Effect of Exchange Rate Volatility on Currency Carry Trade and risk factor
compensation of Currency Carry trade in G10 and Emerging Market

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ผลกระทบจากความแปรปรวนของอัตราแลกเปลี่ยนต่อธุรกรรมการกู้ยืมเงินเพื่อเก็งกำไร และปัจจัยความเสี่ยงที่ส่งผลต่อการปรับตัวของธุรกรรมการกู้ยืมเงินเพื่อเก็งกำไร ในกลุ่มประเทศ จี10 และกลุ่มตลาดเกิดใหม่

นายจิรไพบูลย์ รัตนภาณุรักษ์

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งานวิจัยชิ้นนี้มีจุดประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างผลตอบแทนจากธุรกรรมการเก็งกำไรอัตราแลกเปลี่ยนระหว่างประเทศและปัจจัยความเสี่ยงที่ส่งผลกระทบต่อผลตอบแทนจากธุรกรรมนี้ กรณีศึกษาในกลุ่มประเทศ จี 10 และกลุ่มตลาดเกิดใหม่ อันดับแรกเริ่มต้นจากการตรวจสอบความเป็นไปได้ที่จะทำกำไรจากธุรกรรมนี้ โดยการทำแบบจำลองสมการถดถอยในภาวะความเสมอภาคของอัตราดอกเบี้ยที่ไม่ได้รับการป้องกันความเสี่ยงจากการแลกเปลี่ยนของ FAMA ลำดับถัดไปงานวิจัยชิ้นนี้ได้ศึกษาความสัมพันธ์ระหว่างธุรกรรมการเก็งกำไรอัตราแลกเปลี่ยนและความผันผวนของอัตราแลกเปลี่ยนในอีกหลายแง่มุม เนื่องจากมีงานวิจัยหลายชิ้นในอดีตพบความสัมพันธ์เชิงระหว่างสองตัวแปรนี้ สุดท้ายงานวิจัยชิ้นนี้ได้ใช้แบบจำลองความสัมพันธ์ระหว่างปัจจัยต่าง ๆ ที่ส่งผลต่อผลตอบแทนจากธุรกรรมนี้ เช่น ปัจจัยจากเส้นที่แสดงความสัมพันธ์ของอัตราผลตอบแทนพันธบัตรต่ออายุไถ่ถอน และปัจจัยที่เป็นตัวแทนของความกลัวของนักลงทุน

ผลที่ได้จากการศึกษาในขั้นตอนแรกแสดงให้เห็นว่ามีความเป็นไปได้ที่จะได้รับกำไรจากการทำธุรกรรมการเก็งกำไรอัตราแลกเปลี่ยนระหว่างประเทศ เนื่องจากงานวิจัยชิ้นนี้พบว่าภาวะความเสมอภาคของอัตราดอกเบี้ยที่ไม่ได้รับการป้องกันความเสี่ยงจากการแลกเปลี่ยนของ FAMA ไม่เป็นจริง และความสัมพันธ์ระหว่างผลตอบแทนของธุรกรรมนี้กับความผันผวนของอัตราแลกเปลี่ยนยังคงสอดคล้องกับงานวิจัยที่ผ่านมาซึ่งมีความสัมพันธ์เชิงลบต่อกัน จึงสรุปได้ว่าผลตอบแทนจากธุรกรรมการเก็งกำไรอัตราแลกเปลี่ยนระหว่างประเทศเป็นที่น่าพอใจเมื่อตลาดอัตราแลกเปลี่ยนมีความผันผวนต่ำ และเป็นจริงเช่นกันในทางตรงกันข้ามยิ่งไปกว่านั้นผลการศึกษาจากแบบจำลองความสัมพันธ์ระหว่างปัจจัยต่าง ๆ ที่ส่งผลต่อผลตอบแทนจากธุรกรรมการเก็งกำไรจากอัตราแลกเปลี่ยนระหว่างประเทศก็สอดคล้องกับงานวิจัยที่ผ่านมาเช่นกัน ไม่ว่าจะเป็นความสัมพันธ์เชิงลบของปัจจัยที่เป็นตัวแทนของความกลัวของนักลงทุน, ความสัมพันธ์เชิงบวกของปัจจัยจากเส้นที่แสดงความสัมพันธ์ของระดับอัตราผลตอบแทนพันธบัตรต่ออายุไถ่ถอน และความสัมพันธ์เชิงลบของปัจจัยจากความชันเส้นที่แสดงความสัมพันธ์ของระดับอัตราผลตอบแทนพันธบัตรต่ออายุไถ่ถอน

ภาควิชา	การธนาคารและการเงิน	ลายมือชื่อนิสิต	....
สาขาวิชา	การเงิน	ลายมือชื่อ อ.ที่ปรึกษาหลัก	....
ปีการศึกษา	2560		

JIRAPAIBOON RATTANAPANURAK: Effect of Exchange Rate Volatility on Currency Carry Trade and risk factor compensation of Currency Carry trade in G10 and Emerging Market. ADVISOR: ASST. PROF.ANIRUT PISEDTASALASAI, Ph.D., pp.

Currency carry trade is one of famous currency speculation strategies through latest decade. Return of this strategy comes from the difference of interest rate between countries. In theoretical world, FAMA uncovered interest rate parity (UIP) assumes change in spot exchange rate is going to offset the difference of interest rate. Therefore, the first objective of this paper is to test violation of UIP which implies possibility to do currency carry trade. Secondly, moving on to determine the relationship between currency carry trade return and exchange rate volatility in some difference aspects because there are evidences about negative relationship between currency carry trade return and market volatility which is exchange rate volatility from previous literature. Finally, this paper employs factor model to investigate the contribution of risk factor such as yield curve factors and investors' fear factors on currency carry trade return. The groups of data which are considered in this paper are G10 and Emerging countries.

According to first empirical result of this paper, it shows the violation of UIP which implies opportunity to earn profit from currency carry trade strategy, since change in spot exchange rate does not offset difference of interest rate. Secondly, the negative relationship between currency carry trade return and exchange rate volatility is consistently appeared while we go through steps of investigating the relationship. This result also accorded with previous literatures which had concluded that currency carry trade strategy is likely to yield favorable return while exchange rate volatility is low and vice versa. Finally, the factor model also yields result consistent with previous works whether it would be significantly negative, significantly negative and positive relationship for VIX index, yield curve slope factor and yield curve level factor to currency carry trade return respectively. Moreover, lagged unexpected volatility also yields significantly negative relationship as well.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Uncovered Interest Rate Parity (UIP) (Fama, 1984)is one of the explanation theories which explain about the difference of interest rate and its outcome. If UIP is hold, expected exchange rate between high and low interest rate countries will offset interest rate difference of those countries; low yield currency will relatively appreciate against high yield currency in the same percentage of the interest rate difference. Therefore, there is no room for making profit from taking the position high and low yield currency, assuming no condition in market. In real world, there are countless empirical works that argue UIP. Since currency with lower interest rate tends to depreciate relatively to high interest rate currency (e.g.(Craig Burnside, 2007)), there is the opportunity to capture benefit from this violation.

One of the most popular inter-market investment strategies is currency carry trade which captures benefit from interest rate difference by borrowing in the low interest rate currency and investing in the high interest rate currency. Moreover, the benefit is not only gained from interest rate difference but also from change in exchange rate, because in reality, high yield currencies tend to appreciate relative to low yield currencies. Moreover, evidences claim that investors can make systematic profit from currency carry trade over decades since this inter-market investment strategy is based on the violation of UIP but there is some problem about carry trade, since return from carry trade has been negative in some period but the accumulative is still positive anyway. The return from carry trade strategy can absolutely turn negative if there is market turmoil. Therefore, exchange rate volatility is going to be one proxy for market risk which compensates with carry trade return (e.g.(Charlotte

Christiansen, 2011),(Richard Clarida and Niel Pedersen, 2009)) so currency carry trade does not give arbitrage benefit since it is risk involved investment. In practical, there are two important things to determine about carry trade; which are cost of shorting in low interest rate currency, and benefit of longing in high interest rate currency.

Thus, currency carry trade strategy focuses on currencies which have interest rate differences. That should be interesting for emerging markets, since the interest rate of emerging countries are always relatively high compared to G10(Frankel, 2008). Therefore, emerging countries should be the target group for carry trade investing while G10 is funding currency. Moreover, it is going to be more attractive for carry trade between G10 (developed country) and emerging countries, due to the capital injection in core G4 countries which are major countries in G10; the capital injection will reduce the value of this group's currency. In another aspect, capital inflow of G10 tends to flow to other markets such as emerging markets because of the currency depreciation and the relatively higher yield in other markets. That is going to create the significant appreciation of those currencies against G10(Tanna, 2010).

In investors' point of view, currency carry trade is always favorable to do but there are concerns for the target country's government. The problem will occur for some emerging countries that are export dependent because there will be capital inflow into target currency when carry trade is applied. This creates demand for target currency, which tends to appreciate compared to funding currency. On the other hand, export dependent countries' government always use exchange rate policy to intervene the exchange rate to maintain the level of export since the strengthening value of currency has a negative relation with exportation of those countries. Therefore, this intervention will stabilize exchange rate. The less volatile the exchange rate, the more attractive the carry trade. This might be the reason for the evidence in the increase in

Sharpe's ratio on carry trade portfolio which includes emerging markets currency into sample set, according to Craig Burnside et. al.(2007).

1.2 Statement of Problem

There are many works which study about the currency carry trade but they mostly focus on only developed countries (G10), so there are still few researches which focus on carry trade between developed countries and emerging countries. Therefore, this paper aims to study the currency carry trade among the G10 and emerging market currency. First of all, we start with testing the violation of Uncovered Interest Rate Parity to see whether carry trade is possible or not. Second, we are going to study the relationship between exchange rate volatility and currency carry trade return in full sample. That is G10 blended with emerging countries and 2 subsamples, which are group G10 and emerging separately, by using 5 steps to reconfirm the consistency. Since many works found that exchange rate volatility is a major factor that affects currency carry trade. Finally, we employ the factor model from (John Y. Campbell, 1987) (developed by Richard Clarida(2009)) by adding VIX index to explain currency carry trade return) which is the first empirical and theoretical model that joints determine currency carry trade return and yield curve term premia and we add the lagged of unexpected volatility which implies investors' fear of unexpected risk to be another explanation variable. All analyses of this paper are based on monthly data.

1.3 Objectives

The main objective of this paper is to study about the exchange rate volatility and effect of risk factor to currency carry trade return. This work consists of three objectives. Firstly, we investigate whether currency carry trade is possible to generate profit or not by testing the violation of Uncovered Interest Rate Parity (UIP). If UIP is not hold, currency carry trade will be possible to generate profit because UIP assumes

that exchange rate between countries is going to offset the benefit of interest rate difference. Secondly, we examine the consistency of relationship between exchange rate volatility and currency carry trade return in various aspects. Finally, we study the compensation of risk factors to currency carry trade return by factor model.

1.3.1 The Test of Opportunity to do Currency Carry Trade

First, we recall Fama (1984) UIP to test the violation of this theory for checking possibility of gaining profit from currency carry trade strategy. Because UIP assumed change in spot exchange rate will perfectly offset benefit from interest rate difference between countries which is impact of changing in interest rate difference on the change in spot exchange rate is equal 1. There is empirical result which represented by Froot(1990), C. Burnside et. al. (2007)and R. Clarida et. al. (2009)shown violation of UIP, they found the negative impact of change in interest rate difference on the change in spot exchange rate. We employ the spot exchange rate and 3-months forward implied yield (referred to interest rate) of G10 and emerging market currency to examine. The purpose of hypothesis in this step is to test whether impact of changing in interest rate difference on the change in spot exchange rate is equal 1 or not in full sample (G10 + emerging countries) and 2 subsamples. If impact of changing in interest rate difference on changing in spot exchange rate equals to 1, depreciation of high yielding currency against low yield currency will perfectly offset interest rate difference. Therefore, there are no opportunities to gain profit from currency carry trade strategy which means UIP is hold.

1.3.2 Effect of Exchange Rate Volatility on Currency Carry Trade Return

Second, if there is opportunity to gain profit from currency carry trade strategy we are going to examine the factor which determine currency carry trade return. In the beginning, we create a number currency carry trade portfolio and summarize the characteristics of currency carry trade portfolios. We expect to see the diversification

benefit by comparing Sharpe's ratio to prove that currency carry trade is a risky investment which can diversify non-systematic risk away(Craig Burnside, 2008). According to previous works in this field, there are many evidences about the negative relationship between market volatility and currency carry trade return such G. Galti et. al.(2007), V. Bhansali et. al.(2007), R. Clarida et. al.(2009), Stephanie C. et.al. (2011)and L. Menkhoff et. al.(2012). The investigation of effect of exchange rate volatility on currency carry trade consist with 5 steps to consistently reconfirm the relationship in each step. The first step, we generate the exchange rate volatility following L. Menkhoff et. al. (2012)compute for correlation between currency carry trade return and exchange rate volatility. We expect to find negative correlation between them. In the second step, we create Dollar portfolio which refers to market portfolio and find the correlation of currency carry trade return and market portfolio variance, which is called coskewness following L. Menkhoff et. al. (2012)as well. We expect to see negative relationship in this part. For the third step, we divide the data into 4 quartiles, subject to the exchange rate volatility and re-summarize the currency carry trade return and return's volatility again. We try to figure out that currency carry trade yields favorable profit during low exchange rate volatility and return immediately unwinds when volatility of exchange rate is in high stage. For the fourth step, we estimate Threshold-GARCH model to find the relationship of conditional variance of return which is dominated by exchange rate volatility. Coefficient of conditional variance should be negative to currency carry trade return for consistency. In the last step, we retest UIP again but with 3v3 currency carry trade portfolio and separate data into low and high stage of volatility. We expect to confirm that in low volatility environment, high interest rate currency tends to relatively appreciate and vice versa for high volatility environment; This will result in violation of UIP as well. In every single step, we always investigate the difference in result of 3 groups of sample.

1.3.3 The Compensation of Risk Factors on Currency Carry Trade Portfolio
Return

For further investigation we employ the factor model from R. Clarida et. al.
(2009)which assumes that return of asset is given by random variable. There are 4
explanation variables which we used. They are VIX Index, yield curve level, yield curve
slope and lagged unexpected exchange rate volatility. These variables are proxy of
investor's risk aversion, permanent real interest rate, business cycle and investors' fear
of unexpected risk respectively. We use these explanation variables to explain the
return from currency carry trade. The first three variables follow R. Clarida et. al.
(2009)but the last one is added in this paper to be proxy of investors' risk aversion in
another aspect.

1.4 Scope of the Study

We focus on G10 countries and 8 emerging countries since January 2001 till
October 2017. We employ daily spot exchange rate and 3-months implied forward
yield to calculate currency carry trade return and exchange rate volatility and 2-years,
5-years, 7-years and 10-years treasury yield to compute yield curve level and yield
curve slope from daily Bloomberg data.

1.5 Contribution

This paper makes 3 contributions to the literature as follows. Firstly, this paper
employs the data of emerging market currency to examine currency carry trade
strategy and show that the return from currency carry trade does not only exist in G10
currencies but also in emerging market currencies itself and in G10 + emerging counties
as well. Moreover, currency carry trade will be more prefferable if investors use G10
currencies and emerging market currencies as funding currency and investing currency
respectively. We provide the comparison of doing currency carry trade in only G10,

only emerging and 2 groups blend together and justify currency carry trade portfolio by mean/volatility ratio.

Secondly, this paper reconfirms the relationship between currency carry trade and exchange rate volatility risk in 4 aspects following R. Clarida et al.,(2009). However, these steps are not completely similar to previous works, since we also add the coskewness as additional confirmation and employ the idea of global exchange rate volatility from L. Menkhoff et al. (2012)to be applied as exchange rate volatility of this paper. We are still focusing on the comparison of 3 groups of samples.

Thirdly, this paper uses the factor model to see the effect of risk factor in market compensation with currency carry trade return following R. Clarida et. al.(2009). There are 3 explanation variables used by previous works; VIX Index, yield curve level, and yield curve slope. These variables are proxy of investor's risk aversion, permanent real interest rate, business cycle respectively. Furthermore, we use lagged unexpected exchange rate volatility as an additional explanation variable which is proxy of investors' fear of unexpected risk.

1.6 Research Hypotheses

Hypothesis 1: Impact of changing in interest rate difference on changing on spot exchange rate is not equal to 1 which implied the exchange rate between two countries do not significantly offset the interest rate difference of those countries. This proves the violation of UIP which creates room for currency carry trade. There are many empirical results not only show that UIP is not hold over time but also improve currency carry trade return such Froot(1990), C. Burnside et. al. (2007)and R. Clarida et. al.(2009). They represented negative impact of changing in interest rate difference on changing in spot exchange rate which boost currency carry trade return by appreciation

of high yield currency against low yield currency. They found coefficient roughly equal to -0.97 on average.

Hypothesis 2: There is a negative relationship between VIX Index (; Chicago Board Option Exchange's Market Volatility) and currency carry trade return. VIX Index refers to investors's risk aversion (Whaley, 2000) when VIX increases. It results in the strong negative relationship between VIX index and stock market return (Sarwar, 2012) which implied to decreasing incentive to invest in risky investment. Since, Currency carry trade is risk involve investment strategy(Craig Burnside, 2008). Increasing in VIX index makes investors afraid to do currency carry trade as well, so capital inflow of high yield currency will fall. As the result, depreciation in high yield currency which decreases currency carry trade return.

Hypothesis 3: There is a positive relationship between yield curve level factor and currency carry trade return since yield curve level factor (Richard Clarida and Niel Pedersen, 2009) refers to the permanent increase of interest rate, relatively between high and low interest rate countries. Therefore, when interest rate, which is a part of currency carry trade return, spread of between 2 countries permanently increase currency carry trade return should increase as well. There is empirical evidence from John Y. Campbell (1987) which show that term structure (yield curve level factor) has explanatory power on excess return from currency investment.

Hypothesis 4: There is a negative relationship between yield curve slope factor and currency carry trade return. According to John Y. Campbell(1987), excess return from currency investment could be explained another term structure which is yield curve slope factor as well. Moreover, the negative relationship of yield curve slope factor and currency carry trade is also represented in following work by R. Clarida(2009). Since, yield curve slope factor refers to increase in expected future inflation in high

interest rate currency relatively to low interest rate currency. Thus, inflation causes the depreciation in that currency, so inflation in high interest rate currency will deduct currency carry trade return because change in exchange rate is one part of currency carry trade return.

Hypothesis 5: There is a negative relationship between lagged unexpected volatility and currency carry trade return. We define lagged unexpected volatility as investors' fear of unexpected risk (; investors' degree of risk aversion) which is spread between actual volatility and estimated volatility from AR(1) model. Currency carry trade return will decrease when exchange rate volatility is raised due to decreasing in demand of currency carry trade as well as increasing in unexpected risk also reduces return on currency carry trade. Since, lagged unexpected volatility is implied as investors' degree of risk aversion, so increasing in lagged unexpected volatility makes investors more willing to stay away from risk involved investment(Charles A. Holt, 2002). Demand for doing currency carry trade strategy will drop while lagged unexpected volatility rise. As demand of currency carry trade drops this implied decreasing in capital inflow to high yield currency as well. Therefore, high yield currency is depreciated which reduces currency carry trade return.

AR (1):
$$FX\,Vol_t = \alpha + \beta FX\,Vol_{t-1} + \varepsilon_t \qquad (1)$$

$$UnVol_{t-1} = FX\,Vol_{t-1} - FX\,Vol_{t-1}^{estimate} \qquad (2)$$

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

Currency carry trade is the strategy which gains the benefit from currency speculation. This strategy occurs when there is difference in interest rate between countries. Therefore, profit of currency carry trade comes from borrowing money from a country which has low interest rate (funding currency) and brings this money to invest in a high interest rate country (investment or targeting currency). This is similar to Long-Short Investment Strategy. For simplicity, when domestic interest rate is relatively low to foreign country, we borrow money in domestic (short position in domestic currency) and convert to invest in foreign country (long position in foreign currency) and receive the interest rate difference.

There is a theoretical model called Uncovered Interest Rate Parity (UIP) (Fama, 1984)which claims that the adjustment of spot exchange rate between 2 countries will perfectly offset the difference of interest rate between them. In UIP world, impact of changing in interest rate difference on changing in spot exchange rate will equal to 1 which means there is no impossible way to capture benefit from interest rate difference. In reality, there are some empirical studies that argue that UIP does not hold. Since, they found negative impact of changing in interest rate difference on changing in spot exchange rate; roughly equal to -0.97 on average (e.g. Froot(1990), Kraay(2003), C. Burnside(2007), R. Clarida et. al.(2009)). The result from these empirical studies imply that currency carry trade strategy is able to create profit because interest rate difference does not perfectly offset by change in spot exchange rate.

By the way, currency carry trade is profitable for a long time, some papers suggest that currency carry trade is a risk involve investment which takes time-varying

risk ((Craig Burnside, 2007),(Charlotte Christiansen, 2011)). Furthermore, C. Burnside (2011a) concluded that currency carry trade profitability is not just compensation of risk after they figured out the non-statically significant covariance between the payoffs to currency carry trade strategy and conventional risk factor and suggested the alternative explanation of currency carry trade profitability. The profitability of currency carry trade is relied on foreign exchange markets' price pressure. As they defined price pressure as demand of transaction, the profitability would be driven by willingness to transact in this strategy until average payoffs are zero. This alternative is make sense because increasing in number of transaction on currency carry trade will cause the appreciation in high yield currency and boost up return of this strategy and vice versa. Since, change in spot exchange rate is one component of currency carry trade return.

Return of currency carry trade consists of 2 parts which are interest rate difference and change in spot exchange rate. When currency carry trade is applied, investors are locking in the interest rate in 2 countries. Therefore, the risk that currency carry trade return mostly depends on is exchange rate volatility, since the depreciation of high interest rate currency can directly offset the return from interest rate difference. In a word, this currency excess return is a compensation of volatility risk. Moreover, there are countless studies which investigated the effect of exchange rate volatility on currency carry trade return. According to previous studies (e.g. G. Galti et. al.(2007), V. Bhansali et. al.(2007), R. Clarida et. al.(2009), Stephanie C. et.al. (2011)and L. Menkhoff et. al.(2012)), they found currency carry trade return is very attractive while market is less volatile and currency carry trade return immediately gone when market becomes turmoil. The negative relationship between currency carry trade return have been consistently reconfirmed through many researches in latest decade. One possible reason suggested and proofed by R. Clarida (2009) is the spot exchange rate of high interest rate country tends to appreciate relatively to low interest rate country while

exchange rate volatility is low which enhances currency carry trade return but when exchange rate volatility is high result turns to opposite side. Low interest rate currency is going to appreciate against high yield currency, this causes currency carry trade yields negative return while market is more volatile. This relationship was reconfirmed by regime separation model. C. Christiansen et. al. (2011)and L. Menkhoff et. al. (2012)conducted the regime switching model and also found negative relationship between currency carry trade return and exchange rate volatility as well.

R. Clarida et. al. (2009)found that currency carry trade portfolios have the benefit of diversification while adding more currency into portfolio. This implementation is consistent with studies from C. Burnside(2007),(2008) which states that the Sharpe's ratio of currency carry trade portfolio can explain characteristic of currency carry trade which is a risky investment; when add more pair of currency into currency carry trade portfolio, Sharpe's ratio of portfolio is increased. However, there is benefit diversification for this investment strategy but there is concern about the PESO problem, since currency carry trade's payoff has low mean and exhibit as fat-tail (2011b) . Furthermore, the following work by C. Burnside et. al. (2011b)cracked the concerning about PESO problem on currency carry trade. They investigated the payoff of normal currency carry trade and payoff of currency carry trade which hedged the huge downside loss (PESO problem) by option and found non-different payoff between these two currency carry trade portfolios. As the result they found, they claimed that PESO problem cannot account for major portion of large excess return from currency carry trade. Moreover, currency carry trade can be applied with leverage, the leverage not only dramatically increases profit but also increases downside risk, and level of leverage depends on market inefficiency(Darvas, 2009).

There are opportunities to obtain arbitrage profit from currency carry trade through the forex option and carry market(Bhansali, 2007). According to market

volatility, currency carry trade yield less return when volatility of market is high but forex option price is cheap while volatility is high. This implies better payoff for currency carry trade with hedging by forex option.

According to John Y. Campbell(1987), they are the first paper that conducted the joint determination of currency carry trade return and term spread premium (yield curve slope and yield curve level). They found the negative and positive correlation to yield curve slope and yield curve level respectively. Moreover, this model was developed by R. Clarida et. al. (2009)who used the VIX Index (; Chicago Board Option Exchange Volatility Index), which is a proxy of global investors' risk aversion, to explain the currency carry trade return. The study found the consistent result with the previous work and negative correlation of VIX Index to currency carry trade return. Actually, VIX index is widely known as investors' fear gauge from the empirical study from Whelay (2000) which shown the strong negative relationship between VIX index and U.S. stock market return. Furthermore, study by Berge, Jorda and Taylor (2010) documented that the forward yield curve affects currency carry trade return partly which consistent with John Y. Campbell (1987) in the aspect of impact from macroeconomic factors on currency carry trade. As same as, Refet S. Gurkaynak et. al. (2005)who found the evidence of effects of macroeconomics and monetary policy on the term structure of interest rate. The impact from policy temporary affect to interest rate and interest rate will move to the equilibrium in short-term. These could be concluded that macro factor and monetary policy affect currency carry trade through interest rate.

There is one puzzle of currencies' features which is the dramatically change in exchange rate without fundamental news (e.g. the huge appreciation of JPY against USD in 1998). This puzzle leads the broader notice that immediate changing on asset price cannot be explained by fundamental news (David M. cutler et. al.(1989), Ray C. Fair(2002)). According to another finding by Daron Acemonglu (2008) documents that

currency carry trade strategy is related currency crash risk because the suddenly moving of exchange rate without fundamental news cause by unwinding of currency carry trade when speculators face funding constraints. Moreover, loss in currency carry trade causes increasing in price of crash risk, decreasing in demand of doing currency carry trade which reduce speculators' position in investment currency and reducing probability of crash risk respectively. Furthermore, currency crash after currency bubble which can be emerged when investor hold their position in investment currency too long because he does not realize that other investors already unwind their position, can be the correction of price(Dilip Abreu, 2003).

The currency crash causes the dramatically change in exchange rate which can be harmed export dependent countries. Therefore, currency carry trade is going to be concerned by central bank. Central bank will face the question that what is the appropriate exchange rate policy which can stabilize domestic economy. The flexible exchange rate policy will cause the domestic shock to economy through exportation sector. In the other hands, fix exchange rate policy will increasing number of currency carry trade due to small exchange rate volatility, so foreign shock will hit the economy. There is suggestion from Laura Alfaro et. al. (2013)which mentions "pseudo flexible" exchange rate regime. Pseudo flexible exchange rate regime is applied flexible change rate policy together with issuing local and foreign currency bond in international bond market. Since, issuing local and foreign currency bond will stabilize capital inflow in local currency, thus impact from currency speculate will move to bond market rather than FX market. Another benefit is that, pseudo flexible exchange rate regime partially emulates fixed exchange rate regime without any intervention from central bank, moreover it smooths the consumption through debt services and reserve accumulation conjunction with domestic debt.

2.2 Review of Relevant Theory and Model

2.2.1 Uncovered Interest Rate Parity (UIP) and Currency Carry Trade
Strategy

Uncovered Interest Rate Parity claims that the depreciation of foreign currency
is subject to the interest rate difference of both countries;

$$\Delta s_{t+1} = i_t^f - i_t^d \qquad (3)$$

Where, $\quad \Delta s_{t+1} \quad$ is log of nominal spot exchange rate in a unit of foreign
currency per domestic currency.

$\quad i_t^f \quad$ is log of foreign interest rate.

$\quad i_t^d \quad$ is log of domestic interest rate.

Depreciation of foreign currency always perfectly offsets the difference of
interest rate in UIP's world but UIP does not hold in real world according to many
literatures (e.g. Sachsida et. al.(2001) and R. Clarida et. al.(2009)). Therefore, there is
room to capture the benefit with currency carry trade strategy. Return of currency carry
trade strategy can be written in the difference form between interest rate differential
and depreciation of foreign currency as below;

$$r_{t+1} = (i_t^f - i_t^d) - \Delta s_{t+1} \qquad (4)$$

2.2.2 Foreign Exchange Market Risk Factor and Currency Carry Trade's
Coskewness

Covariance between return and market benchmark volatility called coskewness
(Lukas Menkhoff, 2012) implies the movement between return and market volatility.

$$coskew = \frac{E[(r_k - \mu_k)(r_m - \mu_m)^2]}{\sigma(r_k)\sigma^2(r_m)} \qquad (5)$$

Where, $\quad r_k \quad$ is portfolio k's return.

r_k is return on market benchmark.

μ is mean return.

σ is standard deviation.

Since many evidences show that return from currency carry trade unwinds when market volatility increases, then coskewness between currency carry trade return and market volatility is expected to be negative.

2.2.3 Forward Premium and Interest Rate Differential

According to Fama(1984), the forward exchange rate is the summation of expected spot exchange rate in the future and premium.

$$f_t = E(s_{t+1}) + P_t \tag{6}$$

Where, $f_t = \ln(F_t)$; F_t is forward exchange rate.

                       $s_t = \ln(S_t)$; S_t is spot exchange rate.

From (4); difference between forward re and current spot rate is

$$f_t - s_t = P_t + E(s_{t+1} - s_t) \tag{7}$$

There are two regressions which have significantly non-zero coefficient (β_1,β_2);

$$f_t - s_{t+1} = \alpha_1 + \beta_1(f_t - s_t) + \varepsilon_{1,t+1} \tag{8}$$

$$s_{t+1} - s_t = \alpha_2 + \beta_2(f_t - s_t) + \varepsilon_{2,t+1} \tag{9}$$

According to (7), we can estimate s_{t+1} from the regression, since change in spot rate (s_{t+1} - s_t) is predictable by using forward and spot rate differential (f_t – s_t). Thus, we can plug in future spot rate into (4);

$$f_t - s_{t+1} = P_t + E(s_{t+1}) - s_{t+1} \tag{10}$$

The paper assumes that the expected future spot rate ($E(s_{t+1})$) in the forward rate is rational, thus β_1, β_2 are equal to;

$$\beta_1 = \frac{cov(f_t - s_{t+1}, f_t - s_t)}{\sigma^2(f_t - s_t)} = \frac{\sigma^2(P_t) + cov(P_t, E(s_{t+1} - s_t))}{\sigma^2(P_t) + \sigma^2\big(E(s_{t+1} - s_t)\big) + 2cov(P_t, E(s_{t+1} - s_t))} \tag{11}$$

$$\beta_2 = \frac{cov(s_{t+1} - s_{t+1}, f_t - s_t)}{\sigma^2(f_t - s_t)} = \frac{\sigma^2(E(s_{t+1} - s_t) + cov(P_t, E(s_{t+1} - s_t))}{\sigma^2(P_t) + \sigma^2\big(E(s_{t+1} - s_t)\big) + 2cov(P_t, E(s_{t+1} - s_t))} \tag{12}$$

If there is no correlation between P_t and $E(s_{t+1} - s_t)$, variance of forward differential will be separated into two parts by β_1 and β_2 which are premium (P_t)'s variance and expected change in spot rate's variance but that case does not exist in real world.

If we sum up equation (6) and (7), sum of intercept ($\alpha_1 + \alpha_2$) and sum of coefficient ($\beta_1 + \beta_2$) must be zero and one respectively. Value of the coefficient β_2 is usually found to deviate from 1 because of forward rate's time varying risk premium.

Interest Rate Parity;
$$\left.F_t^{ij}\middle/S_t^{ij}\right. = \left.(1 + R_{it})\middle/(1 + R_{jt})\right. \tag{13}$$

Where, F^{ij}_t and S^{ij}_t are forward and spot rate at time t in a unit of currency i per currency j. R_{it} and R_{jt} are nominal interest rate on bond i and j at time t with no default risk and have same maturity as F^{ij}_t. Next, taking natural log into equation above then;

$$f_t^{ij} - s_t^{ij} = r_{it} - r_{jt} \tag{14}$$

Assuming Fisher's effect and Purchasing Power Parity are hold, forward premium in (12) is explained by interest rate differential. Given V_{it} and V_{jt} are price level in 2 countries, $\Delta V_{i,t+1} = \ln(V_{i,t+1}/V_{i,t})$, $\Delta V_{j,t+1} = \ln(V_{j,t+1}/V_{j,t})$, $r_{i,t+1}$ and $r_{j,t+1}$ are real interest rate on nominal bond in country i and j respectively.

Replacing Fisher's effect into equation (12);

$$f_t^{ij} - s_t^{ij} = \big[E\big(r_{i,t+1} - E(\Delta V_{i,t+1})\big)\big] - \big[E\big(r_{j,t+1} - E(\Delta V_{j,t+1})\big)\big] \tag{15}$$

Simplify into;

$$f_t^{ij} - s_t^{ij} = \left[E\left(r_{i,t+1} - E(r_{j,t+1})\right)\right] + \left[E\left(lnV_{i,t+1} - E(lnV_{j,t+1})\right)\right] - \left[lnV_{i,t} - lnV_{j,t}\right] \tag{16}$$

Spot exchange rate under Purchasing Power Parity's condition is the ratio of price level between two countries ($S^{ij}_t = V_{i,t}/V_{j,t}$), therefore

$$f_t^{ij} = \left[E\left(r_{i,t+1} - E(r_{j,t+1})\right)\right] + \left[E\left(s_{t+1}^{ij}\right)\right] \tag{17}$$

Thus, we get f^{ij}_t in both (4) and (15), so equating them we get;

$$P_t = E\left(r_{i,t+1}\right) + E\left(r_{j,t+1}\right) \tag{18}$$

Therefore, the difference between expected real return on bond of two countries is determined by the premium on forward rate.

2.2.4 Factor Model

Factor model is one of the risk and return model that writes the expected return of the risk involved investment in aspect of risk premium. The assumption of factor model given the investment's return is explained by the random variable called factors;

$$r = \alpha + \sum_{i=1}^{k} \beta_i f_i + \varepsilon \tag{19}$$

Where,   r   is the return of investment.

                f$_i$ is the factor i which determine investment's return.

                ε   is error term which has zero mean.

Currency carry trade return is explained by the volatility risk factor in many previous researches. Burnside et. al. (2008)found that the currency carry trade return is correlated with risk factors, R. Clarida et. al.(2009) used the bond yield and VIX index to determine the return of currency carry trade. Menkhoff et. al.(2012), the most recent study, also tries to confirm that currency carry trade is a risk involved strategy by using

the innovation of FX volatility which is unexpected risk in the market as the factor of currency carry trade return.

CHAPTER 3
DATA

3.1 Data

Currency carry trade is a strategy that deals with pair or group of currencies which have difference interest rate by taking short position in low interest rate currency and taking long position in high interest rate currency. Therefore, the return from this strategy only consists of 2 major components which are cost of short position and benefit of long position. We employ spot exchange rate against US dollar and 3-months forward implied interest rate of 17 currencies, which is 9 currencies from G10 group. They include Australia (AUDUSD), Canada (USDCAD), Euro Zone (EURUSD), Japan (USDJPY), New Zealand (NZDUSD), Norway (USDNOK), Sweden (USDSEK), Switzerland (USDCHF), and United Kingdom (GBPUSD). For 8 emerging countries, there are Brazil (USDBRL), Hongkong (USDHKD), India (USDINR), Singapore (USDSGD), South Africa (USDZAR), South Korea (USDKRW), Taiwan (USDTWD) and Thailand (USDTHB). The data is from daily Bloomberg data during January 2001 – October 2017 to compute currency carry trade return. Next, we employ 2-years, 5-years, 7-years and 10-years treasury yield to compute yield curve level and yield curve slope of countries we are interested in from daily Bloomberg data as well.

3.1.1 Data's source and used to generate variables

Variable	Data used to generate variable	Source
Currency carry trade return	- Daily spot exchange rate (in unit of USD per interested currency) - 3-months implied forward yield	Bloomberg and computed by author

Exchange rate volatility	- Daily spot exchange rate (in unit of USD per interested currency)	Bloomberg and computed by author
VIX Index	- Observe data from Bloomberg	Bloomberg
Yield curve level	- 5-years, 7-years, 10-years treasury rate of interested countries	Bloomberg and computed by author
Yield curve slope	- 2-years and 10-years treasury rate of interested countries	Bloomberg and compute by author
Lagged Unexpected volatility	- Exchange rate volatility	Computed by author

3.1.2 Data descriptive

The statistically summary of spot exchange rate and forward implied yield including minimum, maximum, mean, median and standard deviation of monthly data samples used in this study. Table1, Table 2, Table 3 and Table 4 respectively represent basic statistical descriptive of G10 spot exchange rate, Emerging market spot exchange rate, G10 forward implied yield and Emerging market forward implied yield.

The movement of spot exchange rate of G10 countries seem to move in the same pattern through period which is observe in this paper. There is depreciation against USD after financial crisis in 2008 for some currencies (e.g. GBPUSD, EURUSD, NZDUSD and AUDUSD). Most of spot exchange rate's standard deviation lied between 11.71% - 19.55% except JPYUSD, NZDUSD and SEKUSD which have lower level of standard deviation, according to Table 1.

Figure 1: G10 spot exchange rate against USD
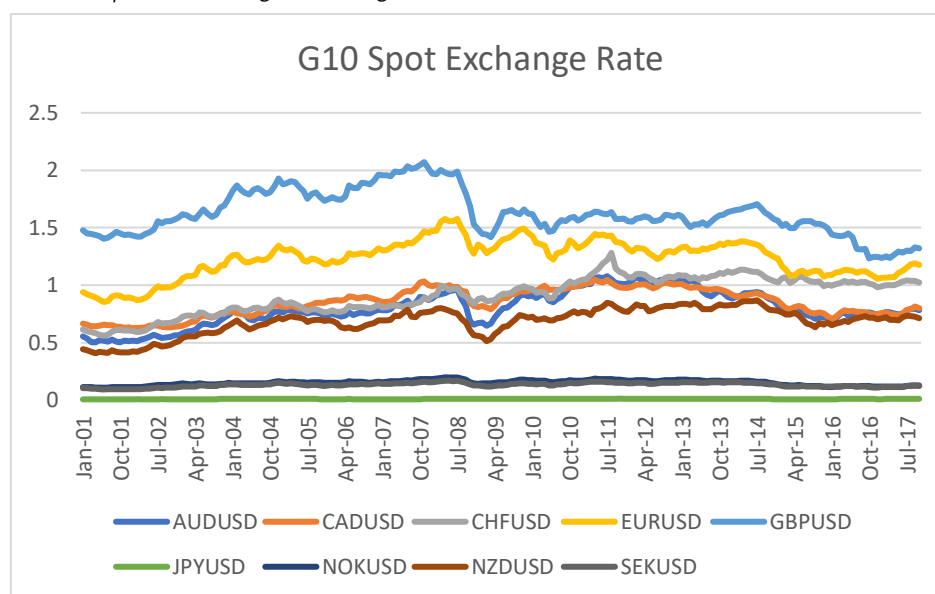
Table 1: Basic statistical descriptive of G10 spot exchange rate

	Count	Mean	S.D.	Min	Max	Median
AUDUSD	202	0.79865	15.13%	0.50253	1.07804	0.77312
CADUSD	202	0.84794	12.18%	0.62538	1.04626	0.85241
CHFUSD	202	0.90945	16.10%	0.56053	1.28074	0.93454
EURUSD	202	1.23362	16.32%	0.85368	1.57646	1.26829
GBPUSD	202	1.62722	19.55%	1.23309	2.07086	1.59565
JPYUSD	202	0.00962	0.14%	0.00749	0.01304	0.00918
NOKUSD	202	0.15085	2.32%	0.10764	0.19783	0.15476
NZDUSD	202	0.68544	11.71%	0.40760	0.86904	0.70379
SEKUSD	202	0.13291	1.84%	0.09268	0.16812	0.13488

The spot exchange rate of emerging market looked no similar pattern with each other through our sample period. There is small volatility in spot exchange rate of emerging market compares to G10, since standard deviation of most currencies are lied between 0.01% - 2.85%, according to Table 2. Manage float or intermediate exchange rate regime is popular choice for emerging market countries (Jeannine Bailliu, 2003) could be possible explanation for this finding. The massive drop in USDARS is

the result from ending of fixed exchange rate regime in Argentina after Argentina great depression in 2002(Alan B. Cibils, 2002).

Figure 2: Emerging Market spot exchange rate against USD
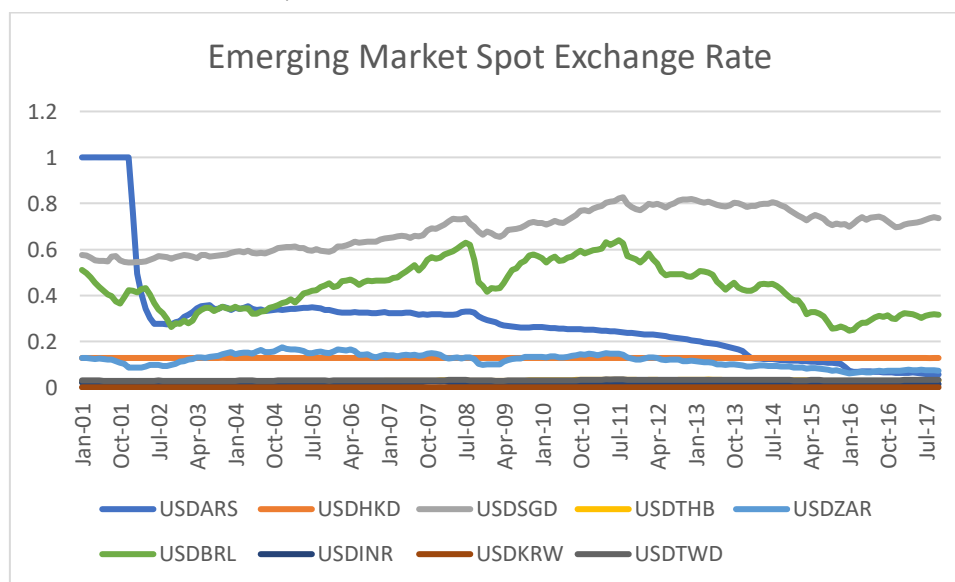
Table 2: Basic statistical descriptive of Emerging market spot exchange rate

	Count	Mean	S.D.	Min	Max	Median
ARSUSD	202	0.28878	20.63%	0.05743	1.00046	0.26688
HKDUSD	202	0.12861	0.03%	0.12786	0.12918	0.12865
SGDUSD	202	0.68588	8.61%	0.54364	0.82708	0.70469
THBUSD	202	0.02828	0.34%	0.02192	0.03439	0.02880
ZARUSD	202	0.11861	2.85%	0.06120	0.17462	0.12473
BRLUSD	202	0.43551	10.33%	0.24689	0.64015	0.43679
INRUSD	202	0.02002	0.30%	0.01466	0.02540	0.02094
KRWUSD	202	0.00090	0.01%	0.00069	0.00109	0.00088
TWDUSD	202	0.03136	0.17%	0.02856	0.03481	0.03106

The forward implied yield of G10 group mostly move in the same direction except the Japanese forward implied yield. For Japanese forward implied yield, it always moves near zero through the time which observed in this paper and has smallest volatility, according to Table 3. There is the immediately and huge drop in

most countries forward implied yield nearly 50% after the burst of financial crisis in 2008. Furthermore, after crisis forward implied yield in G10's pattern is changed into downward trend.

Figure 3: G10 3-months forward implied yield
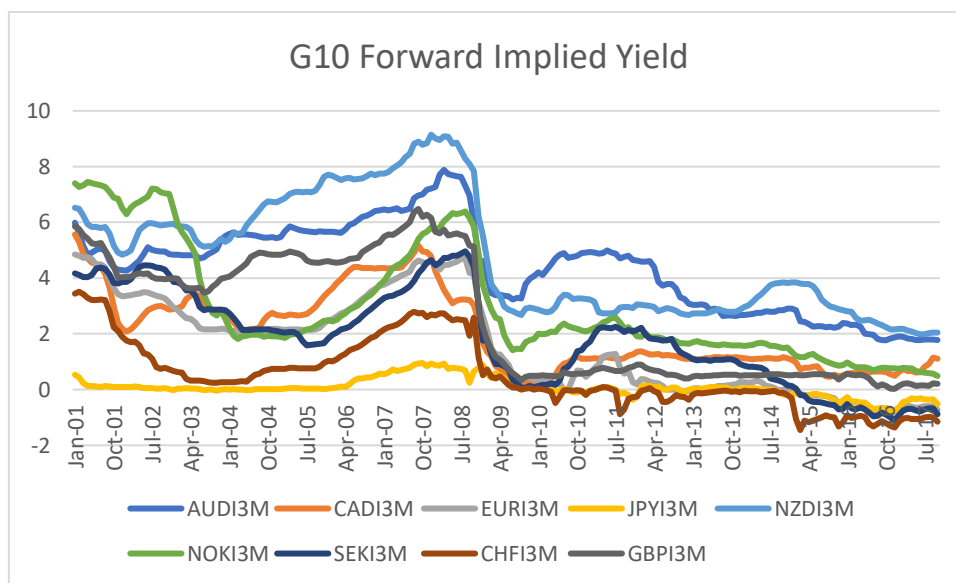
Table 3: Basic statistical descriptive of G10 forward implied yield

	Count	Mean (%)	S.D. (%)	Min (%)	Max (%)	Median (%)
AUDI3M	202	4.390	158.3	1.768	7.881	4.718
CADI3M	202	2.080	141.8	0.240	5.565	1.269
EURI3M	202	1.607	174.3	-0.894	4.846	1.260
JPYI3M	202	0.068	34.8	-0.797	0.951	0.036
NZDI3M	202	4.772	214.8	1.981	9.145	3.826
NOKI3M	202	2.952	205.1	0.488	7.448	2.085
SEKI3M	202	1.842	170.6	-1.125	4.959	1.905
CHFI3M	202	0.501	123.6	-1.453	3.507	0.211
GBPI3M	202	2.533	218.8	0.024	6.478	0.905
US0003M	202	1.767	174.1	0.226	5.698	1.135

There is no common pattern for forward implied yield of emerging market like G10. According to Figure 4, for precise determination Argentine's forward implied yield is not included due to the huge difference in value. As the result in Table 4, average forward implied yield of Argentina is 3 times bigger than the first runner-up. The forward implied yield mostly lied between 2.8% - 8.22% and the smallest group is roughly lied around 1%.

Figure 4: Emerging market 3-months forward implied yield
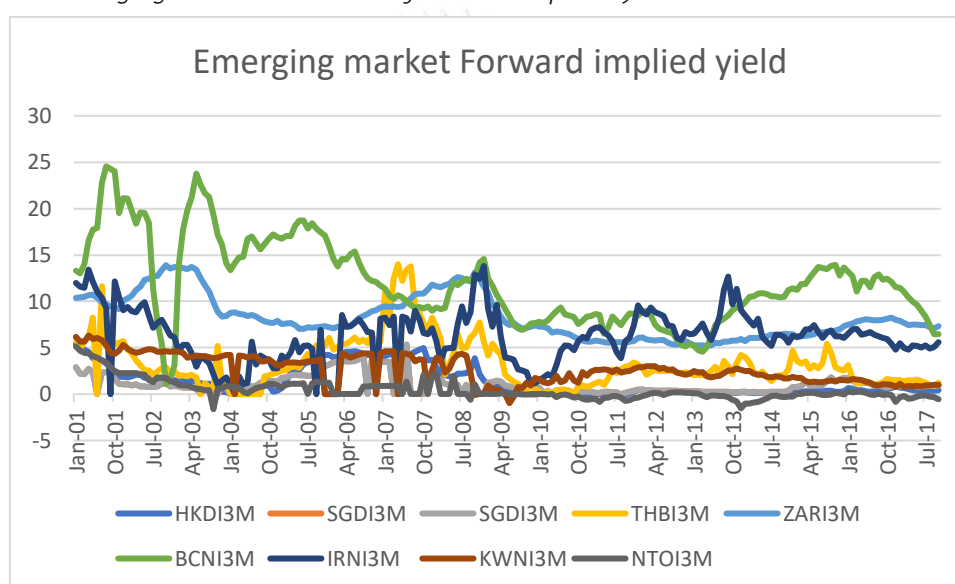
Table 4: Basic statistical descriptive of Emerging market forward implied yield

	Count	Mean (%)	S.D. (%)	Min (%)	Max (%)	Median (%)
APNI3M	202	31.230	4814.5	2.194	395.989	18.237
HKDI3M	202	1.372	157.3	-0.123	5.379	0.451
SGDI3M	202	1.146	99.9	-0.016	5.339	0.848
THBI3M	202	3.509	265.7	0.268	13.993	2.665
ZARI3M	202	8.228	234.4	5.198	13.890	7.528
BCNI3M	202	11.982	461.2	1.064	24.544	11.302
IRNI3M	202	6.454	260.2	0.994	13.806	6.390
KWNI3M	202	2.807	148.3	-0.974	6.319	2.621
NTOI3M	202	0.509	115.9	-1.623	5.135	0.103

3.2 Measurement

3.2.1 Currency Carry Trade Return Measure

Currency carry trade return measure by long position return minus short position cost, since currency carry trade have to borrow low yield currency and lending or investing high yield currency. The measurement accords with the formula below.

Carry trade return: Carry trade return   =   Long return - Short cost

$$(r_t) \qquad\qquad (long_t) \qquad (short_t)$$

$$r_t = \left[\sum_{k=1}^{n} w_k \left[1 + \frac{i_{k,t}}{(100 \times 12)} \times \frac{s_{k,t}}{s_{k,t-1}}\right] - 1\right]_{long} - \left[\sum_{k=1}^{n} w_k \left[1 + \frac{i_{k,t}}{(100 \times 12)} \times \frac{s_{k,t}}{s_{k,t-1}}\right] - 1\right]_{short} \quad (20)$$

Where, r_t is monthly carry trade return in time t.

w_k is weight of currency k in portfolio.

$i_{k,t}$ is 3-months deposit rate of currency k in time t.

$s_{k,t}$ is spot exchange rate against USD in time t.

3.2.2 Exchange Rate Volatility Measure

Exchange rate volatility measured by the average change of all available currencies in sample set. This paper uses absolute change in spot exchange rather than square because minimize the impact from outliner in emerging market.

Given: $$|R_i^k| = |\Delta s_i| \qquad\qquad (21)$$

$$\sigma_t^{FX} = \frac{1}{T_t} \sum_{i=1}^{T} \left[\sum_{k=1}^{K} \frac{|R_i^k|}{K}\right] \qquad\qquad (22)$$

Where, s_i is spot exchange rate in day i

T_t is total number of trading days in month t.

K is the number of available currencies in day i.

3.2.3 VIX Index Measure

VIX Index (Chicago Board Option Exchange Volatility Index) is known as investors' fear gauge(Whaley, 2000). VIX Index measured by the stock market's expectation on volatility over next 360 days on S&P index. In this paper we obtain VIX index from Bloomberg data base.

$$VIX = 100\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2 \tag{23}$$

Where;   T   is time to expiration.

                F   is forward index level desired from index option prices.

                K_0 is first strike price below the forward index level, F.

                K_i is strike price of ith out-of-money option; a call if $K_i > K_0$; and a put if $K_i < K_0$; both put and call if $K_i = K_0$.

                ΔK_i is interval between strike prices – half the difference between the strike on either side of K_i:

$$\Delta K_i = \frac{K_{t+1} - K_{t-1}}{2}.$$

                R   is risk-free rate to expiration.

                $Q(K_i)$ is the midpoint of the bid-ask spread for each option with strike K_i.

3.2.4 Yield Curve Level Factor Measure

Yield curve level factor is proxy of permanent movement of interest rate between countries computed by:

$$Y_{L,t} = \Delta yield^{High}_{avg(level),t} / \Delta yield^{Low}_{avg(level),t} \tag{24}$$

Where; $\Delta yield^i_{avg(level),t}$ is change in average yield level (; yield curve level is average from 5-years, 7-years and 10-years treasury bill rate) in i group of countries in time t.

3.2.5 Yield Curve Slope Factor Measure

Yield curve slope factor is proxy of business cycle between countries which computed by:

$$Y_{S,t} = yield^{High}_{avg(slope),t}/yield^{Low}_{avg(slope),t} \tag{25}$$

Where; $yield^i_{avg(slope),t}$ is average yield curve slope (; yield curve slope is difference between 10-years and 2-years treasury bill rate) in i group of countries in time t.

3.2.6 Lagged Unexpected Volatility Measure

Lagged unexpected volatility is proxy of investors' fear of unexpected risk computed from unpredicted error of previous period. The calculation of lagged unexpected volatility starts with estimation of exchange rate volatility by AR (1) and find difference from actual exchange rate volatility and exchange rate volatility which is estimated from AR (1) model.

AR (1): $$FX\,Vol_t = \alpha + \beta FX\,Vol_{t-1} + \varepsilon_t \tag{26}$$

$$UnVol_{t-1} = FX\,Vol_{t-1} - FX\,Vol^{estimate}_{t-1} \tag{27}$$

Where, $FX\,Vol_t$ is exchange rate volatility in period t.

$UnVol_{t-1}$ is lagged unexpected volatility.

CHAPTER 4

METHODOLOGY

There are 3 major steps to answer the objective. Firstly, we test the violation of UIP to figure out the existing currency carry trade strategy by testing violation of UIP(Fama, 1984). Secondly, we show the relationship between exchange rate volatility and currency carry trade return in some aspects. In this step, we follow methodologies from R. Clarida et. al. (2009)and L. Menkhoff et. al.,(2012). Finally, we run a factor model regression which we set currency carry trade to be a dependent variable and explain by risk factors. Factors in this model are yield curve term spread, VIX index and lagged exchange rate volatility which respectively employed from John Y. Campbell(1987), R. Clarida et. al. (2009)and the last regressor is contributed in by author. For all steps, we always investigate the difference in result of 3 sample sets (G10, Emerging countries, G10 + Emerging countries).

4.1 The Test of Opportunity to do Currency Carry Trade

In this methodology, we try to proof whether currency carry trade is possible to do or not through sample sets that we are interested in. Therefore, this paper employs Fama (1984) Uncovered Interest Rate Parity to test with spot exchange rate against USD and 3-months forward implied yield data. If UIP does not hold, there is a reason for doing currency carry trade strategy. Since, the adjustment from spot exchange rate does not perfectly offset benefit from interest rate difference.

$$\Delta s_{t+1} = \alpha + \beta(i_t^H - i_t^L) + \varepsilon_t \tag{28}$$

Where, $\Delta s^{H/L}$ is spot exchange rate of high yield currency against low yield currency.

i^H is interest rate of high yield currency.

i^L is interest rate of low yield currency.

We run UIP model with full sample set. Fama UIP will hold when beta estimated is significantly equal to 1 which has no room for currency carry trade. Therefore, we can state the hypothesis;

$$H_0 \; : \; \beta = 1 \quad vs \quad H_1 \; : \; \beta \neq 1$$

β is the compensation of interest rate difference on the change in spot exchange rate. UIP is one equilibrium theory when $\beta = 1$ is implied equilibrium state of this theory. Therefore, $\beta < 1$ provides the opportunity to take great profit from currency carry trade, since the depreciation of spot exchange rate high yield currency is smaller than benefit from interest rate. On the other hand, $\beta > 1$ means depreciation of spot exchange rate high currency is bigger than benefit from interest rate difference which cause negative return for carry trade strategy. However, carry trade yield negative return in this case but investors still can hedge against this loss with put option in high yield currency spot exchange rate.

4.1.1. Currency Carry Trade Portfolio's Return and Return Volatility

After we test the feasibility of currency carry trade, we employ daily data of 3-months forward implied yield and spot exchange rate to conduct currency carry trade portfolios which are equally weighted short and long basket of currencies in G10 and Emerging Countries (Daron Acemonglu). For example, 1v1 is pure currency carry trade portfolio which shorts the lowest interest rate currency and longs the highest interest rate currency. 2v2 is conducted with the same logic as 1v1 but shorts the two lowest interest rate currency and longs the two highest interest rate currency which all of the short long positions are weighted equally and so on. Portfolios are monthly rebalanced, conducting currency carry trade portfolio with 2 subsamples which are carrying only in G10, only in EM and full sample (G10 + EM). Compute annualized

return of currency carry trade portfolio and volatility of currency carry trade portfolio return by following formula.

Currency Carry Trade Return

Carry trade return: Carry trade return = Long return - Short cost

(r_t) $(long_t)$ $(short_t)$

$$r_t = \left[\sum_{k=1}^{n} w_k \left[1 + \frac{i_{k,t}}{(100 \times 12)} \times \frac{s_{k,t}}{s_{k,t-1}}\right] - 1\right]_{long} - \left[\sum_{k=1}^{n} w_k \left[1 + \frac{i_{k,t}}{(100 \times 12)} \times \frac{s_{k,t}}{s_{k,t-1}}\right] - 1\right]_{short} \quad (29)$$

Where; r_t is monthly carry trade return in time t.

w_k is weight of currency k in portfolio.

$i_{k,t}$ is 3-months deposit rate of currency k in time t.

$s_{k,t}$ is spot exchange rate against USD in time t.

Currency Carry Trade Cumulative Return Index

$$Index_t = Index_{t-1} \times (1 + Carry\ Return_t) \quad (30)$$

Where; $Index_0$ is equal to 100.

Annualized Return

$$Annualized\ return_t = \left[\frac{Index_t}{Index_{t-1}}\right]^{(1/Number\ of\ years)} \quad (31)$$

Where; Number of years = n/12; n is number of months since start to end date

Mean Return

$$r_{avg} = \frac{1}{N}\sum_{t=1}^{N} Annualized\ return_t \quad (32)$$

Return Volatility

$$\text{Vol} = \sqrt{\frac{1}{N-1}\sum_{t=1}^{N}(Annualized\ return_t - r_{avg})^2} \qquad (33)$$

Next, we summarize mean currency carry trade portfolio return, return volatility and m/v ratio of all portfolios with 3 sample sets. This is to analyze diversification of all portfolios among 3 groups of sample and compare m/v ratio of currency carry trade.

4.2. Effect of Exchange Rate Volatility on Currency Carry Trade Return

Currency carry trade return is consisted which the parts which are interest rate difference and depreciation of high yield currencies against low yield currencies. Moreover, this strategy locks into the interest rate at the period which transaction begin therefore the risk which is the most compensate on the currency carry trade return would be exchange rate risk. Because of that, exchange rate volatility which is proxy of exchange rate risk is going to impact the return of this strategy.

Step 1: In this part, this paper will start with the simplest way to analyze the relationship by compute correlation between currency carry trade return and exchange rate volatility (; FX volatility). According to previous work (e.g. G. Galti et. al.(2007), V. Bhansali et. al.(2007), R. Clarida et. al.(2009), Stephanie C. et.al. (2011)and L. Menkhoff et. al.(2012)), we expect to find <u>negative</u> correlation between currency carry trade return and FX volatility. This correlation implied relationship form exchange rate volatility to return of currency carry trade return. First of all, we compute FX volatility in monthly frequency which is proxy of exchange rate risk is computed from equation 34. Suppose absolute daily log return for each spot currency k on each day i $\left(|R_i^k| = |\Delta s_i|\right)$. This FX volatility is implied to global FX volatility in our sample set which is generated from;

FX volatility:

$$\sigma_t^{FX} = \frac{1}{T_t} \sum_{i=1}^{T} \left[\sum_{k=1}^{K} \frac{|R_i^k|}{K} \right] \tag{34}$$

Where, T_t is total number of trading days in month t.

K is the number of available currencies in day i.

Note: We use absolute returns to minimize the impact of outliner return, due to the added emerging market currencies into the sample set.

Step 2: Compute coskewness between portfolio and Dollar portfolio

In this step, we are willing to determine the relationship between currency carry trade return and exchange rate volatility in aspect of correlation and portfolio return market benchmark volatility by computing coskewness of currency carry trade return and FX market benchmark portfolio. According to L. Menkhoff et.al. (2012), we conduct the Dollar portfolio which equally longs all currency in our sample set and short USD. Given this portfolio to be the FX market benchmark portfolio, compute the coskewness between currency carry trade portfolio return and Dollar portfolio. We try to reconfirm that currency carry trade return is moving in the opposite direction with the market volatility. Therefore, we expect the coskewness between currency carry trade portfolio and Dollar portfolio to be <u>negative</u>. Since, the general idea of portfolio with high coskewness means that portfolio delivering high return when market volatility is high. coskewness is computed follow;

$$coskew = \frac{E[(r_k - \mu_k)(r_m - \mu_m)^2]}{\sigma(r_k)\sigma^2(r_m)} \tag{35}$$

Where; r_k is return on portfolio k.

μ_k is mean return on portfolio k.

r_m is market return.

μ_m is market mean return.

σ is standard deviation.

Step 3: To investigate the relationship between the exchange rate volatility and currency carry trade return more precisely, this paper divides data into 4 quartiles by FX volatility to determine the difference of currency carry trade return in different exchange rate volatility environment. So, we suppose the data below 25th percentile to be low volatility state and high volatility state starts at 75th percentile. Next, we do the summary portfolio return again with 2 subsamples and full sample but now we aim to figure out the difference of return in low and high volatility state.

Step 4: Estimate Threshold GARCH model

This paper investigates relationship between carry trade return and conditional return volatility, since conditional return volatility is dominated exchange rate volatility(Richard Clarida and Niel Pedersen, 2009). So, this paper uses Threshold GARCH model to investigate;

$$r_t = \alpha + \beta r_{t-1} + \theta h_t + u_t \qquad (36)$$

$$h_t = c + a|u_{t-1}|^2 + bh_{t-1} + d|u_{t-1}|^2 (D_{=0\ |u_{t-1}>0}^{=1\ |u_{t-1}<0}) \qquad (37)$$

Where, r_t is carry trade return.

h_t is conditional variance based on u_{t-1}

If θ of the conditional variance is a <u>negative</u> sign, there is the confirmation of carry trade return and exchange rate volatility.

Step 5: In this step, we are willing to figure out the consistency that the exchange rate of high interest rate currency will appreciate when the exchange rate volatility is high and depreciate when exchange rate volatility is low. So, we retest Uncovered Interest Rate Parity again with the 3v3 currency carry trade portfolio but we separate data into 2 states; high and low exchange rate volatility state.

$$\Delta s_{t+1} = \alpha + \beta(i_t^H - i_t^L) + \varepsilon_t \qquad (38)$$

Where, $\Delta s^{H/L}$ is log spot exchange rate of high yield currency against low yield currency.

                i^H is interest rate of high yield currency.

                i^L is interest rate of low yield currency.

We test with full sample and 2 subsamples (G10, Emerging countries and G10 + Emerging countries). We use average yield difference across 3v3 and equally weighted depreciation of high yield currency are replaced with yield difference and log spot exchange rate respectively. We are going to compare β between high and low state volatility. The empirical work by R. Clarida et. al. (2009)documented negative β in low exchange rate volatility environment and the value of β higher than 1 in high exchange rate volatility environment.

In addition: For β > 1   Investors will realize negative return from currency carry trade since the depreciation of high interest rate currency is bigger than yield rate difference. By the way, investors can prevent downside loss by using option to hedge against the appreciation in low interest rate currency.

For 0 < β < 1 Investors will realize positive return, since <u>interest rate</u> <u>difference is still bigger than the depreciation of high</u> <u>yield currency</u>.

For β < 0 <u>When β is less than zero, the high yield currency</u> <u>appreciates against low yield currency</u>. Therefore, investors will realize favorable positive return, due to interest rate difference and the appreciation of high yield currency.

4.3. Currency Carry Trade Return and Risk Factor Compensation

The assumption of the factor model is that the rate of return of an asset is given by factors which are a random variable. Therefore, we use factor model to explain the risk that compensates with currency carry trade return. The first 3 risk factors that we used follow John Y. Campbell (1987) and R. Clarida et al. (2009)which are VIX index, yield slope factor, yield level factor and the last risk factor is lagged unexpected exchange rate volatiltiy.

$$r_t = (i_t^H - i_t^L) + \beta_{VIX}VIX_t + \beta_LY_{L,t} + \beta_SY_{S,t} + \beta_v UnVol_{t-1} + \varepsilon_t \quad (39)$$

r_t is currency carry trade return which is calculated from 4.1.1. We set r_t as dependent variable in this model.

VIX_t is the Chicago Board Option Exchange Volatility Index, which measures the stock market's expectation on volatility over next 360 days S&P index. It is expected future volatility of S&P 500, a proxy of investors' risk aversion. We expect the coefficient of VIX to be <u>negative</u> with currency carry trade return because when the VIX goes up, it means investors are more afraid to invest in the risky investment (Whaley(2000) and Charles A. Holt(2002)). Therefore, the decreasing in willingness to do currency carry trade causes the falling in demand of high interest rate currency, which means relative

depreciation in high interest rate currency. So, this is the reason of decreasing in the in-position currency carry trade return.

$Y_{L,t}$ is yield curve level factor which is the spread of change in average yield in high yield currency country relative to low yield currency; average yield is defined from the 5-year, 7-year, 10-year treasury yield $Y_{L,t} = \Delta yield^{High}_{avg(level),t} / \Delta yield^{Low}_{avg(level),t}$. The yield slope factor is the proxy of permanent moves in interest rate (John Y. Campbell (1987) and R. Clarida et. al.(2009)). Currency carry trade return is going to increase when yield curve level factor increases. Since, there is increasing demand for high interest rate currency due to interest rate relatively increasing, we expect the coefficient of yield curve slope to be a positive sign.

$Y_{S,t}$ is yield curve slope factor which is the spread of change in slope in high yield currency country and low yield currency; slope is defined as 10-year minus 2-year yield $Y_{S,t} = yield^{High}_{avg(slope),t} / yield^{Low}_{avg(slope),t}$. Yield curve slope implies the business cycle (John Y. Campbell (1987) and R. Clarida et. al.(2009)). If yield curve slope is positive, investors will expect the future short-term interest rate to increase. If the slope increases, long term interest rate increases relative to short term interest rate, which results the increase in expected future inflation. Thus, it will result in an opposite way when slope decreases. Therefore, the wider the spread (increasing in yield curve slope factor) implies the higher inflation rate in high interest rate currency relative to low interest rate currency and relatively decrease in interest rate between high against low yield country. This implementation makes currency carry trade return drop. Because of that, we expected the negative coefficient for yield curve slope factor because of the relative depreciation of high interest rate currency by increase in inflation.

UnVol$_{t-1}$ is lagged unexpected volatility which is an unpredicted error of the FX volatility. We use UnVol$_{t-1}$ as the proxy of investors' fear of unexpected risk which is implied unpredicted error of volatility in previous period. We estimate the $FX\ Vol_t^{estimate}$ by running time-series regression of FX volatility as AR (1) and put the $\beta^{estimate}$ back into AR (1) equation. So, Unvol$_{t-1}$ is the difference between actual FX Vol$_{t-1}$ and estimated FX Vol$_{t-1}$.

AR (1):
$$FX\ Vol_t = \alpha + \beta FX\ Vol_{t-1} + \varepsilon_t \tag{40}$$

$$UnVol_{t-1} = FX\ Vol_{t-1} - FX\ Vol_{t-1}^{estimate} \tag{41}$$

Because of increasing in investors' risk aversion, investors are willing to avoid risky investment(Charles A. Holt, 2002). Therefore, we expect the coefficient of UnVol$_{t-1}$ to be <u>negative</u> to currency carry trade return. If investors fear to continuously invest currency carry trade, they tend to close the position that they made, causing the demand for low yield currency will rise relatively high yield currency. So, there is appreciation of low yield currency and it will reduce the profit from interest rate difference or currency carry trade which is in-position.

According to the violation of UIP, it means that only interest rate differential between two countries is not enough to capture the return of currency carry trade. Therefore, we employ model following R. Clarida et. al. (2009)and develop the innovation of FX volatility from L. Menkhoff et. al. (2012)to create the unpredicted error of previous period to explain the compensation of risk factor on currency carry trade return.

CHAPTER 5

EMPIRICAL RESULT

5.1 Testing Violation of Uncovered Interest Rate Parity (UIP)

We begin with the first objective of this paper which tries to examine the possibility of the currency carry trade strategy by finding the violation in the famous FAMA Uncovered Interest Rate Parity (UIP: $\Delta s_{t+1} = \alpha + \beta(i_t^H - i_t^L) + \varepsilon_t$). In this part, we suppose USD to be low yield currency and the rest in sample set as high yield currency and regress UIP equation with data of yield and exchange rate in G10 and emerging country.

After testing the hypothesis through our sample set, almost all of currencies in G10 have statically significant lower than 1 slope except Euro, New Zealand Dollar and Swedish Krona. Moreover, the result from testing equal to 1 slope null hypothesis there are all statically different from 1. According to this statistical evidence, it implies that currency carry trade can yield positive return by using these G10 currencies as targeting currency and funding by U.S. Dollar. As well as emerging market currencies, all of emerging market currencies are able to use as targeting currency and funding by U.S Dollar for currency carry trade strategy, since they are all significantly lower than 1 slope. For F-statistic, almost all currencies in emerging market can reject the equal to 1 null hypothesis except the slope of Singapore Dollar. Furthermore, there are some currencies got negative slope such as Canadian Dollar, Norwegian Krone, African Rand, Brazilian Real, Indian Rupee and South Korean Won. Because of that, these currencies are going to appreciate while the spread of interest rate between them and U.S. is wider. They provide higher profit for currency carry trade than the rest.

The result in this methodology shows the existing of violation of UIP, this finding is consistent with the previous empirical evidences from Froot(1990), Kraay(2003), C.

Burnside(2007), R. Clarida et. al.(2009). One possible explanation for UIP violation is

that, there is the intervention of central bank through the inflation targeting policy,

Table 5: Show the slope and constant of UIP regression and F-statistic test result for β = 1

UIP: $\Delta s_{t+1} = \alpha + \beta\left(i_t^i - i_t^{USD}\right) + \varepsilon_t$

Where; Δs_{t+1} is change in spot exchange rate in period t+1.

i^{USD}_t is interest rate of U.S. in period t.

i^i_t is interest of country i in period t.

β is the impact of changing in interest rate difference on changing in spot exchange rate.

Note; *** p<0.01, ** p<0.05, * p<0.1

Currency	Constant (α)	Slope (β)	F-Stat for β = 1
G10			
AUD	-0.395***	0.704***	8.41***
CAD	-0.167***	-0.222*	87.17***
EUR	0.202***	-0.105	84.34***
JPY	-4.570***	0.596***	64.64***
NZD	-0.364***	-0.104	66.84***
NOK	-1.889***	-0.120*	276.26***
SEK	-2.026***	0.0829	132.57***
CHF	-0.0640***	0.421***	25.66***
GBP	0.447***	0.524***	33.38***
Emerging Market			
HKD	-2.050***	0.0322***	38827.87***
SGD	-0.344***	0.931***	0.46
THB	-3.586***	0.106*	233.51***
ZAR	-1.963***	-0.375***	311.43***
BCN	-0.604***	-0.302***	710.38***
IRN	-3.784***	-0.355***	1450.78***
KWN	-6.993***	-0.302***	242.80***
NTO	-3.459***	0.0431*	1379.33***

which used to stabilize the value of currency(Engel, 2014). Since, Inflation is factor among many that combine to influence country's exchange rate(Investopedia, 2018). Moreover, negatively significant slope for those currencies can be the effect from capital injection in core G4 country which are major currency in G10. The capital injection causes the depreciation in G4 currency which implied the relative appreciation on emerging market currency and represented significantly negative slope in UIP. As a result, emerging market currencies are more preferred to use as targeting or investing currency(Frankel, 2008).

5.1.1 Currency Carry Trade Portfolio's Return and Volatility

After the first objective confirms the possibility of gaining profit from currency carry trade strategy, we conduct currency carry trade portfolios on 3 groups of samples (G10, Emerging country, G10 + Emerging country). Basic descriptive static of currency carry trade portfolio's return which includes average annualized monthly return, standard deviation, variance, min & max value and m/v ratio (mean return divided by volatility of return (; standard deviation)) is represented on Table 6.

According to Table 6, all currency carry trade portfolios yield positive mean return for every sample set and there is decreasing in mean return when add more pair of currency into portfolio. 1v1 portfolio has the highest mean return compares to another portfolio in the same sample set. Moreover, our finding is consistent with Frankel (2008) that currency carry trade will be more preferable when used emerging market currency as targeting currency and G10 as funding currency. This table shows that currency carry trade portfolio in blended group has the highest mean return among our 3 sample sets and the lowest mean return is portfolio in G10.

Table 6 Table 6: Basic descriptive static of currency carry trade portfolio's return

Portfolio		Mean	S.D.	Variance	m/v	Min	Max
G10	1v1	0.02751	0.19034	0.03623	0.14454	-1.05260	0.47343
	2v2	0.02468	0.16363	0.02678	0.15085	-0.95150	0.46890
	3v3	0.02101	0.12337	0.01423	0.17034	-0.66102	0.29397
	4v4	0.01680	0.10416	0.00953	0.16130	-0.58953	0.23811
Emerging Market	1v1	0.05092	0.21670	0.04696	0.23498	-0.61001	0.87719
	2v2	0.04311	0.15741	0.02478	0.27388	-0.31447	0.59367
	3v3	0.02857	0.11924	0.01422	0.23959	-0.40421	0.41660
	4v4	0.02386	0.09373	0.00879	0.25456	-0.31013	0.32866
Blended group	1v1	0.05304	0.23021	0.05300	0.23040	-0.63098	0.78438
	2v2	0.04514	0.16651	0.02773	0.27110	-0.45247	0.60807
	3v3	0.03140	0.14616	0.02136	0.21482	-0.61129	0.43766
	4v4	0.03446	0.12831	0.01646	0.26857	-0.56016	0.35639

***(Note: Return are in unit of percentage annualized monthly return)

Currency carry trade of these 3 sample sets have common characteristic about return volatility or standard deviation which can reduce volatility by including more pair currency into portfolio. We can rank currency carry trade portfolio accord with volatility (standard deviation) and we found currency carry trade portfolio with Emerging market data as the most volatile and currency carry trade portfolio with G10 data is the most less volatile.

According to the decreasing in mean return and volatility while adding more pair currency into portfolio, this paper tries to investigate diversification effect and find optimal portfolio by m/v ratio. The characteristic of m/v ratio is similar to Sharpe's ratio in aspect of figure out optimal portfolio but accord with data in Table 6, we cannot conclude that which portfolio is optimal in each sample set. Because m/v ratio of portfolio in this paper cannot give precise conclusion. For instance, m/v ratio of

portfolio in emerging market and blended group does not consistently increase while more currencies are included into portfolio. According to Markowitz(1952), m/v ratio should increase until reach the peak then continuously drop and portfolio which has highest m/v ratio is the optimal portfolio. Therefore, this paper cannot conclude which portfolio is the best but we still can detect the diversification effect by standard deviation. Decreasing in standard deviation of return is also appropriate to determine diversification effect in the way of decreasing in risk.

5.1.2 Currency Carry Trade Return Data Analysis

5.1.2.1 The group of G10

We start with the group of the most liquid currency called G10 which consists of Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Franc (CHF), Euro (EUR), Great Britain Pound (GBP), Japanese Yen (JPY), Norwegian Krone (Suphachoke Thawornkraiwong), New Zealand Dollar (NZD), Swedish Krona (SEK) and U.S. Dollar (USD)

5.1.2.1.1 The return of 1v1, 2v2, 3v3, and 4v4 portfolios

Currency carry trade return on 1v1, 2v2, 3v3 and 4v4 portfolios which are invested in G10 currencies fluctuate in positive and negative along the studied period. These return of 4 currency carry trade portfolios run in the same trend but different in magnitude. Moreover, there is a sharp drop during 2007 and 2009 since the market turmoil. According to Figure 5, the 4v4 portfolio yields the less fluctuated return because of the risk diversification.

Figure 5: Currency Carry trade return of group G10 country
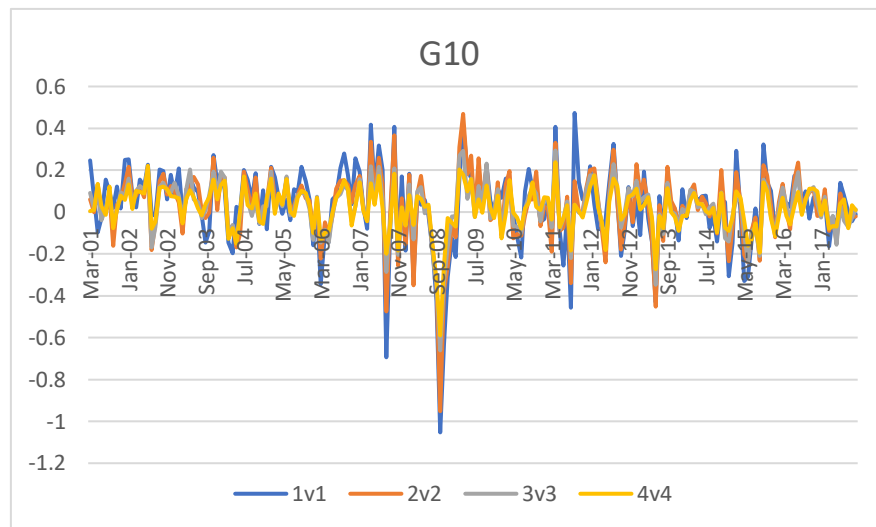
5.1.2.1.2 Return indices of 1v1, 2v2, 3v3, 4v4

The monthly return is brought to calculate the cumulative return index for every portfolio. Figure 6 shows that currency carry trade in the G10 currencies yields positive return on average since 2001, therefore currency carry trade is quite attractive for investors in the latest decade. Return indices consistently climb up during 2001 and 2007. In this period, there is small difference in return and return's volatility of 1v1, 2v2, 3v3 and 4v4 portfolio. The huge change in return pattern comes up while Global Financial Crisis occurs, return dramatically falls after the peak in mid-2007. However, the big drop in return of currency carry trade strategy during market turmoil does not only yield the negative return for doing currency carry trade with G10 currencies but also makes the return indices climb upward slower than before.

Figure 6: Indices of G10 group Currency Carry trade return
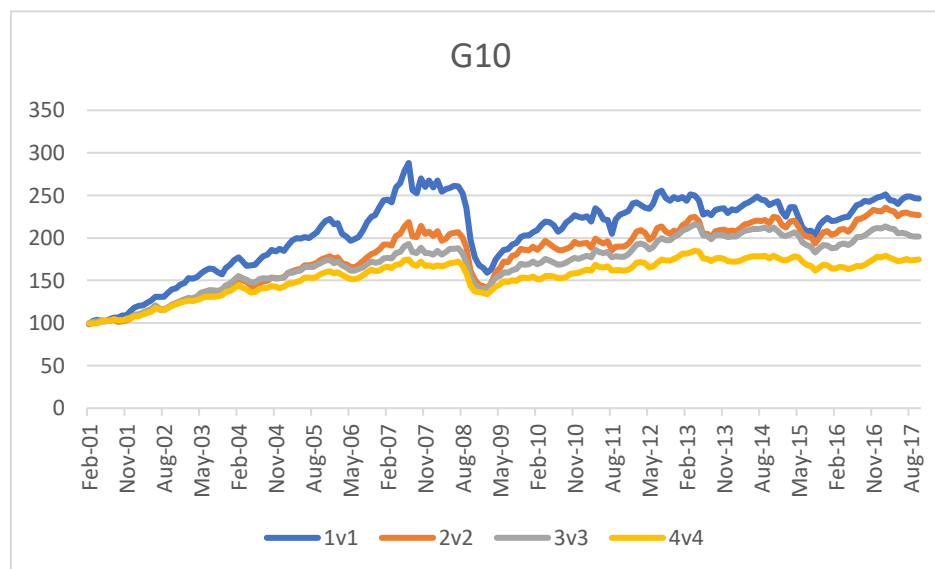
5.1.2.2 The Emerging countries group

Let's move to another group which is emerging countries. There are 8 countries in this group that this paper uses to replicate the emerging market, consisting of Brazil (BRL), Hong Kong (HKD), India (INR), South Korea (KRW), Singapore (SGD), Thailand (THB), Taiwan (TWD) and South Africa (ZAR)

5.1.2.2.1 The return of 1v1, 2v2, 3v3, and 4v4 portfolios

Currency carry trade return on 1v1, 2v2, 3v3 and 4v4 portfolio fluctuate between positive and negative as same as the G10 group but in different patterns. Figure 7 represents the graphical return of currency carry trade portfolio with emerging countries' currencies. It shows that the return pattern moves quite similar among 4 currency carry trade portfolios with emerging countries' currencies. Although, 1v1 currency carry trade portfolio's return is more volatile comparing to the rest. During mid-2007 and mid-2016, which are Global financial crisis and Brexit, the return tends to be more frequently negative than other periods.

Figure 7: Currency Carry trade return of group Emerging countries
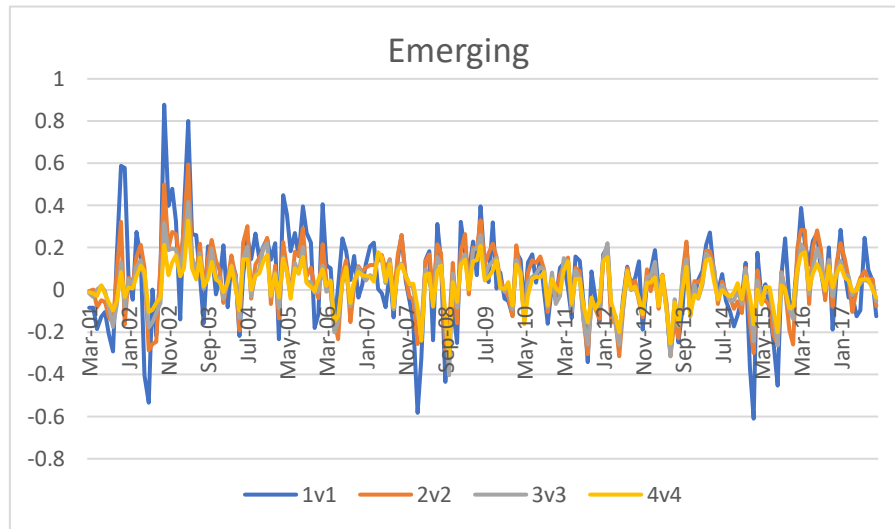
5.1.2.2.2 Return indices of 1v1, 2v2, 3v3, 4v4

The graph of currency carry trade return in emerging countries' indices are represented in Figure 8. All of these indices are moving on the upward trend but 1v1 and 2v2 indices move more aggressively and their performances outstand the other 2 portfolios. Moreover, these group of countries seem to yield higher return than the G10 but their volatility is also higher. Although there is structural change in return pattern after the global financial crisis in mid-2007, the interesting point is that 1v1 and 2v2 portfolio still can climb higher than the peak in mid-2007.

Figure 8: Indices of Emerging Countries Currency Carry trade return
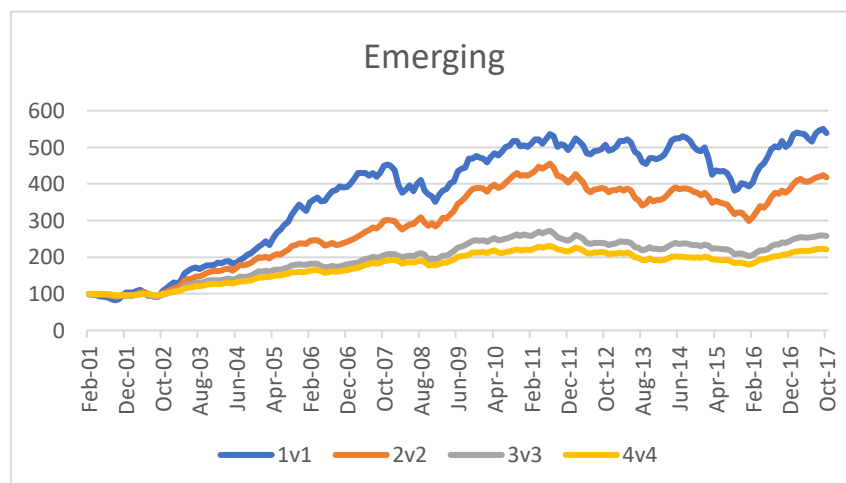
5.1.2.3 The Blended group (G10 + Emerging countries)

The last group of samples in this paper is the group that blends G10 and Emerging countries together for making more realistic environment. Therefore, there are 17 currencies which are 9 currencies from G10 and 8 Emerging countries will be considered. They include Australia (AUD), Canada (USD), Euro Zone (EUR), Japan (JPY), New Zealand (NZD), Norway (Suphachoke Thawornkraiwong), Sweden (SEK), Switzerland (CHF), United Kingdom (GBP), Brazil (BRL), Hongkong (HKD), India (INR), Singapore (SGD), South Africa (ZAR), South Korea (KRW), Taiwan (TWD) and Thailand (THB)

5.1.2.3.1 The return of 1v1, 2v2, 3v3, and 4v4 portfolios

Currency carry trade return on 1v1, 2v2, 3v3 and 4v4 portfolio invested in a blended group of G10 and Emerging countries are shown in Figure 5. Returns of currency carry trade on this group of samples move quite similar to the Emerging countries in the aspect of pattern. We notice this from the more frequent negative return during mid-2007 and mid-2016. However, the return of 1v1 portfolio is still the most volatile as same as two group of samples discussed before.

*Figure 9: Currency Carry trade return of group G10 + Emerging countries*
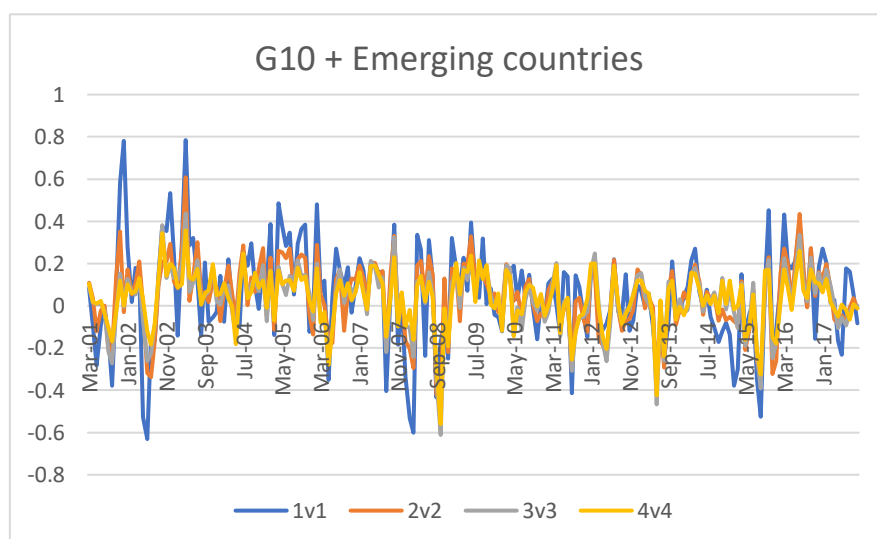
5.1.2.3.2 Return indices of 1v1, 2v2, 3v3, 4v4

Currency carry trade portfolios that invest in G10 + Emerging countries show better performance than portfolios which invest only in G10 or Emerging countries, as you can see in Figure 10. There is one big difference from currency carry trade on this group, the return index of 3v3 and 4v4 move together and 3v3 portfolio performs worse than 4v4 after the global financial crisis. However, performance of currency carry trade in this group of samples is quite attractive, since all of their indices are always going uptrend during 2001 and 2017. Although, there are some points of time that the currency carry trade return falls down as same as other group of samples, the global financial crisis and Brexit are causes of those fallings.

Figure 10: Indices of G10 + Emerging countries group Currency Carry trade return
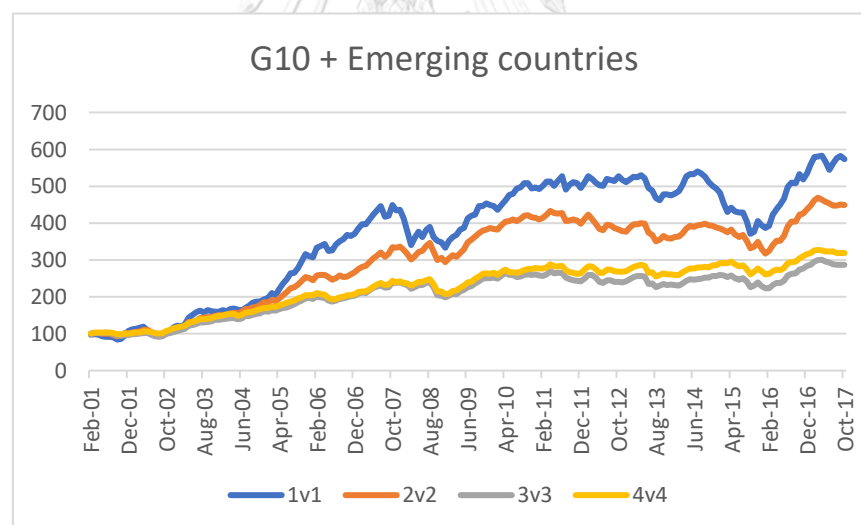
5.2 Currency Carry Trade Return and Exchange Rate Volatility

There are 5 difference steps to show the consistency of relationship between currency carry trade return and exchange rate volatility. First of all, before we start the first step, this paper computes Foreign Exchange volatility which is exchange rate volatility proxy from this $\sigma_t^{FX} = \frac{1}{T_t}\sum_{i=1}^{T}\left[\sum_{k=1}^{K}\frac{|R_k|}{K}\right]$. The graph of Foreign exchange

volatility (FX volatility is represented in Figure 11. The exchange rate volatility (FX volatility) is not that volatile, it swings around 0.002-0.006 but there is massive increase after mid-2007 due to the financial crisis.

Figure 11: Graphical of Foreign exchange volatility
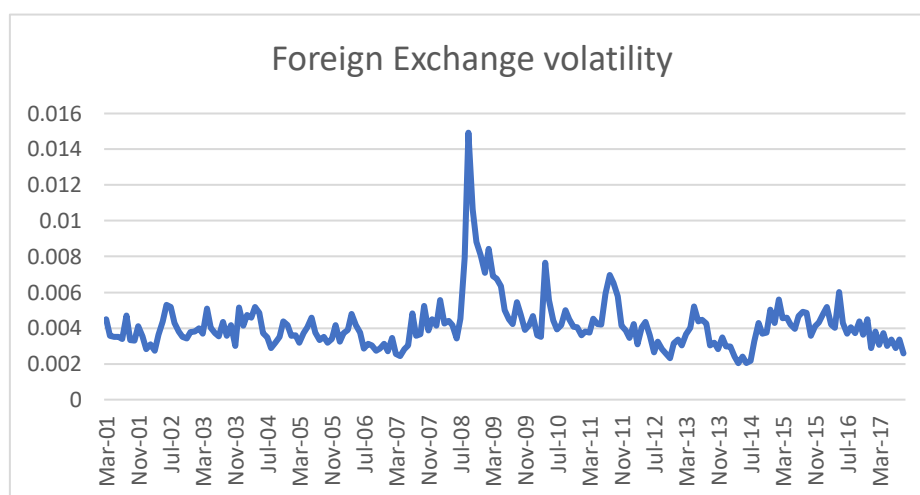
Step 1: Now moving to the first step. We start with the simplest relationship determination which is correlation. This paper computes the correlation of all currency carry trade portfolio return which are computed from previous methodology and FX volatility. According to Table 7, all correlations between currency carry trade return and Foreign exchange volatility are <u>negative</u>, therefore return for every portfolios tend to decline while volatility rises. Moreover, correlation between FX volatility and return of currency carry trade portfolio on G10 is the most negatively correlated and follows by blended group (G10 + Emerging countries) and Emerging countries respectively.

The correlation is the co-movement between currency carry trade return and exchange rate volatility. So, the negative correlation implied the when foreign exchange rate volatility increases currency carry trade return will drop and vice versa for every currency carry trade portfolios.

Table 7: Correlation between Currency carry trade return and FX volatility

Correlation;

$$Corr_{r_x,FX\,vol} = \frac{\sum_{i=1}^{n}\left(r_{x_i}-\mu_{r_x}\right)(FX\,vol_i-\mu_{FX\,vol})}{\sqrt{\sum_{i=1}^{n}\left(r_{x_i}-\mu_{r_x}\right)^2 \sum_{i=1}^{n}(FX\,vol_i-\mu_{FX\,vol})^2}}$$

Where; μ_{rx} is average return of portfolio x.

$\mu_{FX\,vol}$ is average value of FX volatility.

Currency carry trade portfolio		Correlation between Currency carry trade return and FX volatility
G10	1v1	-0.42235
	2v2	-0.4251
	3v3	-0.42205
	4v4	-0.4285
Emerging countries	1v1	-0.18604
	2v2	-0.19606
	3v3	-0.2729
	4v4	-0.27871
Blended group	1v1	-0.18466
	2v2	-0.27744
	3v3	-0.38007
	4v4	-0.38159

Step 2: Next we use Coskewness which is another aspect that can determine the relationship between return and volatility of market benchmark. In this case, this paper assumes Dollar portfolio as market benchmark which is conducted by taking long position of all currencies in sample set equally against U.S. dollar. Dollar portfolio's graph of return (Lukas Menkhoff, 2012) and basic summary are represented in Figure 12 and Table 8 respectively. Dollar portfolio return is volatile between -0.1-0.2% through the time which we investigate. Dollar portfolio return quite less volatility with 9.5% standard deviation but there is a massive drop nearly -0.5% after the global financial crisis.

Figure 12: Dollar portfolio's return

Table 8: The basic information summary of Dollar portfolio

Mean (%)	0.0113626
Variance	0.0090341
S.D.	0.0950481
Min	-0.4702162
Max	0.2581611
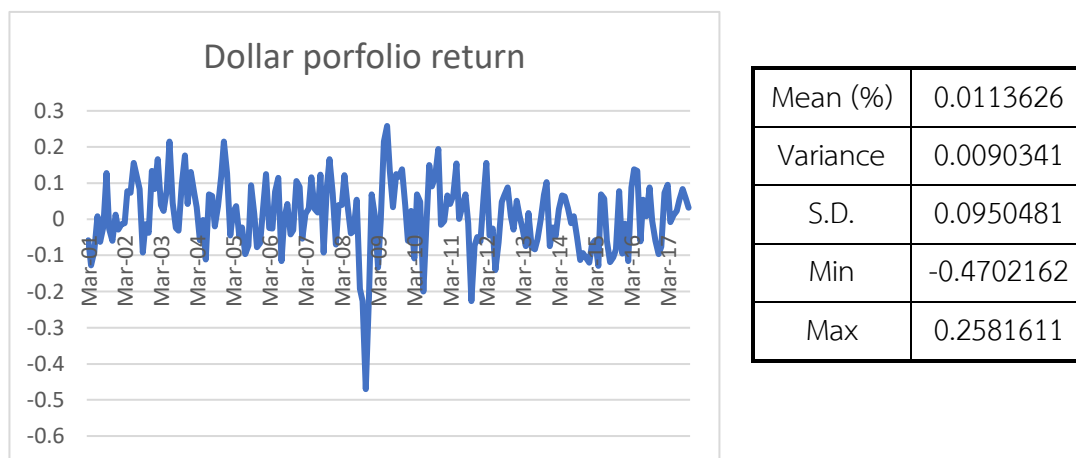
The implication of coskewness is higher level of coskewness the return will higher when market is more volatile and vice versa. According to the result which is represented in Table 9. The sign of coskewness of all currency carry trade portfolio and Dollar portfolio is still consistent with the correlation between currency carry trade return and FX volatility in the previous step which is <u>negative</u>. Finding in this paper is accord with empirical study from Menkhoff(2012). The negative coskewness can be implied that currency carry trade return tends to yield loss when market is in high volatility environment. Moreover, coskewness between Dollar portfolio return and return of currency carry trade portfolio on G10 is the most negative and follows by blended group (G10 + Emerging countries) and Emerging countries respectively, this implied the degree of loss in return between currency carry trade portfolios in our sample set. However, portfolios in emerging market have negative coskewness but they are close to zero which can be interpreted as low coskewness. So, there are very small impact from volatility environment on increasing or decreasing of emerging market currency carry trade portfolios' return.

Table 9: Correlation between Currency carry trade return and FX volatility and
     Coskewness between Currency carry trade portfolio and Dollar portfolio

Coskewness; $Coskew = \dfrac{E[(r_k - \mu_k)(r_{dollar\ port} - \mu_{dollar\ port})^2]}{\sigma(r_k)\sigma^2(r_{dollar\ port})}$

Where; μ_k is average return of portfolio k.

              $\mu_{dollar\ port}$ is average return of Dollar portfolio.

Currency carry trade portfolio		Correlation between Currency carry trade return and FX volatility	Coskewness
G10	1v1	-0.42235	-0.62938
	2v2	-0.42510	-0.52170
	3v3	-0.42205	-0.59521
	4v4	-0.42850	-0.54193
Emerging countries	1v1	-0.18604	-0.16163
	2v2	-0.19606	-0.00439
	3v3	-0.27290	-0.06200
	4v4	-0.27871	-0.09014
Blended group	1v1	-0.18466	-0.21716
	2v2	-0.27744	-0.10657
	3v3	-0.38007	-0.25968
	4v4	-0.38159	-0.25186

Step 3: After figuring out correlation and Coskewness, this paper ranks the currency carry trade return data by FX volatility and divides currency carry trade portfolio return on every sample set into 4 quartiles to investigate the relationship between currency carry trade return and FX volatility in another aspect. We also found the consistent relationship with previous step, moreover the result which this paper found is similar to previous works. Currency carry trade portfolios yield positive return while FX volatility is low and vice versa. The graphical result is represented in Figure

13. The low volatility stage is below the 25th percentile and above 75th percentile is considered high volatility stage.

Figure 13: Currency carry trade return In Low and High Volatility stage
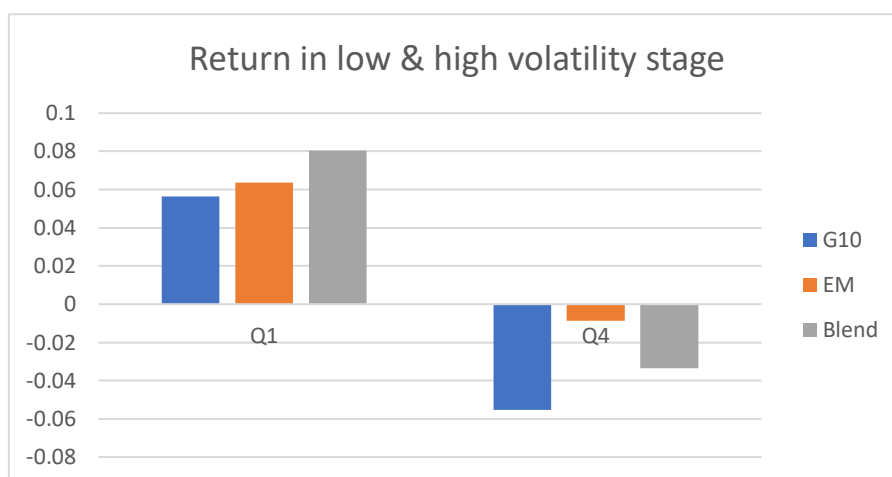
Table 10: Mean return, Standard deviation and Mean per variance ratio of all currency carry trade portfolios in low and high volatility stage

		Low volatility stage			High volatility stage		
		Mean	S.D.	M/V	Mean	S.D.	M/V
G10	1v1	0.07193	0.11880	0.60550	-0.05923	0.28539	-0.20755
	2v2	0.06168	0.09089	0.67856	-0.06990	0.23799	-0.29370
	3v3	0.04891	0.06817	0.71747	-0.04985	0.17625	-0.28282
	4v4	0.04272	0.06089	0.70158	-0.04218	0.14355	-0.29381
EM	1v1	0.09817	0.15737	0.62386	-0.01018	0.22643	-0.04497
	2v2	0.07205	0.11132	0.64724	-0.00082	0.18289	-0.00448
	3v3	0.04655	0.08375	0.55586	-0.01302	0.15357	-0.08480
	4v4	0.03738	0.07374	0.50694	-0.01062	0.12192	-0.08713
Blended	1v1	0.11158	0.16194	0.68901	-0.02802	0.24931	-0.11240
	2v2	0.08101	0.11963	0.67723	-0.02001	0.19834	-0.10088
	3v3	0.06582	0.09023	0.72942	-0.04919	0.18439	-0.26676
	4v4	0.06339	0.08012	0.79113	-0.03721	0.17252	-0.21567

According to Table 10 which represents mean return, standard deviation and mean per variance ratio (m/v ratio), the result between low and high volatility stage is precisely different. Let's focus at the first point; return from currency carry trade for every single portfolio completely turns to the opposite sign when the stage of volatility changes. In low volatility stage, the currency carry trade portfolio with blended group data yields the highest return and following by currency carry trade portfolio in emerging market and G10 respectively. On the other hands, G10 currency carry trade portfolio is the lowest return in high volatility stage following by blended group and emerging market currency carry trade portfolio respectively. Furthermore, the standard deviation of currency carry trade portfolio return tends to increase as well when the exchange rate volatility changes from low to high stage. The decline of standard deviation in low and high volatility stage while more currencies are added into currency carry trade portfolio show that the effect of diversification still can be able to apply whether in low or high volatility stage.

Step 4: In this step, this paper employs Threshold GARCH model (T-GARCH) to investigate the relationship between currency carry trade return and conditional volatility which is estimated from the model below. Table 11 is the represented coefficients of T-GARCH model.

First of all, we discuss about the stability of the model. According the Table 11, $a + b + d$ must be less than 1 but more than zero(Nelson, 1991). There are only G10 and blended group which have value of $a + b + d$ significantly equal to 0.32 and 0.469 respectively. Because of this finding, G10 and blended group T-GARCH are stable except T-GARCH in emerging market data.

According to Table 11, we start to discuss on T-GARCH first which accord with equation (43). This paper found positive, negative and positive statistically significant on coefficient of lagged conditional volatility on conditional volatility (b) in G10,

Emerging market and Blended group respectively which implies that conditional volatility is driven by conditional volatility in previous period. For the negative b in emerging market model, it is not a common result for effect from previous period conditional volatility on itself in this period. Reason of this problem might be cause by the instability of T-GARCH model in emerging market currency carry trade data. Moving to next coefficient (a) which is T-GARCH coefficient that capture the effect of estimation error in mean equation (42) on conditional volatility. This paper found all strong statistically significant on this coefficient in G10 and blended group. Because of that, we can conclude that conditional volatility is driven by the estimation error from mean equation. The last coefficient in variance equation (; equation 43) which is d, it is used to interpret the leverage effect between good (positive error in mean equation) and bad (negative error in mean equation) news by combine with a. The implementation of leverage effect is $a + d$ for good news and a for bad news, if $d < 0$ negative shock (bad news) will have bigger impact on conditional volatility than positive shock (good news)(Enders, 1995). For G10, emerging market and blended group, the effect of good news on conditional volatility equal to 0.003, -0.20 and -0.097 respectively but the effect of bad news on conditional volatility is respectively equal to 0.264, 0.00 (Non-statistically significant) and 0.239. In a word, when bad news exists conditional volatility of these sample sets will increase but it tend to reduce when bad news exists.

Next, we are going to discuss about mean equation of this model (; equation 42), there is only T-GARCH in emerging market sample set yield statistically significant for β (; AR(1) coefficient). It means that emerging market T-GARCH model only represent the impact of lagged currency carry trade return on currency carry trade return. Finally, the estimator that we prioritize in this step is θ, which is the coefficient of conditional variance. We expect to see the negative sign coefficient of this estimator

and we found all <u>negatively</u> significant for every sample sets T-GARCH model. Therefore, this step's result is still consistent to previous steps in the way of reconfirmation of negative relationship between currency carry trade return and exchange rate volatility. Since, the conditional volatility is dominated by exchange rate volatility.

Table 11: Result of T-GARCH on 4v4 Currency Carry trade portfolio

T-GARCH; Mean equation: $r_t = \alpha + \beta r_{t-1} + \theta h_t + u_t$ (42)

Variance equation: $h_t = c + a|u_{t-1}|^2 + bh_{t-1} + d|u_{t-1}|^2(D_{=0\ |u_{t-1}<0}^{=1\ |u_{t-1}>0})$ (43)

Note: Standard errors in parentheses, p-value; *** p<0.01, ** p<0.05, * p<0.1

Variable	Currency Carry Trade Portfolio		
	G10 4v4	Emerging 4v4	Blend 4v4
α	0.0876**	0.0889***	0.120**
	(0.0371)	(0.0312)	(0.0480)
β	0.00283	0.231**	0.0599
	(0.115)	(0.0950)	(0.145)
θ	-7.289*	-8.369**	-5.719*
	(4.314)	(4.185)	(3.405)
c	0.0552***	0.141***	0.0460***
	(0.0156)	(0.0156)	(0.0145)
a	0.264***	0.0499	0.239**
	(0.0885)	(0.0456)	(0.0992)
b	0.297*	-0.570***	0.566***
	(0.166)	(0.151)	(0.142)
d	-0.241**	-0.200**	-0.336***
	(0.103)	(0.0845)	(0.106)

Step 5: This paper uses 3v3 currency carry trade portfolio data to regress the UIP again to investigate the impact from volatility in another aspect. Therefore, we test in low and high volatility stage regression. As you can see on Table 12, coefficient of

slope in G10 and Blended group tend to increase when changing volatility stage from low to high except for Emerging market. In high volatility environment high yielding currency basket in Emerging market tend to appreciate, however high yielding currency basket in others are depreciate. According to the F-Statistic for equal to 1 null hypothesis, it implies that slope almost all difference than 1 except Blended group in high volatility environment which means the depreciation of high yielding currency basket in Blended group perfectly offset the benefit of interest rate difference in high volatility environment. This result is accorded with (Richard Clarida and Niel Pedersen, 2009) that reconfirms negative relationship between currency carry trade return on two sample sets which are g10 and blended group in the way that currency carry trade strategy will be more attractive when volatility is low. Because currency carry trade dose not only capture benefit from interest rate difference, but also gains benefit from currency appreciation. For emerging market sample set, currency carry trade portfolio yields higher profit in high volatility environment compare to low volatility environment. Therefore, currency carry trade among emerging market currencies can always generate profit and profit will increase when exchange rate volatility is raised. This might be the effect of the difference exchange rate regime between G10 and Emerging market, since central bank of each countries in Emerging market have to intervene the exchange rate for stabilizing economy.

Table 12: Show the slope and constant of UIP regression with Currency Carry trade portfolio data

UIP: $\quad\quad \Delta s_{t+1} = \alpha + \beta(i_t^H - i_t^L) + \varepsilon_t$

Where; Δs_{t+1} is change in spot exchange rate between high yield currency against low yield currency in period t+1.

$\quad$ i_t^H $\quad$ is average interest rate of high yield currency group in period t.

$\quad$ i_t^L $\quad$ is average interest rate of low yield currency group in period t.

$\quad$ β $\quad$ is the impact of changing in interest rate difference on changing in spot exchange rate.

Note: Standard errors in parentheses, p-value; *** p<0.01, ** p<0.05, * p<0.1

		Constant (α)	Slope (β)	F-Stat for β = 1
Low volatility	G10	-0.220*** (0.0543)	0.338* (0.194)	11.64***
	EM	-0.292** (0.138)	0.0468 (0.190)	25.16***
	Blend	-0.234 (0.219)	-0.323 (0.277)	22.74***
High volatility	G10	-0.897*** (0.234)	4.611*** (0.646)	31.26***
	EM	-0.292** (0.138)	-2.259** (0.918)	12.60***
	Blend	-2.234*** (0.661)	2.099** (0.876)	1.58

According to 5 step results, there are consistent negative relationship between currency carry trade return and exchange rate volatility. These results are accorded with previous literatures and evidences which found that return of currency carry trade strategy always suddenly unwind while exchange rate volatility rise. There is one explanation for this relationship. When there is increasing in market systematic risk, risk of assets which belong in the market are also increased and the greater risk causes the decreasing in compound return of investment. As well as currency market, the

exchange rate volatility is systematic risk for currency market. Because of this, risk of all currencies is literary increased as well.

5.3 Currency Carry Trade Return and Risk Factor Compensation

Let's move forward to the result of this paper's last methodology. This part of the document explains the result from factor model which investigates the effect of yield curve level factor and yield curve slope factor which are expected to have positive coefficient and negative coefficient to currency carry trade return respectively and VIX which is volatility index. Therefore, its coefficient is expected to be negative according to R. Clarida el.al. (2009)and Whaley(2000). Moreover, this paper adds lagged unpredicted volatility which is used as proxy of fear of unexpected risk and represented as UnVol$_{t-1}$ on Table 13, coefficient of UnVol$_{t-1}$ is expected to be negative.

Considering the result which is represented in Table 13, this paper found the result quite consistent with previous literatures. Let's start with yield curve factor; yield curve level factor's coefficient is significantly positive for some portfolios such 2v2, 3v3 and 4v4 on Emerging countries data and 2v2, 3v3 on blended group (G10+Emerging countries) data. The significantly positive coefficient for yield curve level factor implies the increase in currency carry trade return while there is a relatively increase in permanent interest rate (; parallel shifts in yield curve) between high yield against low yield country. Since, permanent interest rate is proxied by yield curve level in the way that relative rising in permanent interest rate between high yield against low yield country leads appreciation in nominal exchange rate of high yield currency(Richard Clarida, 2002). Because of the bigger difference in interest rate and appreciation of high yield currency, currency carry trade return should be increased. However, the rest coefficient of yield curve level factor, there are combinations of positive and negative insignificant coefficient.

For yield curve slope factor, this paper uses yield curve slope factor to be the proxy of business cycle which affects currency carry trade in aspect of expected inflation. Since, easy monetary policy (; economic growth stimulation policy) which increases money supply by reducing interest rate and increases inflation makes yield curve steeper. Thus, steeper yield curve implied the reducing in interest rate and increasing in inflation rate, therefore we expect to find negative coefficient for the yield curve slope factor. As the result, negative sign of coefficient of yield curve slope factor means effect of exchange rate depreciation and decreasing in interest rate are bigger than effect of increase in nominal exchange rate in high yield country. Yield curve slope factor's coefficients which are figured out in this paper are mostly yield the negative sign but there is no statistical implementation since these coefficients are insignificant. Therefore, there is no effect of changing in yield curve slope on currency carry trade return.

According to previous work; VIX index is Chicago Board Option Exchange's Market Volatility Index is known as the investor fear's gauge(Whaley, 2000), since it captures the volatility of future stock market in next 30 days. The higher VIX means the higher level of investors' fear to invest. Therefore, the capital inflow of high yield currency will decrease. So, high yield currency will depreciate and make the in-position currency carry trade return decrease as well. This paper found the consistent result with previous literature(Richard Clarida and Niel Pedersen, 2009). According to Table 13, there are all negative coefficient of VIX for every currency carry trade portfolio. Moreover, most of them are also significantly negative.

Lagged unexpected volatility ($UnVol_{t-1}$), which is added in this paper, is the last regressor to determine. The coefficient of $UnVol_{t-1}$ is expected to yield negative relationship with currency carry trade return, since fear of unexpected risk is proxied by $UnVol_{t-1}$. Thus, increasing in fear of risk investors tend to reduce number of

investment in risky investment(Charles A. Holt, 2002). According to Table 13, almost all of the coefficients of $UnVol_{t-1}$ are negative which is the same as our expectation about

$UnVol_{t-1}$. However, there is only one of the coefficient of $UnVol_{t-1}$ which is on G10 4v4 currency carry trade portfolio significantly negative. This result confirms the negative relationship between currency carry trade return and lagged unexpected volatility which is investors' fear of unexpected risk.

Table 13: The coefficient of factor model on Currency carry trade portfolio return

Factor Model: $r_t = (i_t^H - i_t^L) + \beta_{VIX}VIX_t + \beta_L Y_{L,t} + \beta_S Y_{S,t} + \beta_v UnVol_{t-1} + \varepsilon_t$

Where; VIX_t is VIX index in period t.

                $Y_{L,t}$ is yield curve level factor in period t which is proxy of permanent movement in interest rate.

                $Y_{S,t}$ is yield curve slope factor in period t which is proxy of business cycle and implied to expected inflation rate.

            $UnVol_{t-1}$ is unexpected volatility in period t-1.

Note: Robust standard errors in parentheses, p-value; *** p<0.01, ** p<0.05, * p<0.1

		Constant	UnVol$_{t-1}$	VIX	Yield level	Yield Slope
G10	1v1	**0.107****	-0.251	**-0.00470***	-0.000365	0.0239
		(0.0475)	(0.176)	(0.00250)	(0.000248)	(0.0372)
	2v2	**0.108****	-0.124	**-0.00488****	0.000142	0.0240
		(0.0420)	(0.136)	(0.00227)	(0.000300)	(0.0299)
	3v3	**0.0648****	-0.154	**-0.00291***	6.32e-05	0.0255
		(0.0310)	(0.102)	(0.00163)	(0.000225)	(0.0220)
	4v4	**0.0530****	**-0.151***	**-0.00242***	-2.72e-05	0.0221
		(0.0255)	(0.0796)	(0.00135)	(0.000195)	(0.0180)
Emerging Market	1v1	0.0651	-0.171	-0.000888	0.000505	0.00767
		(0.0441)	(0.166)	(0.00231)	(0.000585)	(0.0286)
	2v2	**0.0744****	-0.0393	-0.000951	**0.00163***	-0.0242
		(0.0315)	(0.130)	(0.00167)	(0.000523)	(0.0197)
	3v3	**0.0711***	-0.0435	-0.00172	**0.000980***	-0.0165
		(0.0255)	(0.104)	(0.00140)	(0.000415)	(0.0150)
	4v4	**0.0644***	-0.0491	-0.00153	**0.000901***	-0.0199
		(0.0200)	(0.0770)	(0.00105)	(0.000296)	(0.0136)
Blended Group	1v1	**0.101****	-0.0619	-0.00278	0.000429	0.0127
		(0.0429)	(0.159)	(0.00218)	(0.000608)	(0.0343)
	2v2	**0.131***	0.124	**-0.00393****	**0.00141***	-0.0180
		(0.0332)	(0.134)	(0.00178)	(0.000493)	(0.0243)
	3v3	**0.113***	-0.0106	**-0.00400****	**0.000900***	-0.00593
		(0.0320)	(0.118)	(0.00178)	(0.000366)	(0.0216)
	4v4	**0.0994***	-0.0387	**-0.00317***	0.000876	-0.00565
		(0.0269)	(0.102)	(0.00114)	(0.000832)	(0.0215)

CHAPTER 6

CONCLUSION

In this paper we have tried to investigate the factors that can take into account for currency carry trade return, since currency carry trade is one of the most popular inter-market trading strategies in latest decade. G10 and Emerging countries are the focus group in this study during January 2001 and October 2017. Drawing on the previous work of R. Clarida (2009) and L. Menkhoff(2012), this paper firstly checked the feasibility to use currency carry trade strategy to generate profit by testing the famous Uncovered Interest Parity which is called UIP. After we found possibility to gain profit from currency carry trade, we moved on to investigate the relationship between currency carry trade return and exchange rate volatility in some aspect for consistency. Finally, we investigate compensation of yield curve factor, VIX and unexpected volatility on currency carry trade return.

The result we got from second methodology is consistent along with each other steps. Because of negative relationship between currency carry trade return and exchange rate volatility from correlation and coskewness determination. As well as return from currency carry trade in top and bottom quartile of volatility, currency carry trade not only yield negative return in top quartile of volatility but also yield positive return in bottom quartile of volatility. Furthermore, result from Threshold GARCH model also accords with other results, hence the conditional volatility which generated from Threshold GARCH model also yield negative coefficient to currency carry trade return. As same as and UIP equation with 3v3 currency carry trade data, there is the relative depreciation in high yield currency to low yield currency which reduces currency carry trade return while volatility stage is changed. We notice the depreciation of high yield currency in UIP by the positive change in coefficient of interest rate difference of slope in UIP equation. According to result of UIP with currency carry trade

portfolio date, the possible reason of depreciation in high yield currency while the volatility is increased might be that transaction cost, since it will go up high when volatility rise such as liquidity problem. For another possibility is the increasing in volatility make overall investors faced higher risk to invest. So, if overall investors expect to gain the same level of return, the current asset price will fall. In this case the exchange rate of high yield currency is the asset price. As a result, that the value of existing currency carry trade will drop because of the falling in value of high yield currency to low yield currency. Therefore, we can conclude that return of currency carry trade will be high while the exchange volatility is low and vice versa.

The next part, we discussed about effect from group of factors on currency carry trade return. We started with yield curve factor; the relationship of yield curve factor which is reported in this paper seems to be weakly significant. Therefore, there are only 5 of 12 portfolios that have statistically significant coefficient of yield curve level factor. All of significant coefficient of yield curve level factor are positive. Moreover, there is no statistically significant coefficient for yield curve slope on any currency carry trade portfolio. One possible reason for the significant impact of yield curve factor is that relationship between currency carry trade return and interest rate might subject to the volatility stage because when volatility is low interest rate will play big role to the currency carry trade return. On the other hands, when volatility is high return from currency carry trade would be more subjected to exchange rate. This paper's result is accorded with previous work which found that the difference of interest rate between countries has small impact on capital inflow the case study of Thailand(Suphachoke Thawornkraiwong, 2013). Furthermore, there are three main factors that have bigger impact to capital inflow which are economic growth, exchange rate movement and investors' fear. Moving to other 2 factors which are used as proxy of investors' fear. This paper got the consistent result with previous works which found

significantly negative coefficient of VIX (Richard Clarida and Niel Pedersen, 2009) and the lagged unexpected volatility also yield significantly negative coefficient as well. Therefore, we can conclude that investors' fear which captured by these two factors is negative correlate with currency carry trade return. Possible reason behind this relationship might be that when investors' fear increases the demand for high yield currency will decrease, then high yield currency will depreciate and make currency carry trade yield less return.

Nevertheless, this study still has an important point to note. This paper did not consider all of currencies in the Emerging countries because of some data restrictions. Moreover, currency carry trade return which we calculate in this paper was assumed no transaction cost and free capital flow. For next study in this field is recommended to take transaction cost and capital flow policy into account, thus the empirical result will be more replicated to real world.

Currency carry trade strategy is one of the popular trading strategies but it has to be concerned by policy maker. This strategy is playing a big role about flowing capital across counties. Therefore, the high interest rate country like developing countries may be have exportation problem because their currency will appreciate. However, developing countries' central bank need to intervene the exchange rate to maintain exportation level but the intervention is going to reduce the exchange rate volatility. According to the result of this paper and previous works, there is benefit for currency carry trade while the volatility is low. As a result, that intervention makes this trading strategy more attractive. So, the way that can reduce the number of currency carry trade is set exchange rate freely move. Actually, flexible exchange rate still harms the export sector because of the increasing in exchange rate volatility therefore export sector still be harm anyway.

As currency carry trade strategy might be one problem to developing countries as we discussed above. In the case of Thailand, managing float exchange rate can be slow down the impact from this strategy and help export sector to adjust their cost and risk. For another aspect, "pseudo flexible" exchange rate regime might be appropriate. Since, when Pseudo flexible exchange rate regime is applied it will stabilize the exchange rate because impact from currency speculation activity will move from FX market into bond market. Anyways, the more intervention the more attractive for currency carry trade because of low volatility. Therefore, the policy maker should take the keen and vise action to balance the impact from exchange rate volatility and currency carry trade strategy for the most appropriate environment for that country.

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