

EXCHANGE RATE VOLATILITY: AN ANALYTICAL RISK MODEL

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ABSTRACT

Risk management is a paramount topic in the financial sector, following major financial losses from the 1990s onwards. Financial markets are undergoing tremendous change driven by globalisation, advances in technology, mergers and acquisitions and a constantly changing political environment. The resulting competitive and challenging environment makes it imperative that all financial players understand the risks they are facing and have effective analysis and control measures in place to deal with these risks.

Exchange rate risk or currency risk is the risk that a business' operations or an investment's value will be affected by changes in exchange rates. By having a better understanding of the factors that determine and influence a country's currency, it becomes possible to foresee potential fluctuations in a currency's external value. A model to predict the exchange rate risk can be invaluable for international corporations in the evaluation and planning of proposed projects. However, many authors maintain that there is no reliable method available to forecast exchange rates or exchange rate risk.

Due to the continuing international move towards globalisation, emerging markets of the world, of which SA is one, are ever more dependant on the value of their currencies relative to the currencies of their major trading partners. At present the South African Rand floats against the major world currencies since the partial abolition of exchange rate controls, especially those applicable to non-residents. This makes the Rand more vulnerable to fluctuations in the world economy.

The purpose of the study is to develop a model for the analytical assessment of exchange rate risk and volatility for the South African Rand(ZAR) versus the United States Dollar (USD). First a literature study is presented which include a discussion on exchange rates, exchange rate risk and the determinants of demand and supply of foreign currencies. Exchange rate prediction and risk models from the literature are briefly explained and evaluated. An overview of the unique factors contributing to exchange rate volatility and risk in the South African economy is provided.

The monetary model is used for developing the empirical functions for the prediction of the ZAR / USD exchange rate. Multiple regression analysis is applied in developing the different functions. The analysis indicates that the ZAR / USD exchange rate increases when the SA monetary authorities' discipline is deteriorating in comparisons with its US counterpart. Economic growth, as measured by Gross Domestic Product (GDP), can lead to an appreciation of the ZAR compared to the USD, should the domestic expansion of GDP exceed that of the US. Rising inflation rates in SA also lead to an increase in the exchange rate due to rising domestic prices. An exchange rate risk model is developed based on fiscal policy stance, opening or closing of trade regimes and levels of foreign currency reserves relative to GDP. These variables are the explanatory forces behind the volatility of South Africa's exchange rate and are labelled exchange rate risk factors.

Increases in the M3 money supply and GDP levels have the most pronounced effect on volatility of the ZAR versus USD. While the M3 money supply present a depreciation risk, an increase in the domestic GDP level present an appreciation risk for the ZAR / USD exchange rate. Openness of the economy as portrayed by the ratio of imports and exports to GDP as well as inflation and national debt levels, presenting a dimension of fiscal policy stance, have a relative large effect on the volatility of the exchange rate. Increases in the domestic levels of all three these variables present depreciation risks. Fluctuations in the domestic foreign reserve level had only a small impact on the exchange rate.

The exchange rate prediction and risk models developed can be used in conjunction for forecasting and risk analysis purposes.

WISSELKOERS VOLATILITEIT: 'N ANALITIESE RISIKO MODEL

OPSOMMING

Risikobestuur is 'n kontemporêre onderwerp in die finansiële sektor nadat daar die afgelope paar jaar groot verliese gelei is. Finansiële markte ondergaan geweldige veranderinge wat deur globalisasie, tegnologiese ontwikkeling, samesmeltings en oornames asook politiese verandering gedryf word. Die gevolg is 'n uiters kompeterende en dinamiese omgewing wat alle finansiële rolspelers noodsaak om risikos te begryp, analiseer en kontroles in plek te stel om hierdie risikos te bestuur.

Wisselkoersrisiko is die risiko dat 'n onderneming se bedrywighede of 'n belegging se waarde beïnvloed sal word deur verandering van die wisselkoers. Met begrip van die faktore wat die waarde van 'n land se geldeenheid bepaal, word dit moontlik om volatilitéit in die eksterne waarde van 'n geldeenheid te voorspel. 'n Model vir die voorspelling van wisselkoersrisiko kan uiters waardevol wees vir internasionale ondernemings in die analisering en oorweging van voorgenome projekte. Skrywers van finansiële literatuur is egter steeds van mening dat daar geen betroubare metodes beskikbaar is vir die voorspelling van die wisselkoers of wisselkoersrisiko nie.

As gevolg van volgehoue globalisasie, is ontwikkelende lande van die wêreld, waaronder ook Suid-Afrika, uiters afhanklik van die waarde van hul geldeenheid in terme van dié van hul handelsgenote. Die waarde van die Suid-Afrikaanse Rand fluktureer na aanleiding van vraag en aanbod, na die gedeeltelike afskaffing van wisselkoers beheermaatreëls, veral maatreëls van toepassing op nie-inwoners. Hierdie fluktuasie in die waarde van die Rand maak die Suid-Afrikaanse geldeenheid kwesbaar vir veranderings in die wêreld ekonomie.

Die doel van die studie is die ontwikkeling van 'n model vir die voorspelling en analisering van wisselkoersrisiko, in die besonder die volatilitéit in die Suid-Afrikaanse Rand teenoor die Verenigde State Dollar (ZAR / USD) wisselkoers. Eerstens is 'n literatuurstudie uitgevoer wat 'n bespreking van wisselkoerse, wisselkoersrisiko en die faktore wat vraag en aanbod na buitelandse valuta bepaal insluit. Modelle uit die literatuur vir die

voorspelling van wisselkoerse en wisselkoersrisiko word kortliks bespreek. 'n Oorsig van die unieke faktore wat 'n impak het op die Suid-Afrikaanse ekonomie is verskaf.

Die wisselkoersvoorspellingsmodel is gebaseer op die monetêre model. Empiriese funksies is geformuleer deur gebruik te maak van veelvuldige regressie-analise. Die ZAR / USD wisselkoers styg met verslapping van monetêre disipline relatief tot die VSA. Ekonomiese groei, soos gemeet in terme van bruto binnelandse produk (BBP), kan lei tot appresiasie van die Rand, mits die groei in die Suid-Afrikaanse BBP die van die VSA oorskry. Stygende inflasiekoerse lei tot depresiasie van die Rand a.g.v. prysstygings.

'n Model vir die voorspelling van wisselkoersrisiko is ontwikkel gebaseer op fiskale beleid, toeganklikheid van die ekonomie vir handel en die beskikbare vlakke van buitelandse valuta reserwes relatief tot BBP. Hierdie veranderlikes is geïdentifiseer as die dryfkragte van volatiliteit in die waarde van die ZAR teenoor die geldeenheid van die Verenigde State.

Stygings in die vlakke van die M3-geldvoorraad en reële BBP het die grootste invloed op volatiliteit van die ZAR / USD wisselkoers. Stygings in die Suid-Afrikaanse M3-geldvoorraad verteenwoordig 'n risiko vir depresiasie terwyl styging in die BBP 'n appresiasie risiko verteenwoordig. Toeganklikheid van die ekonomie, soos verteenwoordig deur die verhouding van in- en uitvoere tot BBP, sowel as inflasie en fiskale beleid, verteenwoordig deur die verhouding van nasionale skuld tot BBP, het 'n relatiewe groot uitwerking op die volatiliteit van die ZAR / USD wisselkoers. Stygings in die vlakke van hierdie Suid-Afrikaanse veranderlikes lei tot depresiasie van die Rand teenoor die Dollar. Verandering in die beskikbare Suid-Afrikaanse vlakke van buitelandse valuta reserwes het slegs 'n klein depresiasie effek gehad op die wisselkoers.

Die wisselkoersvoorspellings- en risikomodelle kan tesame gebruik word vir beplanning en risiko analise.

GLOSSARY

Current account balance is the sum of net trade (exports minus imports) in goods, services and income plus net current transfers. The current account balance excludes net official capital transfers.

Exchange rate:

- **Effective Exchange Rate** - expresses the value of the Rand relative to a basket of important foreign currencies, mostly those of the main trading partners of the country. It is a kind of average exchange rate and as such, less sensitive to disturbances in a single country.
- **Real Exchange Rate** – an adjusted exchange rate that take differences between countries' price level and inflation rates into account. Calculated as the nominal exchange rate multiplied by the price ratio (terms of trade).
- **Spot Exchange Rate** – the conventional rate that is determined daily for immediate trade in foreign currencies.
- **Forward Exchange Rate** – the agreed-upon exchange rate today for a transaction taking place in the future.

Exports of goods and services — the value of all goods and other market services provided to the rest of the world, including merchandise, freight, insurance, transport, travel, royalties, license fees and other nonfactor services. Labor and property income (formerly called factor services) is excluded, as are transfer payments. (World Bank, Organisation for Economic Co-operation and Development, United Nations)

Foreign direct investment — net inflows of investment to acquire a lasting management interest (10 per cent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital and short-term capital as shown in the balance of payments. (World Bank, International Monetary Fund)

GDP (gross domestic product) — the gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. (World Bank, Organisation for Economic Co-operation and Development, United Nations)

GDP growth — the one-year rate of growth in real gross domestic product. (World Bank, Organisation for Economic Co-operation and Development, United Nations)

GDP implicit price deflator — the one-year rate of price changes in the economy as a whole. (World Bank, Organisation for Economic Co-operation and Development, United Nations)

GNI (gross national income—formerly gross national product or GNP) — GDP [the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output] plus net receipts of primary income (employee compensation and property income) from abroad. (World Bank)

GNI per capita (gross national income per capita—formerly gross national product per capita or GNP per capita) — gross national income divided by midyear population. (World Bank) **GNI per capita** is the gross national income (GNI) in current U.S. dollars as divided by the mid-year population. **GNI** measures the total domestic and foreign income claimed by the residents of the economy. It comprises GDP plus net factor income from abroad, which is the income residents receive from abroad for factor services (labor and capital) less similar payments made to non-residents who contributed to the domestic production. GNI in U.S. dollars is calculated according to the World Bank Atlas method of conversion from national currency to U.S. dollar terms.

The Atlas conversion factor for any year is the average of the country's exchange rate for that year and those for the two preceding years, adjusted for differences in relative inflation between the country and the G-5 countries (France, Germany, Japan, the United Kingdom, and the United States). This three-year average smoothes fluctuation in prices and exchange rates for each country.

Gross capital formation (formerly gross domestic investment) — outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including commercial and industrial buildings, offices, schools, hospitals, and private residential dwellings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." (World Bank, Organisation for Economic Co-operation and Development, United Nations)

Implicit GDP deflator is the ratio of GDP in current prices to GDP in constant prices.

Imports of goods and services — the value of all goods and other market services received from the rest of the world, including merchandise, freight, insurance, transport, travel, royalties, license fees, and other nonfactor services. Labor and property income (formerly called factor services) is excluded, as are transfer payments. (World Bank, Organisation for Economic Co-operation and Development(OECD), United Nations)

Long-Term Trends - Growth rates are computed from time series' expressed in constant local prices. Long-term average growth rates are calculated using the least-squares method.

Overall budget deficit — current and capital revenue and official grants received, less total expenditure and lending minus repayments. (International Monetary Fund)

Overall surplus/deficit is current and capital revenue and official grants received, less total expenditure and lending minus repayments.

Present value of debt —is the discounted sum of all debt service payments due over the life of existing loans. The discount rates used are the interest rates charged by the OECD countries for officially supported export credits. The rates are specified for G7 currencies -- British pounds, Canadian dollars, French francs, German marks, Italian lire, Japanese yen, and U.S. dollars. For debt denominated in other currencies, discount rates are the average of interest rates on export credits charged by other OECD countries. Exports include goods, services, income and workers' remittances.

Changes in net reserves are the net change in a country's holdings of international reserves resulting from transactions on the current, capital and financial accounts. These include changes in holdings of monetary gold, foreign exchange assets, reserve position in the International Monetary Fund and other claims on nonresidents that are available to the central authority. The measure is net of liabilities constituting foreign authorities' reserves and counterpart items for valuation of changes and exceptional financing items.

Reserves including gold comprise holdings of monetary gold, special drawing rights, the reserve position of members in the International Monetary Fund and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (December 31) London prices. For most countries, **conversion rate** is the official exchange rate.

Short-term debt — all debt having an original maturity of one year or less as well as interest in arrears on long-term debt. (World Bank)

Total debt services — the sum of principal repayments and interest actually paid in foreign currency, goods or services on long-term debt, interest paid on short-term debt, and repayments (repurchases and charges) to the IMF. The exports of goods and services denominator include income and workers' remittances received. (World Bank)

Total exports show the free on board value of goods provided to the rest of the world.

Total imports show the cost, insurance and freight value of goods received from the rest of the world.

Trade in goods as a share of GDP — the sum of merchandise exports and imports measured in current U.S. dollars divided by the value of GDP in U.S. dollars.

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EXCHANGE RATE VOLATILITY: AN ANALYTICAL RISK MODEL

CHAPTER 1: INTRODUCTION

1. Risk Management

Risk is a symptom of uncertainty in the world (Lilico, 2004:1).

Risk management is a paramount topic in the financial sector, following major financial losses from the 1990s onwards. Becoming a discipline in its own right, risk management led to greater emphasis on ensuring that money is not lost through adverse market conditions, counter party failure or inappropriate controls, systems or people. Financial markets are undergoing tremendous change driven by globalisation, advances in information and other technologies and telecommunication, mergers and acquisitions and a constantly changing political environment. Establishing operations in foreign countries not only gives a company access to new markets and specialised resources, but also opens up new sources of information and knowledge to stimulate future product development. It also broadens the options of strategic moves and countermoves the company might make in competing with its domestic and international rivals. The resulting competitive and challenging environment makes it imperative that all financial players understand the risks they are facing and have effective analysis and control measures in place to deal with these risks.

1.1 The Risk Spectrum

Three main risk categories exist when operating in financial markets. These categories are market risk, credit risk and operational risk.

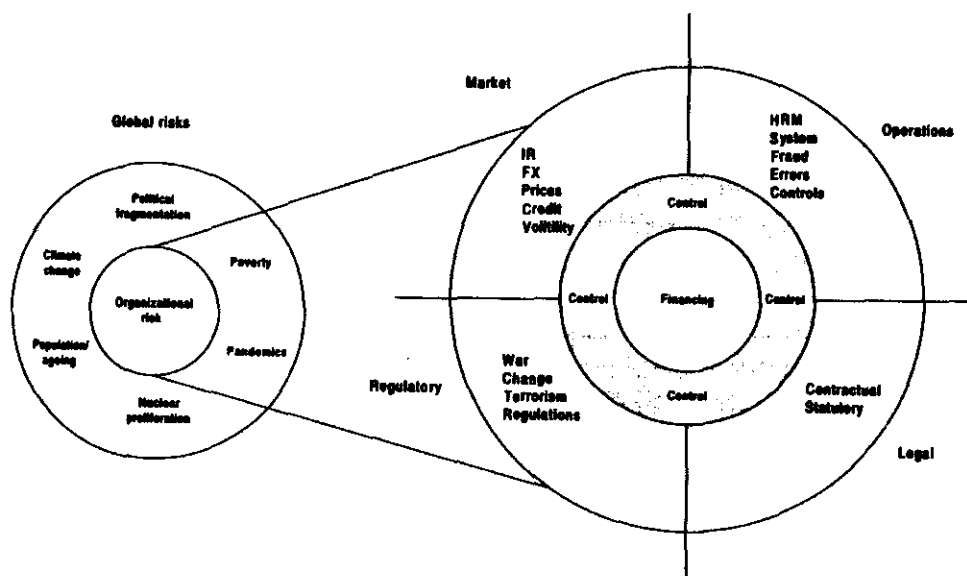
1.1.1 Market risk is the risk to an organisation's financial position resulting from adverse movements in market prices. Market risk arises from factors such as changing interest and currency exchange rates, the

liquidity of markets for specific commodities or financial instruments as well as local and global political and economical events.

1.1.2 Credit risk is the risk that a counter party will fail to perform on an obligation.

1.1.3 Operational risk is an extensive category and can be defined as everything not encompassed in market and credit risk – it can range from natural disasters to a difference in payment conventions. It is a risk that losses will be incurred due to inadequate systems or internal controls, inadequate disaster or contingency planning, human error or management failure (Hussain, 2000:1, 75-79, 87).

Figure 1: The Total Spectrum of Risks.



From: HUSSAIN, A. 2000. *Managing operational risk in financial markets*. Oxford:Butterworth-Heinemann. p. 76.

1.2 Exchange Rate Risk

“The ultimate objective is a world in which exchange rates, while free to vary, are in fact highly stable: Instability of exchange rates is a symptom of instability in the underlying economic structure.” (Friedman, 1953:158)

Exchange rate risk or currency risk is the risk that a business' operations or an investment's value will be affected by changes in exchange rates. For example, if money must be converted into a different currency to make an investment, changes in the value of the currency relative to the domestic monetary unit will affect the total loss or gain on the investment when the money is converted back. This risk usually affects businesses, but it can also affect individual investors who make international investments (Investorwords.com, 2003:1).

Currency risk and currency exposure are not the same concept. Currency risk is defined as the variability in the value of the firm due to unexpected changes in exchange rates. Currency exposure is defined as the amounts of foreign currencies which represent sensitivity of the value of any asset to variation in the purchasing powers of foreign currencies. More broadly defined, currency exposure represents the amounts of foreign currencies, with reference to the sensitivity of the future, real domestic-currency (market) value of any physical or financial asset (liabilities), to random variations in the future domestic purchasing powers of these foreign currencies, at some specific future date. The words currency risk and exposure are therefore not synonyms. Currency risk is to be identified with statistical quantities, which summarise the probability that the actual domestic purchasing power of home or foreign currency on a given future date will differ from its originally anticipated value. Exposure, in contrast, should be defined in terms of what one has at risk. The proper understanding of both terms is crucial for effective foreign exchange management (Lacina, 2000:1-2; Brigham & Ehrhardt, 2002:1026).

The focus of this paper will be on exchange rate risk or currency risk, included mainly in the market risk, but also operational risk categories. Already during the 1970s exchange rate risk management was recognised as being critical for the protection and utilisation of assets as well as the overall planning and functioning of the international firm (Prindl, 1976:1,3).

Included in exchange rate risk is:

- Changes in exchange rates;
- Changes in exchange rate volatility;
- Translation risk - Changes to the value of profit raised abroad on conversion to base currency;
- Convertibility risk – The inability to convert one currency into another due to political or economic policy, for example exchange rate controls; and
- Transaction risk – Risk of movements in the foreign exchange rates when credit transactions are denominated in a foreign currency (Hussain, 2000:77, 87).

The problem of measuring corporate currency exposure is of particular contemporary relevance because the increasing globalisation of markets has put increasing pressure on corporate management to determine the appropriate method of handling exposure to currency fluctuations. Two general approaches can be identified to measure corporate currency exposure: accounting exposure and economic exposure.

Accounting exposure is concerned with the implications of specific accounting rules that deal with the handling of accounting items, which are denominated in foreign currency. Economic exposure is a broader concept that measures: “the extent to which the value of the firm – as measured by the present value of its expected future cash flows – will change when the exchange rate changes” (Poitras, 2002:156). The focus must be on changes in the purchasing power of one currency

relative to another – this leads to the notion of “real” as opposed to nominal exchange rate change. It is changes in the real exchange rates that produce the conventional economic result that exchange rate increases will increase imports and decrease exports (Poitras, 2002:156). The economic exposure approach of exchange rate risk will be the focus of this paper.

According to Fischer(2002:7-8) the risk of future financial crises in emerging country markets are mostly reduced by the adoption of a floating exchange rate regime. What remains most important for risk reduction however is that debt levels should remain at a sustainable level.

1.3 Conclusion

Due to the continuing international move towards globalisation, emerging markets of the world, of which SA is one, are ever more dependant on the value of their currencies relative to the currencies of their major trading partners. By having a better understanding of the factors that determine and influence a country's currency, it becomes possible to foresee potential fluctuations in a currency's external value. Herewith, the exchange rate risk involved in international transactions can be established. A model to predict the exchange rate risk can be invaluable for international corporations in the evaluation and planning of proposed projects. The importance of such a model can be attributed to the fact that exchange rate- and political risk presents the primary sources of risk involved in foreign, compared to local, projects (Brigham & Ehrhardt, 2002:1038).

2. Problem Statement

At present the South African Rand floats against the major currencies of the world and since most of the exchange rate controls have been abolished, it makes the Rand more vulnerable to fluctuations in the world economy. In order to manage future cash flows in foreign currencies, coupled with exchange rate volatility, the risk involved should be calculated quantitatively and included in scenario planning.

However, according to W. Antweiler of the Sauer School of Business at the University of British Columbia (2003:2) there is “no reliable method available to forecast exchange rates or exchange rate risk”.

3. Research Aim and Objectives

3.1 Main Aim of the Study

The purpose of the study is to develop a model for the analytical assessment of exchange rate risk and volatility for the South African Rand(ZAR) versus the United States Dollar (USD).

3.2 Objectives of the Study

Supporting objectives of the study are:

- 3.2.1 Identifying and isolating the factors which influence exchange rates and exchange rate risk;
- 3.2.2 The critical evaluation of existing models for the prediction of exchange rate movements as well as exchange rate risks by performing a literature study;
- 3.2.3 The analysis of techniques employed for managing exchange rate risk;
- 3.2.4 The investigation of the unique factors contributing to exchange rate volatility and risk in the South African economy;
- 3.2.5 Developing a model for the prediction of the ZAR versus the USD exchange rate and testing the predictive power of the model; and
- 3.2.6 Developing a model to assess exchange rate risk due to volatility in the ZAR versus the USD exchange rate and testing the model.

4. Research Methodology

First a literature study is presented which include the following topics:

- 4.1 Exchange rates, exchange rate risk and the balance of payments are defined and explained;

4.2 Determinants of demand and supply of foreign currencies are identified and explained;

4.3 Exchange rate prediction models are briefly explained and evaluated;

4.4 Exchange rate risk models are briefly identified and evaluated;

4.5 The techniques employed for managing exchange rate risk is presented briefly; and

4.6 An overview of the unique factors contributing to exchange rate volatility and risk in the South African economy is provided.

In the empirical study, the monetary model provides a useful tool for exchange rate analysis. Empirical functions for the exchange rate between South Africa and the United States is developed. Multiple regression analysis is applied in developing the different functions. This model tries to determine the explanatory forces behind the volatility of South Africa's exchange rate.

Finally, conclusions are reached from the empirical results regarding exchange rate theory, structural analysis and risk.

5. Limitations to the Study

The emphasis will be on developing a model for use in the South African economy, although not exclusively for the South African market. The empirical study will only be performed on the ZAR versus the USD exchange rate, which presents one of the most influential exchange rates in the South African economy.

An explanation is provided for the model chosen for analysis in the empirical study. The monetary approach falls undoubtedly short of an adequate explanation of the observed volatility in major world currencies. However, an obvious alternative model is lacking – the portfolio balance approach is not chosen due to data considerations and no other clear alternative, based on the asset approach, has emerged yet. Therefore, a monetary model is proposed, which are adapted for the South African economy.

CHAPTER 2: LITERATURE STUDY

1. Exchange Rate

The exchange rate denotes the number of one country's currency that equals one unit of another foreign country's currency, or more simply put - the exchange rate is the domestic price for foreign currency (Tucker, 2000:673; Samuelson & Nordhaus, 1989:938; Smit et al, 1996:412). However, the exchange rate is also a highly visible indicator of confidence in the political and economical policy of a country (Dornbusch, 1990:38).

The prevailing exchange rate depends on the forces of demand and supply for a currency in terms of other currencies. The basic forces behind a country's demand for foreign exchange are its desires for imports and foreign investment abroad. Supply of foreign exchange comes from exports and inflow of investment. The exchange rate of a country is intimately related to its overall economic balance, and governments are concerned about exchange rates as a matter of economic policy. In most countries, exchange rates are free to fluctuate, but are subject to government intervention, called a managed or dirty float. In order to influence exchange rates one way or another, governments intervene in the foreign exchange market as buyers or sellers of foreign currency. Since an exchange rate involve two countries, either country can intervene to influence the rate. Some degree of coordination between the countries is desirable and takes place through both formal and informal channels (Horvitz & Ward, 1983:223-224; Walton & Wykoff, 1998:443-446).

The US dollar has always been a key currency in the global economy. This dollar preference for market convertibility at an exchange rate determined by market forces has reduced the attractiveness of the dollar as a key currency. It is still the dominant reserve currency given the reluctance of other countries to allow their own currencies to replace the dollar, but there has been a degree of currency diversification into alternative strong currencies like the Deutschemark or Yen

(Llewellyn & Milner, 1990:7). The Euro has emerged as a very influential and important currency, replacing many European currencies including the Deutschmark. The exchange rate between the Euro and other major currencies like the Dollar and Yen are closely tracked due to the strong economical and trading powers of the European block.

Floating exchange rate experiences are characterised by three outstanding features namely volatility of real exchange rates, persistent misalignments and pervasive forecasting mistakes according to Dornbusch(1990:23-29). Research proofed that under flexible exchange rates, the variability of bilateral real exchange rates among the main industrial countries is far higher than under fixed rates. When examining the exchange rate changes of major currencies over the past few years, misalignments seem to be apparent. Exchange rate movements are sizeable and are ultimately reversed, however no explanations are offered for the size and pattern of exchange rate changes over time. Poor forecasting performance of exchange rate forecasting models characterise the field. Forecast errors are almost never zero, but are mostly large, although their signs may vary sufficiently to give the impression of randomness. However, on closer analysis, forecast errors are not even random. Dornbusch(1990:29) conclude that forecast errors are a regular occurrence and that forecast averages differ widely from forward rates and from realised depreciation.

According to De Wet(2000:16) seven periods characterised the evolution of the SA exchange rate system. The first was the gold standard which lasted from 1874 to 1914. This era came to an end with the start of World War I. Secondly the inter-war years followed from 1922 to 1963. The next era was the Bretton Woods agreement which dominated till 1971. It was followed by a very turbulent phase of eight years, characterised by attempts to restore exchange rate stability. Between 1979 and 1985 a period of reform followed. The next period, from 1985 to 1994, was characterised by strict exchange rate controls and devaluation of the Rand against the major currencies of the world. A flexible exchange rate system was adopted in 1994 in order to restore the exchange rate system of SA in line with international trends.

In SA the South African Reserve Bank(SARB) is the only official buyer and seller of currency. The role of the SARB is the protection of the internal and external value of the Rand. Internal value concerns the domestic purchasing power of the Rand, which is a reflection of inflation. The exchange rate reflects the external purchasing power of the Rand. By purchasing or selling Rands on a large scale in the foreign exchange market, the SARB can influence the “price” of the Rand. Supporting the Rand requires foreign currency reserves, therefore the level of these reserves are critical. Depreciation cannot be prevented indefinitely and the SARB can at most prevent unwanted short-term drops or try to smooth the behaviour of the exchange rate. The SARB does not officially fix the exchange rate, but intervene as a form of policy influence of the exchange rate (Fourie, 1997:114).

When the exchange rates change, import and export prices in Rand are influenced, as well as the volume of imports and exports, and therefore the balance of payments. Because of this wide influence of exchange rates, it would be very risky to allow the currency market to run its course. Stabilisation of the exchange rate is often beneficial to the economy as a whole (Smit et al, 1996:417).

2. Balance of Payments

Due to the wide influence of imports and exports on the exchange rate, the balance of payments will be discussed next. The balance of payment reflects the balance between the imports and exports of a country. It also plays an important role in the monetary model, which will be discussed in detail below.

The balance of payments is a record of all the international transactions including the flow of goods, services and finance between a country and the rest of the world for a certain period. The values of a nation’s spending inflows and outflows made by individuals, firms and government are recorded. This includes all the goods, services, factor income and current transfers a country receives from or provides to

the rest of the world as well as the capital transfers and changes in external financial claims and liabilities. A double-entry accounting system is used since every transaction covered involves a credit and debit of exactly the same amount and therefore adds up to zero. The four basic categories in the balance of payments are the current account, capital transfer account, financial account and the international investment position, which might be either in deficit or surplus (Walters, 1999:2; Anon, 2005:1-2; Haekel, 2004:1; Wikipedia, 2005:1).

The current account covers transactions which create no future claim in either direction, involving simply an exchange here and now. Included in the current account are all tradeable and physically tangible goods, intangible goods, investment income, unilateral transfers and military expenditure – therefore, currently produced goods and services. Receipts from income-generating assets such as stocks (in the form of dividends) are also recorded in the current account. The largest part of the current account is the balance of trade, which represent the difference between a country's merchandise imports and exports. The overall current account balance is the most important single figure in the balance of payments – it serves as an indicator of the balance of demand and supply within the domestic economy. It should be kept in mind that the current account balance is a tiny quantity relative to the scale of the gross flows in each direction. What might look like a dramatic improvement or deterioration, can result from a purely marginal change on the credit or debit side of the account (Haekel, 2004:1; Wikipedia, 2005:1).

The capital transfer account comprises capital transfers that were part of the current account previously. This account consists of two major components, namely capital transfers and the acquisition or disposal of non-produced, non-financial assets (Walters, 1999:3).

The financial account includes transactions formerly recorded in the capital account. Transactions in this account are classified by functional category or type of investment, namely direct investment, portfolio investment and other investment. Direct investment is classified primarily on a directional basis – non-residents investing in the economy and resident investment abroad. It includes transactions related to the acquisition of share capital in foreign countries by establishing new businesses, or through mergers and acquisitions. Transactions in real-estate also form part of direct investment. Portfolio investment consists of international equity and debt securities not classified as direct investment. In addition to long-term debt and equity securities, money market debt instruments and tradeable financial derivatives are included in portfolio investment (Walters, 1999:4-5; Haekel, 2004:1; Wikipedia, 2005:1).

Other investment is a residual category which includes all financial transactions not covered under either direct investment, portfolio investment or reserve assets. Other investments comprises trade credits, loans, currency and deposits as well as other assets and liabilities. The international investment position measures an economy's stock of external assets and liabilities. In contrast, the financial account measures transactions in these external assets and liabilities. A statistical discrepancy category is included to capture financial flows not captured officially. The most important item in the financial account is labelled official reserves or foreign currency reserves, as referred to in 1 above (Walters, 1999:5).

The balance of payments has a direct impact on the level of foreign reserves. A surplus on the balance of payments implies a net inflow of payments. Since foreign payments to SA initially occur in the form of foreign currency, a surplus on the balance of payments causes the amount of foreign currency reserves in the country to increase – usually due to higher export earnings. Rising levels of reserves indicate that money is flowing in from abroad. This provides a means for economic growth and increased imports. Likewise, a deficit will cause foreign reserves to decline. A decline implies a net outflow of funds from the economy, which reduces

the scope for economic growth. The level of foreign reserves is critically important since imports are financed with these reserves. The level of foreign reserves is regarded as one of the leading economic indicators.

Official reserves are used as a means of exchange rate policy management by the SARB. It presents reserves in foreign currencies, owned by government, and is used for buying or selling their own currency in the foreign exchange market, besides paying for imports. By intervening, government can prevent unwanted short-term drops or try to smooth the behaviour of the exchange rate on a limited scale.

By definition, the official reserves are constant under a regime of pure floating exchange rate, leaving the exchange rate free to move so as to generate a financial account balance just sufficient to offset the current account deficit or surplus. On the other hand, if the exchange rate is prevented from moving (fixed or managed floating), the burden of adjustment must fall on the official reserves. The fact that official reserves changed during a year, proofs that the exchange rate was being managed (Walters: 1999:5).

Imbalances of these accounts have important economical implications. Surpluses in one account must be balanced by deficits in the other. If a country earn more from exports than what is spend on imports, a current account surplus result, which must be balanced by a financial account deficit (Money lend to foreigners to finance their imports) (Walton and Wykoff,1998:447-451; Tucker, 2000:668-671; Copeland, 1989:20-26, 123; Fourie, 1997:106-107; Haydam, 1997:169; Haekel, 2004:1; Wikipedia, 2005:1).

3. Determinants of Demand and Supply of Foreign Currencies

Theoretically, international forces of demand and supply determine the exchange rate of a nation's currency. The foreign exchange market reaches equilibrium at a

certain level, where it has no tendency to rise or fall. Should the exchange rate reach a level above equilibrium, there will be a surplus of supply and the exchange rate will react by falling to a new level to reach a state of equilibrium. On the other hand, below equilibrium, there is a shortage of supply in the world currency market and the exchange rate will rise again. These forces of demand and supply will determine the exchange rate in free-floating conditions, when no intervention is allowed.

There is a link between the balance of payments and the foreign exchange market – any item entering the accounts as a credit generates a supply of foreign currency, while debits generate a demand for foreign currency. The following factors determine the demand and supply of foreign currencies and are therefore considered key macroeconomic variables determining the exchange rate (Walton and Wykoff, 1998:451-453; Tucker, 2000:675-679; Samuelson and Nordhaus, 1989:939-940; MacDonald, 1990:66):

3.1 Interest Rates

Changes in relative real (inflation adjusted) interest rates can have an important effect on exchange rates. Interest rates have an effect on financial account transactions. Should interest rates rise, a higher rate of return can be earned and financial investors worldwide would want to invest in this country. Therefore an increased demand for that country's currency is created resulting in an appreciation of the currency.

Interest rates tend to be higher in developing countries, in part due to higher inflation rates. The theory of interest rate parity holds that if interest rates are higher in one currency than another, the difference reflects the expected depreciation of the higher-yielding currency. Funds would move from the lower-yielding to the higher-yielding currency. This movement occurs because markets tend to equalise risk-adjusted expected rates of return, unless the exchange rate were expected to compensate for the difference in interest rates. Therefore it can be concluded that

differences in interest rates tend to reflect expected depreciation (Gray & Irwin, June 2003:3).

3.2 Inflation

The impact of exchange rates on inflation and visa-versa is well-established according to Dornbusch(1990:37-38). This interaction takes place via several channels of which the prices of homogeneous commodities traded in world markets are the least controversial. Changes in commodity prices directly influence the rate of inflation for food and wages as well as industrial material costs in manufacturing. The prices of traded goods and wages also act as channels for interaction. These channels yield a pervasive pattern of cost and price effects, which are directly and indirectly, associated with exchange rate movements.

Gray and Irwin(June 2003:3) found that over the medium- and long-term, depreciation tends to correlate with inflation. This implicates that the percentage depreciation in the exchange rate between two currencies should roughly match the percentage difference in their inflation rates. Although this relationship does not hold in the short-term, when investment flows often dominate, it holds fairly well in the long-run especially when inflation is high.

Laflèche(1996:22) showed that the exchange rate impacts on the inflation rate, however, he reminds that inflation ultimately depends on monetary policy and that exchange rate fluctuations are themselves influenced by the stance of monetary policy. A monetary policy focused on controlling inflation will not allow exchange rate movement to create an inflationary spiral.

3.3 National Incomes

National incomes of countries around the world can affect supply and demand for foreign currencies through the current account. If national incomes rise abroad, foreign demand for local goods and services will increase and result in increased supply of foreign currencies. The opposite occurs when an increase in the local

national income leads to an increased demand for foreign currencies. Expansion in the relative income of a nation therefore causes a depreciation of their currency. Since national income levels are closely related to demands for goods and services, changes have important effects on merchandise trade balances and current account balances.

3.4 Price Levels

Price level changes in various countries also have its influence on the exchange rate through the current account. If inflation is relatively higher in one country than in others, goods and services produced by this country will become less competitive and consumers will utilise more competitive alternatives. This will lead to a depreciation of that country's currency. The exchange rate act as equaliser by bringing costs back in line with other countries in conditions of persistent wage and price inflation.

3.5 Tastes and Preferences

A change in the taste and preferences of the international community can cause significant shifts in the demand and supply curves for foreign exchange. Trends, political events, marketing and unexplained influences can cause increases in demand for certain products or products produced in a specific country (Walton and Wykoff, 1998:451-453; Tucker, 2000:675-679; Samuelson and Nordhaus, 1989:939-940; MacDonald, 1990:66).

3.6 Monetary and Fiscal Policy

The monetary and fiscal policy stance of a government can enhance or detract from a nation's ability to create wealth and thus to maintain strong export earnings needed to meet future foreign debt servicing. The inflation rate, direction of the inflation rate, the ability to boost interest rates, monetary stability and financial liberalisation are measures of monetary policy. Experience indicates that for countries with a reasonable inflation rate (in the low double-digits) and a floating

exchange rate, the use of inflation targeting should be the basis for monetary policy. The quality of fiscal policy penetration is measured by GDP-ratios (Brink, 2002:124-125; Fischer, 2002:7).

GDP is defined as the total market value of all final goods and services produced within that territory during a specified period, normally one year. GDP is the broadest measure of economic activity. Annualised quarterly percentage changes in GDP reflect the growth rate of total economic output. Whereas nominal GDP refers to the total amount of money spent on GDP in current-year prices, real GDP refers to an effort to correct nominal GDP for the effects of inflation in order to estimate the sum of the actual quantity of goods and services making up GDP. GDP's of different countries are compared by converting their value in national currency according to either the current exchange rate- or purchasing power parity method (Wikipedia, 2004:1-2; Johnston & Williamson, 2004:1).

According to Stanley Fischer(2002:2), the Vice Chairman of Citigroup and former First Deputy Managing Director of the International Monetary Fund, an optimal fiscal policy rule should be developed for an economy. This policy should set standards for desirable levels of budget deficits and debt-to-GDP ratios. Deficit and debt are tied together based on the standard debt dynamics equation:

$$d_t = (1 + r_t - g_t)d_{t-1} + f_t$$

where d_t is the debt-to-GDP ratio, r_t is the real interest rate, g_t is the growth rate of GDP and f_t is the primary deficit. The aim of this equation is to determine the primary deficit or growth rate of GDP that would maintain the debt at a certain level. This equation therefore has important risk implications (Garcia & Rigobon, 2004:8).

Arguably the best-known fiscal rule is defined in the European Stability and Growth Pact, which sets sixty per cent of GDP as the upper bound on national debt, three per cent as an upper bound on the budget deficit and the requirement that the budget should on average be close to balance over the cycle. The above rule on national debt is generally referred to as the Maastricht sixty per cent of GDP

criterion, which seems to have gained status as a norm according to Fischer (2002:2). Fischer (2002:3-4) adds however, that if sixty per cent is a safe norm for national debt for an industrialised country, the safe level for an emerging market should be significantly lower, around forty per cent (Fischer, 2002:3-4). This ratio is important for risk analysis - the higher the debt ratio, the greater the potential instability arising from a decline in growth or an increase in the real interest rate.

The World Bank is using another classification. The World Bank's main criterion for classifying economies is gross national income (GNI) per capita. Based on its GNI per capita, every economy is classified as low-income, middle-income (subdivided into lower-middle and upper-middle), or high-income. Low-income and middle-income economies are sometimes referred to as developing economies. Classification by income does not necessarily reflect development status.

Income group: Economies are divided according to GNI per capita, calculated using the World Bank Atlas method. The groups are: *low-income*, \$765 or less; *lower-middle-income*, \$766 - \$3,035; *upper-middle-income*, \$3,036 - \$9,385; and *high-income*, \$9,386 or more.

Indebtedness: Standard World Bank definitions of severe and moderate indebtedness are used to classify economies. *Severely indebted* means either of the two key ratios is above critical levels: present value of debt service to GNI (80 per cent) and present value of debt service to exports (220 per cent). *Moderately indebted* means either of the two key ratios exceeds 60 per cent of, but does not reach, the critical levels. For economies that do not report detailed debt statistics to the World Bank Debtor Reporting System (DRS), present-value calculation is not possible. Instead, the following methodology is used to classify the non-DRS economies. *Severely indebted* means three of four key ratios (averaged over 2000-2002) are above critical levels: debt to GNI (50 per cent); debt to exports (275 per cent); debt service to exports (30 per cent); and interest to exports (20 per cent). *Moderately indebted* means three of the four key ratios exceed 60 per cent of, but do not reach, the critical levels (World Bank Group, 2004).

Other GDP-ratios often used in economical analysis include:

- Openness of the economy: Ratios of exports and imports to GDP;
- Fiscal Balance: Ratio of annualised fiscal balance to GDP; and
- Net foreign assets position: Ratio of the end of period net foreign assets of the banking system to GDP (MacDonald & Ricci, 2003:21).

3.7 Other Variables determining the Exchange Rate

According to Klein(2004:1) the following short-term factors cause a country's currency to weaken: narrower interest rate gaps between the home- and other countries, higher political risk and the dollar's fluctuation on overseas markets. Long-term factors that strengthen currency include foreign investments, improvement in the balance of payments surplus, raising of capital backed by US guarantees, improvement in risk premium, high levels of foreign currency reserves and the transition from being a net borrower to a net lender.

MacDonald(1990:66) studied the meaningfulness of exchange rate volatility and compared it to movements in key macroeconomic variables. He established that exchange rates are more volatile than factors like money supplies and price levels, but generally less volatile than other asset prices like the interest rate and share prices. This author also recognized the concept of misalignment in exchange rate volatility – misalignment refers to the situation where an exchange rate, although it might be a market clearing rate, moves away from its long-term sustainable level for some time. MacDonald(1990:63,74) concluded that exchange rate volatility is not meaningful, since it can only be meaningful if it is related to the volatility in fundamental factors regarded as determinants of exchange rates. The volatility of exchange rates might lead to a sub-optimal allocation of goods and capital in the international economy through its effect on the distribution of goods internationally via current account imbalances. This arise due to changes in competitiveness and because volatility may affect the behaviour of importers and exporters, regarding involvement in international trade as increasingly risky in periods of high exchange rate volatility.

Bhundai and Gottschalk(2003:1) used an empirical exchange rate model to investigate the sources of fluctuations in the ZAR and USD exchange rate during 2001 and 2002. They identified aggregate demand, aggregate supply and nominal disturbances as possible sources for exchange rate fluctuations.

In response to a positive real demand disturbance, there is an increase in output and in the price level and an appreciation in the real exchange rate. In the short run and in response to a nominal disturbance, an output response lasting for about a year is accompanied by a large depreciation of the nominal and real exchange rate. In the long run however, both the output and real exchange rate responses are restricted to zero. The real exchange rate initially appreciates slightly in response to a supply disturbance, but in the long run, a pronounced and persistent depreciation sets in (Bhundai and Gottschalk, 2003:6-8).

In an investigation of the long run co-integration relationship between the real effective exchange rate and certain explanatory variables, MacDonald and Ricci(2003:3) identified the following main explanatory variables for the real exchange rate of developing countries: real interest rate differentials, GDP per capita, real commodity prices, trade openness, the fiscal balance and the extent of net foreign assets.

3.8 Conclusion: Determinants of Demand and Supply of Foreign Currency

From the above, it can be concluded that the following macro-economical variables are regarded as the most influential in determining the exchange rate: interest rates, inflation rates, national income levels, price levels, specific tastes and preferences as well as monetary and fiscal policy stances of government.

4. Economic Indicators for Identifying Currency Crises Vulnerability

Forecasting currency crises and exchange rate depreciation in general is very hard, but some useful economic indicators include the following (Rosenblat, 2001:2-4):

4.1 Current Account

A large current account deficit suggests that a country must either attract capital from abroad to cover the deficit, or draw down its own stock of foreign reserves. The predictive power of the current account for vulnerability of the currency is not very useful as an absolute measure. However, current account deficits may lead to crisis in the following situation: if capital inflows are in the form of portfolio investments with little foreign direct investments and finance consumption rather than investment.

4.2 Foreign Currency Reserves

The foreign currency reserves to GDP-ratio provide an indirect measure of a country's buffer against capital shifts. High levels of reserves act as a buffer against devaluation and speculation. If capital flows are volatile, a country should hold more reserves to reduce risk. Another measure often used is months of imports covered, indicating the percentage of the current account, which can be financed through reserves.

Foreign currency reserves are a very useful indicator of possible currency crisis. A declining foreign reserve to GDP-ratio signal overvaluation problems and possible future crisis. Conditions are exacerbated by the simultaneous occurrence of a real appreciation and high domestic inflation rates. Low reserve levels can also lead to speculative runs.

4.3 Fiscal Deficit

The link of fiscal deficits to the exchange rate of a country is indirect and therefore fiscal deficit is a less useful indicator of a looming currency crisis. The method of financing the deficit is important and has risk implications:

- If domestic savings rates are low and the budget deficit is financed with foreign debt, there is pressure on the exchange rate due to a twin deficit.
- If domestic savings rates are high, a fiscal deficit may be financed with local savings, without relying on foreign debt.

- If the deficit is financed by printing money (debt monetisation), the pressure on the currency will grow.

4.4 Other Indicators

- **GDP Growth:** Low GDP-growth coupled with a large government deficit, high consumption, low investment and a large current account deficit may contribute to a currency crises.
- **Money Growth:** High money growth rates unmatched by coordination effort by other countries, coupled with low nominal exchange rate adjustment could lead to overvaluation.
- **Exchange Rates:** A decline in the nominal exchange rate index indicates devaluation against a benchmark. An increase in the real effective exchange rate (terms of trade) index indicates that the inflation-adjusted value of the exchange rate has increased, and a possible overvaluation occurred. The exchange rate index changes are very useful in predicting currency crises.

5. Models of Exchange Rate Determination / Forecasting

5.1 The Theoretical Foundation

Increased integration and reduced policy barriers between the financial markets of industrialised economies have increased the international mobility of capital dramatically. Capital transactions and the threat of capital flow dominate current transactions in open economies, emphasising the important role and far-reaching implications of exchange rates (De Wet, 2000:4). This emphasise the need for exchange rate forecasting models.

Numerous models have been devised to forecast the exchange rate, though none is error free. There still remains ample area for improvement in this extremely complex financial forecasting area. Mussa(1979:2) confirmed this complexity with his remark that any exchange rate model which can explain ten per cent of

exchange rate movements should be deemed a success. The most well known, as well as a few adapted models will be discussed below.

Foreign exchange markets came to be viewed as asset markets during the latter half of the 1970s and since the 1973 float the asset-market view has become dominant (Brink & Koekemoer, 2000:2). The asset approach is contrasted to the traditional flow approach, in the sense that the latter allows shocks to affect trade flows. Trade flows are affected via shifts in the terms of trade or an altered relationship between domestic absorption and output. In contrast, the asset approach assigns adjustments in the relative price of goods only a minor supporting role. The exchange rate is viewed as the foreign currency price that equilibrates net stock demands for financial assets denominated in foreign currency (Frankel, 1980:1).

All the asset-market models share the perfect capital mobility assumption, which implies the absence of substantial transaction costs, capital controls or any other form of constraints to the flow of capital. Therefore the exchange rate adjusts instantly, although it may exhibit a degree of volatility exceeding that of their underlying determinants (Frankel, 1980:1). Monetary and non-monetary class approaches are distinguished under the asset approach, of which the former dominate in the literature.

The monetary class approach regards domestic and foreign bonds as perfect substitutes. Portfolio shares become infinitely sensitive to expected rates of return, while bond supplies become irrelevant. Determination of the exchange rate then shifts towards the money markets (Brink & Koekemoer:2000:3).

The perfect substitutability assumption is relaxed in the non-monetary or portfolio balance class of asset-market models. This implies that asset holders are indifferent to the composition of their bond portfolios, provided that the expected rate of return on the two countries' bonds are identical when converted to a common currency.

Asset holders allocate their portfolios across shares which are well-defined functions of expected rates of return.

Little doubt exists that an exchange rate determination model should reflect the asset-market approach as opposed to the traditional flow approach. However, the portfolio balance model is not a natural choice due to data considerations (Brink & Koekemoer, 2000:3-4).

The monetary model is however regarded as the “standard workhorse” in international finance. The monetary approach is based upon the recognition that the exchange rate between two currencies is the relative price of one currency relative to the other. It asserts that the price of a nation’s currency depends not only on foreign exchange transactions, but also on the demand by domestic residents for their own currency.

The monetary approach to the balance of payments analysis relies on the assumption of a relatively stable money demand function and a fixed foreign source of money supply. When demand for money changes, the necessary adjustment to achieve equilibrium occur in the exchange rate. The same exchange rate adjustment occurs if the domestic credit component of supply of money changes. Adjustment occurs in the exchange rate because it cannot be induced in the foreign source component. The exchange rate in turn influences money demand function variables including prices, income levels and return on domestic money. Therefore, the exchange rate has to adjust efficiently to equilibrate the money demand function with the supply of money.

The monetary model provides a useful tool for exchange rate analysis since it clearly defines the role of speculation among exchange rate determinants. Further, it gives a simple definition of the equilibrium exchange rate. It directly relates the equilibrium rate to the underlying instruments of monetary policy (Frankel & Rose, 1994:3; Brink & Koekemoer, 2000:4; Bilson, 1978:48; De Wet, 2000:5). An

obvious alternative for the monetary model for exchange rate determination is lacking.

Two prominent models of the monetary approach to exchange rate determination is distinguished namely the flexible price monetary model and the sticky price monetary model (De Wet, 2000:5). Both will be discussed below.

According to Beenstock(1990:44) exchange rate movements can be classified into movements induced by either temporary or by permanent equilibrium phenomena. The former tend to be inherently short-term while the latter are more concerned with longer term trends in exchange rate movements. The theory of exchange rate dynamics has developed within two distinct intellectual traditions namely the Marshallian and Walrasian traditions. The Marshallian tradition deals with exchange rate dynamics in a partial equilibrium framework, where markets ancillary to the foreign exchange market have been assumed given and spill over effects between these markets ignored. The Walrasian tradition deals in a general equilibrium setting, where the interdependence between the foreign exchange market and other markets is explicitly taken into consideration. The Dornbusch model is considered a Walrasian model, while models dealing with the balance of payments, for example the portfolio theory, are regarded Marshallian models (Beenstock, 1990:45-46).

5.2 Purchasing Power Parity (PPP)

Roots of the PPP-theory is found in the work of Adam Smith, but is usually credited to Gustav Cassels (1920). The earliest version of PPP took the form of the Law of One Price which assumes a one-good world with no transactions or transportation costs. The price of that good, denominated in different currencies, will be the same. Extending this law by using price indices instead of individual prices, lead to the development of Absolute Purchasing Power Parity(APPP). APPP

holds that foreign exchange rate changes are determined by the difference between foreign and domestic inflation rates. This appealing interpretation of exchange rate changes is that prediction of inflation rates will permit exchange rate changes to be forecasted accurately. A more popular form of PPP is Relative Purchasing Power Parity(RPPP). This version defines the real exchange rate as the nominal exchange rate adjusted for changes in the relative purchasing power of each currency since some base period (Poitras, 2002:161-163; Patro, Wald & Wu, 2002:1951-1952; Dornbusch, 1990:31; MacDonald, 1990:78, 90-92).

According to Poitras(2002:157) the real exchange rate is an implication of purchasing power parity: If changes in the nominal exchange rate are fully offset by changes in the relative price level between two countries, then the real exchange rate remains unchanged. Therefore, a change in the real exchange rate is equivalent to a deviation from PPP. Being based on PPP, the real exchange rate can be used to identify substantive changes in foreign currency values.

The basic approach of PPP arguments is to attack the validity of exchange risk – this follows from the PPP implication that exchange rate changes will offset price level changes in the long run. However, shortcomings of the PPP-theory include:

- The long lead-lag time period for the relationship to hold makes PPP inconsistent with the typical types of business decisions time frames.
- Complications are created if the hedger is interested in nontradeable goods, since PPP has greater applicability to tradeable goods and therefore fails to determine actual exchange rate behaviour. Should a price index including both tradeable and nontradeable goods be used, this can impart a bias into the calculation if there are productivity differences between countries.
- Financial and operating contracts are present that are fixed in nominal terms and do not adjust when the aggregate price level changes.
- Slippage is created between the price index which underlies PPP and the specific prices which are of interest to the hedger, since it is relative and

not aggregate price level, that are of interest (Poitras, 2002:163; MacDonald, 1990:78; De Wet, 2000:11).

Copeland(1989:65) however states that whether true or not, PPP is an important benchmark for the analysis of exchange rate movements. PPP is particularly important in so far as it impinge on international competitiveness. If the general level of prices is a reasonably accurate index of the cost of production in a country, which is almost certain to be the case, then the ratio of price levels for any two countries will serve as a measure of relative competitiveness. Competitiveness measured in this way would not only be constant but also equalized across different countries. However, international competitiveness has been far from constant, and for this reason economists often wish to measure deviations from PPP. When factors which determine price levels in a domestic context is studied, PPP will dictate what ought to be the relationship between them and the exchange rate, as performed by the monetary model of flexible prices (Copeland, 1989:72-73).

5.3 More Recently Developed or Adapted Models

5.3.1 Flexible Prices: The Monetary Model

The monetary model combines the quantity theory of the demand for money with PPP to generate unambiguous conclusions about the effect of changes in exogenous variables on the floating exchange rate or balance of payments. Restrictions imposed by this model include the following: It is assumed that the country under consideration is small, the economy operates at full employment and it faces a given exogenous foreign price level and interest rate. However, there are no barriers to trade such as transaction costs or capital controls. Domestic and foreign bonds are regarded as perfect substitutes. Central to the monetary model is the equilibrium of the supply and demand for money (De Wet, 2000:6).

The monetary model of a floating exchange rate predicts that the domestic currency will depreciate when any of the following occurs:

- The domestic (foreign country) money stock increases (decreases);
- Domestic (foreign) national income falls (rises); and
- The foreign price level falls.

The depreciation will be proportionate to any increase in the relative money stock.

The monetary model of a fixed exchange rate predicts that the balance of payments will deteriorate and the home country will lose reserves when any of the following occurs:

- The home country's domestically-generated money stock (domestic credit) increases;
- Domestic (foreign) national income falls (rises); and
- The foreign price level falls.

Devaluation of a fixed exchange rate results in a period of balance of payments surpluses. This comes to an end when reserves have risen sufficiently to restore the value of the real money stock to its pre-devaluation level. At the same time, the real exchange rate is also back at its former level and PPP is reinstated. Therefore, the temporary competitive advantage enjoyed by the home country as a result of the devaluation is completely eliminated by inflation.

Interest rates reflect the market's expected rate of currency depreciation or appreciation and interest rate changes are a reflection of changes in inflationary expectations. Since higher interest rates mean a smaller demand for money, they also imply a higher price level and therefore a lower value for the home country's currency, other things being equal. To summarise, the monetary model predicts that increases in the money stock will be reflected in a depreciation of the same proportion. It also predicts that real income growth will be associated with a rising international currency value. The monetary model also formalises the role that expectations of the future exchange rate play in determining the current exchange rate (Copeland, 1989:143-174, 350; Dornbusch, 1990:31; MacDonald, 1990:79-80; De Wet, 2000:6).

The monetary model must be regarded as inadequate in anything but the long run, which is hardly surprising given the failure of PPP on which it is based. It also ignores the role played by expectations in determining international interest rate differentials. However, it remains an important benchmark with which to compare other models, since its predictions accord in most cases to the long run equilibrium results.

5.3.2 Fixed Prices: The Mundell-Fleming Model

The Mundell-Fleming model adheres to the Keynesian tradition where supply takes the passive role of fixing the price level, while demand variations determine the level of economic activity. It focuses mainly on normative questions relating to the optimal combination of monetary and fiscal measures for demand management in an open economy. The model is set in the context of a flat aggregate supply curve (a constant price level), the absence of PPP, less than perfect capital mobility and static expectations (Dornbusch, 1990:29-30).

The distinguishing feature of the Mundell-Fleming model is the emphasis placed on the different conditions determining the current balance and the net capital inflow. The outcome is a sticky stock-flow equilibrium. The short-run response of a small open economy is described relatively realistically, but the model becomes less and less realistic the longer the time horizon involved (Copeland, 1989:179-185).

With a floating exchange rate, equilibrium requires the domestic money and goods markets to clear, while in the open sector the sum of the deficits on current and financial accounts is zero. The latter ensures a balance of supply and demand in the currency market. Expansionary monetary policy causes depreciation and a fall in interest rates, while fiscal expansion has the opposite effect.

With a fixed exchange rate, expansionary monetary policy has the long run effect of causing a fall in the reserves. Fiscal expansion produces a rise in income and the interest rate with a short-run reserve gain.

The Mundell-Fleming model contrasts with the monetary model in the following two respects: Firstly, its emphasis on the level of activity and interest rates rather than the price level. Secondly, its concentration on flows of spending and capital movements rather than stocks of assets (Copeland, 1989:176-195; Dornbusch, 1990:29-30).

The following model attempts to rectify two of the weaknesses of the Mundell-Fleming model: the constant price level and the static expectations, both of which limit its relevance to only the very shortest horizons.

5.3.3 Sticky Prices: The Dornbusch Model

The Dornbusch model is a hybrid – its short-run features fit into the established Keynesian tradition, with its emphasis on the stickiness of prices in product and labour markets. It also displays the long run characteristics of the monetary model. Dornbusch observed the following (Copeland, 1989:202-224; Dornbusch, 1990:16-23): while product markets adjust only slowly, financial markets appear to adjust far more rapidly, virtually instantaneously. Allowing for this, financial markets have to over adjust to disturbances, in order to compensate for the stickiness of prices in goods markets. Therefore, financial markets are assumed to clear instantaneously, with perfect capital mobility. This ensures that uncovered interest rate parity is maintained at all times.

In the goods market, the price level is sticky, adjusting over time at a rate proportional to the excess demand. In the immediate term, with goods prices initially fixed a change in the nominal money stock amounts to a change in the real

money stock. It follows that there has to be an instantaneous change in the demand for real balances if the money market is to clear. This change can only be brought about by an up- or downward movement in interest rates, especially if output is assumed fixed. In the short-term monetary policy changes have a liquidity effect. (Since the price level is fixed, shocks that create excess supply in the money market have liquidity effects, requiring a fall in the interest rate to clear the domestic money market.)

However, the deviation of domestic interest rates from world levels can only be temporary. The change can only be reconciled with uncovered interest rate parity if there is a simultaneous expectation of exchange rate appreciation. Ultimately, as product prices begin their delayed response, the change in the real money stock starts to reverse itself, as well as the whole process. This process involves driving interest rates, aggregate demand and the real exchange rate back towards their original levels. Market expectations are for the exchange rate to depreciate at a rate proportional to the gap between its current level and its long run equilibrium level. This process ends with all the real magnitudes back where they started. The nominal exchange rate is at a new long-term level, which reflects the proportionate change in the money supply.

The Dornbusch model offers a potentially powerful explanation for the volatility of floating exchange rates, although it ignores the dependence of aggregate demand on the interest rate. When investigating real-life crises and shocks, undershooting rather than overshooting is a possible reaction. Reaction will depend on whether the dominant impact of the disturbance is felt in the goods or money market. Another weakness is that the world economic environment is viewed as being completely static and short-run inflation differences between countries are ignored (Copeland, 1989:199-224; Dornbusch, 1990:15-23; Beenstock, 1990:46-48,60-61; MacDonald, 1990:81-82; De Wet, 2000:8-10).

5.3.4 A General Model of Exchange Rate Dynamics: Portfolio Balance and the Current Account

The portfolio balance theory relies on the same assumption as the Dornbusch model. It allows for the possibility that adjustment in the real sector may well take longer than in the financial markets. Therefore goods prices are taken as fixed in the short run. However, it differs in quite a number of important respects. Divergence starts with the uncovered interest rate parity (UIRP) assumption. Portfolio balance theorists argue that risk aversion is the predominant motive in investors' choice between domestic and foreign currency securities. Financial markets will be characterized by risk premiums large and pervasive enough to make UIRP inoperative due to risk aversion.

Portfolio balance models concentrate not only on the demand for money, but also on the demand for a menu of assets. The demand for any asset as a proportion of wealth will tend to rise when its own return rises, and fall when the return on competing assets increases. Assuming that all markets clear at all times, short-run equilibrium will be obtained when the exchange rate and domestic interest rate are at a level such that demand is equal to supply for any two of the following three assets:

- Domestically issued money
- Domestically issued bonds
- Foreign currency bonds issued by a foreign government or bank.

Open market purchases of either domestic or foreign bonds will cause depreciation and a fall in the interest rate in the short run, with greater repercussion on the exchange rate. Investors will tend to diversify their holdings of risky assets, with portfolio shares that increase as the return on shares rise relative to competing assets. Share increases in foreign bonds can only come about as a result of current account surpluses. The short-run impact on financial markets is an appreciation, in order to keep the domestic currency value of foreign bonds constant. Long-run

equilibrium is characterised by a zero balance of the current account as well as static prices, interest rates and exchange rates (Copeland, 1989:234-251).

The production sector adjusts to disturbances caused by changes in the real exchange rate. As price levels move during the adjustment phase, it interacts with the nominal exchange rate to change the balance of aggregate demand and supply, generating a current account surplus or deficit. The surplus or deficit will persist until the stock of foreign currency assets has reached a level consistent with long-run equilibrium (Beenstock, 1990:53-60).

The process of wealth accumulation proves to be the vital link between short-run equilibrium in the financial sector and long-run equilibrium in the rest of the economy. Private sector savings only take the form of accumulation of foreign currency assets via the financial account of the balance of payments. Under a floating exchange rate the balance on the financial account has to be the reflection of the current account surplus or deficit, providing a link between this sector and the exchange rate.

The portfolio balance model can be seen as an integration of the Mundell-Fleming and Dornbusch models. This model shares the assumption of imperfect capital mobility and the assertion that product prices adjust slowly. However, this is a very complex model, and additionally, it includes variables almost impossible to measure (for example wealth). This makes the model very difficult to apply in practice and of little use for forecasting purposes (MacDonald, 1990:83-84; Copeland, 1989:228-252; Beenstock, 1990:53-60).

5.3.5 The 'News' Approach to Exchange Rate Modelling

The unpredictable nature of exchange rate changes characterises floating exchange rates. In the news approach, the forward rate is viewed as the market's expectation

of the future spot rate. The forward market is regarded as efficient at any time when the forward rate ruling is equal to the rational expectation of the future spot rate and risk premium. Expectations are based on the spot rate when the contract matures, plus the risk premium required as compensation for bearing additional risk. If investors are risk neutral, the risk premium will be zero. According to the unbiasedness hypothesis, it follows that efficiency requires the forward rate to be an unbiased forecast of the future spot rate. It is postulated that most of the movement in exchange rates must be due to the arrival of new information in foreign exchange markets. The main challenge with this approach is obtaining estimates for the expected values of the determinants of the exchange rate. The variable which most consistently yields significant results was found to be the interest differential. Money supply differentials gave more erratic results while income variables proved problematic (Copeland, 1989:289, 297,300-302, 310-313, 315-317; MacDonald, 1990:97).

Researchers have used regression analysis as well as expectational data, obtained from a survey database, to estimate the expected values of the determinants of the exchange rate. MacDonald(1990:98) reported that a number of researchers have empirically implemented news equations, using a variety of news variables they deemed appropriate, and reported results supportive of the news approach.

However, the volatility of the actual news variables used by the researchers in their news equations failed to explain the greater volatility exhibited by exchange rate movements. MacDonald(1990:98) finds this unsurprising, given the fact that a great deal of news is by its very nature unquantifiable. Often non-economic news may dominate, moving the exchange rate by more than what is reflected by the economic fundamentals.

A number of possible explanations for the apparent excess volatility of the major exchange rates are: either currency markets are irrational, there are significant rational price bubbles, or important and highly volatile fundamental variables have

been omitted in previous research. The latter however seems improbable in terms of economic variables. Rational price bubbles are said to occur when a gap opens up between the level of the spot rate and its equilibrium value, as determined by the fundamentals (Copeland, 1989:323, 326-327). Further investigation into the unbiasedness hypothesis revealed the fact that the forward rate contains little of use in the way of a forecast of the future spot rate. Instead it is dominated by the trend in the spot rate at the time it is set (Copeland, 1989:291-293).

5.3.6 Forecasting High-frequency Exchange Rates using Cross-bicorrelations.

In this model time series tests for non-linearity and multivariate exchange rate forecasting are combined. Lags of the cross products with the other exchange rate in the system are incorporated using high frequency data. Analysis and testing revealed that the out-of-sample forecasting performance of this technique using cross-bicorrelations is inferior to that of univariate time series models, in spite of significant in-sample cross-bicorrelation statistics (Brooks & Hinich, 1998:61-72).

5.3.7 Economically-based Exchange Rate Prediction Model

Moolman, an economist from Standard Bank, developed a model to predict the long-term value of the ZAR versus the USD, based on basic economic principles (Van Tonder, 2004:4; Moolman, 2004:1). These principles are:

- The difference between the SA and US inflation rates. (inflation differentials)
- The difference between the SA and US economic growth rates. (growth differentials)
- The difference between the SA and US interest rates. (interest rate differentials)
- The local budget deficit. (South African fiscal policy)

Commodity prices were not needed to explain the behaviour of the Rand. According to Moolman's research, commodity prices only have an impact on the Rand in the short run, and will only impact on the Rand in the long run to the extent that it affects economic growth (Moolman, 2004:1).

Behaviour of the Rand in the long run could be explained by economic fundamentals. Moolman found that the Rand has a tendency to weaken when the local South African inflation rate is higher than the US inflation rate, when the local growth rate is below that of the US or when the budget deficit increases. The Rand will strengthen when real interest rates in SA are higher than those in the US. This is consistent with economic theory since capital flows will follow the highest real returns, appreciating the currency of the country offering the relatively higher return. Rand behaviour due to the inflation differential can be explained by the economic theory of PPP mentioned above.

Moolman emphasises that this model only predicts medium- to long-term trends in the ZAR/USD exchange rate, not short-term fluctuations. Short-term fluctuations occur due to exogenous shocks, speculative behaviour of traders, world events and many other disturbances. These deviations tend not to persist in the long run. The model was found to closely track the historical values of the ZAR / USD exchange rate. However, Moolman also used this same model to forecast the ZAR/British Pound exchange rate and had the same success, due to the fact that the economic ground rules persist, according to Moolman (Van Tonder, 2004:4; Moolman, 2004:1,3,4).

5.3.8 Brink and Koekemoer: A Sticky-price, Dornbusch-type Monetary Model

According to Brink and Koekemoer(2000:4) a truly sophisticated exchange rate model should accommodate forward-looking expectations. These authors focused on a simple, structural long-run macroeconomic model, as Moolman (discussed

above) did. A sticky-price, Dornbusch-type monetary model of the ZAR/USD exchange rate is proposed. The three-step Engle and Yoo co-integration procedure is applied. Test results indicated that the nominal exchange rate is co-integrated with the relative real output, the relative money supplies and the inflation differential. The spot ZAR / USD exchange rate therefore depreciates if SA's monetary discipline becomes slack in comparison to monetary discipline in the US. Likewise, with an increase in the consumer price index(CPI), domestic prices are accelerated compared to the US and depreciation in the dollar value of the Rand will follow. Economic growth may affect an exchange rate appreciation, provided the domestic expansion of the gross domestic product(GDP) exceeds that of its foreign counterpart (Brink & Koekemoer, 2000:10).

Commending on their own models' forecast reliability Brink & Koekemoer (2000:30) admitted that the forecasting reliability of most structural models, like their own, collapses during a crisis when it is most needed. However, it should be noted that the purpose of a structural model is hardly to forecast a crises. It rather serves as an indication of whether the current exchange rate is overvalued or undervalued, and shows how adjustments in economic fundamentals may be expected to affect the Rand. This is also a long-run model, forecasting exchange rates over the medium- to long-term, rather than short-term fluctuations.

5.3.9 The Currency Substitution Approach

Currency substitution models are also monetary models in which domestic and foreign residents are assumed to hold both foreign and domestic currencies. Since markets are not explicitly represented, interest rates are not included. However, an attempt is made to integrate the current and financial accounts through wealth effects. Domestic wealth can only be increased by accumulation of foreign currency arising from a current account surplus.

The exchange rate is determined jointly by financial and goods markets through the interaction of stock and flow variables, integrating both capital and trade account influences on the exchange rate. However, economic evidence of this model is lacking (Copeland, 1989:264; De Wet, 2000:13).

5.4 Conclusion: Exchange Rate Forecasting Models

The simplest model, the monetary model, is founded on the assumption that prices are completely flexible, so that PPP is obtained at all times. By contrast, the Mundell-Fleming model takes the price level as absolutely fixed and allows for variation in national income. The Dornbusch-model offers a compromise with sticky prices and financial markets which compensate in the short-run by over-adjusting. The portfolio balance model offers a richer specification of the menu of assets: domestic and foreign bonds are included. Most of the other models discussed are based on these more well-known basic models. These models offer additional country-specific factors as determinants of exchange rate or use other statistical approaches and analysis techniques to investigate the relationship between macroeconomic variables and the exchange rate.

Each model discussed has certain shortcomings and no ideal conclusion have been reached so far concerning the accurate prediction of exchange rates or explaining exchange rate volatility. Therefore, agreement is reached with Mussa's(1979:2) much earlier remark: "Numerous models have been devised to forecast the exchange rate, though none is error free. There still remains ample area for improvement in this extremely complex financial forecasting area".

However, acknowledging its specific weaknesses, the basic monetary model was selected as the preferable model to base the empirical study on.

6. Exchange Rate Risk

What determine the scale of the compensation required by a risk-averse economic agent to persuade him to speculate? An answer to this question is extremely complex to find due to the paucity of data and the importance of unobservable parameters relating to attitudes toward risk, probability distributions and investors' expectations. Copeland(1989:329, 345) investigated risk premiums in a setting where the investor's utility function is almost unrestricted. He found that the risk premium is given by the ratio of the covariance between marginal utility and the spot exchange rate to the expected marginal utility itself.

6.1 Models for Predicting Exchange Rate Risk

6.1.1 A Formal Approach to Measuring Currency Exposure: Adler & Dumas (1984) and Shapiro (1975) – Regression Analysis

The use of regression analysis is advised to identify the correlation between changes in the nominal exchange rate and the domestic currency value of the firm's cash flows. In effect, using this model involves that changes in a firm's cash flow in the domestic currency are regressed on changes in nominal exchange rates. The resulting estimated slope coefficient is then used as a proxy for currency exposure (Poitras, 2002:161). However, this model has some shortcomings: The use of historical data for regression requires that the nature of the firm has not changed substantively and that no changes are anticipated for the future for which the regression information will be used.

6.1.2 Patro, Wald and Wu: A Panel Approach to Explaining Exchange Rate Risk

Patro, Wald & Wu (2002:1951-1954) used a Generalized Auto Regressive Conditional Heteroskedasticity Model (GARCH) approach to estimate a time-varying two-factor international asset pricing model for weekly equity index returns

of sixteen Organisation for Economic Co-operation and Development (OECD) countries. The model is based on the international asset pricing model. The asset pricing model specifies that an asset's expected rate of return is associated with the covariance of the asset's return with the returns on the world market portfolio as well as returns on foreign exchange rates. A trade-weighted basket of exchange rates and the Morgan Stanley Capital International (MSCI) world market index are used as risk factors. Once the exchange rate betas (exposures) are estimated, the extent to which the foreign exchange exposures can be explained in terms of a country's macroeconomic variables are investigated.

The following variables were found to be significant:

- Exports to gross domestic product (GDP) ratio;
- Imports to GDP ratio;
- Consumer price index (CPI) inflation rate;
- Government surplus to GDP ratio;
- Tax revenues to GDP ratio; and
- Change in the country's credit rating.

The following conclusions were made:

- Countries with higher exports (imports) have more positive (negative) currency risk than countries with lower exports (imports).
- Countries with a better credit rating will be less subject to foreign exchange rate risk, since credit rating is highly negatively correlated with the level of foreign debt.
- Higher tax rates are associated with higher currency risk exposure.

Significant currency risk exposures were found in country equity index returns. These currency betas are explained in terms of several country-specific macroeconomic variables – imports, exports, credit ratings and tax revenues were found to significantly affect currency risks. The authors concluded that these macroeconomic variables might be useful as predictors of currency risk exposure,

agreeing with Moolman and De Wet as well as Brink and Koekemoer discussed above (Patro, Wald & Wu, 2002:1951-1954, 1962-1970).

6.1.3 A Capital Asset Pricing Model Framework for Exchange Risk

The capital asset pricing model (CAPM) is a well-known two-parameter, single period model focusing on the expected rate of return of an asset and the asset's riskiness. Risk is measured by the variance of the asset's rate of return over time measured by ex-post data. Grubel and Solnik in Lackman(1996:1-5) generalized this framework to handle assets denominated in different currencies with an added element of risk due to the presence of foreign exchange and therefore the possibility of devaluation. Grubel and Solnik (1996:3) demonstrated the potential for risk reduction through international diversification.

Diversification for risk reduction was investigated by determining how many securities are necessary to substantially reduce risk. Portfolios were generated for domestic portfolios, international portfolios as well as international portfolios unhedged against exchange rate risk. The aforementioned study was based on weekly stock movements. The diminishing marginal reduction from adding an extra security to the portfolio was evident, as was the reduction of risk through hedging techniques. Solnik found that real exchange risk is due to different consumption preferences and fluctuating commodity prices. It was also shown that, as long as international capital markets are not perfect, real exchange risk exists (Lackman, 1996:1-8).

Although the CAPM-model was generalised into an international general equilibrium framework by many authors, it was done so at great cost. Severely restrictive and unrealistic assumptions must be utilized to make the transition successful. Assumptions made include identical homothetic tastes among all consumers internationally as well as identical expectations about the nature of

exchange rate changes. The analysis further required an equilibrium relationship between interest rates and inflation, in addition to the assumption of a perfect international financial market.

6.2 Conclusion on Exchange Rate Risk Analysis Models

Only a very limited number of models are available for analysing the risk involved due to exchange rate volatility. The three models discussed vary greatly in their approaches to analysis. However, when compared to the models for predicting exchange rate movement, some of the same variables are identified as being significant: GDP-ratios, inflation, the balance of payments as well as import- and export levels. Credit ratings and tax revenues are additional variables identified.

The abovementioned models do not significantly predict exchange rate risk levels and more research are needed in this complicated and ever-changing field of risk analysis.

7. Managing Exchange Rate Risk

7.1 Who should be bearing the exchange rate risk?

According to Maitland(2003:1-2) one of three parties to a contract can bear the risk of exchange rate movements. Some argue that the private investors should bear the risk because they, or at least their ultimate shareholders, can diversify away country-specific exchange rate risk. Others argue that the government should bear the risk because it is responsible for the macroeconomic policies that mainly determine changes in the exchange rate. Some conclude that customers should bear the risk since the customer is ultimately responsible for payment of the cost of the service.

Maitland(2003:2) argues that neither governments nor customers are well placed to bear exchange rate risk and, moreover, that arrangements that attempt to allocate the risk to them often fail in practice. Instead, he concludes that investors should bear the risks created by the use of foreign currency for financing.

7.2 Natural Hedging of Corporate Currency Exposure

Two general types of strategies are available to manage corporate currency exposure according to Poitras(2002:158-159). One type is associated with traditional derivative security hedging techniques, of which the applications include international asset/liability management, where relatively predictable cash flows originate from foreign financial assets. The techniques of swaps, futures and options are well developed in this area. The other general type of strategy involves natural hedges that are dependant on multinational firm management decisions regarding indeterminate cash flows. It involves the assessment of the competitive exposures that originate from inherent differences in competitiveness, due to costs and revenues being denominated in different currencies. Currency exposure management involves adjustments to be made to operating procedures, encompassing marketing, production and capital structure decisions. Natural hedging techniques are inherent in these types of strategies.

Poitras (2002:163) has demonstrated that in the face of deviations from PPP (changes in real foreign exchange rates) a combination of forward exchange contracts, nominal debt and fixed price sales are required to hedge against currency risk.

A company can avoid exchange rate risk by dealing in the forward or future markets for the foreign currency. The company covers known and anticipated external transaction and operating exposures by using foreign currency exchange option, forward and swap contracts.

According to Gray and Irwin (December 2003:2) exchange rate risk can be managed in three ways:

1. The underlying source of the risk can be influenced. Governments can reduce the rate of depreciation and exchange rate volatility by keeping budget deficits small and inflation low.
2. The risk sensitivity of the value of a project, or interest in a project, can be influenced by reducing a project's reliance on foreign currency debt for instance.
3. By hedging or diversifying away the risk.

Research by Priestly and Odegaard(2003:6) showed that exchange rates are priced risk factors, that the price of risk is different for different currencies and different across regimes. According to these authors, the discovery that the price of risk is statistically significant is important for hedging reasons. Firms will therefore obtain a lower cost of capital if they hedge to eliminate exchange rate risk. However this is conditional on the exchange rate regime and the currency.

8. The South African Economy and Exchange Rate

The unique dynamics of the SA economy will be discussed next due to the fact that the empirical study will be based on an analysis in the SA economic framework.

The openness of the SA economy is one of the vehicles for growth, employment and redistribution of income and wealth in the macroeconomic strategy of the SA government. According to this strategy a stable exchange rate, or at least a less unpredictable one, is a prerequisite for a successful outward policy. Therefore it is essential to make sense of the propellants of the exchange rate. The volatility of the Rand is a major cause of uncertainty for SA business, forcing business leaders to re-evaluate plans constantly. Sub-Saharan Africa's currencies have lost 16 per cent of their value relative to the USD on average in the period from 1976 – 2001 (South African Reserve Bank, 2004:3). Therefore, investors not only face a secular decline

in local currencies, but also much uncertainty as to the rate of decline (Brink & Koekemoer, 2000:1; Gray & Irwin: June 2003:1-2). The South African currency has however appreciated against the USD since 2003. Reasons for this appreciation will be discussed below.

Rand strength has helped to curb inflation. Lower import prices have reduced producer inflation, and as it affected domestic consumer prices, it was believed that the Reserve Bank would be able to keep inflation under control. A more relaxed monetary policy stance - manifest in a number of interest rate cuts - was interpreted as a sign of growing confidence that inflation would be kept within the Bank's targets. The possibility now arises that interest rates will be cut even further as the Rand appreciates against the dollar.

Exchange rates are linked to inflation and interest rate differentials. A strong exchange rate encourages hope that the real rate of interest will be lowered to reduce the gap between SA and its trading partners. Lower interest rates improve the efficiency of production by reducing the cost of funding capital formation. Combined with a strong exchange rate, lower funding costs enable businesses to import capital equipment to replace worn-out and obsolete machines. However, when monetary stimulation comes at a time of currency weakness, inflationary pressures will soon increase with the growth of the economy. Growth may initially be rapid, but often cannot be sustained.

The Rand strength is partly the result of the boom in the commodity markets. Commodities represent more than a third of SA's exports. The mining sector plays an important role in this field. During 2001 and 2002, the depreciation of the Rand raised the profitability of mines and boosted their production and exports. But in 2003 the exchange rate appreciation started. Despite the fact that mineral prices have soared, mines are earning less in Rand from their sales in dollars.

Structural imperatives call for a weakening of the exchange rate of the Rand, or a significant cut in interest rates, or both. The economy's growth performance has

been mediocre in comparison with that of the economies of Asia. Real GDP growth forecasts for 2004-2007 range from lows of 2,4 per cent to highs of 3,7 per cent per year (Phillips, 2004:1-2). This is a far cry from the nearly double-digit performance of countries like China, India and Singapore. In 2003, real GDP per capita fell by 0,1 per cent in SA (Phillips, 2004:1-2).

For Old Mutual Asset Managers head Rian le Roux, the main obstacle to higher growth is that South Africa is still saddled with high real interest rates and a strong real exchange rate. Though the Rand is expected to weaken only slightly in 2004/2005, better-than-expected inflation data released during June 2004 (the May CPIX figure remained unchanged at 4,4 per cent year-on-year while PPI was 1,2 per cent) has substantially diminished the risk of a rates hike (Bisseker, 2 July 2004:1). African Harvest Fund Managers economist Adenaan Hardien attributes the fall in inflation to the fact that the currency has been stronger and less volatile. Lower inflation means lower interest rates and higher growth. However, both agree that only once inflation has been in the target area for a few years, and inflation expectations, wage settlements and administered price increases are settled in the range, inflation will be structurally tamed (Bisseker, 2 July 2004:1).

The Rand is being driven mainly by dollar weakness but also by strong global economic growth, firm commodity prices and SA's high real interest rates. Herewith speculative capital flows, or "hot money" is attracted to SA. Up to July 2004, the ZAR was the best-performing currency globally, having gained almost 10 per cent against the dollar. Such unbelievable currency strength spells disaster for exporters and could cut the recovery in manufacturing and mining off at the knees (Bisseker, 16 July 2004:1).

Absa senior economist John Loos argues that while there may be some short-term negative effects of a strong Rand, in the long-term the benefits of sustained pressure exerted by a stronger currency could be significant. It forces the economy to become more competitive and efficient. "Recent Rand strength has helped bring about relatively low interest rates and a significant reduction in the cost of imported

capital goods," he says. "This may partly explain the strong rates of domestic fixed-capital formation, which raises output potential and gears up the economy for stronger growth."

Deputy Governor Ian Plenderleith said: "The South African Reserve Bank's policy continues to be one of gradually accumulating foreign exchange reserves. That is precisely what has been done during the past year or more." Plenderleith reiterates that the Bank's stated position is that it "has no intermediate policy targets or guidelines and is committed to allowing the value of the Rand to be determined by the market" (Bisseker, 16 July 2004:2-4).

Though the bank's policy has obvious merits, some economists wonder why it hasn't accumulated reserves more aggressively or even abolished exchange controls once and for all. It is argued that such steps should help relieve pressure on the currency and get rid of a structural rigidity in the economy.

As far as exchange controls go, Goldman Sachs economist Carlos Teixeira disagrees. Teixeira predicts that though abolishing exchange controls might initially cause a knee-jerk weakening of the currency, over time it could lead to a 20 per cent appreciation in the long-term equilibrium trade-weighted value of the Rand. The bottom line, though, is that the current state of the Rand is due to cyclical rather than structural factors. And if the cyclical factors that have supported the Rand (cheap global capital and accelerating world growth) are indeed reversing, the currency should weaken to levels more easily digestible by industry (Bisseker, 16 July 2004:2-3).

South Africa is currently under way to a fully integrated, open economy. Although necessary, this will lead to vulnerability to international capital flows, investor sentiment towards SA and financial crises. These factors contribute to both short- and long-term fluctuations in the value of the Rand and therefore risk. This makes forecasting of the exchange rate more difficult since authorities have virtually no control over the foreign exchange market (De Wet, 2000:20).

CHAPTER 3: EMPIRICAL STUDY

1. Developing the Basic Equations

1.1 Developing the Monetary Equation for Predicting the Exchange Rate

The following five hypotheses describe a general statement of the monetary approach:

1. Purchasing power parity (PPP) holds over some time horizon in the long run.
2. Uncovered interest parity (UIP) holds at all times.
3. The demand for real money balances is a stable function of a small set of real variables.
4. The supply of money is determined by a stable process.
5. Expectations are (in some sense) rational (Boughton, 1988:4).

From the above, PPP and UIP warrant more discussion since they present very stringent conditions. The relative version of PPP in its expectational form can be written as (Copeland, 1989:66):

$$\varepsilon (de) = \varepsilon (dp) - \varepsilon (dp_f) \quad (1)$$

with $\varepsilon (de)$ the log of the expected depreciation in the domestic currency, $\varepsilon (dp)$ the log of the expected domestic inflation rate and $\varepsilon (dp_f)$ the log of the expected foreign inflation rate. Equation (1) states that the expected exchange rate depreciation equals the expected inflation differential. UIP states that the expected depreciation is equal to the interest differential (Copeland, 1989:86):

$$\varepsilon (de) = i - i_f \quad (2)$$

To establish an ex ante real interest parity (RIP) equation (1) and (2) is combined in equation 3 as follows:

$$\epsilon r - \epsilon r_f = [i - \epsilon (dp)] - [i_f - \epsilon (dp_f)] \quad (3)$$

with r denoting the real interest rate. Equation (3) states that RIP holds if both PPP and UIP hold. Since PPP are assumed to hold in the long run and deviations from PPP are generally caused by exchange rate or inflation forecast errors, such errors are assumed not to exist. In addition, deviations from UIP caused by risk premiums or exchange rate forecast errors are assumed to be absent. The stringiness of the first two hypotheses in the list above should therefore be recognized: Simultaneous PPP, UIP and RIP are implied and all sources of deviation from any of these parity conditions are assumed not to exist (Marston, 1997:289; Brink & Koekemoer, 2000:6-7).

The fundamental equation in the monetary approach is a conventional money demand function (Copeland, 1989:152):

$$m = p + \varphi y - \lambda i \quad (4)$$

where m = the log of the domestic money supply, p = the log of the domestic price level, y = the log of domestic real income, i = the nominal domestic short-term interest rate, φ = the income elasticity of the demand for money and λ = the interest rate semi-elasticity of the demand for money.

A similar money demand function is formulated for the foreign country(f) (of which the exchange rate wants to be predicted) :

$$m_f = p_f + \varphi y_f - \lambda i_f \quad (5)$$

By subtracting equation (5) from equation (4) a relative money demand function is obtained:

$$(m - m_f) = (p - p_f) + \varphi (y - y_f) - \lambda (i - i_f) \quad (6)$$

UIP is implied by the perfect substitutability assumption (Copeland, 1989:86):

$$i - i_f = \epsilon (de) \quad (7)$$

where $\varepsilon (de)$ represents the expected depreciation of the domestic currency.

The relative price level can be obtained by rewriting equation (6):

$$(p - p_f) = (m - m_f) - \phi(y - y_f) + \lambda(i - i_f) \quad (8)$$

Equations (7) and (8) are subsequently combined:

$$(p - p_f) = (m - m_f) - \phi(y - y_f) + \lambda \varepsilon (de) \quad (9)$$

Equation (9) states that relative prices are determined by the domestic money supply relative to the foreign money supply, domestic income relative to foreign income and also by the expected depreciation in the domestic currency.

A long-run version of PPP is now introduced (Copeland, 1989:67):

$$\bar{e} = \bar{p} - \bar{p}_f \quad (10)$$

where the bars over the variables signify long-run relationships and e = the log of the spot exchange rate, reflecting the domestic price of foreign currency.

Equation (9) can be combined with (10) and rewritten as:

$$\bar{e} = (\bar{m} - \bar{m}_f) - \phi(\bar{y} - \bar{y}_f) + \lambda \varepsilon (de) \quad (11)$$

In its expectational form, PPP equals the expected depreciation to the expected inflation differential:

$$\varepsilon (de) = \varepsilon (dp) - \varepsilon (dp_f) \quad (12)$$

A long-run version of exchange rate determination can now be obtained by combining equations (11) and (12):

$$\bar{e} = (\bar{m} - \bar{m}_f) - \phi(\bar{y} - \bar{y}_f) + \lambda \varepsilon(\bar{de}) - \varepsilon(\bar{dp}_f) \quad (13)$$

Equation (13) states that in the long run, the exchange rate as the relative price of currency is determined by the relative supply of and demand for money. A proportionate depreciation results if the domestic money supply expands. Similarly, an increase in domestic income or a decline in the expected inflation rate stimulates the demand for domestic money and results in an appreciation of the domestic currency against its foreign counterpart.

It is assumed that expectations are rational, that the system is stable, that income growth is exogenous (or random with mean zero) and, finally, that monetary growth follows a random walk as a benchmark specification. The expected inflation rates are consequently replaced by the actual domestic and foreign inflation rates, to render the final form of the exchange rate equation (Brink & Koekemoer, 2000:7):

$$\bar{e} = (\bar{m} - \bar{m}_f) - \phi(\bar{y} - \bar{y}_f) + \lambda(\bar{I} - \bar{I}_f) \quad (14)$$

with $\bar{I}$ denoting the actual inflation rate. Relative money supplies, relative income levels and relative inflation rates therefore determine the long-run exchange rate. The ZAR/USD exchange rate depreciates if South Africa's monetary discipline becomes slack in comparison to monetary discipline in a foreign country. Likewise, depreciation in the external value of the Rand results if an increase in the CPI accelerates domestic prices compared to a foreign country. Economic growth may again affect an exchange rate appreciation, provided the domestic expansion of GDP exceeds that of its foreign counterpart.

The exchange rate can be predicted by using forward-looking expectations and substituting them into equation (14). However, all the factors impacting on risk

associated with exchange rate volatility is not addressed in equation (14). A risk equation will be developed next to address exchange rate volatility risk.

1.2 Developing the Risk Equation

From the literature study the following variables were identified, apart from those already described in 1.1, which may predict currency crisis or exchange rate volatility and therefore risk:

- GDP growth rate;
- Fiscal policy as portrayed by the budget deficit to GDP ratio and national debt to GDP ratio;
- Openness of the economy as portrayed by the ratio of exports and imports relative to GDP;
- Levels of foreign currency reserves relative to GDP; and
- Interest rate differentials between the domestic and foreign country.

1.2.1 GDP Growth Rate

GDP presents the broadest measure of economic activity and serves as one of the most important macro-economic aggregates. The percentage change in GDP reflects the growth rate of total economic output. GDP serves as a yardstick for the strength of the economy as it is concerned about development over time. A repeated or steady declining GDP growth rate therefore signals trouble. Low GDP-growth coupled with a large government and current account deficit may contribute to a currency crisis (Gouws, 2000:23-24).

The GDP is calculated in the following way using the expenditure approach:

$$GDP = FCE + GFC + INV + EXP - IMP \quad (15)$$

where FCE = final consumption expenditure, GFC = gross fixed capital formation, INV = changes in inventories, EXP = exports of goods and services and IMP = imports of goods and services. Equation 1 can be reduced to:

$$GDP = GDE + EXP - IMP \quad (16)$$

where GDE = Gross Domestic Expenditure. The South African Reserve Bank publishes GDP data using the expenditure approach, while Statistics SA uses the production approach. The USA utilise both the expenditure and income approaches (South African Development Community, 1999:28; International Monetary Fund, 1997:3).

The annual GDP growth rate is calculated as:

$$GDP \text{ growth rate} = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \times 100 \quad (17)$$

The real GDP growth rate is inflation adjusted and calculated in the following way:

$$Real \text{ GDP} = [(1 + Nom \text{ GDP}) / (1 + INF) - 1] \times 100 \quad (18)$$

where $Real \text{ GDP}$ = real GDP growth rate, $Nom \text{ GDP}$ = nominal GDP growth rate expressed as a decimal value and INF = inflation rate expressed as a decimal value (Fourie, 1997:212-213).

1.2.2 Fiscal Policy

An optimal fiscal policy rule should be developed for an economy which set standards for desirable levels of budget deficits and national debt-to-GDP ratios.

The fiscal rule defined in the European Stability and Growth Pact indicates the following:

- Sixty per cent of GDP as the upper bound on national debt for industrialised countries and forty per cent for emerging market

countries. The higher the debt ratio, the greater the potential instability arising from a decline in growth or an increase in the real interest rate.

- Three per cent of GDP as an upper bound on the budget deficit.
- The budget should on average be close to balance over the cycle (Fischer, 2002:2-4).

1.2.3 Openness of the Economy

A more open trade regime is likely to be associated with a more depreciated real exchange rate. Trade restrictions increase the domestic price of tradable goods, thereby raising the overall price level and the exchange rate.

Openness is proxied by the ratio of exports plus imports to GDP, which is often referred to as trade in goods as a percentage of GDP.

1.2.4 Foreign Currency Reserves

The ratio of foreign currency reserves relative to GDP, provide an indirect measure of a country's buffer against capital shifts. High levels of reserves buffer against currency devaluation and speculation. A balance of payments surplus causes a rise in foreign currency reserves. Foreign reserves are essential in paying for imports and a rule of thumb is that a country should have sufficient reserves to cover at least three months' imports. The level of foreign reserves are one of the most important considerations in interest rate policy decisions – when relatively low levels are reached, the interest rate are increased in order to restrain expenditure and therefore imports.

When evaluating the changes in foreign reserves, the change in gross gold and other foreign reserves is the relevant account to monitor. A declining foreign reserve to GDP ratio, accompanied by high inflation, may signal overvaluation and future currency crisis (Rosenblat, 2001:2-3; Fourie, 1997:104-106).

1.2.5 Interest Rate Differential

The theory of interest rate parity holds that if interest rates are higher in one currency than another, the difference reflects the expected depreciation of the higher-yielding currency. Funds would move from the lower-yielding to the higher-yielding currency because markets tend to equalise risk-adjusted expected rates of return, unless the exchange rate were expected to compensate for the difference in interest rates. Therefore it can be concluded that differences in interest rates tend to reflect expected depreciation (Gray & Irwin, June 2003:3).

Interest rate movements should therefore be monitored as changes result in possible exchange rate movements and therefore risk.

2. Developing the Theoretical Models

2.1 The ZAR/USD Exchange Rate Prediction Model

The ZAR / USD exchange rate prediction model is based on the monetary approach and includes the following variables:

$$EXCH = f\{M3, GDP, INFL\}$$

where $EXCH = \text{LN}(\text{the spot ZAR / USD exchange rate});$

$M3 = \text{LN}(\text{SA M3 money supply / US M3 money supply});$

$GDP = \text{LN}(\text{SA real GDP / US real GDP});$ and

$INFL = \text{SA CPI} - \text{US CPI}.$

This specification corresponds to equation (14) developed in 1.1 above.

The ZAR / USD exchange rate therefore depreciates, or EXCH increases, when the SA monetary authorities' discipline is deteriorating in comparisons with its US counterpart. Economic growth, as measured by GDP, can lead to an appreciation of the ZAR compared to the USD, should the domestic expansion of GDP exceed that of the US. Rising inflation rates in SA also lead to an increase in EXCH due to rising domestic prices, in line with the theory of PPP.

2.2 The Exchange Rate Risk Model

Risk due to volatility of the ZAR / USD exchange rate is based on the following variables:

$$\text{CHANGE} = f(\text{DEF}, \text{DEBT}, \text{INT}, \text{GDP}, \text{OPEN}, \text{FORES})$$

where CHANGE = Change in the ZAR/USD exchange rate (with base year 1978 = 1);

DEF = Change in (SA Budget deficit to GDP ratio) / (US Budget deficit to GDP ratio);

DEBT = Change in (SA National debt to GDP ratio) / (US Foreign debt to GDP ratio);

INT = Change in (SA 3 month Treasury bill rate) / (US 3 month Treasury bill rate);

GDP = Change in (SA GDP growth rate) / (US GDP growth rate);

OPEN = Change in [(SA Exports + Imports) / GDP] / [US Exports + Imports) / GDP]; and

FORES = Change in (SA Foreign Currency Reserves / GDP) / (US Foreign Currency Reserves / GDP).

(Annual changes were calculated using 1978 as base year.)

Changes in the ZAR / USD exchange rate therefore occurs due to the following: Slack or deteriorating fiscal policy in SA, in the form of increasing national debt to GDP ratios as well as budget deficit to GDP ratios, cause potential instability and depreciation of the Rand. The Rand will appreciate to the Dollar if real interest rates in SA are above those in the US. Consistent with economic theory, capital flows will follow the highest real returns, which will strengthen the currency of the country offering the relatively high returns. The Rand will also appreciate relatively to the Dollar to the extent that the SA GDP growth rate exceeds that of the US. Openness of the economy also play an important role in predicting changes in the ZAR / USD exchange rate. Opening up of the SA trade regime is associated with a

risk of depreciation of the Rand relatively to the Dollar. A declining foreign currency reserve to GDP ratio indicates the risk of future currency depreciation.

3. The Data Collection Process

All the South African data was obtained from the South African Reserve Bank web site (www.reservebank.co.za) and Quarterly Bulletins. The three-month Treasury Bill Rate was considered the representative short-term interest rate for South Africa. The consumer price index(CPI) was used to calculate the inflation rate.

United States data was obtained from the Federal Reserve of St. Louis web site (www.stlouisfed.com). The three-month Treasury Bill Rate was used for the US short-term interest rate.

Data was transformed with 1978 as base year where appropriate. To accommodate inflation, data was deflated using the consumer price index. All data, except for inflation data in the form of CPI, was transformed into the logarithmic form. However shorter than would be ideal, the sample period commenced in 1978. South Africa maintained some form of fixed exchange rate until 1978 despite the demise of the Bretton Woods system. It was only from 1978 onwards that the exchange rate was permitted to float. Due to this structural break which manifested itself in 1978, the sample period was restricted to this era of floating of the Rand.

4. The Exchange Rate Prediction Equation – Results Analysis

4.1 Graphical examination of the Data

Data plots of the variables (refer to Figures 2 to 5) predicting the exchange rate indicated the following: EXCH and M3 show definite upward trends and are therefore positively correlated. The upward trend in INFL is less conspicuous. GDP shows a downward trend.

Figure 2: Data Plot for LN(the spot ZAR / USD exchange rate) [EXCH].

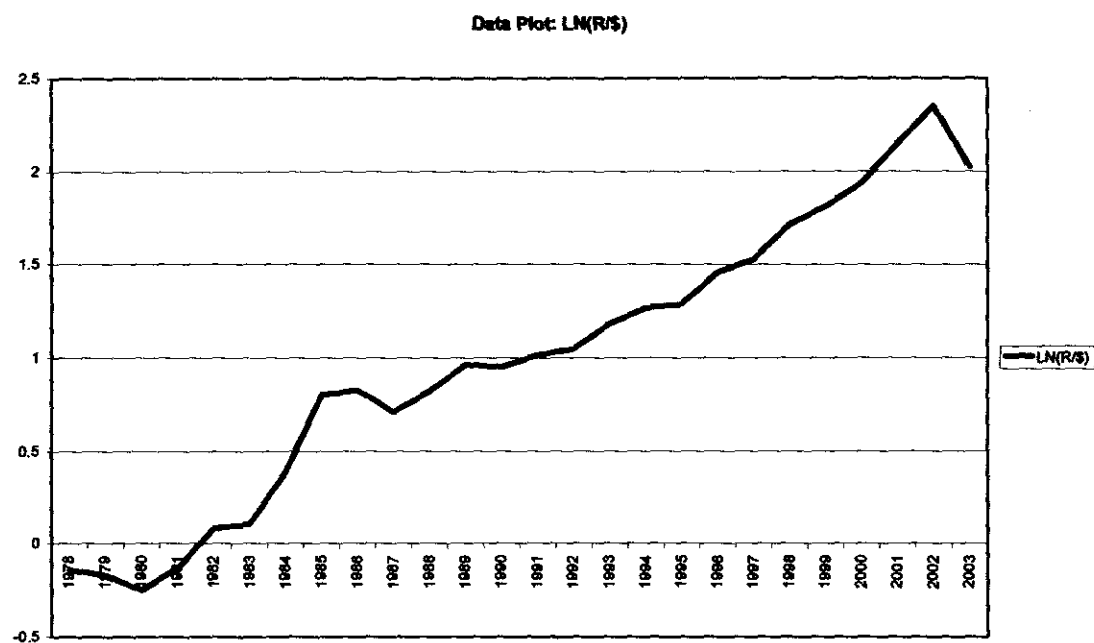


Figure 3: Data Plot for LN(SA M3 money supply / US M3 money supply) [M3].

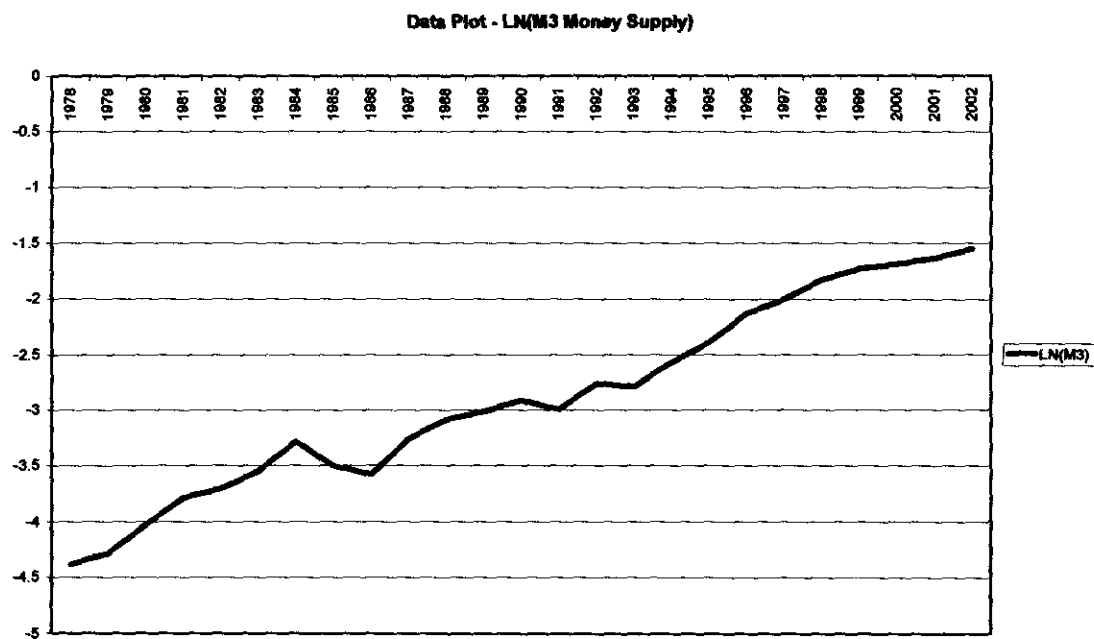


Figure 4: Data Plot for SA CPI – US CPI [INFL].

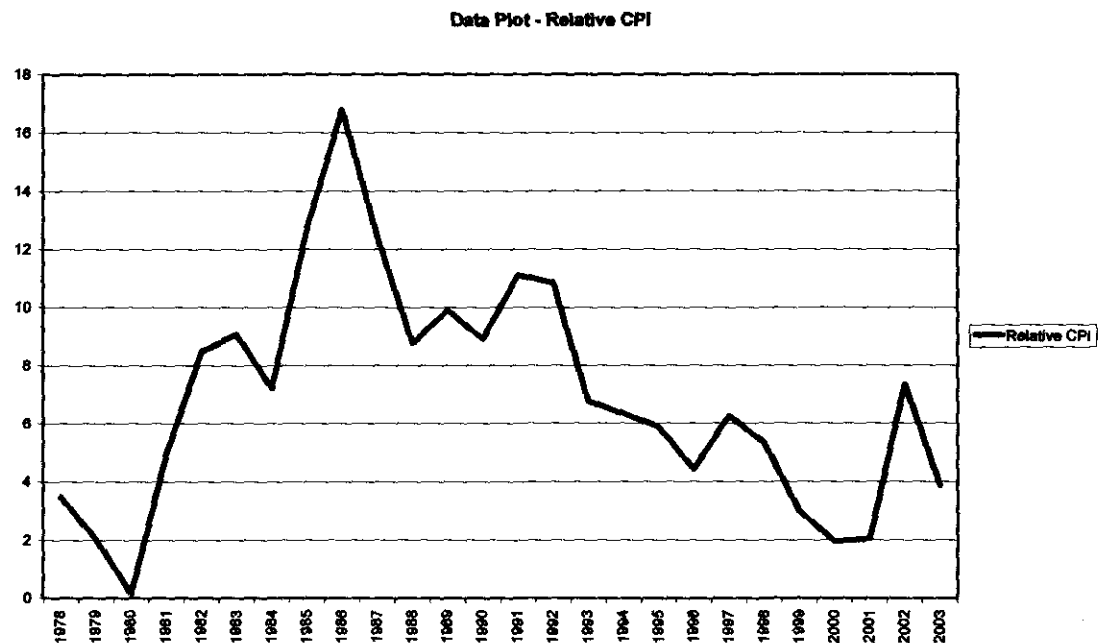
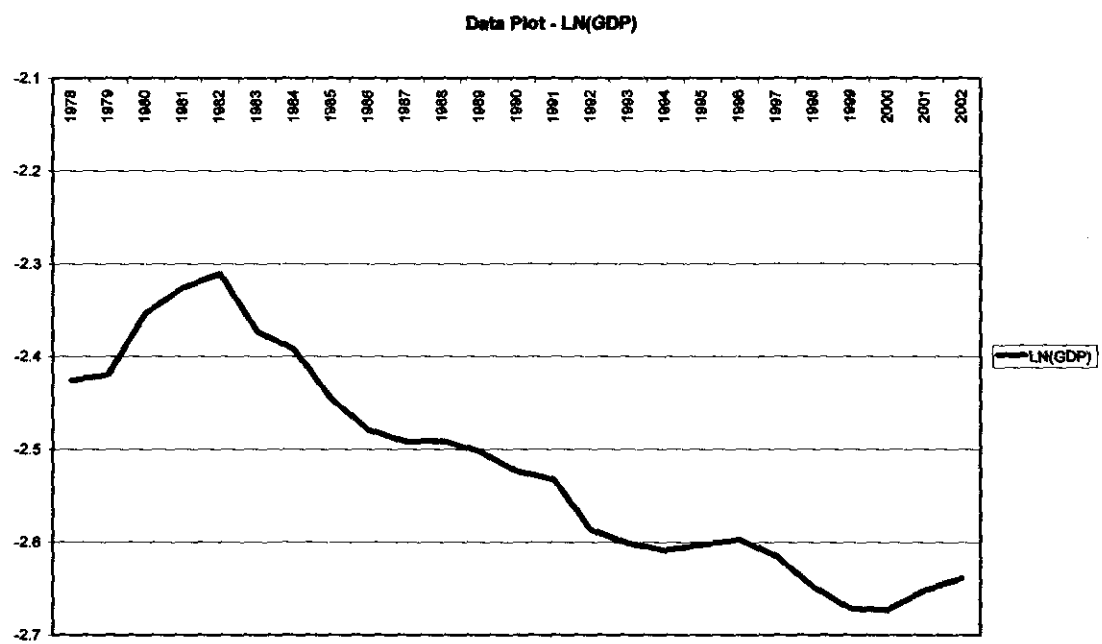


Figure 5: Data Plot for LN(SA real GDP / US real GDP) [GDP].



4.2 Results of the Regression Analysis

Table 1: Summary Output of Regression Analysis – Exchange Rate Prediction Equation

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.983503651
R Square	0.967279432
Adjusted R Square	0.962605065
Standard Error	0.145153562
Observations	25

<i>ANOVA</i>					
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	13.07994168	4.35998056	206.9327148	9.48674E-16
Residual	21	0.44246069	0.021069557		
Total	24	13.52240237			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-2.94469067	1.703245136	-1.728870735	0.098507804	-6.486783449	0.597402109
LN(M3)	0.606098173	0.079191129	7.653611993	1.66202E-07	0.441411177	0.77078517
LN(GDP)	2.174903782	0.594062996	-3.661065906	0.001456704	-3.410325628	-0.939481936
Relative CPI	0.024359931	0.007608907	3.201502009	0.004288544	0.00853634	0.040183522

4.3 Discussion of Output of Regression Analysis

4.3.1 Graphical Representation of the Predicted Values

Referring to Figures 6 to 8, the predicted values lines seem to fit the actual data relatively well.

Figure 6: Line Fit Plot for LN(SA M3 money supply / US M3 money supply).

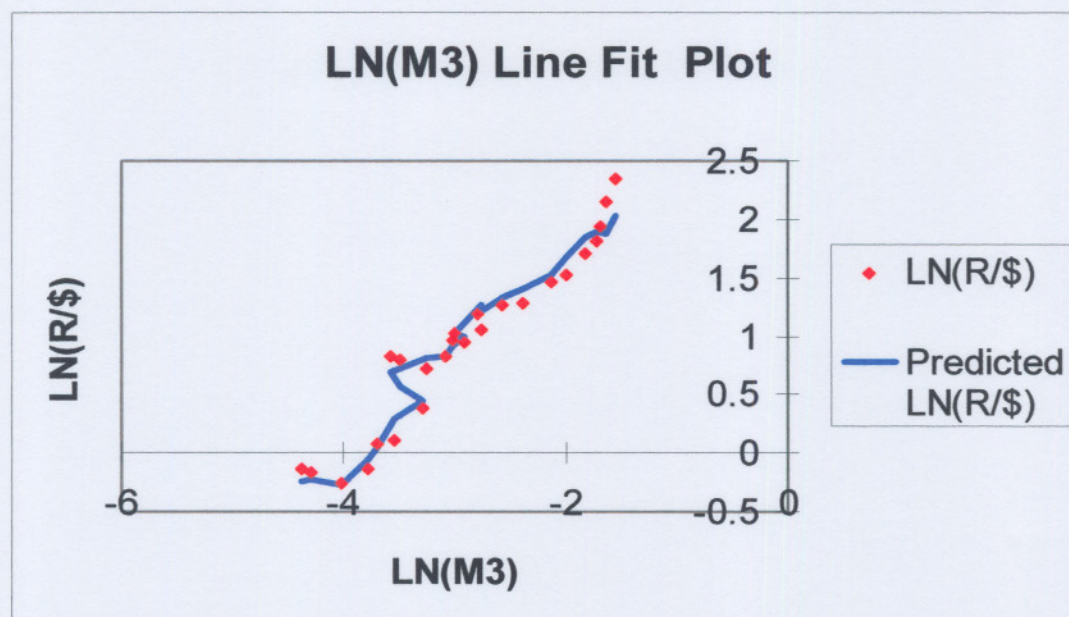
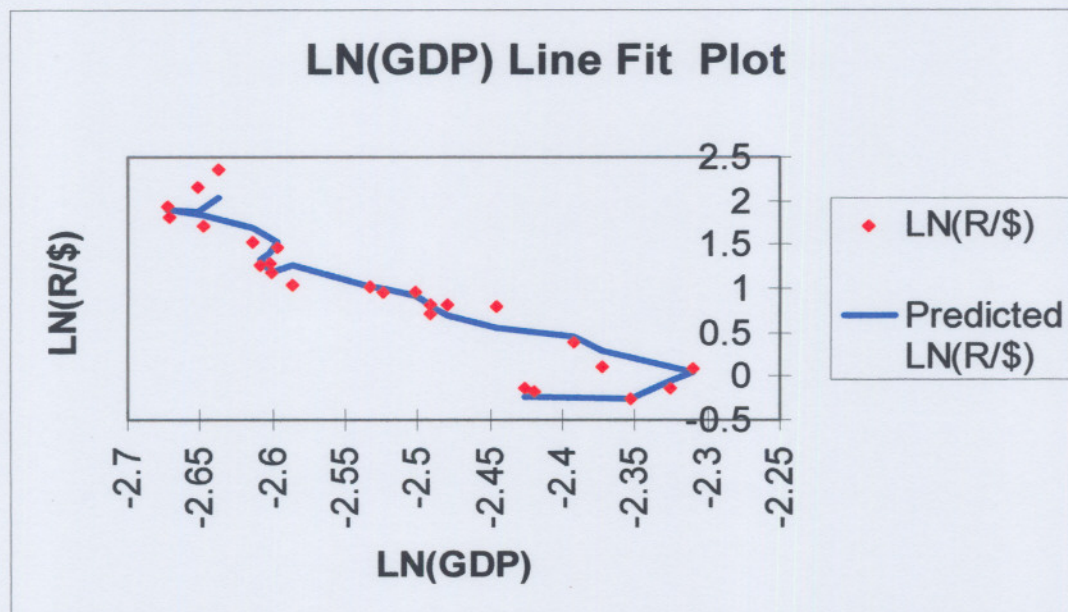


Figure 7: Line Fit plot for LN(SA real GDP / US real GDP).



4.3.2 Coefficient of Determination

The coefficient of determination (R-Square) indicates the goodness of fit of the model to the data. An R-Square value of 0.967279432 is obtained from Table 1. This indicates that nearly 97 per cent of the variation in the dependant variable, EXCH, around its mean can be explained by variations in the three independent variables.

4.3.3 Hypothesis Test for Overall Goodness of Fit Test (F-test)

The F-test is performed to assess the overall goodness of fit of the estimated equation. In the regression equation $Y = a + bX$, the b term indicates the slope of the estimated line indicating the relationship between the dependant and independent variables. The null hypothesis is formulated so that the b term in the equation is not statistically different from zero. Therefore, if the null hypothesis is rejected, it implies that at least one of the independent variables is statistically significant in explaining the dependant variable. Rejection of the null hypothesis also implies that the independent variables overall explains the variation in the dependant variable satisfactorily.

The term *Significance F* in Table 1 refer to the probability that the null hypothesis should not be rejected. Given that the significance F is close to zero, the null hypothesis is rejected, indicating an overall goodness of fit between the dependent and independent variables and that the equation, overall, is statistically significant.

4.3.4 Assessment of the Individual b parameters (T-tests)

In order to assess whether each of the explanatory or independent variables makes a significant contribution to the overall equation, individual t-tests are performed. The t-test is performed by setting each variable's b value to zero and assessing whether it will affect the overall fit of the model. The null hypothesis is therefore

formulated such that we assume there is no relationship between the dependant and independent variables.

When referring to Table 1, under coefficients the estimated b values for the independent variables as well as the standard error for each parameter are displayed. The calculated t-value (t Stat) is shown as well as the probability (P-value) of the calculated t-value exceeding that of the critical t-value if the null hypothesis is correct. All the parameters have a small probability value, indicating a small probability, close to zero, that the null hypothesis is correct. Therefore the null hypothesis is rejected and the alternative accepted, indicating a causal relationship between the dependant and independent variables. With a significance level of 0.05 it would be decided not to reject the null hypothesis only when the probability value was greater than 0.05, which is not the case here. It can be concluded at a 95 per cent confidence level that all the independent variables namely M3, INFL and GDP are statistically significant.

4.3.5 Graphical Representation of the Predicted versus the Actual ZAR / USD Exchange Rate

The ZAR versus the USD exchange rate predicted by using the model developed above, are portrayed in Figures 9 and 10 below. It is compared to the actual exchange rate. It is evident that the Rand sharply depreciated during 2001 and 2002. This sharp depreciation is attributed to speculative attacks on the Rand. An exchange rate model comprising the fundamentals of exchange rate determination loses most of its explanatory powers on occasions such as these, when negative psychology prevails.

Forecasts for the exchange rate for 2004 to 2007 are also displayed. In using this model for forecasting the future values of the Rand, assumptions have to be made on all the explanatory variables used in the model. The assumptions of SA variables were based on Standard Bank's macroeconomic forecasts while the assumptions regarding the US variables were based on OECD forecasts.

Figure 9: Plot examining the Predicted versus Actual LN(ZAR/USD) Exchange Rate.

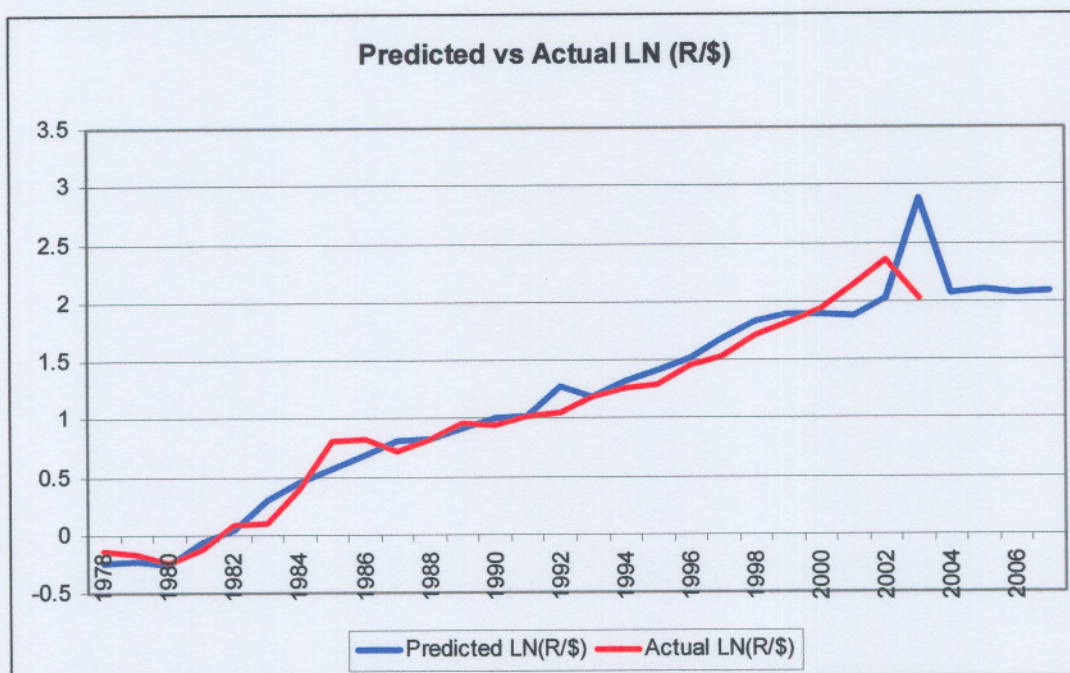
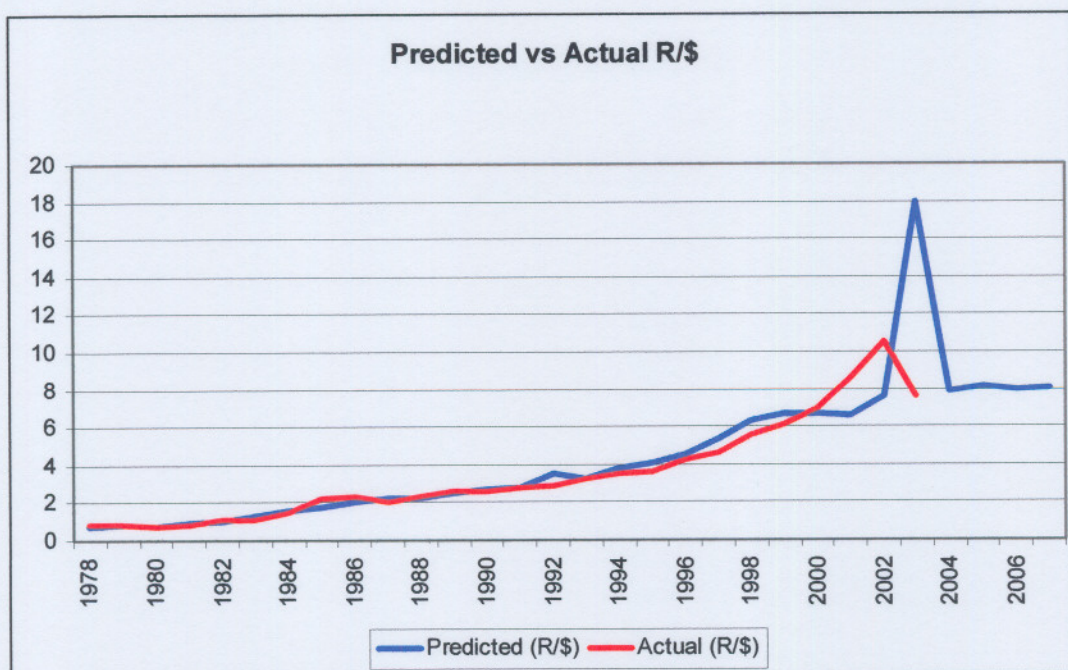


Figure 10: Plot examining the Predicted versus Actual ZAR / USD Exchange Rate.



The SA GDP is expected to increase at 2,8 per cent, 3,2 per cent, 3,0 per cent and 2,7 per cent respectively for each year from 2004 to 2007 while the US GDP is expected to rise at 4,7 per cent, 3,5 per cent, 3,0 per cent and 3,0 per cent for the same period. For the SA CPI an increase of 2,2 per cent, 4,6 per cent, 4,8 per cent and 4,4 per cent was predicted for each year from 2004 to 2007 while US CPI levels was expected to increase by a steady 1,9 per cent each year over the four subsequent years. The M3 money supply levels were predicted to increase. SA M3 money supply levels were predicted at R395 314 million for 2004, R405 879 million for 2005, R405 978 million for 2006 and R430 159 million for 2007. The US M3 money supply levels were predicted at \$1646.24 billion for 2004, \$1724.8 billion for 2005, \$1841.25 billion for 2006 and \$1924.85 billion for 2007.

5. Conclusion - The Exchange Rate Prediction Equation

From the above, it can be concluded that the equation devised to predict the exchange rate is statistically significant. The independent variables do actually influence and predict the dependent variable. The ZAR / USD exchange rate therefore depreciates when the SA monetary authorities' discipline is deteriorating in comparisons with its US counterpart or when SA inflation rates rise. Appreciation occurs when domestic economic growth, as measured by GDP, exceeds that of the US. The equation can therefore be used for forecasting purposes.

6. The Exchange Rate Risk Model – Results Analysis

6.1 Graphical Examination of the Data

Data plots of the variables (see Figures 11 to 17) influencing the volatility in the exchange rate indicated the following: CHANGE and OPEN show definite upward trends and is therefore positively correlated. The upward trend in GDP and FORES is less conspicuous. DEBT and INT show a downward trend. The plot for DEF shows no apparent trend.

Figure 11: Data Plot for Change in the ZAR/USD Exchange Rate [CHANGE].

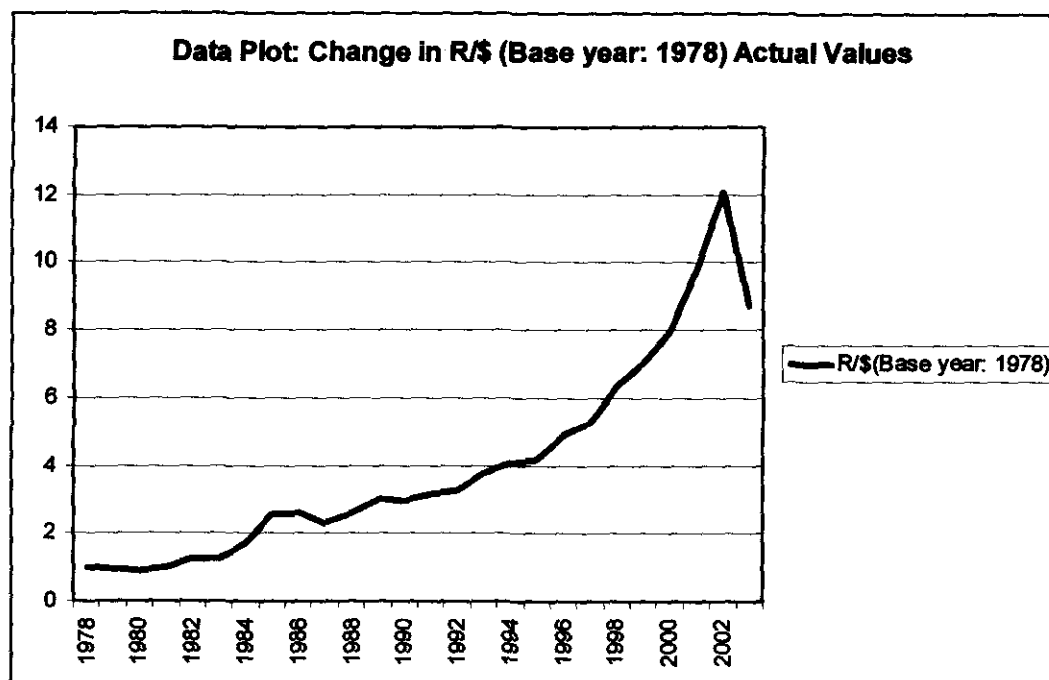


Figure 12: Data Plot for Change in (SA Budget deficit to GDP ratio) / (US Budget deficit to GDP ratio) [DEF].

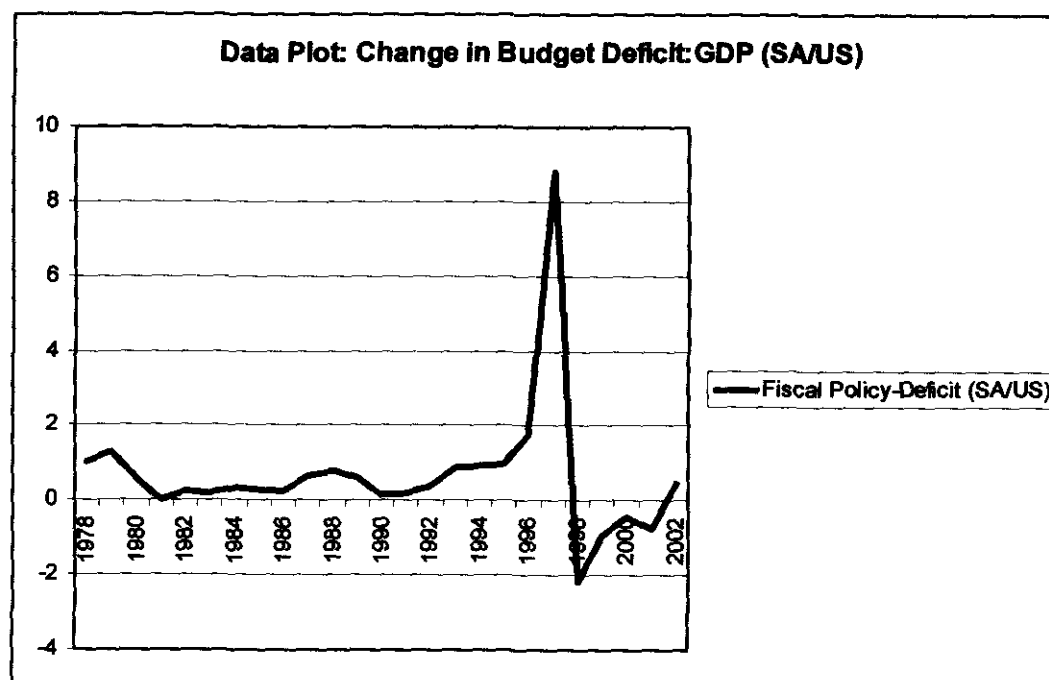


Figure 13: Data Plot for Change in (SA National debt to GDP ratio) / (US Foreign debt to GDP ratio) presenting Fiscal Policy Stance [DEBT].

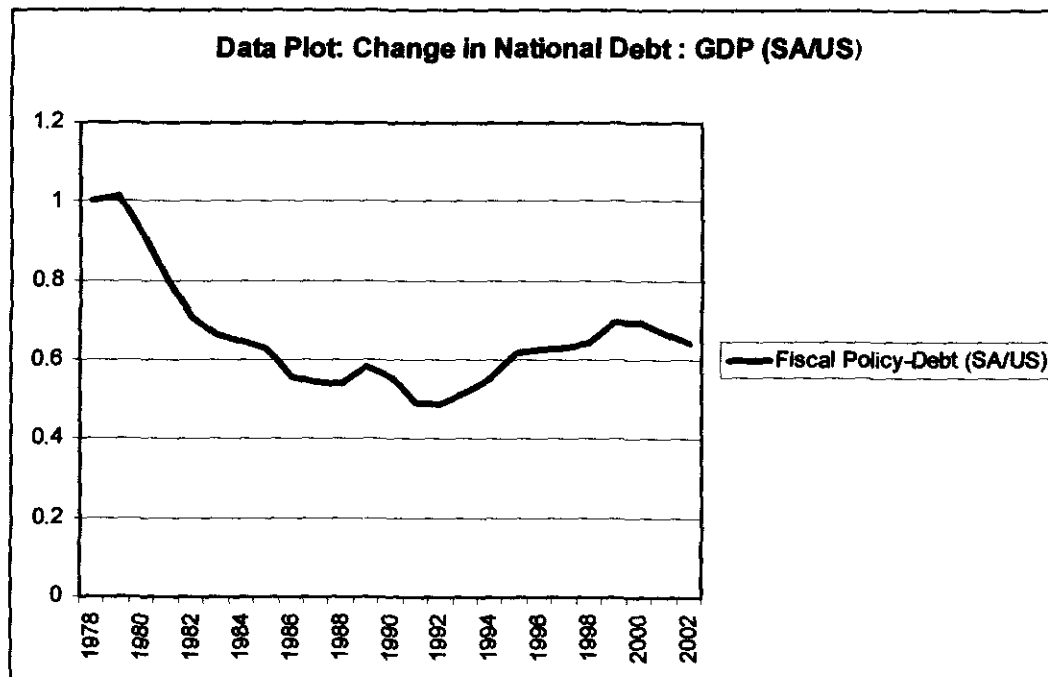


Figure 14: Data Plot for Change in (SA 3 month Treasury bill rate) / (US 3 month Treasury bill rate) presenting Interest Rates [INT].

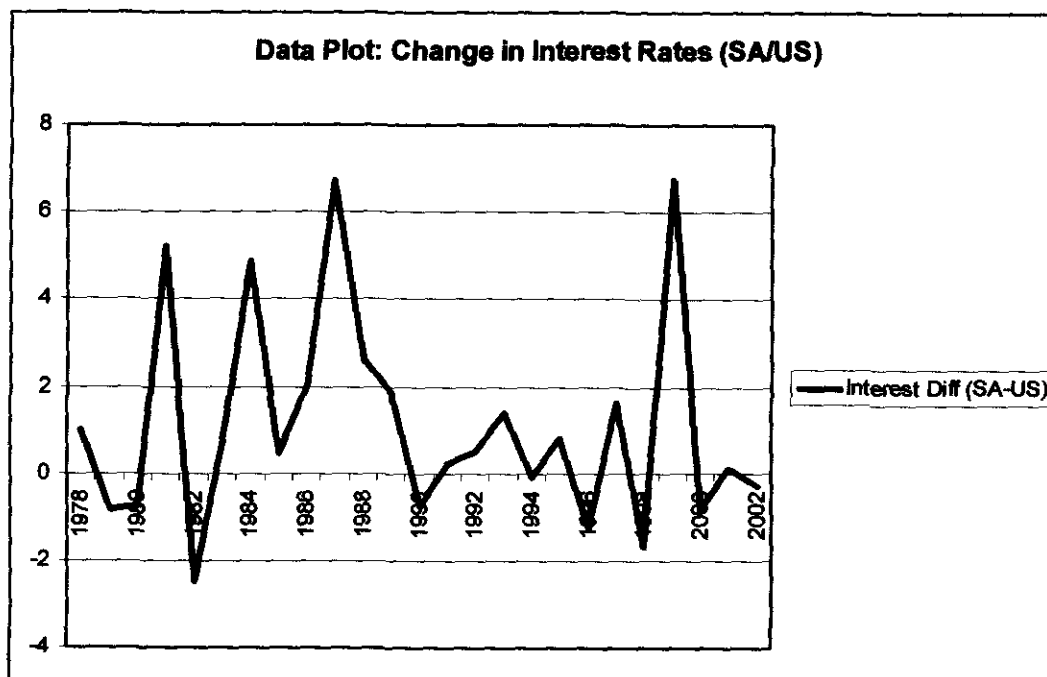


Figure 15: Data Plot for Change in (SA GDP growth rate) / (US GDP growth rate) [GDP].

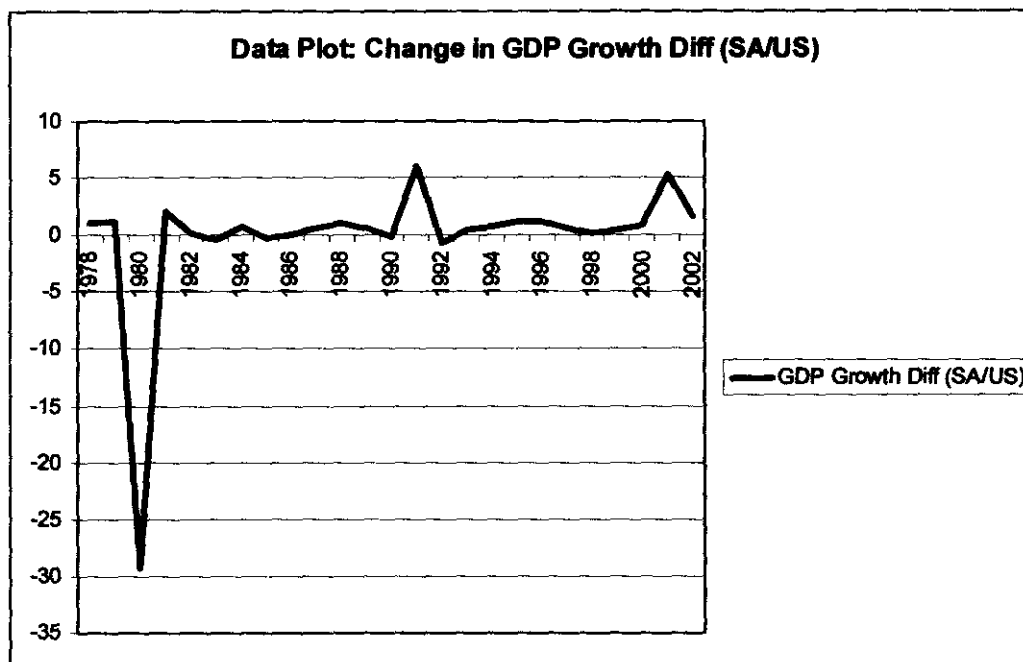


Figure 16: Data Plot for Change in [(SA Exports + Imports) / GDP] / [US Exports + Imports) / GDP] [OPEN].

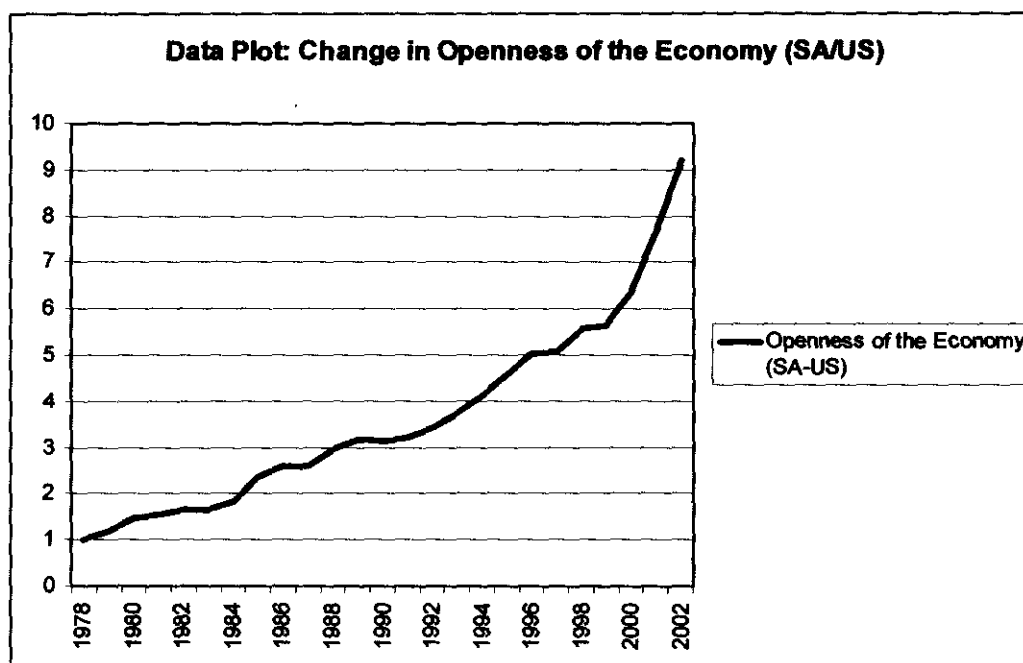
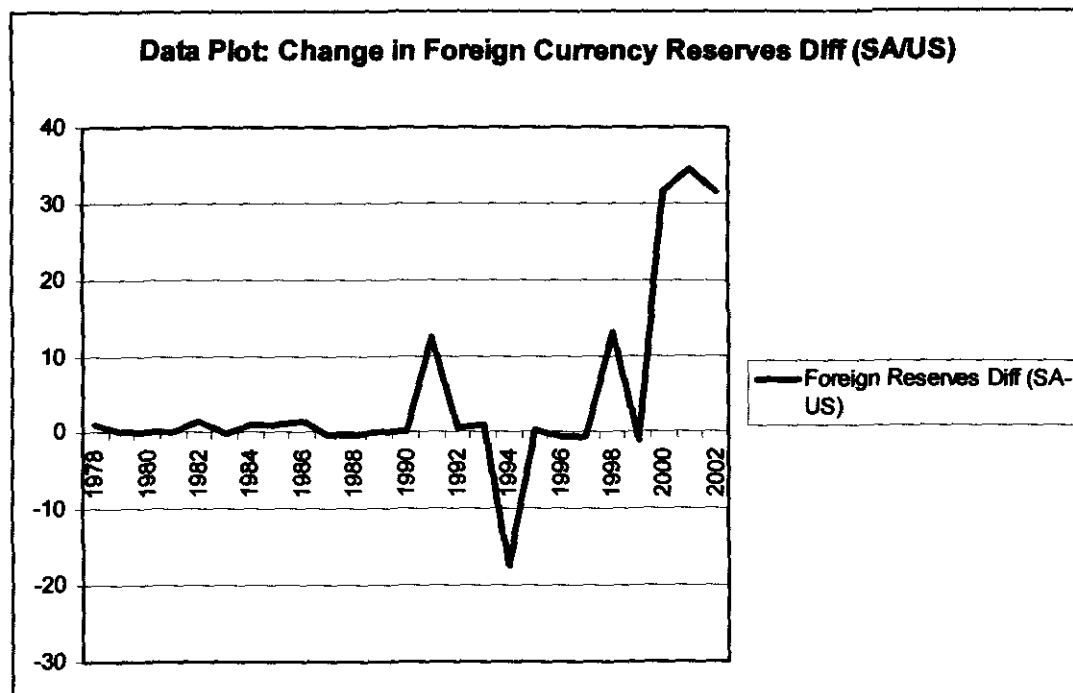


Figure 17: Data Plot for Change in (SA Foreign Currency Reserves / GDP) / (US Foreign Currency Reserves / GDP) [FORES].



6.2 Results of the Regression Analysis

Table 2: Summary Output of Regression Analysis – Exchange Rate Risk Model.

<i>Regression Statistics</i>						
Multiple R	0.995532659					
R Square	0.991085274					
Adjusted R Square	0.988113699					
Standard Error	0.316135435					
Observations	25					

<i>ANOVA</i>						
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	6	199.996269	33.3327115	333.521848	1.92459E-17	
Residual	18	1.798949034	0.099941613			
Total	24	201.795218				

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	1.967597658	0.444842206	4.423136182	0.00032824	2.902177176	-1.03301814
Fiscal Policy-Deficit (SA/US)	0.048837347	0.037203078	1.312723309	0.20576799	0.126998173	0.029323479
Fiscal Policy-Debt (SA/US)	1.431922469	0.544853686	2.628086228	0.01706009	0.287226465	2.576618472
Interest Diff (SA-US)	0.043067953	0.027779582	1.55034564	0.13846231	0.015294827	0.101430734
GDP Growth Diff (SA/US)	0.008590873	0.011572666	0.742341761	0.46745777	0.015722414	0.03290416
Openness of the Economy (SA-US)	1.312506381	0.048204826	27.22769671	4.4304E-16	1.211231721	1.41378104
Foreign Reserves Diff (SA-US)	0.022403926	0.008665487	2.585420284	0.01866229	0.004198399	0.040609453

6.3 Discussion of Output of Regression Analysis

6.3.1 Graphical Representation of the Predicted Values

Referring to Figures 18 to 23, the predicted values lines seem to fit the actual data relatively well.

Figure 18: Line Fit Plot for Change in (SA Budget deficit to GDP ratio) / (US Budget deficit to GDP ratio) [DEF].

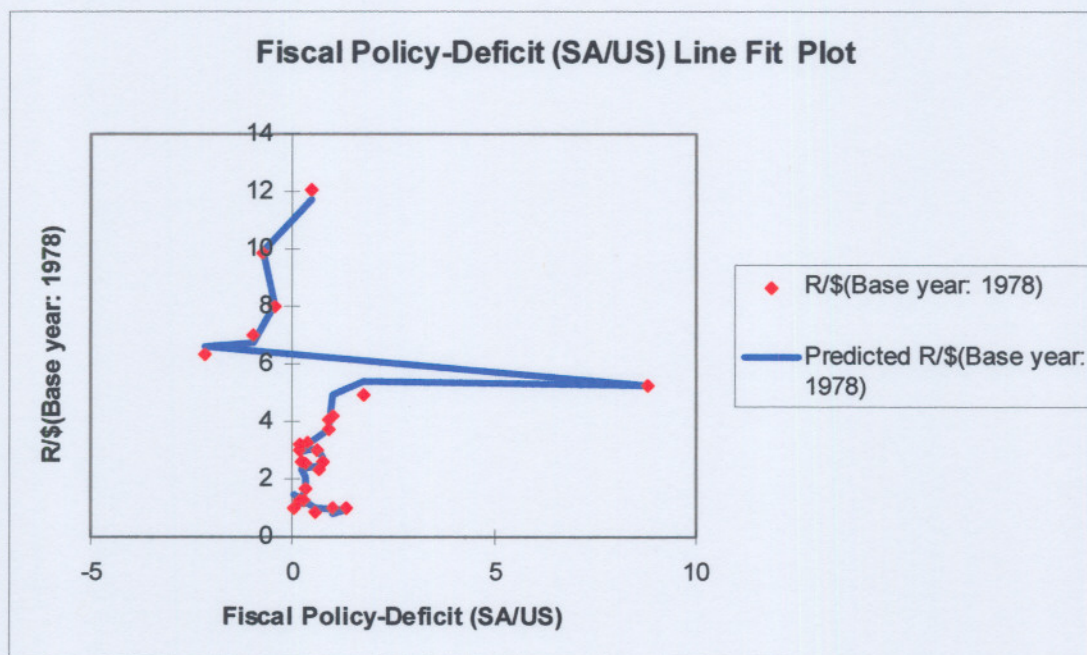


Figure 19: Line Fit Plot for Change in (SA National debt to GDP ratio) / (US Foreign debt to GDP ratio) [DEBT].

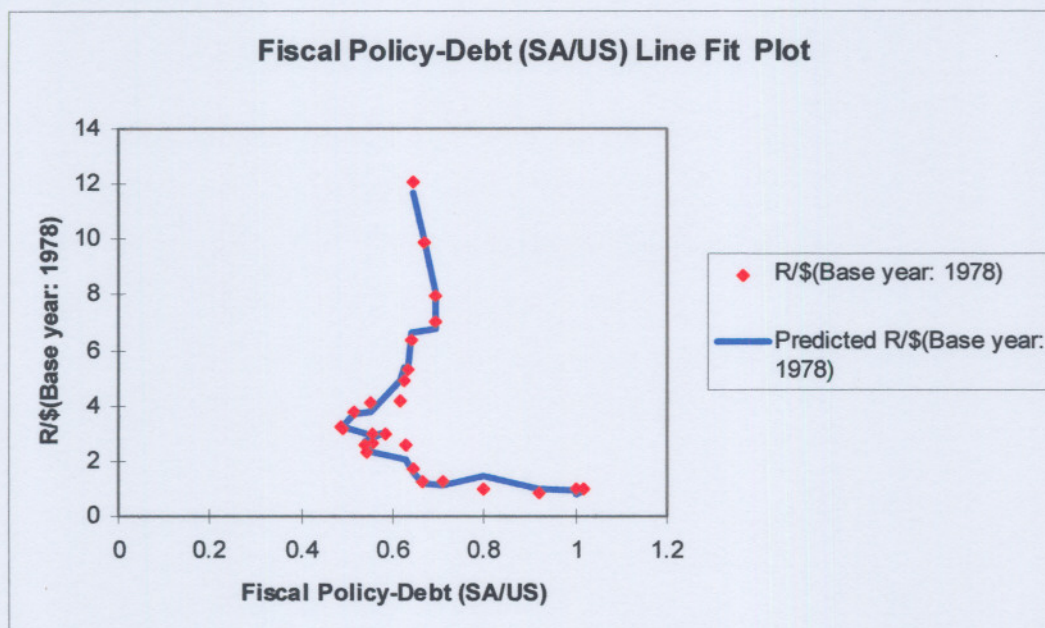


Figure 20: Line Fit Plot for Change in (SA 3 month Treasury bill rate) / (US 3 month Treasury bill rate) [INT].

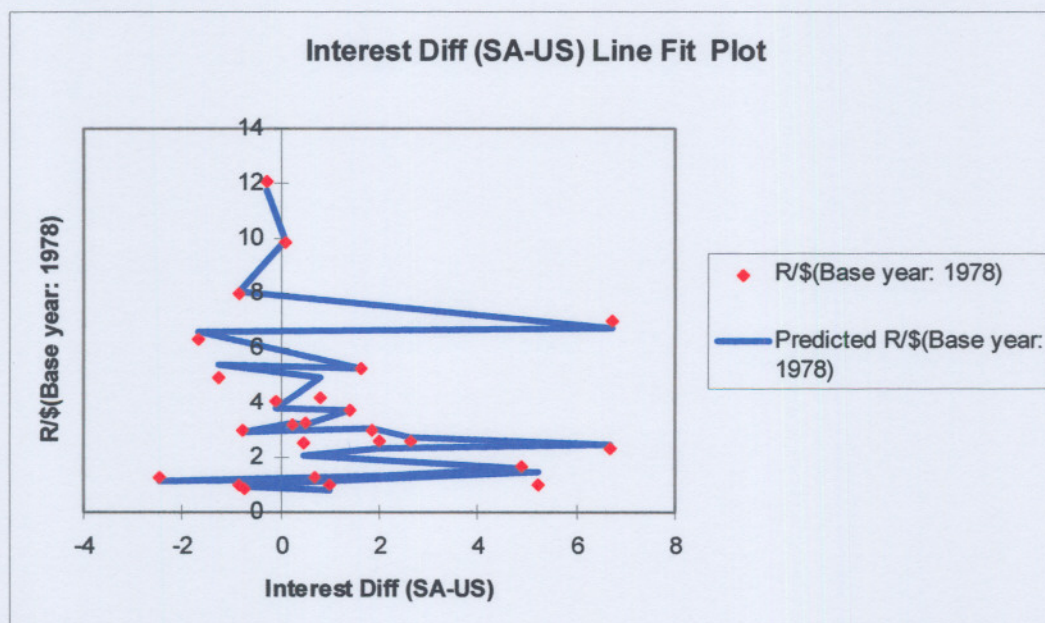


Figure 21: Line Fit Plot for Change in (SA GDP growth rate) / (US GDP growth rate) [GDP].

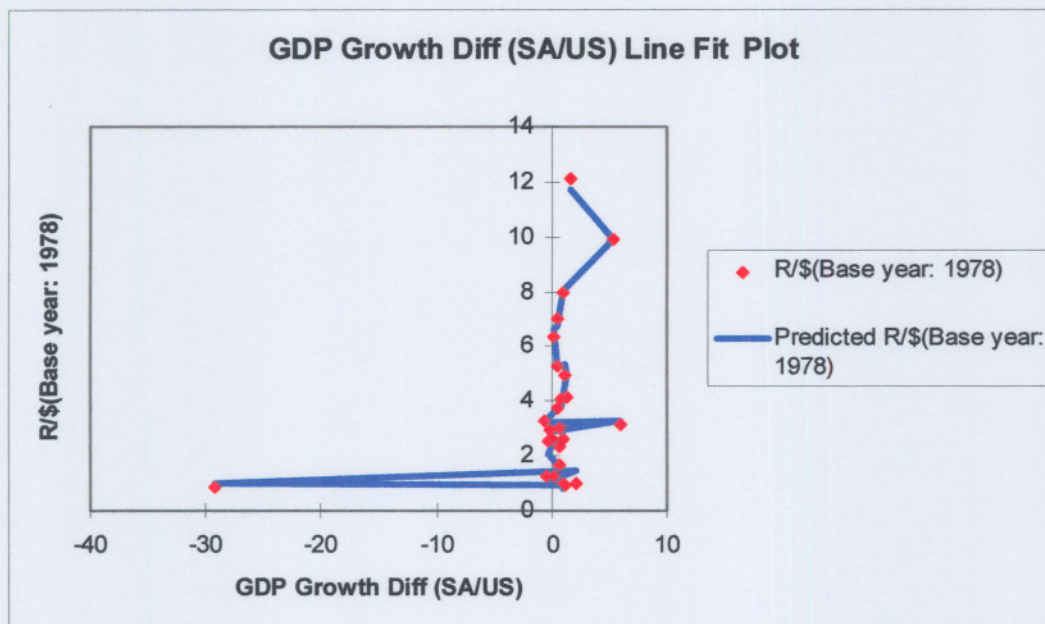


Figure 22: Line Fit Plot for Change in [(SA Exports + Imports) / GDP] / [US Exports + Imports) / GDP] [OPEN].

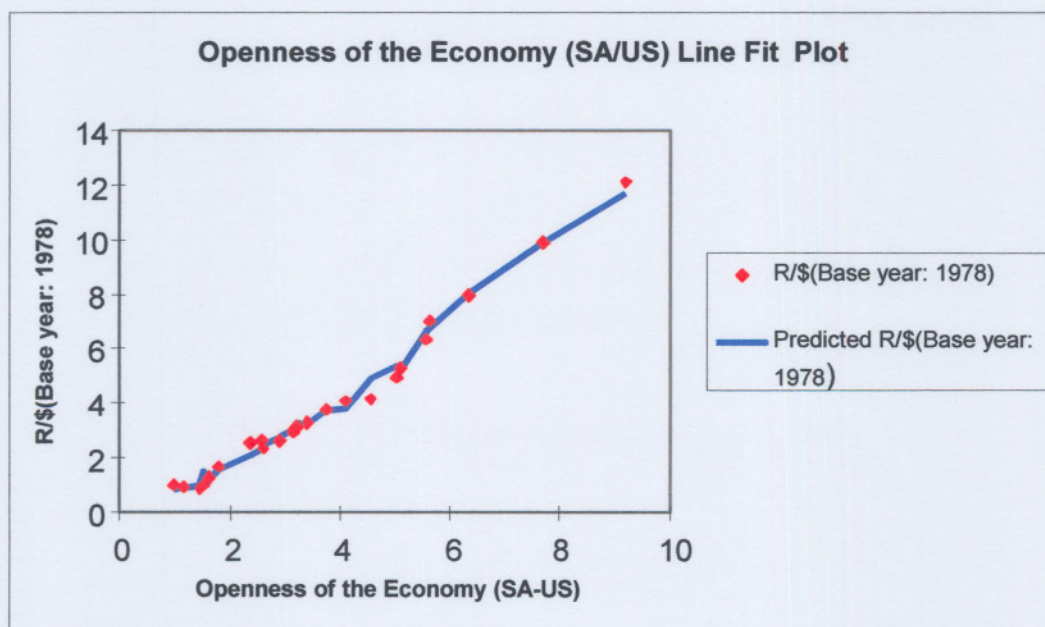
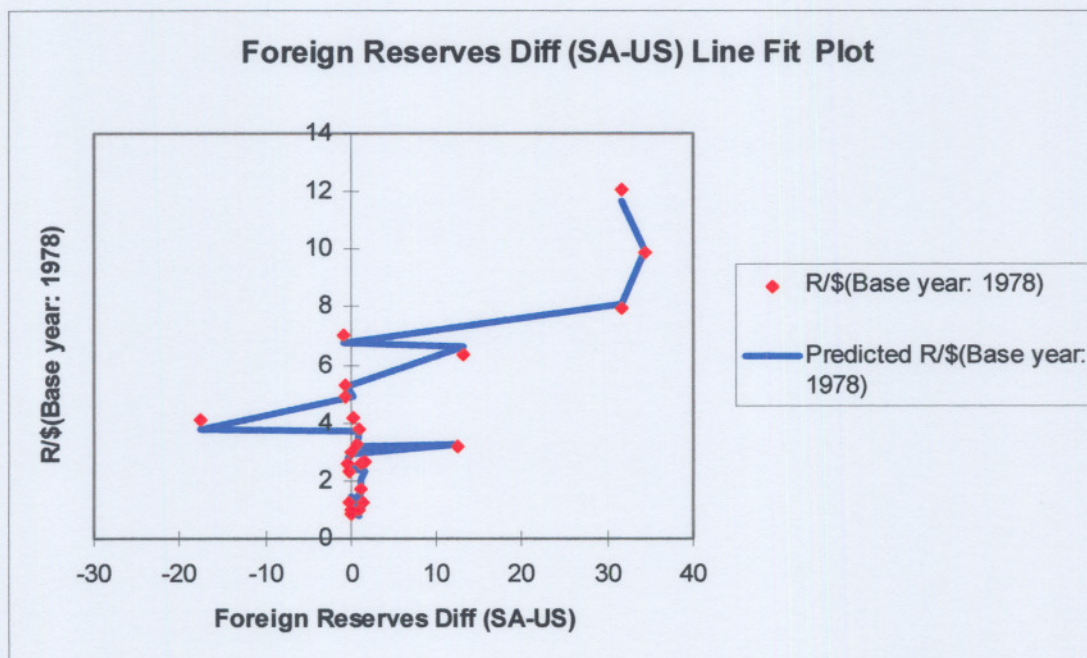


Figure 23: Line Fit Plot for Change in (SA Foreign Currency Reserves / GDP) / (US Foreign Currency Reserves / GDP) [FORES].



6.3.2 Coefficient of Determination

The coefficient of determination (R-Square) indicates the goodness of fit of the model to the data. An R-Square value of 0.991085274 is obtained from Table 2. This indicates that just over 99 per cent of the variation in the dependant variable, CHANGE, around its mean can be explained by variations in the six independent variables.

6.3.3 Hypothesis Test for Overall Goodness of Fit Test (F-test)

The term *Significance F* in Table 2 refer to the probability that the null hypothesis should not be rejected. Given that the significance F is close to zero, the null hypothesis is rejected, indicating an overall goodness of fit between the dependent and independent variables and that the equation, overall, is statistically significant.

6.3.4 Assessment of the Individual b parameters (T-tests)

In order to assess whether each of the explanatory or independent variables makes a significant contribution to the overall equation, individual t-tests are performed. The t-test is performed by setting each variable's b value to zero and assessing whether it will affect the overall fit of the model. The null hypothesis is therefore formulated such that we assume there is no relationship between the dependant and independent variables.

When referring to Table 2, under coefficients the estimated b values for the independent variables as well as the standard error for each parameter are displayed. The calculated t-value (t Stat) is shown as well as the probability (P-value) of the calculated t-value exceeding that of the critical t-value if the null hypothesis is correct. Only three parameters have a small probability value, indicating a small probability, close to zero, that the null hypothesis is correct. With a significance level of 0.05 it would be decided not to reject the null hypothesis only when the probability value was greater than 0.05. Therefore the null hypothesis is rejected in the case of DEBT, OPEN and FORES, indicating a causal relationship between CHANGE and these three independent variables. It can be concluded at a 95 per cent confidence level that only DEBT, OPEN and FORES are statistically significant.

However, in the case of the other three variables, namely DEF, INT and GDP the null hypothesis is accepted. Accepting the null hypothesis indicates that there is no significant causal relationship between these independent variables and CHANGE. Due to the insignificance of these variables, the multiple regression analysis was repeated, but this time these three variables were omitted. The summary analysis of the multiple regression is portrayed in Table 3.

6.3.4.1 Summary of the Regression Analysis portraying three Independent Variables: DEBT, OPEN, FORES

Table 3: Summary Output of Regression Analysis for the independent variables: Foreign Debt, Openness of the Economy and Foreign Currency Reserves – Exchange Rate Risk Model.

<i>Regression Statistics</i>						
Multiple R	0.994216103					
R Square	0.988465659					
Adjusted R Square	0.986817896					
Standard Error	0.332921759					
Observations	25					

<i>ANOVA</i>						
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	3	199.4676432	66.48921439	599.8833957	1.68543E-20	
Residual	21	2.327574846	0.110836897			
Total	24	201.795218				

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	1.690189951	0.446473195	-3.78564709	0.001083382	-2.61868195	0.761697953
Fiscal Policy-Debt (SA/US)	1.109677522	0.535253731	2.073180358	0.045050353	0.003443741	2.222798785
Openness of the Economy (SA-US)	1.294837423	0.049011558	26.41902181	1.34712E-17	1.192912291	1.396762556
Foreign Reserves Diff (SA-US)	0.025297433	0.008269282	3.059205534	0.00595653	0.008100517	0.042494348

6.3.4.2 Discussion of the Output of the Regression Analysis (Table 3)

The coefficient of determination (R-Square) value of 0.988465659 is obtained from Table 3. This indicates that over 98 per cent of the variation in the dependant variable, CHANGE, around its mean can be explained by variations in these three independent variables. Compared to the R-square of 0.991085274 obtained from table 2, it is evident that DEF, INT and GDP only explained 0.262 per cent of the variation in the dependant variable, CHANGE, around its mean.

For the F-test, to assess the overall goodness of fit of the estimated equation, the null hypothesis is formulated so that the b terms in the equation are not statistically different from zero. If the null hypothesis is rejected, it implies that at least one of the independent variables is statistically significant in explaining the dependant variable. Given that the Significance F value in Table 3 is close to zero, the null hypothesis is rejected, indicating an overall goodness of fit between the dependent and independent variables and that the equation, overall, is statistically significant.

The t-test is performed by setting each variable's b value to zero and assessing whether it will affect the overall fit of the model. The null hypothesis is therefore formulated such that we assume there is no relationship between the dependant and independent variables.

Referring to Table 3, all three the parameters have a small probability value, indicating a small probability, close to zero, that the null hypothesis is correct. With a significance level of 0.05 it would be decided not to reject the null hypothesis only when the probability value was greater than 0.05. Therefore the null hypothesis is rejected in all three cases, indicating a causal relationship between the three variables DEBT, OPEN and FORES and the dependent variable CHANGE.

6.3.5 Reformulation of the Exchange Rate Risk Model

From the multiple regression analyses performed above, the exchange rate risk model is reformulated, containing only three independent variables:

$$\text{CHANGE} = f(\text{DEBT}, \text{OPEN}, \text{FORES})$$

where CHANGE = Change in the ZAR/USD exchange rate (with base year 1978 = 1)

DEBT = Change in (SA National debt to GDP ratio) / (US Foreign debt to GDP ratio)

OPEN = Change in [(SA Exports + Imports) / GDP] / [US Exports + Imports) / GDP]

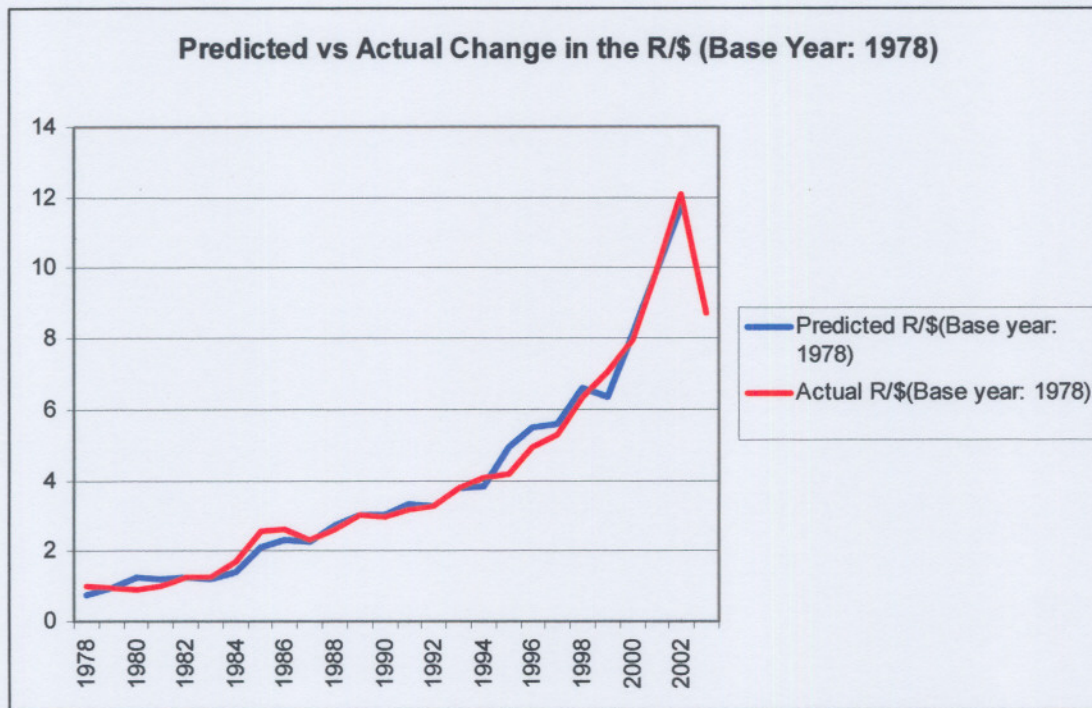
FORES = Change in (SA Foreign Currency Reserves / GDP) / (US Foreign Currency Reserves / GDP)

(Annual changes were calculated using 1978 as base year.)

6.3.6 Graphical Representation of' the Predicted versus the Actual Volatility in the ZAR / USD Exchange Rate indicating Exchange Rate Risk.

The change in the ZAR versus the USD exchange rate predicted by using the model developed above, is portrayed in Figure 24 below. It is compared to the change in the actual exchange rate with base year set at 1978.

Figure 24: Plot examining the Predicted versus Actual Volatility in the ZAR / USD exchange rate.



When compared to the exchange rate prediction model developed above, the exchange rate risk model more closely tracks the volatility of the ZAR / USD exchange rate which occurred from 2000 onwards. Refer to Figures 10 and 24. This is a good indication of the predictive power of the risk model developed.

7. Conclusion - The Exchange Rate Risk Model

From the above, it can be concluded that the equation devised to predict the volatility in the exchange rate is statistically significant. The independent variables do actually influence and predict the dependent variable. Volatility in the ZAR / USD exchange rate therefore occurs due to deteriorating fiscal policy, in the form of increasing national debt to GDP-ratios, opening or closing of trade regimes and decline in foreign currency reserve to GDP-ratios. The equation can therefore be used for exchange rate risk analysis.

CHAPTER 4: EVALUATION OF THE EXCHANGE RATE MODELS

1. Exchange Rate Prediction Model

1.1 Economic Evaluation

According to the equation developed above, the ZAR versus USD exchange rate is influenced by the relative M3 money supply, relative GDP and relative inflation rates between SA and the US. This equation produces the expected results as described by economic theory. The coefficients of the independent variables produce the correct signs, influencing the exchange rate in the right direction.

The ZAR / USD exchange rate depreciates, or EXCH increases, when the SA monetary authorities' discipline is deteriorating in comparisons with its US counterpart. Economic growth, as measured by GDP, can lead to an appreciation of the ZAR compared to the USD, should the domestic expansion of GDP exceed that of the US. Rising inflation rates in SA also lead to an increase in EXCH due to rising domestic prices, in line with the theory of PPP.

1.2 Dynamic Response Properties

The exchange rate prediction model was subjected to shocks of each of the independent variables. This has important implications for risk analysis, in assessing the result of shocks in the variables impacting on the exchange rate.

1.2.1 Shocks Applied to Variables

The variables were shocked one at a time. Firstly, a shock is applied to GDP, allowing the SA GDP to rise ten per cent above its baseline level from 1982 onwards. The second shock consisted of a ten per cent increase in the SA M3 money supply, also from 1982 onwards. The final shock was an increase of ten percentage points in the domestic inflation rate of SA from 1982 onwards.

The year 1982 was considered appropriate to commence with the shocks applied to the variables due to the sample period being relatively short and allowing enough time for the multiplier effect to develop. The shocks also couldn't be applied sooner, as to allow for two-period time lags.

1.2.2 Results of the Shocks Applied

1.2.2.1 M3

The shock applied to the M3 money supply of SA resulted in a large divergence of the exchange rate from its original forecasted path as can be seen in Figure 25 below. The domestic monetary shock in 1982 resulted in a sharp depreciation of the Rand (an increase in EXCH) reaching a peak in 1986 of R17.40 and a maximum of R19.02 in 1992. Thereafter the predicted exchange rate stabilises and follows a new equilibrium level. The difference between the actual predicted and 'shocked' exchange rate converges at 160 per cent above its original path. Refer to Figure 26.

Figure 25: Predicted Exchange Rate path after a 10% SA M3 money shock was applied.

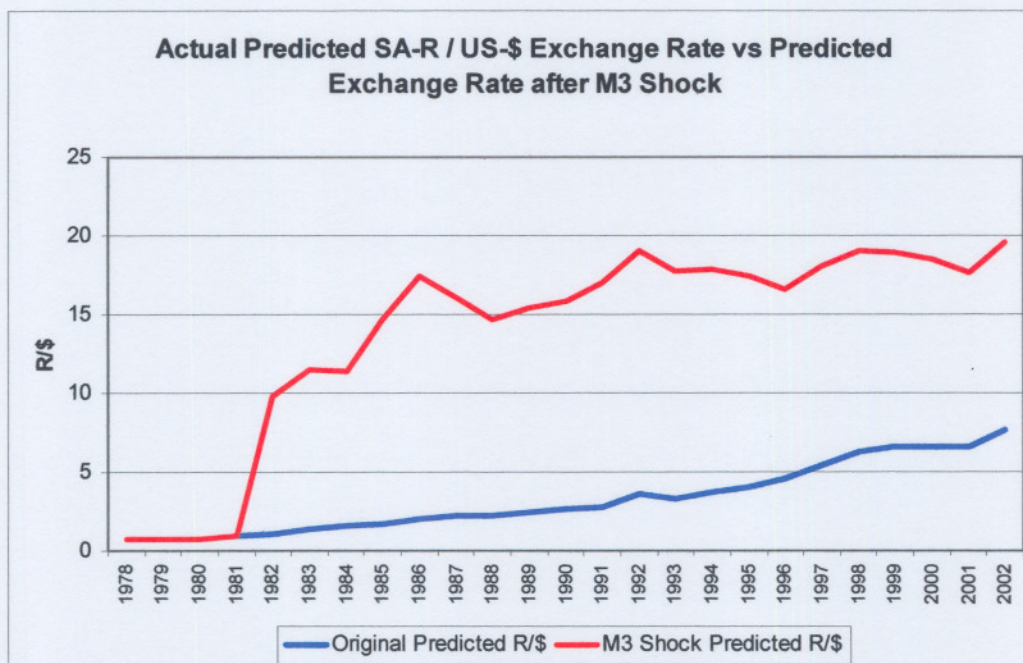
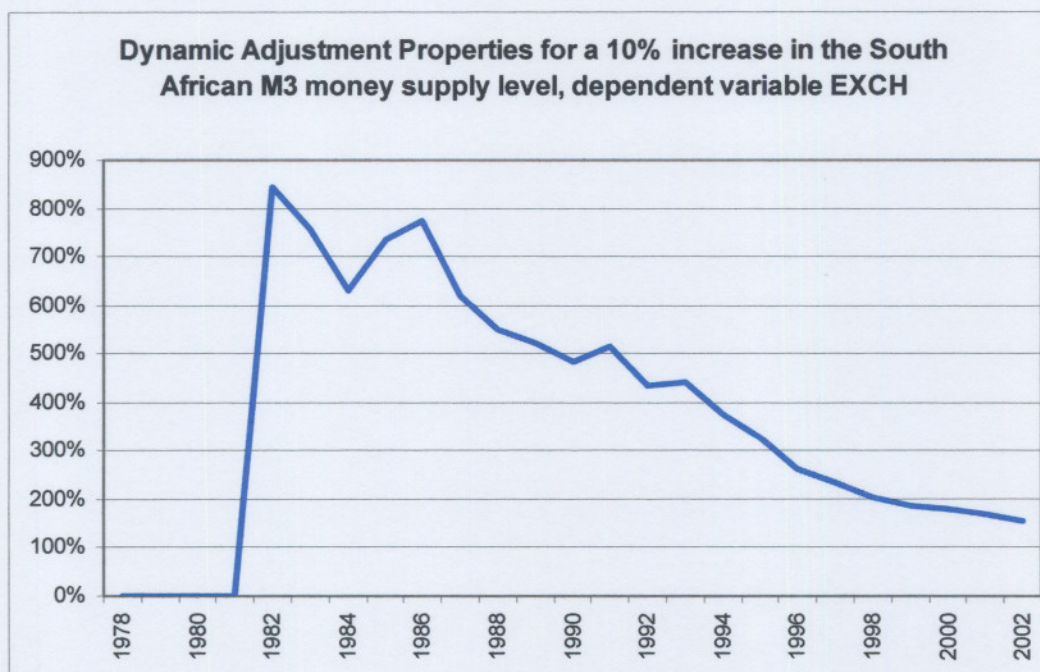


Figure 26: Dynamic Adjustment Properties for a 10% increase in the South African M3 money supply level.

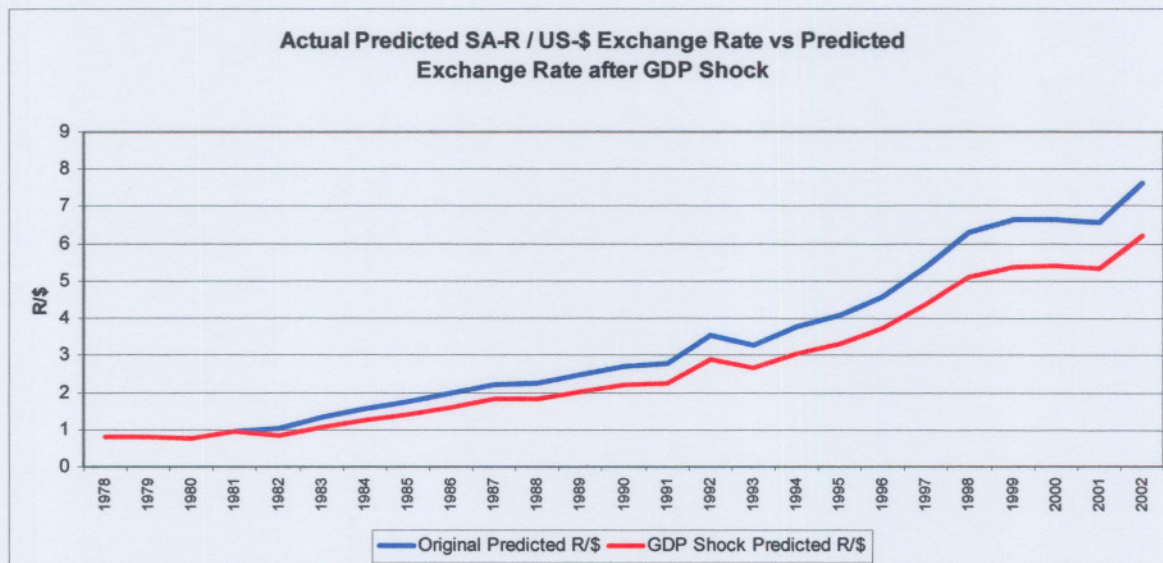


From the above, it can be derived that a domestic monetary shock can have a pronounced impact on the ZAR/USD exchange rate due to inflationary expectations resulting from the monetary expansion. Therefore anticipated changes in the money supply should be tracked carefully, since it inherently represents the most important risk factor for deterioration of the ZAR relative to the USD.

1.2.2.2 GDP

An appreciation in the exchange rate (EXCH declines) occurred in 1982, resulting from the shock applied to the SA GDP. The appreciation occurred up to a turning point of just below twenty per cent and then converges to the actual forecasted path. Refer to Figure 27. The predicted exchange rate in 1982 is R0.85 compared to the actual forecast of R1.04 for the same period. Thereafter the predicted exchange rate converge the actual forecast, but at a level 18.72 per cent below the original forecast.

Figure 27: Predicted Exchange Rate path after a 10% SA GDP shock was applied.



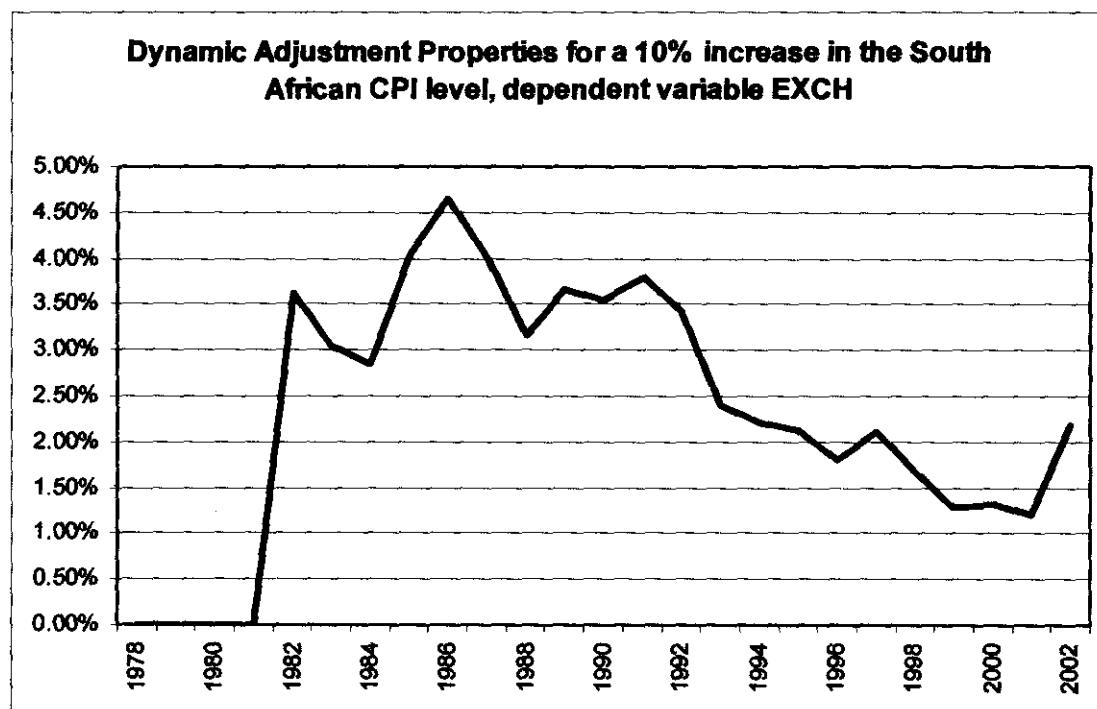
An anticipated increase in the domestic GDP therefore represents a fairly high risk factor for appreciation of the ZAR/USD exchange rate. Given the openness of the

economy, a GDP expansion is normally preceded by an increase in exports, which in turn supports the Rand.

1.2.2.3 INFL

The shock applied to the domestic inflation rate from 1982 onwards resulted in a 3.65 per cent depreciation of the Rand in 1982. Due to the multiplier effect, the inflation shock has its maximum impact four years later with a resulting 4.65 per cent depreciation in the exchange rate. Refer to Figure 28. The initial depreciation is reversed in 1986 and this initial recovery is followed by a relatively smooth adjustment path towards a new long-run equilibrium at a level approximately two per cent above the original forecast. A rise in the domestic inflation rate represents a risk factor for depreciation of the Rand, reaching its maximum effect within four years following the inflation increase.

Figure 28: Dynamic Adjustment Properties for a 10% increase in the South African CPI level.



2. Exchange Rate Risk Model

2.1 Dynamic Response Properties

The exchange rate risk model was subjected to shocks of each of the independent variables. This has important implications for risk analysis, in assessing the result of shocks in the variables impacting on the volatility of the exchange rate.

2.1.1 Shocks Applied to Variables

The variables were shocked one at a time. Firstly, a shock is applied to SA national debt levels, allowing a ten per cent increase from 1982 onwards. The second shock consisted of a ten per cent increase in either import or export levels of SA from 1982 onwards. A shock of ten per cent was also allowed in the levels of SA foreign reserves. The final shock was an increase of ten percentage points from 1982 onwards in the SA GDP level.

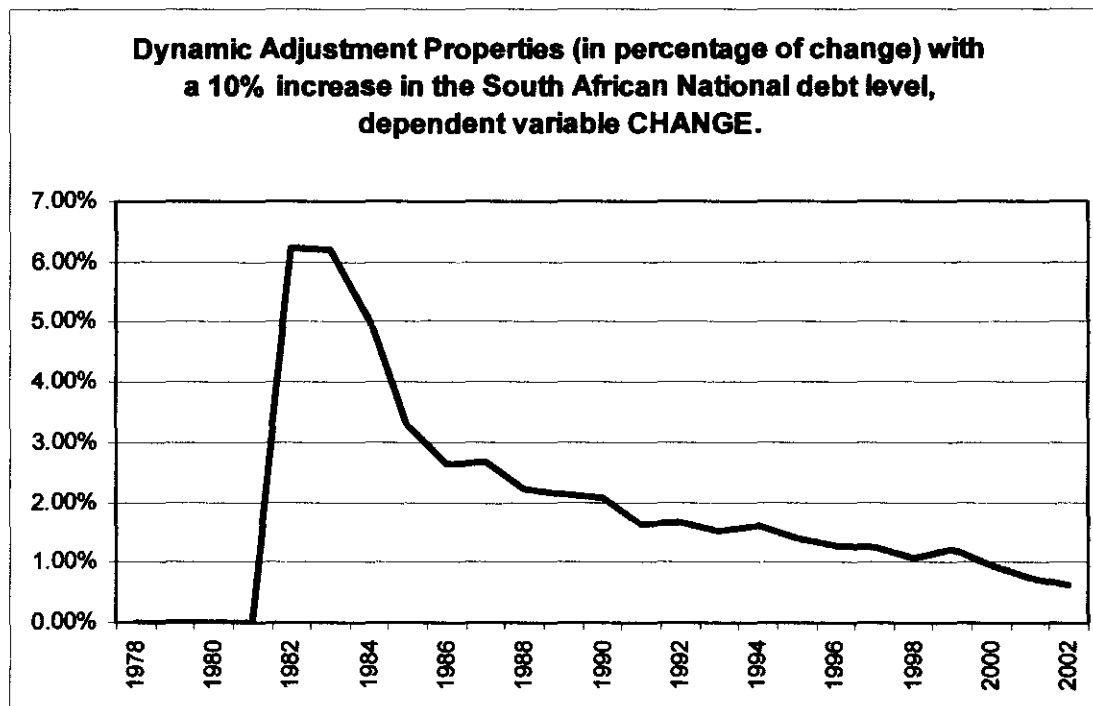
The year 1982 was once again considered appropriate to commence with the shocks applied to the variables.

2.1.2 Results of the Shocks Applied

2.1.2.1 National Debt Levels

A sharp depreciation in the exchange rate, amounting to a maximum of just over six per cent, followed the shock in the SA national debt level during 1982. The initial depreciation is reversed in 1983. The exchange rate function returns to a steady path four years later and the difference in volatility between the 'shocked' exchange rate and the actual predicted exchange rate converges around one per cent above the original level at the end of the sample period. Refer to Figure 29.

Figure 29: Dynamic Adjustment Properties with a 10% increase in the South African National debt level.



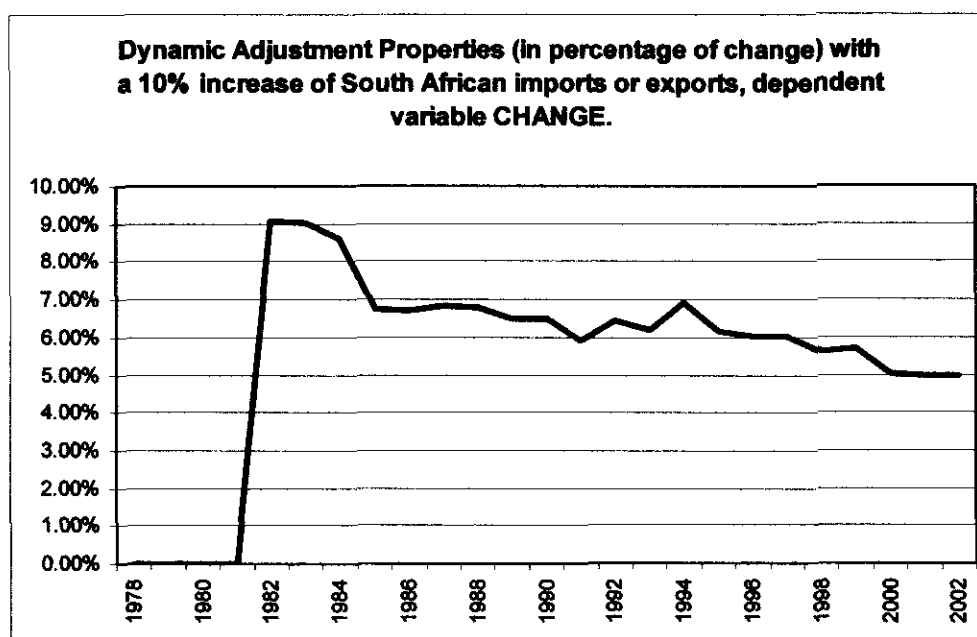
In 2002, the 'shocked' exchange rate volatility level after the ten per cent shock in SA national debt levels settles at R11.80, compared to the baseline forecast of R11.72, constituting a depreciation of only 0.61 per cent in the long-run equilibrium exchange rate level. Increasing domestic national debt therefore present a depreciation risk for the ZAR / USD exchange rate.

2.1.2.2 Import or Export Levels

The shock applied to either domestic import or export levels from 1982 onwards resulted in a 9.07 per cent depreciation of the Rand in 1982. Refer to Figure 30. The initial depreciation is reversed in the following year and the brief recovery period of two years is followed by a relatively smooth adjustment path towards convergence at a new long-run equilibrium level approximately five per cent above the original forecast.

Changing import and export levels therefore have a more sustained effect on the exchange rate than national debt levels. Increasing domestic import and export levels also present a more significant long-term risk factor for depreciation of the ZAR versus the USD.

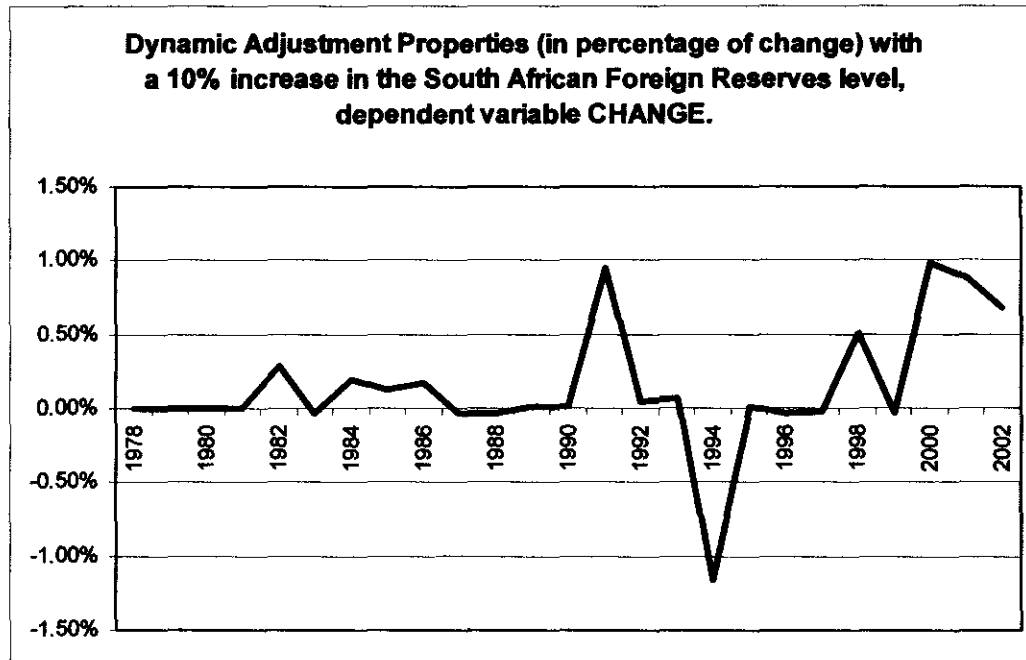
Figure 30: Dynamic Adjustment Properties with a 10% increase of South African import or export levels.



2.1.2.3 Foreign Reserve Levels

The shock applied to the foreign reserve levels of SA in 1982 caused only a brief and short-lived depreciation in the exchange rate of 0.3 per cent. The 'shocked' exchange rate then converged with the actual predicted exchange rate volatility level. Only mild depreciation and appreciation responses of around one per cent occurred in the following years. Foreign reserve level shocks therefore did not have a significant effect on the long-run equilibrium of the predicted exchange rate volatility level. Changing foreign reserve levels therefore present less risk for exchange rate volatility than changing national debt and import or export levels.

Figure 31: Dynamic Adjustment Properties with a 10% increase in South African Foreign Reserve Levels.

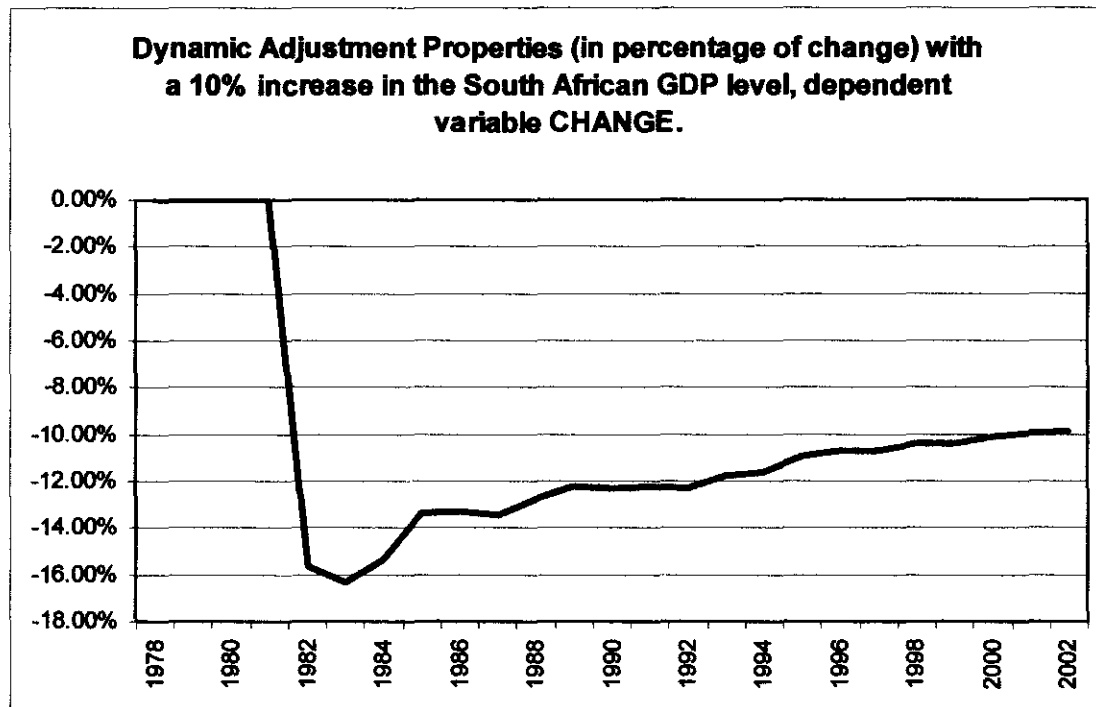


2.1.2.4 GDP Levels

A sharp appreciation in the ZAR / USD exchange rate occurred in 1982, resulting from the ten per cent shock applied to the SA GDP. The appreciation occurred up to a turning point of sixteen per cent in 1983. A recovery period followed and the volatility level of the exchange rate then converged to the actual forecasted path, but at a level ten per cent below the actual forecasted path as portrayed in Figure 32. The predicted exchange rate volatility level at the end of the sample period is R10.57 compared to the actual predicted level of R11.73 for this period.

An increasing domestic GDP level presents a significant appreciation risk for the ZAR / USD exchange rate. Changing GDP levels therefore present a significant risk factor for exchange rate volatility analysis.

Figure 32: Dynamic Adjustment Properties with a 10% increase in the South African GDP level.



3. Conclusion

Increases in domestic variables impacting exchange rate volatility, and therefore exchange rate risk, is shaped by the following variables:

- Increases in the M3 money supply and GDP levels have the most pronounced effect on volatility of the ZAR versus USD. While the M3 money supply present a depreciation risk, an increase in the domestic GDP level present an appreciation risk for the ZAR / USD exchange rate.
- Openness of the economy as portrayed by the ratio of imports and exports to GDP as well as inflation and national debt levels, presenting a dimension of fiscal policy stance, have a relative large effect on the volatility of the exchange rate. Increases in the domestic levels of all three these variables present depreciation risks for the ZAR / USD exchange rate.

- Fluctuations in the domestic foreign reserve level had only a small impact on the exchange rate.

The exchange rate prediction and risk models developed can be used in conjunction for forecasting and risk analysis purposes. The exchange rate can first be predicted, by using forward-looking expectations and computing the exchange rate prediction equation. Then the exchange rate risk involved can be assessed by utilising the exchange rate risk model. Herewith future volatility of the exchange rate can be predicted. By adding the results computed with the developed equations, the estimated future exchange rate is established. The independent variables can be adapted for different possible situations, setting up possible future scenarios for exchange rate prediction. The exchange rate prediction equation can also be used in conjunction with other exchange rate forecasting models.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

1. Introduction

The theory of floating exchange rate determination and the risk inherently involved is still in its early development phase. This is a dynamic field of study due to increasing globalisation as well as a tendency toward a growing, open world economy.

This study set out to develop a model for the analytical assessment of exchange rate risk and volatility for the South African Rand versus the United States Dollar in the long run. The model was not devised to capture short-term fluctuations in the exchange rate due to speculative behaviour of traders, exogenous shocks and other disturbances. The monetary approach was selected for exchange rate prediction despite its shortcomings, since a clear alternative is still lacking.

2. Empirical Results

In the light of the results discussed in chapter three and four, the monetary approach captures long-run determination of the exchange rate relatively well. However, this approach fails to capture short-term fluctuations.

The behaviour of the ZAR / USD exchange rate can be explained by economic fundamentals in the long run. Money supply, income levels and inflation rates of South Africa relative to those of the United States play a major role in determining the ZAR / USD exchange rate in the long run. Relative M3 money supply levels have a great effect on exchange rate determination and are the single most important factor impacting the long-run ZAR / USD exchange rate.

Fiscal policy, openness of the economy and foreign currency reserves are additional important risk factors impacting exchange rate volatility. The relevance and importance of GDP becomes clear in the risk analysis model as it emerges as the single most influential variable impacting exchange rate volatility.

3. Conclusion

On completion of both the literature and empirical study, the purpose and objectives set for the study were achieved. The factors, which influence exchange rates and exchange rate risk, were identified. Existing models for the prediction of exchange rate movements as well as exchange rate risks were evaluated. Techniques employed for managing exchange rate risk were briefly discussed. Unique factors contributing to exchange rate volatility and risk in the South African economy were examined. Models for the prediction of the ZAR versus the USD exchange rate as well as exchange rate risk, due to volatility, were developed and tested.

From the above it can be concluded that exchange rate behaviour can be explained by economic fundamentals in the long run. The fundamental factors impacting the ZAR versus USD exchange rate in the long run is money supply, income levels and inflation rates. Long-run models are ideally suited for evaluating economic fundamentals, which determine the value of the Rand as well as for forecasting purposes. It should be kept in mind however, that there will always be fluctuations in the short-term from this long-run equilibrium level predicted, due to speculative behaviour, commodity prices, exogenous shocks and other unexplored variables. During these times of financial crisis a sound model for exchange rate forecasting is needed. The exchange rate prediction model developed does not predict these periods of crisis however.

Fiscal policy, openness of the economy and foreign currency reserves coupled with GDP levels are important risk factors impacting exchange rate volatility. Increases

in the M3 money supply and GDP levels have the most pronounced effect on volatility of the ZAR versus USD. While the M3 money supply present a depreciation risk, an increase in the domestic GDP level present an appreciation risk for the ZAR / USD exchange rate. These factors should be monitored and managed closely by monetary authorities to limit fluctuations and promote a stable and predictable exchange rate.

The exchange rate prediction and risk models developed can be used in conjunction for forecasting and risk analysis purposes. By employing forward-looking expectations and computing the exchange rate prediction equation the exchange rate can be predicted. The exchange rate risk involved can be assessed by utilising the exchange rate risk model. Herewith future volatility of the exchange rate can be predicted. By utilising different exchange rate prediction and risk models and combining these in scenario analysis, a more accurate and wider based view can be developed of the future volatility of an exchange rate.

Although the models developed try to predict the future path as well as the volatility risk involved in the ZAR / USD exchange rate, there still remains ample area for improvement as portrayed in the recommendations for future research. This dynamic field of study is ever evolving and with increased globalisation and technological development, exchange rate prediction and risk analysis models need to evolve with the changing landscape.

4. Recommendations for Future Research

Research concerning variables impacting short-term fluctuations of exchange rates can prove invaluable for international firms in assessing potential projects or for the determination of a forward exchange rate.

Research encompassing more world economies, not only a single developing country and exchange rate, will bring new insight to the field of exchange rate analysis.

Additional insight into exchange rate volatility and prediction factors might be gained through research on testing and possibly adapting the developed equations for other additional exchange rates.

Alternative exchange rate risk analysis models should be developed to improve risk analysis and planning, to add to this limited and restricted field of study.

Alternative statistical analysis methods utilising more complex statistical methods might prove valuable in gaining additional insights into the relationships between variables impacting the exchange rate. Other causative factors might also be established in this way.

It might also be considered to combine exchange rate prediction and risk analysis models with political risk models or factors, since these have a widespread influence on the future path of an exchange rate.

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