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FOREIGN CURRENCY SPECULATION

An interest parity approach to investigate the opportunities for making speculative profits in the foreign exchange market

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Abstract

The foreign exchange market is a very large and liquid market all over the world. Daily trades in foreign exchange amount to enormous sums that are larger than the annual GDP of several countries. The question remains of whether a market of this size and trading volume is efficient. According to the theory of interest parity, it should not be possible to achieve speculative profits by engaging in carrying trades between different currencies since returns on deposits should be equal in all currencies. However, there are deviations from interest parity since the theory does not always hold. This creates opportunities for making speculative profits.

This thesis tests whether it is possible to make speculative profits in the foreign exchange market through so called carrying trades. We test to what extent interest parity holds between several currencies with large interest differentials over different maturities. The conclusion is that interest parity does not hold well for several currency combinations. Specific patterns were found for certain currencies. The Japanese yen, which is a low interest rate currency, does not appreciate as much as indicated by the interest differential relative to all currencies tested. The Indonesian rupiah, which is a high interest rate currency, does not depreciate by as much as it should relative to most of the currencies tested.

Key Words

Interest parity, uncovered interest parity, carry trading, exchange rates, interest rates, foreign currency speculation, international finance, international monetary economics, forecasting.

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List of abbreviations

Currencies

AUD	Australian dollar
CAD	Canadian dollar
CHF	Swiss franc
EUR	Euro
GBP	British pound
IDR	Indonesian rupiah
JPY	Japanese yen
SEK	Swedish crown
USD	US dollar
ZAR	South African rand

Theoretical

UIA	Uncovered interest arbitrage
UIP	Uncovered interest parity

1. Introduction

The introduction to this thesis will provide a general background on the topic for the reader. This chapter also presents the problem, the scope, the limitations and the purpose of the thesis. We will also emphasize what distinguishes our approach from previous studies and finally an outline of the thesis is presented.

1.1 Background

International financial markets are dependent on three conditions for explaining the links between international currencies, one of which being the uncovered interest parity (Martson 285). Uncovered interest parity states that the return on deposits in domestic and foreign currencies should be the same. If interest parity holds, the return on the domestic currency deposits should, therefore, equal the expected return on foreign currency deposits when domestic currency is converted and invested at the foreign deposit rate and converted back to the domestic currency at the future exchange rate. In order for interest parity to hold, the currency with the higher interest rate should depreciate by the interest differential. Hence, if interest parity holds, it should not be possible to make speculative profits by engaging in so-called carrying trades. A carrying trade is performed by taking loans in low interest rate currencies and making deposits in high interest rate currencies. The assumption underlying interest parity is that speculative profits in the foreign exchange market are zero. Several academic articles have been written about interest parity and several have tested to what extent interest parity holds between certain currencies.

The interest rates in Japan have been extremely low during the last couple of years. At the current date interest rates are close to zero and at times some interest rates have even turned negative. It would therefore be interesting to analyze if it is possible to make speculative profits by engaging in carrying

trades by taking loans in the yen and depositing in foreign currencies with higher interest rates. It would also be interesting to determine if speculative profits can be made through carrying trades with other currencies. The Swiss franc is another currency with very low interest rates. Therefore, we would like to test whether borrowing in the Swiss franc and depositing in higher interest rate currencies could lead to speculative profits. The South African rand and the Indonesian rupiah are currencies with high interest rates. Hence, we would like to test whether going long in these currencies while going short in lower interest rate currencies can result in uncovered interest arbitrage. We also want to test interest parity for other major currencies such as the US dollar, the British pound and the euro. The Swedish crown will also be investigated due to our personal interest. The euro is an especially interesting case since it is rather new and has only existed since January 1, 1999. Hence, there are not many studies up until today that have investigated to what extent interest parity holds for the euro.

The foreign exchange market is a very large and liquid market all over the world. It is the world’s largest financial market with a daily average turnover of approximately 1.5 trillion USD. In comparison, the US equity market has a daily turnover of 50 billion USD with NYSE and NASDAQ combined. This implies that the foreign exchange market is 30 times larger than the US equity market (Galant). One could ask whether a market of this size and trading volume is efficient. However, the answer is ambiguous. One could argue that speculative traders and economic agents act rational by buying low and selling high and thereby make sure that exchange rates reflect their true value based on fundamentals that determine currency values. However, another argument could be that the size of the market and the volume of trading by speculators can be destabilizing to the market as a whole.

The case of Long-term Capital Management (LTCM) is a clear and well-documented case of speculation in the foreign exchange market. LTCM was a

hedge fund founded in 1994 by the former Salomon Brother trading star John Meriwether and the two Nobel Prize winners in Economics in 1997, Myron Scholes and Robert Merton. The fund speculated in many different international financial markets. It started out as an arbitrage fund but changed into a speculative macro fund. The fund was very successful during its first years and achieved an annual rate of return of about 40%. One of their investment strategies consisted of investing in Japanese, US and European bonds with large interest spreads. The founders of the fund believed that these bonds would converge in value and profits would be made as the spread of the bonds narrowed towards zero. The downfall of the fund was that it was too risky. By continuously decreasing the capital base, the founders wanted to increase the return to their shareholders. The debt-equity ratio of the fund was extremely high (Dowd 2-4).

In the beginning of 1998, LTCM had equity capital of $5 billion and debt of $125 billion. The speculation trading led to heavy losses in August 1998 when the Russian ruble was devalued. This led to a decrease in the creditworthiness of several emerging market bonds. LTCM had speculated on the belief that the spreads between prices of Western bonds and those of the emerging markets would narrow over time. However, the events in Russia led to an increase in these spreads. The fund lost even more of its capital base and the debt-equity ratio became as high as 45 to 1 (Dowd 2-4).

By September in 1998, LTCM had lost so much capital that their debt-equity ratio was reaching enormous levels. The capital base was down to $600 million while the asset base was $80 billion. Several Wall Street firms and the Federal Reserve were worried that a failure of LTCM would have disastrous effects on financial markets. Therefore, they started to negotiate a rescue package that would salvage LTCM. In the end, a bailout from a consortium of

banks and the Federal Reserve was needed in order to rescue LTCM and avoid a larger financial crisis (Dowd 4-5).

1.2 Problem

According to the theory of interest parity, the interest return on deposits should be equal in all currencies. Thus, the basic assumption underlying interest parity is that the expected rate of return of speculation in the foreign exchange market is zero. By testing beta values, several previous studies on interest parity have empirically rejected the theory since the currency depreciation and appreciation is not equal to the interest differential. However, beta tests are not always the optimal way of testing interest parity since they do not consistently indicate the direction of the exchange rate changes.

The result of the majority of previous studies is that interest parity does not always hold in the short run although it usually holds in the long run. Interest parity is more often rejected in studies based on short maturities while the theory tends to hold more often when tested for longer maturities as argued by Alexius (C, 5) and Chinn and Meredith (18). Based upon the findings of previous studies that deviations of interest parity exist we want to ask the question:

Can speculative profits be made in the foreign exchange market?

The interest parity relation could therefore be tested in order to investigate whether it is possible to make speculative profits by engaging in carrying trades. Carry trading is only profitable if the exchange rate changes deviate from the interest differential. The actual deviation from interest parity is sometimes called a forecast error. Mun and Morgan argue that the forecast error can be due to a time-varying *risk premium*. The research of Mun and Morgan provides evidence that there exists a risk premium on foreign exchange that varies over time. However, the accuracy of the forecast error in predicting the risk premium is not very high (Mun and Morgan 231-250). The risk premium or the money to be

paid for carrying the additional risk needs to be forecasted in order to make an accurate assessment of whether speculative profits can be made.

A forecasting approach will be presented in the thesis in order to investigate whether exchange rates can be forecasted in the event that prediction errors based on interest parity are different from zero. However, an actual forecast will not be performed. Instead a discussion around the usage of a forecast model will be presented. Methods of how exchange rate forecasting can be performed will also be discussed in order to explain how speculators can determine when to engage in carrying trades. The forecasting of exchange rates in past studies has proved to be both inaccurate and unreliable due to the number of variables contributing to the volatility of exchange rates. Exchange rates are similar to stock prices in the sense that they react very strongly to “news”, i.e. unexpected announcements and political events. This makes them very difficult to forecast. Richard M. Levich made a thorough evaluation in 1982 of the accuracy of exchange rate forecasters. His evaluation of the accuracy of exchange rate forecasters showed that there is very little evidence supporting specialized forecasters as better than individuals who simply used the forward rate as a predictor of the future spot rate. It is the news component in the exchange rate determination that makes exchange rates so difficult to forecast (Krugman 357).

The delimitations of this thesis from a problem perspective are that we will investigate whether it is possible for banks to make speculative profits by engaging in carrying trades. We will focus on currency combinations with large interest differentials. The scope of the study lies in testing to what extent interest parity holds and whether speculative profits can be made. It is beyond the scope of this thesis to determine which explanatory variables or factors that are the underlying cause for any deviations from interest parity.

1.3 Purpose

The purpose of our study is to investigate whether it is possible for banks to make speculative profits in the foreign exchange market through uncovered interest arbitrage. This will be tested by measuring to what extent interest parity holds between different currency combinations. Testing whether speculative profits can be made will also be performed by calculating figurative examples of carrying trades. However, in order to achieve speculative profits, a forecast of future exchange rates is needed. An actual forecast will not be performed due to the large difficulties and low reliability in exchange rate forecasting. Instead we will have a discussion regarding the usage of a forecast model and explain what type of forecast models are available and would be appropriate to apply in order to investigate whether to engage in foreign currency speculation. Another thing that will be investigated is whether interest parity holds better for interest rates with longer maturities than for shorter ones, which is something that has been indicated by previous studies.

1.4 Special focus of the thesis

There are a few points that make this study different from previous studies and that will lead to be contribution to this field of study. We will test whether it is possible for banks to make speculative profits by engaging in carrying trades in the foreign exchange market. Interest parity will be tested between currencies with large interest differentials in order to test whether speculative profits can be made by taking loans in low interest rate currencies and making deposits in high interest rate currencies. The majority of previous studies have applied beta tests in order to test interest parity. However, beta values can sometimes be misinterpreted since they do not consistently indicate the direction of the exchange rate changes, i.e. whether the correct currency is appreciating or

depreciating. Therefore, we will not use beta values but instead prediction errors and prediction error ratios. The prediction errors will indicate the deviations from interest parity in absolute terms while the prediction error ratios will give the deviation relative to the interest differential. The prediction error ratios allow us to tell which currency that has appreciated or depreciated on average.

Many previous studies have been limited when testing interest parity in the form of making beta tests in the sense that they have had one main benchmark currency, which all regressions were made against. Some academic scholars argue that the choice of benchmark currency used when conducting the beta calculations is not irrelevant (Huisman et al. 214). In contrast to previous studies, we will not have one single benchmark currency since we will calculate prediction errors between all the combinations of the currencies included in our study. We emphasize that our calculations will be focused on pairs of currencies with high interest differentials. Hence, the Japanese yen and the Swiss franc will be widely used in the calculations due to their low interest rates.

Although it has been tested before, it would be interesting to determine whether interest parity holds better for interest rates with longer maturities than for shorter ones. Our study will be different from previous studies as we use prediction error ratios rather than beta values to determine if interest parity holds better for longer maturities than for shorter maturities. The ratio is found by dividing the prediction error by the interest differential. The analysis of these ratios will allow us to tell exactly in which direction one currency has appreciated or depreciated on average. Another key difference is that the majority of previous studies have been conducted in the pre-euro era, meaning they did not have the euro included in their studies.

1.5 Outline of the thesis

Our thesis is divided into five main chapters. The chapters that follow the introduction are theoretical framework; methodology; research findings and interpretation; and the conclusion and recommendations. The last section after the five chapters contains the bibliography and appendices. The theoretical framework explains the underlying theories behind interest parity. A discussion around exchange rate forecasting is also presented although forecasting itself is not a part of the methodology. Previous studies about interest parity are discussed and we summarize the main conclusions of these studies. The third chapter is the methodology in which we explain the research design, data collection and the delimitations of the data collection. We also defend the quality of our research by discussing the issues of validity and reliability. The empirical analysis and findings is the chapter in which the empirical results are presented and analyzed. The fifth chapter is the conclusion and recommendations where we summarize our findings and draw a conclusion from these. We provide recommendations for whether carrying trades could and should be made and give suggestions for future research within the field of study.

2. Theoretical framework

The theoretical framework of this thesis will provide the reader with a thorough background of the concepts underlying the theory used in our research. The theory is interest parity and the concept of exchange rate forecasting will be discussed. These form a base for our research paper and will be explained in detail so that the reader will be able to analyze and interpret the results. An overview of previous studies on interest parity is also presented. The explanation of previous studies will broaden the theoretical framework and help explain why a certain research design is chosen. The delimitations of the study will also be presented and explained in detail.

2.1 General theoretical background

2.1.1 Interest parity

One of the most important theories in international economics is the theory of interest parity. There are two types of interest parity, uncovered interest parity and covered interest parity. These will differentiated between in section 2.1.4. We will focus on uncovered interest parity in this thesis, which is often referred to as interest parity. The theory states that the return on investments in the domestic currency should be equal to the return on foreign currency deposits under the same investment horizon. Hence, it should not matter where investments are made since the expected currency appreciation should be equal to the interest rate differential. If interest parity holds, the return on the domestic currency should therefore equal the expected return on foreign currency deposits when converted from domestic currency and invested at the foreign currency interest rate and afterwards converted back to the domestic currency at the future

exchange rate. Under these conditions the expected excess return on investments in the foreign exchange market is equal to zero and it is not possible to make speculative profits by engaging in carrying trades.

The theory of interest parity states that the expected return on deposits when measured in the same currency should be the same in all currencies in order for the foreign exchange market maintain equilibrium. Hence, investors in the foreign exchange market should view all currencies as equally desirable assets. The interest parity can be explained by the following formula:

$$R_{\$} = R_{€} + (E^{e}{}_{\$/€} - E_{\$/€}) / E_{\$/€}$$

This formula shows that the return on dollar deposits is equal to the return on euro deposits plus the expected appreciation of the euro. Therefore, if the interest rate is 8% in the US and 3% in Euroland, the expected appreciation of the euro has to be 5% in order for interest parity to hold, i.e. $(E^{e}{}_{\$/€} - E_{\$/€}) / E_{\$/€} = 5\%$ (Krugman 350-351).

2.1.2 Expected return

When explaining how the foreign exchange market clears when exchange rates are settled it is necessary to consider how current exchange rates affect the expected return in different currencies. Under the assumption that expected future exchange rates are not changed by current changes, a depreciation of the domestic currency today lowers the domestic currency return on foreign currency deposits and increases the return on domestic currency deposits. The reason for this is that the expected future depreciation of the domestic currency decreases due to the current depreciation. Similarly, everything else being constant, an appreciation of the domestic currency today increases the domestic currency return on foreign currency deposits since the expected domestic currency depreciation increases (Krugman 351-352).

This theory of expected exchange rate changes can be easily clarified by giving an example. One could ask how a change in today’s dollar/euro exchange rate, all else equal, changes the expected return on euro deposits measured in terms of dollars. Suppose that today’s dollar/euro exchange rate is 1 dollar/euro and the exchange rate expected in a year from today is 1.05 dollar/euro. This implies that the expected depreciation of the dollar is 5%, i.e. (1.05-1)/1 = 0.05 or 5%. Hence, when investing in the euro, you not only expect the interest on euro deposits but also a 5% premium relative to the dollar. Now suppose that the dollar/euro exchange rate changes to 1.02 dollar/euro, i.e. a depreciation of 2%, but the expected future exchange rate in a year from today is still 1.05 dollar/euro. This means that the expected depreciation of the dollar in a year from today has fallen from 5% to 3% due to the current depreciation of the dollar. The interest rate on euro deposits has not changed, which implies that the expected dollar return on euro deposits has fallen by 2%. The expected depreciation of the dollar is now only 3% (5% - 2%).

This example emphasizes the fact that a rise in today’s dollar/euro exchange rate, i.e. a depreciation of the dollar, decreases the expected dollar rate of return on euro deposits when holding the future dollar/euro exchange rate and interest rates constant. Alternatively, a fall in the dollar/euro exchange rate, i.e. an appreciation of the dollar, increases the expected return on euro deposits. Thus, a depreciation of the dollar today makes dollar deposits more attractive relative to euro deposits since the expected future depreciation of the dollar decreases, or to put it in another way, the future appreciation of the dollar increases. Since the dollar depreciates by a given amount today, it needs to depreciate by less over the next year in order to reach the expected level in the future. Usually a current change in exchange rates also changes the expected future rate, but the assumption of constant future exchange rates are made in

order to explain the effects of current exchange rate changes on expected returns (Krugman 351-352).

2.1.3 Equilibrium exchange rate

We mentioned earlier that the condition of interest parity states that returns in all currencies *must* be the same for the foreign exchange market to be in equilibrium. Suppose for example that the dollar interest rate is 8% and the euro interest rate is 5% and the dollar is expected to depreciate by 6% over the next year. This implies that the yearly rate of return on euro deposits would be 3% higher than that on dollar deposits. Since market participants are expected to prefer holding deposits of currencies offering the highest expected return, no one would be willing to hold dollar deposits. Hence, there would be an excess supply of dollars and an excess demand for euros in the foreign exchange market. Holders of dollar deposits will be trying to sell them for euro deposits. However, the problem is that no holders of euros would be willing to sell euros for dollars at the current exchange rate. Only if the price of euros in terms of dollars rises will holders of euros be given the incentive to sell them for dollars. By how much will the dollar/euro exchange rate have to rise in order for the foreign exchange market to reach equilibrium? Remember that the foreign exchange market is in equilibrium only when the returns on deposits in two different currencies are equal when measured in the same currency. The following formula shows the relationship between dollars and euros given by interest parity: $R_{\$} = R_{€} + (E^{e}_{\$/€} - E_{\$/€}) / E_{\$/€}$. Since $R_{\$}$ is 8%, $R_{€}$ is 5% and $(E^{e}_{\$/€} - E_{\$/€}) / E_{\$/€}$ is 6%, the price of euros in terms of dollars has to increase by 3%, i.e. \$/€ has to rise by 3% so that $(E^{e}_{\$/€} - E_{\$/€}) / E_{\$/€}$ decreases by 3%. Only then will the expected return be the same, 8%, in both the dollar and the euro (Krugman 350-353).

In the previous example the return in euros was higher than in dollars so the dollar/euro exchange rate had to rise in order for the foreign exchange market to be in equilibrium and interest parity to hold. Now suppose that the interest rate in dollars is 8%, the interest rate in euros is 10% and the expected appreciation of the dollar is 4%. Hence, the expected return on dollar deposits is 2% higher than that on euro deposits. This is the opposite case than in the previous example and there will now be an excess demand for dollars and an excess supply of euros. No holders of dollars would be willing to sell them for euros at the current rate. Only if the dollar price in euros increases will euro holders entice dollar holders to sell them for euros. This means that the dollar/euro exchange rate will fall so that the dollar appreciates. Only if the appreciation is 2% will the return in both currencies be the same. This results in a 2% lower appreciation of the dollar in the future so that the dollar is now only expected to appreciate by 2% over all, and the expected return on deposits becomes 10% in both currencies. The appreciation of the dollar today produced less attractive dollar deposits in a futuristic perspective and made interest parity hold. Hence, the conclusion is that the foreign exchange market will only be in equilibrium when interest parity holds so that deposits are equal in all currencies when measured in the same currency. This implies that the expected return to speculation is zero (Krugman 350-353).

2.1.4 Covered interest parity vs. Uncovered interest parity

The interest parity conditions explained above constitute the form of interest parity that is called uncovered interest parity (UIP). The other form is called covered interest parity (CIP). The conditions behind CIP imply that forward exchange rates are set according to the interest differentials or the forward premiums. The formula for CIP is approximately the same as for UIP. The only difference is that the future expected exchange rate, $E^{e}_{\$/€}$, is substituted by the

given forward rate, $F_{\$/€}$. The formula for CIP then becomes $R_{\$} = R_{€} + (F_{\$/€} - E_{\$/€})/E_{\$/€}$, where $(F_{\$/€} - E_{\$/€})/E_{\$/€}$ is equal to the forward premium on euros against the dollar when the interest rate is higher in dollars. The forward premium in this case is the amount of the expected appreciation in the euro. This is also called the forward discount on dollars against the euro. This implies that the return on dollar deposits is equal to the return on euro deposits plus the forward premium on euros against the dollar. Both the uncovered and covered interest parity conditions can be true if the forward exchange rate is equal to the expected future exchange rate, i.e. $F_{\$/€} = E^{e}{}_{\$/€}$.

The difference between covered and uncovered interest parity is that transactions with covered interest parity do not involve any exchange rate risk while transactions with uncovered interest parity do. Hence, when covered interest parity holds, the return on deposits in two different currencies are the same and it is not possible to make speculative profits since the forward premiums on exchange rates are set according to the interest differentials (Krugman 363-365).

2.1.5 Uncovered interest arbitrage

This thesis will focus on the possibility of arbitrage through uncovered interest transactions. For arbitrage to be possible there has to be a violation of the conditions behind the uncovered interest parity (UIP). Uncovered interest arbitrage (UIA) is also called carry trading in the jargon of the foreign exchange markets. UIA is based on the idea of an open speculative position that tries to take advantage of UIP. In order for an arbitrage opportunity to be present the UIP cannot hold. Carry trading is performed by borrowing in a low interest country and investing into a higher interest yielding country. UIA aims to profit by gaining the interest differentials. Once the investment matures then the money is converted back into the borrowed country's currency to maybe

experience a gain or loss. The gain or loss depends on the position of the exchange rates over the investment horizon. Unlike a covered interest arbitrage, the speculator is open to exchange rate changes. The open position is the risk portion of the trade since it is not known whether the exchange rate at the end of the investment horizon will make the trade profitable or not. The trade can provide a positive return but this is dependent on the exchange rate. The positive profit is possible if the low interest rate yielding currency appreciates by less than the interest differential so that the interest differential captures excess returns beyond the exchange rate changes.

Suppose that a loan is taken in the euro at an interest rate of i_e. The borrowed funds in euros are then directly converted into dollars and invested at the dollar interest rate over the same maturity as the loan in euros. The dollar interest rate is i_{US}. If the interest rate is higher in dollars, $i_{US} \succ i_e$, then the expected appreciation of the euro, $\Delta E_{\$/€}$, is equal to the interest differential under the condition of UIP. However, if the expected appreciation of the euro is less than the interest differential, a situation of uncovered interest arbitrage would arise. UIA implies that a speculator takes advantage of the interest differential, by borrowing in the low interest rate currency and depositing in the high interest rate currency, while simultaneously estimating the expected future change in the exchange rate. The transaction is uncovered since the long position in the borrowed currency is left open to exposure for exchange rate risk (Moosa 37).

Suppose that $i_{US} \succ i_e$ and that an uncovered interest transaction is considered over the time period from *t* until *t+1*. At the time *t*, a short position of the amount K will then be taken in euros. The amount K borrowed in euros is directly converted into dollars at the exchange rate (€/$) at time *t*. An amount of K/(€/$) dollars is then received and a long position in dollars is taken at the interest rate i_{US} over the same investment horizon, i.e. from *t* until *t+1*. The

amount of dollar deposits received at time *t+1* is known already at time *t* and is equal to $K(1+i_{US})/(€/\$)_t$. However, the amount of dollar deposits in terms of euros is not known at time *t* since it depends on the euro/dollar exchange rate at time *t+1,* namely $(€/\$)_{t+1}$. Hence, the expected amount of dollar deposits in euros will be equal to $K(1+i_{US})E(€/\$)_{t+1}/(€/\$)_t$. At time *t+1* the principal and interest on the loan in euros also has to be repaid. This is equal to $K(1+i_e)$. Overall, this results in a net profit of:

$$E_{\Pi} = \frac{K(1+i_{US})E(€/\$)_{t+1}}{(€/\$)_t} - K(1+i_e)$$

The condition of positive profits in this transaction is that:

$$\frac{E(€/\$)_{t+1}}{(€/\$)_t}\left[\frac{1+i_{US}}{1+i_e}\right] \succ 1$$

This condition suggests that if the expected appreciation of the euro is smaller than the interest differential when $i_{US} \succ i_e$, then it is possible to make uncovered interest arbitrage. Thus, if $(i_{US} - i_e) \succ E\Delta(€/\$)_{t+n}$, situations for arbitrage arise in the form of going short in euros and long in dollars. The profit made on this transaction is $\Pi = (i_{US} - i_e) - \Delta(€/\$)_{t+n}$ (Moosa 37-38).

The expected exchange rate is not known at time T so it needs to be forecasted which requires the use of a multivariate model that incorporates the factors that influence exchange rates. This is however an extremely difficult task and has never been performed with accuracy. It is possible to make uncovered interest arbitrage even by taking loans in the higher interest rate currency but it requires that the appreciation of the low interest rate currency will be greater than the interest differential. However, the position is extremely vulnerable and is dependent on the correct currency appreciating to cover the loss from the interest rate differentials. As this operation is dependent on forecasting it is not recommended unless an accurate forecast can be produced.

As with all of the foreign exchange transactions, there is a bid-ask spread on the exchange rates. This bid-offer spread reflects the transaction cost associated with exchanging currencies through a dealer in the foreign exchange markets. The bid-offer spread, even though small, can affect the profit gained from a carry trade. The spread needs to be incorporated in the actual carry trade to accurately reflect the profit or loss on the trade.

2.1.6 Previous studies on interest parity

In the past there have been several studies performed on the uncovered interest parity (UIP) and most of them have one common conclusion. The conclusion reached in most of the studies is that UIP does not hold for investments in short maturities. Meridith and Chinn (1-31), Alexius (C, 1-24) and Alexius and Sellin (1-21) argue that UIP holds better for investments in instruments with long maturities. Alexius and Sellin found β-coefficients for short investments in long-term bonds that were close to +1. On the other hand, the β-coefficients for the corresponding short-term interest rates were highly negative.

This finding implies that the result of UIP holding better for long interest rates than for short interest rates is due to the maturity of the instrument and not the investment horizon. The studies of UIP for long-term instruments are however limited in the sense that it is difficult to find longer series of high quality data for long term bonds. Furthermore, floating exchange rates have only existed between the major currencies since the end of the Bretton Woods era in 1973.

Most studies on UIP have been tailored, or in a sense biased, as the studies performed have used a benchmark currency to determine the validity of the theory. In the study of UIP by Huisman et al (211-228), they argue that a benchmark currency is relevant for testing the UIP. In all previous studies one benchmark currency is used to show that UIP does not hold but it is incorrect to

use one currency as the theory states that it should hold regardless of the currencies. The interest rate differentials should be reflected in the exchange rate changes of the respective currencies used. Huisman et al also found that UIP holds better in periods when the forward premium is large while currency combinations with small forward premiums hardly had any forecasting power for future spot exchange rates. However, Jones (1-43) argues that the forward exchange rates are biased predictors of future spot rates since exchange rates change by less than the forward spread on average. He suggests that this violation of UIP implies that carry trading can be something of a money tree.

The previous studies have mainly focused on determining the beta based on a regressionary tool. The beta determined is then tested using hypothesis testing of confidence intervals. The beta analysis is validated using the hypothesis test and can therefore be used to reject the UIP theory. The main hypothesis examined in most studies has been whether the beta equals one. The beta variable from the regression results is tested using the provided t-statistic. The t-statistic is tested against the values from the chosen confidence interval, which can then be used to determine whether the hypothesis can be rejected or whether it fails to be rejected.

The results of the previous studies have been for the most part unanimous that UIP does not hold in the short run and holds to some degree in the long run. However, the results have conflicted to some extent since the results depend on the horizon chosen. The unanimous result shows that interest rate differentials are not useful as predictors of exchange rate movements in the short-term horizon. In the long-run some predictability has been provided but this is small in comparison to the needed predictability. The small but relative predictability on the long-term horizon can be partly explained by model dynamics of the UIP and the foreign exchange markets.

There are a few studies that have tried to find underlying causes for the deviation from UIP. Alexius (A, 1-34) argues that the deviations from UIP and the risk premium puzzle can partly be explained by the negative co-movements of interest differentials and exchange rates that are a consequence of the response of monetary policy to shocks in the economy. She suggests that endogenous monetary policy and interest smoothing are two reasons for deviations from UIP. Anker (835-851) came to a similar conclusion and found that UIP deviations can occur when the central bank reacts to exogenous shocks in the economy. Interest smoothing is then a potential explanation for the failure of UIP because it leads to a manipulation of exchange rate expectations and a destabilization of exchange rates.

2.2 Forecasting

As mentioned earlier, forecasting of exchange rates is an integral part of carry trading as the exchange rate at T_{T+n} is not known at time T. The unknown exchange rate at T_{T+n} establishes an unknown factor and this creates a degree of risk as the return of the trade is unknown. During the past decades there have been several studies performed that tried to forecast exchange rates or rather changes in exchange rates. It is the volatility of the exchange rate that is of concern as the impact of the change affects the profit. All of the studies have had little success in forecasting the volatility and in some cases the exchange rate has even changed in the opposite direction of the forecast. The inaccuracy and inability of forecasting are major concerns if profitable carry trading is to be performed consistently over time.

One way to forecast the future exchange rate movements is by using the interest differential as a predictor of the future spot rate. However, in the cases where interest parity does not hold, it is possible to forecast future spot rates

based on forecasting the forecast errors given by the interest differentials of the specific exchange rates. If people are trying to predict the future exchange rate, E_{t+1}, based on the interest rate differentials, then the forecast error, u_{t+1}, is equal to the actual minus the expected depreciation, i.e., $u_{t+1} = (E_{t+1} - E_t)/E_t - (E^e{}_{t+1} - E_t)/E_t$. These forecasting errors are sometimes referred to as risk premiums. Statistical methods can be used to determine whether the forecasting error can be predicted. For example, past forecast errors could be used to predict future errors. These forecast errors are assumed to be the profits or losses made when trading in the foreign exchange market. This is just an example of a forecasting model that can be used to estimate future exchange rates in order to find profit opportunities.

A discussion of previous models used and possible additions to the more accurate models will be presented. This discussion is to inform and enlighten any banks that are going to perform carry trading and need to forecast exchange rate changes. The models that have previously been used range from an easily applicable averaging and univariate time series model to complex multi-equation econometric models. The degree of accuracy will be discussed as well as how the most accurate model developed could be improved to even more accurately forecast exchange rate changes. A general statement of the results of the different studies on the forecasting models will also be provided. The models have preliminarily been found to be less accurate as forecasting models than a simple random walk model (Meese 20-21).

2.2.1 Random Walk Model

A random walk model is a basic ordinary least squares model; the basic properties of a random walk are that the observations in the time series exhibit no real pattern. The movements of the observations wander slowly upwards or

downwards. This model is based on the previous observations and an additional term. The following model is a basic random walk model (Hill 336, 338):

$$y_t = y_{t-1} + v_t$$

The random walk model above is the model that is referred to as the simple walk model throughout this forecasting section.

2.2.2 Univariate Time Series Models

2.2.2.1 Averaging Models

The first models that are used on an extremely superficial level and are easily applied to any forecasting method are the simple averaging and moving averaging methods (Moosa 62-71).

Where

$$\hat{E}_{T+n} = \frac{1}{T}\sum_{i=1}^{T} S_i$$

is the actual rate at T+n and it shows the forecast error as

$$e_{T+n} = E_{T+n} - \hat{E}_{T+n}$$

Although this method is simple to apply, it is inappropriate for data that has an observed trend or seasonal change (Moosa 65-66).

Other averaging models that can be used are the single and double moving average models that use constant number of observations. An average is taken of these observations and then the average is used to produce a forecast. The single moving average model uses a weight system that is based on the idea that recent observations are more relevant in forecasting the future exchange rate. The double moving average models work as the single moving with one exception, the use of another moving average. First the single moving average is

calculated to arrive at a number, and then another set of observations on a moving average is calculated based on the single moving average calculation (Moosa 66-70).

In order to calculate the double moving average of order time T, T observations on the single moving average is needed. The first set of observations at time T covers the single average period of T and 2T-1. The calculation of the double moving average of the period 2T-1 is as follows where M´ is the double average:

$$M'_{2T-1} = \frac{1}{T}\sum_{i=T}^{2T-1} M_i$$

The observations desired in the forecast can be arrived at by using the formula above. As stated before, all models do not function in all scenarios or environments. Single and double moving average models do not function in a seasonal or extreme trend observation period. The single moving average is mainly useful if the data is stationary because if there was a trend in the data then the model would inaccurately forecast the exchange rates. In the case of the double moving average model, some linear trends can be observed and the model will function properly. Again, seasonality cannot be incorporated into the model and as such cannot account for there being seasonality in the observations. Even though the models cannot account for seasonality they can be smoothed by assigning more weight to the high shifting observations so this “seasonality” can be incorporated into the actual average number (Moosa 66-70).

A thought has to be given to determining the validity of using a moving average; the validity is pretty obvious as it uses an average. In using an average the user assumes that the past reflects the future. There is nothing wrong in

thinking that the past is reflected in the future but the user of the model should be aware of the past as a predictor of the future.

2.2.2.2 Time Series

Time-series models have become increasingly popular in exchange rate studies in the areas of forecasting and theory testing. In using a time series model for forecasting, variables incorporated are factors that are thought to affect the accuracy of the forecast. The individual components of the time series have to be identified. Once the identification has been made then the series can be used to produce a forecast. Time series can be used to determine a single factor that incorporates several variables. The variables included can be seasonality, trend, cycle, and e for a random event (Moosa 75-76). For an example, the exchange rates can take the form of the following time series:

$$E_t = F(\mu_T, \phi_T, \gamma_T, \varepsilon_T)$$

In this series, the variables include a trend μ, a cycle ϕ, a seasonal component γ, and an error term ε. This relationship can be used as an additive or multiplicative function to get the accurate specification. In order to use a time series of this sort a moving average has to be calculated. Then this moving average is subtracted from the original time series to arrive at the respective functions of a trend, cycle or season. Each of the components are then added or multiplied, depending on the form chosen, to arrive at a forecasted exchange rate (Moosa 75-79).

2.2.2.3 Autoregressive models

Autoregressive models are models that can forecast a series based on detecting patterns in historical data series. These models are adapted using a dependent variable and an independent variable. The model that is to be used as a forecasting model is found through an iterative process and tested against historical data. When a satisfactory accurate model is found for forecasting then this model can be used. A good fit of a model has to have small and random residuals. ARIMA (Autoregressive Integrated Moving Average) is one model that is used for forecasting. However, this model requires stationary data in order for the model to work. In order to forecast with an ARIMA model, stationarity has to be achieved. Stationarity is the first step and has to be attained before the model can be used. The actual forecasting performed by the model produces a sequential forecast that base the forecast in period two on the forecast for period one (Moosa 79, 83-85, 88).

These average models have been found to be insufficient in their forecasting ability. The main reason to why moving averages do not have the predictability of exchange rates is due to other factors that are not included in a small time-series equation. By using a small time-series model, variables that are not included could have powerful influence on the changes in an exchange rate.

2.2.3 Multivariate Time Series Models

Multivariate time series models are models that use more than one equation within another explanatory equation. The models can be used to forecast exchange rates jointly or for a single exchange rate. The exchange rates that are to be forecasted are determined by determination variables, which may be comprised individually of several variables in an equation. A multivariate model

also includes a single equation model that uses one dependent variable (exchange rate) to be explained by functions of several variables. A multivariate model uses these individual equations to arrive at an explanatory relationship that can be used to determine an actual relevant model (Moosa 98).

2.2.3.1 Single equation economic models

The economic models included in single equation models are standard ordinary least squares (OLS) models. The model only includes one dependent variable with one or more explanatory variables and this model can be used to provide an unconditional forecast by finding the estimated variable. The estimated variables are compared to the actual variables in the historical data to provide a forecast error. With OLS models as they are estimated parameters of actual values, these parameters have to be tested using standard T-tests and the construction of confidence intervals to determine the validity of the estimated parameters. Below a representative model of the above explanation of the single equation model is provided:

$$\hat{E}_{T+n} = \hat{\alpha} + \hat{\beta}\hat{X}_{T+n}$$

where the intercept and variable coefficients are estimates of the actual variables respectively. Thus, the forecast error is the difference between the forecast variables and the actual variables. This error is hoped to be zero, but in all case studies no such result has been given from a single equation model (Moosa 99-101).

There are several problems with using single equation models as forecasting models of exchange rates and each of the problems will be discussed briefly. The first problem is defined the "black box" problem; the information that is received by the equation is produced by variables that are unexplained.

The variables that are included in the equation do not explain how the information within the variable was determined. The single equation does not show which factors determine the exchange rate. The black-box problem is solved by the identification of multivariate models, which will be discussed later (Moosa 101-102).

Other problems associated with single equation models include data frequency, measurement errors, and qualitative variables. The frequency of data may be mismatched with some of the explanatory variables that are incorporated to explain the changes in the exchange rates. For example, if exchange rates are determined by consumer prices, inflation, and interest rates then daily forecasts of exchange rates will need daily changes in each of the variables. However, in the case of inflation and consumer prices, these are only produced monthly and quarterly so there is a mismatch in the frequency. Therefore, such a model cannot be used to forecast daily exchange rates. The other problems are that measurement errors and qualitative variables often have errors associated with how they are measured, which provides a basis for not explaining the dependent variable to a high degree. Measurement errors occur due to a discrepancy in the data which can be corrected through manipulation, which can affect the exchange rate results (Moosa 102-103).

2.2.3.2 Multi-equation economic models

As stated above one of the problems with using a single equation is the "black box" problem. The solution to the "black box" problem is the use of a multi-equation model that may be designed to incorporate the different factors in the macro economy (Moosa 129). Several studies have used multi-equation models but have not been able to specifically identify the factors that affect exchange rates (Ericsson 1). But the main factors that influence the exchange rates include interest rates, country trade, monetary policy and market news (Moosa 24-30).

These are just a few of the factors that are considered to be heavily influential factors. All of these factors can be incorporated into the model by using a multi-equation model. However, the main constraint of these models is the data and estimation requirements. The use of macro components in a model requires several hundreds of integrated equations from which the data may not be easily accessed. Another concern is that the specification error of one equation will influence and damage the rest of the system (Moosa 129).

Below is an example of a multi-equation model, provided by Moosa in his book of forecasting, that incorporates four behavioral equations and one definitional equation containing five endogenous variables, six exogenous variables and one predetermined lagged variable. The model is as follows:

$$\Delta E_T = \alpha_0 + \alpha_1 \Delta p_T + \alpha_2 \Delta p_T^* + \alpha_3 i_T + \alpha_4 i_T^*$$

$$\Delta p_T = \beta_0 + \beta_1 \Delta p_T^m + \beta_2 \Delta m_T + \beta_3 \left(y_T - \bar{y}_T \right)$$

$$i_T = \gamma_0 + \gamma_1 \Delta p_{T+1}^e$$

$$y_T - \bar{y}_T = \delta_0 + \delta_1 \Delta m_T + \delta_2 \Delta g_T$$

$$\Delta p_T^e = \frac{1}{2} \left(\Delta p_T + \Delta p_{T-1} \right)$$

The endogenous variables are as follows:

ΔE First log difference of the exchange rate

Δp Domestic inflation rate

Δp^e Expected domestic inflation rate

i Domestic interest rate

y Actual output

The exogenous variables are variables that influence the model but are determined based on information outside the model. They are presented below:

Δp^* Foreign inflation rate

Δp^m First log difference of import prices

Δm First log difference of the money supply

Δg First log difference of government expenditure

i^* Foreign interest rate

$\bar{y}$ Potential output

By looking at the first equation, it is clear that the exchange rate is a function of the inflation and interest rates, both foreign and domestic. The equation allows for the effects of interest rates in the short-run. The second equation describes the domestic inflation rate in terms of macroeconomic variables such as money supply, import prices and output gap. The third equation states that the domestic interest rate is determined by expected inflation rates. The fourth equation explains that any deviation of actual output from potential output is determined by monetary and fiscal factors in the economy. The last equation states that the expected inflation rate is based on a two period moving average of the actual inflation rate (Moosa 129-131).

The empirical evidence of the use of either a single equation or multi-equation models has been less than positive. The evidence suggests that no single model could outperform the random walk model consistently over any forecast horizon. The study by Meese and Rogoff (3-24) could not specify an accurate reason for the consistent outperforming of the random walk and only speculation on the possible explanations were presented. As the models presented suggest, there may be other factors that are not incorporated into the models that may play a significant role in the determination of the exchange rates. This has already been discussed as a problem of a multi-equation model since the specification error can be a source of error as the variables do not accurately reflect the magnitude of the impact on exchange rate changes. In a forecasting study made by Gandalfo, he showed the results of a multi-equation that he developed that actually outperformed the random walk model in forecasting the lira against the dollar (Moosa 131-133).

In applying this information about forecasting to our study, it is unlikely that a forecast of the change in the exchange rate will aid in capturing the profits that are possible. The area of forecasting has been developing over the past decades and has shown little significant progress in forecasting exchange rates. This seems to be an area where there may be too many unidentifiable influential factors that make it extremely difficult to forecast with success.

2.2.4 Previous studies on forecasting

It is well known that exchange rates are some of the most difficult variables to forecast within macroeconomics. Several previous studies have tried to develop forecasting models for out of sample exchange rates based on certain explanatory variables but the outcomes have not been successful. Meese and Rogoff (3-24) perform an evaluation of out of sample forecasts and they came to the conclusion that none of the models tested performed better than a random walk forecast. Degrér et al (1-10) reached similar findings for the Swedish nominal exchange rate. They tested several single equation forecast models and none of the models could beat the random walk on any forecasting horizon. However, Alexius (B, 1-24) tested the forecasting power of the two most common forecasting models, i.e. UIP and PPP, for horizons of ten years. Although both models are often rejected in previous studies, she found that they contain useful information about future exchange rates at the ten-year horizons. Both UIP and PPP beat the random walk in most of the cases.

3. Methodology

The aim of our paper is to determine if interest parity holds or if speculative profits can be made. This can be tested using historical data, using a couple of different methods; these methods can then be used to determine if speculative profits can be made. The method of achieving our purpose is important to define so that the data can be narrowed enough to support our conclusion and our purpose of the study. The data is an important part of an established method; the data to be used is quantitative historical interest rates and exchange rates.

3.1 Research design

One way to test whether interest parity holds is to estimate the beta based on historical data between the currency appreciation and the interest differential. The beta calculation is made through a regression between the change in the exchange rates and the lagged interest differentials. The beta value is equal to the covariance between the exchange rate changes and the interest differentials divided by the variance of the interest differentials. The formula for UIP becomes $\frac{E_{t+1}-E_t}{E_t} = \alpha + \beta(R_{t,t+1} - R^*_{t,t+1}) + \varepsilon_{t+1}$, where E_t is equal to the nominal exchange rate, $R_{t,t+1}$ is the domestic nominal interest rate between t and $t+1$, $R^*_{t,t+1}$ is the foreign interest rate between t and $t+1$, and ε_{t+1} is an error term (Alexius, C, 6).

If α=0 and β=1, interest parity holds perfectly on average and it is not possible to make speculative returns by engaging in carrying trades. Beta values have been widely used in previous studies in order to test interest parity. We have decided not to use beta values when testing interest parity. The reason for this is that the time series of exchange rate changes tend to be stationary and

have a high volatility when looking at the graphs. This is especially the case for the time series of exchange rate changes based on short maturities. This leads to difficulties finding a representative slope of the time series. The importance when testing interest parity lies in detecting if the correct currency appreciates, i.e. the one with the lower interest differential. Beta values do not always give the right indication of this. Therefore, we have decided to use prediction errors and prediction error ratios when testing interest parity.

The method of calculating prediction errors when testing the interest parity stems from the following equation:

$$R_{SEK} = R_{YEN} + (E^{e}{}_{SEK/YEN} - E_{SEK/YEN}) / E_{SEK/YEN}$$

This tells us that the interest return on Swedish crown deposits should be equal to the interest return on yen deposits plus the expected depreciation in the Swedish crown. For example, if the interest rate is 3.5% in Swedish crowns and 0.2% in Japanese yen, the expected depreciation in the Swedish crown has to be 3.3% for interest parity to hold. This formula can be used when analyzing historical data on exchange rates and interest rates in order to examine whether interest parity holds between certain currencies. The prediction error itself is equal to the difference between the actual change in the exchange rate and the interest differential, i.e., $(E^{t+1}{}_{SEK/YEN} - E_{SEK/YEN}) / E_{SEK/YEN} - (R_{SEK} - R_{YEN})$. It is important to note that the actual interest differential is equal to $\left[\frac{R_{SEK} - R_{YEN}}{1 + R_{YEN}}\right]$, and that $(R_{SEK} - R_{YEN})$ is only an approximation of the actual interest differential unless a logarithmic or continuous form of the interest rates is applied (Levich 145). We will calculate the correct interest differential, which is the previous formula. This leads to the following calculation of the prediction errors:

$$\left[((E^{t+1}{}_{SEK/YEN} - E_{SEK/YEN}) / E_{SEK/YEN}) - \frac{R_{SEK} - R_{YEN}}{1 + R_{YEN}}\right]$$

These two methods are both feasible but the validity can differ and we will focus on calculating the prediction errors for different pairs of currencies based on historical exchange rate and interest rate data. It is important to emphasize that the prediction errors indicate the actual interest deviation from interest parity in absolute terms. Therefore, it does not say anything about the size of the deviation in relation to the interest differential between the pair of the two currencies for which the test was made. The prediction errors should be equal to zero if interest parity holds perfectly. The reason for this is that the actual change in the exchange rate should be equal to the interest differential. We will always calculate the interest differentials as positive values when possible. In these cases the ratio of the exchange rate has to be high interest rate currency per low interest rate currency. If this results in negative prediction errors, it gives an indication that it could be possible to make speculative profits through carry trading. However, the spreads of the interest rates and exchange rates have to be taken into account although they are very small. We also want to test to what degree interest parity holds in relative terms, i.e. when measuring the deviation of interest parity in terms of the interest differential of the currency pair. This can be tested by dividing the prediction error by the interest differential, i.e.

$$\left[\frac{((E^{t+1}{}_{SEK/YEN} - E_{SEK/YEN})/E_{SEK/YEN}) - \frac{R_{SEK} - R_{YEN}}{1+R_{YEN}}}{\frac{R_{SEK} - R_{YEN}}{1+R_{YEN}}}\right]$$

This ratio will tell which currency that has appreciated or depreciated and by how much in relation to the interest differential. Given that the ratio is calculated by always comparing the high interest currency to the low interest currency so that the interest differential always is positive, we can make the following conclusions. If the ratio is zero, then interest parity holds perfectly. If it is higher than zero, the correct currency, i.e. the one with the lower interest rate, has

appreciated by more than the interest differential. If it is equal to 1, the correct currency has appreciated by 100% more than predicted by interest parity. In the case when the ratio is between 0 and –1, the correct currency has appreciated by less than indicated by interest parity, e.g. a ratio of –0.6 implies that the low interest rate currency has appreciated by 60% less than it should have. Finally, when the ratio is more negative than –1, then the wrong currency has appreciated, i.e. the one with the high interest differential. In these cases the opportunity for carry trading can be extremely profitable by taking loans in low interest rate currencies and making deposits in high interest rate currencies. It is important to be aware of the fact that these ratios can be misrepresentative in some cases. One example is when the interest differential is extremely small. As the interest differential approaches zero, the ratio becomes infinitely large. Small interest differentials can also occur between short maturities such as 1-month and 3-months. This can also result in high ratios.

If you are interested in testing whether it is possible to make speculative profits, then relative measures are not of a great importance. Instead prediction errors would be appropriate since they state the interest deviation in absolute terms. A negative value would indicate profit opportunities in absolute interest rates. However, when measuring to what extent interest parity holds, it becomes more important to measure the deviation of interest parity in relative terms to the interest differential. Then the ratios of the prediction errors divided by the interest differential would be an appropriate measure.

In order to test interest parity and determine whether speculative profits can be made, we have decided to calculate prediction errors between all currency combinations in order to measure the deviation from interest parity in absolute terms. We will then measure the deviation relative to the interest differential by calculating the prediction error ratios. The way of calculating these two measurement tools is explained in section 3.2. Beta values will not be

used since they can be misrepresentative when determining the direction of the currency changes. Section 3.3 explains how we test the statistical significance of the prediction errors. Section 3.4 discusses how we calculated the figurative examples of carrying trades when taking into account the bid and ask spread of exchange rates and interest rates.

3.2 Calculating prediction errors

The prediction error between two currencies was explained earlier and is equal to the difference between the change in the exchange rate during the maturity of the interest rate and the interest differential. The formula becomes:

$$\left[((E^{t+1}{}_{A/B} - E_{A/B}) / E_{A/B}) - \frac{R_A - R_B}{1 + R_B} \right]$$

where A and B are the two currencies. Prediction errors were calculated between all possible combinations of pair of currencies for all maturities among the eight currencies included in the study. The maturities of the interest rates were 1 month, 3 months and 1 year. It is important that the ratio of the exchange rate is correct when calculating the deviations of interest parity given by the prediction errors. We chose to calculate the interest differentials as high interest rate currency minus low interest rate currency divided by one plus the low interest rate currency. Hence, the change in the exchange rate must be the change in the ratio of the high interest rate currency divided by the low interest rate currency.

When calculating the interest differentials we had to put the interest rate in the correct form for the 1-month and 3-month interest rates. All interest rates were quoted as yearly rates so the 1-month maturity rates had to be divided by 12 and the 3-month rates divided by 4. The interest differentials were only possible to calculate for weekdays since no interest rate data are available for weekends. In order to solve this problem we used the interest differentials for Fridays for the following Saturday and Sunday. All exchange rate and interest

rate data were daily rates during the time period January 1, 1999 until August 1, 2003. The prediction errors were therefore calculated on a daily basis for each of the maturities. The interest differentials had to be lagged by the maturity of the interest rate in order to get the exchange rate changes and interest differentials on the same level. An average of all the daily prediction errors were then calculated for each currency pair. This average gives the deviation of interest parity per observation for the three maturities tested. Since one of our purposes is to test whether interest parity holds better for longer maturities than for shorter ones, we had to multiply the 1-month averages by 12 and the 3-month averages by 4 in order to get these maturities in an annual form so that they could be directly compared to the 1-year prediction errors.

The prediction error tells the exact deviation of interest parity in absolute percentage terms and a negative value implies that the exchange rate with the higher interest differential has not depreciated by as much as suggested by the interest differential on average. In this case $((E^{t+1}{}_{A/B} - E_{A/B})/E_{A/B})$ has not risen by as much as $\frac{R_A - R_B}{1+R_B}$. In the case where $\frac{R_A - R_B}{1+R_B}$ is higher than $(E^{t+1}{}_{A/B} - E_{A/B})/E_{A/B})$ it would be possible to reach profits by engaging in carrying trades by borrowing in currency B and investing the proceeds in currency A. It is important to emphasize that prediction errors are in an absolute form and do not say by how much one currency has appreciated or depreciated relative to another currency. A prediction error of -10 implies that the currency with the higher interest rate depreciated by 10% less on average than it should have in absolute percentage terms. Since we want to test interest parity in relative terms, we also calculate the relative deviation of interest parity by dividing the prediction errors by the interest differential. These ratios indicate exactly by how much one currency has actually changed in relation to how much it was predicted to change based on interest parity. From now on we will refer to these

ratios as prediction error ratios. They are calculated in the following way:

$$\left[\frac{((E^{t+1}{}_{A/B} - E_{A/B}) / E_{A/B}) - \frac{R_A - R_B}{1 + R_B}}{\frac{R_A - R_B}{1 + R_B}} \right]$$

The prediction errors should equal zero if interest parity holds perfectly. Simply looking at the prediction errors themselves does not tell us whether speculative profits could be made in the form of carrying trades when the prediction errors are negative. The reason for this is that the prediction errors do not take into account the interest rate and exchange rate spreads. The interbank lending rates and the middle exchange rates were used to calculate the prediction errors. However, large deviations from zero of the prediction errors indicate that interest parity does not hold and speculate profits could be attainable. To calculate the profit opportunities, the deposit rates and the bid and ask exchange rates must be taken into account. This is done when we make figurative examples of carrying trades, which is explained in section 3.4.

3.3 Testing statistical significance

As part of the study, the significance of the prediction errors is unknown. In order to test whether they are significantly different from zero a hypothesis was formed and tested using a t-test of the mean of the prediction errors. The null hypothesis is stated as the prediction error is equal to zero and the alternative hypothesis stated that the prediction error is not equal to zero. The hypothesis testing was performed using a standard t-test for a mean with a 95% confidence interval. The test is two tailed with 2.5% in each tail of the distribution. The t-test was applied to all of the currency combinations and the results will be discussed in the empirical findings section of the thesis. The standard t-test is performed as follows:

$$t_{n-1} = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

Where

t_{n-1} = t-statistic with n-1 degrees of freedom

$\bar{x}$ = the sample mean

μ_0 = the hypothesized value of the mean

s = the sample standard deviation

One of the key assumptions in performing a significance test is that the sample is normally distributed (Defusco 327). The t-test results will be discussed in the empirical analysis part of the thesis.

3.4 Calculating carrying trades

We have calculated examples of carrying trades in order to illustrate how speculative positions of uncovered interest arbitrage can be conducted. These were calculated with the maturities of 1-month and 1-year. The calculation of

carrying trades differs in the approach used when calculating the prediction errors in the sense that the interest rate and exchange rate spreads were taken into account. This is easily explained by giving an example of a carrying trade between two currencies, e.g. the Indonesian rupiah (IDR) and the Japanese yen (JPY).

Suppose that an uncovered interest transaction is undertaken over the time period from *t* until *t+1* by borrowing an amount K in JPY at the JPY lending rate and investing the proceeds in IDR at the IDR deposit rate since $i_{IDR}^{\ dep} \succ i_{JPY}^{\ ldn}$. The proceeds from the JPY loan in IDR are equal to the amount of JPY multiplied by the IDR/JPY bid rate. These proceeds are then invested at the IDR interest rate for the specific maturity. If the maturity of the interest rate is 1-month, the IDR proceeds at the end of the month are equal to $[(K * E_{IDR/JPY}^{\ bid_t}) * (1 + i_{IDR}^{\ dep} * (n/365))]$, where n is the number of days for the maturity. At the end of the investment the principal and interest of the loan in JPY have to be repaid. This is equal to $K * (1 + i_{JPY}^{\ ldn} * (n/365))$. The amount of the funds invested in IDR in the terms of JPY at the end of the investment horizon is equal to $[(K * E_{IDR/JPY}^{\ bid_t}) * (1 + i_{IDR} * (n/365))] * E_{JPY/IDR}^{\ bid_{t+1}}$. The profit over the investment horizon is then equal to:

$[(K * E_{IDR/JPY}^{\ bid_t}) * (1 + i_{IDR} * (n/365))] * E_{JPY/IDR}^{\ bid_{t+1}} - K * (1 + i_{JPY}^{\ ldn} * (n/365))$. This answer is divided by K in order to get the profit/loss in percentage over the investment horizon.

In section 3.6 we explain how we estimated the interbank deposit rates and the bid and ask exchange rates for the currencies for which these were not readily available. We calculated examples of carrying trades for the currency pairs that were interesting from a carrying trading perspective after having analyzed the prediction errors. These currency pairs comprised of combinations of the following exchange rates: IDR, ZAR, CHF and JPY. We chose to enter a position on the first day in each month. This implies that positions were entered

on the 1st of every month for the 1-month interest rate maturities. Positions with the 1-year maturity were entered on January 1st and closed on December 31st. This could lead to a large degree of randomness that could deviate from the results found by the prediction errors. Total profit per year and average profit per annum were calculated for each of the positions in order to get an overview of the profits/losses generated by the carrying trades. In the empirical chapter we will present the results of the average profits/losses per annum in order to investigate whether they result in speculative profits.

3.5 Data collection

Our research is mainly based on quantitative analysis conducted through numerical data retrieved from certain databases. Literature studies and interviews have also been used in order to gain knowledge of specific topics that are related to our study.

3.5.1 Primary data

Primary data can be obtained by observation or by communication. A large part of our research has been based on primary data in the form of gathering data through databases, e.g. Oanda and DataStream Advance, and then conducting quantitative analysis based on this data. We have also conducted interviews with several people who have in-depth knowledge of the research topics. These interviews have both been face-to-face and in writing through e-mails and phone correspondence. Informal discussions with our supervisor at Handelshögskolan have also provided additional vital information.

3.5.2 Secondary data

Some parts of our study, e.g. the theoretical framework, are based on secondary data. The type of secondary data used is academic literature and articles collected from either books or journals. Several articles have also been collected via the internet, which is a great source for finding working papers in economics. One such website is the Scandinavian working papers in economics.

3.5.3 Interest rate and exchange rate data

We have chosen to use eight different currencies in our numerical estimations, which are the Japanese yen (JPY), the Swiss franc (CHF), the US dollar (USD), the British pound (GBP), the Swedish crown (SEK), the euro (EUR), the South African rand (ZAR) and the Indonesian rupiah (IDR). The choice of currencies depended to a large extent on the interest rates. We wanted to calculate prediction errors for pairs of currencies with large interest differentials. For example, the interest rates are very low in the Japanese yen and the Swiss franc and very high in the South African rand and the Indonesian rupiah. It would therefore be interesting to analyze whether the low interest rate currencies actually appreciate by the whole interest differential vis-à-vis currencies with relatively large interest rates. The dollar and pound are also interesting since they are major currencies. The Swedish crown was included due to our personal interest in our domestic currency. We also considered the euro an interesting currency to analyze since it is one of the world’s three main currencies and has only existed since January 1, 1999.

The foreign exchange rate data we have collected are interbank exchange rates between the eight different currencies ranging from January 1, 1999 until August 1, 2003. We think that four and a half years of data should be a sufficient time period to examine. It is also advantageous to include as recent data as

possible. Furthermore, exchange rate conditions change to a large extent over longer periods, which implies that ten year old data might not be relevant to the current conditions existing in the foreign exchange market.

We want to test to what degree interest parity holds among the chosen currencies and this implies testing interest parity over different maturities. The choice of maturity is up to the author to decide since interest parity should hold regardless of the maturity chosen. Since some studies have found evidence that interest parity usually holds more often for longer maturities than for shorter, we have decided to use interest rates of three different maturities for the interest rates, namely 1 month, 3 months and 1 year. These maturities were recommended to us by Freddy Van den Spiegel who is a chief economist at a Belgian bank and also a professor at the University of Brussels. It makes sense to use different maturities since we want to measure the effect that different maturities have on the prediction errors. The interest rates used are interbank lending rates for the specific currencies and maturities. The interest rates were collected from the DataStream Advance database. The importance when choosing the interest rates is that the interest rate differential is not affected by the choice of interest rate. Therefore, we will be consistent and choose the same type of interest rate for each currency when testing interest parity so that interest rate differentials are valid. Hence, interbank lending rates are used for all calculations of the prediction errors while deposit and lending rates are used in the figurative examples of carrying trades. All exchange rate and interest rate data were daily rates during the time period January 1, 1999 until August 1, 2003. Table 1 shows the average of all the interest rates used. Averages between two periods were calculated. The first average for each maturity is for the period January 1, 1999 until December 31, 2000. The second average corresponds to the period of January 1, 2001 until August 1, 2003.

Table 1: *Average interbank lending rates (In tables comma means period)*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
1-month 1999-2000	16,85%	11,94%	5,74%	5,83%	3,49%	3,55%	2,04%	0,23%
1-month 2001-2003	14,08%	11,28%	4,82%	3,57%	3,90%	3,72%	2,01%	0,14%
3-months 1999-2000	17,71%	11,88%	5,87%	5,98%	3,63%	3,68%	2,24%	0,28%
3-months 2001-2003	14,30%	11,27%	4,86%	3,58%	3,95%	3,74%	2,07%	0,17%
1-year 1999-2000	17,86%	12,14%	6,16%	6,29%	4,14%	3,99%	2,62%	0,32%
1-year 2001-2003	14,65%	11,46%	5,06%	3,81%	4,22%	3,83%	2,27%	0,19%

The exchange rates were collected from the Oanda website. The rates are middle rates, i.e., the average of the bid and ask rates. In order to calculate the outcomes of carrying trades, bid and ask exchange rates are needed. These were not always available so we had to calculate them in certain cases. For example, the spread for the JPY/USD exchange rate is 0.05 basis points. If the JPY/USD middle rate is equal to 113.20, the bid rate is 113.175 and the ask rate is 113.225. From these JPY/USD bid and ask rates we can retrieve the USD/JPY bid and ask rates. The USD/JPY bid rate is equal to 1 divided by the JPY/USD ask rate and the USD/JPY ask rate is equal to 1 divided by the JPY/USD bid rate.

3.6 Delimitations

As with most studies, there are several limitations that have to be made before conducting the actual research. There are some general limitations that we had to decide upon before engaging in the study. These limitations concerned which type of interest rates and exchange rates to use and which time horizon to select, which were explained in 3.5.3.

One limitation in the thesis will be that we cannot test the actual speculative profits or losses made by testing interest parity. The reason for this is that interest parity has to be tested using the same type of interest rate for all

currencies in order to get consistent interest differentials. Therefore, lending rates will be used when testing interest parity. Since we also want to investigate the possibility of making speculative profits by engaging in carrying trades, we will make figurative examples of carrying trades. When conducting these calculations we will use the bid/ask spreads for the interest rates. This will lead to more accurate results for the carrying trades. In this case lending rates will be used for currencies with low interest rates and deposit rates for currencies with high interest rates. In these calculations, we will also take into account the bid and ask spreads of the exchange rates when funds are converted from one currency into another.

There are also some additional limitations related to the data used in the study that we had to modify to some extent since all data was not available. Exchange rates are available on a daily basis throughout the year and change even on weekends and on holidays. However, interest rates are only available on weekdays. This presents a problem when calculating the prediction errors since we need to have data available for all days. To solve this problem we used the VLOOKUP function in Excel so that the interest rates for Fridays were used for the following Saturday and Sunday.

When retrieving the interest rates we chose to use the interbank lending rates for all currencies since we wanted to take the perspective of banks and these rates were widely available. However, we also wanted deposit rates since they have to be used when calculating the profits or losses made by engaging in carrying trades. Interbank deposit rates were only available in Swiss francs and British pounds. Therefore, we had to estimate the spreads in order to retrieve the deposit rates from the lending rates for the remaining countries. What we did was to calculate an average of the spread divided by the average of the lending rates for the Swiss franc and British pound. These ratios resulted in 4.6% for the Swiss franc and 3.2% for the British pound. We estimated the spread of the

remaining interest rates to be 4% of the lending rates. This was the best assumption that we could make up. From these spreads we then calculated the deposit rates.

The exchange rates retrieved from Oanda were middle rates of the bid and ask rates. Since we needed the bid and ask rates in order to calculate the profits and losses made through carrying trades we looked up the spreads for different currency pairs by using the spreads of Saxobank, an investment bank focusing on foreign exchange trading. The spreads were then used to calculate the bid and ask rates. The spreads were available for almost all currency pairs except for the Indonesian rupiah (IDR) for which we had to estimate spreads. Most spreads ranged between 0.4% and 0.7% of the middle rates so we estimated the spreads for the IDR to be 1% of the middle rates. A higher spread is normal for this currency since the IDR is not as liquid as the major currencies.

Another limitation is that we do not take into account transaction costs in the form of commissions when making carrying trades. However, these commissions are extremely small since we are taking the perspective of banks. We do, however, take into account of the transaction costs in the form of the spreads of the interest rates and exchange rates.

We chose the IDR as part of our study since the interest rates are very high in this currency. However, the IDR is different from the other currencies since the Bank of Indonesia has pursued a policy of a managed float/crawling peg exchange rate since 1978. By managing the exchange rate of the IDR, the Bank of Indonesia seeks to maintain the international competitiveness of the rupiah against a basket of foreign currencies. The US dollar has a heavy weight in the basket and the rupiah tends to move parallel with the dollar. The rupiah was devalued highly in 1983 and 1986 but the Indonesian Government is not in favor of any further devaluation in the future. The monetary policy in form of a managed float has instead resulted in a gradual depreciation (of between 4 and 5

percent against the dollar in recent years), which has resulted in higher confidence in the currency and expanded the demand for Indonesian exports (Bank of Indonesia). Despite the IDR being a managed currency, we do not think that this is a negative factor for our study since our purpose is to investigate whether speculative profits can be made. It might even be positive that the IDR is not freely floating since this might create deviations from interest parity. A limitation of the IDR is however that Indonesia has capital controls that place restrictions on the amount of funds that can be transferred from Indonesia abroad. We have tried to find information about the exact amount of the capital controls for foreign exchange but we have been unable to do so since this information is not widely dispersed. The remaining currencies chosen are, however, freely floating.

3.7 Quality of research

In order for a study to be reliable, one must keep a high level of quality. By that we mean that the study itself must possess a high degree of trustworthiness and credibility in order to ensure the quality of the findings. This section judges the value of our research design through tests of its validity and reliability.

3.7.1 Validity

Validity is defined as the absence of systematic errors of measurement. This refers to whether the researcher is measuring what he desires to measure. There are three different types of validity: construct, internal and external. Construct validity concerns whether there is a correct existing relationship between the underlying theories and the empirical findings of the research (Yin 32-38). Internal validity refers to whether or not the research is measuring what it is supposed to measure. Internal validity is of great importance when, and only

when, a causal relationship is measured in a study. In most observational and descriptive studies, internal validity is not of importance. The internal validity of a study depends on how well the methodologies used lead to the observed findings, i.e. the method is the cause of the findings and outside factors of the method do not affect the result. What internal validity implies is that you have evidence that your measurements in the model used, for example, a program, caused what you observed (i.e. the outcome) to happen (Trochim, “Internal validity”). The meaning of external validity is that the conclusions reached in the study would hold for other researchers as well in other places and other times. This relates to the issue of generalizing when constructing the measurement process. In most studies, a sample of the population that is thought to be representative of the population as a whole has to be drawn in order to conduct the research. If the sample is representative, the generalization can be related back to the population. External validity is high in a study if the generalizations of the measurements are representative to the study (Trochim, “External validity”).

Validity is sometimes defined as an instrument’s ability to accurately measure the aspects of the object that it is designed to measure. In our report, internal and external validity are a main concern since our research is explorative and we want to measure causal relationships and be able to perform generalizations based on our findings.

The methods used in this thesis possess a high degree of validity since the prediction errors are the optimal way to test the deviation of interest parity in an absolute form. We then test to what extent interest parity holds in relative terms by calculating the ratio of the prediction error to the interest differential. The method chosen is the cause of the findings and the prediction errors test exactly what we want to measure, namely whether interest parity holds. The ratio of the prediction error to the interest differential tests in what direction interest parity

holds, i.e. if the right or wrong currency is appreciating or depreciating. The main reason for choosing the prediction errors and its ratio to the interest differential as our measuring tool of interest parity is that they provide the study with a higher internal validity than if, for example, beta values would have been used. Beta values do not always indicate which currency is appreciating or depreciating. They only measure how a change in the interest differential affects the exchange rate changes on average. For example, the interest differential could be constant over time while the exchange rate changes are decreasing although always higher than the interest differential. This would imply a negative beta value. However, the correct currency is appreciating or depreciating by more than the interest differential over the entire sample period.

There are both advantages and disadvantages with calculating the prediction errors on a daily basis. The advantage is that the average will show the difference between the exchange rate change and the interest differential for every day. This is positive since it shows the overall average deviation from interest parity between each currency pair on a daily basis. The disadvantage is that this type of calculation leads to double counting when an average per year is calculated. This is because the exchange rate on one given day is taken into account 32 times when calculating exchange rate changes for 31-day intervals. For example, the exchange rate on August 1 is used to calculate the change between this date and July 1. The rate of August 1 is then used in all the exchange rate changes for all the remaining days in August and the last time when the change between September 1 and August 1 is calculated. Even if using daily prediction errors lead to double counting in a certain sense, it gives a clearer view of the degree to which interest parity holds. In fact, all prediction errors should be equal to zero if interest parity would hold. In our analysis section we will focus on the average value per observation. However, since we want to be able to compare the average prediction errors over different

maturities we have to put them in a comparable form. One could, for example, multiply the average prediction error for a 1-month interest rate maturity by 12 in order to get the average prediction error for that maturity on an annual basis. The average prediction errors for the 3-month maturities can be multiplied by 4. These adjustments enable us to compare the prediction errors over different maturities. The same adjustments are not necessary for the prediction error ratios since they only indicate the direction of the exchange rate changes relative to the interest differentials.

External validity is different in the sense that it is difficult to make generalizations for exchange rates due to their high volatility and since they are highly influenced by unpredictable news. Even though the findings of our calculations will be representative for the given time period, it is almost impossible to make generalizations of our findings to out of sample years, since exchange rates are so difficult to predict. External validity plays an important role when we calculate the figurative examples of carrying trades. Here we pick one trading day per month and year at random in order to test whether speculative profits can be made. We are aware that this can lead to low external validity since one random observation can deviate from the averages reached by the prediction errors. This is something that will be taken into account in the analysis of the results from the carrying trades.

The construct validity of this paper is low in the sense that the underlying theories of interest parity will probably not indicate a correct relationship with the empirical results of the research study that we have conducted. This does not decrease the validity of our research since our intentions are to investigate whether speculative profits can be made and this requires that the theories of interest parity are violated. Hence, the construct validity will not affect the validity of our methodology since a rejection of interest parity would imply low

construct validity. However, interest parity is one of the theories in international economics that is most widely rejected by academic scholars.

3.7.2 Reliability

The reliability of a study measures the extent to which research findings can be reproduced if the same study was conducted again by another investigator. Hence, reliability concerns the consistency with which a study is undertaken (Yin 36-38). A test should result in the same results if it is conducted by another researcher. This implies that independent researchers must be able to reach the same results given that the same procedures are undertaken. Therefore, an academic study with high reliability is not affected by who conduct the measuring. In a quantitative research like this study, where we use a lot of primary data, the reliability lies within the extent to which our measurement procedures are justified and explained in detail so that another researcher would be able to replicate our study and come to the same conclusion. Reliability is the reflection of accuracy that can be defined by the books and reports chosen. We also used secondary data and it is of great importance to make sure that this type of data is trustworthy before applying it to our study. When searching for reports we only looked at reports that came from trustworthy sources, which means that the reports have been accepted before publication. When searching on the internet, a common problem is that no one can guarantee the reliability of the material found. However, the reports that we found on the internet came from reliable sources and were written by professionals with great knowledge of the subject. The material that is used in this study is to the outermost reliable according to these criteria. We have conducted a thorough search approach when selecting our references in order to be sure that they can be considered to be of high quality. This is important in order to provide our paper with a high degree of reliability.

All the methods and limitations applied when calculating the prediction errors and carrying trades have been explained in detail so that another researcher could easily replicate them. However, since all data was not readily available we had to make estimations, e.g., of certain interbank deposit rates. This would decrease the reliability of our study somewhat but is should not affect the overall results and findings since most data was available and justified and the measurement tools are correctly implemented.

4. Empirical analysis and findings

This chapter presents the empirical findings from our tests, which are analyzed in detail. Prediction errors are discussed as well as the prediction error ratios, i.e., the ratios of the prediction errors to the interest differentials. All possible combinations of exchange rates have been tested but we focus on the findings of the currencies with large interest differentials. Figurative examples of carrying trades are also presented.

4.1 Prediction errors

Prediction errors were calculated for all possible combinations of currency pairs in order to find the absolute interest deviations from interest parity. The analysis will be divided into three parts related to the maturity of the interest rate tested. The reason that we divided it into different maturity parts was to determine in the analysis if interest parity holds better for longer maturities than for shorter maturities. Each part is then divided into five sections. We devote one section to each of the following currencies: IDR, ZAR, JPY and CHF. These are especially interesting as they are the two highest and the two lowest interest rate currencies. The last section of each part presents some general remarks about the major findings and includes the other currencies as well.

4.1.1 1-Month maturities

Table 2 shows the average prediction errors for all the combinations of currency pairs. The currencies on the top of the table have been tested against the currencies on the left-hand side. Hence, the relationships have been chosen so that the interest differentials are positive in as many cases as possible. Overall, there are 28 possible relationships to test since there are eight currencies. In the

analysis, the focus will be placed on combinations with large interest differentials. The average prediction errors have been adjusted to an annual basis by multiplying the average errors by 12. This makes them possible to compare to the prediction errors derived from the 1-year maturities since the average errors are given in absolute percent on an annual basis.

Table 2: *Average prediction errors 1-Month on an annual basis*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-6,35%							
GBP	-9,01%	-0,20%						
USD	-9,81%	-1,02%	-0,36%					
SEK	-10,75%	-1,76%	-1,22%	-0,38%				
EUR	-10,57%	-1,77%	-1,21%	-0,29%	0,19%			
CHF	-11,25%	-3,16%	-2,06%	-1,16%	-0,58%	-0,78%		
JPY	-14,38%	-5,94%	-4,88%	-4,36%	-3,30%	-3,22%	-2,43%	

4.1.1.1 Depositing in IDR

As seen in Table 2, the IDR-combinations provide the most negative errors which indicates that there are opportunities for profits by making carrying trades through deposits in the IDR from funds borrowed in the other currencies. The most negative prediction error is for IDR/JPY, which amounts to –14.38%. The errors for the IDR-combinations are between –9.01% (GBP) and –11.25% (CHF) for the remaining currencies except for IDR/ZAR, which is –6.35%. This lower value is explained by the lower interest differential on average between the IDR and the ZAR. This interest differential is close to zero during long periods and even negative during short periods. Overall, the prediction errors are very negative for all the IDR-combinations, which give the indication about profit opportunities through carrying trades.

4.1.1.2 Depositing in ZAR

The ZAR provides some interesting results as high interest differentials suggest large negative prediction errors. However, the ZAR does not provide as large negative prediction errors as expected against all of the currencies. The deviation is largest against the CHF (-3.16%) and the JPY (-5.94%). The rest of the errors are quite small, between -0.20% (GBP) and -1.77% (EUR) on an annual basis. These prediction errors are quite small for being on an annual basis since the interest differentials are very high for the ZAR. The prediction error analysis of the ZAR indicates that the ZAR is only a good carry trade currency against the extremely low interest rate currencies.

4.1.1.3 Borrowing in JPY

In the analysis of the JPY, the results show negative prediction errors for all of the JPY-combinations as can be seen in Table 2. These results indicate that the yen constitutes a good currency to borrow in when conducting carrying trades vis-à-vis other currencies. As previously mentioned, the most negative prediction error overall is for IDR/JPY (-14.38%). Other prediction errors that are highly negative are ZAR/JPY (-5.94%), USD/JPY (-4.36%) and GBP/JPY (-4.88%). The large negative prediction errors give the indication that the yen is a good currency to borrow in as interest parity does not hold on average. However, as with the other currencies there are periods of more or less profitability.

4.1.1.4 Borrowing in CHF

In comparing the two lowest interest rate currencies it can be seen that all of the prediction errors are negative for both currencies. The CHF-combinations' prediction errors are not as negative as for the JPY-combinations. The errors are

most negative against the IDR (-11.25%) and the ZAR (-3.16%). The remaining errors are between -0.58% (SEK/CHF) and –2.06% (GBP/CHF). The results indicate that the deviations from interest parity are not that large for the CHF, except against the IDR.

4.1.1.5 General remarks

The prediction errors are negative for all combinations except for SEK/EUR. This suggests that in absolute terms, the currencies with the higher interest rates are not depreciating by as much as they should on average in absolute percentage terms. The errors for other currency pairs that do not comprise of either the high interest rate currencies (IDR and ZAR) or the low interest rate currencies (JPY and CHF) are very small. This is natural since the interest differentials between these pairs vary a lot and are often close to zero. Examples of these are USD/EUR (-0.29%) and SEK/EUR (0.19%).

4.1.2 3-Month maturities

Table 3 shows the average prediction errors for the 3-month interest rate maturity. The average prediction errors have once again been adjusted to an annual basis by multiplying the average errors by 4. This makes it possible to compare prediction errors for different maturities.

Table 3: *Average prediction errors 3-Months on an annual basis*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-8,41%							
GBP	-10,47%	0,43%						
USD	-11,30%	-0,38%	-0,79%					
SEK	-11,48%	-0,76%	-0,85%	0,45%				
EUR	-11,12%	-0,51%	-0,57%	0,79%	0,34%			
CHF	-11,78%	-1,04%	0,03%	-1,28%	-0,62%	-0,19%		
JPY	-15,63%	-5,00%	-3,71%	-4,78%	-3,63%	-3,81%	-2,27%	

4.1.2.1 Depositing in IDR

The IDR, which is the highest interest rate currency, has the most negative prediction errors for the 3-month maturities. The errors are also negative for all the combinations. Most of the errors are somewhat more negative than for the 1-month maturities. This would suggest that the IDR holds worse for the 3-months maturity than for the 1-month. The errors range from between -8.41% (ZAR) and -15.63% (JPY).

4.1.2.2 Depositing in ZAR

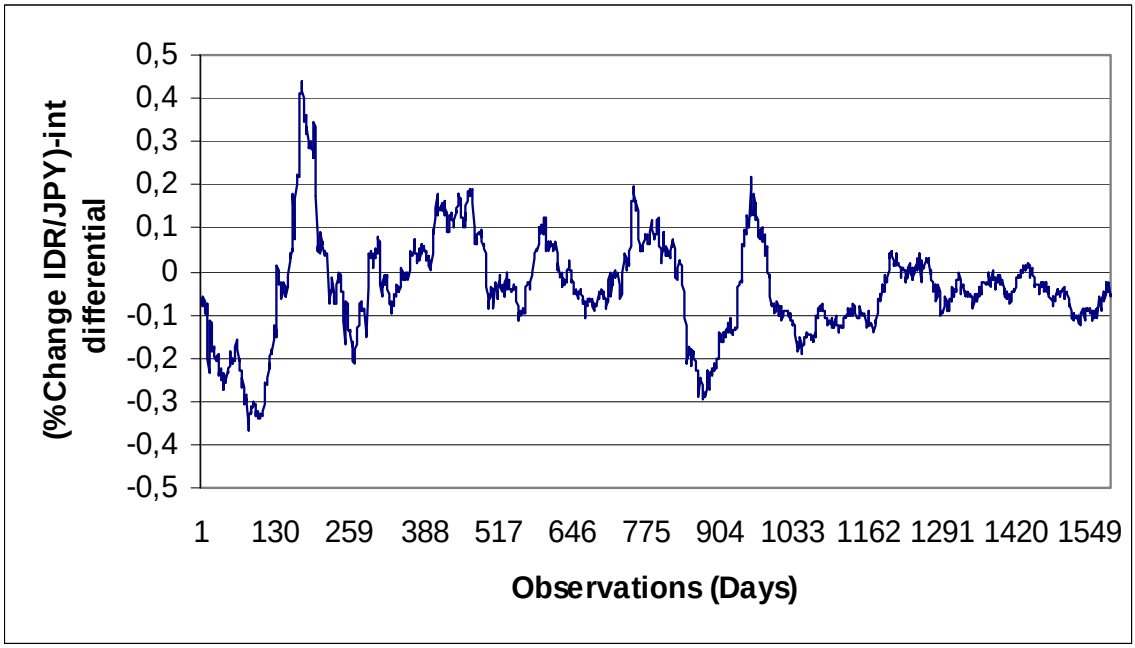
The errors for the ZAR-combinations are also negative for all combinations except for ZAR/GBP, which is 0.43%. However, the errors for the ZAR-combinations are less negative in all cases than they were for the 1-month

maturities. The most negative error for the ZAR-combinations is for ZAR/JPY, which is –5.00%. The other ZAR errors are not very negative for being on an annual basis; they range between –0.38% (ZAR/USD) and –1.04% (ZAR/CHF).

4.1.2.3 Borrowing in JPY

The JPY, which is the lowest interest rate currency, has negative prediction errors vis-à-vis all other currencies. The errors are almost as negative as they were for the 1-month maturity. The most negative errors for the JPY are against the IDR (-15.63%), ZAR (-5%) and GBP (-4.78%). These errors suggest that the JPY is not appreciating as much as it should on average. Figure 1 shows the prediction errors between the IDR and the JPY. Although the average prediction errors were most negative for this combination (-15.36%), the figure shows that it is difficult to find longer periods when the IDR depreciation is lower than the interest differential. Fluctuations in the deviations from interest parity are quite large and there are periods when the IDR deprecation is higher than expected but on average it is lower than expected. In the end of the horizon, interest parity seems to hold rather well since deviations are close to zero.

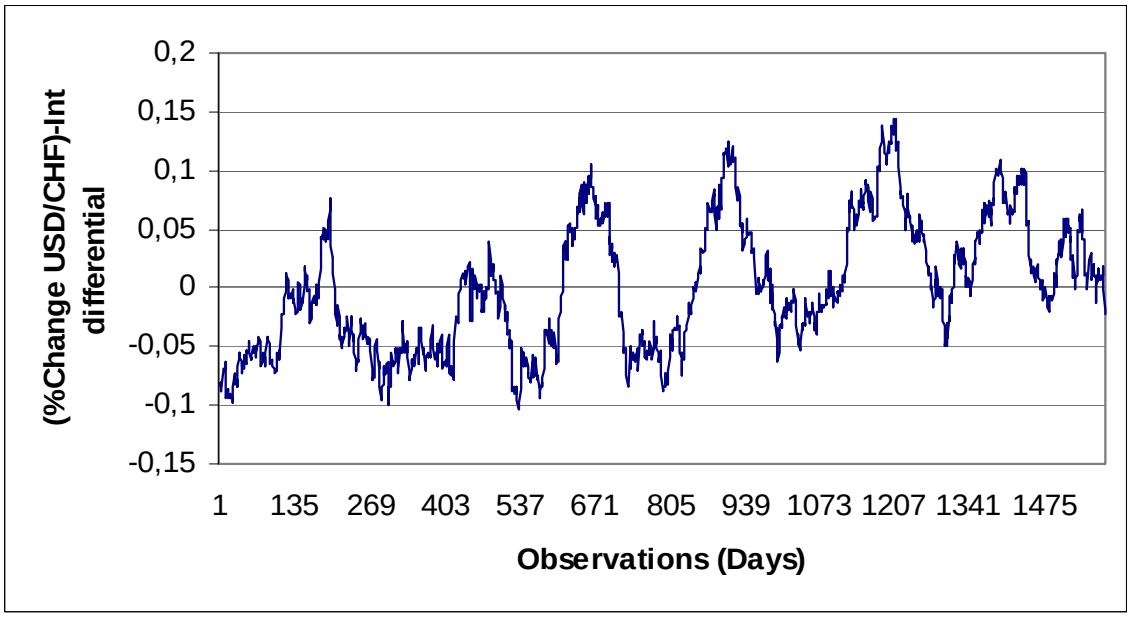
Figure 1: *Prediction Errors for the IDR/JPY 3-Months combination*



4.1.2.4 Borrowing in CHF

The prediction errors for the second lowest interest rate currency, the CHF, are quite close to zero (between 0.03% and –1.28%) except for IDR/CHF, which is –11.78%. The errors are very similar to those for the 1-month maturity and the CHF does not seem to deviate much on average from interest parity measured in absolute terms. However, even though the average prediction errors are close to zero, deviations during specific periods can be quite large. This is illustrated in figure 2 between the USD and the CHF. The prediction errors vary a lot and are never close to zero during any longer periods. Hence, deviations from interest parity can seem to be small according to the average prediction errors while the deviations during specific periods can be very large.

Figure 2: *Prediction Errors for the USD/CHF 3-Months combination*



4.1.2.5 General remarks

The prediction errors indicate a similar pattern compared to the errors for the 1-month maturity, at least for the currency pairs with high interest differentials. Overall, the IDR seems to be the most favorable currency to make deposits in when borrowing in the alternative currencies and the JPY seems to be the optimal currency to borrow in when investing in the other currencies. The prediction errors for the ZAR and the CHF seem to be quite close to zero on an annual basis even though the ZAR is the second highest interest rate currency and the CHF is the second lowest interest rate currency. The only exceptions are for the ZAR against the JPY and the CHF against the IDR. This indicates that the currencies that usually do not seem to provide large negative prediction errors, i.e. the ZAR and the CHF, do so against currencies that have large negative errors against the remaining currencies, namely the IDR and the JPY.

The errors for other currency pairs that are not comprised of either the high or the low interest rate currencies are again very small. They range between 0.79% (USD/EUR) and -0.85% (GBP/SEK).

4.1.3 1-Year maturities

Table 4 shows the average prediction errors for the 1-year maturities. These are analyzed and compared to the errors for the 1-month and 3-month maturities.

Table 4: *Average prediction errors 1-Year*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-9,68%							
GBP	-7,73%	6,13%						
USD	-7,19%	6,63%	0,14%					
SEK	-10,16%	3,44%	-1,91%	-1,08%				
EUR	-8,91%	4,62%	-1,09%	-0,36%	1,02%			
CHF	-8,21%	5,85%	-0,40%	0,22%	1,85%	0,78%		
JPY	-13,77%	-0,88%	-5,97%	-5,81%	-3,54%	-4,03%	-4,75%	

4.1.3.1 Depositing in IDR

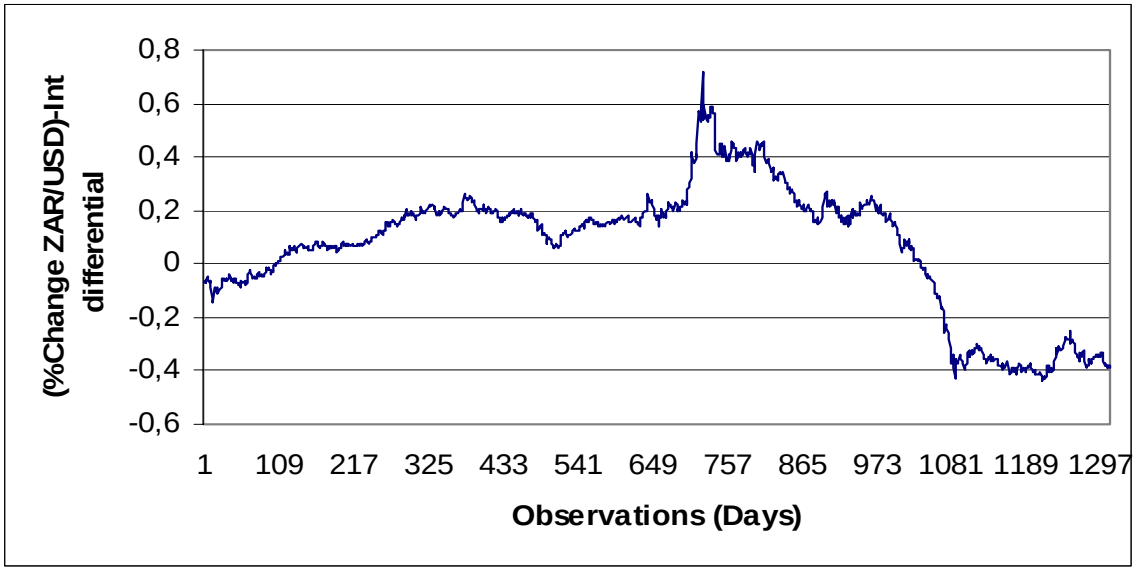
In performing a comparative analysis of the 1-year to the 1-month and 3-month maturities, it can be seen that the 1-year prediction errors are still highly negative but not as negative as they were for the 1-month and 3-month maturities. The prediction errors for the IDR range between –7.19% (IDR/USD) and –13.77% (IDR/JPY). By looking at Table 4, it can be seen that the IDR still has the most negative prediction errors even for the 1-year maturity. There is no error for any other currency pair that is more negative than for any of the IDR-combinations. This suggests that the IDR does not hold even for a long maturity such as the 1-year and opportunities for uncovered interest arbitrage should exist when borrowing in other currencies and investing the proceeds in the IDR. The

prediction error ratios analyzed in section 4.3 will test whether the IDR actually depreciates by less than it should in relative terms.

4.1.3.2 Depositing in ZAR

It is interesting to note that the ZAR prediction errors, in relation to the other currencies, are positive except for ZAR/JPY (-0.88%). The other errors for the ZAR range between 3.44% (ZAR/SEK) and 6.63% (ZAR/USD). This indicates that on average the interest differential is lower than the increase in ZAR value (ZAR depreciation) in relation to the other currencies. This is of course in absolute terms, but the indication is that the ZAR is not a good carry trading currency since it seems to depreciate by more than the interest differential suggests. Figure 3 depicts such a relationship between the ZAR and the USD. The average prediction errors are positive during almost the whole time horizon indicating that the ZAR depreciation exceeds the interest differential. Based on figure 3 and Table 4, it can be concluded that the ZAR does not conform to the conditions of interest parity. We will test whether the ZAR depreciates by more than it should by analyzing the prediction error ratios in section 4.3.

Figure 3: *Prediction Errors for the ZAR/USD 1-year combination*



4.1.3.3 Borrowing in JPY

All errors are negative for all JPY-combinations, which indicates that the JPY is still the best currency to borrow in. Highly negative errors except for IDR/JPY (-13.77%) are GBP/JPY (-5.97%) and USD/JPY (-5.81%). The only error that is close to zero is against the ZAR (-0.88%).

4.1.3.4 Borrowing in CHF

One of the most interesting findings is that the errors in relation to the CHF are positive in many cases. There are only two negative errors for the CHF, namely IDR/CHF (-8.21%), and GBP/CHF (-0.40%), which is close to zero. The rest of the errors are positive for the CHF and this should imply that the CHF is appreciating by more than the interest differential against most currencies except against the IDR since that error is highly negative. This will also be analyzed in 4.3. The indication, however, is that the CHF is not a good currency to borrow in when conducting carrying trades since the prediction errors are positive.

4.1.3.5 General remarks

The overall findings indicate that the IDR and the JPY deviates the most from interest parity in absolute terms when analyzing the prediction errors. The deviations are highly negative and this implies that the currency with the higher interest rate is not depreciating by the whole interest differential in absolute terms. The errors for the ZAR were positive in most cases, which suggest that the ZAR depreciates by more than it should. Most errors that do not involve either of the high interest rate currencies (IDR, ZAR) or low (JPY, CHF) result in prediction errors that are very close to zero. Examples of these are GBP/USD (0.14%), USD/EUR (-0.36%) and SEK/EUR (1.02%). This is not surprising

since the interest differentials are often close to zero and sometimes negative for these combinations. That is the reason why the analysis focuses on the currency pairs with high interest differentials.

4.2 Testing significance of the prediction errors

We have tested the statistical significance of the prediction errors by calculating T-statistical values for all the currency combinations. We implemented these tests in order to investigate whether the prediction errors are statistically different from zero. The test is two-tailed and if the T-statistic is larger than $+-1.96$ then we can conclude that the deviation of the prediction errors is statistically different from zero. By stating that the T-statistics are statistically significant we mean that the prediction errors are statistically different from zero. The standard deviations of the prediction errors are also analyzed and compared. These indicate by how much the prediction errors deviate from the mean on average in percentage terms. We have again divided the analysis into three parts depending on the maturity of the interest rate. Each part contains five sections, four sections covering the high and low interest rate currencies and a last section with general remarks about all the tests.

4.2.1 1-Month maturities

Table 5 shows the T-statistics for the 1-month maturities. These are analyzed in order to determine whether the prediction errors are statistically different from zero. Table 6 gives the standard deviations for the same prediction errors. These are analyzed in order to examine the degree of volatility in the deviations from interest parity. Both the T-statistics and the standard deviations of the 1-month maturities will later be compared to the 3-month and 1-year maturities in order

to see if the deviations from interest parity depend on the maturity itself and if the volatility of the deviations is related to the maturity.

Table 5: *1-Month T-statistics for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-2,88							
GBP	-4,58	-0,13						
USD	-5,14	-0,68	-0,56					
SEK	-5,62	-1,11	-1,72	-0,43				
EUR	-5,38	-1,09	-1,88	-0,31	0,39			
CHF	-5,52	-1,96	-3,12	-1,27	-0,96	-2,67		
JPY	-6,99	-4,10	-5,23	-5,09	-3,23	-3,10	-2,37	

Table 6: *1-Month standard deviations for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	7,45%							
GBP	6,64%	5,34%						
USD	6,46%	5,08%	2,19%					
SEK	6,47%	5,35%	2,39%	3,04%				
EUR	6,64%	5,47%	2,17%	3,16%	1,61%			
CHF	6,88%	5,46%	2,22%	3,08%	2,03%	0,99%		
JPY	6,95%	4,90%	3,15%	2,89%	3,45%	3,51%	3,47%	

4.2.1.1 Depositing in IDR

All the T-statistical values for the IDR-combinations are statistically significant. We can therefore conclude that the 1-month prediction errors for all the IDR-combinations are statistically different from zero. This is not a surprising finding since the prediction errors for the IDR were the most negative of all currency pairs (see Table 2). The T-statistics seen in Table 5 range between -2.88 (ZAR) and -6.99 (JPY). The range of the T-statistics supports the fact that interest parity does not hold for the IDR as they are statistically different from zero. The

volatility reflected by the standard deviations in Table 6 shows that the IDR has the highest volatility of all currency pairs. The standard deviations for the IDR range between 6.46% (USD) and 7.45% (ZAR). These are higher than for the remaining currency combinations, indicating that the prediction errors of the IDR deviate more from the mean.

4.2.1.2 Depositing in ZAR

The results of depositing in the ZAR show that there is only one significant T-statistic. The only significant statistic is against the JPY (-4.10). This number allows us to reject the null hypothesis that prediction errors are equal to zero on average. The other values range between -0.13 (GBP) and -1.96 (CHF). This is not surprising since the prediction errors were close to zero for the combinations that proved to be insignificant. The CHF has a statistic of -1.96 and we are unable to reject the null hypothesis. The standard deviations are not as large for the ZAR-combinations as they were for the IDR, but they are still higher than for the remaining currency pairs. They range between 4.90% (JPY) and 5.47% (EUR).

4.2.1.3 Borrowing in JPY

In looking at the bottom row in Table 5, the JPY-combinations are all significant at the 95% level as the values exceed the hypothesis rejection at the point -1.96. This was expected since all the JPY prediction errors were negative and seemed to be significantly different from zero. The values range between -2.37 (CHF) and -6.99 (IDR). We can therefore conclude that all the prediction errors for the JPY-combinations are statistically different from zero. This result allows us to reject the null hypothesis that the prediction errors are zero and prove that the prediction errors are statistically different from zero. The standard deviation is

highest vis-à-vis the IDR (6.95%). The remaining standard deviations are rather low, ranging between 2.89% (USD) and 4.90% (ZAR).

4.2.1.4 Borrowing in CHF

All T-statistics for the CHF-combinations are statistically significant except vis-à-vis the USD (-1.27), the SEK (-0.96) and the ZAR (-1.96). USD/CHF and SEK/CHF also resulted in prediction errors very close to zero, -1.16% and -0.58% respectively. ZAR/CHF had a prediction error of -3.16% and just fell short of being rejected at the 95% confidence interval. The most negative T-statistic is against the IDR (-5.52). This is also the combination that produced the most negative prediction error (-11.25%). The standard deviation for IDR/CHF is the highest for the CHF-combinations (6.88%). The other standard deviations range between 0.99% (EUR) and 5.46% (ZAR).

4.2.1.5 General remarks

Overall, there are 15 T-statistics that are statistically significant and 13 that are not. All T-statistics for combinations comprising of either the IDR or the JPY are significant. This is interesting and provides strong support for the findings since the prediction errors were negative for all combinations containing these currencies. This strengthens the theory that the IDR is the best currency to make deposits in and the JPY is the best currency to borrow in when conducting carrying trades. Most of the T-statistics are insignificant for the USD, GBP and the ZAR. The conclusion is, therefore, that the USD, GBP and the ZAR are not good currencies to perform carrying trades in as the prediction errors are not statistically different from zero. However, the GBP was significant against the CHF and the JPY, signifying a possible profitable relationship. The USD and the ZAR were only significant against the JPY. When analyzing the standard

deviations, we find that the volatility of the prediction errors is largest for combinations comprising of either the IDR or the ZAR. The standard deviations comprising of either the IDR or the ZAR range between 4.90% (ZAR/JPY) and 7.45% (IDR/ZAR). The remaining standard deviations for other currency combinations are rather low, ranging between 0.99% (EUR/CHF) and 3.51% (EUR/JPY).

4.2.2 3-Month maturities

Table 7 shows the T-statistics for the 3-month maturities. These are analyzed and compared to the 1-month maturities in order to find patterns related to the type of maturity. Table 8 gives the standard deviations for the 3-month prediction errors.

Table 7: *3-Months T-statistics for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-6,80							
GBP	-9,53	0,45						
USD	-9,72	-0,37	-2,29					
SEK	-10,18	-0,80	-2,38	0,80				
EUR	-9,63	-0,55	-1,56	1,33	1,35			
CHF	0,64	-1,05	-3,53	0,06	-0,60	-3,68		
JPY	-13,29	-5,50	-9,87	-6,84	-6,43	-5,74	-3,82	

Table 8: *3-Months standard deviations for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	12,16%							
GBP	10,81%	9,44%						
USD	11,43%	10,12%	3,38%					
SEK	11,09%	9,27%	3,49%	5,48%				
EUR	11,48%	9,34%	3,66%	5,88%	2,50%			
CHF	10,99%	9,86%	3,60%	5,50%	3,17%	1,68%		
JPY	11,56%	8,93%	4,77%	5,34%	5,83%	6,22%	5,85%	

4.2.2.1 Depositing in IDR

All the T-statistics for the IDR-combinations are once again statistically significant with the exception of IDR/CHF for which the T-statistic is 0.64. However, the remaining combinations are highly significant so we can deduce that these prediction errors are statistically different from zero. This is an expected finding since the prediction errors were highly negative for the IDR for the 3-month maturities. The volatility is higher for the 3-month prediction errors than for the 1-month. The standard deviations range between 10.81% (GBP) and 12.16% (ZAR). These results suggest that the volatility of the prediction errors is higher for the 3-month maturities than for the 1-month. This implies that the prediction errors vary more from the mean for the 3-month maturity. The average prediction errors are also more negative for the 3-month maturity. When the higher volatility of the prediction errors leads to changes in the right direction, larger speculative profits can be made.

4.2.2.2 Depositing in ZAR

Only one combination of the ZAR is statistically significant. The T-statistic for ZAR/JPY is significant at -5.50. The other T-statistics are insignificant and this is not surprising when looking at the prediction errors for the ZAR-combinations in Table 3. The prediction errors when excluding the JPY were very small and ranged between 0.43% (GBP) and -1.04% (CHF). The standard deviations for the ZAR-combinations are still quite large ranging between 8.93% (JPY) and 10.12% (USD).

4.2.2.3 Borrowing in JPY

All the prediction errors for the JPY-combinations are highly statistically significant. The T-statistics range between -3.82 (CHF) and -13.29 (IDR). This is also an expected result since almost all the 3-month prediction errors were as negative or at least very close to the prediction errors for the 1-month maturities. Overall, all the T-statistics for the JPY (both 1-month and 3-months) have turned out to be significant. This suggests that the JPY is a good currency to borrow in when conducting carrying trades. The JPY standard deviations are highest vis-à-vis the IDR (11.56%) and the ZAR (8.93%). The remaining standard deviations are higher than they were for the 1-month maturities. They range between 4.77% (GBP) and 6.22% (EUR). The volatility of the JPY prediction errors is still not that high compared to the IDR and the ZAR-combinations.

4.2.2.4 Borrowing in CHF

Only two of the six CHF-combinations resulted in significant T-statistics for the 3-month maturities. These are vis-à-vis the GBP (-3.53) and the EUR (-3.68). The prediction errors did not deviate from zero by large amounts except vis-à-vis the IDR, so the overall results are not surprising. What is surprising is the low T-statistic against the IDR (0.64). The average prediction error for the IDR/CHF was -11.78% so we expected this to be statistically different from zero. The standard deviations for the CHF are largest against the IDR (10.99%) and the ZAR (9.86%).

4.2.2.5 General remarks

In looking at the 28 T-statistics of the currency combinations, it was found that 16 were statistically significant. When comparing the 3-Month to the 1-Month

the number of statistically significant combinations is almost the same. All of the JPY- and IDR-combinations were statistically different from zero with the exception of IDR/CHF. This proves that the IDR and the JPY are good choices of currencies when engaging in carrying trades since going long in the IDR and going short in the JPY result in average negative prediction errors statistically different from zero vis-à-vis the other currencies. Only one of the T-statistics was significant for the ZAR-combinations. The average prediction errors were also very close to zero for the T-statistics that resulted in insignificant results. The USD had insignificant T-statistics against all other currencies except vis-à-vis the JPY in the cases where the USD is considered to be the high interest rate currency. GBP/USD is significant at a T-statistic of -2.29. However, the GBP/USD is still difficult to analyze since the interest differentials are often close to zero and sometimes negative.

It is interesting to note that the standard deviations of the prediction errors are larger for all currency combinations of the 3-month maturities than they were for the 1-month maturities. This implies that the volatility of the prediction errors increase as the maturity lengthens. The standard deviations are largest for the high interest rate currencies (IDR and ZAR). The standard deviations for the remaining currency combinations not comprising of either IDR or the ZAR range between 1.68% (EUR/CHF) and 6.22% (EUR/JPY).

4.2.3 1-Year maturities

Table 9 shows the T-statistics for the 1-year maturities. These will be analyzed in order to examine whether the prediction errors are statistically different from zero. Table 10 gives the standard deviations. A comparison is also made to the results for the other maturities in order to determine whether the deviations from interest parity and the volatility are related to the maturity of the interest rate.

Table 9: *1-Year T-statistics for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-14,86							
GBP	-14,25	10,71						
USD	-10,39	10,10	0,58					
SEK	-19,59	6,56	-8,97	-2,52				
EUR	-14,63	7,97	-5,57	-0,90	5,83			
CHF	-12,87	9,09	-2,23	0,62	8,71	9,75		
JPY	-25,30	-1,76	-22,86	-20,69	-10,53	-9,56	-11,64	

Table 10: *1-Year standard deviations for average prediction errors*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	23,56%							
GBP	19,63%	20,71%						
USD	25,03%	23,76%	8,40%					
SEK	18,76%	18,95%	7,69%	15,45%				
EUR	22,03%	20,96%	7,09%	14,31%	6,32%			
CHF	23,06%	23,25%	6,53%	13,06%	7,69%	2,90%		
JPY	19,69%	18,23%	9,45%	10,16%	12,15%	15,27%	14,76%	

4.2.3.1 Depositing in IDR

We find similar results for the IDR-combinations with the 1-year maturity as with the 1-month and 3-month maturities. All the IDR-combinations show T-statistics that are highly significant and different from zero. They range between -12.87 (CHF) and -25.30 (JPY). This is an expected result since the prediction errors for the IDR-combinations resulted in large negative prediction errors for the 1-year maturities. We can therefore conclude that the prediction errors for the IDR-combinations are statistically different from zero. This strengthens the prospect that the IDR is advantageous to go long in when making carrying trades. However, one should also look at the standard deviations, and these are quite large for all IDR-combinations. The standard deviations are not only larger

than they were for the 1-month and 3-month maturities, but they are also larger than for other currency combinations except for the ZAR-combinations. The analysis leads to large average deviations of the IDR that are in the right direction if one decides to go long in the IDR. However, the volatility is high and this implies that random observations can result in losses. One should trade frequently if profits are to be made through carrying trades in the IDR. The direction of the movements in the exchange rates are discussed more in detail in section 4.3.

4.2.3.2 Depositing in ZAR

All the T-statistics for the ZAR-combinations are statistically significant except against the JPY (-1.76). The T-statistics are positive and quite large. This is not surprising since the prediction errors were all positive, except vis-à-vis the JPY, ranging between 3.44% (SEK) and 6.63% (USD). The results indicate that one should not go long in the ZAR since the prediction errors are positive and statistically different from zero. ZAR/JPY was the only combination that led to a negative prediction error. However, the ZAR/JPY relationship led to a prediction error of -0.88% and the T-statistic (-1.76) was not significant so the indication is that one should not use the ZAR to go long in when conducting carrying trades. The volatility of the prediction errors for the ZAR is very high, ranging between 18.23% (JPY) and 23.76% (USD).

4.2.3.3 Borrowing in JPY

The JPY-combinations resulted in statistically significant T-statistics for all prediction errors over all maturities except for ZAR/JPY (-1.76) for the 1-year maturity. The JPY T-statistics for the 1-year maturity (except ZAR) range between -9.56 (EUR) and -25.30 (IDR). This is what we expected since the JPY

prediction errors for the 1-year maturities were highly negative with the ZAR being the only exception. We can therefore conclude that the JPY is a good currency to go short in when making carrying trades since the prediction errors are highly negative and statistically different from zero. The direction of the currency changes are analyzed in 4.3 to determine whether the JPY actually appreciates by less than it should according to the interest differential. The standard deviations are quite high for the JPY. They range between 9.45% (GBP) and 19.69% (IDR). All standard deviations are larger than they were for the 1 and 3-month maturities. Hence, the volatility of the prediction errors increases with the length of the maturity for the JPY. This higher volatility can also imply that it becomes more difficult to achieve profits when entering carrying trades on random occasions. However, on average the prediction errors are negative and statistically different from zero indicating that the JPY is a good currency to go short in.

4.2.3.4 Borrowing in CHF

Almost all the CHF-combinations resulted in T-statistics that were significant but in different directions. The only insignificant T-statistic was against the USD (0.62). This prediction error was also very low, 0.22%. The GBP/CHF resulted in a significant T-statistic (-2.23) despite the low prediction error (-0.40%). The most interesting CHF-combination in the perspective of carry trading was the CHF vis-à-vis the IDR. IDR/CHF had a prediction error of -8.21% and a T-statistic of -12.87. The CHF seems to appreciate by more than it should against all currencies except against the IDR. This will be further analyzed in 4.3. The volatility of the prediction errors for the CHF is quite large this time. The highest standard deviation is found for the CHF vis-à-vis the IDR (23.06%), ZAR (23.25%), and the USD (13.06%). The high standard deviation for the CHF against the IDR implies that although this combination looks attractive

from a carry trading perspective, one has to be aware of large fluctuations that can lead to losses when entering random trades. However, on average it leads to deviations that suggest a profitable trading relationship.

4.2.3.5 General remarks

Only four of the 28 currency combinations resulted in prediction errors that were insignificant. The rest were statistically different from zero. The IDR and JPY-combinations looked most interesting before the T-tests since they had highly negative prediction errors. The prediction errors were also statistically different from zero. This suggests that the IDR should be a good currency choice to go long in and the JPY should be favorable to go short in when conducting carrying trades against the other currencies. One exception is ZAR/JPY since the T-statistic was insignificant. The ZAR does not look like a good currency choice to go long in due to its highly positive prediction errors that are statistically different from zero. The CHF only looks attractive relative to the IDR. The currency combinations that do not comprise either of high or low interest rate currencies had very low prediction errors. Four of these turned out to have significant T-statistics, namely USD/SEK (-2.52), GBP/EUR (-5.57), GBP/SEK (-8.97) and SEK/EUR (5.83). The currency pair that had the most negative prediction errors of these combinations was GBP/SEK (-1.91%).

It is interesting to note that the volatility has increased for all currency combinations for the 1-year maturities compared to the 3-month maturities. All standard deviations are now higher and this implies that the volatility increases with the maturity of the interest rate. A similar result was found earlier since the standard deviations for all currency combinations were higher for the 3-month maturities than for the 1-month maturities. Hence, the volatility of the prediction errors increases as the maturity of the interest rate lengthens.

4.3 Prediction error ratios

We have also calculated ratios in the form of the prediction errors divided by the interest differentials in order to investigate by how much a certain currency appreciates or depreciates relative to the interest differentials. These ratios were calculated for all possible combinations of currency pairs. The analysis will again be divided into three parts related to the maturity of the interest rate tested. The analysis will be additionally divided into sections consisting of the two highest and the two lowest interest rate currencies. An additional section is included to discuss general remarks about the remaining currencies. Focus will be placed on how the currency pairs with large interest differentials function since this is what we want to measure. As mentioned in the methodology, currency pairs with small interest differentials can create relatively large ratios of the prediction error to the interest differential. This should be expected between pairs among currencies such as the USD, EUR, GBP and SEK.

4.3.1 1-Month maturities

Table 11 shows the prediction error ratios for the 1-month maturities. The calculations performed are averages on a daily basis for interest rate maturities of one month.

Table 11: *Prediction errors ratios 1-Month (average per observation)*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-157,7092							
GBP	0,2460	0,8760						
USD	0,7760	1,0594	28,0357					
SEK	-0,2278	0,3891	95,4748	-7,4563				
EUR	-0,1238	0,5736	1,1069	-8,6956	-46,6825			
CHF	-0,2046	-0,1659	-0,1965	6,4710	4,4904	0,1010		
JPY	-0,5126	-0,2852	-1,1839	-0,6304	-0,8406	-0,5332	-0,3544	

4.3.1.1 Depositing in IDR

The Indonesian rupiah is the highest interest rate currency and is of great interest as the expected profits from depositing are larger than in any other currency. In Table 11, a clear picture is provided as to the direction of the prediction error ratios. In the comparison of the IDR and the ZAR, a ratio of -157.7 is found. This would suggest that the IDR has depreciated by 15770% less than predicted by the interest differential. This would suggest an extreme possibility to profit. However, a closer look shows that this number is due to the interest differential being close to zero or even negative at times. Due to the interest rate differential relationship it is difficult to draw any conclusions about profitability.

In looking at Table 11, a clear trend is seen in the IDR as the prediction error ratio is highly negative for all currency combinations except vis-à-vis the USD and the GBP. This relationship suggests that the uncovered interest rate theory does not hold for the IDR. This is exactly the result that we were looking for and wanted to determine if it was true. In looking at the prediction error ratio of the IDR to the JPY, the IDR depreciates by 51.26% less than predicted by the interest differential. Again, the same depreciating relationship can be seen with the EUR (12.38%), SEK (22.78%), and the CHF (20.46%). The IDR shows a good relationship in proving that the uncovered interest rate parity does not hold for large interest rate differentials and is a good example in providing positive carry trading profits.

4.3.1.2 Depositing in ZAR

The ZAR is another currency that is considered to be of interest in the study. When analyzing the ZAR ratios we find that they are positive in some cases. The implication of positive prediction error ratios is that the ZAR has depreciated by more than it should relative to the USD (105.94%), GBP

(87.60%), EUR (57.36%) and the SEK (38.91%). The positive numbers do not provide good opportunities in general for performing carry trades as the depreciation of the ZAR will lower the amount of the currency value received at the conversion. The ratios are negative against the CHF and the JPY, which means that the ZAR has depreciated by less than the interest differential against these currencies (16.59% against the CHF and 28.52% against the JPY). In general, the ZAR is not a good candidate for providing positive profits for currencies other than the CHF and the JPY.

4.3.1.3 Borrowing in JPY

The JPY, as the lowest currency, has the expectation of being a currency that could lead to speculative profits due to the high interest differentials. The low interest rate in Japan provides high interest differentials with the other currencies and as such, prediction error ratios are expected to be negative for all currencies. By looking at Table 11, we find that all prediction error ratios are negative. They are between 0 and –1 for all combinations except GBP/JPY, which is –1.18. This implies that the GBP, the higher interest rate currency, has on average appreciated by 18% of the interest differential. Hence, on average the change in the GBP/JPY exchange rate is in the opposite direction as suggested by interest parity. As previously described, a ratio of –1 means that the high interest rate currency has not depreciated at all on average. The JPY appreciates by less than predicted against the remaining currencies, 51.26% against the IDR, 28.52% against the ZAR, 63.04% against the USD, 53.32% against the EUR, 84.06% against the SEK and 35.44% against the CHF. This indicates that the JPY is a good currency to borrow in when making carrying trades since the average appreciation of the JPY in relation to higher interest currencies is not as large as the interest differential predicts.

4.3.1.4 Borrowing in CHF

In comparison to the JPY, the CHF should also be a good carry trading currency as it provides a large interest differential. However, the calculated prediction error ratios show a difficult picture which clearly does not depict a positive relationship between the currencies. The ratios for the CHF have different signs and it is not easy to make any general statements from these. The CHF appreciates by less than it should against the IDR (20.46%), the ZAR (16.59%) and the GBP (19.65%). On the other hand, the CHF appreciates by more than the interest differential against the USD (647%), the SEK (449%) and the EUR (10.10%). As seen with the IDR to ZAR relationship, a close to zero interest rate differential can make it extremely difficult to determine a clear relationship which also is the case for the USD to CHF. The prediction error ratio of this relationship is 6.47, indicating a strong relationship in the opposite direction. However, this relationship is only possible because of the close to zero relationship.

4.3.1.5 General Remarks

There are only five ratios of the 28 calculated for the 1-month maturities that have the incorrect sign, i.e. more negative than –1. In those cases, the currency with the higher interest rate has appreciated on average relative to the lower interest rate currency. However, in four of these cases the ratios are very negative and this can be explained by interest differentials between currencies that are close to zero that generate these ratios, e.g. IDR/ZAR (-157.71), USD/EUR (-8.70), USD/SEK (-7.46) and SEK/EUR (-46.68). All these currency pairs have low interest differentials that are sometimes positive and sometimes negative. The only good example of a currency pair with a negative sign is therefore GBP/JPY (-1.18) since the interest differential is always positive. This

ratio is therefore more representative when concluding that the wrong currency has appreciated since the interest differentials between the GBP and the JPY are always much larger than 0.

4.3.2 3-Month maturities

Table 12 shows the prediction error ratios for the 3-month maturities. These are analyzed and compared to the ratios for the 1-month maturities.

Table 12: *Prediction errors ratios 3-Months (average per observation)*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-7,3874							
GBP	0,0872	1,0552						
USD	0,6305	1,1919	199,1530					
SEK	-0,2361	0,5046	-22,3450	-10,5035				
EUR	-0,1603	0,7171	1,7523	-13,3517	-24,9462			
CHF	-0,1996	0,5903	-0,0344	77,6140	5,5792	0,2130		
JPY	-0,6002	-0,4489	-1,1264	-0,3273	-0,9742	-0,0091	-32,1756	

4.3.2.1 Depositing in IDR

The signs are the same for all IDR-combinations as they were for the 1-month maturities. The IDR depreciates by less than it should against the EUR (16.03%), the SEK (23.61%), the CHF (19.96%) and the JPY (60.02%). The depreciation of the IDR is larger than the interest differential against the USD (63.05%) and the GBP (8.72%). Once again this shows that the USD and the GBP are more stable relative to the IDR. One should not go short in these currencies when investing in the IDR. The most favorable IDR-combination is against the JPY since the IDR depreciates by 60% less than it should according to the interest differential. The high ratio between the IDR and the ZAR (-7.39) implies that the IDR appreciates by 639% of the interest differential. The reason

for this high ratio is that the interest differential is often very small between these currencies.

4.3.2.2 Depositing in ZAR

The ratios for the ZAR against the other currencies indicate that the ZAR deviations from interest parity are larger for the 3-month maturities than for the 1-month maturities for all combinations except against the JPY. The ZAR depreciates by 44.89% less than the interest differential against the JPY, which implies opportunities for profitable carrying trades. The ZAR depreciates by more against the following currencies than it did for the 1-month maturities: USD (now 119%), GBP (now 106%), EUR (now 71.71%), SEK (now 50.46%) and the CHF (now 59.03%). The ZAR depreciated by less than the interest differential (16.59%) against the CHF for the 1-month maturities but now depreciates by more than the interest differential (59.03%) for the 3-month maturities. The ZAR does not seem to be a good currency to conduct carrying trades in since it depreciated by more than it should against all other currencies except against the yen.

4.3.2.3 Borrowing in JPY

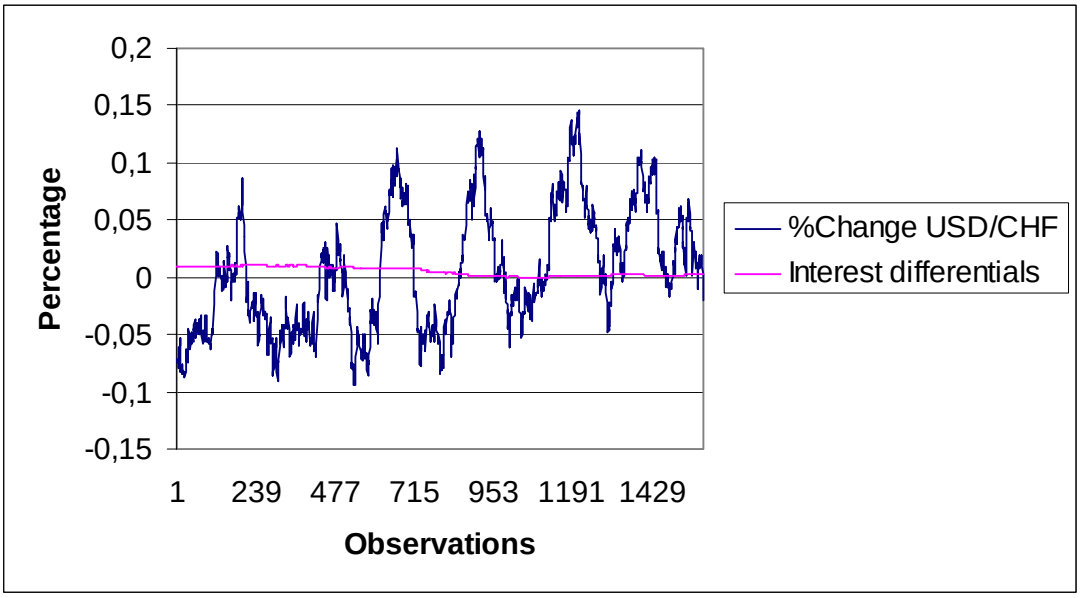
All ratios are once again negative for the JPY-combinations, as they were for the 1-month maturities. The JPY appreciates by less than the interest differential against the IDR (60.02%), the ZAR (44.89%), the USD (32.73%), the GBP (113%), the EUR (0.9%) and the SEK (97.42%). The ratio between the CHF and the JPY is extremely negative (-32.18) but this is due to interest differentials close to zero. One can still conclude that the CHF appreciates by much more than the interest differential suggests, namely 3118%. The sign of the ratio between GBP and JPY is still wrong (-1.13), which means that the GBP has

appreciated by 13% of the interest differential. The JPY is a very good currency to go short in for the 3-month maturities since it does not appreciate by as much as it should against any other currency.

4.3.2.4 Borrowing in CHF

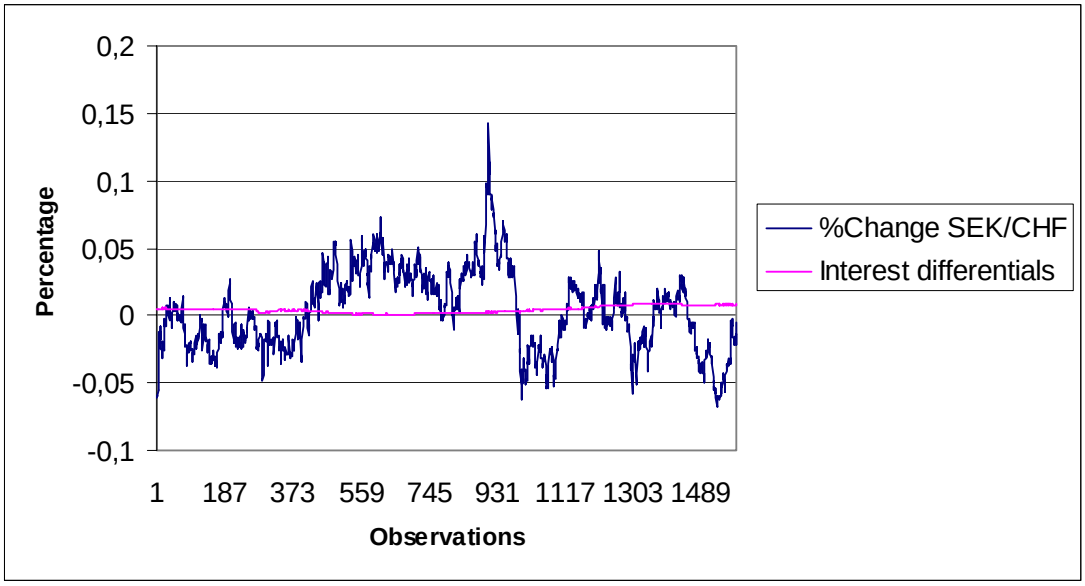
The ratios for the CHF are still in the same directions as for the 1-month maturities except against the ZAR, which was explained earlier. The CHF appreciates by less against the IDR (19.96%) and the GBP (3.44%). It appreciates by more against the ZAR (59.03%), the USD (7761%), the EUR (21.30%) and the SEK (558%). The extreme deviation against the USD can be explained by interest differentials close to zero since the interest rates in the USD decreased over the later period of the time horizon included in the study. However, the CHF has still appreciated by much more than the interest differentials, which is depicted in Figure 4. The figure consists of two graphs, namely the change in the USD/CHF exchange rate and the interest differential. The interest differentials are very close to zero during the last years of the time horizon while the USD depreciates much more than it should. This is the reason for the high prediction error ratio of 77.61.

Figure 4: *UIP Composite Graph of USD/CHF (3-Months)*



The large deviation to the SEK is due to large periods of CHF appreciation relative to the SEK (see Figure 5). Although the interest differentials are very close to zero in the middle of the time horizon, the CHF has still appreciated by much more than it should as indicated by the graphs. The CHF is still not a good choice of currency to borrow in when conducting carrying trades. The only cases resulting in negative ratios are against the IDR and the GBP. The prediction errors were also negative for these combinations as explained in section 4.1.2.

Figure 5: *UIP Composite Graph of SEK/CHF (3-Months)*



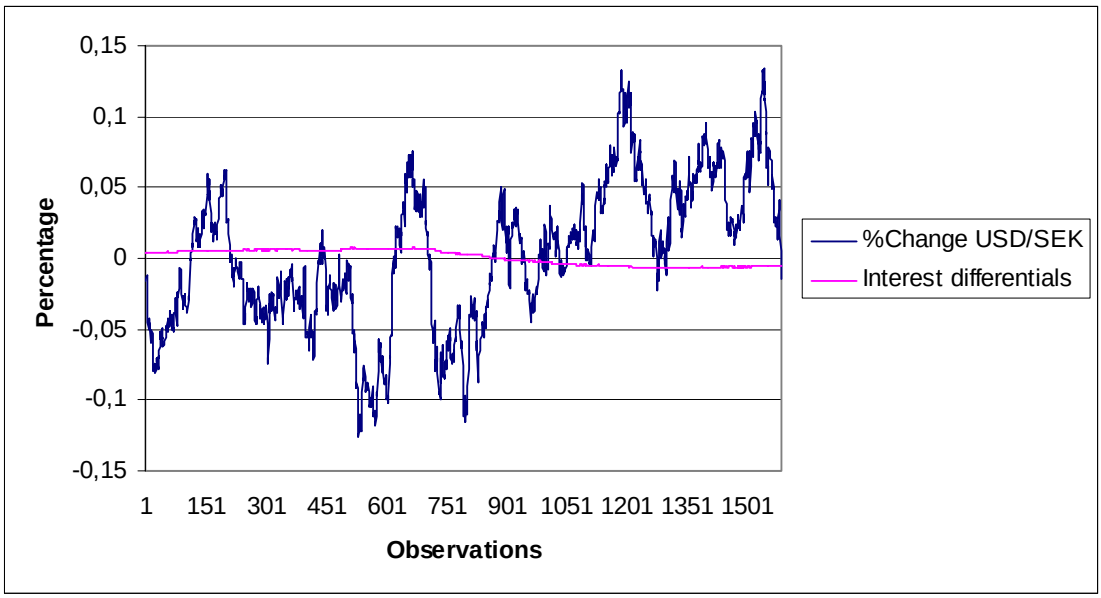
4.3.2.5 General remarks

Overall, the IDR still seems to be a good currency to deposit in when taking loans in the EUR, SEK, CHF and the JPY. The JPY is the best currency to borrow in since it does not appreciate by the whole interest differential against any other currency. The ZAR depreciated by more than the interest differential against all currencies except against the JPY.

Seven of the 28 ratios are of the incorrect sign, meaning that the wrong currency is appreciating. These are IDR/ZAR (-7.39), USD/EUR (-13.35), USD/SEK (-10.50), GBP/SEK (-22.35), SEK/EUR (-24.95), CHF/JPY (-32.18) and GBP/JPY (-1.12). However, all of these, except for GBP/JPY, are excellent examples of currency pairs with interest differentials that are close to zero under long periods or even negative during other periods. GBP/JPY is the only relationship that always has positive interest differentials. The interest differential for USD/SEK is, for example, negative during the last period of the time horizon and this creates large negative ratios of the prediction error to the

interest differential. Figure 6 depicts an interesting phenomenon for the USD/SEK exchange rate since the USD appreciates during periods when the interest rate in the USD is higher than in the SEK. This can be seen during the first years in the UIP composite graph in Figure 6. In contrast, during the last period the SEK appreciates almost all the time while the Swedish interest rate is higher than the US interest rate. These are very contradicting results to interest parity, which seems not to hold at all well for this currency pair since the wrong currency appreciates.

Figure 6: *UIP Composite Graph of USD/SEK (3-Months)*



4.3.3 1-Year maturities

Table 13 shows the prediction error ratios for the 1-year maturities. These are analyzed and compared to the ratios for the 1-month and 3-month maturities in order to investigate whether interest parity holds better for longer maturities.

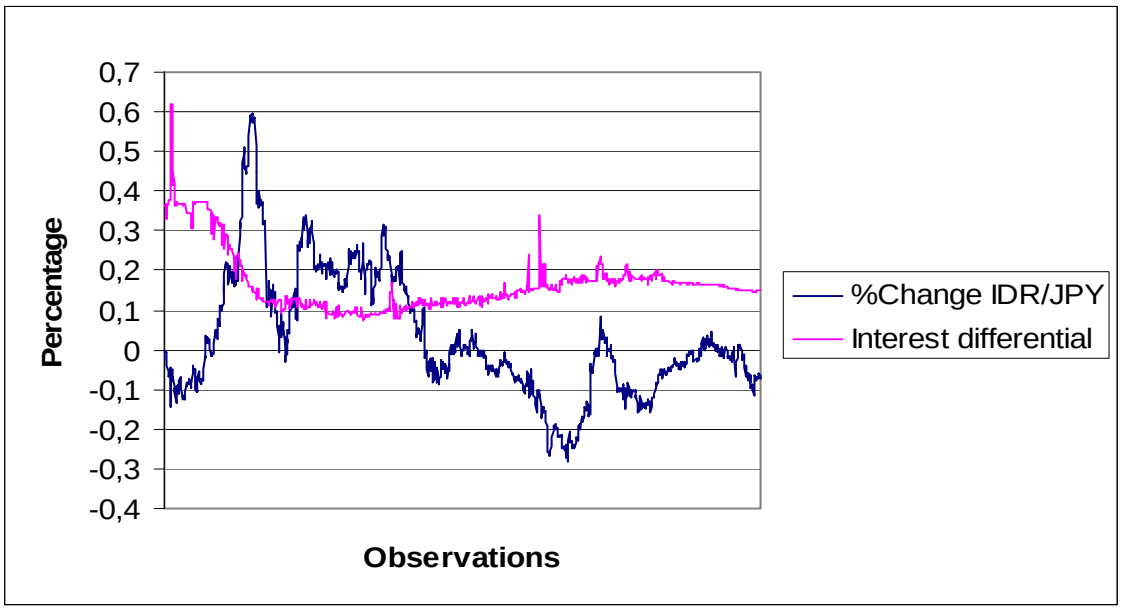
Table 13: *Prediction errors ratios 1-Year (average per observation)*

	IDR	ZAR	GBP	USD	SEK	EUR	CHF	JPY
IDR								
ZAR	-0,6405							
GBP	0,2947	1,7844						
USD	0,9677	2,0696	-5,7812					
SEK	-0,3667	0,8882	-0,5900	-11,9017				
EUR	-0,0915	1,2264	0,7600	-11,7926	-10,0490			
CHF	-0,0203	1,1767	0,1688	8,7988	3,2451	0,8326		
JPY	-0,6298	-0,0167	-1,1388	-0,8143	-0,5956	-0,4283	0,1219	

4.3.3.1 Depositing in IDR

Once again the directions of the ratios for the IDR-combinations are the same as for the other maturities. The IDR depreciates by less than the interest differential against the ZAR (64.05%), the EUR (9.15%), the SEK (36.67%), the CHF (2.03%) and the JPY (62.98%). The IDR depreciated by more than the interest differential against the USD (96.77%) and the GBP (29.47%). This implies that the IDR is a good choice of currency to go long in against the EUR, SEK, CHF and the JPY since it depreciates by less than the interest differential against those currencies. The IDR/ZAR has a different relationship since the interest differentials between them are not always positive. One should not borrow in the USD or the GBP since they are more stable and appreciate by more than they should according to the interest differential. Figure 7 shows the UIP composite graph for the IDR/JPY combination. The graphs depict a relationship in which the IDR does not depreciate as much as it should according to the interest differential on average. There are however short periods where the IDR-depreciation exceeds the interest differential.

Figure 7: *UIP composite graph (1-Year)*



4.3.3.2 Depositing in ZAR

The ratios for the ZAR indicate that interest parity holds worse for the ZAR 1-year maturities than for the 1-month and 3-months. The difference is that the ZAR depreciates by much more than it should for 1-year maturities. The only exception is against the JPY, which now almost holds since the JPY only appreciates by 1.67% less than it should against the ZAR on average. The ZAR depreciates by more than it should against the USD (207%), the GBP (178%), the EUR (123%), the SEK (88.82%) and the CHF (118%). These findings suggest that the ZAR is not a good choice of currency to make deposits in when making carrying trades since it depreciates by more than the interest differential on average.

4.3.3.3 Borrowing in JPY

The ratios are negative for all JPY-combinations, which indicate that the JPY appreciates by less than the interest differential on average against all other currencies except against the CHF (appreciated by 12.19% more than the interest differential). The JPY appreciates by 62.98% less against the IDR, 1.67% against the ZAR, 81.43% against the USD, 114% against the GBP, 42.83% against the EUR and 59.56% against the SEK. Hence, the JPY is a good choice of currency to go short in for carrying trades against higher interest rate currencies since it appreciated by less than it should on average. The most interesting relationship for the JPY is vis-à-vis the GBP. The reason for this is that this is the only combination with the wrong sign, i.e. the wrong currency is appreciating. Although the magnitude of the change was incorrect for the remaining combinations, the directions were correct. However, the GBP appreciates on average against the JPY although the British interest rate is always higher than the Japanese interest rate. This can be seen in figure 8 in which the GBP appreciates during longer periods although the interest differentials are positive. It is only during the first year that longer periods of JPY appreciation that is higher than the interest differential can be found. There is also one observation that results in a large peak of the change in the GBP/JPY exchange rate at the end of the horizon. This is due to a 19.55% depreciation of the GBP relative to the JPY that occurred on August 11 2002.

Figure 8: *UIP Composite Graph (1-Year)*

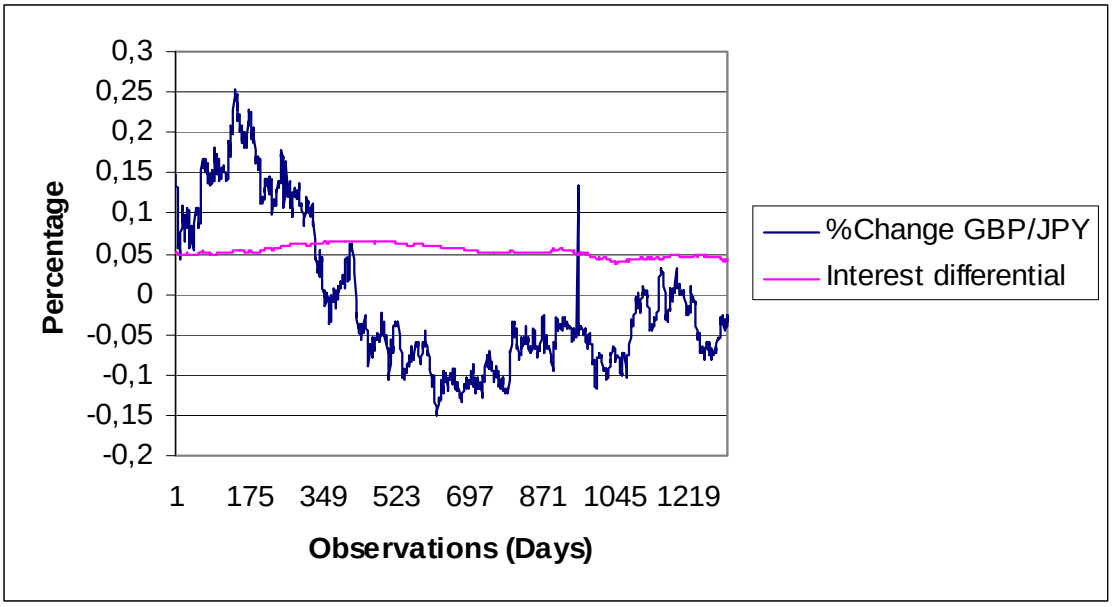
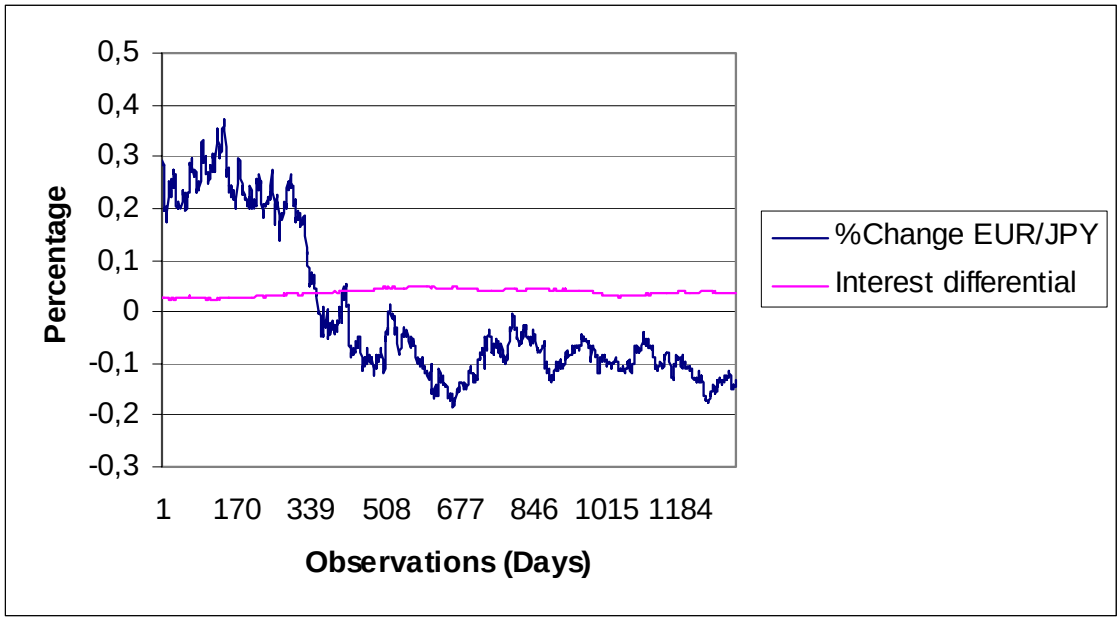


Figure 9 shows the relationship between the EUR and the JPY. On average, the EUR depreciates by 42.83% less than it should according to the interest differential. This is clear in the graphs since the EUR appreciates continuously after 1999, though the Euro interest rate is always above the Japanese. This creates opportunities for profits when conducting carrying trades by borrowing in the JPY and investing in the EUR.

Figure 9: *UIP Composite Graph (1-Year)*



4.3.3.4 Borrowing in CHF

The directions of the ratios for the CHF-combinations are similar as for the 3-month maturities. The main difference is that the GBP now depreciates by more than the interest differential (16.88%). For the 3-month maturities the GBP depreciated by 3.44% less than the interest differential. The CHF now appreciated by less than it should only against the IDR (2.03%). For the remaining combinations the CHF appreciated by more than the interest differential: 118% against the ZAR, 880% against the USD, 16.88% against the GBP, 83.26% against the EUR and 325% against the SEK. These results suggest that the CHF is only a good currency to go short in when making carrying trades against the IDR although the relative deviation is very small for this combination for the 1-year maturity (2.03%).

4.3.3.5 General remarks

There are five examples of currency pairs that have the wrong sign for the 1-year maturities. These are USD/EUR (-11.79), USD/SEK (-11.90), GBP/USD (-5.78), GBP/JPY (-1.14) and SEK/EUR (-10.05). These are all examples of currency pairs with low interest differentials except for the GBP/JPY exchange rate. The IDR does not depreciate by as much as it should against all currencies except for against the USD and the GBP. This makes the IDR the most favorable currency to go long in when conducting carrying trades. The JPY does not appreciate by as much as the interest differential against any other currency except against the CHF. This means that the JPY is the best currency to go short in. The ZAR, which has high interest rates, depreciates by more than it should against all currencies except against the JPY. Hence, it would not be favorable to make deposits in this currency. The CHF, on the other hand, appreciates by more than it should against all currencies except against the IDR, which implies that one should not go short in the CHF despite its low interest rates.

4.4 Examples of carrying trades

We have calculated examples of carrying trades in order to illustrate how speculative positions of uncovered interest arbitrage can be conducted. The reason for doing this is that the calculation of carrying trades differs in the approach used when calculating the prediction errors in the sense that the interest and exchange rate spreads are taken into account. Even though these spreads are very small and do not affect the result much, they have to be taken into account. The calculation of the interest rate and exchange rate spreads were explained in section 3.6. Examples of carrying trades have been calculated for the maturities of 1-month and 1-year with currency pairs consisting of the two high interest rate currencies (IDR and ZAR) and the two low interest rate

currencies (JPY and CHF). We calculated the average annual profits or losses that resulted from these trades.

4.4.1 1-Month maturities

Table 14 shows the average annual profits for the carrying trades of the 1-month interest rate maturities. The currencies on the top of the table are the high interest rate currencies that deposits are made in. We see that all the trades result in average losses for carry trades that involve the IDR and the ZAR. These results are contradictive to the average prediction errors and also to most of the prediction error ratios. The prediction error ratios indicated that the JPY did not appreciate by as much as it should on average against all the remaining currencies for the 1-month maturity. However, the carry trades conducted in our example lead to losses on average against the IDR (-12.27%), the ZAR (-12.87%) and the EUR (-0.16%). The explanation for the contradictive results are that there are a lot of randomness that affects the results of the actual carry trades that we chose since we only picked one day per month on which a trade was entered. If we would have chosen to enter trades every single day, the results would be very similar to the trends indicated by the prediction error ratios.

Table 14: *Profit/Loss 1-Month carry trades (average per annum)*

	IDR	ZAR	USD	GBP	EUR	SEK	CHF	JPY
IDR								
ZAR	-9,29%							
USD	-14,15%	-6,69%						
GBP	-14,54%	-9,61%						
EUR	-12,31%	-9,07%						
SEK	-12,99%	-13,28%						
CHF	-13,03%	-13,74%	1,05%	0,84%	-0,90%	0,07%		
JPY	-12,27%	-12,87%	1,71%	1,95%	-0,16%	0,39%	0,47%	

The actual results of the carrying trades for the 1-month maturities can be seen in Appendix 2-5. In the appendix the profit or loss for the individual years of the 1-month trades are displayed where a year total for each of the four and half years is provided along with an average per month. In 1999, a clear result is that it was profitable to perform carrying trades by borrowing in Swiss francs and depositing in other currencies. All of the results for 1999 show positive numbers except for the ZAR. If you invested in all of the positions for 1999, then this would have brought a return of almost sixty percent for that year. Again, the table only shows the investment into the different currencies on the first day of the month and the completion of the transaction on the last day of the month. Randomness could be a contributing factor to the positive results. However, the period is also one where it was seen that the Swiss franc weakened in comparison to the other currencies which contributes to the general positive returns.

The horizon beyond 1999 does not show the same positive returns for the CHF-combinations as in 1999 but rather extremely high losses. The interesting currencies are the IDR and the ZAR where the high interest differentials that are expected to bring positive profits have reverted to huge negative losses. They were even 51 percent in 2001 vis-à-vis the ZAR and 41 percent vis-à-vis the IDR in 2000.

4.4.2 1-Year maturities

Table 15 shows the average annual profits for carrying trades conducted for the 1-year maturities. Detailed results over the different years can be found in appendix 1. Since our data stretches over 4 years and 7 months, we calculated trades for the first four years. These results are more in line with the trends indicated by the prediction errors and the prediction error ratios. All the IDR and

the JPY combinations result in average annual profits. The profits are especially high when funds are invested in the IDR. The profits range between 13.12% (GBP) and 19.33% (EUR). The tables for the IDR-combinations in appendix 1 show that the IDR-trades result in profits for all combinations in 1999. The profits range between 38.74% (JPY) and 78.21% (CHF). Year 2000 resulted in losses for all the IDR-positions. The trading positions in IDR during 2001 and 2002 resulted in profits in all but two cases, which were against the USD in 2001 (-0.30%) and against the ZAR in 2002 (-12.46%).

Table 15: *Profit/Loss 1-Year carry trades (average per annum)*

	IDR	ZAR	USD	GBP	EUR	SEK	CHF	JPY
IDR								
ZAR	18,38%							
USD	13,89%	0,78%						
GBP	13,12%	-0,83%						
EUR	19,33%	2,00%						
SEK	16,57%	0,60%						
CHF	18,94%	2,24%	4,25%	3,27%	-0,78%	0,50%		
JPY	17,56%	3,32%	6,30%	5,42%	2,11%	2,60%	-1,04%	

All the JPY-combinations result in average annual profits except against the CHF (-1.04%). The profits range between 2.11% (EUR) and 17.56% (IDR). It is difficult to find any patterns in the yearly results for the JPY-positions since losses and profits exist for all combinations over the different years. There is no combination that results in profits over all the four years. The largest profits were between the IDR and JPY in 1999 (38.74%).

The positive profits for the ZAR are somewhat contradictive since the ZAR depreciates by more than it should on average against all currencies for the 1-year maturity except against the JPY. The carry trades involving the ZAR have profits ranging between -0.83% (GBP) and 3.32% (JPY). When analyzing the individual years we find that the ZAR-positions mainly resulted in profits in 1999 and 2002, while losses were realized for all positions in 2000 and 2001.

The CHF-combinations resulted in profits against all currencies except against the EUR (-0.78%). All the CHF-positions realized profits in 1999 ranging between 1.60% (EUR) and 78.21% (IDR). The contradictive results for the trades of the CHF is due to randomness since the prediction error ratios for the 1-year maturities indicated that the CHF appreciated by more than it should over the one year maturity vis-à-vis all currencies except against the IDR.

The only results that follow the pattern from the earlier findings are that the trades involving the IDR and the JPY result in profits. The previous analysis suggested several times that, on average, the IDR is a good currency to go long in and the JPY is a good currency to go short in when conducting carry trades. The positive profits of these carrying trades support these findings.

5. Conclusion

This chapter concludes the thesis by presenting a summary of the major findings of our research. We will also provide recommendations based upon our findings about whether speculative profits can be made by engaging in carrying trades between certain currencies. Suggestions for further research within this field of study will also be presented.

5.1 Summary

In the empirical section, the results were presented and most of the prediction errors were found to be negative for all currency combinations over all maturities. The most negative prediction errors were found for the IDR-combinations. The combinations for the IDR and the JPY did all result in negative prediction errors over all maturities. Each of these currencies had only one T-statistic that was insignificant. Hence, almost all prediction errors were negative and statistically different from zero. When analyzing the prediction error ratios we found that the JPY did not appreciate as much as it should according to the interest differential relative to all currencies over all maturities except against the CHF over 1-year. The IDR did not depreciate by as much as it should relative to the ZAR, EUR, SEK, CHF and the JPY over all maturities. It depreciated by more than it should relative to the USD and the GBP. These results indicate that the IDR is the best currency to make deposits in when conducting carrying trades. The JPY is the best currency to borrow in since almost all prediction errors were negative and statistically different from zero. The prediction error ratios also showed that the JPY appreciated by less than the interest differential against almost all currencies. The findings are supported by research made by the largest bank in Singapore, DBS Bank, which recommended the specific strategy consisting of going short in the JPY and

simultaneously going long in the IDR. This strategy was mentioned in their Market Outlook report for the third quarter in 2003. Among other strategies that they recommended were to short the EUR and the CHF vis-à-vis higher yielding currencies such as the CAD, AUD and the IDR (DBS Bank 15-20).

Despite the ZAR being a high interest rate currency, it is not a good choice to make deposits in when engaging in carrying trades since it depreciates by more than it should relative to all currencies except to the JPY over all maturities and the CHF over the 1-month maturity. Another interesting result is that the ZAR deviates more from interest parity as the maturity lengthens, i.e., it depreciates even more than it should as the maturity increases. The CHF, which is the second lowest interest rate currency, appreciated by more than expected relative to the interest differential vis-à-vis most currencies over all maturities. The main exception was against the IDR. In this case the CHF appreciated by less than it should for all maturities. The prediction errors were also negative and the T-statistics were significant except for the 3-month maturity. It seems difficult to make speculative profits by borrowing in CHF for the other combinations since the CHF appreciates by more than it should in most cases.

The standard deviations of the prediction errors increase for all currency combinations as the maturity of the interest rate lengthens. This implies that the volatility of the prediction errors increases as the maturity lengthens. We can deduce from this is that it can become more difficult to achieve profits through carrying trades when entering random trades for longer maturities even if the average prediction errors are negative and the prediction error ratios indicate that the low interest rate currency does not appreciate by as much as the interest differential. However, the higher volatility could lead to larger speculative profits overall if the exchange rate changes are in the right direction.

The directions of the changes in the exchange rates were correct in most cases, i.e. the currency with the larger interest differential tended to depreciate.

There were only a few exceptions for each maturity and these were often between currency pairs that had small interest differentials that sometimes turned negative. The main exception was the GBP vis-à-vis the JPY, where the GBP appreciated on average although it always had a larger interest rate. Even though we can deduce that the direction of the change in the exchange rate is correct in most cases, the magnitude is not correct. There were only four cases in which the magnitude of the change was less than 5% of the interest differential for all the currency combinations. These were GBP/CHF 3-months (-3%), EUR/JPY 3-months (-0.9%), IDR/CHF 1-year (-2%) and ZAR/JPY 1-year (-1.7%).

It is difficult to find any clear patterns of whether interest parity holds better for longer than for shorter maturities when analyzing the size and the magnitude of the prediction error ratios. The only clear evidence is that the ZAR does not hold as well for longer maturities since it depreciates by more than it should as the maturity of the interest rate lengthens. The standard deviations of the prediction errors suggest that the volatility of the deviations increases as the maturity lengthens but the average changes do not indicate any clear patterns according to the prediction error ratios.

The random examples of carrying trades resulted mainly in losses or small profits for the 1-month trades. The 1-year trades led to large profits for the IDR-combinations just as the average prediction errors and prediction error ratios indicated. All the JPY-combinations except for CHF/JPY resulted in profits for the 1-year carrying trades. This was expected due to the negative prediction errors and prediction error ratios of the JPY.

The conclusion of the results from the average prediction errors, prediction error ratios and the 1-year carrying trades are that there exist profit opportunities through foreign exchange speculation. However, it is risky due to the high volatility of exchange rates and it is unlikely that forecasting will aid

much in capturing the profits that are possible. There has been limited progress of the forecasting techniques developed and there are not many models that have been able to outperform the random walk. There are too many unidentifiable influential factors that make it difficult to estimate future exchange rates with high accuracy.

Since the conclusion is that there exist profitable foreign exchange speculation opportunities, the opportunities can only be captured through a forecasting model or by random transactions. As discussed before, the success of forecasting models has been limited and due to this we recommend using a multivariate model. The multivariate models, based on research, have the greatest potential for accurately forecasting exchange rates changes. However, before using a multivariate model, research on the exact variables affecting exchange rates needs to be performed. The model needs to continuously incorporate simultaneous changes in the factors affecting exchange rates. This is required as daily changes in the factors affecting exchange rates determine future exchange rate fluctuations.

5.2 Recommendations

Based on the findings and conclusions from our research it is clear that there exist large deviations from interest parity. It is possible to make uncovered interest arbitrage by engaging in carrying trades between currency pairs with large interest differentials. However, the volatility of the prediction errors is very high and this implies that one has to trade frequently in order to achieve profits in the cases where the prediction errors are negative and the low interest rate currency is not appreciating by as much as the interest differential. Profits are possible to achieve between some currency pairs with large interest differentials. The IDR is the best currency to go long in and the JPY is the best

currency to go short in when conducting carrying trades. These currencies had negative prediction errors for almost all combinations over all maturities.

When entering a carrying trade one should be aware of the high risk that uncovered interest arbitrage entails since the positions are left open and the volatility of the exchange rates is very high. However, when trading frequently it is possible to achieve profits especially among the IDR and the JPY-combinations. Forecasting of future exchange rates should be a part of the analysis made before entering a position although it is very complex and difficult to forecast future exchange rates. It is however clear that forecasting based on the interest differentials is not always the optimal approach when estimating future exchange rate changes.

5.3 Suggestions for further research

Several previous studies have tested interest parity through different approaches. It is clear from results found concerning uncovered interest parity that it does not always hold. There are not many studies that have tried to identify the specific factors that cause the changes in the exchange rates that lead to deviations from interest parity. Therefore, there is more research necessary for investigating which factors influence exchange rates and cause deviations from interest parity. One of these factors is time varying risk premia and these can be estimated between different currency combinations. Forecasting of exchange rates is another topic that requires more research in order to find a proper model to forecast future changes in exchange rates. It is clear from previous studies that the interest differentials are not always unbiased predictors of future exchange rates since they do not predict the correct magnitude of the changes although the direction is often correct. Exchange rate forecasting is, however, one of the most challenging topics within international finance and there remains to be found a model that consistently outperforms the random walk.

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Appendix

Appendix 1: *1-Year Carry trades*

1 Year	Depositing in IDR						
Borrowing in	ZAR	USD	GBP	EUR	SEK	CHF	JPY
1999	44,68%	49,37%	51,33%	76,27%	58,69%	78,21%	38,74%
2000	-14,02%	-27,47%	-21,06%	-19,32%	-17,00%	-23,77%	-11,83%
2001	55,34%	-0,30%	2,96%	7,65%	14,36%	7,67%	20,62%
2002	-12,46%	33,97%	19,26%	12,73%	10,24%	13,66%	22,71%
Total profit	73,54%	55,57%	52,49%	77,33%	66,29%	75,77%	70,25%
Average yearly profit	18,38%	13,89%	13,12%	19,33%	16,57%	18,94%	17,56%

1 Year	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
1999	5,49%	6,47%	7,38%	11,87%	26,00%	-1,47%
2000	-16,76%	-9,68%	-14,14%	-5,82%	-13,69%	-0,52%
2001	-37,04%	-35,00%	-35,79%	-27,50%	-30,95%	-22,10%
2002	51,43%	34,87%	50,54%	23,87%	27,61%	37,35%
Total profit	3,11%	-3,34%	7,98%	2,42%	8,96%	13,26%
Average yearly profit	0,78%	-0,83%	2,00%	0,60%	2,24%	3,32%

1 Year	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
1999	38,74%	-1,47%	-6,02%	-8,64%	-20,80%	-11,85%	-13,54%
2000	-11,83%	-0,52%	18,58%	9,97%	8,06%	5,07%	7,71%
2001	20,62%	-22,10%	20,64%	17,04%	12,11%	5,76%	12,38%
2002	22,71%	37,35%	-8,00%	3,32%	9,06%	11,43%	-10,70%
Total profit	70,25%	13,26%	25,20%	21,69%	8,43%	10,41%	-4,15%
Average yearly profit	17,56%	3,32%	6,30%	5,42%	2,11%	2,60%	-1,04%

1 Year	Borrowing in CHF					
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK
1999	78,21%	26,00%	20,41%	17,29%	1,60%	12,87%
2000	-23,77%	-13,69%	3,75%	-4,24%	-5,49%	-8,40%
2001	7,67%	-30,95%	7,69%	4,33%	-0,27%	-5,71%
2002	13,66%	27,61%	-14,86%	-4,29%	1,03%	3,26%
Total profit	75,77%	8,96%	16,99%	13,09%	-3,12%	2,02%
Average yearly profit	18,94%	2,24%	4,25%	3,27%	-0,78%	0,50%

Appendix 2: *1-Month carry trades (JPY-combinations)*

1999							
1 Month	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
January	-8,67%	-1,74%	2,30%	1,11%	-0,14%	7,22%	-0,82%
February	3,10%	0,19%	3,31%	0,71%	0,23%	-1,31%	0,97%
March	0,37%	-1,33%	-0,13%	0,02%	-2,40%	-1,74%	-2,67%
April	4,85%	0,67%	0,17%	0,56%	-1,44%	-1,48%	-2,45%
May	3,15%	-1,66%	1,68%	1,46%	0,43%	-0,52%	1,68%
June	16,67%	1,91%	-0,14%	-1,92%	-1,17%	1,56%	-1,84%
July	-5,98%	-8,51%	-5,23%	-2,56%	-1,79%	-2,05%	-1,05%
August	-14,24%	-3,74%	-4,31%	-5,42%	-5,73%	-4,76%	-5,99%
September	-12,87%	-3,27%	-3,16%	-1,00%	-2,86%	-2,90%	-2,74%
October	15,86%	-4,45%	-1,32%	-1,62%	-1,68%	-2,01%	-2,22%
November	-8,54%	-3,44%	-2,00%	-4,66%	-7,54%	-5,48%	-7,43%
December	1,02%	-0,95%	-0,16%	1,01%	-0,58%	-0,45%	-0,97%
Total	-5,28%	-26,32%	-8,98%	-12,30%	-24,66%	-13,91%	-25,52%
Average	-0,44%	-2,19%	-0,75%	-1,02%	-2,06%	-1,16%	-2,13%

2000							
1 Month	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
January	-2,09%	0,52%	4,72%	5,14%	1,32%	0,54%	1,07%
February	0,57%	-0,01%	1,92%	0,48%	2,03%	4,18%	2,04%
March	-6,81%	-8,63%	-4,28%	-3,37%	-5,06%	-2,99%	-3,97%
April	0,09%	0,61%	5,68%	2,92%	0,69%	2,61%	2,38%
May	-9,27%	-3,90%	-0,07%	-5,15%	0,98%	-1,32%	1,57%
June	-4,52%	-1,38%	-2,46%	-1,25%	-0,88%	-1,45%	0,11%
July	-0,12%	-0,26%	3,38%	2,45%	0,20%	-0,96%	0,76%
August	2,89%	-3,58%	-2,66%	-5,25%	-6,16%	-5,58%	-6,19%
September	-5,91%	-4,60%	0,82%	1,73%	0,28%	-2,13%	1,17%
October	-6,09%	-3,08%	1,29%	0,43%	-3,53%	-2,66%	-2,94%
November	-0,89%	-1,97%	1,90%	-0,03%	2,89%	0,61%	3,97%
December	0,87%	4,73%	3,64%	8,57%	11,94%	10,25%	11,22%
Total	-31,27%	-21,55%	13,88%	6,68%	4,71%	1,10%	11,18%
Average	-2,61%	-1,80%	1,16%	0,56%	0,39%	0,09%	0,93%

2001							
1 Month	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
January	2,82%	-2,22%	1,22%	-0,88%	-0,44%	-0,12%	-0,98%
February	-5,14%	-0,66%	-0,25%	-1,69%	-2,17%	-4,24%	-2,74%
March	1,50%	1,78%	7,62%	5,71%	2,21%	1,43%	3,00%
April	-15,11%	-2,07%	-1,79%	-0,34%	-0,08%	0,17%	-0,89%
May	-1,58%	-3,14%	-2,67%	-2,93%	-5,92%	-5,79%	-5,04%
June	1,48%	3,14%	4,64%	4,50%	5,16%	4,02%	4,77%
July	16,18%	-2,81%	0,22%	1,07%	3,33%	2,73%	4,13%
August	0,87%	-6,78%	-4,52%	-2,40%	-0,05%	-2,56%	-0,25%
September	-9,72%	-6,64%	0,63%	2,11%	0,31%	-1,92%	3,25%
October	-4,99%	-3,29%	1,89%	0,48%	1,77%	2,64%	1,76%
November	-0,21%	-0,21%	-0,21%	-0,21%	-0,21%	-0,21%	-0,21%
December	5,79%	-10,72%	6,23%	8,12%	5,01%	7,08%	4,20%
Total	-8,11%	-33,62%	13,03%	13,55%	8,91%	3,21%	10,99%
Average	-0,68%	-2,80%	1,09%	1,13%	0,74%	0,27%	0,92%

2002							
1 Month	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
January	1,17%	5,75%	0,90%	-1,97%	-2,48%	-1,35%	-2,19%
February	0,22%	-1,26%	-0,30%	0,36%	0,56%	1,43%	0,55%
March	1,42%	-0,96%	-0,79%	-0,05%	-0,63%	-0,27%	-0,13%
April	0,95%	2,06%	-3,54%	-1,27%	0,22%	-2,15%	0,31%
May	1,28%	4,60%	-4,05%	-3,56%	-0,08%	1,06%	-0,70%
June	-6,27%	-9,84%	-3,80%	1,17%	2,16%	2,09%	1,81%
July	-4,21%	1,40%	0,43%	3,14%	-0,43%	-2,13%	0,39%
August	0,15%	-4,70%	-1,36%	-2,15%	-0,88%	-0,45%	-2,36%
September	0,55%	1,86%	3,25%	4,25%	3,37%	4,55%	3,69%
October	-3,97%	4,47%	0,96%	0,25%	0,66%	1,68%	0,06%
November	1,79%	6,92%	-0,06%	-0,50%	0,42%	1,04%	-0,42%
December	-3,96%	2,85%	-3,30%	-0,42%	1,94%	-0,03%	3,34%
Total	-10,87%	13,15%	-11,65%	-0,75%	4,82%	5,48%	4,35%
Average	-0,91%	1,10%	-0,97%	-0,06%	0,40%	0,46%	0,36%

2003							
1 Month	Borrowing in JPY						
Depositing in	IDR	ZAR	USD	GBP	EUR	SEK	CHF
January	0,27%	-0,61%	0,21%	2,95%	3,25%	2,39%	1,99%
February	-3,13%	2,79%	-1,96%	-5,99%	-1,87%	-0,63%	-1,64%
March	0,59%	1,82%	1,45%	1,48%	1,41%	1,01%	0,27%
April	1,00%	11,51%	1,45%	2,17%	2,91%	4,14%	0,58%
May	3,88%	-9,85%	0,24%	2,57%	5,70%	5,61%	4,64%
June	-0,22%	6,79%	0,22%	1,12%	-2,66%	-3,30%	-3,65%
July	-3,75%	1,26%	0,40%	-1,95%	-1,00%	-0,76%	-0,72%
Total	-1,35%	13,70%	2,01%	2,35%	7,74%	8,48%	1,47%
Average	-0,19%	1,96%	0,29%	0,34%	1,11%	1,21%	0,21%

Appendix 3: *1-Month carry trades (CHF-combinations)*

1999						
1 Month Trades	Borrowing in CHF					
Depositing in	IDR	ZAR	USD	EUR	GBP	SEK
January	-7,99%	-1,17%	3,05%	1,16%	1,81%	8,00%
February	2,02%	-1,01%	2,23%	-0,86%	-0,33%	-2,28%
March	3,04%	1,11%	2,53%	0,24%	3,01%	0,94%
April	7,41%	2,89%	2,61%	0,95%	2,66%	1,00%
May	1,34%	-3,62%	-0,11%	-1,26%	-0,49%	-2,20%
June	18,78%	3,49%	1,68%	0,60%	-0,20%	3,48%
July	-5,05%	-7,83%	-4,28%	-0,48%	-1,80%	-1,00%
August	-8,87%	2,06%	1,68%	0,15%	1,33%	1,28%
September	-10,50%	-0,88%	-0,52%	-0,20%	1,77%	-0,18%
October	18,40%	-2,57%	0,84%	0,36%	1,62%	0,22%
November	-1,30%	3,95%	5,79%	-0,13%	1,78%	2,10%
December	1,91%	-0,37%	0,73%	0,19%	1,75%	0,50%
Total	19,19%	-3,94%	16,23%	0,72%	12,92%	11,84%
Average	1,60%	-0,33%	1,35%	0,06%	1,08%	0,99%

2000						
1 Month Trades	Borrowing in CHF					
Depositing in	IDR	ZAR	USD	EUR	GBP	SEK
January	-3,20%	-0,90%	3,55%	0,35%	3,74%	-0,52%
February	-1,53%	-2,38%	-0,19%	-0,12%	-2,45%	2,09%
March	-3,04%	-5,20%	-0,41%	-0,83%	-0,58%	1,01%
April	-2,35%	-2,08%	3,12%	-1,63%	0,53%	0,20%
May	-10,77%	-5,69%	-1,71%	0,36%	-5,13%	-2,87%
June	-4,72%	-1,77%	-2,66%	-1,19%	-1,49%	-1,58%
Juli	-0,96%	-1,28%	2,54%	-0,67%	1,56%	-1,71%
August	9,60%	2,48%	3,69%	-0,07%	0,95%	0,66%
September	-7,10%	-6,01%	-0,44%	-1,47%	0,47%	-3,28%
October	-3,32%	-0,42%	4,31%	-0,24%	3,43%	0,30%
November	-4,78%	-5,97%	-2,09%	-1,09%	-3,74%	-3,25%
December	-9,38%	-6,00%	-6,87%	0,80%	-2,35%	-0,87%
Total	-41,55%	-35,23%	2,83%	-5,82%	-5,07%	-9,82%
Average	-3,46%	-2,94%	0,24%	-0,48%	-0,42%	-0,82%

2001						
1 Month Trades	Borrowing in CHF					
Depositing in	IDR	ZAR	USD	EUR	GBP	SEK
January	3,75%	-1,40%	2,18%	0,23%	-0,11%	0,86%
February	-2,54%	2,00%	2,54%	0,44%	1,03%	-1,54%
March	-1,51%	-1,32%	4,47%	-0,81%	2,61%	-1,50%
April	-14,45%	-1,38%	-1,00%	0,57%	0,08%	1,03%
May	3,55%	1,81%	2,42%	-0,95%	2,17%	-0,80%
June	-3,23%	-1,76%	-0,17%	0,17%	-0,37%	-0,72%
July	11,50%	-6,82%	-3,78%	-0,88%	-3,04%	-1,33%
August	1,05%	-6,63%	-4,31%	0,14%	-2,21%	-2,32%
September	-12,63%	-9,60%	-2,58%	-2,46%	-1,16%	-5,01%
October	-6,71%	-4,92%	0,08%	-0,55%	-1,38%	0,87%
November	1,06%	-7,73%	1,06%	-0,12%	-0,68%	-0,21%
December	1,47%	-14,14%	1,93%	0,73%	3,96%	2,80%
Total	-18,70%	-51,90%	2,85%	-3,48%	0,90%	-7,85%
Average	-1,56%	-4,32%	0,24%	-0,29%	0,07%	-0,65%

2002						
1 Month Trades	Borrowing in CHF					
Depositing in	IDR	ZAR	USD	EUR	GBP	SEK
January	3,37%	8,36%	3,12%	-0,41%	0,15%	0,87%
February	-0,49%	-1,71%	-1,00%	-0,16%	-0,31%	0,78%
March	1,46%	-0,66%	-0,72%	-0,66%	-0,24%	-0,15%
April	0,52%	1,87%	-3,93%	-0,19%	-1,56%	-2,50%
May	1,95%	5,51%	-3,41%	0,59%	-2,91%	1,80%
June	-8,03%	-11,32%	-5,59%	0,06%	-0,73%	0,25%
July	-4,63%	1,22%	0,02%	-0,78%	2,68%	-2,48%
August	2,54%	-2,18%	1,00%	1,30%	0,02%	2,01%
September	-3,11%	-1,58%	-0,49%	0,54%	0,30%	0,83%
October	-4,03%	4,66%	0,91%	0,59%	0,18%	1,69%
November	2,14%	7,50%	0,32%	0,83%	-0,20%	1,46%
December	-7,15%	-0,39%	-6,51%	-1,36%	-3,67%	-3,28%
Total	-15,48%	11,29%	-16,27%	0,35%	-6,27%	1,28%
Average	-1,29%	0,94%	-1,36%	0,03%	-0,52%	0,11%

7-Months 2003 1 Month Trades	Borrowing in CHF					
Depositing in	**IDR**	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**
January	-1,71%	-2,41%	-1,77%	1,18%	0,90%	0,44%
February	-1,54%	4,64%	-0,35%	-0,38%	-4,28%	1,07%
March	0,20%	1,55%	1,05%	1,07%	1,16%	0,69%
April	0,30%	10,80%	0,76%	2,21%	1,47%	3,49%
May	-0,80%	-13,82%	-4,27%	0,93%	-1,99%	0,93%
June	3,46%	10,86%	3,90%	1,12%	5,11%	0,33%
July	-3,14%	1,98%	1,04%	-0,38%	-1,32%	-0,06%
Total	-3,23%	13,60%	0,36%	5,74%	1,04%	6,90%
Average	-0,46%	1,94%	0,05%	0,82%	0,15%	0,99%

Appendix 4: *1-Month carry trades (IDR-combinations)*

1999 1 Month Trades	Depositing in IDR						
Borrowing in	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**	**CHF**	**JPY**
January	-8,25%	-10,76%	-8,88%	-10,99%	-14,92%	-7,99%	-8,67%
February	2,06%	-0,25%	2,57%	2,46%	4,39%	2,02%	3,10%
March	0,74%	0,45%	2,80%	0,00%	2,06%	3,04%	0,37%
April	3,12%	4,63%	6,38%	4,52%	6,36%	7,41%	4,85%
May	3,77%	1,41%	2,61%	1,78%	3,64%	1,34%	3,15%
June	13,42%	16,79%	18,00%	18,87%	14,80%	18,78%	16,67%
July	1,84%	-0,84%	-4,27%	-3,47%	-4,09%	-5,05%	-5,98%
August	-11,65%	-10,43%	-8,95%	-9,40%	-10,06%	-8,87%	-14,24%
September	-10,82%	-10,07%	-10,41%	-12,10%	-10,32%	-10,50%	-12,87%
October	20,05%	17,36%	19,26%	20,24%	18,14%	18,40%	15,86%
November	-6,22%	-6,73%	-2,38%	-6,01%	-3,31%	-1,30%	-8,54%
December	1,00%	1,12%	1,65%	0,03%	1,40%	1,91%	1,02%
Total	9,06%	2,69%	18,36%	5,93%	8,10%	19,19%	-5,28%
Average	1,39%	0,41%	2,83%	0,91%	1,25%	2,95%	-0,81%

2000 1 Month Trades	Depositing in IDR						
Borrowing in	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**	**CHF**	**JPY**
January	-3,73%	-6,55%	-3,60%	-6,60%	-2,75%	-3,20%	-2,09%
February	-0,39%	-1,37%	-1,53%	-0,11%	-3,49%	-1,53%	0,57%
March	0,99%	-2,69%	-2,29%	-3,78%	-4,03%	-3,04%	-6,81%
April	-1,53%	-5,34%	-0,84%	-2,92%	-2,60%	-2,35%	0,09%
May	-6,54%	-9,25%	-11,03%	-5,80%	-8,09%	-10,77%	-9,27%
June	-4,10%	-2,16%	-3,62%	-3,31%	-3,19%	-4,72%	-4,52%
July	-0,87%	-3,45%	-0,38%	-2,54%	0,82%	-0,96%	-0,12%
August	5,65%	5,65%	9,66%	8,53%	8,85%	9,60%	2,89%
September	-2,37%	-6,74%	-5,80%	-7,63%	-3,95%	-7,10%	-5,91%
October	-4,06%	-7,34%	-3,12%	-6,54%	-3,60%	-3,32%	-6,09%
November	0,10%	-2,80%	-3,81%	-1,03%	-1,54%	-4,78%	-0,89%
December	-4,65%	-2,74%	-9,91%	-7,06%	-8,59%	-9,38%	0,87%
Total	-21,51%	-44,77%	-36,27%	-38,77%	-32,17%	-41,55%	-31,27%
Average	-3,31%	-6,89%	-5,58%	-5,96%	-4,95%	-6,39%	-4,81%

2001							
1 Month Trades	**Depositing in IDR**						
Borrowing in	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**	**CHF**	**JPY**
January	4,11%	1,50%	3,19%	3,80%	2,81%	3,75%	2,81%
February	-5,46%	-4,97%	-3,01%	-3,58%	-1,01%	-2,54%	-5,14%
March	-1,27%	-5,75%	-0,95%	-3,87%	-0,01%	-1,51%	1,50%
April	-14,20%	-13,62%	-15,10%	-15,01%	-15,33%	-14,45%	-15,11%
May	0,59%	1,07%	4,61%	1,34%	4,37%	3,55%	-1,58%
June	-2,60%	-3,08%	-3,46%	-2,90%	-2,49%	-3,23%	1,48%
July	18,40%	15,86%	12,60%	15,01%	13,00%	11,50%	16,18%
August	7,13%	5,58%	0,86%	3,30%	3,44%	1,05%	0,87%
September	-4,24%	-10,33%	-10,17%	-11,59%	-8,01%	-12,63%	-9,72%
October	-2,77%	-6,80%	-6,30%	-5,42%	-7,49%	-6,71%	-4,99%
November	1,06%	1,06%	1,06%	1,06%	1,06%	1,06%	1,06%
December	15,72%	-0,47%	0,71%	-2,40%	-1,30%	1,47%	5,79%
Total	16,47%	-19,93%	-15,97%	-20,27%	-10,95%	-18,70%	-6,85%
Average	2,53%	-3,07%	-2,46%	-3,12%	-1,68%	-2,88%	-1,05%

2002							
1 Month Trades	**Depositing in IDR**						
Borrowing in	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**	**CHF**	**JPY**
January	-4,94%	0,23%	3,74%	3,11%	2,48%	3,37%	1,17%
February	0,46%	0,49%	-0,37%	-0,20%	-1,26%	-0,49%	0,22%
March	1,91%	2,18%	2,03%	1,49%	1,65%	1,46%	1,42%
April	-2,20%	4,60%	0,89%	2,18%	3,12%	0,52%	0,95%
May	-3,79%	5,51%	1,31%	4,95%	0,13%	1,95%	1,28%
June	2,97%	-2,61%	-8,28%	-7,43%	-8,29%	-8,03%	-6,27%
July	-6,77%	-4,68%	-3,91%	-7,20%	-2,24%	-4,63%	-4,21%
August	4,46%	1,49%	1,02%	2,35%	0,52%	2,54%	0,15%
September	-2,28%	-2,67%	-2,74%	-3,54%	-3,91%	-3,11%	0,55%
October	-9,02%	-4,93%	-4,62%	-4,28%	-5,65%	-4,03%	-3,97%
November	-5,93%	1,79%	1,30%	2,27%	0,66%	2,14%	1,79%
December	-7,59%	-0,72%	-5,86%	-3,59%	-4,00%	-7,15%	-3,96%
Total	-32,70%	0,69%	-15,48%	-9,90%	-16,77%	-15,48%	-10,87%
Average	-5,03%	0,11%	-2,38%	-1,52%	-2,58%	-2,38%	-1,67%

7-Months 2003							
1 Month Trades	Depositing in IDR						
Borrowing in	**ZAR**	**USD**	**EUR**	**GBP**	**SEK**	**CHF**	**JPY**
January	-0,48%	0,01%	-2,91%	-2,60%	-2,15%	-1,71%	0,27%
February	-7,08%	-1,23%	-1,18%	2,93%	-2,59%	-1,54%	-3,13%
March	-2,20%	-0,88%	-0,88%	-0,96%	-0,49%	0,20%	0,59%
April	-10,68%	-0,49%	-1,93%	-1,21%	-3,08%	0,30%	1,00%
May	14,58%	3,59%	-1,77%	1,18%	-1,72%	-0,80%	3,88%
June	-7,52%	-0,48%	2,44%	-1,35%	3,10%	3,46%	-0,22%
Juli	-5,88%	-4,17%	-2,80%	-1,87%	-3,10%	-3,14%	-3,75%
Total	-19,26%	-3,66%	-9,02%	-3,88%	-10,02%	-3,23%	-1,35%
Average	-2,75%	-0,52%	-1,29%	-0,55%	-1,43%	-0,46%	-0,19%

Appendix 5: *1-Month carry trades (ZAR-combinations)*

1999						
1 Month	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
January	-3,39%	-3,85%	-0,98%	-8,46%	-1,17%	-1,74%
February	-2,44%	-0,03%	-0,26%	1,46%	-1,01%	0,19%
March	-0,62%	-1,30%	1,27%	0,33%	1,11%	-1,33%
April	1,08%	0,73%	2,40%	2,10%	2,89%	0,67%
May	-2,71%	-2,60%	-1,72%	-1,19%	-3,62%	-1,66%
June	2,66%	4,23%	3,02%	0,27%	3,49%	1,91%
July	-2,90%	-5,71%	-6,62%	-6,68%	-7,83%	-8,51%
August	1,18%	2,09%	2,27%	0,94%	2,06%	-3,74%
September	0,46%	-2,04%	-0,16%	-0,45%	-0,88%	-3,27%
October	-2,60%	-0,44%	-0,81%	-2,56%	-2,57%	-4,45%
November	-0,90%	-0,38%	2,70%	2,07%	3,95%	-3,44%
December	-0,22%	-1,54%	-0,42%	-0,58%	-0,37%	-0,95%
Total	-10,39%	-10,85%	0,69%	-12,76%	-3,94%	-26,32%
Average	-0,87%	-0,90%	0,06%	-1,06%	-0,33%	-2,19%

2000						
1 Month	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
January	-3,42%	-3,71%	-1,00%	-0,14%	-0,90%	0,52%
February	-1,30%	-0,27%	-1,58%	-4,04%	-2,38%	-0,01%
March	-3,97%	-5,28%	-4,11%	-5,92%	-5,20%	-8,63%
April	-4,20%	-1,98%	0,50%	-2,07%	-2,08%	0,61%
May	-3,22%	0,21%	-6,47%	-2,64%	-5,69%	-3,90%
June	1,75%	0,30%	0,06%	-0,01%	-1,77%	-1,38%
July	-2,92%	-2,25%	-0,08%	0,68%	-1,28%	-0,26%
August	-0,32%	2,13%	3,20%	2,01%	2,48%	-3,58%
September	-4,78%	-5,94%	-4,44%	-2,60%	-6,01%	-4,60%
October	-3,71%	-3,12%	0,37%	-0,53%	-0,42%	-3,08%
November	-3,18%	-1,67%	-4,51%	-2,63%	-5,97%	-1,97%
December	1,70%	-3,06%	-5,37%	-5,10%	-6,00%	4,73%
Total	-27,58%	-24,63%	-23,44%	-22,99%	-35,23%	-21,55%
Average	-2,30%	-2,05%	-1,95%	-1,92%	-2,94%	-1,80%

2001						
1 Month	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
January	-2,79%	-1,00%	-2,13%	-2,18%	-1,40%	-2,22%
February	0,24%	1,45%	1,19%	3,67%	2,00%	-0,66%
March	-4,81%	-3,15%	-0,56%	0,28%	-1,32%	1,78%
April	0,38%	-1,48%	-1,02%	-2,32%	-1,38%	-2,07%
May	0,19%	0,21%	3,42%	2,72%	1,81%	-3,14%
June	-0,78%	-0,84%	-1,20%	-0,89%	-1,76%	3,14%
July	-2,38%	-3,34%	-5,99%	-5,49%	-6,82%	-2,81%
August	-1,71%	-4,06%	-6,59%	-4,41%	-6,63%	-6,78%
September	-6,58%	-8,10%	-7,10%	-4,88%	-9,60%	-6,64%
October	-4,41%	-3,19%	-4,06%	-5,83%	-4,92%	-3,29%
November	-0,21%	-0,21%	-0,21%	-0,21%	-0,21%	-0,21%
December	-15,33%	-17,12%	-13,30%	-16,71%	-14,14%	-10,72%
Total	-38,20%	-40,83%	-37,54%	-36,24%	-44,37%	-33,62%
Average	-3,18%	-3,40%	-3,13%	-3,02%	-3,70%	-2,80%

2002						
1 Month	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
January	5,62%	8,47%	7,54%	7,12%	8,36%	5,75%
February	-0,20%	-1,05%	-0,89%	-2,73%	-1,71%	-1,26%
March	0,59%	-0,26%	-1,10%	-0,72%	-0,66%	-0,96%
April	6,60%	3,94%	2,93%	4,25%	1,87%	2,06%
May	9,82%	9,04%	4,59%	3,41%	5,51%	4,60%
June	-5,59%	-10,43%	-11,22%	-11,78%	-11,32%	-9,84%
July	1,70%	-1,14%	1,61%	3,49%	1,22%	1,40%
August	-2,67%	-2,00%	-3,86%	-4,36%	-2,18%	-4,70%
September	-0,62%	-1,67%	-0,17%	-2,66%	-1,58%	1,86%
October	4,23%	4,78%	4,33%	2,64%	4,66%	4,47%
November	7,74%	8,06%	6,53%	5,72%	7,50%	6,92%
December	7,12%	3,84%	1,45%	2,81%	-0,39%	2,85%
Total	34,33%	21,57%	11,74%	7,20%	11,29%	13,15%
Average	2,86%	1,80%	0,98%	0,60%	0,94%	1,10%

2003						
1 Month	Depositing in ZAR					
Borrowing in	USD	GBP	EUR	SEK	CHF	JPY
January	-0,13%	-2,90%	-3,83%	-3,00%	-2,41%	-0,61%
February	5,57%	9,83%	5,25%	3,37%	4,64%	2,79%
March	1,05%	0,78%	0,94%	0,72%	1,55%	1,82%
April	10,62%	9,60%	8,38%	6,99%	10,80%	11,51%
May	-9,47%	-11,75%	-15,25%	-14,71%	-13,82%	-9,85%
June	7,27%	6,13%	11,33%	10,35%	10,86%	6,79%
July	1,52%	3,76%	2,64%	1,95%	1,98%	1,26%
Total	16,44%	15,45%	9,45%	5,65%	13,60%	13,70%
Average	2,35%	2,21%	1,35%	0,81%	1,94%	1,96%

Appendix 6: *Bid and ask spread for exchange rates*

Currency pair	Basis point spread
JPY/CHF	0.06
SEK/CHF	0.0050
ZAR/CHF	0.05
CHF/EUR	0.00050
GBP/EUR	0.00050
JPY/EUR	0.05
SEK/EUR	0.0050
USD/EUR	0.0005
ZAR/EUR	0.0500
CHF/GBP	0.00080
EUR/GBP	0.0009
JPY/GBP	0.10
SEK/GBP	0.0075
USD/GBP	0.0005
ZAR/GBP	0.0600
JPY/SEK	0.010
CHF/USD	0.0006
JPY/USD	0.05
SEK/USD	0.0050
ZAR/USD	0.0225

The spreads were retrieved from the website of Saxobank.
http://www.saxobank.com/