UTKKU BORA GEYİKÇİ

ESSAYS IN INTERNATIONAL FINANCE

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ESSAYS IN INTERNATIONAL FINANCE

A Ph.D. Dissertation

by

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The Department of Management
İhsan Doğramacı Bilkent University
Ankara

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To my father

ESSAYS IN INTERNATIONAL FINANCE

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

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In Partial Fulfillment of the Requirements for the Degree of
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ABSTRACT

ESSAYS IN INTERNATIONAL FINANCE

Geyikçi, Utku Bora
Ph.D. in Department of Management
Advisor: Assoc. Prof. Dr. Süheyla Özyıldırım

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This thesis investigates FX market characteristics of emerging markets by examining the uncovered and covered interest parity deviations, There is an extensive literature studying parity conditions in the currency markets. However, we mainly focus on the violation of the parity conditions, especially during post financial crisis period. In the first chapter, we study carry trades which is a well known violation of the so-called uncovered interest-rate parity (UIP). We show that the carry strategy matters in the emerging markets in the sense that the dollar neutral carry strategy outperforms the dollar carry strategy. We also show that carry trade is not a profitable strategy, compared to the returns from U.S. stocks and/or U.S. dollar risk-free rate. The findings indicate that risk factors explain the dollar carry strategies better than the dollar neutral strategy particularly in the post-crisis period. Because emerging markets are riskier than developed ones, investors are expected to hedge using FX options. However, the evidence suggest that hedging carry trade is not a good idea in the emerging markets because crash risk that is priced in the options seems to evaporate carry profits. In the second chapter, we study deviations from covered interest parity (CIP) for six emerging market economies: Hungary, Mexico, Poland, Russia, South Africa, Turkey, using daily data following the global financial crisis. After documenting large and persistent discrepancies between January 2010 and July 2018, cost of illiquidity and interest differentials are found to be main drivers of CIP deviations in the emerging countries. We find that the impact of credit risk on CIP deviations may take two forms. In low-carry currencies, the well-known mechanism for credit risk operates so that the increase in credit risk exacerbates CIP deviations. Conversely, in high-carry currencies, the high usage of FX swaps makes swap rates react more than domestic rates, which causes CIP to decrease.

Keywords: Carry trade, Covered interest parity, Uncovered interest parity, Emerging economies, FX swap

ÖZET

ULUSLARARASI FİNANSTA MAKALELER

Geyikçi, Utku Bora
Doktora, İşletme
Tez Danışmanı: Doç. Dr. Süheyla Özyıldırım

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Bu tez, kapsanmış ve kapsanmamış faiz paritesi üzerinden gelişmekte olan ülkelerde döviz kuru piyasasını incelemeyi amaçlamaktadır. Döviz piyasalarındaki parite koşullarını inceleyen kapsamlı bir literatür bulunmaktadır. Ancak bu tezde özellikle ağırlıklı olarak finansal kriz sonrası dönemdeki parite koşullarının ihlaline odaklanıyoruz. Birinci bölümde, kapsanmamış faiz paritesinden sapmanın iyi bilinen bir ihlali olan ara kazanç ticaretini inceliyoruz. Ara kazanç ticareti stratejilerinin önemli olduğunu ve dolar nötr ara kazanç stratejisinin dolara bağlı stratejiden daha fazla getiri sağladığını göstermekteyiz. Ayrıca ABD hisse senetleri ve ABD risksiz getirileriyle karşılaştırıldığında ara kazaç ticaretinin daha düşük getiriye sahip olduğunu göstermekteyiz. Bulgularımız risk faktörlerinin dolara bağlı ara kazanç stratejilerini özellikle kriz sonrası dönemde dolar nötr stratejilere göre daha iyi açıkladığını göstermektedir. Gelişmekte olan ülkelerin gelişmiş ülkelere göre daha riskli olduğu düşünüldüğünde yatırımcıların gelişmekte olan ülkelerde yaptıkları yatırımlarını döviz opsiyonları kullanarak risklere karşı koruması beklenmektedir. Ancak, bulgularımız gelişmekte olan ülkelerde ara kazanç ticaretinin risklerinden korunmak için opsiyon kullanmanın opsiyonlarda fiyatlandırılan çöküş riskinden dolayı karları azalttığını göstermektedir. İkinci bölümde, küresel finansal krizin ardından günlük verileri kullanarak altı gelişmekte olan piyasa ekonomisi (Macaristan, Meksika, Polonya, Rusya, Güney Afrika, Türkiye) için kapsanmış faiz paritesinden sapmaları inceliyoruz. Ocak 2010 ile Temmuz 2018 arasındaki büyük ve kalıcı tutarsızlıkları belgeledikten sonra, gelişmekte olan ülkelerde likidite eksikliği ve faiz farklılıklarının kapsanmış faiz paritesinden sapmaları açıklamadaki önemli faktörler olduğunu buluyoruz. Bulgularımız, kredi riskinin gelişmekte olan ülkelerin kapsanmış faiz paritesinden sapmaları üzerindeki etkisinin iki şekilde olabileceğini göstermektedir. Düşük faizli para birimlerinde, kredi riski için iyi bilinen mekanizma, kredi riskindeki artışın kapsanmış faiz paritesinden sapmalarını şiddetlendirecek şekilde çalışırken, tersine, yüksek faizli para birimlerinde, döviz swaplarının yüksek kullanımı, swap oranlarının yurt içi faizlerden daha fazla tepki vermesine neden olarak kapsanmış faiz paritesinden sapmaların düşmesine neden olmaktadır.

Anahtar Kelimeler: Ara kazanç ticareti, Kapsanmış faiz paritesi, Kapsanmamış faiz paritesi, Gelişmekte olan ülkeler, Döviz swapları

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I devoted my thesis to the memory of my father, Sabri Geyikçi who we lost 12 years ago. He always stood by me and I am doubtless that he is so proud of me.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1. Overview

In the international finance literature, the interconnection between exchange rates and interest rates has been extensively documented. The basic theory that describes the relationship between exchange rates and interest rates is known as interest rate parity and it can be in two forms: uncovered interest rate parity and covered interest rate parity. The former indicates that the difference between two countries' interest rate is expected be reflected in the exchange rates whereas the latter claims that the difference between two countries' interest rates should be reflected in the exchange rates. In the literature, it is well-documented that uncovered interest parity is systematically violated given the high degree of uncertainty regarding the exchange rates. Carry trade is an investment strategy that bets on the violation of the uncovered interest parity. Carry stands for the interest rate differential between two countries and the currency traders earns from these differential on average. On the other hand, according to Claudio Borio et al. (2016), covered interest parity "verges on a physical law in international finance." The departure from the parity means arbitrage opportunity. Since the global financial crisis, the deviation from covered interest parity is frequently observed.

In the literature, numerous studies seek to understand the reasons behind the violation of both uncovered and covered interest parity. However, most of these studies focus on developed countries overlooking emerging countries systematically. As emerging economies grow, they constitute an important part of the global financial markets. Therefore, addressing this gap in the literature, we aim to explore the dynamics of carry trade activities and the deviation from covered interest parity in emerging economies.

After the global financial crisis when the interest rates in developed economies reached very low levels, emerging economies became more attractive destinations for the carry trade. In the next chapter, the performance of three carry trade strategies (equal-weighted, dollar neutral, dollar-based) in 16 emerging economies are examined.[1] Interestingly, it is found that the profitability of carry trades decreases more after the global financial crises. Moreover, it is less profitable than U.S. stock market returns. Another interesting result is that base currency seems to matter in carry trade strategies. For example, euro based carry trades are found to be more profitable than the US dollar based and Japanese yen based carry trades. The finding that dollar-neutral carry strategies consistently performs better than the dollar-based carry returns particularly in the post-crisis period suggesting carry investors to be careful on choosing the right carry strategy. Furthermore, risk factors are found to be important to explain the dollar-based carry returns but not to explain the dollar-neutral carry returns. In the chapter, it is also shown that hedging the carry trades by using FX options in emerging economies is not a good idea. Although, options protect the investors from serious loss, option prices are too high that they sweep away the profits suggesting that investors need to be careful when hedging their carry trades.

[1]This chapter is accepted for publication in the *Journal of International Financial Markets, Institutions & Money, forthcoming.*

In the third chapter of this thesis, we focus on the determinants of the deviation from the covered interest parity. Although deviations from covered interest parity have more obvious policy implications on the financial stability of the emerging countries, previous empirical studies rarely concern with this question in these countries. For example, as Helene Rey (2013) emphasized, the global financial cycle has transformed trilemma to a dilemma, thus, in addition to the restricted monetary policy autonomy, hampered monetary transmission mechanism due to the deviations from covered interest parity puts additional pressure to the emerging economies' central banks. Keeping this in mind, we first, examine whether the covered interest parity holds in the six emerging economies in which there is no capital controls that restrict foreign capital inflows. It is documented that deviations occur nearly for all sample countries' currencies. It is also found that local factors play a much more critical role than the global factors. Among local factors, the FX liquidity seems to be the main reason of the deviations. Nominal interest rate differences and credit risk contribute to the deviations as well. The findings in this chapter contribute to the literature by documenting the different effects of credit risk on deviations. The literature predicts a positive relationship between deviations from covered interest rate parity and the credit risk; however, we find a contrary association in that increasing usage of FX swaps to implement carry trades stands as the major reason behind this negative relationship.

CHAPTER II

TO HEDGE OR NOT TO HEDGE: CARRY TRADE DYNAMICS IN THE EMERGING ECONOMIES

2.1. Introduction

The persistence and high profitability of carry trade returns[1] have long puzzled researchers. Carry trade is a strategy in which an investor goes long on the high interest rate currency and short on the low interest rate currency. In essence, the carry trade reflects a bet against uncovered interest rate parity, and if the parity fails, the carry strategy is profitable. Carry returns are known to do poorly in highly volatile environments (Bhansali, 2007; Suh, 2019; Cho et al., 2019). After the global financial crisis, when the interest rates in developed markets were at historically low levels, emerging market currencies become more attractive destinations for carry trades. Although there is a significant increase in the depth and liquidity of the currency markets of the emerging market countries, the existing studies on carry trade are mostly focus on the developed markets (Bekaert and Panayotov (2020)). As such, there is a lack of evidence with regards

[1]Burnside (2012) documents for 20 advanced country currencies that the carry-trade strategy has an average annualized payoff of 4.5 percent and a Sharpe ratio of 0.86. During the same period of January 1976 to October 2010, the average excess return to the U.S. stock market is 6.5 percent and a Sharpe ratio of 0.41.

to the dynamics of emerging market carry trades.[2] Our chapter aims to fill this gap by presenting evidence that highlights the different characteristics of the returns to carry trading that are unique to the emerging market currencies rather than reconcile to the past findings from developed markets.

We contribute to the recent literature by focusing on four interrelated objectives. First, we present the performance of three carry trade strategies in a sample of emerging market economies and compare them to U.S. stock market returns. Second, we document to what extent base currency (U.S dollar, euro and Japanese yen) explains carry returns. Third, we investigate whether risk factors that have been long used to explain carry returns in developed markets are also valid in the emerging markets. Fourth, we analyze the effect of hedging on carry returns. In many emerging markets, the local currency is volatile and hence, hedged strategies may protect investors against large exchange rate changes including currency crash risk. In the literature, all of the empirical evidence on hedged carry trades refer to the developed markets (see e.g. Burnside et al., 2011; Jurek, 2014) although crash risk is a more relevant concern in case of the emerging markets than in the case of developed economies. To our knowledge, none of the prior work has attempted to examine the link between the carry trade returns and crash risk in the emerging markets.[3]

Our main empirical findings are as follows. First, we find that the returns from the equally weighted dollar carry strategy between 2004 and 2019 is 1.94 percent, whereas the dollar neutral strategy earns 4 percent. Contrary to the evidence from most of the previous studies, emerging markets' carry returns are less profitable than the U.S. stock returns, particularly after the global financial

[2]Transactions in global foreign exchange markets have become more diversified, and the share of transactions against emerging market currencies rose further, to 25 percent (BIS, 2019).

[3]As Li (2017) underlines that emerging markets have different dynamics than the developed markets in terms of currency volatility and crash risk, the effects of hedging are expected to have different outcomes on the carry returns in the emerging markets.

crisis. We show that the Sharpe ratio of the U.S. stock market is nearly five times higher than the carry returns after 2010. Moreover, during the same period, even risk-free rates perform better than the dollar carry strategy.

Second, a less obvious but important insight is that base currency stands as a key determinant of carry returns among the emerging economies. Dollar-based carry returns are smaller than the euro-based and yen-based carry returns. The Sharpe ratio of euro-based carry trade is double that the Sharpe ratio of dollar-based carry returns. After the financial crisis, the difference is even more striking (i.e., the Sharpe ratio of the euro-based carry return is 0.5, whereas it is 0.04 for the dollar-based carry return).

Third, our findings suggest that traditional and nontraditional risk factors explain dollar-based carry returns, while they fail to explain dollar neutral carry returns particularly in the post-crisis period. The explanatory power of factors that are already highlighted in the literature are higher in the pre-crisis period for the dollar neutral strategy than the post-crisis period

Lastly, we find that hedged carry returns are far less than unhedged carry returns, regardless of the carry strategy, which indicates a crash risk. We find that the equal weighted unhedged carry strategy has a 0.92 percent return, whereas the hedged carry return, using at-the-money options, has a -0.57 percent return. This finding differs from findings of other studies that focus on developed market currencies. Higher FX volatilities in emerging markets, and hence, higher option premiums when options are used to hedge the investments, seem to explain the lower carry returns from emerging market currencies.

The remainder of the chapter is organized as follows: Section 2 reviews the related literature. Section 3 provides carry trade basics. In Section 4, we discuss the potential risk factors that have an effect on carry returns. We present empirical results on unhedged carry trades in Section 5 and hedge carry trades in Section 6. The chapter concludes in Section 7.

2.2. Related Literature

Under risk-neutrality and rational expectations, uncovered interest parity states that a currency with higher interest rate is expected to depreciate against the lower interest rate currency in order to eliminate the returns coming from the interest rates difference. However, a number of empirical studies show that currencies that have higher interest rates do not depreciate but rather appreciate and help investors to establish a profitable investment strategy, carry trade. Since the profit from carry trade is a violation of the uncovered interest parity and considered as a puzzle, a new literature emerges beginning from 1980s to understand and solve this puzzle.

Main explanation to unveil the puzzle comes from the invalidity of the risk-neutral assumption. Because the investors are risk-averse, positive returns from carry trades have been considered as a compensation of taking risks for investors (Fama, 1984; Hansen and Hodric, 1980). Therefore, one strand of the literature focuses on finding the risk factors that are related to the carry returns. Although there is no consensus in the existing literature regarding those risk factors (see e.g., Panayotov, 2020), thus far, the profitability of the carry trade has been examined with a set of factors from stock and currency markets.

In an extensive review of the literature, Burnside (2012) documents that the empirical performance of a different risk factors from stock market (i.e., stock market excess returns, consumption growth, Fama and French (1993) or term premium) mostly fails to provide a consistently correlated relationship between traditional risk factors and carry trade returns. However, he also shows that these traditional risk factors have joint explanatory power for currency and stock returns unless foreign exchange and equity markets are segmented. Lustig et al. (2011) present evidence that risk factors in currency market (i.e., the dollar risk factor (average excess returns of the portfolio) and slope factor (short the lowest interest rate currency and long the highest interest rate currency) can explain more than 80 percent of the time series variation in currency carry returns.

Menkhoff et al. (2012) argue that global foreign-exchange volatility is another systematic risk factor that effects the carry returns. They show that unexpected changes (innovations) in global FX volatility and high interest rates are negatively correlated in a sense that in the times of high volatility, high interest rates perform low returns. According to Raffety (2012), skewness of the returns also matters to explain the carry returns. In particular, negative skewness, i.e., an increase in uncertainty among currency investors is found to be associated with negative carry returns. Mancini et al. (2013) argue that there is also liquidity risk factor on the carry returns in which high interest rate currencies offer compensation to liquidity risk. Similarly, Brunnermeire et al. (2008), also underline that liquidity and global risk aversion are robust factors on carry returns. Berg and Mark (2018) discuss that global economic uncertainty is strongly priced into the currency carry trades.

While the literature has sought risk-based explanations for the returns to the carry trade for advanced country currencies, Burnside (2014) points out that risk factors that are valid for developed markets may not explain the carry returns in emerging markets. However, risk factors that are valid in the emerging markets' carry returns have been largely understudied in the literature. Hence, one of the aims of this study is to understand the relationship between the carry returns and risk factors in emerging markets.

Currency carry trade is an unhedged strategy in that the investor takes the exchange risk. However, it is possible to hedge the carry trade against downside risk by using FX options. Several studies use hedged carry trades to investigate whether carry returns are related to crash risk, that is, whether positive interest rate differentials are associated with the negative conditional skewness of exchange rate movements factor, using at-the-money options (Burnside et al., 2011; Caballero and Doyle, 2012; Farhi and Gabaix, 2016; Farhi et al., 2015) and out-of-the money options (Jurek, 2014; Farhi and Gabaix, 2016; Farhi et al., 2015). The evidence by Jurek (2014) suggests that crash risk premia explain no more than one-third of the excess return earned by carry trades in G10 currencies. Similarly, Burnside et al. (2011) and Bekaert and Panayotov (2020) have criticized the idea of crash risk in carry returns by using FX options. On the other hand, Farhi and Gabaix (2016) show that rare crash risk has a significant effect on the returns of carry trades. While all these papers provide useful evidence for developed markets, our study is the first to investigate the linkage between currency carry and currency crash risk in the emerging markets.

2.3. Carry Trade Basics

2.3.1 Carry Strategy

Following Lustig et al. (2011) we use forward and spot exchange rates to proxy carry trade activities. The use of data from spot and forward currency markets has several advantages. First, it is easy to implement carry trades in these markets. Second, counterparty and default risks in these markets are very low. In this section we describe our strategy to implement carry trades from the perspective of the U.S. investor. Let s denote the log of the spot exchange rate expressed as foreign currency per U.S. dollar and f is the log of the forward exchange rate as the same unit of s. An increase of the s means the depreciation of the foreign currency with respect to the U.S. dollar. The carry trade is implemented by selling the foreign currency and buying the domestic currency when it is at a forward premium $(f_t - s_t)$, and buying the foreign currency and selling the domestic currency when it is at a forward discount $(-f_t + s_t)$.

2.3.2 Hedged Carry Trade

Because carry trade is an unhedged strategy, an investor can hedge his/her future position by buying options. When an investor goes long on the foreign currency, buying a call option limits the carry trade losses arising from the unexpected depreciation of the foreign currency.[4] Let c_t be a dollar price of a call option, and k_t be the strike price to exercise the option. The payoff to the call option is

$$z^c_{t+1} = \max(0, s_{t+1} - k_t) - c_t(1 + r_t) \tag{2.1}$$

where r_t represents domestic interest rate. Similarly, when an investor goes short on the foreign currency, buying a put option limits the carry trade losses arising from unexpected appreciation of the foreign currency. Let p_t be a dollar price of a put option and k_t be the strike price to exercise the option. The payoff to the put option is

$$z^p_{t+1} = \max(0, k_t - s_{t+1}) - p_t(1 + r_t). \tag{2.2}$$

If an investor buys a foreign currency forward when it is at a forward premium, the depreciation of that currency more than the forward rate will lead to a loss. To limit possible losses, an investor simultaneously buys a call option on the foreign currency with a strike price k_t. At the end of the investment period, if

[4] We mainly follow the notation of Burnside et al. (2011)

$s_{t+1} > k_t$, the payoff to the hedged carry trade is

$$(f_t - s_{t+1}) + (s_{t+1} - k_t) - c_t(1 + r_t). \tag{2.3}$$

Similarly, if an investor sells a foreign currency forward due to the forward discount, in order to limit possible losses, she/he buys, at the same time, a put option on the foreign currency with a strike price k_t. At the end of the investment period, if $s_{t+1} < k_t$, the payoff to the hedged carry trade is

$$(s_{t+1} - f_t) + (k_t - s_{t+1}) - p_t(1 + r_t). \tag{2.4}$$

To normalize the size of the bet to one dollar, we divide the hedging part with $1/s_{t+1}$. Then our dollar hedged payoff strategy (z^h) is

$$z^h_{t+1} = \begin{cases} z_{t+1} + z^c_{t+1}/s_{t+1} & \text{if } f_t > s_t \\ \\ z_{t+1} + z^p_{t+1}/s_{t+1} & \text{if } f_t < s_t \end{cases} \tag{2.5}$$

where z_{t+1}, z^c_{t+1} and z^p_{t+1} come from equations (1) to (4). In the empirical analysis, we implement hedged carry returns with both out-of-the money (10 delta and 25 delta) and at-the-money options (50 delta).

2.3.3 Data

Carry trades are short-term investments, and investors would like to enter and exit from carry trades easily. However, such a flexibility exists in only a few countries within the emerging markets. Therefore, we limit our sample to 16 emerging market currencies.[5] Using daily spot and (one-month) forward

[5] These currencies are: Brazilian real, Chilean pesos, Colombian peso, Czech koruna, Hungarian forint, Indian rupee, Indonesian rupiah, Israeli shekel, Mexican peso, Polish zloty, Philippine peso,

exchange rates, we calculate the monthly returns by taking the last working day of each month. We obtain the data from Datastream database. Our unhedged data span covers the period from April 2004 to December 2019, except in the case of Indonesia, in which it begins March 2006.

We obtained implied volatilities, risk reversals and butterfly options from Bloomberg and calculate the option prices using the Garman-Kohlhagen (1983) model. The span of the data varies due to availability. Our hedged data span covers February 2006 to December 2019 whereas data begins in July 2007 for Indonesia, January 2008 for Colombia, and January 2010 for Chile.

2.3.4 Carry Trade Return Characteristics

We have three carry trade strategies. The first is equally weighted carry trade (EQW) strategy (Burnside et al., 2008). For each currency, if the interest rate of the foreign currency is higher than the U.S. interest rate, we go long on the foreign currency and short on the U.S. dollar and vice versa. We then compute the equally weighted average of all carry trade returns. The second strategy is the dollar carry strategy (Lustig et al., 2014). To calculate the carry returns in this strategy we use the average interest rate of the foreign currencies. Whenever the average interest rate of the foreign currencies is higher than the U.S. dollar interest rate, we go long on the foreign currencies and short on the U.S. dollar, and vice versa. Our last strategy is the dollar neutral (high minus low) strategy (Daniel et al., 2017). We go long for the first four currencies that have the highest interest rates and short for the last four currencies that have the lowest interest rates. In other words, we borrow from the lowest interest rate currencies and invest in the highest interest rate currencies. Lustig et al. (2014), Jurek et al.

Russia ruble, South Africa rand, South Korean won, Thailand baht and Turkish lira. These currencies have the highest FX turnover rates among the emerging markets excluding Chinese renminbi (BIS, 2019).

Table 2.1: Descriptive Statistics

	Equally Weighted (EQW)	Dollar Carry	Dollar Neutral	U.S. Stock Market
Full Sample (04/2004 - 12/2019)				
Mean	1.94	1.54	4.00	8.70
Std. Dev	6.82	8.49	8.47	14.03
Sharpe ratio	0.28	0.18	0.47	0.62
Post-Crisis (01/2010 - 12/2019)				
	Equally Weighted (EQW)	Dollar Carry	Dollar Neutral	U.S. Stock Market
Mean	0.29	-0.44	2.18	13.10
Std. Dev	6.88	8.23	8.01	12.97
Sharpe ratio	0.04	-0.05	0.27	1.01
Pre-Crisis (04/2004 - 08/2008)				
	Equally Weighted (EQW)	Dollar Carry	Dollar Neutral	U.S. Stock Market
Mean	5.86	6.82	7.61	2.54
Std. Dev	4.63	5.79	8.88	9.74
Sharpe ratio	1.27	1.18	0.86	0.26

Notes: The table presents the annualized mean, standard deviation, and Sharpe ratio on returns to different carry trade strategies and the US stock market. Carry trade strategies are the equally weighted carry strategy, dollar carry strategy and dollar neutral strategy. Robust standard errors are in parentheses. The strategies are conducted over the period April 2004 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and April 2004 to August 2008 for the pre-crisis period. For U.S. stock market excess returns, the value-weighted stock market is used from Kenneth French's database.

(2014), and Daniel et al. (2017) present evidence that the EQW carry trade and dollar carry strategies in G10 countries have significantly different returns than the dollar neutral strategy.

Table 2.1 reports the descriptive statistics of the different carry trade strategies and the excess returns to the value weighted U.S. stock market for the full sample (4/2004-12/2019), post-crisis (1/2010-12/2019) and pre-crisis (4/2004-8/2008). As one can see in the table, the annualized average return to equally weighted strategy, dollar carry strategy, and dollar neutral strategy are 1.94 percent, 1.54 percent and 4 percent, respectively, whereas the average excess return to the U.S. stock market is 8.70 percent. This suggests a poor return performance of each carry trade strategy compared to the U.S. stock market. During the sample period, the Sharpe ratio of the U.S. stock market (0.62) is higher than the carry trade strategies (0.28, 0.18 and 0.47 for EQW, dollar carry and dollar neutral strategies respectively). We observe that carry trade returns significantly decrease after the global financial crisis. The dollar carry strategy makes an average loss of 0.44 percent. Furthermore, the gap between the carry returns and U.S. stock market returns widens, not only because carry trade returns decrease but because U.S. stock market returns increase. During the post-crisis period, the Sharpe ratio of the U.S. stock market (1.01) is nearly five times higher than the dollar neutral carry trade strategy (0.27). The significant drop in carry returns in the post-crisis period seems to be in line with the findings of Burnside (2019), who argues that carry trades in developed markets became less profitable after 2007. He emphasizes that the fall in profitability can mostly be explained by the decrease in interest rate differentials since 2008. In the pre-crisis period, returns and Sharpe ratios of the carry strategies are higher than the U.S. stock market. Moreover, all three strategies perform better in comparison to the post-crisis period and dollar-neutral strategy has the highest return among the carry strategies. It is important to note that the U.S. stock market performance and carry performance show opposite characteristics. The U.S. stock market performance is better in post-crisis period whereas carry strategies' performances are better in pre-crisis period. To complement the analysis, we also report the crisis period (9/2008-12/2009). In the crisis period, U.S. stock market, EQW and dollar carry strategies have very low or negative returns (-3.89 percent, 1.33 percent and -1.02 percent respectively), whereas dollar neutral strategy outperforms the others with 5,64 percent returns.[6]

[6]We have no separate estimation for the global financial crisis period due to the limited observations available (16 months) for the crisis time.

In order to trace the historical developments of carry trade activities in the emerging markets, we are able to extend data back to 1997 for nine of our sample countries: Czechia, Hungary, India, Mexico, Philippines, Poland, South Africa, Thailand and Turkey. During the period from 1997 to 2007, the average annualized carry returns for the EQW portfolio and Sharpe ratio are 6.10 percent and 1.14, respectively. Between the years 2008 and 2019, the carry returns for the EQW portfolio and Sharpe ratio decrease to 0.6 percent and 0.08 respectively. The notable change after 2008 can be explained by the suppressed interest rates and heightened annualized volatility of the currencies (7.40 percent from 5.30 percent after 2008), suggesting that carry trades have lost its attractiveness for investors.[7]

Because the U.S. dollar is a low interest rate funding currency over 1990-2012, Jurek (2014) argues that returns from dollar neutral carry trade are found to be lower than from the EQW carry trade in G10 countries. In our sample of emerging countries, we observe that the dollar neutral strategy performs better than the EQW and dollar carry strategies particularly in the post-crisis period, because the appreciation of U.S. dollar was more than expected against our sample currencies. In other words, strong U.S. dollar works against the emerging markets' currencies after the financial crises.

Figure 2.1 shows the cumulative returns as a result of investing 100 U.S. dollars in April 2004 to carry portfolios (EQW, dollar carry and dollar neutral), the U.S. stock market, or Treasury bills. Based on these cumulative returns, we observe four major trends: First, until mid-2013, carry trade strategies perform better than the return from the U.S. stocks. After taper tantrum (May-June 2013), carry trade strategies perform losses; however, U.S. stocks earn notable profits. Second, the dollar neutral strategy consistently performs better than the other two carry

[7]Even by excluding the periods of financial crisis, we find that carry returns and Sharpe ratio for the EQW strategy are very low (0.8 percent and 0.12 respectively) during 2010-2019.

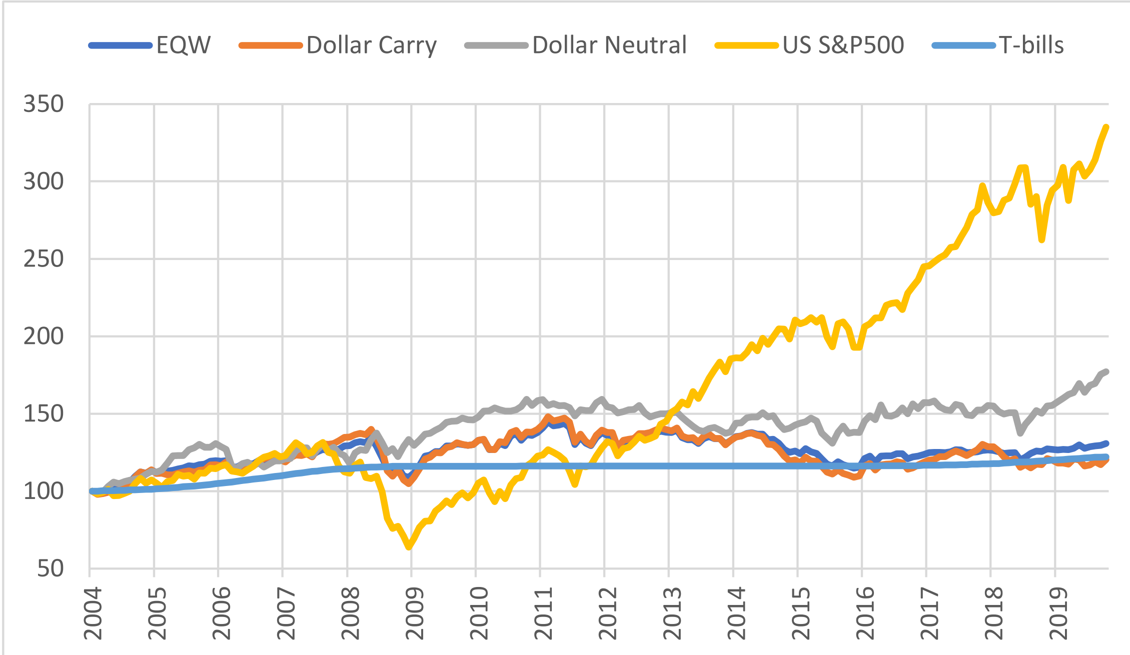

Figure 2.1: The Cumulative Returns of Different Investment Strategies: The cumulative returns as a result of investing 100 U.S. dollars in April 2004 to carry portfolios (equally weighted (EQW), dollar carry and dollar neutral), U.S. stock market (US S&P500), or Treasury bills (T-bills).

trade strategies. Third, return of EQW and dollar carry strategies are very close to each other. Fourth, the dollar carry strategy performs worse than the risk-free rate, and the EQW strategy hardly outperforms the risk-free rates.

2.3.5 Base Currencies

Most of the studies about carry trades use the U.S. dollar as the base currency, (i.e., funding currency.) However, there is evidence that investors take advantage of borrowing from other lower interest rate currencies, such as the Japanese yen and euro. Cabellero and Doyle (2012) find that when the Japanese yen is the base currency, carry trade returns have more than twice the carry returns as when the base currency is U.S. dollars. Daniel et al. (2017), on the other hand, calculate the carry returns for each of the G10 currencies when they are used as a base currency, and conclude that the U.S. dollar gives the largest profit as a base currency.

Table 2.2 presents the results obtained from the EQW carry returns based on U.S. dollars, the euro, and the Japanese yen. The U.S. dollar-based currency strategy has the lowest return (1.94 percent) and the lowest Sharpe ratio (0.28). The Sharpe ratio of the euro-based carry return (0.56) is twice the Sharpe ratio of the dollar-based returns. Despite its lower return than the Japanese yen, the euro has the highest Sharpe ratio due to the high volatility of Japanese yen-based carry returns. In the post-crisis period, carry returns from the U.S. dollar-based strategy decreased by more than 80 percent and Japanese-yen based returns halved; however, euro-based carry returns decrease by a much smaller amount. Similarly, euro-based carry returns have the highest Sharpe ratio. In the pre-crisis period, on the other hand, the Japanese yen-based strategy has slightly higher Sharpe ratio than the others. These results show, the euro-based carry returns perform way better than the other base currencies both in the full sample and particularly in the post-crisis period.

2.4. Risk Factors

In this section, we examine the association between risk factors and carry returns. In line with the literature, we divide risk factors into groups and examine the relationship between risk factors and carry returns separately. The first group consists of the equity factors (traditional). The second and third group include non-currency-based factors and currency-based factors respectively. In order to understand the risk factors affecting the carry trade, we perform a linear regression analysis (OLS) which is widely used in the literature (see e.g. Gilmore and Hayashi, 2011; Doukas and Zhang, 2013; Cenedese et al., 2014) between the

Table 2.2: Carry Trade Base Currency

	U.S. dollar based	Euro based	Japanese yen based
	Full Sample (04/2004 - 12/2019)		
Mean	1.94	3.27	3.87
Std. Dev	6.82	5.84	11.29
Sharpe ratio	0.28	0.56	0.34
	Post-Crisis (01/2010 - 12/2019)		
	U.S. dollar based	Euro based	Japanese yen based
Mean	0.29	2.87	1.95
Std. Dev	6.88	5.81	10.40
Sharpe ratio	0.04	0.50	0.19
	Pre-Crisis (04/2004 - 08/2008)		
	U.S. dollar based	Euro based	Japanese yen based
Mean	5.86	5.03	12.47
Std. Dev	4.63	5.45	8.61
Sharpe ratio	1.27	0.92	1.45

Notes: The table presents the annualized mean, standard deviation and Sharpe ratio of the equally weighted carry return strategy based on U.S. dollars, the euro and Japanese yen. Robust standard errors are in parentheses. Results are conducted over the period April 2004 to December 2019 for the full sample and January 2010 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and April 2004 to August 2008 for the pre-crisis period.

carry returns (Z_t) and risk factors (X_t) as in equation (6):

$$Z_t = \alpha + \beta * X_t + \epsilon_t \quad (2.6)$$

2.4.1 Traditional Risk Factors

The association between traditional risk factors (CAPM and the Fama-French factors) on carry returns has been a substantive debate in the literature. Burnside (2012) highlights that carry trade returns are correlated with stock returns in the post-Bretton Woods period, but the market beta of the carry trade is far too small to explain its high average return. Although theoretically there is some consensus on the possible association between traditional risk factors and carry returns (Mark, 1988; McCurdy and Morgan, 1991), the evidence show almost no consistently significant correlation between them. In a rather small sample of currencies from G10 countries, Daniel et al. (2017) show that dollar neutral trade strategy is correlated with these factors during the sample period of February 1976 to August 2013.

In the chapter, our first traditional risk factor is the CAPM factor, which uses the market excess returns of the U.S. stock market. The second traditional risk factor comes from the Fama-French (1993) three-factor model. Three factors are the excess return of the U.S. stock markets ($R_m - R_f$) where the risk free rate is the one-month Treasury bill rate, the SMB (Small Minus Big) which is the average return difference of the small portfolios and the big ones and the HML (High Minus Low), which is the average return difference of the value and the growth portfolios. The data come from Kenneth French's website.[8]

[8] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

2.4.2 Non-Currency-based Risk Factors

We investigate whether risk factors that are not related to the currencies have any effect on the carry returns. Our first non-currency-based risk factor is the global risk aversion proxied by the VIX index, which is the implied volatility of the S&P 500 Index. Brunnermeier et al. (2009) show that an increase in the VIX, which indicates a decrease in the global risk appetite, coincides with the carry trade losses by unwinding the speculator carry positions. VIX data comes from Bloomberg, and we use innovations in the VIX index simply by taking its first differences, as in Menkhoff et al. (2012). Our second non-currency-based risk factor is the funding liquidity which is proxied by TED spread, difference between the London Interbank Offer Rate (LIBOR) and the risk-free Treasury bill rate. We obtain TED spread data from Bloomberg, and use it as an innovation. As emphasized by Brunnermeier et al. (2009) and Doukas and Zhang (2013), a higher TED spread causes funding liquidity to be tighter and leads carry trade positions to decrease, which leads to a decline the carry returns.

Our third and fourth non-currency-based risk factors are global uncertainty[9] from Berg and Mark (2018) and the geopolitical index[10] from Filippoi et al. (2019) respectively. An increase in the global uncertainty or the geopolitical risk indicator is expected to decrease the carry returns. Our last non-currency-based risk factor is the global downside market risk factor (GlobDownsideRisk). Ang et al. (2006) underline that investors in the stock market need additional premium

[9]Baker et al. (2016) construct indices for 21 countries which are Australia, Brazil, Canada, Chile, China, Colombia, France, Germany, Greece, India, Ireland, Italy, Japan, Mexico, the Netherlands, Russia, South Korea, Spain, Sweden, the United Kingdom, and the United States. Global macro uncertainty index is the GDP-weighted average of all countries. We download the index from their website: `https://www.policyuncertainty.com/index.html`

[10]Caldara and Iacoviello (2018) constructed the geopolitical index by using newspaper coverage about the geopolitical tensions in the world and Filippoi et al. (2019) show that geopolitical risk index captures the global events that affect the carry returns. The data is from Matteo Iacoviello's website: `https://www.matteoiacoviello.com/gpr.htm`

for stocks that have high sensitivities to downside market movements. Dobrynskaya (2014), Lettau et al. (2014), and Jurek (2014) also provide supporting evidence that the high returns to carry trades are fair compensation for their high downside market risk. In the chapter, we use the downside risk factor from Byrne et al. (2018). It is a dummy variable which takes a value of one when the S&P500 Index has negative excess returns and zero otherwise. We then multiply the excess returns with the dummy variable. The market return data are obtained from Kenneth French's website.

2.4.3 Currency-Based Risk Factors

There are several currency-based risk factors, mostly designed for developed markets, proposed in the literature to explain the carry trade returns. In the chapter, we study four of those factors to test whether they have an impact on the carry returns of the emerging markets. Our first currency-based risk factor is the dollar risk factor (Dol), which is the average excess carry trade return of 37 currencies[11] (Lustig et al., 2011).

The second risk factor is the Global FX volatility (FXVol) proxied by Menkhoff et al. (2012). We calculate FXVol by using the daily absolute returns of spot exchange rates in our sample currencies. We take the average of all currencies for a given day and then take the average of the days to obtain our monthly global volatility. In the regression analyses, we use the innovations of the FXVol by taking the first differences. We expect a negative correlation between the FXVol and carry returns as in Menkhoff et al. (2012). Using data from advanced and emerging countries, Menkhoff et al. (2012) document that the increase in the FX

[11]Our sample includes 37 currencies from Australia, Brazil, Bulgaria, Canada, Colombia, Chile, Croatia, Czechia, Denmark, Euro area, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Japan, Kuwait, Malaysia, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Sweden, Switzerland, Taiwan, Thailand, Turkey, and United Kingdom. Our data comes from the Datastream.

volatility leads to a decline in the carry trade positions which in turn reduces the returns.

Our third risk factor is the global FX liquidity (FXLiq), which we proxy by analogous to the Menkhoff (2012). We take the bid-ask spreads of the spot currencies of our currencies. We then average spreads across currencies for a given day. Finally, we average the days to calculate our monthly global FX liquidity indicator. Higher spread indicates lower liquidity which is associated with the decrease in carry returns (Karnaukh et al. 2015).

Our last risk factor is the skewness factor (Skew). Brunnermeier et al. (2009) argue that negative skewness[12] is the property of high investment currencies which are subject to crash risks. Following Rafferty (2012), we construct a factor by calculating the intra-month realized skewness of the currencies. We sort the currencies into two groups according to their forward premiums. We measure the skewness of the currencies for the forward premium as calculated and take the negative of the skewness of the currencies with a forward discount. We then take the average of the currencies' skewness.

2.5. Results

2.5.1 Traditional Risk Factors

Table 2.3 presents the association between traditional risk factors and carry trade returns.[13] In the table, we only report for the EQW carry return strategy and dollar neutral strategy because of the high correlation between the EQW carry

[12]We denote the exchange rates as foreign currency per U.S. dollar opposite to Brunnermeier et al. (2009). Therefore, our investment currencies, have positive skewness.

[13]All of the risk factors are standardized to make comparisons about their magnitudes.

and dollar carry strategies.[14] First, we report the alphas of the EQW strategy and the dollar neutral strategy, which are zero, after controlling only the CAPM factor over the full sample period. The coefficients of CAPM on both strategies are positive and statistically significant. The magnitude of the coefficient of CAPM on EQW is much higher than the dollar neutral portfolio. The R-square of EQW (0.343) is almost seven times larger than the R-square of the dollar neutral portfolio (0.048).

In the model with CAPM and Fama-French factors, we document that the CAPM factor covaries with both of the alternative carry trade strategies while Fama-French factors (SMB and HML) do not load any of them. The estimates of the CAPM are similar to the estimates in the Fama-French risk factors, in which CAPM loads more to the EQW and less to the dollar neutral strategy. As seen in the table, all of our findings continue to hold during the post-crisis period. However, in the pre-crisis period, alphas are not zero after controlling for the CAPM factor which demonstrates that the CAPM factor fails to explain the returns in the carry strategies. Thus, we have three major findings. First, we show that only the CAPM factor, not the other Fama-French factors, has explanatory power on carry returns. Second, we find that the CAPM factor explains the EQW strategy more than the dollar neutral portfolio particularly in the post-crisis period which is a contrast to what exists in G10 countries (Daniel et al., 2017). Third, we show that the relationship between the carry returns and the CAPM factor changed after the global financial crisis. Significant alphas indicate that in the pre-crisis period CAPM factor is not sufficient to explain the carry returns.

[14]The correlation between the EQW strategy and dollar carry strategy is 0.93. To save space, we don't report the findings for the dollar carry strategy, but the results are also valid for the dollar carry strategy.

Table 2.3: Carry Trade and Traditional Risk Factors

	Full Sample (04/2004 - 12/2019)				Post-Crisis (01/2010 - 12/2019)				Pre-Crisis (04/2004 - 08/2008)			
	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral
CAPM	1.153***	0.538***	1.197***	0.520**	1.151***	0.516**	1.242***	0.513**	0.794***	1.414***	0.852***	1.411**
	[0.145]	[0.194]	[0.160]	[0.220]	[0.232]	[0.207]	[0.228]	[0.227]	[0.229]	[0.495]	[0.225]	[0.534]
SMB			-0.200	0.019			-0.279*	-0.150			-0.048	0.100
			[0.135]	[0.193]			[0.167]	[0.224]			[0.249]	[0.435]
HML			0.136	0.050			0.190	0.543*			0.255	0.456
			[0.151]	[0.265]			[0.210]	[0.294]			[0.260]	[0.566]
Constant	0.162	0.333	0.162	0.333	-0.080	0.135	-0.085	0.159	0.589**	0.813**	0.560**	0.746**
	[0.116]	[0.214]	[0.116]	[0.215]	[0.161]	[0.205]	[0.161]	[0.200]	[0.227]	[0.317]	[0.209]	[0.316]
R-squared	0.343	0.048	0.356	0.049	0.286	0.042	0.309	0.088	0.170	0.147	0.189	0.164

Notes: The table reports regressions of returns to two carry trade strategies on the three Fama and French (1993) traditional risk factors: CAPM - the excess return of the U.S. stock markets ($R_m - R_f$) where the risk free rate is the one-month Treasury bill rate), SMB (Small Minus Big) - the average return difference of the small portfolios and the big ones and the HML (High Minus Low) - the average return difference of the value and the growth portfolios. Robust standard errors are in parentheses. Results are conducted over the period April 2004 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and April 2004 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

2.5.2 Non-Currency-Based Risk Factors

Table 2.4 presents the association between non-currency-based risk factors and carry returns. We have three non-currency-based risk factors, which are innovations in the TED spread, the economic policy uncertainty index (EPU), and the geopolitical index (GEO Risk) in all regressions. We add either innovation in the VIX index or downside risk to the models due to their high correlation (0.70) during the sample period. As reported in the table, the alpha of the EQW strategy is zero after controlling the risk factors. Moreover, only the innovation in the VIX index has a significant and negative coefficient, suggesting that positive changes in the VIX index leads to lower carry returns.

When we use downside risk instead of innovation in the VIX index, the results do not change materially/noticeably. Downside risk loads the EQW strategy, which one can expect considering that all of the currencies in our sample are from emerging market economies and thus susceptible to downside risk. Moreover, the innovation in TED spread is found to load the EQW strategy in the model with downside risk, which implies that relation between the innovation TED spread and carry returns of equally weighted portfolios is faded by innovation in the VIX index in the full period.

Although innovation in the VIX index significantly and negatively covaries with the dollar neutral strategy, the size of the coefficient is half of the coefficient of the EQW strategy. R-squares of the dollar neutral strategy models are one-fourth the size of the R-squares of the EQW strategy models. As in traditional risk factors, we have weak evidence that the non-currency-based risk factors can explain the returns from dollar neutral strategies in the emerging market economies during the sample period. In the post-crisis period, the results are very

Table 2.4: Carry Trade and Non-Currency Based Risk Factors

	Full Sample (04/2004 - 12/2019)				Post-Crisis (01/2010 - 12/2019)				Pre-Crisis (04/2004 - 08/2008)			
	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral
D(VIX)	-1.951***	-0.966**			-1.932***	-0.888**			-1.202***	-3.482***		
	[0.273]	[0.376]			[0.405]	[0.393]			[0.584]	[1.199]		
D(TED)	-0.076	-0.370	-0.481***	-0.582*	0.421	1.875	0.395	1.870	-0.363**	-0.982**	-0.344	-0.979**
	[0.188]	[0.354]	[0.147]	[0.327]	[0.866]	[1.454]	[0.901]	[1.478]	[0.174]	[0.382]	[0.207]	[0.428]
EPU	-0.058	-0.104	0.160	-0.019	0.223	0.099	0.404	0.184	0.384	-0.317	0.678**	0.275
	[0.129]	[0.181]	[0.132]	[0.187]	[0.196]	[0.245]	[0.289]	[0.247]	[0.299]	[0.698]	[0.289]	[0.786]
GEO	-0.059	0.012	-0.176	-0.036	-0.056	0.051	-0.076	0.042	0.224	0.115	0.112	-0.160
	[0.113]	[0.169]	[0.122]	[0.169]	[0.131]	[0.177]	[0.142]	[0.178]	[0.267]	[0.525]	[0.216]	[0.497]
Downside Risk			1.006***	0.422*			1.108***	0.520**			0.658***	1.188*
			[0.171]	[0.214]			[0.349]	[0.246]			[0.230]	[0.604]
Constant	0.167	0.339	0.169	0.34	-0.059	0.121	-0.199	0.055	0.975	0.481	1.144	0.809
	[0.120]	[0.214]	[0.124]	[0.216]	[0.166]	[0.221]	[0.191]	[0.226]	[0.619]	[0.753]	[0.727]	[0.777]
R-squared	0.316	0.070	0.275	0.052	0.274	0.055	0.212	0.047	0.157	0.257	0.194	0.175

Notes: The table reports regressions of returns to two carry trade strategies on the non-currency based risk factors. Risk factors are the implied volatility of S&P500 Index (VIX), difference between the LIBOR and risk-free Treasury bill rate (TED spread), economic policy uncertainty index (EPU), geopolitical risk index (GEO) and downside risk. Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Robust standard errors are in parentheses. Results are conducted over the period April 2004 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and April 2004 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

similar to the full sample period in a sense that only TED spread is not significant on the post-crisis period. When we examine the pre-crisis period, we find that VIX index, downside risk and TED spread load to the carry returns. Moreover, explanatory power of these factors on dollar neutral strategy is higher compared to full period and post-crisis period. Thus, it is interesting to note that it becomes more difficult to explain the dollar neutral strategy with the non-currency based risk factors especially during the post-crisis period. Overall, our empirical findings show that mainly innovation in the VIX index and downside risk are the non-currency-based risk factors that explain the returns of the EQW strategy in all periods. On the other hand, although these two factors are statistically significant on the returns of the dollar neutral strategy, the explanatory power of those factors is weak except the pre-crisis period. Similar to our findings with the traditional factors, during the post-crisis period, it becomes harder to explain the returns of the dollar neutral strategy than those of the EQW portfolio strategy.

2.5.3 Currency-Based Risk Factors

Table 2.5 reports the results of the currency-based-risk factors on carry returns. We use dollar risk factor (Dol), global FX volatility (FXVol), global FX liquidity (FXLiq) and the global skewness factor (Skew). We cannot find any significant association of the variables, other than Dol and FXVol on the EQW strategy. Dol, average carry return of all currencies (developed and emerging currencies), together with the FXVol, explain the carry return of the EQW strategy with the R-square of 82 percent. High explanatory power might be expected as it is underlined by Burnside (2012), and the dollar factor, by construction is related to the carry returns. In case of the dollar neutral strategy, the dollar factor and global FX volatility factor explain the carry returns in the emerging markets. These findings are again in line with the Burnside (2012); however, the

Table 2.5: Carry Trade and Currency Based Risk Factors

	Full Sample (04/2004 - 12/2019)		Post-Crisis (01/2010 - 12/2019)		Pre-Crisis (04/2004 - 08/2008)	
	EQW	Dollar Neutral	EQW	Dollar Neutral	EQW	Dollar Neutral
Dol	1.730***	0.432**	1.827***	0.859***	1.414***	-0.139
	[0.083]	[0.215]	[0.097]	[0.231]	[0.186]	[0.528]
Skew	-0.073	-0.216	-0.124	-0.362*	-0.029	-0.022
	[0.061]	[0.171]	[0.079]	[0.189]	[0.169]	[0.504]
D(FXVol)	-0.158**	-0.707***	-0.240**	-0.327	-0.594**	-2.539***
	[0.078]	[0.208]	[0.098]	[0.371]	[0.234]	[0.641]
Fxliq	0.044	0.150	0.023	0.230	0.447*	0.449
	[0.076]	[0.239]	[0.079]	[0.229]	[0.224]	[0.489]
Constant	0.161	0.338	0.105	0.273	0.136	0.616
	[0.112]	[0.216]	[0.074]	[0.213]	[0.183]	[0.492]
R-squared	0.820	0.156	0.838	0.183	0.674	0.336

Notes: The table reports regressions of returns to two carry trade strategies on the currency based risk factors. Risk factors are dollar factor (Dol), skewness (Skew), global FX volatility (FXVol) and global FX liquidity (FXliq). Carry strategies are equally weighted (EQW) and dollar neutral carry strategies. Robust standard errors are in parentheses. Results are conducted over the period April 2004 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and April 2004 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

explanatory power of the risk factors are too low compared to the EQW strategy. Similar to other risk factors, currency-based risk factors are more successful in explaining carry returns for the EQW strategy. Results of the post-crisis period are mostly in line with the full sample, although the significance of FX volatility vanishes for the dollar neutral strategy and skewness becomes significant. Similarly, results for the pre-crisis period are in line with the full sample, while Dol factor is not significant in the dollar neutral strategy.

2.6. Hedged Carry Trade

In this section, we focus on how hedging strategies change our findings considering high crash risk or peso problems in the emerging economies. In particular, we examine whether using options to hedge carry trades has significant effects on the profitability of carry returns. The data start from February 2006 due to availability. Table 2.6 reports descriptive statistics for hedged and unhedged carry trade strategies. The average returns for hedged carry trades are reported for the 10 delta (far out-of-the-money option), 25 delta (out-of-the-money option), and at-the-money (ATM) option strategies. The more the option is "out-of-the-money," the lower the option premia. Thus, 10 deltas options have the lowest premia whereas ATM options have the highest premia.

Four key features are worth noting: First, in this shorter full sample, the returns of unhedged carry trades are smaller than the returns in the longer sample period (from February 2004 to December 2019 that we reported in Section 4). The annualized average returns are 0.92 percent for the EQW strategy, 0.60 percent for the dollar carry strategy, and 3.06 for the dollar neutral strategy, whereas they are 1.94 percent, 1.54 percent and 4.00 percent, respectively, for the longer period. It is also striking to note that between April 2004 and January 2006, the average returns to carry strategies are 9.67 for the EQW strategy, 8.75 for the dollar carry strategy and 13.82 for the dollar neutral strategy. These high returns of carry trades are due to the relatively low volatility of the exchange rates between 2003 and 2007 (Zurawski and D'Arcy, P., 2009).

Second, in each carry strategy, options-hedged average carry returns are lower than the unhedged average returns. Average returns for the 10 delta options are the highest and close to the unhedged returns whereas returns for the ATM

Table 2.6: Hedged Carry Return - Descriptive Statistics

	Panel A: Full Sample (02/2006 - 12/2019)											
				Hedged Carry Returns								
	Unhedged Carry Returns			EQW			Dollar Carry			Dollar Neutral		
	EQW	Dollar Carry	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Mean	0.92	0.60	3.06	0.30	-0.14	-0.57	-0.21	-0.68	-0.82	2.12	1.66	0.92
Std Dev	7.05	8.78	8.86	6.25	5.03	3.32	7.82	6.34	4.03	7.46	6.52	5.49
Sharpe ratio	0.13	0.07	0.35	0.05	-0.03	-0.17	-0.03	-0.11	-0.20	0.28	0.25	0.17
	Panel B: Post-Crisis (01/2010-12/2019)											
				Hedged Carry Returns								
	Unhedged Carry Returns			EQW			Dollar Carry			Dollar Neutral		
	EQW	Dollar Carry	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Mean	0.29	-0.44	2.18	-0.41	-0.64	-0.78	-1.26	-1.45	-1.34	0.92	0.50	0.37
Std Dev	6.88	8.23	8.01	6.15	4.97	3.29	7.40	5.99	3.87	7.08	6.18	5.09
Sharpe ratio	0.04	-0.05	0.27	-0.07	-0.13	-0.24	-0.17	-0.24	-0.35	0.13	0.08	0.07
	Panel C: Pre-Crisis (02/2006-08/2008)											
				Hedged Carry Returns								
	Unhedged Carry Returns			EQW			Dollar Carry			Dollar Neutral		
	EQW	Dollar Carry	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Mean	3.15	5.46	6.26	2.63	1.73	0.62	4.58	3.25	2.25	4.93	2.91	0.66
Std Dev	4.83	6.00	10.56	4.03	3.19	2.18	5.29	4.50	3.06	9.02	7.63	5.51
Sharpe ratio	0.65	0.91	0.59	0.65	0.54	0.28	0.87	0.72	0.73	0.55	0.38	0.12

Notes: The table presents the annualized mean, standard deviation and Sharpe ratio on returns to different hedged and unhedged carry trade strategies. Carry trade strategies are the EQW carry strategy, dollar carry strategy and dollar neutral strategy. Hedged carry strategies are the 10 delta out-of-the-money strategy (10Δ), 25 delta out-of-the money strategy (25Δ) and at-the-money delta strategy (ATM). Robust standard errors are in parentheses. The strategies are conducted over the period February 2006 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis and crisis period.

options are the lowest. This result is consistent with the price of the options. Moreover, the difference between the hedged and unhedged carry returns is not as small as previous studies have documented for advanced economies (see e.g., Burnside et al., 2011; Cabellero and Doyle, 2012). Prior evidence shows that using FX options is a less expensive way to hedge carry trades. However, we find that this is not the case for the emerging markets. The difference between unhedged returns and ATM hedged returns becomes more pronounced. For example, the EQW unhedged carry strategy produces a return of 0.92 percent, whereas there is a return of -0.57 percent for the hedged carry return using ATM options. The main reason behind the large difference could be the volatility risk in currency options in the emerging markets, which makes the option prices more expensive than in the developed markets.

Third, we present that hedged carry trades have lower standard errors than unhedged carry trades. For example, for the unhedged EQW strategy, standard error is 7.05 whereas it drops to 3.32 for the EQW ATM strategy. This result reflects that options work well to curb some of the carry trade losses.

Fourth, when we divide the whole sample into two sub-periods: pre-crisis and post-crisis, we find that nearly all hedged returns of the EQW and dollar carry strategies are less than the dollar neutral strategy in the post-crisis period. Moreover, we show that the dollar carry strategy has the lowest Sharpe ratio in the post-crisis period but has the highest Sharpe ratio in the pre-crisis period which verifies the findings of Jurek (2014). This result reflects that using the dollar as a base currency worsens the carry returns of the emerging markets' currencies in the post-crisis period.

2.6.1 Risk Factor Analysis of Hedged Carry Strategies

Traditional Risk Factors

Table 2.7 reports the association between the CAPM factor and hedged and unhedged carry returns. The alphas of the unhedged EQW strategy and dollar neutral strategy are zero after controlling for the CAPM factor. Similar to our previous findings, the magnitude of the coefficient on the CAPM factor in the EQW strategy indicates a larger association compared to the dollar neutral portfolio. As reported in the table, hedging the carry trade returns reduces the exposure of CAPM factor only on dollar neutral 25 delta and dollar neutral ATM strategies. We also report our findings during the post-crisis period and pre-crisis period. The effect of CAPM factor on the sub-periods are similar to the whole/full period. However, explanatory power of CAPM on dollar-neutral strategies in the pre-crisis period is more than the post-crisis period and the whole/full period which indicates the declining power of CAPM factor on the dollar neutral strategy after the post-crisis period.

Table 2.8 presents the association between carry returns to hedged and unhedged trades and the Fama-French (1993) risk factors. We find that the CAPM explains a reasonable amount of carry trade returns but SMB and HML hardly load to the carry trade returns. The results of this table are no different from the previous table, which strengthens the idea that only the CAPM factor is significant on explaining the carry return. These results, together with the ones in Table 7, demonstrate that using FX options to hedge carry trades do not reduce the exposure to traditional risk factors, and particularly to the CAPM factor.

Table 2.7: Hedged Carry Trade and Traditional (CAPM Factor) Risk Factors

	Unhedged Carry Returns		Hedged Carry Returns					
			EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Panel A: Full Sample (02/2006 - 12/2019)								
CAPM	1.193***	0.539**	1.044***	0.820***	0.463***	0.380**	0.193	0.021
	[0.158]	[0.218]	[0.141]	[0.124]	[0.103]	[0.163]	[0.169]	[0.172]
Constant	0.082	0.255	0.025	-0.012	-0.047	0.177	0.138	0.077
	[0.129]	[0.194]	[0.114]	[0.093]	[0.065]	[0.165]	[0.145]	[0.123]
R-squared	0.342	0.044	0.335	0.319	0.233	0.031	0.010	0.000
Panel B: Post-Crisis (01/2010 - 12/2019)								
CAPM	1.151***	0.516**	1.108***	0.898***	0.556***	0.530***	0.446**	0.254
	[0.232]	[0.207]	[0.198]	[0.149]	[0.111]	[0.191]	[0.197]	[0.194]
Constant	-0.080	0.135	-0.129	-0.13	-0.112	0.031	0.003	0.01
	[0.161]	[0.205]	[0.139]	[0.110]	[0.073]	[0.182]	[0.161]	[0.137]
R-squared	0.286	0.042	0.307	0.309	0.271	0.053	0.049	0.024
Panel C: Pre-Crisis (02/2006 - 08/2008)								
CAPM	0.463**	1.992***	0.374*	0.332*	0.269**	1.708**	1.401**	1.084***
	[0.223]	[0.680]	[0.202]	[0.176]	[0.131]	[0.625]	[0.509]	[0.352]
Constant	0.359	0.919	0.295	0.210	0.105	0.752*	0.521	0.271
	[0.253]	[0.569]	[0.224]	[0.177]	[0.118]	[0.413]	[0.365]	[0.271]
R-squared	0.158	0.210	0.153	0.166	0.193	0.220	0.206	0.237

Notes: The table reports regressions of returns to two hedged and unhedged carry trade strategies on the U.S. market excess return (CAPM). Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Hedged carry strategies are the 10 delta out-of-the-money strategy (10Δ), 25 delta out-of-the-money strategy (25Δ) and at-the-money delta strategy (ATM). Robust standard errors are in parentheses. Results are conducted over the period February 2006 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 2.8: Hedged Carry Trade and Traditional (CAPM and Fama-French) Risk Factors

	Full sample (02/2006 -12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
CAPM	1.247***	0.547***	1.091***	0.859***	0.485***	0.383**	0.186	0.000
	[0.173]	[0.240]	[0.154]	[0.134]	[0.110]	[0.182]	[0.178]	[0.175]
SMB	-0.23	-0.001	-0.225*	-0.187*	-0.089	0.039	0.093	0.151
	[0.147]	[0.215]	[0.132]	[0.105]	[0.071]	[0.183]	[0.153]	[0.124]
HML	0.103	-0.029	0.125	0.103	0.035	-0.067	-0.103	-0.125
	[0.165]	[0.275]	[0.148]	[0.112]	[0.075]	[0.221]	[0.200]	[0.192]
Constant	0.082	0.255	0.025	-0.012	-0.047*	0.177	0.138	0.077
	[0.128]	[0.195]	[0.113]	[0.092]	[0.065]	[0.165]	[0.146]	[0.123]
R-squared	0.355	0.045	0.352	0.338	0.242	0.032	0.015	0.013
	Post-Crisis (01/2010-12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
CAPM	1.242***	0.513**	1.202***	0.983**	0.601***	0.526**	0.453**	0.218
	[0.228]	[0.227]	[0.195]	[0.145]	[0.106]	[0.213]	[0.204]	[0.197]
SMB	-0.279*	-0.150	-0.259*	-0.218*	-0.106	-0.101	-0.078	0.055
	[0.167]	[0.224]	[0.151]	[0.117]	[0.076]	[0.206]	[0.175]	[0.135]
HML	0.190	0.543*	0.142	0.068	0.007	0.405*	0.223	0.109
	[0.210]	[0.294]	[0.195]	[0.154]	[0.100]	[0.243]	[0.190]	[0.142]
Constant	-0.085	0.159	-0.137	-0.138	-0.117	-0.0036	0.005	0.015
	[0.161]	[0.200]	[0.138]	[0.109]	[0.073]	[0.179]	[0.160]	[0.137]
R-squared	0.309	0.088	0.329	0.329	0.281	0.083	0.062	0.029
	Pre-Crisis (02/2006-08/2008)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
CAPM	0.490**	1.860***	0.415*	0.369*	0.285*	1.640**	1.354**	1.049**
	[0.173]	[0.591]	[0.223]	[0.190]	[0.148]	[0.638]	[0.551]	[0.384]
SMB	-0.200	0.864	-0.236	-0.182	-0.070	0.472	0.403	0.282
	[0.460]	[0.785]	[0.378]	[0.285]	[0.168]	[0.569]	[0.456]	[0.355]
HML	-0.064	0.118	0.028	0.085	0.057	0.110	0.226	0.132
	[0.425]	[0.877]	[0.352]	[0.280]	[0.186]	[0.686]	[0.570]	[0.396]
Constant	0.362	0.918	0.291	0.202	0.101	0.748*	0.509	0.264
	[0.241]	[0.544]	[0.213]	[0.171]	[0.119]	[0.425]	[0.377]	[0.283]
R-squared	0.174	0.264	0.182	0.198	0.207	0.244	0.236	0.263

Notes: The table reports regressions of returns to two hedged and unhedged carry trade strategies on the three Fama and French (1993) traditional risk factors which are CAPM- the excess return of the U.S. stock markets (R_m-R_f) where the risk free rate is the one-month Treasury bill rate, the SMB (Small Minus Big) is the average return difference of the small portfolios and the big ones and the HML (High Minus Low) is the average return difference of the value and growth portfolios. Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Hedged carry strategies are 10 delta out-of-the money strategy (10Δ), 25 delta out-of-the money strategy (25Δ), and at-the-money delta strategy (ATM). Robust standard errors are in parentheses. Results are conducted over the period February 2006 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

Non-Currency Based Risk Factors

Table 2.9 presents the hedged and unhedged carry trade returns, controlling for non-currency-based risk factors such as innovations in the VIX index, innovations in TED spread, the EPU and GEO. We observe that although the explanatory power of the models decreases with hedging, the VIX index has a significant association with all unhedged and hedged EQW strategies. This indicates that using options does not provide satisfactory protection for the changes in the VIX index for EQW strategy. Similarly, the VIX index loads to the unhedged dollar neutral and dollar neutral 10 delta strategies. However; the dollar neutral 25 delta and dollar neutral ATM strategies are not affected by the VIX index. Moreover, the explanatory power of the risk factors on any of the dollar neutral strategies is very low compared to the EQW strategies.

We do not find any significant effect of other variables on any of the carry return strategies. When we look at the sub-periods, the results are similar for the post crisis period, except in the case of the EQW 25 delta and the EQW ATM strategy, where EPU coefficients become significant in the post-crisis period. It is expected that the EPU coefficient should be negative, because an increase in EPU loads negatively to carry returns. However, hedging protects the investor against policy uncertainty. For the pre-crisis period, results are similar with the full sample but TED spread is also significant in both of the carry strategies. Innovation in VIX index is also effective in hedged returns of dollar neutral strategy. Moreover, R-squares of the dollar neutral strategies are much higher than the full period and post crisis period which demonstrate that non-currency based risk factors seems to be more successful to explain the dollar neutral carry strategies in the pre-crisis period.

In Table 2.10, we report our findings with downside risk instead of VIX index.

Table 2.9: Hedged Carry Trade and Non-Currency Based Risk Factors (with VIX)

	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Full sample (02/2006 -12/2019)								
D(VIX)	-2.014***	-1.059**	-1.672***	-1.177***	-0.582***	-0.589*	-0.21	0.184
	[0.291]	[0.415]	[0.260]	[0.220]	[0.174]	[0.312]	[0.283]	[0.273]
D(TED)	-0.03	-0.138	-0.012	0.014	0.016	-0.219	-0.21	-0.091
	[0.210]	[0.377]	[0.204]	[0.183]	[0.133]	[0.293]	[0.315]	[0.301]
EPU	0.007	-0.051	0.052	0.091	0.101	0.011	0.141	0.204
	[0.140]	[0.204]	[0.127]	[0.105]	[0.071]	[0.170]	[0.154]	[0.130]
GEO	-0.077	0.043	-0.078	-0.051	-0.015	0.053	0.022	0.062
	[0.119]	[0.180]	[0.105]	[0.088]	[0.062]	[0.148]	[0.126]	[0.104]
Constant	0.082	0.244	0.026	-0.011	-0.046	0.163	0.138	0.08
	[0.133]	[0.195]	[0.121]	[0.102]	[0.071]	[0.166]	[0.147]	[0.123]
R-squared	0.314	0.062	0.275	0.207	0.121	0.033	0.015	0.024
Post-Crisis (01/2010 - 12/2019)								
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
D(VIX)	-1.932***	-0.888**	-1.775***	-1.307***	-0.716***	-0.755**	-0.365	0.024
	[0.405]	[0.393]	[0.339]	[0.252]	[0.178]	[0.378]	[0.355]	[0.327]
D(TED)	0.421	1.875	0.309	0.386	0.339	1.124	0.49	0.882
	[0.866]	[1.454]	[0.856]	[0.738]	[0.535]	[1.353]	[1.310]	[1.050]
EPU	0.223	0.009	0.254	0.250*	0.188**	0.115	0.15	0.143
	[0.196]	[0.245]	[0.171]	[0.135]	[0.085]	[0.220]	[0.194]	[0.155]
GEO	-0.056	0.051	-0.054	-0.029	0.002	0.083	0.094	0.124
	[0.131]	[0.177]	[0.115]	[0.093]	[0.064]	[0.153]	[0.130]	[0.108]
Constant	-0.059	0.121	-0.097	-0.117	-0.115	0.024	-0.016	-0.028
	[0.166]	[0.221]	[0.145]	[0.119]	[0.081]	[0.186]	[0.163]	[0.136]
R-squared	0.274	0.055	0.276	0.241	0.182	0.045	0.023	0.028
Pre-Crisis (02/2006 - 08/2008)								
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
D(VIX)	-0.891**	-4.298**	-0.677**	-0.613*	-0.488*	-3.020**	-2.916***	-2.101***
	[0.371]	[1.726]	[0.288]	[0.314]	[0.256]	[1.274]	[0.967]	[0.649]
D(TED)	-0.323**	-0.653*	-0.345**	-0.332**	-0.209*	-0.767***	-0.658**	-0.345
	[0.138]	[0.341]	[0.131]	[0.121]	[0.104]	[0.273]	[0.262]	[0.248]
EPU	0.161	-0.237	0.116	0.123	0.032	-0.543	-0.241	-0.135
	[0.360]	[0.827]	[0.330]	[0.272]	[0.207]	[0.736]	[0.586]	[0.422]
GEO	-0.143	0.674	-0.212	-0.283	-0.306*	0.390	0.051	-0.186
	[0.419]	[1.145]	[0.355]	[0.273]	[0.162]	[0.835]	[0.731]	[0.516]
Constant	0.429	0.635	0.310	0.221	0.022	0.079	0.162	-0.025
	[0.529]	[1.124]	[0.484]	[0.391]	[0.281]	[0.997]	[0.819]	[0.597]
R-squared	0.110	0.295	0.124	0.191	0.235	0.255	0.298	0.279

Notes: The table reports regressions of returns to two carry trade strategies on the non-currency based risk factors. Risk factors are the implied volatility of SP500 Index (VIX), difference between the LIBOR and risk-free Treasury bill rate (TED), economic policy uncertainty index (EPU) and geopolitical risk index (GEO). Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Hedged carry strategies are the 10 delta out-of-the money strategy (10Δ), 25 delta out-of-the-money strategy (25Δ), and at-the-money delta strategy (ATM). Robust standard errors are in parentheses. Results are conducted over the period February 2006 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis period. *, **, and *** indicate significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 2.10: Hedged Carry Trade and Non-Currency Based Risk Factors (with Downside Risk)

	Full sample (02/2006 -12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Downside risk	1.042***	0.489**	0.872***	0.643***	0.316***	0.234	0.009	-0.167
	[0.190]	[0.243]	[0.176]	[0.152]	[0.115]	[0.164]	[0.156]	[0.165]
D(TED)	-0.478***	-0.383	-0.382**	-0.241*	-0.111	-0.362	-0.273	-0.062
	[0.171]	[0.367]	[0.155]	[0.137]	[0.104]	[0.264]	[0.281]	[0.273]
EPU	0.231	0.049	0.240*	0.232**	0.170**	0.055	0.135	0.162
	[0.145]	[0.213]	[0.132]	[0.108]	[0.072]	[0.181]	[0.161]	[0.125]
GEO	-0.197	-0.012	-0.178	-0.126	-0.052	0.028	0.023	0.082
	[0.130]	[0.181]	[0.114]	[0.093]	[0.064]	[0.150]	[0.126]	[0.103]
Constant	0.082	0.244	0.026	-0.011	-0.046	0.163	0.138	0.08
	[0.138]	[0.197]	[0.124]	[0.103]	[0.071]	[0.167]	[0.147]	[0.123]
R-squared	0.267	0.045	0.236	0.194	0.111	0.022	0.011	0.031
	Post-Crisis (01/2010 - 12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Downside risk	1.108***	0.520***	1.022***	0.763***	0.418***	0.455*	0.277	0.054
	[0.349]	[0.246]	[0.294]	[0.203]	[0.128]	[0.230]	[0.233]	[0.234]
D(TED)	-0.395	1.870	0.281	0.372	0.332	1.126	0.532	0.931
	[0.901]	[1.478]	[0.871]	[0.733]	[0.525]	[1.368]	[1.288]	[1.026]
EPU	0.404	0.184	0.412**	0.367***	0.253***	0.185	0.192	0.151
	[0.289]	[0.247]	[0.170]	[0.137]	[0.088]	[0.223]	[0.195]	[0.150]
GEO	-0.076	0.042	-0.072	-0.043	-0.005	0.074	0.088	0.123
	[0.142]	[0.178]	[0.127]	[0.101]	[0.068]	[0.155]	[0.130]	[0.108]
Constant	-0.199	0.055	-0.224	-0.211*	-0.167**	-0.032	-0.051	-0.036
	[0.191]	[0.226]	[0.163]	[0.127]	[0.084]	[0.189]	[0.167]	[0.145]
R-squared	0.212	0.047	0.214	0.193	0.149	0.039	0.026	0.029
	Pre-Crisis (02/2006 - 08/2008)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Downside risk	0.443*	1.840*	0.337	0.297	0.217	1.206	1.032	0.756*
	[0.226]	[0.957]	[0.241]	[0.186]	[0.136]	[0.783]	[0.621]	[0.390]
D(TED)	-0.315*	-0.650	-0.340**	-0.328**	-0.208*	-0.775**	-0.680**	-0.359
	[0.163]	[0.406]	[0.150]	[0.139]	[0.114]	[0.316]	[0.311]	[0.281]
EPU	0.441	0.949	0.329	0.312	0.171	0.242	0.444	0.365
	[0.444]	[1.184]	[0.367]	[0.299]	[0.231]	[0.976]	[0.790]	[0.554]
GEO	-0.208	0.345	-0.261	-0.328	-0.342**	0.154	-0.185	-0.356
	[0.363]	[0.756]	[0.316]	[0.239]	[0.137]	[0.622]	[0.510]	[0.390]
Constant	0.655	1.562	0.483	0.373	0.132	0.682	0.670	0.347
	[0.595]	[1.288]	[0.530]	[0.425]	[0.306]	[1.144]	[0.964]	[0.714]
R-squared	0.113	0.243	0.127	0.191	0.224	0.201	0.196	0.181

Notes: The table reports regressions of returns to two carry trade strategies on the non-currency based risk factors. Risk factors are the downside risk, difference between the LIBOR and risk-free Treasury bill rate (TED), economic policy uncertainty index (EPU) and geopolitical risk index (GEO). Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Hedged carry strategies are the 10 delta out-of-the-money strategy (10Δ), 25 delta out-of-the-money strategy (25Δ) and at-the-money delta strategy (ATM). Robust standard errors are in parentheses. Results are conducted over the period February 2006 to December 2019 for the full sample, January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis period. *, **, and *** indicates significance at 10 percent, 5 percent, and 1 percent, respectively.

Downside risk loads all the EQW strategies similar to the VIX index; innovations in TED spread is also significant on the EQW strategies, except for with the EQW ATM strategy. EPU is significant on the hedged returns of the EQW strategy. When the dollar neutral strategy is considered, results are notably different than the EQW strategies. Downside risk is significant only on the unhedged return, and all the other variables do not have any effect on any of the dollar neutral strategies. Since all of the emerging markets in our sample are affected from downside risk in a similar way, the returns of the dollar neutral strategies do not change much. This result points out that hedging the dollar neutral carry strategy using FX options against the downside risk does not limit the losses of the investors. As reported in the table, the results do not change significantly in the sub-periods showing that the lack of effectiveness of the downside risk in the dollar-neutral hedged returns.

Currency-Based Risk Factors

Table 2.11 reports the effects of currency-based-risk factors on hedged and unhedged carry returns. In the full sample period, we find that the dollar factor has a significant effect, not only on the unhedged returns of the EQW strategy, but also on the hedged returns of the EQW strategy. When the dollar factor increases, carry return increases as well. The magnitude of the coefficient declines as the degree of hedging increases; this is expected because the carry return decreases as the option price increases. However, for the dollar neutral strategy, the dollar factor barely loads the unhedged returns and does not load the hedged returns. FXVol behaves differently on unhedged returns compared to hedged returns. In unhedged returns, FXVol loads negatively to carry returns, in which heightening volatility leads to a decline in carry returns; it works in the opposite direction for the hedged returns. An increase in FXVol leads the options to be exercised, thus,

Table 2.11: Hedged Carry Return and Currency-Based Risk Factors

	Full sample (02/2006 -12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Dol	1.791***	0.425*	1.621***	1.305***	0.772***	0.29	0.116	-0.036
	[0.092]	[0.239]	[0.081]	[0.077]	[0.075]	[0.205]	[0.201]	[0.188]
Skew	-0.118*	-0.21	-0.129**	-0.154***	-0.119***	-0.268	-0.244	-0.223
	[0.068]	[0.179]	[0.064]	[0.055]	[0.045]	[0.171]	[0.156]	[0.140]
D(FXVol)	-0.113**	-0.742***	0.081	0.278**	0.312***	-0.321*	-0.008	0.296***
	[0.55]	[0.205]	[0.148]	[0.118]	[0.080]	[0.184]	[0.151]	[0.113]
FXLiq	-0.019	-0.011	-0.04	-0.06	-0.023	0.063	0.194	0.194
	[0.095]	[0.272]	[0.101]	[0.081]	[0.063]	[0.219]	[0.174]	[0.150]
Constant	0.082	0.255	0.025	-0.012	-0.047	0.177	0.138	0.077
	[0.070]	[0.184]	[0.065]	[0.058]	[0.048]	[0.163]	[0.145]	[0.119]
R-squared	0.811	0.152	0.788	0.738	0.584	0.07	0.035	0.085
	Post-Crisis (01/2010 - 12/2019)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Dol	1.827***	0.859***	1.704***	1.365***	0.818***	0.693***	0.446*	0.182
	[0.097]	[0.231]	[0.083]	[0.095]	[0.095]	[0.217]	[0.236]	[0.220]
Skew	-0.124	-0.362*	-0.129*	-0.123*	-0.08	-0.327	-0.193	-0.101
	[0.079]	[0.189]	[0.077]	[0.071]	[0.059]	[0.208]	[0.179]	[0.142]
D(FXVol)	-0.240**	-0.327	-0.072	0.203**	0.322***	-0.032	0.31	0.647***
	[0.098]	[0.371]	[0.097]	[0.091]	[0.075]	[0.330]	[0.278]	[0.205]
FXLiq	0.023	0.230	-0.041	-0.095	-0.051	0.173	0.13	0.044
	[0.079]	[0.229]	[0.071]	[0.060]	[0.050]	[0.226]	[0.230]	[0.163]
Constant	0.105	0.273	0.024	-0.023	-0.045	0.127	0.083	0.047
	[0.074]	[0.213]	[0.069]	[0.065]	[0.059]	[0.191]	[0.181]	[0.145]
R-squared	0.838	0.183	0.824	0.757	0.6	0.126	0.068	0.106
	Pre-Crisis (02/2006 - 08/2008)							
	Unhedged Carry Returns		EQW			Dollar Neutral		
	EQW	Dollar Neutral	10Δ	25Δ	ATM	10Δ	25Δ	ATM
Dol	1.204***	-0.461	1.100***	0.962***	0.706***	-0.522	-0.323	-0.041
	[0.332]	[0.861]	[0.261]	[0.131]	[0.092]	[0.728]	[0.734]	[0.725]
Skew	-0.125	0.084	-0.148	-0.104	-0.012	-0.498	-0.424	-0.168
	[0.202]	[0.555]	[0.162]	[0.118]	[0.087]	[0.513]	[0.475]	[0.366]
D(FXVol)	-0.831***	-3.053***	-0.661***	-0.455*	-0.137	-2.511***	-1.791***	-0.713
	[0.275]	[0.804]	[0.203]	[0.153]	[0.134]	[0.603]	[0.588]	[0.492]
FXLiq	0.084	-1.693	0.364	0.379	0.168	-1.035	-0.436	-0.740
	[0.703]	[2.226]	[0.485]	[0.348]	[0.240]	[1.496]	[1.309]	[1.019]
Constant	0.133	0.849	0.087	0.001	-0.091	0.989*	0.686	0.267
	[0.223]	[0.601]	[0.185]	[0.140]	[0.103]	[0.565]	[0.524]	[0.429]
R-squared	0.620	0.373	0.662	0.709	0.640	0.400	0.295	0.121

Notes: The table reports regressions of returns to two carry trade strategies on the currency based risk factors. Risk factors are the dollar factor (Dol), skewness (Skew), global FX volatility (FXVol) and global FX liquidity (FXliq). Carry strategies are the equally weighted (EQW) and dollar neutral carry strategies. Robust standard errors are in parentheses. Hedged carry strategies are 10 delta out-of-the-money strategy (10Δ), 25 delta out-of-the-money strategy (25Δ) and at-the-money delta strategy (ATM).Results are conducted over the period April 2004 to December 2019 for the full sample January 2010 to December 2019 for the post-crisis period and February 2006 to August 2008 for the pre-crisis period. *, **, and *** indicates significance at 10 percent, 5 percent, and 1 percent, respectively.

an investor can compensate the carry losses with the profit coming from the options. Therefore, hedging using options is a profitable strategy when turmoil in the markets is high. Interestingly, the effect of FXVol is similar in the EQW strategy and the dollar neutral strategy; this is an indicative of the robustness of this factor.

Global liquidity has no explanatory power on any carry return strategy, whereas global skewness loads to the hedged and unhedged EQW strategies. Therefore, skewness appears as an another variable that has an effect on the EQW strategy, but does not have any effect on the dollar neutral strategy. Results for the post-crisis period demonstrate that the effect of dollar factor increases for the dollar neutral strategy, particularly for hedged returns. On the other hand, in the pre-crisis period the dollar factor has no effect on the dollar-neutral strategy which indicates a difference between the pre-crisis and post-crisis period for the effect of dollar factor. Global FX volatility loses its significance on the dollar neutral strategy, except in the ATM hedged returns in the post-crisis period. In the pre-crisis period global FX volatility is negative even in the hedged returns for the dollar-neutral strategy and EQW strategy. The ineffectiveness of global liquidity does not change in the sub-periods. The effect of skewness seems to be lower in the sub-periods compared to the full sample. This result might come from the fact that since full sample also covers the crisis period and as Hutchison and Sushko (2013) argue that skewness matters more in the crisis terms which implies that the effect of skewness is expected to be more on the crisis periods.

2.7. Concluding Remarks

We show that carry trade strategies make a difference in the sense that the dollar neutral carry strategies earn more than the dollar carry strategies. We also find that carry trade in the emerging markets is not a profitable strategy compared to U.S. stock market. Particularly after the global financial crisis, the dollar carry strategy cannot beat risk-free rates. Base currency is an important determinant for the profits of carry returns among emerging countries. When the base currency is the euro, carry returns are much higher compared to when the base currency is the U.S. dollar or Japanese yen. We show that risk factors have an explanatory power on the dollar carry strategies but fail to explain the dollar neutral strategies particularly in the post-crisis period. Therefore, future work will concentrate on the risk factors that are related to the dollar-neutral strategy in emerging markets.

Because emerging markets are riskier than developed ones, investors are expected to hedge themselves using FX options. Our findings show that hedging carry trade in the emerging markets is not a good idea because crash risk that is priced in the options seems to evaporate carry profits. The findings in the chapter have important policy implications for investors. Carry return in emerging markets depends on the carry strategy, in which investors should prefer dollar neutral carry strategies rather than dollar carry strategies. Moreover, investors may not use options to hedge their investments unless they expect large volatilities and/or reconcile with very low Sharpe ratio in the FX market.

Considering the fact that carry trade activities are intertwined with foreign currency credit in emerging markets and hence are able to accumulate currency risk in the process among these countries, we believe that there has to be more research done to better understand the currency dynamics in the emerging markets.

CHAPTER III

DEVIATIONS FROM COVERED INTEREST PARITY IN THE EMERGING MARKETS AFTER THE GLOBAL FINANCIAL CRISIS

3.1. Introduction

The global financial crisis followed by the European sovereign debt crisis had enormous impacts on international financial markets, particularly on covered interest parity (CIP), which is ordinarily anchored in riskless arbitrage during tranquil periods. Since 2008, CIP deviations have become a regular feature of advanced economies and hence a subject of research scrutiny (Borio et al., 2016; Du et al., 2017; Avdjiev et al., 2019). However, despite its far more importance than advanced economies, the CIP deviations associated with emerging market currencies are relatively understudied. The violation of CIP in the emerging economies suggests dampening monetary autonomy, i.e., conducting effective monetary policies and limiting the ability of financial intermediation among these countries. Emerging countries are known to be more dependent on the US dollar liquidity (Baba and Packer, 2009; Rose and and Spiegel, 2012). A failure of CIP deviation, which indicates financial friction in foreign exchange and money markets, would raise financial stability concerns by impairing the monetary transmission mechanism (Cerutti et al., 2021). Recent attempt by Central Bank of Turkey (CBRT) is an example that shows the importance of CIP deviations from the perspective of central banks. CBRT implemented FX swap operations in 2017 to increase the FX swap implied rates to the level of policy rate thus reduce the CIP deviations.

Moreover, actions of major central banks in the global financial crisis and afterwards have made it harder than ever to implement effective monetary policies for emerging markets. The financial trilemma - that financial integration and exchange rate stability mean a loss of monetary autonomy - has recently been challenged. Rey (2013) argues that even flexible exchange rates in the emerging economies cannot assure monetary autonomy without capital controls. That is, violation of CIP has made it even more challenging for emerging market central bankers to pursue effective monetary policies. In this chapter, we focus on the deviations from the CIP condition in the six emerging economies: Hungary Mexico, Poland, Russia, Turkey and South Africa, using daily data from January 2010-December 2018. During the post-crisis period, many other emerging economies did deploy capital controls.[1] As shown by Sener et al. (2012), implementing arbitrage activities in the case of pure CIP is not possible under capital controls. Thus, we argue that our sample is consistent with the assumptions of covered interest parity.

Earlier studies on the validity of CIP following the collapse of Bretton Woods in 1973 show that CIP generally holds in advanced countries (Frenkel and Levich, 1975; Taylor, 1987; Fletcher and Taylor, 1996; Akram et al., 2008). Later research considers the empirical validity of CIP for major currencies during the 2007-2008 global financial crisis (GFC). It demonstrates that the increasing credit and

[1]Jinjarak et al. (2013) document the cases of capital controls in several emerging economies, such as Thailand, Korea, Peru, Indonesia and Brazil, since the beginning of the global financial crisis in 2008.

liquidity risks of non-US financial institutions were mainly responsible for the significant deviations from CIP in developed countries (Baba and Parker, 2009a, 2009b; Coffey et al., 2009; Fong et al., 2010; Mancini-Griffoli and Ranaldo, 2010). More recently, researchers have investigated the persistent deviation from parity without accompanying market anomalies during the post-GFC period. For example, Avdjev et al. (2019) argue that there is a triangular relationship between the value of the US dollar, CIP deviations and cross-border bank lending in which the domestic currency's increasing strength against the dollar dampens CIP deviations. Du et al. (2018) show that monetary policy shocks and balance sheet costs are both responsible for those CIP deviations that cannot be explained by transaction costs or credit risks. Fukuda and Tanaka (2017), and Bräuning and Puria (2017) argue that countries having higher nominal interest rates have lower or positive CIP deviations while Borio et al. (2016) and Sushko et al. (2016) show that the hedging demand of non-financial firms and tighter limits to arbitrage both affect CIP deviations, particularly in the long run. These latter two studies suggest that credit and liquidity risks are the main drivers of short-term CIP deviations and have no relationship with longer maturities.

Few studies have analyzed CIP deviations in emerging economies due to the relative absence of deep financial markets. From their examination of deviations from CIP in advanced and emerging market economies between 2003 and 2006, Skinner and Mason (2011) showed that there is no deviation from CIP in the short run (three-month horizon) for Brazil, Russia and Chile after taking into account transactions costs. In the long run (five-year horizon), however, there is evidence of significant deviations because of the high credit risk embedded in emerging markets. Focusing on the South Korean market between 2007 and 2009, Baba and Shim (2014) showed that the major determinants of CIP deviations are global uncertainty in the short run and credit risk in the long run. However, no studies have yet examined post-crisis violations of CIP in emerging economies, where deviations are on average many times greater than in advanced economies.[2]

In this chapter, we examine violation of CIP in six diverse emerging economies and show that CIP deviations occur for nearly all these currencies. This increased following the European sovereign debt crisis before reducing after 2014. On average, CIP deviations for the Turkish lira, Hungarian forint and Russian rouble hovered around or above 100 basis points (bps) at the three-month horizon whereas the Mexican peso and Polish zloty remained below 100bps. This demonstrates that borrowing at a synthetic rate using FX swaps is cheaper than borrowing directly in the local currency. The South African rand exhibited the only negative and lowest CIP deviation (nearly -4 bps).

We demonstrate that local factors have more impact on CIP deviations than global ones, which have a rather heterogeneous effect across the six countries. FX liquidity is a main factor that is significantly and positively associated with CIP deviations for all currencies for all periods. Lower liquidity in emerging market currencies causes a liquidity premium, which in turn drives CIP deviations. Credit risk is also significantly related to CIP deviations, although its impact is unexpected in a sense that increase in the CDS lowers the CIP deviation. We argue that the changing nature of carry trade activities is the main reason for this. The National Bank of Poland (2016) reports that non-resident investors use FX swaps more than domestic money market instruments to implement carry trade activities. In other words, FX swaps are used more for the carry activities than the hedging purposes. Investors have long position in domestic currency when they use FX swaps for carry trade unlike the hedging purpose where they have the short position in the domestic currency. Therefore as BIS (2015) documents that

[2]Du et al. (2018) reported 20 basis point (bps) deviations from parity for G10 countries during 2010-2016. Using data from our six emerging economies over the same period, we find that CIP deviations are, on average, almost five time (91.5 bps) more than in G10 countries.

investors who heavily use FX swaps for carry trade activities become more sensitive to FX swap rates than local interest rates. Thus, we conclude that the apparent negative relationship occurs because when credit risk of a high carry currency increases, investors demand higher interest rates for FX swap rates.

We also show that another significant factor driving CIP deviations is nominal interest rate differences. When the nominal interest rate between the local currency and the U.S. dollar increases, CIP deviation decreases due to growing demand for the high interest currency. This causes more currency hedging demand to buy the low interest currency and sell the high interest currency. The subsequent rise in FX swap demand increase the forward premium beyond the CIP-implied value.

While there is growing evidence regarding CIP deviation in advanced countries, their policy implications remain undiscussed (see Du et al., 2018; Cerutti et al., 2021). Our study shows that liquidity (currency bid-ask spreads) is a key factor behind CIP deviations in emerging economies. Liquidity mostly impacts CIP deviations in advanced economies suggesting that financial development matters. Yet, this is precisely where emerging markets fall short despite their share in the world economy. Improving financial development may therefore help emerging economies to decrease their CIP deviations and implement more effective monetary policies.

The chapter is organized as follows. Section 3.2 reviews the empirical implement of CIP deviations. Section 3.3 discusses the data and methodology. Section 3.4 presents the results of the regression analyses and discusses potential explanations of CIP deviations. Section 3.5 focuses on the changing power of credit risk to explain times-series variations in CIP deviations. Section 3.6 reports robustness exercises, specifically subdividing the sample period and using deposit rates instead of LIBOR rates to measure CIP deviations. Section 3.7 concludes.

3.2. Empirical Implementation

The transaction-cost adjusted deviation from covered interest parity can be written as in Du et al. (2018):[3]

$$\text{CIP deviation:} \exp(nr^{b}_{t,t+n}) - \frac{F^{a}_{t,t+n}}{S^{b}_{t,t+n}} \exp(nr^{*,a}_{t,t+n}) \;>\; 0 \quad \text{or}$$
$$\text{CIP deviation:} \exp(nr^{a}_{t,t+n}) - \frac{F^{b}_{t,t+n}}{S^{a}_{t,t+n}} \exp(nr^{*,b}_{t,t+n}) \;>\; 0$$

where a and b denote ask and bid rates respectively. $r_{t,t+n}$ and $r^{*}_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar, respectively. S_t is the spot rate and F_t is the forward rate.

In the literature (e.g. Akram et al., 2008; Buraschi et al., 2015), the dominant strategy to investigate whether CIP holds, is to calculate the transaction cost-adjusted (bid-ask spreads) deviations. Although recent evidence show that transaction costs are not enough to explain CIP deviations (see e.g., Du et al., 2018), in theory, to take advantage of CIP deviations, an investor has to conduct more than one transaction, thereby transaction costs may affect the profitability of currency trading strategy of an investor. CIP comprises four variables: spot exchange rate, forward exchange rate, domestic interest rate and foreign interest rate, that are often not fully synchronized. Following the first paper by Taylor (1987) that uses hand-collected, high-frequency data, there are many papers that study CIP deviations using high-frequency data, especially for the currencies of advanced economies (e.g., see Akram et al., 2008; Fong et al., 2010; Rime et al., 2016). Nonetheless, there are also several other important papers that use low-frequency (daily) data by ignoring the synchronization issue (e.g., see Du et

[3] As reported in Appendix Table A.1, currency markets in emerging economies have grown considerably since the GFC. Yet, they are still small relative to the markets in the advanced economies and hence market size matters for transaction costs (see e.g. Munro and Wooldridge, 2011).

al., 2018; Fukuda and Tanaka, 2017; Avdjiev et al., 2016; Allen et al., 2017). In this chapter, we use daily data to measure CIP deviations due to limited access to high frequency data for the currencies of emerging market economies (see also Karnaukh et al., 2015).[4]

For the benchmark analysis, we use interbank interest rates for each country and USD LIBID (interbank bid rate) for U.S. interest rates.[5] Although the indicative nature of interbank interest rates has been criticized during and after the global financial crisis in 2008-2009, in line with recent studies (e.g. Mancini-Griffoli and Ranaldo, 2010; McAndrews, 2009; Cerutti et al., 2021), we use LIBOR (interbank offer rate) but also use interbank deposit rates as an alternative interest rate to measure CIP deviations of emerging market currencies. As emphasized by Sushko et al. (2016), finding similar CIP deviations for different interest rates suggest that these deviations do not result from the conditions in underlying money markets but from frictions in FX swap markets.

Figure 3.1 presents the three-month CIP deviations for six countries from January 4, 2010 to July 30, 2018, suggests clear CIP deviations for nearly all six currencies. The deviations from CIP clearly increase during 2011 and 2012 for Hungarian forint, Turkish lira and Russian rouble (during the European debt crisis) before declining after 2014. Except the South African rand (ZAR), all currencies have positive CIP deviations, indicating that direct borrowing in the local currency is costlier than borrowing at a synthetic rate using FX swaps. Thus,

[4]Coffey et al. (2009) find similar results using hourly (high-frequency) and daily (low-frequency) data for the euro-USD exchange rate. Similarly, we compare (three-month and six-month) CIP deviations using both hourly and daily data for Turkey, Mexico, South Africa and Poland between August 27, 2013 and July 30, 2018 due to data availability. As seen in Appendix, Table A.2, the correlations between hourly and daily CIP deviations with respect to different tenors and currencies are very high and also not statistically different from each other for all currencies and tenors.

[5]LIBID (interbank bid rate) is used for considering the transaction costs in the interest rates. On the other hand, after doing the calculations using LIBOR (interbank offer rate), the difference was negligible.

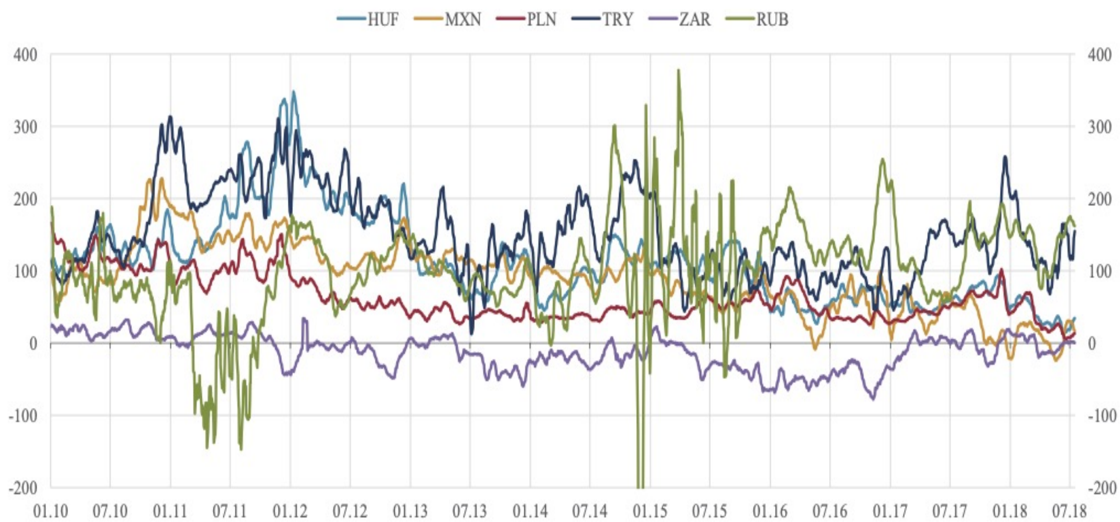

Figure 3.1: CIP Deviations (3 month LIBOR based, 10 day moving average, basis point)

an arbitrageur could borrow U.S. dollars from the money market before entering an FX swap deal to buy local currency. With this local currency, this arbitrageur would invest in the local currency money market to earn its interest rate. After the swap contract expires, local currencies are converted to dollars to pay back the dollar-denominated debt and thereby earn a profit. According to Figure 3.1, the Russian rouble (RUB) is more volatile than other currencies, particularly in 2015. During the second half of the 2014, Russia, whose economy is highly dependent on oil prices slipped into a recession by the decreasing oil prices and international sanctions.

Table 3.1 reports the descriptive statistics for the three-month CIP deviations. In the full sample, the Turkish lira, on average, has the greatest deviation (151 bps) whereas the South African rand has the only positive and lowest (-4 bps) deviation. The Hungarian forint follows the Turkish lira with a 113 bps deviation. Although the Russian rouble and Mexican peso have similar deviations (99 bps and 90 bps respectively), the rouble has the largest volatility of the sampled currencies. We divide our sample into two sub-periods to assess whether CIP

Table 3.1: Summary Statistics for 3-month CIP Deviations in basis point

	Full Sample		Sub-Samples			
	Jan 2010-July 2018		Jan 2010-Dec 2013		Jan 2014-July 2018	
Hungarian Forint	113.11	(62.45)	156.63	(61.10)	76.01	(33.04)
Mexican Peso	90.11	(49.93)	127.76	(35.09)	57.26	(35.75)
Polish Zloty	64.94	(33.85)	85.78	(36.15)	46.75	(17.22)
Russian Rouble	98.75	(112.02)	73.86	(84.63)	120.53	(127.44)
Turkish Lira	151.08	(62.88)	178.56	(64.15)	127.09	(50.81)
South African Rand	-4.25	(26.12)	5.32	(24.53)	-12.60	(24.56)
Average	85.62	(57.83)	104.65	(51.17)	69.17	(48.14)

Notes: The table presents the mean and standard deviations (in parenthesis) of LIBOR based 3-month CIP deviations. CIP deviations are calculated as follows:

$$\text{CIP Deviations} = \exp(nr^{a}_{t,t+n}) - \frac{F^{b}_{t,t+n}}{S^{a}_{t+n}} \exp(nr^{*,b}_{t,t+n})$$

where a and b denote ask and bid rates respectively. $r_{t,t+n}$ and $r^{*}_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and US dollar respectively. S_t is the spot rate and F_t is the forward rate.

deviations are similar under different periods. The first sub-sample covers 4 January 2010 to 31 December 2013, which includes the European debt crisis, the tapering announcement and the first reduction of the quantitative easing program. The second sub-sample is between 4 January 2014 and 30 July 2018, which we can call the post-European debt crisis period. The deviations are found to be higher in the first sub-period. Mean CIP deviation in the first sub-sample is 105 bps whereas it is 69 bps in the second sample. All CIP deviations except for the Russian rouble decrease in the second sub-period.

According to the 2016 BIS Triennial Central Bank Survey, FX swaps are the major instruments in emerging markets rather cross-currency swaps. The former is usually used up to a one-year maturity whereas the latter is employed for maturities longer than a year. As reported in Table 3.2, except for Turkey and South Africa, the share of currency swaps is less than two percent of the total volume of FX and currency swaps among the sample countries. The shares of currency swaps in Turkey and South Africa in total volume are less than 10% and 15% respectively. Thus, FX swap transactions are more liquid than the currency swaps that we focus on FX swaps in calculating CIP deviations. These contracts have several tenors up to one year.

Table 3.2: Daily Averages of FX and Currency Swap Transactions

Currency	FX Swaps	Currency Swaps ((Million U.S. dollars)
Hungarian Forint (HUF)	7,994	105
Mexican Peso (MXN)	35,730	206
Polish Zloty (PLN)	18,042	375
Russian Rouble (RUB)	27,063	546
Turkish Lira (TRY)	39,645	4,162
South African Rand (ZAR)	23,542	3,541

Notes: The data is from BIS Triennial Central Bank Survey, April 2016. Table 2 shows the daily average volume of FX swap and currency swap transactions for that currency.

Bräuning and Puria (2017) emphasize that there is no stable relationship between maturity and CIP deviations. They show that CIP deviations increase with maturity only in recent years. During the global financial crisis and the European sovereign crisis, deviations are higher for short maturities. Fong et al. (2010) show that CIP deviations increase with maturity using one-week, one-month and three-month contracts. As seen in Table 3.3, we find no clear-cut relationship between CIP deviations and maturity from examining CIP deviations calculated from five tenors (i.e., one-week, one-month, three-month, six-month, and 12-month). Increasing CIP deviations with maturity is found only in the Russian rouble whereas deviations decrease with maturity for the Hungarian forint. Deviations follow no pattern for the Mexican peso, Polish zloty and Turkish lira. Although the average deviations of one-week maturity do not differ from the other maturities, they are much more volatile than for other maturities for each currency, which is consistent with Du et al. (2018).

Although we calculate the deviations from CIP using the U.S. dollar as the reference rate, the euro is another currency used in FX swap transactions, particularly in Hungary, Poland, Russia and Turkey. In their seminal paper, Buraschi et al. (2015) show that, during the 2008-2009 global financial crisis, there is a significant pricing anomaly between Eurobonds denominated U.S. dollars and the euro for Turkey, Brazil and Mexico. Thus, we document euro-based CIP deviations to understand whether they differ from U.S. dollar-based deviations between January 2010 and July 2018.

As seen in Table 3.4, U.S. dollar-based deviations are, on average, less than euro-based deviations. Although CIP deviations vary significantly in size across currencies, the difference between U.S. dollar- and euro-based deviations are nearly the same for almost all currencies. Yet, there is a clear CIP deviation in

Table 3.3: CIP Deviations with Different Maturities (basis point, Jan 2010 - July 2018

	HUF	MXN	PLN	RUB	TRY	ZAR
1 week	113.63 (90.7)	–	–	56.50 (613.1)	131.62 (92.7)	–
1-month	114.08 (65.0)	52.10 (64.9)	60.10 (30.9)	73.32 (138.6)	142.99 (66.0)	-6.70 (37.9)
3-month	113.11 (62.5)	90.11 (49.9)	64.94 (33.9)	98.78 (112.0)	151.08 (62.9)	-4.25 (26.1)
6-month	109.77 (68.6)	61.63 (44.9)	63.93 (39.7)	102.52 (141.2)	141.61 (64.0)	17.67 (23.0)
12-month	95.72 (76.0)	–	53.08 (44.5)	–	103.09 (67.1)	13.05 (23.8)

Notes: The table presents the mean and standard deviations (in parenthesis) of LIBOR based different tenors of CIP deviations in basis point for six emerging markets currencies. CIP deviations are calculated as follows:

$$\text{CIP} = \exp(nr^{a}_{t,t+n}) - \frac{F^{b}_{t,t+n}}{S^{a}_{t+n}} \exp(nr^{*,b}_{t,t+n})$$

where a and b denote ask and bid rates respectively. $r_{t,t+n}$ and $r^{*}_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar respectively. S_t is the spot rate and F_t is the forward rate.

Table 3.4: CIP Deviations Based on Us dollar and Euro (3 months, basis point)

Currency	U.S. Dollar	Euro	Difference
Hungarian Forint (HUF)	113.11	86.98	26.13
Mexican Peso (MXN)	90.11	65.80	25.31
Polish Zloty (PLN)	64.94	38.71	26.23
Russian Rouble (RUB)	98.78	76.45	22.33
Turkish Lira (TRY)	151.08	127.85	23.22
South African Rand (ZAR)	-4.25	-30.42	26.17

Notes: The table presents the mean of USD LIBOR based three-month CIP deviations, EUR LIBOR based three-month CIP deviations and the difference of two deviations in basis point for six emerging markets currencies during Jan 2010 to July 2018.

euro-based calculations in the post-European debt crisis period. Figure 3.2 shows the difference between U.S. dollar- and euro-based deviations for our sample currencies and EURUSD CIP deviation itself. The difference between U.S. dollar-based CIP deviations and euro-based CIP deviations are captured by the EURUSD CIP deviations. Unlike Buraschi et al. (2015), we do not observe any anomaly among emerging market currencies, coming from the base currencies in the post-European debt crisis period..

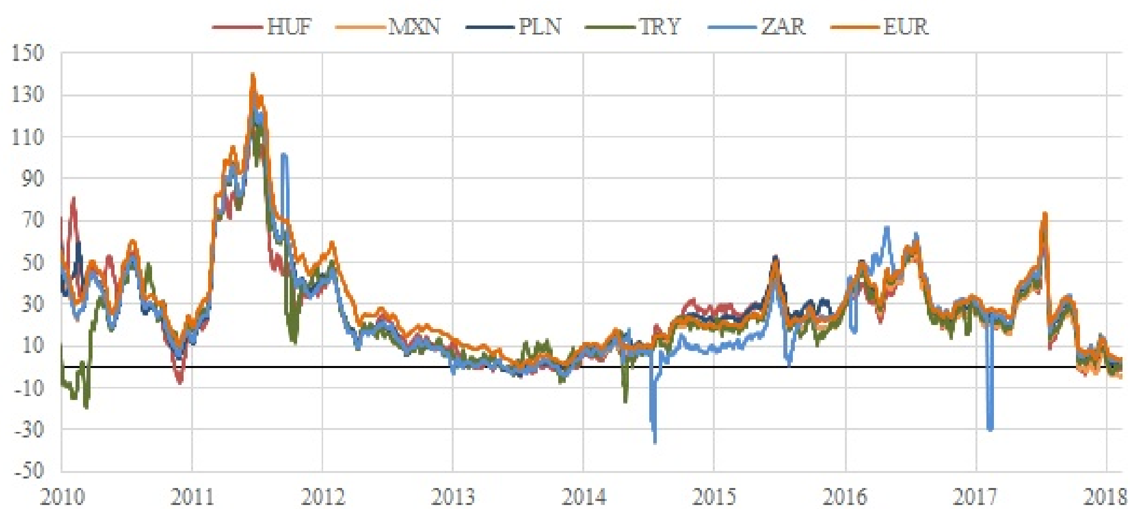

Figure 3.2: Differences between Euro based and US dollar based CIP Deviations vs CIP Deviation in EURUSD (3 month, 10 day moving average, basis point). For the sake of presentation clarity, we do not report CIP deviations for Russian Rouble.

3.3. Data and Methodology

The estimations are at daily frequency over the sample period from January 4, 2010 to July 30, 2018, subject to data availability. Our dependent variable is three-month CIP deviations, which is the most widely used maturity measure in the literature. Baran and Witzany (2017) underline that short-end spreads are affected more by LIBOR rates and credit/liquidity premiums whereas supply and demand conditions are more pronounced in the long run. In our empirical model for deviations from short-term CIP, we have no structural factor. We include three variables for local factors: credit risk, liquidity risk and countries' nominal interest rate differences; and three variables for global factors: VIX index, U.S. dollar index and 3-month EURUSD CIP deviations (see Appendix Table A.3 for detailed descriptions of the variables).

We use sovereign five-year CDS spreads from Bloomberg[6] as the premium attached to credit risk in the sample countries. As emphasized by Longstaff et al. (2011), the sovereign CDS market is more liquid than the corresponding sovereign bond market and hence captures more accurate estimates of credit spreads. Baba and Parker (2009a) and Baba and Shim (2011) provide evidence that credit risk plays an important role in explaining CIP deviations associated with the currencies of advanced economies during the global crisis period. However, in the papers covering the post-crisis period, the association of credit risk with CIP deviations is found to be mostly insignificant (see e.g., Du et al., 2018).

Interest rate credit risk premia in emerging economies are much higher than those for U.S. dollar interest rates. It might be natural to expect that the higher

[6]Although there are studies that use bank CDSs instead of sovereign CDSs, not all countries in our sample have CDS data for banks. Moreover, as shown by Shim and Shin (2018), sovereign and bank CDSs are very highly correlated.

level of perceived credit risk in the emerging economies would cause CIP deviations to differ in favor of the U.S. dollar. However, in this chapter, we emphasize that there might be an opposite relation between credit risk and CIP deviations depending on the carry trade activities in the emerging economies. We argue that if carry trade activities are large in volume and FX swaps are used in these activities, a different association between CDS spreads and CIP deviations might be observed. FX swap transactions are mainly used for two purposes: hedging and carry trade, both of which have different mechanisms depending on the purpose of their usage.

As we explain in Figure 3.3, when FX swap transactions are implemented due to the hedging purposes, foreign banks receive domestic currency at the first leg and in return give foreign currency. This makes foreign banks short on domestic currency and long on foreign currency. Therefore, foreign banks receive foreign interest rate and pay domestic interest rate. On the other hand, when FX swap is used as a carry trade purpose, foreign banks provide domestic currency and in return receive domestic interest rate which create a long position in domestic currency and a short position in foreign currency. Therefore, when hedging activity is strong, an increase in the credit risk of a domestic country may lead to an increase in domestic interest rate but may not affect so much the FX swap rate since foreign banks receive foreign interest rate. Or, when carry trade activity is strong, since foreign banks are long on the domestic currency and receive domestic interest rate, an increase in credit risk would lead FX swap rates to increase since foreign banks ask higher interest rate due to increase in sovereign credit risk (Dos Santo et al., 2016). Under these circumstances, domestic interest rates also increase; however, if FX swaps are widely used, the reaction of the FX swap rates to the increase in the credit risk would be higher than the increase in the domestic interest rates which causes CIP deviation to decrease.

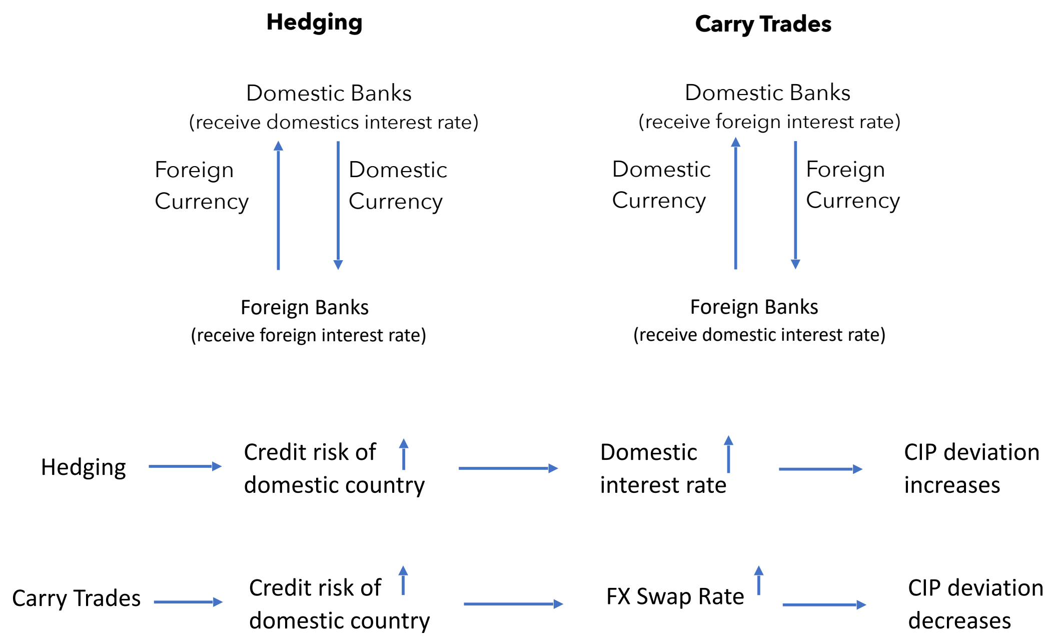

Figure 3.3: Mechanisms of FX swap according to purpose of usage

Liquidity is another important factor that can be related to CIP deviations. In addition to the seminal paper by Mancini et al. (2013) in which a new liquidity measure is developed particularly tailored to the FX market,[7] several other papers such as Brunnermeier et al. (2009) and Burnside (2009) show the importance of liquidity in the FX market. Given that the emerging countries have lower liquidity than advanced economies, low FX liquidity is hypothesized to widen CIP deviations among emerging countries. We proxy FX liquidity using bid-ask spreads, which is the most commonly used measure (see e.g. Banti and Phylaktis, 2015). We calculate the bid-ask spread by taking the difference between the daily series of the ask and bid prices divided by the mid prices. In this way, our liquidity measure provides a standardized average of the bid-ask spreads of forward and spot rates. A wider bid-ask spread (increase in FX liquidity coefficient) thus indicates lower liquidity.

[7]In the new liquidity measure, Mancini et al. (2013) uses "ultra" high frequency data for the following currency pairs: AUD/USD, EUR/GBP, GBP/USD and USD/CAD.

CIP deviations decrease with the nominal interest rate differential between the foreign currency and U.S. dollar when the gap between two interest rates increases in favor of the former (Du et al., 2017; Avdjiev et al., 2019). When the foreign currency interest rate rises compared to the U.S. dollar interest rate, demand for foreign currency increases, which in turn causes currency hedging demand to increase through selling foreign currency and buying U.S. dollars in the swap market. Because these hedging contracts have a cost for financial intermediaries, CIP deviation becomes less positive to justify the high balance sheet costs associated with the larger positions. As in Avdjiev et al. (2019), we use 10-year government bond yields for nominal interest rates.

We introduce VIX index[8] as a global factor to explain CIP deviations in the currencies of emerging economies. The VIX index, the implied volatility of S&P 500 Index options, captures global risk sentiment (Cerutti et al., 2021). VIX rises when uncertainty and volatility in the global economy rises. Skinner and Mason (2011) find that an increase in the VIX index increases CIP deviations since it increases the possibility of governments' defaulting. Moreover, Baba and Shim (2014) show that an increase in VIX causes investors to diminish their positions, particularly in emerging economies, which can bolster CIP deviations.[9]

Our second global factor is U.S. dollar index (DXY)[10] which compares the value of the U.S. dollar against its major trading partners. Avdjiev et al. (2019) and Cerutti et al. (2021) claim that there is a positive relationship between the U.S. dollar

[8]All variables enter in first differences (see Table 3.5 for unit root tests) but for the VIX, we report only first difference for the sake of space but also examine in log-level or first difference and log-level together as in Avdjiev et al. (2019).

[9]As an alternative to the VIX index, we employed the Economic Policy Uncertainty Index (Baker et al., 2016). To save space, we do not report the results which are similar to our findings with VIX index.

[10]Since DXY measures the value of the U.S. dollar against a basket of six currencies (euro, Swiss franc, Japanese yen, Canadian dollar, British pound and Swedish krona), we also use the Wall Street Journal Dollar Index, which includes 16 currencies, as an alternative to the U.S. dollar index. However, this does not change our results.

index and deviations from CIP. When the U.S. dollar strengths, CIP deviations widen in advanced economies, suggesting that synthetic local funding using FX swaps is outweighed by direct funding of local currencies. From their examination of the real implications of the U.S. dollar on emerging economies using data for 1970-2014, Druck et al. (2018) show that real GDP growth in emerging economies slows when the U.S. dollar appreciates despite the positive impulse of U.S. growth, and vice versa. Hence, we hypothesize that the strength of the U.S. dollar is positively associated with CIP deviations in emerging economies.

Our third global factor is three-month LIBOR-based CIP deviations of the euro. We use this variable to capture the effect of other global factors than the VIX and U.S. dollar that can affect CIP deviations in emerging economies. Du et al. (2018) show that CIP deviations in advanced economies move together. Hence, we include this third global variable to determine whether there is any communality between CIP deviations in emerging economies and advanced economies.

In our estimations, we use Nelson's (1991) exponential GARCH (EGARCH) model. The advantage of EGARCH(1,1) over other types of GARCH models is its log-form specification of conditional variance. This avoids the need to force the variance equation to take a non-negative constraint. Panorska et al. (1995) underline that financial times series often exhibit fat-tail properties, which necessitates the use of a t-distribution in GARCH models. Therefore, consistent with Baba and Shim (2014), we rely on the Student t-distribution as a conditional distribution in our regressions. As shown in Table 5, the standard unit root tests suggest that CIP deviations are stationary at different significance levels. The results for other variables are mixed, particularly in the first sub-period, January 2010 to July 2013. We therefore use all variables in first-difference form throughout our analysis, as in Baba and Shim (2014).[11]

[11]We check the correlations between differenced local and global factors, and find that they are

Table 3.5: Augmented Dickey-Fuller Test

	Jan 2010-July 2018		Jan 2010-Dec 2013		Jan 2014-July2018	
	Level	1st Difference	Level	1st Difference	Level	1st Difference
CIP Deviations						
HUF	-2.624*	-15.849***	-2.705*	-14.396***	-2.736*	-11.138***
MXN	-2.633*	-16.321***	-2.996**	-16.884***	-2.868**	-11.651***
PLN	-3.238**	-18.394***	-2.766*	-14.647***	-3.281**	-11.185***
RUB	-5.143***	-13.599***	-2.781*	-14.967***	-8.580***	-16.057***
TRY	-4.235***	-18.068***	-3.049**	-13.222***	-3.807***	-12.718***
ZAR	-4.237***	-14.937***	-3.007**	-13.532***	-3.095**	-12.694***
Determinants						
DXY	-1.262	-47.222***	-2.303	-31.581***	-2.036	-35.029***
VIX	-6.008***	-22.522***	-3.214**	-22.910***	-6.427***	-27.218***
EURUSD-CIP	-2.708*	-16.755***	-1.454	-30.875***	-3.272**	-11.946***
CDS-HUF	-1.296	-42.401***	-1.768	-28.488***	-2.520	-26.727***
CDS-MXN	-3.282**	-26.150***	-2.988**	-17.737***	-2.310	-22.437***
CDS-PLN	-1.887	-42.357***	-1.665	-28.388***	-2.596*	-36.278***
CDS-RUB	-2.220	-30.431***	-3.092**	-18.611***	-1.445	-23.13 ***
CDS-TRY	-2.997**	-43.105***	-2.237	-18.528***	-2.316	-31.551***
CDS-ZAR	-3.063**	-42.830***	-2.972**	-19.581***	-1.869	-26.492***
LIQ-HUF	-3.919***	-17.273***	-4.217***	-16.089***	-4.161***	-13.666***
LIQ-MXN	-4.511***	-18.873***	-5.497***	-15.469***	-4.262***	-14.442***
LIQ-PLN	-4.777***	-17.389***	-3.916***	-14.777***	-5.384***	-13.466***
LIQ-RUB	-6.891***	-19.712***	-4.336***	-18.067***	-5.282***	-22.339***
LIQ-TRY	-4.242***	-17.410***	-2.854*	-15.567***	-8.585***	-14.455***
LIQ-ZAR	-5.749***	-17.224***	-4.443***	-16.003***	-4.995***	-13.968***
$(i^{huf}$-$i^{us})$	-1.005	-44.404***	-1.271	-30.024***	-1.794	-33.299***
$(i^{mxn}$-$i^{us})$	-2.765*	-30.806***	-3.242**	-33.971***	-1.860	-26.012***
$(i^{pln}$-$i^{us})$	-1.101	-48.814***	-0.973	-32.246***	-2.044	-37.321***
$(i^{rub}$-$i^{us})$	-1.940	-42.682***	-2.141	-32.242***	-1.562	-29.521***
$(i^{try}$-$i^{us})$	1.230	-46.734***	-1.860	-30.143***	1.416	-35.449***
$(i^{zar}$-$i^{us})$	-2.850*	-35.983***	-3.410**	-33.250***	-2.343	-27.631***

Notes: HUF, MXN, PLN, RUB, TRY and ZAR denote the 3-month LIBOR based CIP deviations of the currencies respectively; Hungarian forint, Mexican peso, Polish zloty, Russian rouble, Turkish lira and South African rand. DXY is the Dollar index, VIX is the implied volatility of S&P 500 Index , EURUSD CIP is the 3 month LIBOR based CIP deviations of Euro, CDS is the 5-year credit default swap spread of countries, LIQ is the average of normalized bid-ask spread of the 3 month forward and spot rates of currencies, (i-i^{us}) is the nominal 10 year government bond yield differences of the respective country and United States. Lag lenght is determined by the Schwarz Information criterion. ***, ** and * indicate significance at the 1%, 5% and %10 respectively.

3.4. Empirical Results

Table 3.6 reports the estimation results for the time-series and panel estimation for Jan 4, 2010 to July 30, 2018. The panel regression results show that all local factors (i.e. credit risk (measure by CDS spreads), FX liquidity (measured by bid-ask spread) and nominal interest rate differences) are significantly related to CIP deviations. The sign of the CDS coefficient is negative, which indicates that CIP deviations decrease when a country's credit risk increases. This negative association is contrary to the given early evidence that credit risk is found to be positively associated with CIP deviations in the sample of emerging economies (see Skinner and Mason, 2011).

We find that at the individual currency level, there is a heterogeneity in the association between credit risk and CIP deviation. Sovereign CDS spreads for Mexico, Russia, Turkey and South Africa were negatively and significantly related to CIP deviations whereas Hungary and Poland were positively but not significantly related to CIP deviations. Since currencies with negative CDS coefficients are so-called highest-yield carry currencies, the negative association of credit risk on CIP deviations is in line with our expectations. As we explain in section 3.3 (see also Figure 3.3), the changing nature of carry-trade activities in the post-crisis period among some of the emerging economies and given the wide use of FX swaps in these countries for the carry trade causes a negative relationship between the CIP deviation and CDS.

Direct evidence on carry trade activities requires the detailed data on individual investor positions, which are rarely available. Thus, when we order the average LIBOR rates of currencies as a proxy for the incentives for carry-trade activities,

not high. To save space, these results are not reported but are available on request.

Table 3.6: Full Sample Regression (3-month LIBOR rate, January 2010 to July 2018)

	Time Series Regressions						
	Hungary (HUF)	Mexico (MXN)	Poland (PLN)	Russia (RUB)	Turkey (TRY)	South Africa (ZAR)	Panel
	Dependent Variable: D(CIP) $= D(\exp(nr_{t,t+n}) - F_{t,t+n}/S_{t+n}\exp(nr^*_{t,t+n}))$						
Constant	0.194	-0.697***	0.107	-1.333***	-1.310***	-0.812***	-0.032
	(0.153)	(0.183)	(0.085)	(0.378)	(0.380)	(0.213)	(0.221)
D(CDS)	0.035	-0.130***	0.033	-0.536***	-0.427***	-0.139***	-0.570***
	(0.028)	(0.047)	(0.027)	(0.070)	(0.072)	(0.042)	(0.070)
D(LIQ)	0.214 ***	0.781 ***	0.472 ***	1.359 *	5.293 ***	2.663 ***	4.737 ***
	(0.077)	(0.093)	(0.041)	(0.725)	(0.267)	(0.104)	(0.393)
D(i-i^{us})	-1.658	-7.338**	1.813	-31.100***	-29.324***	-14.540***	-24.951***
	(2.219)	(2.869)	(1.614)	(5.688)	(3.343)	(2.603)	(4.537)
D(VIX)	0.187 *	0.304 **	0.005	-1.052	0.326	0.264 ***	0.427
	(0.106)	(0.121)	(0.060)	(0.295)	(0.252)	(0.125)	(0.272)
D(EURUSD CIP)	0.154 ***	0.060	0.199 ***	0.059	0.030	0.059	0.319 **
	(0.049)	(0.060)	(0.032)	(0.131)	(0.132)	(0.081)	(0.139)
D(DXY)	-0.135	-0.447	1.077 ***	-1.634	-0.502	1.066 **	1.028
	(0.399)	(0.474)	(0.218)	(1.067)	(0.989)	(0.531)	(1.025)
	Variance Equation						
γ_0	-0.090***	3.389 ***	-0.106***	0.007	4.616 ***	0.617 ***	
	(0.025)	(0.350)	(0.022)	(0.048)	(0.433)	(0.138)	
γ_1	0.226 ***	0.617 ***	0.283 ***	0.630 ***	0.652 ***	0.482 ***	
	(0.024)	(0.059)	(0.025)	(0.066)	(0.072)	(0.036)	
γ_2	0.079 ***	-0.247***	0.035	-0.157***	-0.269***	-0.191***	
	(0.020)	(0.041)	(0.021)	(0.037)	(0.046)	(0.033)	
γ_3	0.982 ***	0.173 ***	0.969 ***	0.951 ***	0.181 ***	0.796 ***	
	(0.005)	(0.072)	(0.006)	(0.006)	(0.068)	(0.030)	
Student t	5.415 ***	4.994 ***	5.182 ***	2.700 ***	4.056 ***	8.067 ***	
R-squared	0.022	0.013	0.066	0.030	0.097	0.150	0.047
N	2235	2235	2235	2235	2110	2235	13285

Notes: In this table, we report coefficients both from EGARCH(1,1) model and panel model for CIP deviations. For individual currency estimates mean equation is as follows:

$$\text{D(CIP)} = \alpha_0 + \alpha_1\text{D(CDS)} + \alpha_2\text{D(LIQ)} + \alpha_3\text{D(i-i}^{\text{us}}) + \alpha_4\text{D(VIX)} + \alpha_5\text{D(EURUSD-CIP)} + \alpha_6\text{D(DXY)} + \epsilon$$

where $\epsilon \sim N(0, \sigma^2)$ and thus, variance equation is as follows:

$$\ln(\sigma^2) = \gamma_0 + \gamma_1 \ln(\sigma^2_{-1}) + \gamma_2\epsilon_{-1} + \gamma_3(|\epsilon_{-1}/\sigma_{-1}| - \sqrt{2/\pi})$$

where $r_{t,t+n}$ and $r^*_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar, respectively. S_t and F_t are spot and forward rate, respectively. CDS is the 5-year credit default swap spread of countries, LIQ is the average of normalized bid-ask spread of the 3 month forward and spot rates of currencies, i-i^{us} is the nominal 10 year government bond yield differences of the respective country and United States. VIX is the implied volatility of S&P 500 Index , EURUSD CIP is the 3 month LIBOR based CIP deviations of Euro, DXY is the Dollar index. Numbers in parentheses are standard errors. In panel data, standard errors are robust to conditional heteroscedasticity and cross-sectional and serial correlation as in Driscoll and Kraay (1998). ***, ** and * denote 1%, 5% and 10% significance levels, respectively. N denotes number of observations.

countries with the highest LIBOR rates have negative signs for the CDS coefficients.[12] BIS (2015) documents that FX derivatives tools have become more popular for implementing carry-trade activities, especially in emerging economies. The ease of implementation of FX derivatives and their low default risk properties are the main reasons for investors to shift their carry-trade investments from fixed income markets to FX derivatives markets (Lustig et al., 2011). In our sample countries, four currencies (Mexican peso, Russian rouble, South African rand, Turkish lira) belong to the high carry countries and the usage of FX swaps is high in those currencies. Since the FX swaps are done in OTC, it is difficult to reach the volume of the FX swap transactions. Yet, surprisingly, Banking Regulation and Supervision Agency in Turkey (BRSA) publishes data about the FX swap positions of domestic banks with non-residents in Turkey on monthly basis.

Using BRSA data, we compile FX swap positions (in billions USD) of non-residents between January 2010 and July 2018 (Figure 3.4). The amount that foreigners give the Turkish lira (TL) and receive the US dollars at the first leg is always higher than the amount that foreigners receive the Turkish lira (TL) and give the US dollar. Considering that the former is used for the carry trade activities and the latter is used for hedging purposes, it is clear that the amount of carry trade activities are higher than the amount used for hedging during the sample period in Turkey. Therefore, when credit risk of Turkey increases, one should expect that FX swap rates would increase more than the domestic interest rates and hence the CIP deviation would diminish. We believe that credit risk affects CIP deviations in two ways. In low-carry currencies, the well-known mechanism for credit risk works so that an increase in credit risk increases CIP deviations. Conversely, in high-carry currencies, FX swaps rates seem to react

[12] We also used the interest rate difference between two currencies adjusted for implied volatility as a proxy to measure the incentive for carry-trade activities. This produced similar results for high-yielding currencies.

more than domestic interest rates, which reduces CIP deviations.

Figure 3.4: FX swap (foreign currency to Turkish lira (TL)) positions of non-residents with Turkish banks (billions U.S. dollar). Source: Turkey's Banking Regulation and Supervision Agency.

We find that FX liquidity is significantly and positively associated with CIP deviations in the single country and the panel regressions. Our findings suggest that a decrease in FX liquidity (the higher the liquidity coefficient) widens CIP deviations. In the single country regressions, we find a similar association, such that liquidity has strongly significant positive effects on CIP deviations in all six emerging economies.

Nominal interest rate differences have negative and significant coefficients in the panel regression, which implies that CIP deviation decreases when the interest rate differential between the sample countries' currencies and the U.S. dollar widens. Except for Poland, the single country regressions revealed significant negative associations between nominal interest rates and CIP deviations. Bräuning and Ivashina (2017) argue that an increase in the differences of interest rates raises demand for FX swaps from the lower rate currency to the higher one. This in turn increases the forward premium beyond its CIP-implied value. This finding underlines that nominal interest rates are important drivers of CIP deviations.

Global factors, on the other hand, seem to have a smaller impact on CIP deviations than local factors. The VIX coefficient is found to be significant for the CIP deviations in the Hungarian forint, Mexican peso and South African rand. Studies of advanced economies provide conflicting evidence about the effect of VIX during the post financial crisis period. For example, Avdjiev et al. (2019) find no significant impact of VIX on CIP deviations whereas Cerutti et al. (2021) show that VIX is an important driver of CIP deviations, particularly in low-interest currencies. Our findings seem to fall between these two studies.

We find a significant positive relationship between three-month EURUSD CIP deviation and local currency CIP deviations in the panel regression. In the single-country regressions, we find similar significant relationship, only for the Hungarian forint and Polish zloty. Hungary and Poland have been European Union members since 2004 and have financial and trade ties with Eurozone countries. Therefore, factors that affect EURUSD CIP deviations seem to contribute to the CIP deviations in these countries.

The panel regression shows no effect of U.S. dollar strength (DXY). CIP deviations are only positively associated with the value of the U.S. dollar for the Polish zloty and, to a lesser extent, the South African rand. Cerutti et al. (2021) and Avdjiev et al. (2019) argue that the financial channel of exchange rates dominates the net exports channel. Consequently, depreciation of a domestic currency widens CIP deviation in advanced economies. In most emerging economies, however, this mechanism does not work as it does in advanced economies. Other factors, particularly domestic ones, have more influence on EME currency CIP deviations.

3.4.1 Implied Volatility of the Currencies, Credit Risk and CIP Deviations

To further understand the mechanism behind the effect of credit risk on CIP deviations, we add the three-month implied volatility of the currencies to our basic model. The relationship between implied volatility and a country's credit risk is well-documented in the literature (e.g. see Della Corte et al., 2016; Hui and Fong, 2015; Carr and Wu, 2007). The two variables often move in tandem, whereby an increase in sovereign risk is accompanied by higher foreign exchange (FX) volatility. Empirical studies also show that implied volatility, as a measure of market risk, explains CIP deviations (Coffey et al., 2009; Mancini-Griffoli and Ranaldo, 2010; Park, 2015; Sushko et al., 2016). Both credit risk and implied volatility appear to amplify CIP deviations in advanced economies.

Table 3.7 reports the estimation results of a model with implied volatility as a proxy for FX market risk. Our findings are generally in line with our previous results. That is, the sign of the credit risk and implied volatility are the same for all currencies, being positive in low-carry currencies (Hungarian forint and Polish zloty) and negative for high-carry currencies (Mexican peso, Russian rouble, South African rand and Turkish lira). As explained in section 3, greater usage of FX swaps in carry-trade activities makes investors more sensitive to FX swap interest rates than domestic rates. Therefore, an increase in implied volatility and/or credit risk reduces CIP deviations since investors demand a greater return for the higher risk.

3.4.2 Time Varying Measure of Credit Risk and CIP Deviations

Although credit risk is central to CIP deviations across advanced economy currencies during the global financial crisis, we find a significant but negative

Table 3.7: Full Sample Regression with Implied Volatility (3-month LIBOR rate, Jan 2010 to July 2018)

	Time Series Regressions						
	Hungary (HUF)	Mexico (MXN)	Poland (PLN)	Russia (RUB)	Turkey (TRY)	South Africa (ZAR)	Panel
	Dependent Variable: D(CIP) $= D(\exp(nr_{t,t+n}) - F_{t,t+n}/S_{t+n} \exp(nr^*_{t,t+n}))$						
Constant	0.178	-0.678***	0.102	-1.435***	-1.321***	-0.784***	-0.112
	(0.153)	(0.182)	(0.085)	(0.377)	(0.378)	(0.214)	(0.189)
D(CDS)	0.053 *	-0.070	0.017	-0.498***	-0.287***	-0.094**	-0.581***
	(0.029)	(0.051)	(0.028)	(0.073)	(0.079)	(0.044)	(0.072)
D(LIQ)	0.223 ***	0.761 ***	0.474 ***	1.350 *	5.532 ***	2.672 ***	4.737 ***
	(0.077)	(0.092)	(0.041)	(0.738)	(0.269)	(0.103)	(0.393)
D(i-i^{us})	-1.265	-6.568**	1.193	-29.233***	-26.640***	-12.774***	-25.389***
	(2.248)	(2.904)	(1.646)	(5.766)	(1.122)	(2.721)	(4.623)
D(VIX)	0.213 **	0.345 ***	-0.009	-0.998***	0.387	0.270 **	0.416
	(0.107)	(0.128)	(0.061)	(0.298)	(0.246)	(0.126)	(0.274)
D(EURUSD CIP)	0.172 ***	0.096	0.192 ***	0.056	0.059	0.088	0.311 **
	(0.05)	(0.061)	(0.033)	(0.130)	(0.133)	(0.078)	(0.139)
D(DXY)	-0.017	-0.424	1.02 ***	-1.499	-0.382	1.083 **	1.003
	(0.405)	(0.473)	(0.219)	(1.07)	(0.988)	(0.532)	(1.027)
D(IMPVOL)	-0.840	-1.839**	0.709 **	-2.816**	-5.841***	-1.956***	0.659
	(0.621)	(0.475)	(0.344)	(1.287)	(3.351)	(0.682)	(1.050)
	Variance Equation						
γ_0	-0.090***	3.563 ***	-0.106***	0.008	4.733 ***	0.627 ***	
	(0.025)	(0.342)	(0.022)	(0.048)	(0.433)	(0.141)	
γ_1	0.226 ***	0.618 ***	0.281 ***	0.633 ***	0.643 ***	0.474 ***	
	(0.024)	(0.059)	(0.025)	(0.066)	(0.072)	(0.036)	
γ_2	0.078 ***	-0.240***	0.036*	-0.157***	-0.255***	-0.187***	
	(0.021)	(0.041)	(0.022)	(0.037)	(0.047)	(0.033)	
γ_3	0.983 ***	0.136 ***	0.970 ***	0.951 ***	0.164 ***	0.796 ***	
	(0.005)	(0.071)	(0.006)	(0.006)	(0.07)	(0.031)	
Student t	5.409 ***	4.846 ***	5.143 ***	2.689 ***	3.961 ***	7.992 ***	
R-squared	0.025	0.016	0.067	0.029	0.101	0.155	0.047
N	2235	2235	2235	2235	2110	2235	13285

Notes: In this table, we report coefficients both from EGARCH(1,1) model and panel model for CIP deviations. For individual currency estimates mean equation is as follows:

$$\text{D(CIP)} = \alpha_0 + \alpha_1 \text{D(CDS)} + \alpha_2 \text{D(LIQ)} + \alpha_3 \text{D(i-i}^{\text{us}}) + \alpha_4 \text{D(VIX)} + \alpha_5 \text{D(EURUSD CIP)} + \alpha_6 \text{D(DXY)} + \epsilon$$

where $\epsilon \sim N(0, \sigma^2)$ and thus, variance equation is as follows:

$$\ln(\sigma^2) = \gamma_0 + \gamma_1 \ln(\sigma^2_{-1}) + \gamma_2 \epsilon_{-1} + \gamma_3(|\epsilon_{-1}/\sigma_{-1}| - \sqrt{2/\pi})$$

where $r_{t,t+n}$ and $r^*_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar, respectively. S_t and F_t are spot and forward rate, respectively. CDS is the 5-year credit default swap spread of countries, LIQ is the average of normalized bid-ask spread of the 3 month forward and spot rates of currencies, i-i$^{\text{us}}$ is the nominal 10 year government bond yield differences of the respective country and United States. VIX is the implied volatility of S&P 500 Index , EURUSD CIP is the 3 month LIBOR based CIP deviations of Euro, DXY is the Dollar index and IMPVOL is the 3-month implied volatility of the currencies. Numbers in parentheses are standard errors. In panel data, standard errors are robust to conditional heteroscedasticity and cross-sectional and serial correlation as in Driscoll and Kraay (1998). ***, ** and * denote 1%, 5% and 10% significance levels, respectively. N denotes number of observations.

association between credit risk and CIP deviation among emerging economies, except for those in Europe. We investigate the effect of credit risk further by estimating with a 500-day window.[13] In this way, we explore the time-varying importance of credit risk in explaining CIP deviations.

Figure 3.5 plots the estimated coefficient of each currency's five-year CDS spread over the whole sample period. The coefficients are mostly consistent with our previous findings. In particular, the five-year CDS spreads coefficient is significantly and negatively associated with CIP deviations in the Russian rouble and Turkish lira. For most of the period, it is also negative for the South African rand and Mexican peso. For the Polish zloty, our rolling-window regressions show a significant and positive relation between CDS spreads and CIP deviations before 2014, although the relation turns negative afterwards. The Hungarian forint is the only currency with no association between CDS spreads and CIP deviations. Based on these results, we suggest that the impact of credit risk on CIP deviations must be interpreted cautiously, especially when carry-trade activities are frequent.

3.5. Robustness Checks

To examine whether the dynamics of CIP deviations are similar in different periods, we divide the whole sample into two sub-periods: January 2010 to December 2013 and January 2014 to July 2018. We report the estimated coefficients in Table 3.8. Overall, we find similar outcomes to the panel regression except for the insignificant impact of EURUSD CIP deviations in the sub-sample regressions.

[13] We also used a 250-day window. However, this did not change the results much. To save space, these are not reported here but can be shared on request.

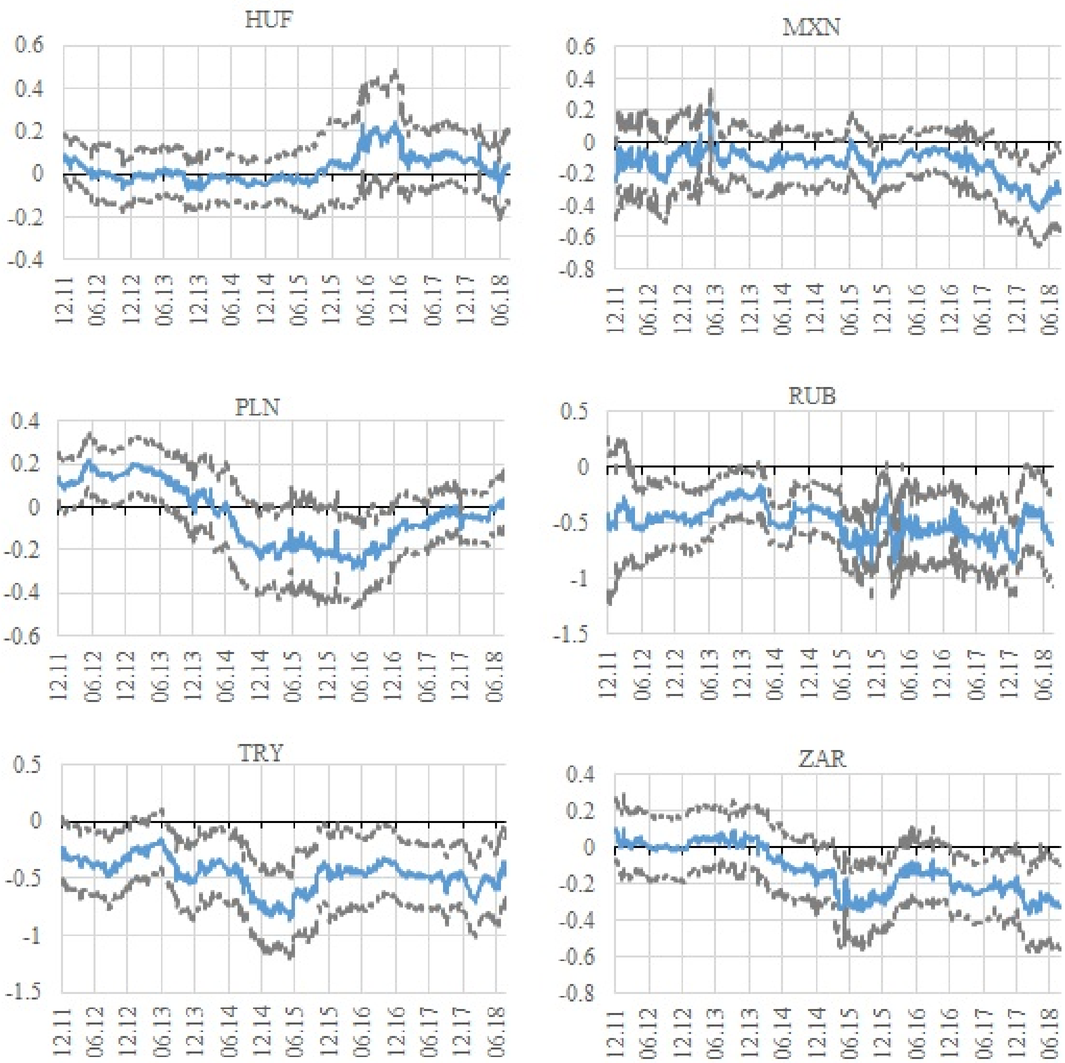

Figure 3.5: Estimated CDS coefficients from 500-day rolling regression (3 month LIBOR based CIP deviations and 95 percent confidence bands)

Table 3.8: Sub-Samples Regression (3-month LIBOR rate, January 2010 - December 2013, January 2014 - July 2018)

	Time Series Regressions												Panel	
	Hungary (HUF)		Mexico (MXN)		Poland (PLN)		Russia (RUB)		Turkey (TRY)		South Africa (ZAR)			
	2010-2013	2014-2018	2010-2013	2014-2018	2010-2013	2014-2018	2010-2013	2014-2018	2010-2013	2014-2018	2010-2013	2014-2018	2010-2013	2014-2018
	Dependent Variable: D(CIP) $= D(\exp(nr_{t,t+n}) - F_{t,t+n}/S_{t+n}\ \exp(nr^{*}_{t,t+n}))$													
Constant	0.003**	0.192	-0.439*	-0.877***	-0.377*	0.186**	-1.310***	-1.289**	-0.224	-2.196***	-0.674**	-0.940***	-0.030	-0.030
	(0.326)	(0.161)	(0.263)	(0.257)	(0.211)	(0.085)	(0.498)	(0.569)	(0.506)	(0.542)	(0.301)	(0.305)	(0.264)	(0.264)
D(CDS)	-0.002	0.063	-0.173**	-0.061	0.087**	-0.085*	-0.429***	-0.699***	-0.415***	-0.380***	0.012	-0.274***	-0.129*	-0.984***
	(0.038)	(0.053)	(0.075)	(0.063)	(0.044)	(0.045)	(0.097)	(0.100)	(0.107)	(0.108)	(0.059)	(0.058)	(0.077)	(0.115)
D(LIQ)	1.407***	0.020	0.398*	0.952***	1.290***	0.305***	1.389*	1.882	4.042***	5.425***	3.266***	2.547***	2.449***	5.592***
	(0.178)	(0.081)	(0.218)	(0.107)	(0.103)	(0.042)	(0.845)	(1.232)	(0.405)	(0.321)	(0.265)	(0.117)	(0.470)	(0.569)
D(i-i^{us})	-2.373	-2.952	-5.948*	-11.710***	0.471	1.898	-26.563***	-33.828*	-21.797***	-29.967***	-13.512***	-14.385***	-16.016***	-31.267***
	(3.232)	(3.032)	(3.513)	(4.834)	(3.485)	(1.686)	(9.131)	(7.407)	(5.617)	(4.571)	(3.862)	(3.642)	(5.272)	(7.021)
D(VIX)	0.611***	-0.058	0.428**	0.276	-0.081	0.047	-1.090**	-0.913**	0.336	-0.024	0.082	0.551***	0.048	0.723
	(0.212)	(0.122)	(0.172)	(0.176)	(0.138)	(0.061)	(0.489)	(0.387)	(0.337)	(0.363)	(0.180)	(0.188)	(0.315)	(0.447)
D(EURUSD CIP)	0.169*	0.151***	0.013	0.183***	0.404***	0.117***	-0.001	0.035	-0.029	0.139	0.105	-0.102	0.123	0.251
	(0.098)	(0.054)	(0.098)	(0.072)	(0.076)	(0.033)	(0.188)	(0.200)	(0.192)	(0.211)	(0.106)	(0.105)	(0.153)	(0.225)
D(DXY)	2.321**	-0.864**	-1.604**	-0.212	1.873***	0.957***	-2.722*	-0.896	1.173	-1.726	-0.318	2.188***	-0.956	1.404
	(0.927)	(0.434)	(0.749)	(0.622)	(0.624)	(0.218)	(1.498)	(1.561)	(1.471)	(1.398)	(0.815)	(0.726)	(1.313)	(1.530)
	Variance Equation													
γ_0	3.785***	-0.099***	5.136***	2.702***	2.784***	-0.101**	-0.067	0.060	0.074	5.365***	0.858***	0.559***		
	(1.031)	(0.032)	(0.857)	(0.348)	(0.645)	(0.042)	(0.058)	(0.064)	(0.084)	(0.551)	(0.248)	(0.192)		
γ_1	0.415***	0.238***	0.413***	0.691***	0.488***	0.370***	0.538***	0.531***	0.245***	0.694***	0.515***	0.465***		
	(0.081)	(0.036)	(0.087)	(0.079)	(0.073)	(0.047)	(0.083)	(0.075)	(0.049)	(0.097)	(0.057)	(0.049)		
γ_2	0.039	0.120***	-0.039	-0.341***	-0.069	0.125***	-0.209***	-0.045	-0.066*	-0.325***	-0.163***	-0.214***		
	(0.056)	(0.031)	(0.057)	(0.056)	(0.059)	(0.033)	(0.053)	(0.048)	(0.037)	(0.063)	(0.050)	(0.046)		
γ_3	0.166	0.981***	-0.168	0.301***	0.238	0.937***	0.966***	0.951***	0.957***	0.071	0.738***	0.812***		
	(0.211)	(0.006)	(0.182)	(0.074)	(0.158)	(0.014)	(0.007)	(0.008)	(0.015)	(0.085)	(0.055)	(0.041)		
Student's t	6.010***	4.852***	4.097***	6.750***	5.403***	5.000***	2.738***	2.743***	4.826***	4.397***	6.678***	10.824***		
R-squared	0.058	0.013	0.009	0.027	0.089	0.082	0.013	0.045	0.125	0.072	0.089	0.216	0.014	0.012
Observations	1041	1194	1041	1194	1041	1194	1041	1194	916	1194	1041	1194	6121	7164

Notes: In this table, we report coefficients both from EGARCH(1,1) model and panel model for CIP deviations. For individual currency estimates mean equation is as follows:

$$\text{D(CIP)} = \alpha_0 + \alpha_1 \text{D(CDS)} + \alpha_2 \text{D(LIQ)} + \alpha_3 \text{D(i-i}^{us}) + \alpha_4 \text{D(VIX)} + \alpha_5 \text{D(EURUSD CIP)} + \alpha_6 \text{D(DXY)} + \epsilon$$

where $\epsilon \sim N(0, \sigma^2)$ and thus, variance equation is as follows:

$$\ln(\sigma^2) = \gamma_0 + \gamma_1 \ln(\sigma^2_{-1}) + \gamma_2 \epsilon_{-1} + \gamma_3(|\epsilon_{-1}/\sigma_{-1}| - \sqrt{2/\pi})$$

where $r_{t,t+n}$ and $r^{*}_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar, respectively. S_t and F_t are spot and forward rate, respectively. CDS is the 5-year credit default swap spread of countries, LIQ is the average of normalized bid-ask spread of the 3 month forward and spot rates of currencies, i-i^{us} is the nominal 10 year government bond yield differences of the respective country and United States. VIX is the implied volatility of S&P 500 Index , EURUSD CIP is the 3 month LIBOR based CIP deviations of Euro, DXY is the Dollar index. Numbers in parentheses are standard errors. In panel data, standard errors are robust to conditional heteroscedasticity and cross-sectional and serial correlation as in Driscoll and Kraay (1998). ***, ** and * denote 1%, 5% and 10% significance levels, respectively. N denotes number of observations.

For the individual currencies, there are some interesting results. For example, the Polish zloty has different signs for the credit risk in the two sub-samples. While there is no significant effect of credit risk on CIP deviations for the Polish zloty for the full sample, it has a significant positive effect on CIP deviations in the first sub-sample and a significant negative effect in the second sub-sample. We argue that the former trend is due to the European debt crisis whereas the latter is due to increased usage of FX swaps in non-residents' carry-trade activities (National Bank of Poland, 2016, pp.10). Moreover, the impact of credit risk on the Mexican peso and South African rand differs between the sub-samples, in that it is only significant in the first sub-sample for the Mexican peso and in the second sub-sample for the South African rand.

In the sub-samples, liquidity risk remains the most important factor driving CIP deviations in individual currencies. The Hungarian forint and Russian rouble are not significant in the second sub-period compared to the first. The impact of nominal interest rate differences on CIP deviations in each sub-sample is the same for all currencies. Although VIX is an important factor in CIP deviations for the Hungarian forint, Mexican peso and South African rand in the full sample, it is only significant in the first sub-sample for the forint and peso and in the second sub-sample for the South African rand.

EURUSD CIP deviations in the sub-samples have similar effects on CIP deviations using full-sample data. Likewise, in both sub-periods, euro/dollar CIP deviations are still a significant driver of CIP deviations only for the Hungarian forint and Polish zloty. This time, we observe that the Mexican peso is related to EURUSD CIP deviations in the second sub-sample but not in the first.

The association between the U.S. dollar index and CIP deviations across the sub-samples is mixed. In the full sample, only the Polish zloty and South African rand are positively related to the U.S. dollar index, which remains a significant driver of CIP deviations in the Polish zloty in both sub-samples and the South African rand in the second sub-sample. The Hungarian forint, Mexican peso and Russian rouble have different associations. The coefficients of the U.S. dollar index for the Hungarian forint are significant in both periods but with a positive sign in the first sub-period and a negative in the second. For the Mexican peso and Russian rouble, the sign of the coefficient is negative and significant in the first sub-sample. These dissimilar patterns for the U.S. dollar index suggest that U.S. dollar index cannot be common driver of CIP deviations in the emerging economies.

In the literature, using the LIBOR rate for measuring CIP deviations has been criticized due to the measurement problem. As another robustness check, we calculate CIP deviations with deposit rates available as bid/ask rates for the sample countries (Figure 3.6). Table 3.9 reports the estimated coefficients to explain CIP deviations measured with deposit rates. Similarly, we observe that local factors play important roles on CIP deviations in the emerging economies.

3.6. Conclusion

In this chapter, we examine the CIP deviations for Hungarian forint, Mexican peso, Polish zloty, Russian rouble, South African rand, Turkish lira during the post financial crisis period. We show that persistent CIP deviations exist for nearly all of these currencies. However, the scale of the deviations varies by currency and time. FX liquidity is clearly the most important indicator in explaining CIP deviations. Lower liquidity in emerging economies causes higher liquidity premia, which widens CIP deviations.

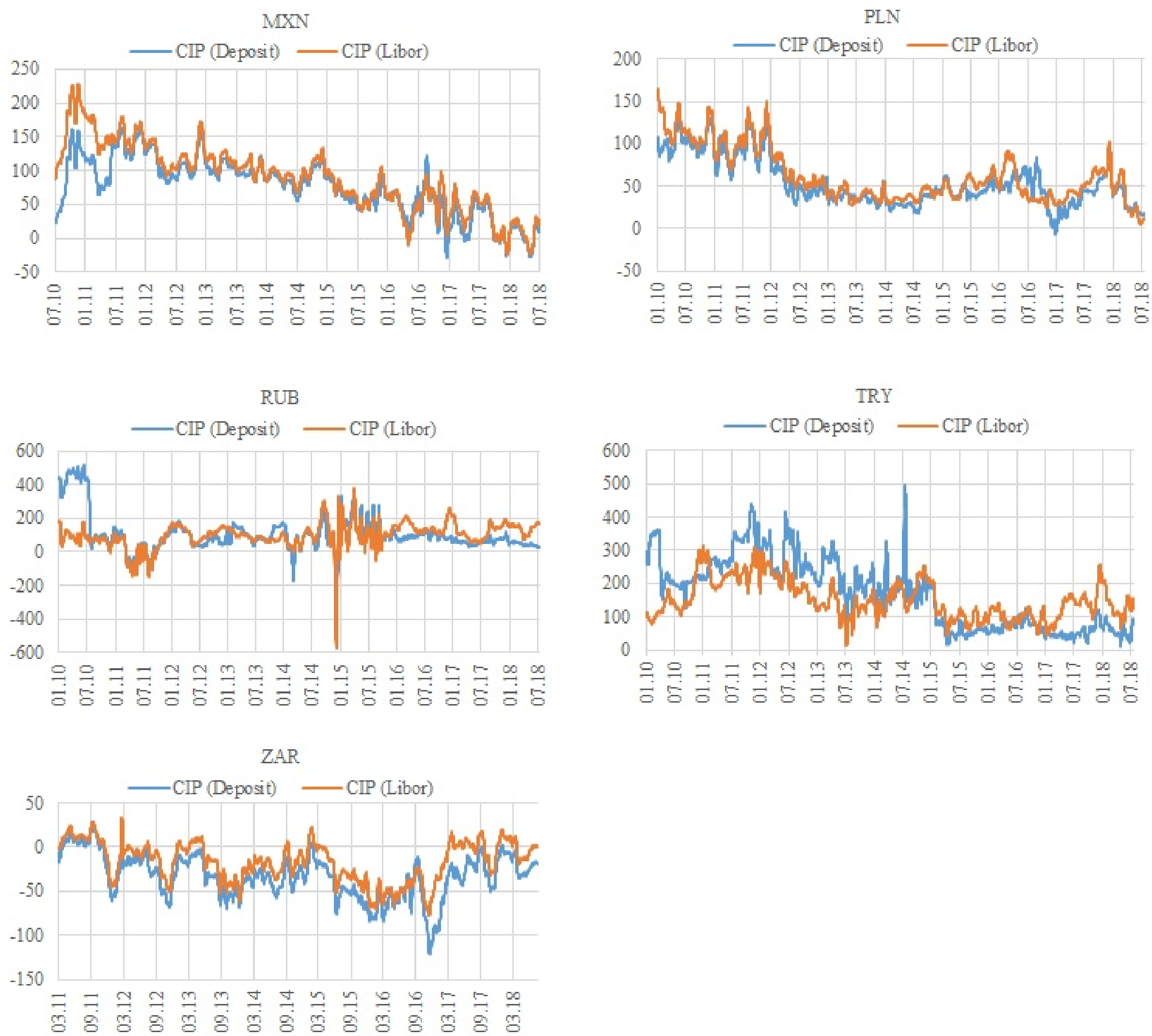

Figure 3.6: CIP Deviations (3 month, 10 day moving average, basis points) based on deposit rates and LIBOR

Table 3.9: Full Sample Regression (3-month Deposit rate)

	Time Series Regressions					
	Mexico (MXN)	Poland (PLN)	Russia (RUB)	Turkey (TRY)	South Africa (ZAR)	Panel
	Dependent Variable: D(CIP) $= D(\exp(nr_{t,t+n}) - F_{t,t+n}/S_{t+n}\ \exp(nr^*_{t,t+n}))$					
Constant	-0.509***	-0.087	-0.771	-0.999**	-0.504*	0.285
	(0.197)	(0.127)	(0.471)	(0.456)	(0.258)	(0.209)
D(CDS)	-0.049	0.032	-0.382***	-0.239**	-0.140***	-0.686***
	(0.05)	(0.042)	(0.097)	(0.096)	(0.051)	(0.112)
D(LIQ)	0.700 ***	0.732 ***	2.104 **	4.666 ***	2.651 ***	5.111 ***
	(0.11)	(0.062)	(0.961)	(0.292)	(0.131)	(0.554)
D(i-i^{us})	-4.257	-1.922	-10.983	-15.982***	-16.168***	-17.530***
	(3.016)	(2.444)	(6.977)	(4.217)	(3.317)	(6.916)
D(VIX)	0.108	0.074	-0.398	0.594 **	0.235	0.583
	(0.125)	(0.093)	(0.351)	(0.298)	(0.167)	(0.434)
D(EURUSD CIP)	0.083	0.562 ***	0.363 **	0.030	-0.003	0.221
	(0.064)	(0.057)	(0.18)	(0.171)	(0.094)	(0.216)
D(DXY)	-0.401	0.883 ***	-1.531	0.786	1.709 ***	1.455
	(0.505)	(0.335)	(1.352)	(1.265)	(0.67)	(1.349)
	Variance Equation					
γ_0	0.086	-0.037	0.093	2.761 ***	0.160 *	
	(0.061)	(0.04)	(0.059)	(0.453)	(0.084)	
γ_1	0.359 ***	0.515 ***	0.743 ***	1.458 **	0.399 ***	
	(0.037)	(0.049)	(0.149)	(0.616)	(0.036)	
γ_2	-0.128***	-0.048	-0.070	-0.276**	0.103 ***	
	(0.029)	(0.031)	(0.044)	(0.135)	(0.029)	
γ_3	0.931 ***	0.943 ***	0.950 ***	0.623 ***	0.910 ***	
	(0.013)	(0.008)	(0.006)	(0.036)	(0.017)	
Student t	4.327 ***	2.853 ***	2.308 ***	2.138 ***	6.938 ***	
R-squared	0.002	0.021	0.018	0.035	0.115	0.028
N	2087	2235	2235	2110	1926	10593

Notes: In this table, we report coefficients both from EGARCH(1,1) model and panel model for CIP deviations. Dependent variable is the deposit rate-based deviations from CIP. For individual currency estimates mean equation is as follows:

$$\text{D(CIP)} = \alpha_0 + \alpha_1\text{D(CDS)} + \alpha_2\text{D(LIQ)} + \alpha_3\text{D(i-i}^{\text{us}}) + \alpha_4\text{D(VIX)} + \alpha_5\text{D(EURUSD CIP)} + \alpha_6\text{D(DXY)} + \epsilon$$

where $\epsilon \sim N(0, \sigma^2)$ and thus, variance equation is as follows:

$$\ln(\sigma^2) = \gamma_0 + \gamma_1 \ln(\sigma^2_{-1}) + \gamma_2\epsilon_{-1} + \gamma_3(|\epsilon_{-1}/\sigma_{-1}| - \sqrt{2/\pi})$$

where $r_{t,t+n}$ and $r^*_{t,t+n}$ denote the continuously compounded n-year interest rates at date t in local currency and U.S. dollar, respectively. S_t and F_t are spot and forward rate, respectively. CDS is the 5-year credit default swap spread of countries, LIQ is the average of normalized bid-ask spread of the 3 month forward and spot rates of currencies, i-i^{us} is the nominal 10 year government bond yield differences of the respective country and United States. VIX is the implied volatility of S&P 500 Index , EURUSD CIP is the 3 month LIBOR based CIP deviations of Euro and DXY is the Dollar index. Numbers in parentheses are standard errors. In panel data, standard errors are robust to conditional heteroscedasticity and cross-sectional and serial correlation as in Driscoll and Kraay (1998). ***, ** and * denote 1%, 5% and 10% significance levels, respectively. N denotes number of observations.

Credit risk also significantly affects CIP deviations. Contrary to previous research, our findings suggest that increased credit risks, particularly in high carry-trade currencies, lessen CIP deviations. We argued that this association results from the changing nature of carry-trade activities. Increased use of FX derivatives instruments for carry-trade activities makes investors more sensitive to FX swap rates than domestic money market rates. Therefore, when a country's credit risk increases, investors demand higher premia for their investments in the form of FX derivatives. These investor behaviors affect FX swap rates to react more than domestic rates and narrow CIP deviations. Moreover, nominal interest rate differences between an emerging economy currency and the U.S. dollar also affect CIP deviations. That is, when such a difference widens, there is more FX swap demand to sell the high-interest currency and buy the low-interest rate currency. This in turn reduces CIP deviations. Finally, three global factors (the VIX index, U.S. dollar index and euro CIP deviations) are not consistently significant drivers of CIP deviations in the six analyzed currencies.

After the global financial crisis, emerging economy central banks have faced mounting difficulties in implementing independent monetary policies due to the dominance of the policies of advanced market central banks. CIP deviations may also influence the transmission mechanisms of these central banks by creating financial frictions. Although the policy implications of the CIP are still relatively unexplored in advanced economies, emerging countries with larger CIP deviations than advanced ones should be more cautious when implementing monetary policy.

CONCLUSION

The violation of interest parities (uncovered and covered interest parities) has been one of the key research areas in the international finance. The literature suggests that the violation of them has different implications. While the violation of uncovered interest parity is related to carry trade strategies, the violation of covered interest parity implies an arbitrage opportunity. In this thesis, we focus on both types of the violations and try to understand the dynamics behind them in emerging economies.

In the first chapter, we look at the carry trade dynamics in 16 emerging economies. We find that profitability of carry trades after the global financial crisis is less than the pre-crisis period. Moreover, we show that during the period of 2010 through 2018, monthly returns from a dollar neutral carry strategy are higher than the returns from a dollar carry strategy. The returns from both of the carry strategies are much lower than US stock market returns particularly in the post-crisis period. The significance of base currency is another finding in that when euro is the base currency, the returns are much higher than when the base currency is the U.S. dollar or the Japanese yen. In the emerging economies, we show that risk factors have a higher explanatory power to explain returns from the dollar carry strategies than the dollar-neutral carry strategies. Since the conventional wisdom is that emerging markets are riskier than the developed markets, investors are inclined to hedge their investments. We show that hedging activities using FX options are not necessarily a good strategy since the profit coming from the carry return vanishes out due to the high option prices.

In the second chapter, we study the reasons behind the deviation from covered interest parity (CIP) in six emerging economies: Hungary, Mexico, Poland, Russia, South Africa, Turkey with no capital controls. First, we document that persistent

CIP deviations exist nearly in all of the currencies of the sample countries. Then we show that FX liquidity is the main reason behind the deviations. Interest rate differences and credit risk are also other important indicators explaining the CIP deviations. We find that CIP deviation's reaction to the change in the credit risk among sample countries differs from what the literature suggests in that an increase in the credit risk lessens the CIP deviations. We argue that changing nature of carry trades accounts for this effect.

This research contributes to the literature in several ways. We investigate the dynamics behind the interest rate parities in emerging economies which is an underexamined research topic. In doing so, we highlight the link between the carry trade returns and the crash risk in the emerging economies. We also document that the unconventional mechanism between the credit risk and the CIP deviations begs for further research in the emerging economies considering the impact of CIP deviations on the efficiency of transmission of monetary policies and resource allocations.

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APPENDICES

Table A.1

OTC Foreign Exchange Turnover by Currency (Net daily averages in billions of USD)

	High Income Countries				Emerging Market Economies		
	2010	2016	%Δ		2010	2016	%Δ
U.S. dollar	3371	4438	31.6	Chinese Renminbi	34	202	489.8
Euro	1551	1591	2.5	Mexican Peso	50	97	94.4
Japanese Yen	754	1096	45.2	Korean Won	60	84	39.1
British Pound	512	649	26.8	Turkish Lira	29	73	148.6
Australian Dollar	301	348	15.6	Russian Rouble	36	58	62.0
Canadian Dollar	210	260	24.1	Indian Rupee	38	58	53.6
Swiss Franc	250	243	-2.8	Brazilian Real	27	51	86.3
Swedish Krona	87	112	29.1	South African Rand	29	49	71.9
New Zealand Dollar	63	104	64.5	Polish Zloty	32	35	10.4
Singapore Dollar	56	91	62.5	New Taiwan Dollar	19	32	68.9
Hong Kong Dollar	94	88	-6.7	Thai Baht	8	18	138.4
Norwegian Krone	52	85	61.4	Malaysian Ringgit	11	18	65.4
Danish Krone	23	42	84.3	Hungarian Forint	17	15	-10.8

Notes: Derivatives currencies (Leg 1) are from 2010 and 2016 BIS Triennal Survey. Emerging markets are classified according to International Monetary Fund classification. %Δ indicates percentage change.

Table A.2
Correlations of Hourly Data with Daily Data

	Currencies			
Tenor	Mexican Peso	Turkish Lira	South African Rand	Polish Zloty
3-month	0.97*	0.98*	0.97*	0.97*
6-month	0.98*	0.99*	0.97*	0.99*

Notes: Correlations of the high frequency (hourly) and daily 3-month and 6-month CIP deviations are calculated for the time period between Aug 27, 2013 and July 30, 2018. All the numbers with stars indicate that hourly data and daily data are statistically not different from each other at the 5% significance level.

Table A.3

Description of the Variables and Data Sources

Variable	Description	Source
D(CIP)	Three-month LIBOR based CIP deviations	Authors' calculations†
CDS	Five-year credit default risk spread of countries	Bloomberg
LIQ	Average of normalized bid-ask spread of the three-month forward and spot rates of currencies	Authors' calculations†
$i\text{-}i^{us}$	Nominal 10 year government bond yield differencesof the respective country and United States	Bloomberg
VIX	Implied Volatility of S&P 500 Index	Bloomberg
DXY	U.S. Dollar Index	Bloomberg
EURUSD CIP	Three-month LIBOR based CIP deviations of Euro	Bloomberg
IMPVOL	Three-month implied volatility of the currencies	Bloomberg

Notes: D(CIP) is deviation from CIP. †The data used in authors' calculations are from Bloomberg