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Carry trade and Momentum: performance, country development, and exchange movement

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ABSTRACT

The paper explores carry trade and momentum strategies in five developed and five developing countries against USA or Japan from January 2003 to January 2023. The average return and Sharpe ratio of the portfolios reveal that the Yen carry trade with carry trade strategy has shown a positive return and performance irrespective of the country's development status. The paper also examines the further relationship between currency speculation approaches and related variables via OLS regression analysis and the Newey West estimation model. The finding of regression analysis suggests that being a developed investing country is more likely to have a negative association with its return compared to being a developing country. Furthermore, the results for the Newey West estimation model challenge the common belief among investors that the boom in currency speculation investment will lead to an increase in demand, and so does the exchange rate. Overall, it sheds light on the impact of country development on returns and performance of currency speculation investment and challenges conventional beliefs about the relationship between performance, country development status, and exchange rate movement.

Keywords: Carry trade, Momentum, Performance, Country Development, Exchange rate movement

JEL codes: G11, G15

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CHAPTER 1 Introduction

Two speculation approaches dominate the foreign exchange market today: carry trade and momentum strategies. Carry trade provides the gains from interest rate differential between two countries: borrowing in a funding currency with a low-interest rate while investing in a target currency with a high-interest rate. Momentum offers a profitable opportunity by buying (selling) currencies whose long positions have recently produced positive (negative) returns. Among investors in foreign exchange market, finding a strategy that can provide the highest return is the key. Conventionally, funding the currency speculation investment with the US dollar was the most popular option in FX market as it is believed to be the "safe haven" for investors. However, the recent trend is to borrow in Japanese Yen since the Japanese interest rate dropped to an all-time low due to its current economic issue. In the past few months, it is reported that many investors have gained an excess return from Euro or Australian Dollar against the Japanese Yen (Shome, 2023). This phenomenon indicates an increased movement in seeking new pairs of currencies that generate high yields.

As the currency speculation strategies gain popularity among investors, many academic journals are published to examine the performance of carry trade and momentum with a diverse currency pair. For example, Burnside et al (2008) highlighted the importance of currency diversification in a portfolio for the carry trade against the US Dollar by analyzing the relationship between the diversification and the performance of the carry trade. To elaborate, they compared Sharpe ratios of the carry trades from 1967 to 2007 with 23 currencies against the dollar under three different portfolio strategies: equally weighted, currency-specific, and high-low. Note that the Sharpe ratio plays a significant role in the analysis since it exhibits how well the carry trade is performed in comparison to the risk-free investment. In his following work (Burnside et al, 2011), the return and performance of carry trade and momentum strategy were compared and its exposure to risk was analyzed based on Fama and CAPM model. Similarly, Menkhoff et al (2012) compares the return of momentum strategies to the one of carry trade using Sharpe Ratio. Finally, Brunnermeier, Nagel, and Pedersen (2008) conducted empirical research on the relationship between carry trade return and crash risk, using time series data on exchange rates of 8 currencies against the US dollar from 1986 to 2006. They emphasizes the importance of incorporating macroeconomic insight into analyzing the returns to carry trade.

In many studies, it is realized that return to currency speculation strategies differ depending on the countries, time horizons, and other factors. However, most of the studies do not have enough discussion on characteristics of country that are also influential to the rate of return. Thus, this can be the area to be studied, leading to the research question, “How does the return and the performance of each trading strategy differ depending on the characteristics of the country?.” Note that characteristics of the country are the term to indicate whether the country is a developed or developing country. To answer the research question, the thesis will focus on how the return and the Sharpe ratio of the portfolios with different strategies and funding currencies will vary between developed and developing countries.

In this way, it will be possible to specify which strategy and funding currency are more suitable for developed or developing countries. In addition, the following relationships will be investigated in this thesis: (1) the relationship between the characteristics of the countries and the return and (2) the relationship between the exchange rate movement and the return.

The thesis will mainly study the difference between the carry and momentum strategies, focusing on the return and the performance of the Yen or Dollar carry trade in developed and developing countries. To research the thesis idea mentioned above, up-to-date data for the spot exchange rates of the currencies is collected from Datastream, referring to the existing journals. Currencies for the carry trade are classified into two groups based on the criteria suggested by the United Nations (2022); developed countries are Australia, Canada, Japan, Netherlands, New Zealand, Switzerland, and the United States whereas developing countries are Brazil, China, Mexico, South Africa, and South Korea. With the collected data, the return will be calculated under the portfolios with two different strategies: basic carry trade and momentum strategies. The portfolios are to be equally weighted, which means taking a long (short) position on 1/N of the funding currency if the interest rate of investing currency is higher (lower) than the interest rate of the funding currency country. The sample size of the portfolio might be the annual returns for 5 developed countries and 5 developing countries from January 2003 to January 2023. So, in total, 2400 observations are generated for the empirical analysis. Moreover, the Sharpe ratio of each portfolio in developed and developing countries will be calculated to compare their economic performances across developed and developing countries. The calculation for Sharpe ratios will be the expected return divided by the standard deviation of the portfolio. Skewness and kurtosis will be derived for further analysis of the performance of each strategy. To analyze the impact of being developed country on the return to carry trade and momentum strategy, the paper will attempt a regression analysis on the given panel data. Finally, Newey West estimation analysis will be conducted on time-series data to research the relationships between and the exchange movement and the return. A more detailed explanation of the methodology will be discussed in **Chapter 4**.

The expected outcomes from this thesis can be summarized as follows. First, a strong association will be observed between the Sharpe ratio and the return to carry trade. The good performance of carry trade strategies is likely to be associated with its excess return. Second, the discussion on the suitable strategy for either developed or developing countries will allow us to explore the link between the characteristic countries and high-yielding returns. Third, the portfolios for developed countries will have more outstanding performance and excess return because of their solid economic background. Finally, the returns to carry trade will have a positive association with the exchange rate movements. If the return to carry trade increases, more investors will dive into the transaction. Then, the demand for currency will be increased, leading to an appreciation in the exchange rate. However, in reality, many other risk factors could impact the exchange rate movement, leaving a room for further analysis.

CHAPTER 2 Theoretical Framework

2.1 Carry trade: background

Carry trade is an investment strategy prevalently used in the foreign exchange (FX) market. If the investors want to profit from arbitrage between two countries, they need to be aware of the following foreign exchange rules and regulations, the trading platform that enables the transaction between the countries (Thaxton, R., 2022). First, the forex interest rate, also known as the rollover rate, should be paid in the form of transaction costs. However, in this paper, we will assume that there is no transaction cost following the work of Frenkel & Levich (1975), which will be elaborated in **section 2.1.1**. Second, the trading can be performed five days a week from 9 pm Sunday to 10 pm Friday. Finally, the investors should be conscious of the fact that each currency has all different requirements for its margin to place the trading.

Respecting the rules and regulations in the FX market, the investors attempt to figure out the way to acquire the best return from the carry trade, leading to an increase in the demand for research on it in the field of finance. As a result, there are numerous studies have developed the means to investigate the return and performance of the strategies in carry trade, and it will be demonstrated explicitly in **Chapter 2**. Before reviewing the analysis of carry trade, it is necessary to understand the concept of interest rate parity. Investors with covered interest rate parity take short or long positions on forward contracts to hedge the exchange risks; it is not required for uncovered interest rate parity, referring to Laux and Zhang (2014).

2.1.1 Covered Interest Parity (CIP)

Covered Interest Parity condition indicates the absence of the interest differential between the two countries. It means that the relationship between the interest rates of the two countries is equal to the relationship between the spot and the forward currency of the two countries. This can be expressed as

$$\frac{F}{S} = \frac{1 + r_d}{1 + r_f}$$

where F is the forward rate, S is spot exchange rate, r_d and r_f are the interest rates of the domestic and foreign countries. If this theorem does not hold, there is an opportunity of gaining from arbitrage. Many studies perform an empirical analysis of the concept of CIP. Frenkel & Levich (1975) argue for the profitability with the deviations from CIP in terms of the transaction cost. In addition to their work, Taylor (1986) found no profitable arbitrage opportunity for the majority of currencies, but only for US Dollar from the deviation of CIP. To sum up, the violation of CIP will provide an opportunity for profitable arbitrage from interest rate differential between two countries.

2.1.2 Uncovered Interest Parity (UIP)

Uncovered Interest Parity theorem indicates the existence of the interest differential between two countries equals the exchange rates in the previous period. This can be expressed as

$$(1 + r_d) = (1 + r_f)\frac{E_t(S_{t+1})}{S_t}$$

where S is the exchange rate for domestic currencies per a unit of foreign currency, and $E_t(S_{t+1})$ is the expected exchange rate at time t. If this relationship does not hold, there is an opportunity for profitable arbitrage in international markets. Rose & Flood (2001) is one of the studies that tested the concept of UIP. They found that UIP works differently in some cases since the volatilities of the countries in crisis are sensitive and different. Sachsida et al (2001) support UIP, however, pointed out the limitation that the UIP works at a theoretical level, but not at an empirical level. The UIP hypothesis was only accepted during the period with the flexible exchange rate and high political instability. To summarize, the gains from deviations of UIP vary over time due to macroeconomic factors and uncertainties in the reality.

2.2 Carry trade: empirical studies

2.2.1 Carry trade and momentum strategies

The most popular speculation approaches in the FX market are the carry trade and momentum strategies. This is also shown in the field of research on the returns to investments in the international market. Burnside et al (2008), Menkhoff et al (2011), Barroso et al (2015), and Daniel et al (2017) examined the performance of the carry trade in different countries and exposure of its returns to risk in the different financial markets. These studies built a profound knowledge in developing currency speculation strategies, shedding light on the different strategies like momentum. Especially, Lustig et al (2009), Burnside et al (2011), and Menkhoff et al (2012) expanded their analysis of the speculation strategies in the FX market by comparing the results of carry trade and momentum strategies. Those studies highlighted that momentum strategies are different from the carry trade strategy, so the results of momentum strategies are rather to be small compared to that of carry trade strategies.

2.2.2 Dollar and Yen carry trade

The most popular funding currency for the analysis of the carry trade is USD. According to Daniel et al (2017), the carry trade with the base currency of the USD has the largest return compared to other G10 currencies. It is important to note that all the currencies generate significant returns with negative skewness. Negative skewness means that it is expected to have small gains and a few large losses as observed in the work of Sachsida et al (2001) for exploring the UIP condition. On the other hand, positive skewness refers to the expectation of frequent small losses and a few large gains. Although USD is known as the best funding currency in numerous existing literatures, some investors would love to borrow in another funding currency that can generate greater values than any other

investors. JPY is the answer to those investors. The reason is that Japanese interest rates are recorded at an all-time low as mentioned in **Chapter 1**. The increasing trend of borrowing in JPY is observed in the field of studies. For example, Fong (2010) emphasized the recent phenomenon that JPY becomes a dominant option for the carry trade in terms of funding currency. However, Kim (2010) pointed out that there is a lack of empirical investigations that measured and estimated the returns to Yen carry trade yet.

2.2.3 Other strategies for carry trade: portfolio composition

The profitability of the carry trade depends on the portfolio composition. For example, the recent academic literature written by Daniel et al (2014) introduces three different styles of constructing a portfolio. The first method is "equally weighted": long 1/n of funding currency if the foreign interest rate is greater than the interest rate for funding currency, and vice versa. The second approach is "spread-weighted": invest in the currency with a large interest differential. The third strategy is "OPT": using the weights which maximize the risk-adjusted return for the most. For simplicity, only an equally weighted portfolio will be considered in this paper. This same consideration was made in the work of Burnside et al (2011), analyzing the returns and performance of the carry trade and momentum strategy. Instead of modifying the portfolio composition by its weight, the paper will diversify the returns by comparing them with two different funding currencies, USD and JPY.

2.3 Carry trade related factors: Sharpe ratio, characteristics of the country, and exchange rate movement

2.3.1 Sharpe ratio

Sharpe ratio is actively utilized in analyzing the performance of an investment in any kind of asset. Of course, this can be applied to investigating the gains from interest differential and exchange rate movements in FX markets. For example, Burnside (2008) and Barros and Santa-Clara (2015) discussed the impact of diversification in the currencies of portfolios on the performance of the carry trade, which is measured by the Sharpe ratio. To support their claim on the positive association between diversification and performance, they also performed further analysis by measuring the skewness and excess kurtosis of the portfolios. Among the results, there are some returns to carry trade that seems to be outperformed compared to the one for other currency pairs. Thus, the researchers point out the risk of "Peso problem," that might give unprecedent impact on the profitability of the carry trade.

2.3.2 Characteristics of the country: country development

Numerous factors can affect the returns to carry trade. For example, the excess return will differ depending on the characteristic of countries although it performs the carry trade against the same funding currencies. Note that the characteristics of countries mentioned in this thesis indicate whether the country has developed or developing markets. Currency of the emerging countries is not usually selected

as the funding currency of the carry trade. The reason is explained by Kritzer (2012) that short-term interest rates are high in developing countries due to their higher volatility, monetary instability, and lower liquidity compared to developed countries. It shows that there is an opportunity to gain from arbitrage between the developed and developing countries as the interest rate of the developing countries are usually low while that of the developed countries are comparatively high. There are a few empirical analysis on the relationship between the characteristics of the country and the carry trade. Tomio (2023) conducted a Granger Causality test to check whether nominal exchange rate, investment position, and the interest differential Granger causal with the currencies utilized for the carry trade, referring to the work of Toda and Yamamoto (1995). As a result, they found that the exchange rate can be a great predictor of carry trade. For target currencies, the bi-directional Granger causality was found between the interest rate and the carry trade.

2.3.3 Exchange rates movement

Note that there are not many studies that discuss the relationship between the exchange rate movements and carry trade, but the relationship between one and another investment made by foreign investors. For example, Pavola and Rigobon (2003) conduct an empirical analysis of the relationship between the asset price and the exchange rates by proving the co-movement between the assets concerning the change in exchange rates. Furthermore, Hau and Rey (2006) build a model that shows the relationship between the exchange rates, stock price, and capital flows in the foreign exchange market to see how the capital flows from abroad are related to the exchange rate movements, or vice versa. A return to currency speculation strategies is also a way of gaining profit for the investors, same analysis framework can be applied to the investigation of the relationship between the exchange rate movement and the gains from carry trade. Kim (2010) attempts to analyze the relationship between the return to carry trade and Yen carry trade via Newey West estimation analysis.

2.4 Summary of hypothesis based on the literature review

Section 2.3 give a grasp on how the ideas are developed regarding the speculation strategies in the FX market, leading to the hypothesis stated as follows. The first hypothesis is that the Sharpe Ratio of the portfolios with carry trade and momentum strategies will be higher in developing countries than in developed countries. This is because the interest rates tend to be higher in developing countries, so the return and the Sharpe ratio will be significantly larger compared to the ones in developed countries. The second hypothesis is that the exchange rate movement will increase as more capital flows into the country for currency speculation. If the carry trade keeps generating an excess return, the demand for the currency will increase, and so does the capital inflow and exchange rate.

CHAPTER 3 Data

The paper will mainly focus on the returns and performance of carry trade in the different countries. The countries are classified into either developing or developed countries based on the criteria suggested by United Nations in 2022 (World Economic Situation and Prospects 2022, pp. 153-154). To be specific, developed countries are Australia (AUD), Canada (CAD), Japan (JPY), Netherlands (EUR), New Zealand (NZD), Switzerland (CHF), and the United States (USD). Developing countries are Brazil (BRL), China (CNY), South Africa (ZAR), South Korea (KRW), and Mexico (MXN). It is important to note that USD and JPY are used as funding currencies for the carry trade, so they are excluded from the sample of the currencies of developed countries.

Both spot exchange rates and interest rates are measured on the last trading day of each month under the sample period from 31 January 2003 to 31 January 2023. The data of the spot exchange rates for each currency pair are collected monthly from Datastream. Spot exchange rates indicate the convertible amounts of funding currency per a unit of foreign currency, referring to Burnside et al (2011) and Daniel et al (2014). The thesis assumed the portfolio to be rebalanced every 3 months, so the returns to carry trade are calculated based on the 3 months interbank rates. The interest rates for Brazil, China, South Korea, and Switzerland are collected from Federal Reserve Economic Data (FRED) due to the lack of data availability in Datastream.

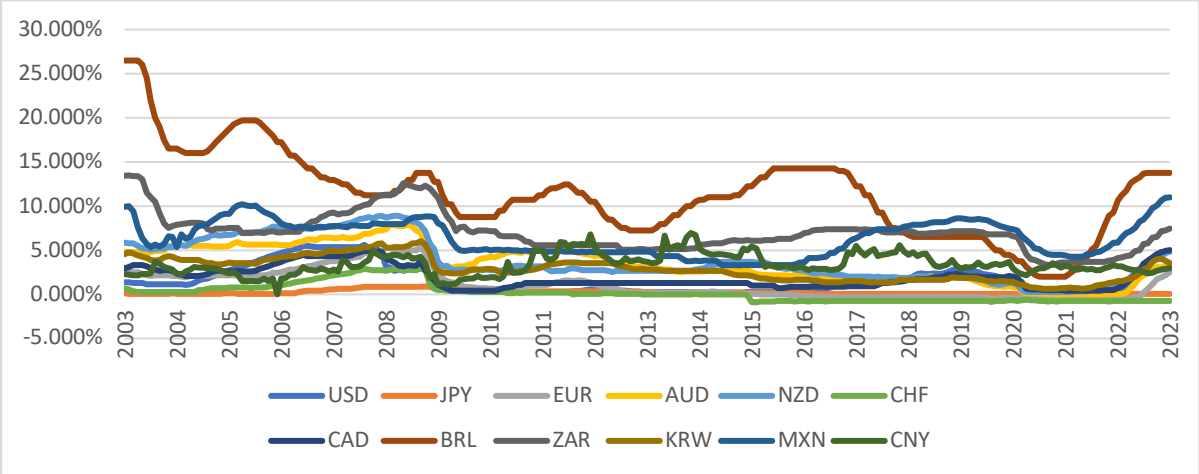

Figure 1. 3 months interbank rates of the different countries form January 2003 to January 2023

The differences between the interest rates are summarized in **Figure 1**. It shows that Brazil has the all-time-high and JPY has the all-time-low interest rates. Besides the analysis on the relationship between the performance and the return of the carry trade, the paper will also discuss the relationship between the exchange rate movement and the return of the carry trade, focusing on the case of South Korea against USD or JPY. The data sample is collected quarterly from January 2003 to January 2023. With this model suggested by Kim (2010), the exchange rate of KRW per a unit of USD or JPY will be collected from Datastream. The interest differential will be calculated based on 3 months interbank rates collected from FRED. Finally, the data for capital inflow is collected from the Korean South Korean Ministry of Trade, Industry and Energy, and it normalized via log transformation.

CHAPTER 4 Method

4.1 Trading strategies

The paper will consider two major currency speculation strategies: carry trade and momentum. The return of Dollar and Yen carry trade with those strategies will be derived based on the mathematical framework suggested by Burnside at al (2011). To calculate the return to the different carry trade strategies, we should first derive the payoff to take a long position on foreign currency, assumed the absence of transaction cost. This can be expressed as

$$v_{t+1} = (1 + i^*)\frac{S_{t+1}}{S_t} - (1 + i_d)$$

where v_{t+1} indicates the payoff to take a long position on foreign currency, $i^*$is the foreign currency interest rate, i_d is the interest rate of the funding currency (Dollar or Yen), and S_t is the spot exchange rate of funding currency per a unit of foreign currency. To highlight, the currency pairs in the portfolios for each strategy are equally weighted, following the work of Burnside et al (2011). It means that the total value of the transaction is normalized to one USD or JPY.

4.1.1 Return to carry trade strategy

With carry trade, investors buy the funding currency in exchange for the foreign currency which has a higher interest rate than the funding currency. In this paper, Yen and Dollar are considered as the funding currency since Japan has the lowest interest rates and the United States is known as a "safe haven" in carry trade. Using the equation above, Burnsid et al (2011) derived the excess return to carry trade strategy of borrowing in Yen or Dollar and investing in the foreign currency in developed or developing countries. This can be written as

$$r^c_{t+1} = sign(i^* - i_d)\, v_{t+1}$$

where r^c_{t+1} shows the return to carry trade strategy. The sign will be positive (+) if $i^* > i_d$, and vice versa. Note that interest differential is the key here since it determines the profitability of the carry trade to be gain or loss.

4.1.2 Return to momentum strategy

Momentum strategy refers to the way of profiting from selling foreign currency forward if taking a short position on the forward at the previous period is profitable. Recently, many studies have highlighted the importance of not only the interest differential but also the appreciation or depreciation in exchange rate in generating excess return to carry trade, leading to the rise in the use of momentum strategy. Burnside et al (2011) define the excess return to the momentum strategy using v_{t+1}. This can be stated as

$$r^m_{t+1} = sign(v_t)\, v_{t+1}.$$

where r_{t+1}^{m} represents the return to momentum strategy. The sign will be positive (+) if the payoff in the previous month is positive. Note that return to this strategy is sensitive to exchange rate risk as it varies depending on the return of the previous month.

4.2 Performance measures

4.2.1 Sharpe ratio

Sharpe ratio measures how well the carry trade and momentum is performed in comparison to the investment with a risk-free rate. As it presented in the work of Burnside, et al. (2008), Brunnermeier et al (2008), and Menkhoff et al (2012), it has been used widely in the field of analyzing carry trade. Sharpe ratio can be calculated as

$$SR_p = \frac{r_p - r_f}{\sigma_p}$$

where SR_p is the Sharpe ratio of the portfolio. r_p is the return to the portfolio with the different trading strategies and σ_p is standard deviation of the excess returns. r_f is the risk-free rate, which is assumed to be zero in this paper. Note that the results for the Sharpe ratio become significant when the returns are normally distributed.

4.2.2 Skewness and Kurtosis

Referring to Brunnermeier, et al. (2008), skewness and kurtosis will be measured as the proxy for the financial risk existed in the FX market. Since it is based on the assumption that the portfolio will have a normally distributed returns, skewness and kurtosis will enable us to analyze the potential outliers in a given data set. As it also mentioned in the work of Daniel, et al (2017), the returns to portfolios with different strategies in carry trade are likely to have negative skewness, implying that there might be a small gain and a few large losses. In addition, Burnside, et al. (2008) showed that more skewness and kurtosis is found in the portfolio with the relatively higher risk. Skewness and kurtosis will be calculated by using the function in Stata.

4.3 Further analysis of the carry trade with other factors

4.3.1 Relationship between excess return and characteristics of the country

Developed countries are likely to have lower interest rates while developing countries tend to have higher interest rates. It means that the interest rates differential will be larger between the developed and developing countries. The funding currency of the carry trade and momentum in this thesis is set to be either the US Dollar or Japanese Yen, which are the currencies of developed countries. Thus, the excess return will be higher for the Yen or Dollar carry trade against the currencies of the developing countries. The first hypothesis states that Sharpe Ratio of the portfolios with carry trade and momentum strategies will be higher in developing countries than in developed countries. This will be explored with:

$$R_p = \alpha + \beta_1 Country\ Developement_i + \beta_2 \gamma_i + u_i$$

where $R_p$is the average returns of the portfolios against dollar or yen with carry trade or momentum strategies. Note that there will be four types of portfolios for each strategy: Dollar carry trade in developed countries, Dollar carry trade in developing countries, Yen carry trade in developed countries, Yen carry trade in developing countries. $Country\ Developement_i$ is the dummy variable that shows whether the currency speculation happens [1] between developed countries or [0] between developed and developing countries. For example, it is [1] if the Yen or Dollar carry trade is performed against the Netherlands whereas it is [0] if the Yen or Dollar carry trade is implemented against South Korea. The regression will allow us to understand how much percentage points of return to carry trade will be affected by the characteristics of the country. The model is derived from the work of Dellas & Hess (2005). In their work, they also include exchange rate volatility as a control variable to check to what extent the volatility of stock returns is driven by exchange rate volatility. Thus, this paper will also consider exchange rate volatility as the control variable, represented as γ_i in the regression model above. Exchange rate volatility will be measured as the standard deviation of the portfolio consisting of the currencies of developed or developing counties with carry trade or momentum strategies. The heteroscedasticity is detected with white test and it was corrected by the use of white (robust) standard errors.

4.3.2 Relationship between the exchange rate movement and the excess return

As the return of carry trade and momentum strategies increase, demand for the currency of investing country will rise and more capital flow will flow from the funding country. Kim (2010) pointed out the limitation of the analysis on the relationship between the exchange rate and the return to carry trade. Instead, Kim attempt to explore the relationship with the regression

$$\Delta S_t = \alpha_0 + \alpha_1(r^* - r)_i + \alpha_2 r_i + \alpha_3 k_i + u_i$$

where ΔS_t is the change in exchange rate of foreign currency per a unit of Dollar or Yen. r^* is return to the investing country, which is South Korea in this paper, and r is the return to the funding country, which is USA and Japan in this paper. k_i represents the capital flow of funding currency into investing country, and u_i incorporates all the error terms assumed to be "white noise." Since capital inflow are right skewed, it is normalized via log transformation. Since Kim (2010) observed difficulty finding the estimator of risk factors (δ), it is replaced by the interest differential. The constant term demonstrates the characteristics of each capital market in different countries. α_1 shows the estimator of the interest differential with the exchange rate movements. α_2 shows the estimator of market risks of funding currency. Finally, α_3 will show estimator showing how the capital flow impacts the exchange rate movements. This is the most important variable to consider as the increase in demand for investment will lead to the expansion in capital flow from funding to investing country, resulting in the appreciation of the exchange rates that demonstrate the convertible amount of funding currencies per unit of investing currency. The author highlight the use of Newey West estimation to avoid the risk of autocorrelation.

CHAPTER 5 Results & Discussion

Chapter 5 will begin with introducing the descriptive statistics of the return and performance of carry trade and momentum strategies. Then, the relationship between the return and characteristics of the country will be explored via OLS regression analysis with panel data samples. Finally, the relationship between the exchange rate and the excess return will be also discussed by referring to the model suggested by Kim (2010) with time-series data samples, focusing on the case of South Korea against the USA and Japan.

5.1 Carry Trade strategy

Carry Trade strategy is performed in the currencies of 10 different countries against Dollar or Yen from January 2003 to January 2023. Table 1 shows that the carry trade strategy will have positive average returns and Sharpe ratios regardless of the funding currency to use. For the Dollar carry trade of developed countries with a carry trade strategy, the lowest average return is 0.478% in Canada and the highest average return is 2.330% in Australia. The same trend is shown with the Sharpe ratio; the lowest Sharpe ratio is 0.177 in Canada and the highest Sharpe ratio is 0.590 in Australia. For the carry trade of developing countries against the Dollar, the lowest average return and Sharpe ratio are 1.396% and 0.412 in South Korea, and the highest return and Sharpe ratio are 9.706% and 1.326 in Brazil. For Yen carry trade with carry trade strategy in developed countries, the highest average return and Sharpe ratio are 3.690% and 0.784 in New Zealand, and the lowest return and Sharpe ratio are 0.447% and 0.148 in Switzerland. For the developing countries with a carry trade strategy against Yen, the highest return and Sharpe ratio are 11.146% and 1.412 in Brazil, and the lowest return and Sharpe ratio are 2.647% and 0.706 in South Korea. The descriptive statistics show that the return and performance of the dollar carry trade with the carry trade strategy tend to be higher in developed countries than in developing countries. The results can be summarized from the largest to smallest as follow:

i) Dollar carry trade
   a. Return: Brazil, South Africa, Mexico, China, Australia, New Zealand, South Korea, Switzerland, Netherlands, and Canada
   b. Sharpe Ratio: Brazil, China, Mexico, South Africa, Australia, New Zealand, South Korea, Netherland, Switzerland, and Canada

ii) Yen carry trade
   a. Excess return: Brazil, South Africa, Mexico, New Zealand, China, Australia, South Korea, Canada, Netherland, and Switzerland
   b. Sharpe ratio: Brazil, Mexico, South Africa, China, New Zealand, South Korea, Australia, Canada, Netherlands, and Switzerland

In total, Yen carry trade in Brazil has the best return and performance while Yen carry trade in Switzerland shows the worst return and performance. These results make sense since Brazil has the highest interbank rates while Japan has the lowest interbank rates and Switzerland has the second lowest

interest bank rates as mentioned in Chapter 3. Thus, the largest interest differential between Brazil and Japan and the smallest interest differential between Switzerland and Japan are reflected in their return and performance. Furthermore, Table 1 also reports that the distribution of returns is likely to have a negative skewness, indicating that there are possible abrupt drawdowns with the strategy. Also, the excess kurtosis is found in all currency pairs for the strategy, indicating that there is an abrupt large change in return distribution. A similar observation for the negative skewness and the excess kurtosis is found in the work of Brunnermeirer et al (2009), Burnside et al (2011), and Daniel et al. (2017).

Table 1. Result of carry trade strategy against Dollar or Yen

	Dollar carry trade					
	Avg. Return (%)	Std. Dev. (%)	Skewness	Kurtosis	Sharpe Ratio	Number of observations
Australia	2.330	3.950	-0.004	3.899	0.590	240
Canada	0.478	2.705	-0.059	4.984	0.177	240
Netherlands	1.106	2.852	-0.156	4.244	0.388	240
New Zealand	2.262	4.030	-0.179	3.611	0.561	240
Switzerland	1.205	3.122	-0.514	4.610	0.386	240
Brazil	9.706	7.319	0.513	4.941	1.326	240
China	2.464	1.863	0.078	2.779	1.323	240
South Africa	5.195	5.519	0.147	3.459	0.941	240
South Korea	1.396	3.387	0.408	7.176	0.412	240
Mexico	4.520	3.808	-0.603	5.577	1.187	240

	Yen carry trade					
	Avg. Return (%)	Std. Dev. (%)	Skewness	Kurtosis	Sharpe Ratio	Number of observations
Australia	3.210	4.613	-0.318	4.080	0.696	240
Canada	1.665	3.760	-0.634	4.964	0.443	240
Netherlands	0.949	3.430	-0.367	3.941	0.277	240
New Zealand	3.690	4.709	-0.157	3.435	0.784	240
Switzerland	0.447	3.011	-0.031	4.049	0.148	240
Brazil	11.146	7.896	0.435	4.381	1.412	240
China	3.326	2.977	-0.102	3.217	1.118	240
South Africa	6.618	5.734	0.258	3.725	1.154	240
South Korea	2.647	3.748	-0.304	4.930	0.706	240
Mexico	5.967	4.945	-0.476	4.057	1.207	240

Notes. The table represents the descriptive statistics for the carry trade strategy against Dollar or Yen. See Chapter 4 for the calculation process. Note that average return and standard deviation are reported in percentage (%). The numbers are rounded up by 3 significant figures.

5.2 Momentum strategy

Momentum strategy is conducted with 10 different currencies against Dollar and Yen from January 2003 to January 2023. Table 2 shows that the momentum strategy will have positive average returns and Sharpe ratio regardless of the selection of the funding currencies. For Dollar carry trade in developed countries with momentum strategy, Australia has the highest average return and Sharpe ratio by 1.360% and 0.310 respectively. The lowest average return and Sharpe ratio are found in Canada by 0.032% and 0.012 accordingly. For Dollar carry trade in developing countries with a momentum strategy, the highest return is 8.785% in Brazil, but the highest Sharpe ratio is 1.258 in China. The lowest return and Sharpe ratios are 0.840% and 0.235 in South Korea. For Yen carry trade in developed countries with a momentum strategy, the highest return and Sharpe ratio are 2.420% and 0.477 in Australia, and the lowest return and Sharpe ratio are 0.198% and 0.007 in Switzerland. For Yen carry trade in developing countries with a momentum strategy, Brazil has the highest return and Sharpe ratio by 10.676% and 1.252 while South Korea has the lowest return and Sharpe ratio by 1.823% and 0.433. The summary below arranges the results for average return and Sharpe ratio from the largest to smallest:

i) Dollar carry trade
   a. Excess return: Brazil, Mexico, South Africa, China, Australia, New Zealand, South Korea, Switzerland, Netherlands, and Canada
   b. Sharpe ratio: China, Brazil, Mexico, South Africa, Australia, Netherlands, Switzerland, New Zealand, South Korea, and Canada

ii) Yen carry trade
   a. Excess return: Brazil, South Africa, Mexico, China, Australia, New Zealand, South Korea, Canada, Netherlands, and Switzerland
   b. Sharpe ratio: Brazil, Mexico, South Africa, China, Australia, South Korea, New Zealand, Canada, Netherlands and Switzerland

The best average return is derived from Yen carry trade in Brazil while the worst average return is gained with Dollar carry trade in Canada. Moreover, the best performance is observed with Dollar carry trade in China, and the worst performance is found with Yen carry trade in the Netherlands. Unlike the carry trade strategy, the momentum strategy showed few discrepancies between the return and Sharpe ratio. In addition, Table 2 represents that the most of return distributions have negative skewness and excess kurtosis, and these results are in line with the work of Brunnermeirer et al (2009), Burnside et al (2011), and Daniel et al. (2017).

Table 2. Result of momentum strategy against Dollar or Yen

	Dollar carry trade					
	Avg. Return (%)	Std. Dev. (%)	Skewness	Kurtosis	Sharpe Ratio	Number of observations
Australia	1.360	4.382	0.101	3.319	0.310	240
Canada	0.032	2.747	-0.200	4.834	0.012	240
Netherlands	0.737	2.969	-0.028	3.850	0.248	240
New Zealand	1.079	4.495	-0.144	3.150	0.240	240
Switzerland	0.800	3.250	-0.338	3.996	0.246	240
Brazil	8.785	8.407	-0.150	5.131	1.045	240
China	2.418	1.922	0.006	2.741	1.258	240
South Africa	3.798	6.563	-0.090	3.151	0.579	240
South Korea	0.840	3.567	-1.028	7.875	0.235	240
Mexico	4.150	4.210	-0.667	4.666	0.986	240

	Yen carry trade					
	Avg. Return (%)	Std. Dev. (%)	Skewness	Kurtosis	Sharpe Ratio	Number of observations
Australia	2.420	5.073	-0.365	3.611	0.477	240
Canada	1.039	3.979	0.180	3.426	0.261	240
Netherlands	0.609	3.507	0.186	3.351	0.174	240
New Zealand	2.278	5.535	-0.337	3.186	0.412	240
Switzerland	0.198	3.038	0.150	3.954	0.007	240
Brazil	10.676	8.524	0.024	4.778	1.252	240
China	2.780	3.495	-0.502	3.625	0.795	240
South Africa	5.460	6.850	-0.258	3.823	0.797	240
South Korea	1.823	4.212	-0.589	4.447	0.433	240
Mexico	5.445	5.517	-0.631	3.845	0.987	240

Notes. The table represents the descriptive statistics for the momentum strategy against Dollar or Yen. See Chaper 4 for the calculation process. Note that average return and standard deviation are reported in percentage (%). The numbers are rounded up by 3 significant figures.

5.3 Suggestion for the funding currency and strategy

The results from **section 5.1** and **section 5.2** can be summarized as follow:

	The highest average return	**The highest Sharpe ratio**
Australia	Carry trade against Yen	Carry trade against Yen
Canada	Carry trade against Yen	Carry trade against Yen
Netherlands	Carry Trade against Dollar	Carry Trade against Dollar
New Zealand	Carry Trade against Yen	Carry Trade against Yen
Switzerland	Carry Trade against Dollar	Carry Trade against Dollar
Brazil	Carry Trade against Yen	Carry Trade against Yen
China	Carry Trade against Yen	Carry Trade against Dollar
South Africa	Carry Trade against Yen	Carry Trade against Yen
South Korea	Carry Trade against Yen	Carry Trade against Yen
Mexico	Carry Trade against Yen	Carry Trade against Yen

Notes. The options are following: 1) carry trade against Yen, 2) carry trade against Dollar, 3) momentum against Yen, and 4) momentum against Dollar.

As it shown in the summary above, the greater average return and performance is derived from the carry trade strategy over momentum strategy in both developed and developing countries. In addition, Yen carry trade seems to have a higher return and better performance than what Dollar carry trade made. Except for China, the results for the strategies and funding currency match between the consideration of the highest average return and Sharpe ratio.

5.4 Regression analysis: excess return and country development

Using the regression model suggested by Dellas & Hess (2005), **Table 3** shows the analysis of the relationship between the excess return and country development. **Panel A** indicates the regression model of the average return to carry trade or momentum strategy against the Dollar on the country's development and exchange rate volatility from January 2003 to January 2023. It shows that performing Dollar carry trade in developed countries instead of developing countries is likely to be associated with a negative change in average return to carry trade strategy by -2.366 percentage points. It also presents that Dollar carry trade in developed countries instead of developing countries is likely to be associated with a drop in average return to momentum strategy by -2.676 percentage points. As more variables are added, the magnitude of the constant term decreases. This means that there were omitted variable biases before adding the control variable, highlighting the role of exchange rate volatility as a control variable.

Panel B suggests the regression model of the average return to the strategies against Yen on the same variables mentioned above for the same sample period. It provides us an insight that performing a carry trade strategy against Yen in developed countries instead of developing countries is likely to be associated with a decrease in average return by -2.945 percentage points. Additionally, Yen carry trade with momentum strategy in developed countries instead of developing countries is likely to be associated

with a drop in average returns by -3.327 percentage points. The constant term in **Panel B** decreases as the additional variable is included in the one-variable model, demonstrating that the exchange rate volatility works well as the control variable. To sum up, performing the strategies in the developed country instead of developing against Dollar or Yen are likely to be associated with a negative change in the average returns.

Table 3. Regression analysis of the return to different strategies on country development

Panel A: Dollar carry trade

	Dependent variable: Average return to carry trade strategy (%)		
	(1)	(2)	(3)
Country development	-3.180***		-2.366***
	(0.224)		(0.243)
Exchange rate volatility		0.685***	0.481***
		(0.717)	(0.077)
constant	4.656***	0.475**	2.430***
	(0.198)	(0.240)	(0.359)
R-squared	0.297	0.271	0.411
Numbers of observations	480	480	480

	Dependent variable: Average return to momentum strategy (%)		
	(1)	(2)	(3)
Country development	-3.196***		-2.676***
	(0.235)		(0.265)
Exchange rate volatility		0.459***	0.234***
		(0.692)	(0.080)
constant	3.998***	0.544**	2.789***
	(0.194)	(0.246)	(0.379)
R-squared	0.280	0.153	0.312
Numbers of observations	480	480	480

Panel B: Yen carry trade

	Dependent variable: Average return to carry trade strategy (%)		
	(1)	(2)	(3)
Country Development	-3.949***		-2.945***
	(0.307)		(0.630)
Exchange rate volatility		0.867***	-0.629***
		(0.073)	(0.076)
constant	5.941***	0.591**	2.988***
	(0.254)	(0.265)	(0.401)
R-squared	0.258	0.245	0.370
Numbers of observations	480	480	480

	Dependent variable: Average return to momentum strategy (%)		
	(1)	(2)	(3)
Country Development	-3.928***		-3.327***
	(0.314)		(0.336)
Exchange rate volatility		0.498***	0.240***
		(0.079)	(0.085)
constant	5.236***	1.182***	3.927***
	(0.242)	(0.315)	(0.439)
R-squared	0.246	0.128	0.270
Numbers of observations	480	480	480

Notes. The table shows the regression analysis on return to portfolios with carry trade or momentum strategies against Dollar or Yen. Panel A shows the results of OLS regression model with dollar carry trade and Panel B shows the one with Yen carry trade. Model (1) regress the average return to carry trade or momentum strategy on country development, model (2) regress the average return on the exchange rate volatility, and model (3) regress the return to the portfolios on country development, holding the characteristics of country constant. Furthermore, each regression considered to be robust to the errors to correct the potential heteroscedasticity. Standard errors are reported in parentheses and significance are represented with significance stars.

*** Significant at the 1 percent level [p<0.01]

** Significant at the 5 percent level [p<0.05]

* Significant at the 10 percent level [p<0.10]

5.5 Newey West estimation: exchange rate movement and excess return

As the exchange rate plays a key role in profiting from an arbitrage with carry trade, it must be important to understand the relationship between the exchange rate movement and the excess return. Table 4 represents the relationship between the exchange rate movement and the excess return, referring to the model suggested by Kim (2010). The investing country to focus on is South Korea because it is the country where the author of this thesis belongs to.

Table 4. Newey West estimation of exchange rate movement

	Dependent variable: exchange rate movement	
	Dollar carry trade	Yen carry trade
Interest rate differential	-0.003	-0.283**
	(0.293)	(0.137)
FX Market risk	0.001	-0.009
	(0.002)	(0.006)
Capital inflow	0.006**	0.008***
	(0.003)	(0.003)
constant	-0.080*	0.012
	(0.040)	(0.038)
Number of observations	80	80

Notes. The table represents the Newey West estimation on the relationship between the exchange rate movement and the excess return. Interest rates of South Korea, USA, and Japan are collected from Datastream. The data for capital inflow from Japan or USA into South Korea is derived from South Korean Ministry of Trade, Industry and Energy. It has been normalized via log transformation. All the data is measured quarterly from 2003 to 2023. The numbers are round off to 3 significant figures. Standard errors are reported in parentheses and significance with significance stars.

*** Significant at the 1 percent level [p<0.01]

** Significant at the 5 percent level [p<0.05]

* Significant at the 10 percent level [p<0.10]

The Newey West estimation model in **Table 4** suggests that we can estimate that the return of currency speculation strategies of South Korea and USA move in a different direction while that of South Korea and Japan move in the same direction. This can be inferred from the estimators of interest rate differential and FX market risk. The estimator for capital flow shows a positive result although its magnitude is extremely small. This implies that the exchange rate of investing country against the

funding country is likely to move in a positive direction as more capital flows into the investing country from the funding country. To sum up, the Newey West estimation model allows us to estimate the positive correlation between the exchange rate and return to currency speculation approaches.

CHAPTER 6 Conclusion

The paper examines the various aspects of carry trade and momentum strategies in the FX market, focusing on five developed and five developing countries against the USA or Japan from January 2003 to January 2023. To be specific, the analysis of the average return and Sharpe ratio provides us an insight that Yen carry trade with carry trade strategy is the most favorable option for currency speculation investment irrespective of a country's development status. The descriptive statistics also showed that negative skewness and excess kurtosis are observed in the line with work of Burnside (2011), Brunnermeier, et al. (2008), and Daniel (2008). Notably, the results for average return and Sharpe ratio seem to be better than the existing literatures written in the early 2000s and 2010s. This indicates that greater uncertainty and risk that may influence currency speculation outcomes are included in the data sample of this paper due to the longer time period. Therefore, further investigation on the currency speculation approaches will be required, considering the potential risks and uncertainty in reality.

Next, the regression analysis of return to each strategy against Yen or Dollar on the country development, holding exchange volatility constant, is performed. The results revealed a negative association between the country's development status and the return to Yen or Dollar carry trade with carry or momentum strategies. There are limited attempts to analyze the relationship between the return and the country development in the research field, so the results of this paper and the work of Dellas & Hess (2005) could build a stepping stone to further investigation on this topic. Furthermore, the relationship between the exchange rate movement and the return to currency speculation strategies is explored by the model with Newey estimation suggested by Kim (2010), focusing on South Korea, which is the country the author of this thesis belongs to. The finding suggests that the variables for South Korea and the USA move in the opposite direction while South Korea and Japan move in the same direction. This implies that the positive consequences following the currency speculation strategies are more likely to be occurred in South Korea against Japan, but not against the USA. Thus, the conventional belief that the carry trade can stimulate the increase in demand for the investing currency and exchange rate movement is ambiguous and different across the countries.

Besides the results found in this paper, the possibility of the risk that might be influential to the profitability and performance of the carry trade can be discussed in further research. For example, there are numerous financial crises and events such as the COVID-19 pandemic occurred during the given sample period. This means that the profitability and the performance of the carry trade can be driven by other factors that are not explained in this paper. Analyzing these additional factors will contribute to the development of the research on the carry trade, encouraging investors to develop investment strategies in the FX market against unforeseen risks and uncertainties. Therefore, the research on the carry trade should be continued to evolve as long as the world figures out a way to gain from arbitrage between two countries in comparison to the risk-free investment.

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