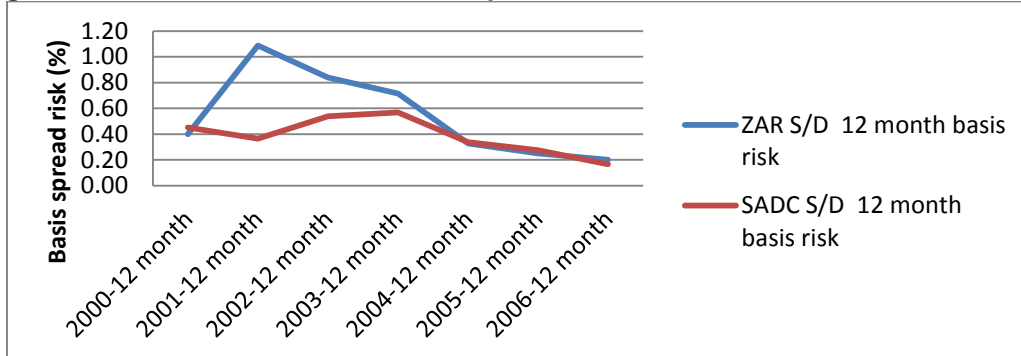
Source: Own Compilation

Figure 5.2.24: Nine Month Basis Risk Comparisons of USD/ZARN and USD/SADC dollar



Source: Own Compilation

Figure 5.2.25: 12 Month Basis Risk Comparisons of USD/ZARN and USD/SADC dollar

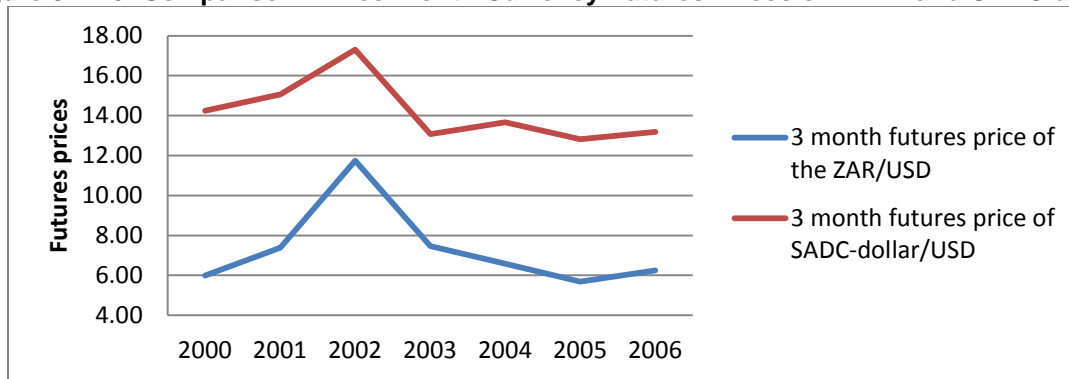


Source: Own Compilation

The three month currency futures basis spread risk of the USD/SADC dollar is the only instance where the basis spread risk is greater than the ZARN/USD basis risk spread.

However, this occurs for a very short time period. In all the other contracts, namely six, nine and 12 month currency futures contracts the basis spread risk of the SADC dollar implementation results in a lower basis spread risk. In the nine and 12 month currency futures contracts category there is a large deviation in 2001/2002, while in all the other years the deviation is less significant. The reason for this large deviation in the basis spread risk is due to the large currency futures prices which resulted from the high domestic interest rate for the ZAR and SADC. The diagram below illustrates that in 2002, the high three-month currency futures price of the ZAR/USD and the SADC dollar/USD is a function of the large compounding domestic central bank discount rate and the small discount foreign US T-bill interest rate.

Figure 5.2.26: Comparison: Three-month Currency Futures Prices of ZARN and SADC dollar



Source: Own Compilation

In order to determine if a SADC dollar nominal currency has a significant impact on hedging decisions of South African investors, the variance of these different hedged positions must be determined first. This is shown as the S^2 in Table 5.2.27 below. The F-statistic was used to compare variances of USD/ZAR and USD/SADC hedged positions using the formula provided below. The F-statistic is calculated by dividing the maximum variance of SADC by the minimum variance of the ZAR. As shown in the table below, the 3-month currency futures contracts have a maximum variance for SADC dollar as 0.03 or 3% and the minimum variance for the ZAR as 0.03, also for the 3-month contract. Thus, the F-statistic has a value of 1.00. The p-value was computed using the F-distribution with n-1 parameters. If the variance of the SADC dollar's implementation has a significant effect on the ZAR variance it obtains a value of 1, otherwise 0. In the table below, the only two hedged positions which are

significant, are the, 2001 nine month, currency futures contract and the, 12-month, currency futures contract. All of the other currency futures positions are insignificant.

$$F\text{-statistic} = \frac{\text{Max variance}}{\text{Min variance}}$$

$$1.) H_0: \sigma^2\text{USD/ZAR} = \sigma^2\text{USD/SADCZ}$$

$$1.) H_1 \neq \sigma^2\text{USD/ZAR} \neq \sigma^2\text{USD/SADCZ}$$

Table 5.2.27: Significance of Hedged Positions

Date	2000-3 month	2000-6 month	2000-9 month	2000-12 month	2001-3 month	2001-6 month	2001-9 month	2001-12 month
n	4	7	10	13	4	7	10	13
SADC								
S	0.18	0.31	0.30	0.40	0.35	0.11	0.27	0.36
S2	0.03	0.10	0.09	0.16	0.12	0.01	0.07	0.13
ZAR								
S	0.180	0.310	0.300	0.400	0.180	0.170	0.490	1.090
S2	0.032	0.096	0.090	0.160	0.032	0.029	0.240	1.188
SADC vs. ZAR								
F=	1.00	1.00	1.00	1.00	3.78	2.39	3.29	9.17
p-value	0.50	0.50	0.50	0.50	0.15	0.16	0.05	0.00
significant	0	0	0	0	0	0	1	1

Source: Own Compilation

This allows the null hypothesis to be rejected in favour of the alternate hypothesis stating that at a 5% level of significance the variance of the USD/ZARN is different from the variance of the USD/SADC dollar.

Graphically, from figures 5.2.22 to 5.2.25, it was evident that the basis spread risk has declined for the three, six, nine and 12 month currency futures contracts. However, when testing the significance of this decline in basis spread risk (Table 5.2.27), it was shown with the F-statistic that this decline has no significant effect on the alternate hedge positions. Thus, investors in the South African market would rather use the ZARN as opposed to implementing and using the SADC dollar nominal exchange rate.

The only two significant hedged positions during which the basis spread risk declined were the 2001-9month and 12 month currency futures contracts. While, the basis spread risk is a function of domestic interest rates and foreign interest rates. The most prominent variable in the currency futures market is the spot and future spot exchange rate. The reason for the significant decline in basis spread risk between the USD/ZAR and USD/SADC in 2001 is the depreciation of the USD/ZAR exchange rate in 2001 as presented below:

Table 5.2.28: Depreciation of ZAR, 2001

Date	31 - Dec- 00	31 - Jan - 01	28 - March 01	31 - Mar 01	30 - April 01	31 - May 01	30 - June 01	31 - July 01	31 - Aug 01	30 - Sep 01	31 - Oct 01	30 - Nov 01	31 - Dec 01
1 USD =ZAR	7.629	7.787	7.711	8.038	7.975	8.003	8.049	8.227	8.389	9.010	9.415	10.270	11.551

Source: Own Compilation

The USD/ZARN depreciated from 7.629 to 11.551 over the period of one year. It could be argued that a depreciating ZAR relative to the USD would provide significant declines in basis spread risk in currency futures hedged positions, if replaced with a SADC dollar currency. However, South Africa have recently implemented policies on an appreciating and depreciating ZAR relative to the USD (Bhundia & Ricci, n.d). The SARB wishes to maintain a stable ZAR/USD exchange rate at 1 USD = 7 ZAR by buying USD and selling ZAR in order to build a sufficient reserve. This sufficient foreign exchange reserve would prevent speculators from putting extreme downward pressure on the ZAR. The section that follows provides a more accurate comparison of the USD/SADC dollar on currency index with the USD/ZARC currency index.

5.2.7 Comparison: USD/ZARC and USD/SADC dollar Basis Spread Risk

The USD/ZARN comparison with the USD/SADC dollar shown previously resulted in a decline in the currency risk by 25.23 basis points. However, the total reduction in currency risk is 45 basis points, almost twice that of the USD/ZARN when the SADC dollar replaces the ZARC. The comparison of the USD/SADC dollar with the ZARC produces a greater reduction in basis spread shown below:

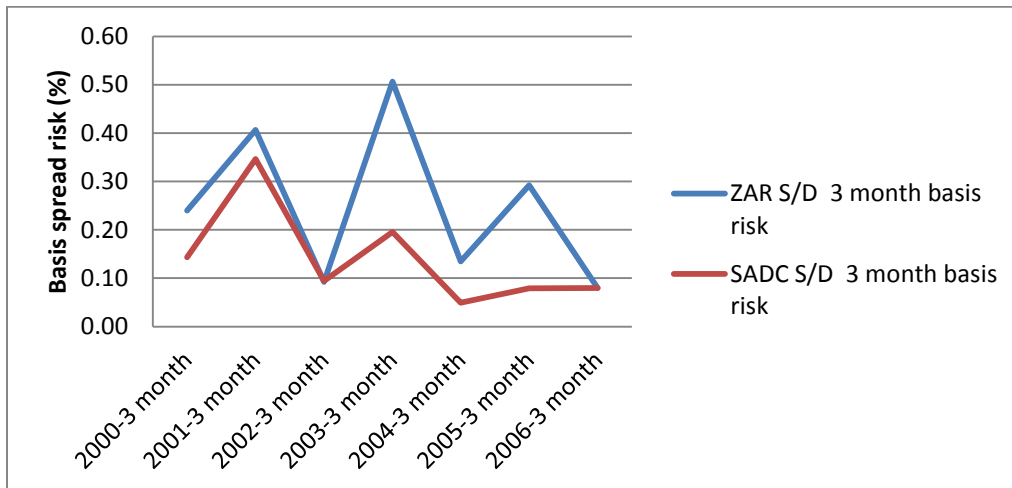
Table 5.2.29: Comparison of USD/ZARC and USD/SADC dollarVolatility

Date	ZAR/USD on Currency Index	SADC/Dollar Nominal Currency Value On Index	% Deviation Between ZAR Index and SADC Index	Basis Points (bpts.)
2000	0.782	0.452	0.331	33.069
2001	1.458	0.321	1.137	113.710
2002	1.284	0.534	0.750	74.961
2003	0.889	0.517	0.372	37.246
2004	0.446	0.351	0.095	9.476
2005	0.376	0.233	0.143	14.257
2006	0.488	0.145	0.343	34.318
Average Deviation:			0.453	45.291

Source: Own Compilation

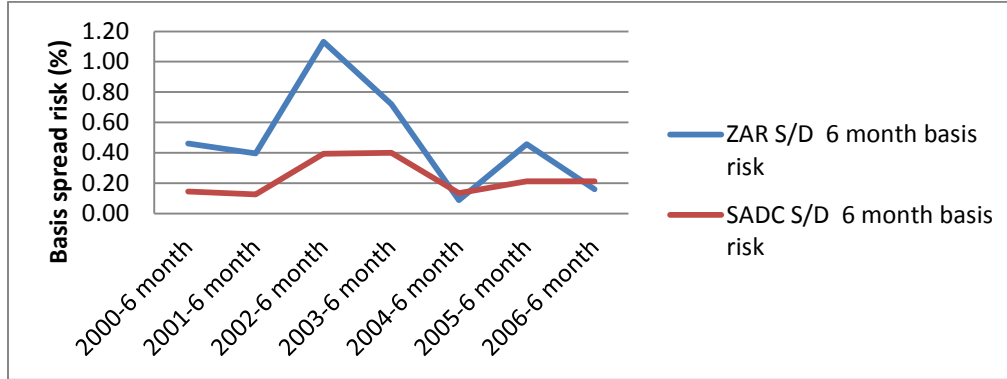
To provide a more accurate comparison of the SADC dollar nominal exchange rate on the currency index with the ZAR, the ZAR nominal exchange rate is modeled on the ZAR foreign currency index. This calculation and comparison of the basis spread risk is analogous with the approach used previously and is shown graphically below:

Figure 5.2.30: Three Month Basis Risk Comparisons of USD/ZARC and USD/SADC dollar



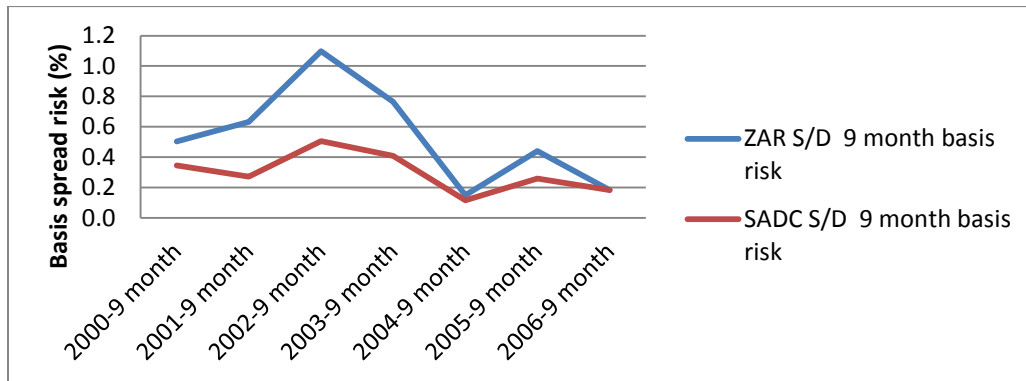
Source: Own Compilation

Figure 5.2.31: Six Month Basis Risk Comparisons of USD/ZARC and USD/SADC dollar



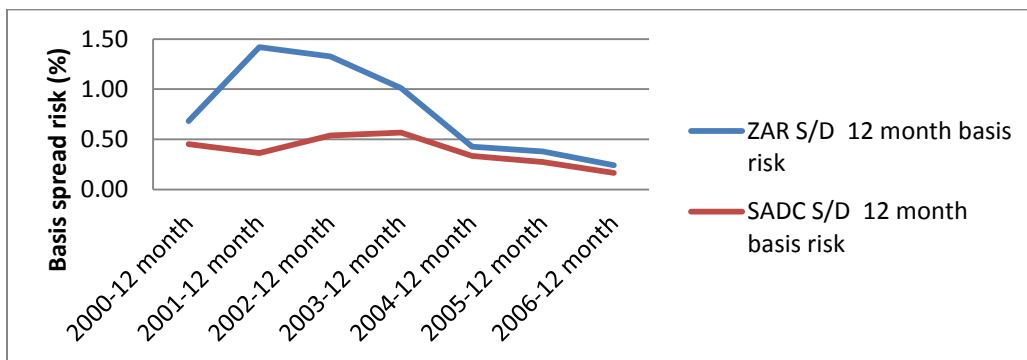
Source: Own Compilation

Figure 5.2.32: Nine Month Basis Risk Comparisons of USD/ZARC and USD/SADC dollar



Source: Own Compilation

Figure 5.2.33: 12 Month Basis Risk Comparisons of USD/ZARC and USD/SADC dollar



Source: Own Compilation

When analyzing the four diagrams above regarding the comparison of basis spread risk between USD/SADC dollar and USD/ZARC, it is evident that the three month currency futures contracts basis spread risk of the SADC dollar/USD was marginally less than the ZARC/USD

during 2000 and 2002 with a larger decline during 2003 until 2006. For the six, nine and twelve month currency futures contracts: The USD/SADC dollar basis spread risk was less than the ZARC/USD basis spread risk for the period 2000 until 2004. There is still a decline after 2004 up to 2006, but this decline becomes smaller. The six, nine and twelve month SADC dollar and ZARC conclusions are similar to the comparison done previously between the SADC dollar and the ZARN. However, one aspect that stands out is the larger decline in basis spread risk when the USD/SADC dollar replaces the USD/ZARC.

In general there has been a reduction in the basis spread risk regardless of the variables used to compare the USD/SADC dollar with more significant hedge positions shown in appendix G. Another key observation in this chapter is the presence of seasonality in the currency index for the SADC region which was reinforced by analyzing the kurtosis when modeling the nominal SADC dollar exchange rate on this currency index. This seasonality can be removed which will eliminate problems when applying fixed weights or by using a rebalancing approach at the beginning of each year. Another possible reason for this abnormal seasonality is due to the double use of imports and exports. Import and export weights were used to model the currency index and account for the foreign position of each SADC member state. "Double" refers to the fact that imports and exports are also part of the GDP weighting factors used. To account for this dilemma, imports and exports can be reversed calculated or may be derived from the GDP weighting factors as shown below:

$$g_{it} = (GDP_{it} - [X_{it} - M_{it}]) / (\sum_i^n GDP_{it} - [\sum_i^n X_{it} - \sum_i^n M_{it}]), \text{ If:}$$

$$GDP_{it} = C_{it} + I_{it} + G_{it} + (X_{it} - M_{it})$$

This aspect was not dealt with in this study and may therefore be considered in further research. An alternate approach to analyze the accuracy of the SADC-dollar currency index or the relation between the currency indexes created for the ZAR and the SADC to the RAIN currency index is to compare volatilities. This can be done by extrapolating the daily RAIN data into monthly data and then by comparing the monthly currency indices created in this manner. Another limitation that needs to be mentioned is that the JSE calculates the daily RAIN index only from 2006. Another point of criticism is the need for annual rebalancing on

the trade-weights. In this study the weights are monthly weights due to the use of interpolated data.

During this study, the USD/SADC dollar is calculated for 2005 representing the SADC member states and applied to the base year of the index in 2005. The SADC dollar/USD nominal exchange rate is modeled on the currency index, thus already reflecting exports and imports in the market and allowing market participants to trade this nominal exchange rate. When the SADC dollar is first issued in 2005 (the base year), it should reflect the forces of supply and demand in the international markets as trade between the region and the world economy takes place. To improve the transparency between the SADC member states and the international economy, a balance of payments weight can be applied to the trade weight (imports and exports) of the SADC currency index. This would however serve as a recommendation for further research.

As a safety precaution, the SADC dollar could be revalued every year by moving the base year of the currency index forward and applying a new USD/SADC dollar to this base year. This removes the risk of speculation on the SADC dollar relative to other major world currencies and ensures the credibility of the SADC central bank. If no adverse speculation has taken place, the SADC central bank can decide whether or not to adjust or apply the nominal SADC dollar exchange rate currently trading in the market to the base year. Under adverse speculation in the SADC region, the base year can be moved forward to the period of speculation with a gradual change to the new USD/SADC dollar being implemented.

From the descriptive statistics shown previously, some questions arise as to the use of the standard deviation formula in calculating the deviation of the basis. The reason why this question arises is due to the standard deviation which is more usable when the distribution is normal. Rather than using the standard deviation, a more conservative and accurate approach would be to rather compare volatilities of three stationary exchange rate time series.

5.3 APPROACH TWO

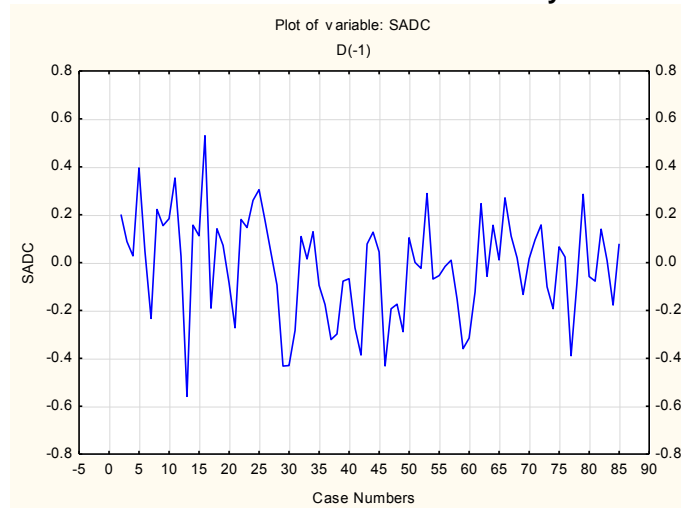
This section compares the volatilities, means squared residuals (MS residuals), of three exchange rate time series using econometric techniques. The approach used in this section

fits a model to the error terms of each time series and removes the problems of normality discussed in section 5.2.

5.3.1 Transforming the Original Data

All three exchange rate time series reflect non-stationary characteristics. This was presented previously in Figure 5.2.11. This presented a problem as only the mean and volatilities can be compared for stationary time series. To obtain stationarity, all three time series for the SADC dollar were first differenced (represented as $D(-1)$), as shown below. The differenced data can be seen in figure 5.3.1 with the SADC dollar nominal exchange rate fluctuating around the mean of zero. Refer to appendix H for the ZARN and ZARC nominal exchange rate time series.

Figure 5.3.1: USD/SADC dollar Differenced Monthly Movements $D(-1)$



Source: Own Compilation

5.3.2 Fitting a Model to the Data

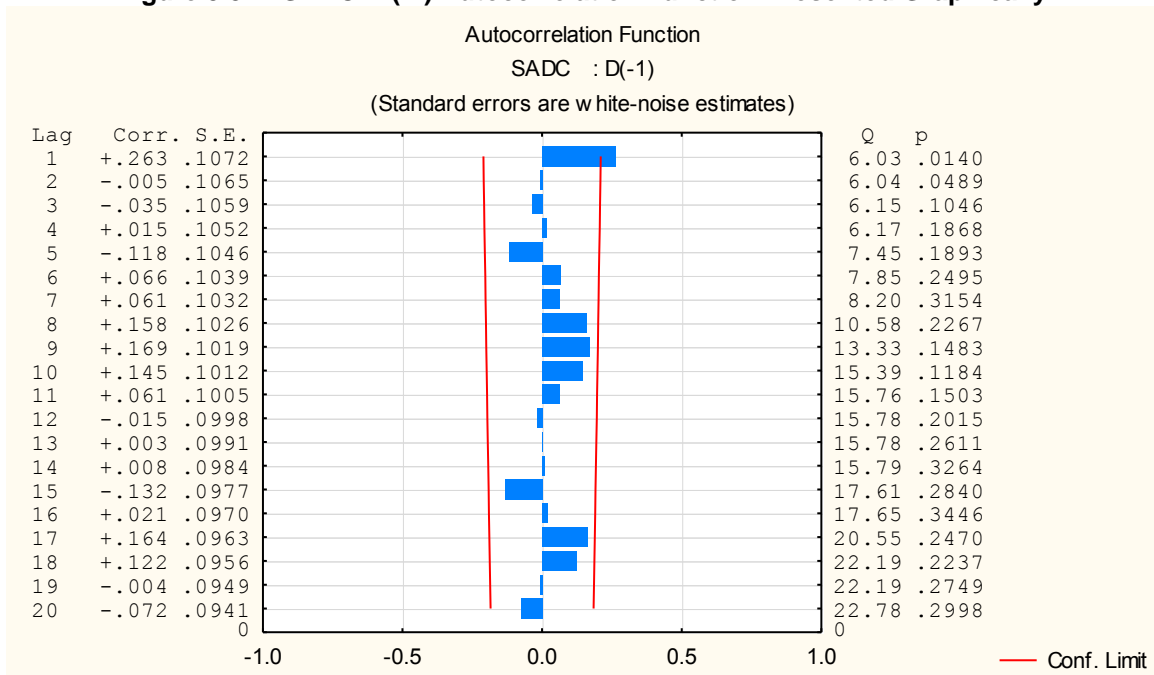
In order to fit a model to the data, the autocorrelations of the differenced data were examined. For all three time series, the first lag of the autocorrelations, AR (1) was the most significant. This is shown in table 5.3.1 below by the smallest p-value of 1.4% using a 5 % level of significance. This is presented graphically with an autocorrelation function for the SADC region below. See Appendix I for the extensions to the ZARN and ZARC time series.

Table 5.3.1: SADC D (-1) Autocorrelation Function

Autocorrelation Function (DATA20110308)				
SADC : D(-1)				
(Standard errors are white-noise estimates)				
Lag	Auto-Corr.	Std.Err.	Box & Ljung Q	p
1	0.263308	0.107189	6.03417	0.014037
2	-0.005050	0.106541	6.03641	0.048903
3	-0.035403	0.105890	6.14819	0.104641
4	0.015486	0.105234	6.16985	0.186846
5	-0.118302	0.104574	7.44964	0.189323
6	0.065558	0.103910	7.84768	0.249512

Source: Own Compilation

Figure 5.3.2: SADC D (-1) Autocorrelation Function Presented Graphically



Source: Own Compilation

Next, various models were tested on the first differenced data (D (-1)). It was found that an AR(1) model was the most significant with the first lag having the lowest p-value. Alternatively in figure 5.3.2, the standard errors were white noise estimates on the differenced data and when an AR(1) model was fitted to the error terms with one lag. This is shown graphically in figure 5.3.2 from the standard errors falling outside the confidence bands of the first lag. No lagged forecast error terms were used which allowed for the conclusion to be reached that an ARIMA(1,1,0) model fitted the error terms. To test if this model fits, the autocorrelations were re-examined. From the table below, it can be seen that none of the autocorrelations were

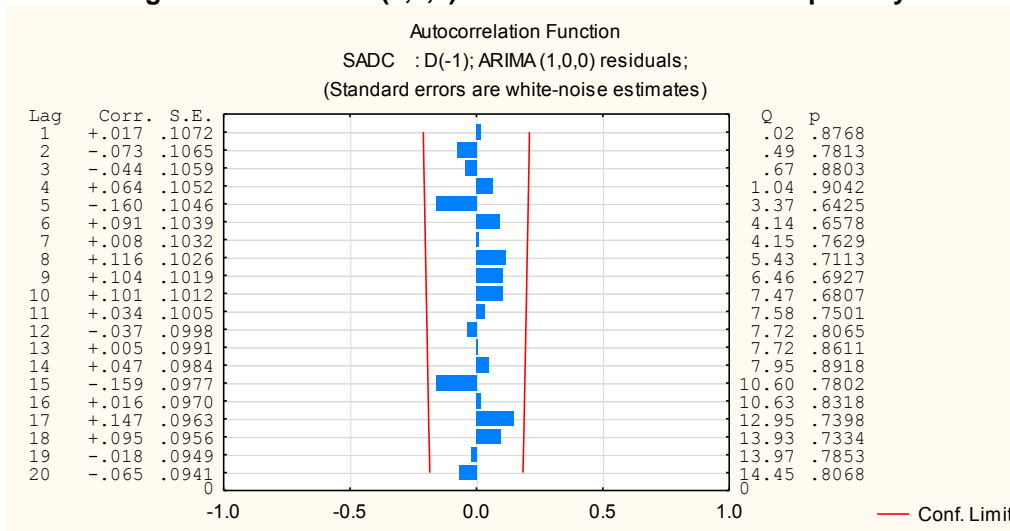
significant due to the large p-values for the different lags. The standard errors are thus only white-noise estimates proving that this model is a good fit to the data. This goodness of fit can also be seen graphically below from the decline in autocorrelations to fall within the confidence limits.

Figure 5.3.3: ARIMA (1,1,0) Model fit to SADC Data

Autocorrelation Function (DATA20110308) SADC : D(-1); ARIMA (1,0,0) residuals; (Standard errors are white-noise estimate)				
Lag	Auto-Corr.	Std.Err.	Box & Ljung Q	p
1	0.016622	0.107189	0.02405	0.876769
2	-0.073012	0.106541	0.49368	0.781268
3	-0.044456	0.105890	0.66989	0.880261
4	0.063714	0.105234	1.03646	0.904216
5	-0.159902	0.104574	3.37454	0.642454
6	0.090887	0.103910	4.13958	0.657799

Source: Own Compilation

Figure 5.3.4: ARIMA (1,1,0) Model fit to SADC Data Graphically



Source: Own Compilation

Since the model fits the original data, volatilities can be compared among the different exchange rates. The table below provides a volatility estimate for the SADC region in the form of a mean square residual together with the significance of this estimate. This MS residual for the SADC region is 0.04229 which is statistically significant at a 5% level of significance by examining the low p-value.

Figure 5.3.5: MS Residual from SADC D (-1) ARIMA (1,1,0) Model

Input: SADC : D(-1) (DATA20110308)						
Transformations: none						
Model:(1,0,0) MS Residual= .04229						
Paramet.	Param.	Asympt. Std.Err.	Asympt. t(83)	p	Lower 95% Conf	Upper 95% Conf
p(1)	0.269190	0.106449	2.528816	0.013338	0.057467	0.480913

Source: Own Compilation

This approach has been followed analogously for the USD/ZARN and the USD/SADC dollar. Next, the standard errors are analyzed to determine if any models can be applied to these errors.

5.3.3 Fitting a Model to the Residuals

As mentioned previously, an AR (1) model was fitted to all three time series. Thus, an ARIMA (1,1,0) was applied with a 12 month moving average allowing for convergence to be achieved after 12 iterations. To obtain autoregressive errors, the residuals were squared. This resulted in the residuals with a p-value of 0.9352 as shown below.

Table 5.3.2: Significance of using ARCH and GARCH (1,1) models on SADC Residuals

Dependent Variable: D(SADC)

Method: ML - ARCH

Sample (adjusted): 2000M02 2006M12

Included observations: 83 after adjustments

Convergence achieved after 12 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(2) + C(3)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	0.265339	0.112407	2.360525	0.0182
Variance Equation				
C	0.042229	0.007461	5.660304	0.0000
RESID(-1) ²	-0.010176	0.125096	-0.081350	0.9352
R-squared	0.065923	Mean dependent var		-0.018629
Adjusted R-squared	0.065923	S.D. dependent var		0.212843
S.E. of regression	0.205708	Akaike info criterion		-0.264780
Sum squared resid	3.469889	Schwarz criterion		-0.177352
Log likelihood	13.98839	Hannan-Quinn criter.		-0.229657
Durbin-Watson stat	1.949807			
Inverted AR Roots	.27			

No significant ARCH, p = 0.9352

Source: Own Compilation

This resulted in residuals that were not significant and not autoregressive and no ARCH or GARCH model could be fitted to the standard errors. This was the same situation for the ZARN and ZARC timeseries. The standard errors were only white noise estimates, thus showing that no model could be fitted to the standard errors. An extract of the data is provided below. The partial autocorrelation functions were also examined which provided similar results below.

Figure 5.3.6: Partial Autocorrelation Function

Partial Autocorrelation Function (DATA20110308)			
SADC : D(-1)			
(Standard errors assume AR order of k)			
Lag	Partial-Auto r.	Std.Err.	
1	0.263306	0.109109	
2	-0.079920	0.109109	
3	-0.013974	0.109109	

Source: Own Compilation

5.3.4 Comparison of Volatilities (Variances)

An ARIMA (1,1,0) model has been fitted to the USD/ZARN, USD/ZARC and USD/SADC dollar with MS residuals provided for each of these time series.

Table 5.3.3: Comparison of Volatilities

Input: ZARN (DATA20110308)							ZARN MSE =	0.11519
Transformations: D(1)								
Model:(1,1,0) MS Residual= .11519								
	Param.	Asympt.	Asympt.	p	Lower	Upper	N1=84	
p(1)	0.252939	0.107064	2.362509	0.020492	0.039994	0.465884		
Input: ZARC (DATA20110308)							ZARC MSE =	0.17456
Transformations: D(1)								
Model:(1,1,0) MS Residual= .17456								
	Param.	Asympt.	Asympt.	p	Lower	Upper	N2=84	
p(1)	0.367006	0.102784	3.570634	0.000596	0.162572	0.571440		
Input: SADC (DATA20110308)							SADC MSE =	0.04229
Transformations: D(1)								
Model:(1,1,0) MS Residual= .04229								
	Param.	Asympt.	Asympt.	p	Lower	Upper	N3=84	
p(1)	0.269190	0.106449	2.528816	0.013338	0.057467	0.480913		

Source: Own Compilation

Using the F-test to compare variances or volatilities, a significant difference exists in MS residuals between the USD/ZAR and the USD/ZARC. There is also a significant reduction in volatilities when the SADC dollar replaces the ZARN or ZARC. This reduction is greater when the SADC dollar replaces the ZARC. These p-values of the F-test are shown below:

Table 5.3.4: F-tests

F-tests	1: ZARN	2: ZARC	3: SADC dollar
1: ZARN		0.02921228503	0.00000359804
2: ZARC			0.00000000023
3: SADC dollar			

Source: Own Compilation

An adjustment must however be made to the F-test and p-values when testing multiple comparisons among time-series analyses. This adjustment is known as the Bon Ferroni method which results in a new F-test called the F-test (corrected) with new p-values. These new p-values are shown below:

Table 5.3.5: Bon Ferroni F-test

F-tests (corrected)	1: ZARN	2: ZARC	3: SADC dollar
1: ZARN		0.08763685508	0.00001079412
2: ZARC			0.00000000068
3: SADC dollar			

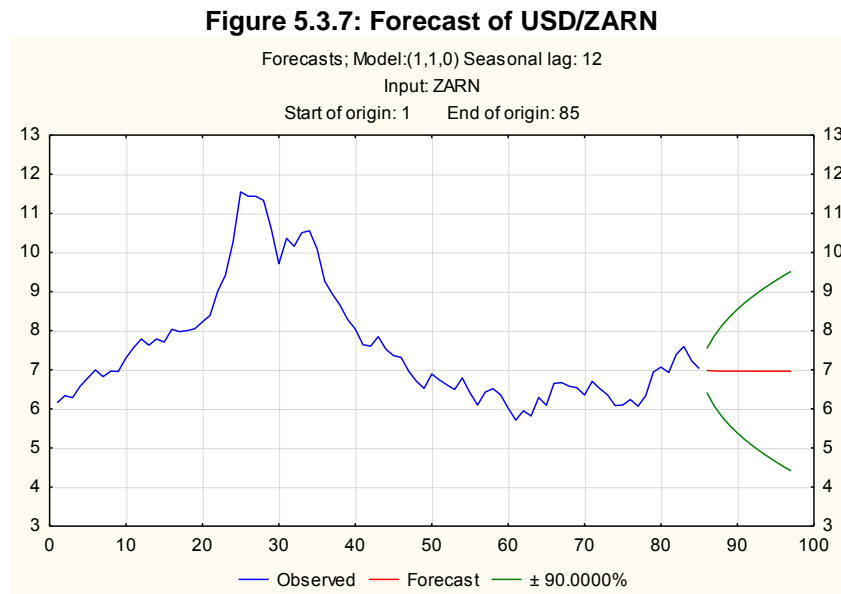
Source: Own Compilation

These new adjusted p-values show that the volatilities of the ZARN are not statistically significantly different from the ZARC. This makes sense from an investment perspective as the value of the ZARN nominal exchange rate should be reflective of the level of trade with its foreign trading partners. The only reason why the ZARN was modeled on the foreign currency index of the ZAR (ZARC) is to provide better comparisons with the SADC dollar on the SADC foreign currency index. Regardless of the comparison, when the SADC dollar replaces the ZARN or ZARC, there is a significant reduction in volatility. This supports the conclusions reached in approach 1 that there will be a considerable reduction of currency risk resulting in lower basis risk. Another conclusion is that there is a significant reduction in currency risk

using the SADC dollar due to the very small MS residual. The next section provides a discussion on the forecasting of these three exchange rate time series.

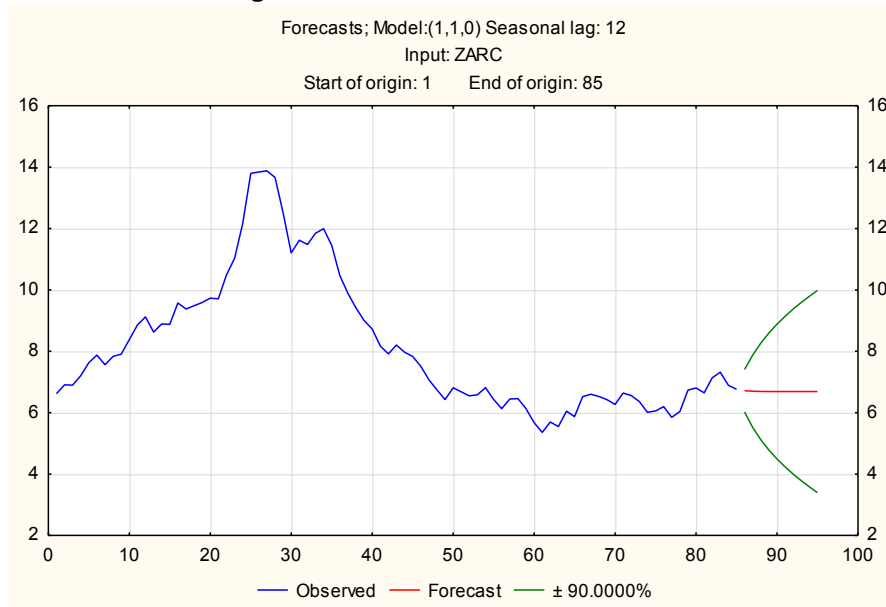
5.3.5 Forecasting of Original Time Series

The reason for the inclusion of this section is that investors trading in foreign currency markets, whether it is for hedging, arbitrage, investing in foreign multinational corporations or speculating, all have expectations about future exchange rate movements. This expectation will influence the type of hedge position entered into in the market. These diagrams are provided below with observed data and a forecast within a certain confidence band.



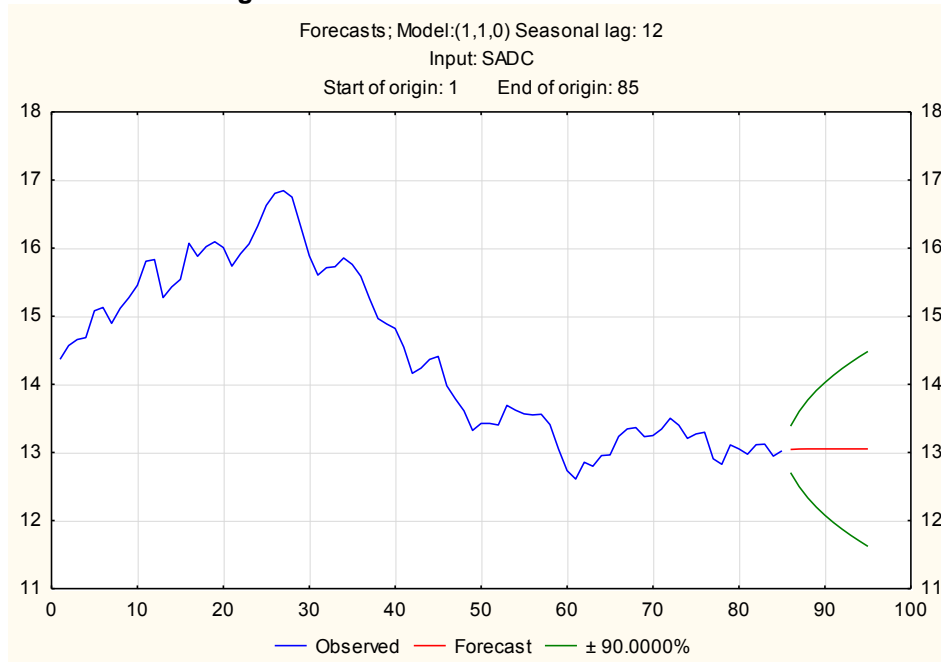
Source: Own Compilation

Figure 5.3.8: Forecast of USD/ZARC



Source: Own Compilation

Figure 5.3.9: Forecast of USD/SADC dollar



Source: Own Compilation

Using the ARIMA (1,1,0) model proposed previously, 15 observations have been forecasted post 2006 year end. When analyzing the ZARN and ZARC, there is a confidence band of approximately two and a half deviations from the mean of 1USD = 7 ZAR. Whereas when analyzing the SADC, the confidence band is only one and a half deviations from the mean of

1 USD = 13 SADC dollar. This implies that investors with certain future exchange rate expectations on the SADC dollar have less risk of deviations in contrast to the ZARN and ZARC.

From approach two, the assumption underlying normality was removed with different econometric models being fitted to the exchange rate time series. This study focuses on a currency futures basis risk comparison of different exchange rate time series. A less volatile exchange rate time-series, holding the domestic interest and foreign interest rate the same for the different time series should result in a reduction in basis risk.

It was found that an ARIMA (1,1,0) model with a first difference, an AR (1) process and no future forecasted lags, fits all three exchange rate time series (ZARN, ZARC and SADC dollar). An ARCH/GARCH (1,1) was also proposed as a suitable model to be fitted to all three exchange rate time-series. The use of ARCH/GARCH (1,1) models was to provide short range and long range volatility estimates. It was, however, found that the residual terms squared had negative coefficients which were an indication of an over-fitted model and that the ARIMA (1,1,0) was the most appropriate model. This similar fitted ARIMA (1,1,0) model to all time-series allows the mean squared residual estimates (volatility estimates) to be compared with each other using F-tests and Bon Ferroni F-tests.

The Bon Ferroni F-stats showed that no significant difference existed in volatility estimates between ZARN and ZARC. There was, however, a significance difference in volatility estimates when the SADC dollar replaced both ZARN and ZARC. The last finding under approach two considered the forecast ability of all three time series using the ARIM (1,1,0) model. It was found that the SADC dollar has less risk, namely one and a half standard deviations, as opposed to the ZARN and ZARC which lie two and half standard deviations away from the mean. This implies that investors have less risk in forecasting ability using the SADC dollar opposed to using the ZAR. This may lead to less currency risk that need to be hedged and even greater hedging effectiveness.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This study set out to test the effect that the implementation of a new fictitious nominal exchange rate would have on:

- Basis spread risks as it related to currency futures.
- The management of currency risk between countries (sovereign risk).

6.2 SUMMARY AND FINDINGS

In order to test the effect that the implementation of a new fictitious nominal exchange rate would have on basis spread risks or volatility estimates, two approaches were used. In approach one the currency futures basis spread risk was determined as the standard deviation amongst the currency futures hedged positions. Under this approach it is assumed that the nominal exchange rates of the USD/SADC dollar, USD/ZARN and USD/ZARC were normally distributed. Table 6.1.1 below the basis spread risk of the USD/SADC dollar nominal exchange rate on the SADC currency index was compared with the basis spread risk of the USD/ZAR nominal exchange rate as quoted in the South African foreign exchange market. These basis spread risk comparisons are presented in table 6.1.1 below for three, six, nine as well as 12 month currency futures contracts. These basis spread risk comparisons were also computed between the USD/SADC dollar as well as the USD/ZARC. This comparison provides more accurate results due to both the SADC dollar as well as ZARC being nominal exchange rates modeled on currency indices.

Table 6.1.1: Summary of Basis Spread Risk Comparisons

Quarterly Hedged Positions	SADC Basis Spread Risk (Using Standard Deviation Approach)	ZARC Basis Spread Risk (Using Standard Deviation Approach)	ZARN Basis Spread Risk (Using Standard Deviation Approach)
2000: 3 months	0.24	0.24	0.18
6 months	0.38	0.46	0.31
9 months	0.3	0.50	0.3
12 months	0.49	0.68	0.40
2001: 3 months	0.41	0.41	0.18
6 months	0.32	0.39	0.17
9 months	0.63	0.63	0.49
12 months	1.23	1.42	1.09
2002: 3 months	0.09	0.09	0.09
6 months	1.13	1.13	0.70
9 months	1.10	1.10	0.63
12 months	1.33	1.33	0.84
2003: 3 months	0.51	0.51	0.40
6 months	0.72	0.72	0.51
9 months	0.77	0.77	0.55
12 months	1.01	1.01	0.71
2004: 3 months	0.09	0.13	0.12
6 months	0.15	0.09	0.08
9 months	0.20	0.15	0.20
12 months	0.43	0.43	0.33
2005: 3 months	0.25	0.29	0.25
6 months	0.37	0.46	0.37
9 months	0.31	0.44	0.34
12 months	0.19	0.38	0.25
2006: 3 months	0.08	0.08	0.07
6 months	0.16	0.16	0.19
9 months	0.20	0.18	0.21
12 months	0.28	0.24	0.20

Source: Own Compilation

Regardless of the type of comparison, when the SADC dollar replaces the USD/ZAR, the basis risk declines for three, six, nine and 12 month hedged currency futures contracts over a period of six years. This has been elaborated on more in approach two in the previous chapter. Under approach one the currency risk was quantified with the standard deviation of each nominal exchange rate time-series. The total currency risk comprises of two components. The first component includes an intra-country currency risk component as well as a foreign currency risk component. The implementation of the USD/SADC dollar results in

the intra-country currency risk component being eliminated due to all SADC member states being quoted in terms of 1 USD. This resulted in only the foreign currency risk component of the total currency risk component remaining. When comparing the foreign currency risk component, the following conclusions can be made from table 6.1.1:

- There is a 45 basis point reduction in the nominal exchange rates when the USD/SADC dollar replaces the USD/ZARN;
- There is a 25 basis point reduction in the nominal exchange rates when the USD/SADC dollar replaces the ZARC.

Approach two drops the normality assumption by fitting econometric models to each of the nominal exchange rate time-series. The econometric model fitted to all of the nominal exchange rate time-series was an ARIMA (1,1,0). As a result of the same model being fitted to all of the time-series, it allowed the mean squared residuals to be compared with one another. The mean squared residuals calculated for each exchange rate time-series have been shown in table 5.3.3. In comparing the mean squared errors, F-Tests have been used. It was found that the mean squared errors of the SADC dollar were significantly different from both the ZARN and ZARC. It was also found that the mean squared errors of the ZARC were statistically different from ZARN (see p-values in table 5.3.6).

To do multiple comparisons of mean squared errors, a more accurate approach which accounts for this multiple comparison was to use a Bon Ferroni F-Test. This test adjusts the p-values accordingly (see table 5.3.5). From table 5.3.5 it was found that ZARN was not statistically significant from ZARC. It was also found that the mean squared errors (residuals) of the USD/SADC dollar were more statistically different from ZARC than ZARN (comparison of p-values).

6.3 MANAGERIAL IMPLICATIONS OF FINDINGS

An important question that may be asked is: How foreign currency futures hedged positions of the USD/ZARN and USD/ZARC can be compared with the USD/SADC dollar. Since at maturity, hedged futures positions have no risk therefore making any comparisons senseless holding no apparent merit for institutional investors. The answer to this question stems from

the analysis of the basis spread in these hedged positions over a time-series analysis with focus on the deviation of the basis spread before the maturity date of the relevant futures contracts. Investors in corporations and financial markets in South Africa and in SADC member states (and globally) use the basis spread and basis spread risk in analyzing interim trades. The major portion of the futures trading is of speculative nature, meaning the long and short traders close out positions very close to maturity date leaving a zero net position in the futures market. Another reason why financial analysts analyze the basis spread is that it is a reflection of the future interest rate differential or disparity between countries as it relates to foreign currency futures. Any approach that may cause a reduction in risk with no impact on return is favored by investors in financial markets and managers of corporations. One such example is the efficient frontier used by portfolio managers in evaluating which investments to include in their portfolio which could cause risk reduction benefits. Reduction in the context of this study refers to the investors trading and hedging the fictitious USD/SADC dollar nominal exchange rate as opposed to the USD/ZARN.

For both foreign currency futures hedged positions mentioned above, the most appropriate instrument to use for comparison purposes is the currency futures contract. Currency futures contracts are used by corporations to hedge both export and import prices of goods against currency fluctuations. A fixed exchange rate can be obtained by hedging. Thus, eliminating or at least reducing currency risk in the future may ultimately lead to an increase in firm value. This was the rationale of including both imports and export weights of foreign trading members in the currency indices of the SADC and the ZAR.

In approach one it was assumed that investors would hedge the USD/ZARN opposed to hedging the USD/SADC dollar using currency futures contracts. The deviations amongst the three, six, nine and twelve month currency futures hedged (basis spread) positions were analyzed. These deviations were calculated under the assumption of a normal distribution. It was found that the basis spread risk declined when investors hedged the USD/SADC dollar as opposed to the USD/ZARN. The reason for this decline in basis spread risk was due to the USD/SADC dollar being modeled on a less volatile SADC foreign currency index. A problem introduced with this comparison was that a fictitious USD/SADC dollar nominal exchange rate was being compared to a USD/ZARN nominal exchange rate traded in the South African

foreign exchange market which made comparison difficult due to large fluctuations in nominal exchange rates. To overcome this dilemma, a South African foreign currency index was composed in a similar fashion to the SADC foreign currency index. Hereafter, the USD/ZARN was modeled on the South African foreign currency index (ZARC). The answer after this was evident, there was still a reduction in the basis spread risk for the quarterly currency futures hedged positions when comparing the USD/SADC dollar to USD/ZARC. This reduction in currency risk of the USD/SADC dollar was 45 basis points when compared to the ZARN and 25 basis points when compared to the ZARC.

When analyzing the descriptive statistics identified in approach one, the skewness of the ZARN and ZARC was relatively small and positive. This was primarily the reason why the assumption of lognormal distribution was used in the creation of the fictitious USD/SADC dollar nominal exchange rate in the base year of the SADC foreign currency index. The data was, however, not normally distributed which presented a problem. To overcome this problem in approach two, an econometric regression model was fitted to each of the exchange rate time-series. An ARIMA (1,1,0) model was found as the best fitted model which allowed the mean squared errors to be compared with each other. To compare these mean squared errors, a Bon Ferroni F-test was used which adjusted the p-values for multiple comparisons. When analyzing the p-values of the mean squared errors, it was found that the USD/ZARN was not statistically different from the USD/ZARC. This was the case even though the USD/ZARN had a higher mean squared error estimate than the USD/ZARC. This made intuitive sense from an investment and managerial perspective as USD/ZARC was only the nominal South African rand modeled on a rand currency index. As the rand currency index comprises of imports and exports, it would be expected not to be different from the nominal South African rand exchange rate traded in the foreign exchange market which factors into account the trade with its major trading partners. It was, however, found that the mean squared errors of the USD/SADC dollar were statistically different from USD/ZARN and USD/ZARC. The p-values suggested that the mean squared error were less statistically different from the USD/SADC dollar and USD/ZARC. This made intuitive sense as both fictitious nominal exchange rates have been modeled on foreign currency indices. This suggests that under approach two, the USD/SADCdollar, as was expected, has a lower mean

squared error or volatility estimate in relation to USD/ZAR. This lower volatility estimate of the USD/SADC dollar has the following implications:

- A lower volatility estimate for an exchange rate series implies that investors can move in and out of currency futures hedged positions with less basis spread risk and consequently losing less on bad hedges.
- Investors have less difficulty forecasting the USD/SADC dollar nominal exchange rate in comparison to forecasting the USD/ZARN or USD/ZARC.
- Similar to approach one when the normality assumption is removed.

Regardless of using approach one or two, volatility/currency risk estimates of the USD/SADC dollar declined causing the basis spread to decline over a time-series analysis. This may allow interim traders trading on the basis spread to move in and out of currency futures positions at generally a lower risk when hedging the SADC dollar as opposed to hedging the ZAR. Futures traders also have less interest rate risk when hedging using the USD/SADC dollar as investors or foreign currency risk managers could fix the interest rate differential when quarterly futures contract are entered into.

Other management implications that may be highlighted here are that investors can use the SADC currency index to consider the competitiveness of this region in relation to other indices. This may entice speculators into the SADC market, which may have the following advantages.

- More market participants, greater capital availability by corporations in the region with growing efficient financial markets and systems.
- It may encourage speculators to take futures positions on the SADC index by analyzing each of the component countries indices (Z_{it}) and making arbitrage profits.
- It may also lastly lead to greater currency and futures liquidity

6.5 RECOMMENDATIONS FOR FURTHER STUDY

The factors listed below may be considered for future research:

- Determining the role of the central bank discount rate on other yields in the pricing of currency futures in both developed and emerging markets.
- Considering alternate weighting schemes for computation of the SADC dollar which has not been considered in this study.
- The compounding currency futures formula can be used to compute the basis spread and basis risk spread. When consulting market participants this was not the approach used in practice.
- Regression analysis can be applied using the ZAR, SADC region as the dependent variables and then using all the relevant variables that may cause these currencies to change over time as the independent variables. Regressions can provide the weights of these variables in a new SADC index.
- Recalculation of the basis spread and basis spread risk with the exclusion of Angola may be considered.
- This new currency index was only recently introduced by the JSE. It thus serves as a recommendation for further research to calculate the SADC currency index in a similar computational approach to that of RAIN.
- Recalculation of currency futures prices and F-statistics using compound interest in as opposed to simple interest.
- Considering hedging the euro/ZAR, euro/SADC, pound/ZAR and the pound/SADC exchange rates and comparing the basis spread risk.
- Use fixed weights to calculate the ZAR and SADC currency index and include the Balance of Payments of each country as a contributing factor to this weight.
- Remove imports and exports from the GDP weighting factors as the foreign currency index already comprises of import and export weights which results in biases. Calculation of futures prices on the SADC foreign currency index with underlying futures prices on each individual currency comprising this index. Simultaneously, calculating the basis risks over time from these positions.

6.6 CONCLUSION

The purpose of this study was to shed light on the basis spread risk alterations in currency futures hedged positions. These alterations in basis spread risks were the eventual outcome

of investors using currency futures to hedge or trade a fictitious USD/SADC dollar nominal exchange rate opposed to the USD/ZAR traded in the foreign exchange market.

The introduction and implementation of the USD/euro exchange rate seems to imply benefits for the companies of the EMU. Benefits include higher firm valuations, cross-border mergers and the development of totally new financial markets with financial systems. This research has shown that there are some benefits for companies in SADC such as better business management decisions, increased profit margins, increased investments by banks, increased cross-border mergers of companies and more effective hedged positions for intra-traders in the ZAR and SADC market which is a similar situation experienced by EMU countries.

While there are still structural, macro-economic and financial system constraints hindering the implementation of a common currency, policy makers have set their sights on a SADC common currency by 2028. Not to delay the inevitable implementation of a common currency for the SADC region set by policy makers. This research has shown that despite these constraints, a fictitious financial currency unit traded between the SADC member countries may provide significant reductions in hedged positions for institutional investors.

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APPENDIX A: RAIN CONTRACTSPECIFICATIONS

Name	Currency Derivatives
Contract	Rand Currency Index Futures Contract (RAIN)
Underlying Instrument	RAIN Index = the sum of 6 Euro + 3 US Dollar + 3 Chinese Yuan + 1 British pound + 2 Japanese Yen futures contracts, divided by 10
Codes	e.g. Dec 10 RAIN
Contract Months	Mar, Jun , Sep & Dec
Listing Program	Near, middle and far contracts Specials on demand
Expiry Dates & Times	At 10H00 New York time (i.e. 16H00 in SA winter and 17H00 in SA summer) two business days prior to the 3 rd Wednesday of the expiry month (or the previous business day if close-out day is a public holiday)
Expiration Valuation Method	30 iterations, Arithmetic average of the underlying spot taken every 1 minute for a period of 30 minutes, ending at 10H00 New York time. (SA Summer: 16H31 – 17H00 and SA Winter: 15H31 – 16H00)
Contract Size	R10 times nominal
Quotations	Index point to two decimals
Minimum Price Movement	0.01 (R0.10)
Settlement	Cash settlement of 6 x 1,000 Euros; 3 x 1,000 US Dollars; 3 x 10,000 Chinese Yuan; 1 x 1,000 British Pounds and 2 x 100,000 Japanese Yen, in ZAR
Initial Margin Requirements	As determined by JSE Portfolio Scanning Methodology
Mark-to-market	Explicit Daily The forward value of the arithmetic average of the traded underlying taken for a 5 minute period between 16h55 and 17h00
Exchange Fees	As determined by the Exchange. Refer to the fee structure on the JSE website: http://www.jse.co.za/Markets/Currency-Derivatives-Market/Currency-Derivatives-Fees
Market times	As determined by Yield-X (9 am - 5 pm) The JSE will extend the closing market times by 30 minutes on the expiry days that fall in the SA winter time.

Source: JSE (n.d.c)

**APPENDIX B:
THE FIVE PROPOSED ECONOMIC COMMUNITIES IN AFRICA**

Map 1 Building blocks for monetary union

The African Union's plan for an African-wide monetary union relies on the prior creation of monetary unions in five existing regional economic communities.



Source: Masson and Patillo (2004:10)

**APPENDIX C:
DIAGRAMMATIC REPRESENTATION
OF RESEARCH DESIGN**

Currency futures prices:

Countries outside SADC as the underlying currency

South African Rand as the underlying currency

SADC dollar from a currency basket as the underlying currency

Euro index

Dollar index

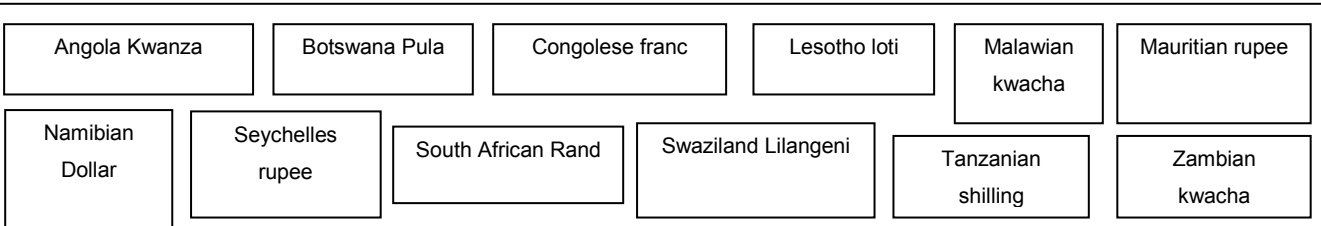
Pound index

South African Rand index

Repeat steps 1 and 2 to provide the foundation for comparison of foreign indices with SADC index.

Repeat steps 1 and 2 to provide the foundation for comparison of ZAR index with SADC index.

$$=ABS [f_0(T) - S_{SADC-D}(T)]$$



For each of the above countries the following is computed:

Step 1:

Obtain the nominal exchange rates for each country in the SADC.

S_{ijt} = Express these nominal exchange rates of country i relative to country j at time t in an index form. The base year = 2005.

Step 2:

Obtain the major trading partners with country i and **normalise their weights** reason: $\sum_j^n < 1$.

$$p^{x/m}_{ijt} = w_j / \sum_j^n w_{jt}$$

Trade-weighted average:

$w_{ijt} = (X_{ijt} + M_{ijt}) / TT_{it}$, where

$$X_{ijt} = p^x_{ijt} * \sum_i^n X_{it};$$

$$M_{ijt} = p^m_{ijt} * \sum_i^n M_{it}$$

and

$$TT_{it} = \sum_i^n X_{ijt} + \sum_i^n M_{ijt}$$

Calculate the NEER

index_{it}:

$$NEER_{it} (N_{it}) = \sum_i^n S_{ijt} * w_{ijt}$$

Step 3:

Index the NEER due to the effect of different exchange rates.

Weight index of each country in terms of:

$$g_{it} = (GDP_{it} - [X_{it} - M_{it}]) / (\sum_i^n GDP_{it} - [\sum_i^n X_{it} - \sum_i^n M_{it}]), \text{ Reason:}$$

$$GDP_{it} = C_{it} + I_{it} G_{it} + (X_{it} - M_{it})$$

Thus each country's index in SADC:

$$Z_t = \sum_i^n N_{it} * g_{it} = (\sum_i^n S_{ijt} * w_{ijt}) * g_{it}$$

Calculate Futures prices of USD/ZAR and other currencies relative to SADC-d using simple and compound interest

$$f_0(T) = [S_{ijt} * (1 + r_d)^T] / (1 + r_f)^T$$

$$f_0(T) = (S_{ijt} e^{-r_d T}) e^{r_f T}$$

Calculate Futures prices of USD/S_{SADC-D} using simple and compound

$$f_0(T) = [S_{SADC-D} * (1 + r_d(SADC))^T] / (1 + r_f)^T$$

$$f_0(T) = (S_{SADC-D} e^{-r_d T}) e^{r_f T}$$

$$R_d(SADC)_t = \sum_j^n CB_{it} * g_{it}$$

- T = 3, 6, 9 and 12 month futures prices
- Nominal Spot exchange rate indices on a monthly basis.

Basis spread

$$=ABS [f_0(T) - S_{ijt}(T)]$$

$$\sigma^2_{F-SADC-D} = \sigma^2_F + \sigma^2_{SADC-D} - 2 \sigma^2_{F,SADC-D}$$

(Basis risk is computed from an absolute basis spread)

$$\sigma^2_{F-S} = \sigma^2_F + \sigma^2_S - 2 \sigma^2_{F,S}$$

(Basis risk is computed from an absolute basis spread)

Basis risk spread
(Using GARCH model for short and long range volatility)

Compare and identify variables

Complemented by

Complemented by

**APPENDIX D:
BASIS SPREAD AND BASIS SPREAD RISK OF THE
USD/ZARN**

Date	H ₃ - S ₀	H ₃ - S ₁	H ₃ - S ₂	H ₃ - S ₃	H ₃ - S ₄	H ₃ - S ₅	H ₃ - S ₆	H ₃ - S ₇	H ₃ - S ₈	H ₃ - S ₉	H ₃ - S ₁₀	H ₃ - S ₁₁	H ₃ - S ₁₂	ZAR S/D	ZAR S/D	ZAR S/D	ZAR S/D
2001-3 month	0.25	0.41	0.33	0.66										0.18			
2001-6 month	0.06	0.22	0.14	0.47	0.41	0.43	0.48								0.17		
2001-9 month	0.57	0.73	0.66	0.98	1.17	1.33	1.96	1.17	1.33	1.96						0.49	
2001-12 month	0.32	0.16	0.24	0.09	0.03	0.06	0.10	0.28	0.44	1.06	1.47	2.32	3.60				1.09
2002-3 month	0.19	0.30	0.30	0.41										0.09			
2002-6 month	0.02	0.14	0.14	0.25	0.97	1.86	1.22								0.70		
2002-9 month	0.91	1.02	1.03	1.13	1.86	2.75	2.10	2.31	1.96	1.91						0.63	
2002-12 month	1.27	1.38	1.38	1.49	2.21	3.11	2.46	2.66	2.31	2.26	2.73	3.55	3.88				0.84
2003-3 month	1.46	1.18	0.81	0.57										0.40			
2003-6 month	0.02	0.30	0.67	0.92	1.32	1.35	1.11								0.51		
2003-9 month	0.41	0.69	1.06	1.31	1.70	1.74	1.50	1.82	1.98	2.03						0.55	
2003-12 month	0.58	0.86	1.23	1.48	1.87	1.91	1.67	1.99	2.15	2.20	2.55	2.81	2.99				0.71
2004-3 month	0.06	0.31	0.16	0.03										0.12			
2004-6 month	0.18	0.19	0.04	0.09	0.20	0.09	0.29								0.08		
2004-9 month	0.29	0.08	0.07	0.20	0.31	0.02	0.40	0.71	0.38	0.29						0.20	
2004-12 month	0.50	0.13	0.27	0.40	0.52	0.23	0.61	0.92	0.59	0.50	0.65	1.00	1.30				0.33
2005-3 month	0.03	0.27	0.14	0.61										0.25			
2005-6 month	0.05	0.19	0.06	0.53	0.33	0.89	0.91								0.37		
2005-9 month	0.05	0.19	0.06	0.53	0.33	0.89	0.91	0.82	0.78	0.59						0.34	
2005-12 month	0.23	0.00	0.13	0.34	0.14	0.70	0.72	0.63	0.59	0.41	0.76	0.57	0.41				0.25
2006-3 month	0.12	0.16	0.15	0.01										0.07			
2006-6 month	0.01	0.29	0.27	0.13	0.30	0.03	0.57								0.19		
2006-9 month	0.14	0.42	0.41	0.27	0.44	0.17	0.44	0.56	0.43	0.89						0.21	
2006-12 month	0.28	0.56	0.54	0.40	0.57	0.31	0.30	0.43	0.29	0.75	0.95	0.59	0.39				0.20

**APPENDIX E:
BASIS SPREAD AND BASIS SPREAD RISK OF THE
USD/SADC dollar**

Date	H ₃ - S ₀	H ₃ - S ₁	H ₃ -S ₂	H ₃ - S ₃	H ₃ - S ₄	H ₃ - S ₅	H ₃ - S ₆	H ₃ - S ₇	H ₃ - S ₈	H ₃ - S ₉	H ₃ - S ₁₀	H ₃ - S ₁₁	H ₃ - S ₁₂	ZAR S/D	ZAR S/D	ZAR S/D	ZAR S/D
2001-3 month	0.21	0.37	0.48	1.01										0.35			
2001-6 month	0.47	0.31	0.20	0.33	0.14	0.28	0.35								0.11		
2001-9 month	0.35	0.50	0.62	1.15	1.08	0.81	0.99	1.08	0.81	0.99						0.27	
2001-12 month	1.82	1.66	1.55	1.02	1.21	1.07	1.00	1.08	1.36	1.18	1.03	0.77	0.47				0.36
2002-3 month	0.67	0.49	0.45	0.55										0.09			
2002-6 month	0.04	0.14	0.18	0.09	0.34	0.78	1.06								0.39		
2002-9 month	2.52	2.34	2.30	2.40	2.83	3.26	3.54	3.43	3.42	3.29						0.51	
2002-12 month	3.43	3.25	3.21	3.31	3.74	4.17	4.45	4.34	4.33	4.20	4.30	4.47	4.79				0.54
2003-3 month	2.20	1.90	1.82	1.76										0.20			
2003-6 month	0.40	0.70	0.78	0.85	1.12	1.51	1.43								0.40		
2003-9 month	1.80	2.10	2.18	2.24	2.52	2.90	2.82	2.70	2.65	3.08						0.41	
2003-12 month	2.45	2.75	2.83	2.89	3.17	3.55	3.48	3.35	3.30	3.74	3.93	4.10	4.39				0.57
2004-3 month	0.34	0.24	0.24	0.26										0.05			
2004-6 month	0.80	0.69	0.69	0.72	0.43	0.50	0.55								0.13		
2004-9 month	1.24	1.14	1.14	1.16	0.87	0.94	1.00	1.01	1.00	1.16						0.12	
2004-12 month	1.16	1.05	1.05	1.08	0.79	0.86	0.91	0.93	0.92	1.07	1.43	1.75	1.87				0.34
2005-3 month	0.21	0.04	0.02	0.14										0.09			
2005-6 month	0.66	0.41	0.47	0.32	0.30	0.03	0.08								0.22		
2005-9 month	0.92	0.67	0.73	0.58	0.56	0.29	0.18	0.16	0.30	0.28						0.26	
2005-12 month	1.62	1.37	1.43	1.28	1.27	1.00	0.88	0.87	1.00	0.98	0.89	0.73	0.83				0.27
2006-3 month	0.21	0.02	0.08	0.11										0.08			
2006-6 month	0.08	0.28	0.21	0.19	0.58	0.66	0.37								0.21		
2006-9 month	0.41	0.60	0.54	0.51	0.90	0.98	0.70	0.76	0.84	0.70						0.18	
2006-12 month	0.74	0.93	0.86	0.84	1.23	1.31	1.03	1.08	1.16	1.02	1.01	1.19	1.11				0.17

**APPENDIX F:
USD/ZARN HEDGED POSITION VOLATILITY vs.SADC DOLLAR HEDGED
POSITON VOLATILITY**

Date	2002-3 month	2002-6 month	2002-9 month	2002-12 month	2003-3 month	2003-6 month	2003-9 month	2003-12 month	2004-3 month
n	4	7	10	13	4	7	10	13	4
SADC dollar									
S	0.09	0.39	0.51	0.54	0.2	0.4	0.41	0.57	0.05
S ²	0.01	0.15	0.26	0.29	0.04	0.16	0.17	0.32	0.00
ZAR									
S	0.090	0.700	0.630	0.840	0.400	0.510	0.550	0.710	0.120
S ²	0.008	0.490	0.397	0.706	0.160	0.260	0.303	0.504	0.014
F-stat	1.00	3.22	1.53	2.42	4.00	1.63	1.80	1.55	5.76
P-value	0.50	0.09	0.27	0.07	0.14	0.28	0.20	0.23	0.09
Significant	-	-	-	-	-	-	-	-	-

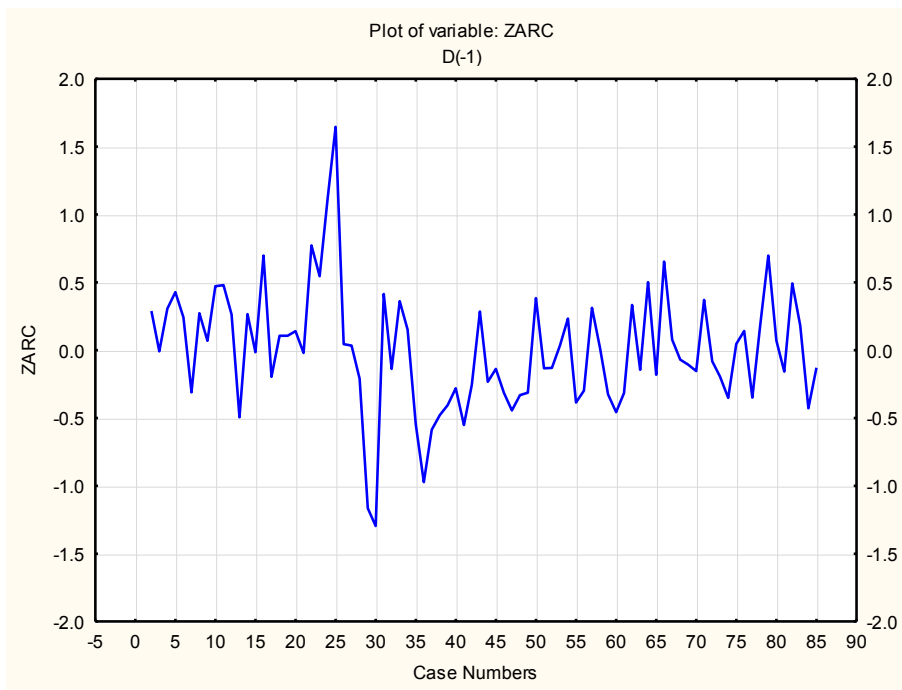
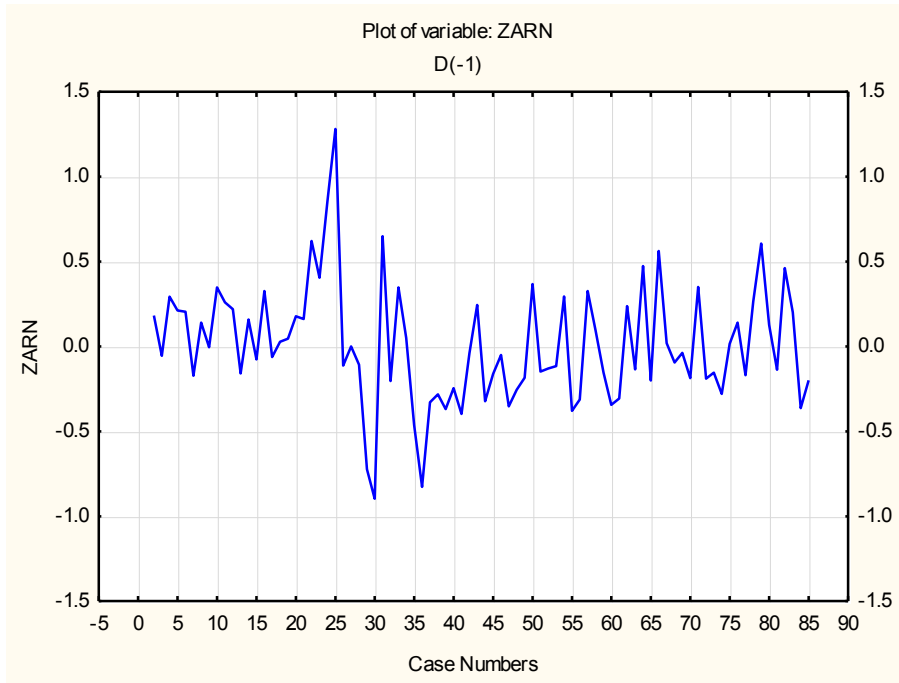
Date	2004-6 month	2004-9 month	2004-12 month	2005-3 month	2005-6 month	2005-9 month	2005-12 month	2006-3 month	2006-6 month	2006-9 month	2006-12 month
N	7	10	13	4	7	10	13	4	7	10	13
SADC dollar											
S	0.13	0.12	0.34	0.09	0.22	0.26	0.27	0.08	0.21	0.18	0.17
S ²	0.02	0.01	0.12	0.01	0.05	0.07	0.07	0.01	0.04	0.03	0.03
ZARN											
S	0.080	0.200	0.330	0.250	0.370	0.340	0.250	0.070	0.190	0.210	0.200
S ²	0.006	0.040	0.109	0.063	0.137	0.116	0.063	0.005	0.036	0.044	0.040
F-stat	2.64	2.78	1.06	7.72	2.83	1.71	1.17	1.31	1.22	1.36	1.38
P-value	0.13	0.07	0.46	0.06	0.12	0.22	0.40	0.42	0.41	0.33	0.29
Significant	-	-	-	-	-	-	-	-	-	-	-

**APPENDIX G:
THE BASIS SPREAD RISK BETWEEN USD/ZARC AND USD/SADC DOLLAR**

Date	2000-3 month	2000-6 month	2000-9 month	2000-12 month	2001-3 month	2001-6 month	2001-9 month	2001-12 month	2002-3 month	2002-6 month	2002-9 month	2002-12 month	2003-3 month	2003-6 month	2003-9 month	2003-12 month
n	4	7	10	13	4	7	10	13	4	7	10	13	4	7	10	13
SADCR																
S	0.143	0.14	0.345	0.452	0.346	0.126	0.271	0.364	0.094	0.393	0.506	0.539	0.195	0.401	0.408	0.568
S2	0.02	0.02	0.12	0.20	0.12	0.02	0.07	0.13	0.01	0.15	0.26	0.29	0.04	0.16	0.17	0.32
R																
S	0.240	0.462	0.504	0.683	0.407	0.395	0.632	1.417	0.093	1.131	1.098	1.328	0.506	0.721	0.766	1.012
S2	0.058	0.213	0.254	0.466	0.165	0.156	0.400	2.009	0.009	1.279	1.206	1.763	0.256	0.520	0.586	1.024
SADCR vs.R																
F=	2.81	10.16	2.14	2.28	1.38	9.84	5.42	15.16	1.03	8.29	4.71	6.06	6.72	3.24	3.53	3.17
p-value	0.21	0.01	0.14	0.08	0.40	0.01	0.01	0.00	0.49	0.01	0.02	0.00	0.08	0.09	0.04	0.03
significant		1				1	1	1		1	1	1			1	1

Date	2004-3 month	2004-6 month	2004-9 month	2004-12 month	2005-3 month	2005-6 month	2005-9 month	2005-12 month	2006-3 month	2006-6 month	2006-9 month	2006-12 month
n	4	7	10	13	4	7	10	13	4	7	10	13
SADCR												
S	0.049	0.212	0.116	0.336	0.079	0.133	0.259	0.275	0.080	0.211	0.182	0.166
S2	0.00	0.05	0.01	0.11	0.01	0.02	0.07	0.08	0.01	0.04	0.03	0.03
R												
S	0.134	0.088	0.150	0.428	0.292	0.458	0.441	0.381	0.080	0.159	0.182	0.241
S2	0.018	0.008	0.023	0.183	0.085	0.210	0.194	0.145	0.006	0.025	0.033	0.058
SADCR vs.R												
F=	7.50	5.81	1.66	1.62	13.52	11.76	2.90	1.92	1.00	1.76	1.00	2.11
p-value	0.07	0.03	0.23	0.21	0.03	0.00	0.06	0.14	0.50	0.25	0.50	0.11
significant		1			1	1						

**APPENDIX H:
STATIONARY TIME SERIES, ARCH AND GARCH MODELS ON RESIDUALS**



Dependent Variable: D(ZARC)
 Method: ML - ARCH
 Date: 03/08/11 Time: 22:36
 Sample (adjusted): 2000M02 2006M12
 Included observations: 83 after adjustments
 Convergence achieved after 12 iterations
 Presample variance: backcast (parameter = 0.7)
 GARCH = C(2) + C(3)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	0.288270	0.132446	2.176504	0.0295
Variance Equation				
C	0.134532	0.027196	4.946759	0.0000
RESID(-1)^2	0.203200	0.155658	1.305421	0.1917
R-squared	0.128998	Mean dependent var		-0.001730
Adjusted R-squared	0.128998	S.D. dependent var		0.450709
S.E. of regression	0.420635	Akaike info criterion		1.101968
Sum squared resid	14.50860	Schwarz criterion		1.189396
Log likelihood	-42.73167	Hannan-Quinn criter.		1.137092
Durbin-Watson stat	1.867927			
Inverted AR Roots	.29			

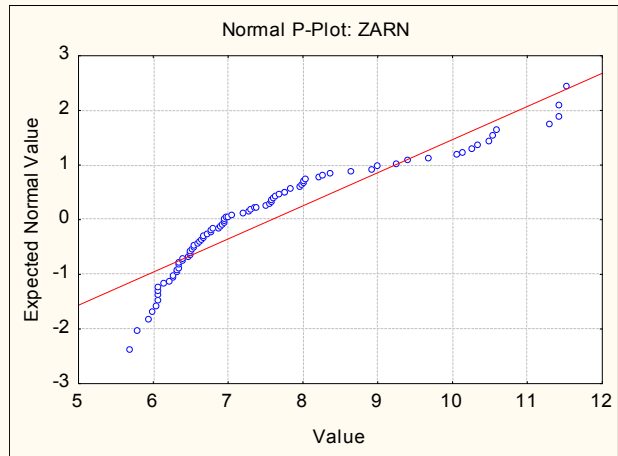
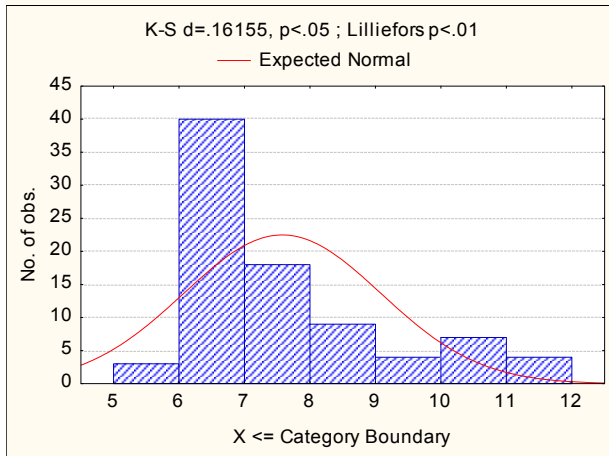
No significant ARCH, p = 0.1917

Dependent Variable: D(ZARN)
 Method: ML - ARCH
 Date: 03/08/11 Time: 22:39
 Sample (adjusted): 2000M02 2006M12
 Included observations: 83 after adjustments
 Convergence achieved after 13 iterations
 Presample variance: backcast (parameter = 0.7)
 GARCH = C(2) + C(3)*RESID(-1)^2

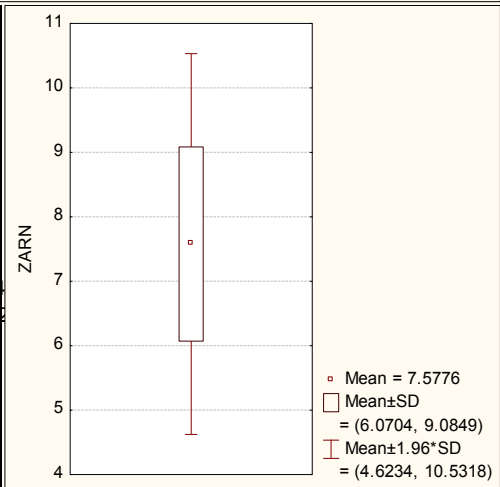
Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	0.148837	0.138737	1.072798	0.2834
Variance Equation				
C	0.074242	0.018415	4.031545	0.0001
RESID(-1)^2	0.345550	0.195390	1.768514	0.0770
R-squared	0.052569	Mean dependent var		0.008342
Adjusted R-squared	0.052569	S.D. dependent var		0.352209
S.E. of regression	0.342827	Akaike info criterion		0.644974
Sum squared resid	9.637476	Schwarz criterion		0.732402
Log likelihood	-23.76643	Hannan-Quinn criter.		0.680098
Durbin-Watson stat	1.814085			
Inverted AR Roots	.15			

No significant ARCH, p = 0.0770

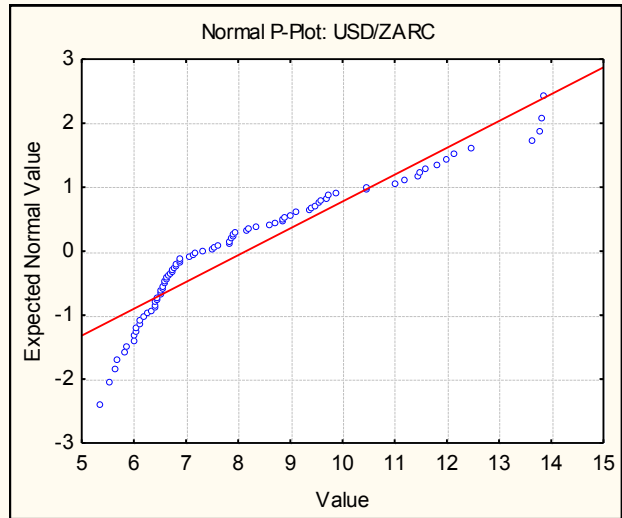
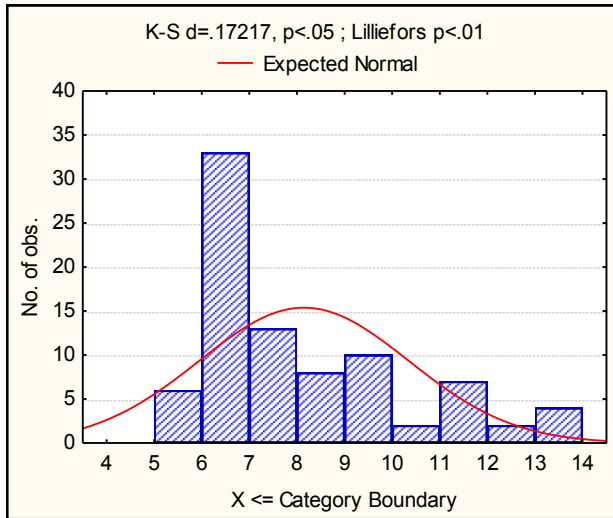
Summary: ZARN



Summary Statistics:ZARN	
Valid N=85	Lower Quartile= 6.516075
% Valid obs.=100.000000	Upper Quartile= 8.040700
Mean= 7.577639	Percentile 10.00000= 6.098800
Confidence -95.000%= 7.252533	Percentile 90.00000= 10.270000
Confidence 95.000= 7.902745	Range= 5.837200
Trimmed mean 5.0000%= 7.465465	Quartile Range= 1.524625
Winsorized mean 5.0000%= 7.547619	Variance= 2.271799
Grubbs Test Statistic= 2.635969	Std.Dev.= 1.507249
p-value= 0.615494	Confidence SD -95.000%= 1.309754
Geometric Mean= 7.446141	Confidence SD +95.000%= 1.775432
Harmonic Mean= 7.330154	Coef.Var.= 19.890743
Median= 6.995000	Standard Error= 0.163484
Mode= 1.000000	Skew ness= 1.206152
Frequency of Mode= 2.000000	Std.Err. Skew ness= 0.261153
Sum=644.099310	Kurtosis= 0.547017
Minimum= 5.713500	Std.Err. Kurtosis= 0.516756



Summary: USD/ZARC



Summary Statistics:USD/ZARC

Valid N=85	Lower Quartile= 6.529894
% Valid obs.=100.000000	Upper Quartile= 9.408414
Mean= 8.147192	Percentile 10.00000= 6.049531
Confidence -95.000%= 7.671764	Percentile 90.00000= 11.619390
Confidence 95.000= 8.622619	Range= 8.519225
Trimmed mean 5.0000%= 7.987668	Quartile Range= 2.878520
Winsorized mean 5.0000%= 8.099411	Variance= 4.858342
Grubbs Test Statistic= 2.600020	Std.Dev.= 2.204165
p-value= 0.689651	Confidence SD -95.000%= 1.914
Geometric Mean= 7.887759	Confidence SD +95.000%= 2.59
Harmonic Mean= 7.662622	Coef.Var.= 27.054289
Median= 7.319661	Standard Error= 0.239075
Mode= 1.000000	Skewness= 1.071978
Frequency of Mode= 1.000000	Std.Err. Skewness= 0.261153
Sum=692.511285	Kurtosis= 0.282049
Minimum= 5.358839	Std.Err. Kurtosis= 0.516756
Maximum= 13.878064	

