US Dollar Carry Trades in the Era of 'Cheap Money'

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Abstract

In this paper, we employ a unique dataset of actual US dollar (USD) forward positions against a number of currencies taken by so-called Commodity Trading Advisors (CTAs). We investigate to what extent these positions exhibit a pattern of USD carry trading or other patterns of currency trading over the recent period of the ultra-loose US monetary policy. Our analysis indeed shows that USD positions against emerging market currencies are characterised by a pattern of carry trading. That is, the USD, as the lower yielding currency, is associated with short positions. The payoff distributions of these positions, moreover, are found to have positive Sharpe ratios, negative skewness and high kurtosis. On the other hand, we find that USD positions against other advanced country currencies have a pattern completely opposite to carry trading which is in line with uncovered interest parity trading; that is, the lower (higher) yielding currency is associated with long (short) positions.

Key words: Commodity Trading Advisors (CTAs), foreign exchange rate, carry trade.

JEL Classification: F31, G11, G15

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1. Introduction

In this paper, we employ and analyse a unique data set of actual USD forward positions versus a number of emerging and advanced market currencies. Our objective is to shed a light on the characteristics of the currency trading styles implied by these positions during a recent sample period, with an emphasis on USD carry trading[6]. The motivation behind this emphasis is the near-zero US interest rate over the vast majority of our sample period.

Currency carry trading implies that traders invest in higher yielding currencies (investment or target currencies) using borrowings in lower yielding currencies (funding currencies). So, by USD carry trading we mean the carry trades in which the USD is the funding currency. Under the assumption of the covered interest rate parity (CIP), this strategy can be implemented in the foreign exchange (FX) forward markets by taking long positions in currencies which are traded on forward discount (high interest rate currencies) and short positions in currencies which are traded on forward premium (low interest rate currencies). The motivation behind currency carry trading is the well-established finding of the downward bias in the unbiasedness hypothesis (UH) predictions, i.e. the forward premium bias puzzle (see e.g. Fama, 1984; Frankel and Chinn, 1993; Bansal and Dahlquist, 2000; Frankel and Poonawala, 2010 among others). The standard expression of this hypothesis is through the Fama regression of[7]:

$$s_{t+k} - s_t = \alpha + \beta(fp_t^k) + \varepsilon_{t+k} \qquad (1)$$

Where s_t (s_{t+k}) is the natural log of the spot exchange rate at time t ($t+k$), fp_t^k is the forward premium (log difference of the k-period forward rate and spot rate at time t) and ε_{t+k} is the error term. The null hypothesis is that $\alpha = 0, \beta = 1$ and ε_{t+k} is a white noise process which implies that currency excess return is expected to be zero.

In contrast, the well-documented finding of significantly less than unity and, more often, negative slope coefficient implies that positive currency excess return can be achieved by trading on currency interest differentials (on the carry). Carry trades have been found to be

[6] Generally speaking, carry trade strategies attempt to capitalize on yield differentials between financial instruments. Specifically, carry trades involve investments in higher yielding instruments financed by borrowings in lower yielding instruments. Koijen et al. (2013) define broadly a carry of an asset as "its expected return assuming that its price does not change". They find that carry is a common phenomenon existing amongst variety of asset classes such as equities, commodities, bonds, treasuries, currencies, credit, and index options. More importantly, they demonstrate the ability of carry to predict returns on these asset classes.
[7] Named after the influential work of Fama (1984).

profitable on average with an attractive Sharpe ratio compared to stock and bond markets (see e.g., Hochradl and Wanger, 2010; Pojarliev, 2005; Burnside et al., 2006; 2007; 2008; Gilmore and Hayashi, 2011; Menkhoff et al., 2012). The traditional common target currencies are found to include the Australian dollar, New Zealand dollar, Mexican peso, Brazilian real, Indian rupee, while funding currencies include mainly the Japanese yen and the Swiss franc (see Bilson, 2013; Galati and Melvin, 2004; Galati et al., 2007; McGuire and Upper, 2007; Gagnon and Chaboud, 2007; Curcuru et al., 2010).

In the wake of the 2007-2008 financial crisis, many countries, especially developed countries including the USA, have adopted unconventional loose monetary policies with the purpose of stimulating their sluggish and unstable economies. This period is termed in the financial press as "the era of cheap money". On the other hand, other countries, especially emerging markets, have maintained relatively high interest rates over the same period. Because of the potential impact of these effects on the trading decisions of the FX traders, it is worthwhile to consider currency trading in general and USD carry trading in particular over the sample period of the paper. For example, Gilmore and Hayashi (2011) find a strong relation between currency excess return and the carry. Spronk et al. (2013) show that the more important the interest rate differential, the more attractive the currency carry trading. It is also suggested that the relatively high-yielding emerging markets have been major recipients of carry trade flows in the wake of the crisis, and that this flow represents a "global search for yield" which is triggered by the unconventional expansion monetary policy of advanced economies (see e.g. Kim, 2015; Mishra et al., 2014). For a set of major currencies, Brière and Drut (2009) document the superiority of "fundamentals-based" trades over carry trades when uncertainty is high.

In light of this, the crux of the paper is to analyse our dataset of the USD forward *positions* to find out to what extent they show characteristics of USD carry trading or another trading strategy over the recent period of record-low US interest rates. In other words, we investigate whether these positions exhibit a response to the very low US interest rates by having a pattern of USD carry trading or other patterns of trading strategies can be identified across different currency markets. The distinctive feature of this study is that we have access to a dataset of daily-aggregated USD forward positions against a number of advanced and emerging currencies. It is collected from a Swedish investment specialist, Risk & Portfolio Management AB (RPM) which is a fund of hedge funds investing in Managed Futures strategies which are also known as Commodity Trading Advisors (CTAs). CTAs engage in various strategies like trend-following, short-term trading, and global macro that often employs carry trading as a sub-strategy.

By exploiting and analysing our private dataset we find significant long-run equilibrium relationships which directly relate the USD forward positions to its forward premium. The relationships point to different trading strategies for emerging and advanced market currencies. For emerging currencies, we find that these relationships are consistent with carry trading. That is the lower yielding currency (the USD) is associated with short positions and vice versa. This carry trading pattern of forward shorting lower-yielding currency is induced by the expectations that the lower-yielding currency will not actually appreciate on average as much as the forward rate implies, or even it will depreciate. This in turn implies a profit on average at maturity. On the other hand, we find that the reverse holds between the USD and advanced currencies. In other words, we find a pattern of “fundamentals-based” trading consistent with the uncovered interest parity condition. That is, the lower (higher) yielding currency is associated with more long (short) positions. These anti-carry positions can reflect the unattractiveness of the advanced currencies-USD carry trading due to the increased uncertainty and narrow interest differentials for these markets over the period following the recent crisis.

Given that our data set is collected from FX traders which are mainly trend-followers, these results of the different trading strategies for emerging and advanced market currencies shed some light on the trading behaviour of this group of the FX market participants. On the one hand, the characteristics of carry trades for EM currencies which involve long high-interest currency aginst the low-interest currency reflect a trend-following strategy which is based on the expectations that high-interest currency is going to appreciate -i.e. based on the appreciation trend of the high-interest rate currency. On the other hand, the characteristics of “fundamentals-based” trades for AM currencies which involve long low-interest currency against high-interest currency reflect a trend-following strategy which is based on the expectations that low-interest rate currency is going to appreciate –i.e. based on the appreciation trend of the low-interest rate currency. This is in line with the heterogeneous agents model developed by Spronk et al. (2013). The model demonstrates that depending on the dominant trend in the market, FX trend-followers can be in the same line of either carry traders or fundamentalists. In this sense, our results provide some insights into these features of the FX trend-following traders.

Our work is also mainly related to the studies of tracking and providing evidence on currency carry trading. The findings of the existing studies on tracking carry trading activities are, to a large extent, deemed implicit and indirect. This is because they only use publically available datasets such as the Bank for International Settlements (BIS) reports and statistics, FX turnovers and FX futures positions (see Galati et al., 2007, McGuire and Upper, 2007; Gagnon and Chaboud, 2007; Curcuru et al., 2010). In contrast, our dataset enables us to document a direct relationship between forward positions and forward premium, so that provides explicit evidence on these activities. Despite of the speculation that "the unprecedented low interest rates of the US could have induced a large-scale carry trades against high-yielding emerging currencies" (Aizenman et al., 2014), the existing literature, to our knowledge, lacks such direct evidence on this trend especially in currency forward markets. Tracking currency carry trades is important because of their vital implications. For example, identifying periods of increasing carry trades is relevant as it is suggested and found that carry trades increase the risk of currency crashes for investment currencies (see e.g. Brunnermeier et al., 2008; Breeden et al., 2014), and that a sudden and massive unwinding of carry positions can contribute substantially to the volatility shocks of the FX and other financial markets, especially for target countries (see e.g. Gagnon and Chaboud, 2007; Nishigaki, 2007; Galati et al., 2007; Eichengreen and Gupta, 2014; Mishra et al., 2014). So, tracking carry trades can help in enhancing the understanding of markets' volatility dynamics. Currency carry trades can also play a role in deepening the violation of the uncovered interest parity (UIP) by creating "self-enforcing" speculation opportunities which intensified by the FX trend-followers (see, e.g. Plantin and Shin, 2007; Gagnon and Chaboud, 2007; Spronk et al., 2013).

Moreover, our dataset allows us to analyse the performance of actual and not synthetic carry trading strategies. Earlier papers relying on hypothetical carry positions; assuming short positions in lower yielding currencies and long positions in higher-yielding currencies, have found carry trades to be profitable. These studies have also documented high kurtosis and negative skewness for carry trade returns (See e.g. Burnside et al., 2008; Burnside et al., 2007; Burnside et al., 2006; Menkhoff et al., 2012). In contrast to these studies, we evaluate the performance of the actual USD positions against the emerging currencies where we have explicit evidence that carry trades were being executed. We investigate to what extent the properties documented based on synthetic positions also apply to our actual positions.

The remainder of the paper is organized as follows: Section 2 describes the data set while Section 3 explains the methodology. The results are presented in Section 4 and Section 5 concludes.

2. Data

The empirical analysis in the paper draws on a private dataset[8]. For the analysis, we employ a dataset of daily-aggregated short term long and short forward positions in USD against various developed and emerging market currencies. The complete dataset contains positions' forward rate (F), spot rate (S), maturity date, and the spot rate that transpired ex-post at the maturity date. The source of the dataset is RPM Risk & Portfolio Management AB (RPM), a specialist investment manager based in Stockholm, Sweden. RPM is a fund-of-funds specializing in Managed Futures strategies, i.e. CTAs and liquid Global Macro managers that trade in many futures markets such as currencies, bonds, equity indices, and many other commodity futures.

It is well-known that trend following is the most widely used strategy by CTAs. Galati and Melvin (2004) and Galati et al. (2007) point to the increasing active role of CTAs in the FX market and their engagement in currency carry trades. Spronk *et al.* (2013) study the interactions of fundamental, trend following, and carry trade strategies in a theoretical model. They argue that carry traders have a directional role in driving the UH beta. When interest rate differentials are persistent, carry traders introduce momentum effects in a currency that is picked up and extrapolated by trend followers. Furthermore, it is only due to the existence of trend followers that carry traders can have such a profound effect on FX markets.

We have daily-aggregated short term forward positions in USD against twelve developed and emerging market currencies. Developed market currencies include EUR, JPY GBP, CHF,

8 In contrast to earlier works, this paper overcomes the deficiencies of commonly used datasets in measuring carry trade activity by examining a unique dataset. One of the datasets most often used to investigate currency carry trades is non-commercial "position-takers" net positions in currency futures traded on Chicago Mercantile Exchange (CME) which is available on weekly frequency through the Commitments of Trader Reports (COT). However, these datasets have several drawbacks. Firstly, the number of reported currencies is limited as a currency is reportable only if there is a minimum of twenty or more traders. Secondly, the reported currency positions are all against the USD; there are no reported positions for different currency pairs such as, JPY against AUD or CHF against GBP etc. Last but not least, the definition of non-commercial traders as "position-takers" has its own limitations. Another commonly used dataset is the BIS international banking statistics and other similar reports issued by other entities where cross-border lending and borrowing by currency are reported. The main problem with these datasets is that it is difficult to differentiate the true carry positions from other carry-unrelated positions. For a detailed overview, the reader may refer to Curcuru et al. (2010).

SEK and CAD, while emerging market currencies include INR, BRL, MYR, ZAR, CLP and MXN. Spot and forward exchange rates are expressed where the USD is the base currency (other currency units per 1 USD). From these positions, we construct a variable which we call “net position” NP. Against every other currency, the daily-aggregated NP in terms of the USD is calculated as the net of the long and short USD positions. That is, the USD long positions minus short positions;

$$NP_t = \sum_{p=1}^{m} Pos_{p,t}^{L} - \sum_{p=1}^{m} Pos_{p,t}^{S}$$

where m is the number of position takers. (2)

And Pos^j, $j = L, S$ is the position held in the currency, long and short respectively

Positive (negative) NP, therefore, implies net long (short) position in the USD against the other currency. NP is typically stationary so in our cointegration analysis in the paper, we make use of the cumulative net position (*CNP*). *CNP* is the cumulative sum of the NP series: by construction it is I(1) and its first difference is NP.

Table 1 reports the sample period for every currency pair along with descriptive statistics of the variables of interests. We note that the USD typically has net short (long) positions whenever it is at a forward premium (discount), except for SEK/USD.

Figure 1 depicts the benchmark policy interest rate for every country in the sample. The main feature to be noticed is the difference between developed and emerging interest rates. For developed countries including the US, we can see the pattern of very low interest rates during the period after late 2008. For emerging countries, although many have cut their rates, they still have maintained relatively high interest rates. This further motivates the study of the carry trade during the sample period.

To make it clearer, Figure 2 depicts the monthly average of interest rate differentials, calculated as other currency interest rate minus USD interest rate. We obviously note the very low advanced currencies-USD interest rate differentials compared to those of emerging market currencies.

3. Methodology

The existence of a co-integrated relationship between variables implies that there is long-run equilibrium relationship binding them together which also reveals important insights about their dynamic behaviour. Thus, multivariate Johansen co-integration analysis techniques are employed to test for the existence and the number of co-integrated relationships between the USD forward positions (CNP) , spot exchange rates $(LogS)$ and forward exchange rates $(LogF)$ in order to investigate how they are related over the long run. We employ the co-integration analysis as we first intend to document whether or not these variables are co-integrated, which implies that there are common forces driving the variables over the long-run, and then this is used to cast light on what the resulting co-integrated relationships imply for currency trading styles. The co-integration setup has the advantage that it provides an overview picture on how the variables are related over long-runs with a more dynamic framework apart from the possible short-run deviations on the observation-by-observation basis.

Given that there is a significant long-run equilibrium relationship binding our variables together, according to Engel and Granger (1987), a vector error correction mechanism (VECM) can be estimated. Such a VECM as specified below, along with an unrestricted VAR model will enable us to evaluate the relationships between the variables and investigate the direction of causality among them.

$$\Delta CNP_t = \phi_1 + \alpha_1 \hat{e}_{t-1} + \sum_{i=1}^{n} \delta_{1i} \Delta CNP_{t-i} + \sum_{i=1}^{n} \gamma_{1i} \Delta LogS_{t-i} + \sum_{i=1}^{n} \psi_{1i} \Delta LogF_{t-i} + \varepsilon_{1t} \qquad (3)$$

$$\Delta LogS_t = \phi_2 + \alpha_2 \hat{e}_{t-1} + \sum_{i=1}^{n} \delta_{2i} \Delta CNP_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \Delta LogS_{t-i} + \sum_{i=1}^{n} \psi_{2i} \Delta LogF_{t-i} + \varepsilon_{2t} \qquad (4)$$

$$\Delta LogF_t = \phi_3 + \alpha_3 \hat{e}_{t-1} + \sum_{i=1}^{n} \delta_{3i} \Delta CNP_{t-i} + \sum_{i=1}^{n} \gamma_{3i} \Delta LogS_{t-i} + \sum_{i=1}^{n} \psi_{3i} \Delta LogF_{t-i} + \varepsilon_{3t} \qquad (5)$$

where ϕ s are constants, α s are adjustment coefficients, $\hat{e}_{t-1}$ is the error correction term and ε s are error terms.

In the framework of an unrestricted VAR model, specified similarly as in the equations above but with the exclusion of the error correction term $\hat{e}_{t-1}$, i.e. setting α s=0, Granger Causality/Block Exogeneity Wald test is performed to determine whether the lags of other variables Granger cause the respective dependant variable. In other words, the test shows whether the lags of other variables can be excluded from the respective dependent variable equation without losing relevant information.

For example, in ΔCNP_t equation we can test the joint null hypothesis for the coefficients of $\Delta LogS$ lags as $\gamma_{1i} = ... = \gamma_{1n} = 0$, and similarly for $\Delta LogF$ lags as $\psi_{1i} = ... = \psi_{1n} = 0$, and we can test for the coefficients of the two variables' lags together as $\gamma_{1i} = ... = \gamma_{1n} = \psi_{1i} = ... = \psi_{1n} = 0$. This test will provide insights on the Granger causality amongst the variables, as well as the exogeneity/endogeneity of the variables.

For the cases in which we have evidence on carry trading, we evaluate the performance of this trading strategy and investigate the properties of its payoff distribution. For every trading day, we calculate the payoff of all positions taken. The daily-aggregated payoff (π_t) in terms of the quote currency is then computed as follows:

$$\pi_t = \sum_{p=1}^{m} Pos_{p,t}(S_{p,t+k} - F_{p,t}) \qquad (6)$$

Where Pos stands for long and short positions where long positions take positive sign and short positions take negative sign, S_{t+k} is the spot rate at position's maturity, F is the position's forward rate.

4. Empirical Results

4.1 USD forward positions and forward premium/discount

Recall that in the FX forward market, the carry trading condition implies taking short positions in (i.e. selling forward) the currency that is at a forward premium and taking long positions in (i.e. buying forward) the currency that is at a forward discount. Therefore, the conjecture is that, based on our co-integration analysis for every currency pair, finding (or not) a long-run equilibrium relationship meeting this condition would provide direct evidence on the position-takers' behaviour with respect to USD carry trading over the sample period of the paper.

Tables 2 and 3 report the results of the two specifications of the ADF and PP stationarity tests for emerging and developed market currencies, respectively. The results reveal that the variables in level exhibit a unit root, but not in their first differences, that is, they are integrated of order one.

These results enable us to proceed to test for the existence and the number of co-integrated relationships among variables using Johansen co-integration tests. Table 4 reports the results of trace statistic and maximum eigenvalue tests. Both test statistics indicate the existence of only one co-integrated equation between *CNP*, *LogS and LogF* except for the GBP/USD case where both statistics indicate two co-integrated vectors.

In Table 5 Panel A we report the variables' co-integration coefficients normalized on *CNP*[9], and in Panel B we report the results of a significance test on the coefficients. For the emerging market currencies, the three variables have significant co-integration coefficients at 5% significance level. For the developed market currencies, *LogF* and *LogS* have significant co-integration coefficients at the 1% significance level, but results are varying regarding *CNP*. In the JPY/USD, CHF/USD and SEK/USD equations, *CNP*'s coefficient is significant at the 1% level, whereas, it is significant only at the 10% level in the EUR/USD case and insignificant in the GBP/USD and CAD/USD cases. A co-integration relationship between spot and forward rates is normally expected. So, the point to be noticed here is the significant co-integration coefficient of the *CNP* for most of the cases.

In order to illustrate what the resulting co-integration equations imply for the USD carry trading, we take the INR/USD case as an example. The co-integration vector is in the form

$$CNP \;=\; 154.66\,LogS \;-\; 152.41\,LogF \;-\; 8.399$$

By a simple rearrangement, we have:

$$CNP \;=\; 152.41\,Log\left(S\,/\,F\right) \;+\; 2.24\,LogS \;-\; 8.399,$$

where *Log(S/F)* is the forward premium/discount on the base currency. Apart from the scale differences, the positive sign of the forward premium/discount coefficient is particularly interesting. The co-integration equation above implies that an increase in *Log(S/F)* - which

[9] Note that the co-integrating coefficients of *LogF* and *LogS* appear to be equal though opposite in sign. In the Appendix, we formally test this restriction. We find that, at 5% significance level, the restriction is rejected for all cases except for MYR/USD, MXN/USD, and CHF/USD.

means that the base currency is at a discount in the forward market - is associated with an increase in *CNP* (i.e. more long positions in the base currency) and vice-versa.

Table 6 reports the co-integration equation for every currency pair. Note that the same relationship, as described above, holds for all emerging market currencies, but it is the *opposite* for advanced ones. For emerging currencies, the relationships between the USD forward positions and forward premium are in line with the carry trading condition. As the USD, over our sample period, is the lower yielding currency against these emerging currencies, i.e. it is forward premium-quoted currency, these long-run equilibrium relationships imply that the record-low US interest rate was being exploited against the higher rates of these emerging markets through the USD carry trading.

In order to demonstrate this point and further illustrate the direction of the carry trading in these positions, Figure 3 depicts the *CNP* for every emerging currency along with the corresponding spot exchange rate. Over our sample periods, it is clear that USD is almost consistently on the short side of the position. Most importantly, USD carry trading in these positions appears obvious by observing the behaviour of the *CNP* where it is typically on a downward trend. This is consistent with the USD being the funding currency. We also note that the downward trend of the *CNP* is associated with periods over which the USD exhibits a depreciation trend. On the other hand, a change in the *CNP* behaviour, for some currencies, can be noticed approximately after mid-2011, the period where we can note an appreciation trend in the USD. This change in the *CNP* trend can imply a change in the trading strategy and so reflect the actions of position-takers to reduce carry trade losses which result from the appreciation of funding currency (USD) even though these actions could contribute to further funding currency appreciation.

For developed market currencies, on the other hand, the co-integration equations imply patterns which are opposite to the carry trading condition. That is, forward discount-quoted currency is associated with more short positions and vice versa. This trading style is indeed consistent with the uncovered interest rate parity condition which implies that low-interest rate currency should appreciate against high-interest rate currency. Although the equations for the GBP/USD and CAD/USD cases appear to satisfy the carry trading condition, the *CNP* variable in the two cases has insignificant co-integration coefficients as shown in Table 5 Panel B. In other words, the resulting co-integration equations for these two cases just comes from the $LogS$ and $LogF$ variables.

In accordance with the literature on the currency carry trading determinants, we argue that the reasons behind the anti-carry USD-advanced currencies positions are; the increased uncertainty which followed the recent financial crisis in these markets; and the narrow interest rate differentials during the vast majority of the sample period, especially from late-2008 onwards. The reasoning behind our argument comes from the dependence of currency carry trade payoffs on exchange rate volatility as well as interest rate differentials (see e.g., Menkhoff et al, 2012; Clarida et al, 2009; Coudert and Mignon, 2013; Spronk et al, 2013; Hoffmann, 2012; Gilmore and Hayashi, 2011; Brière and Drut; 2009). Specifically, with a low interest rate differential, a slight adverse exchange rate movement would wipe out any gains from the interest rate differential. But, with a relatively high interest rate differential exchange rate needs a large adverse movement to cancel out the interest rate differential, creating space for profitable currency carry trades even with minor adverse movements in the exchange rate. In this sense, it is not enough for a currency to be at a forward premium or discount so that position-takers decide to engage in currency carry trades, but the magnitude of the forward premium/discount is also important.

Menkhoff et al. (JF forthcoming) study the relationship between different FX end-users (spot) order flows and several lagged explanatory variables with the aim of identifying the trading styles implied by these flows. They find different trading strategies among their customer groups. For example, asset managers are found to be trading against interest rate differential and are best characterized as trend followers. Surprisingly, they find that carry trading is not the dominant trading style for hedge funds, and that corporate customers trade with the interest rate differential. Their final customer group of private clients are found to be best described as contrarians.

In order to shed more light on the drivers of our net positions and in what direction, we run the regression of the net positions for every currency pair against lagged forward premium (carry), lagged spot return and lagged net position itself. We perform two regression specifications: in the first specification, the first lagged carry is the lone explanatory variable; in the second specification, explanatory variables include the first and second lagged carry, lagged spot returns and lagged net positions. The estimation results are reported in table 7.

For emerging market currencies, the results of the first specification show that except for MYR, which has insignificant positive coefficients on lagged carry, and MXN, which has zero coefficient, BRL, ZAR, INR and CLP have negative coefficients. The coefficient for

BRL and ZAR is significant at 5% significance level while for INR it is significant at about 15% significance level. These negative coefficients mean that net position is related to lagged carry through a pattern of carry trading. Note that the strongest carry relation is for those currencies which have the highest interest rates. the results of the second specification show that net position is significantly and positively related to lagged spot return (for the six currency pairs) and to its own lagged net position (all currency pairs except MXN). The positive coefficients on lagged spot return are consistent with a trend-following trading. However, even after accounting for these additional variables, the coefficient on the first lagged carry remained significantly negative for BRL and ZAR, and for MYR the second lagged carry has significantly negative coefficient.

For advanced market currencies, lagged carry coefficient, in the first specification, is positive for all cases, and it is significant for EUR, JPY, GBP and CHF. In the second specification where lagged spot return and lagged net position are accounted for, lagged carry coefficient is significantly positive for the six currency pairs except SEK. These positive coefficients indicate to anti-carry trading pattern, specifically, consistent with trading on the uncovered interest parity condition. The estimation results of the second specification also show that lagged spot return has positive coefficient for all cases except GBP, and it is significant for JPY, SEK and CAD. In addition, lagged net position has significantly negative coefficients in the cases of EUR and CHF, but significantly positive coefficients in the cases of GBP, SEK and CAD.

Overall, these results show that even after accounting for the trend-following aspect of the positions, the carry remained influential and its effects are in different directions; while the carry effect tends to be in line with carry trading for EM currencies, the effect is in line with "fundamentals-based" trading –i.e. UIP, for AM currencies. These different trading strategies for emerging and advanced currencies give rise to the trend followers trading behaviour as introduced in the heterogeneous agents model of Spronk et al. (2013). The model consists of; fundamentalists, who may form their expectations according to the UH; carry traders, who trade against the UH predictions; and chartists, who simply follow the dominant trend in the market. In our analysis for emerging currencies - where USD carry trading is very attractive - carry traders dominate the market trend. Consequently, CTAs, which are mainly trend followers, behave just like carry traders. On the other hand, for currencies of advanced countries, carry trading is unattractive so that the market is dominated by the fundamentalists who trade in accordance with the UH predictions. Thus, CTAs USD dollar positions against these currencies once again follow the dominant, but very different, trend. Given these, the analysis from now on will focus on emerging market currencies where we have clear evidence of currency carry trade activities.

In order to evaluate the long-run relationships and investigate the direction of causality between our variables, we estimate the VECM and unrestricted VAR model as specified in the methodology section - see equations (3) - (5).

Table 8 reports the variables' adjustment coefficients. In the cases of INR/USD, BRL/USD, MYR/USD and MXN/USD, the three variables all have significant adjustment coefficients. This means that in the short run they respond significantly to the departure from the reported long run equilibrium relationships. In the cases of ZAR/USD and CLP/USD, only the $\Delta LogS$ variable has significant coefficients

Table 9 reports the results of the VAR Granger Causality/Block Exogeneity Wald Test as described in the methodology section. This framework enables us to assess whether cumulative net forward positions could be driving the spot and forward rates in a way that could counter the strategy. For all currency pairs, the lags of the ΔCNP variable are jointly insignificant in the $\Delta LogF$ and $\Delta LogS$ equations, and thus could be excluded from the equations without losing relevant information. Also, these results suggest that ΔCNP does not Granger cause $\Delta LogF$ or $\Delta LogS$. On the other hand, for the equation of ΔCNP variable we note that, at least, either the lags of $\Delta LogF$ variable are jointly significant, or the lags of the two variables taken together; "Both", cannot be excluded from the ΔCNP equation. One exception is the BRL/USD case where neither the lags of the two variables taken separately nor taken together are jointly significant. The results of this test shed the light on the endogeneity of the *CNP* variable, at least in the short run. In addition, the lack of any adverse casual effect from the forward shorting to the forward rate implies that the strategy pays off on average.

4.2 Currency Carry Trade Payoffs

Several studies investigate the performance and properties of currency carry trade returns. These studies are mainly based on synthetic carry positions. Generally, they create carry trade portfolios by sorting currencies periodically according to forward premium/discount, and then they assume short positions in lower-yielding currencies and long positions in higher-yielding currencies. The resulting payoffs from these positions are found to be, on average, profitable with relatively high Sharpe ratios, and they have high kurtosis and negative skewness (See e.g. Burnside et al., 2006; 2008; 2011; Menkhoff et al., 2012). In this section, we evaluate and explore the characteristics of payoffs generated from the carry positions against the emerging market currencies.

We calculate the daily-aggregated payoff of our actual USD positions against every emerging market currency as in Eq. (6). The properties of the calculated payoffs are then compared to the results of the earlier studies which rely on synthetic trading. We then have six currency-specific carry trades. In Table 10 we report the main descriptive statistics of the payoffs for each currency pair. For comparison purposes, we also report the same statistics for excess returns of a value-weighted portfolio of US stocks, obtained from Kenneth French's website.

For all currency pairs, except for the case of ZAR/USD, the Sharpe ratios are positive. The INR/USD and MYR/USD pairs beat the US stock market based on Sharpe ratio. Carry trading payoffs exhibit positive kurtosis and negative skewness. Moreover, in all cases, except for MYR/USD, Sortino ratios are lower than that of the US stock market, indicating that they are more subject to large losses. Jarque-Bera p-values indicate that distributions are far from being normal.

The negative skewness of currency carry trade payoffs reflects a higher likelihood of large negative outcomes. This results from the tendency of target currencies to occasionally depreciate against funding currency, which, in turn, results in large occasional negative profits. This payoff behaviour implies that currency carry trades are subject to what so-called downside risk. Gyntelberg and Remolona (2007) and Brunnermeier et al. (2008) also find that currency carry trades are exposed to crash risk.

Our results of positive Sharpe ratios, high kurtosis and negative skewness are consistent with many studies which investigate the properties of currency carry trading payoffs, and confirm the common description of currency carry trade payoffs as being "picking up pennies in front of a truck".

5. Conclusion

Currency trading strategies in general and carry trades in particular have been of interest to many researchers. In this paper, we make use of a unique dataset consisting of daily-aggregated forward positions in the US dollar against several emerging and developed market currencies. The dataset is collected from RPM; a specialist investment manager based in Stockholm, Sweden. Our aim is to investigate whether these positions exhibit a carry trading behaviour in which the US dollar represents the funding currency in response to the low US interest rates, or other trading styles can be identified.

By applying Johansen multivariate co-integration analysis, we find long-run equilibrium relationships between the USD-emerging market currencies forward positions and forward premium/discount meeting the carry trading condition, which involves going short in currencies that are at a forward premium and going long in currencies that are at a forward discount. Furthermore, the USD forward positions against those emerging market currencies exhibit short position trends, implying carry trade direction in which the USD represents the funding currency.

On the other hand, the co-integrated relationships for the developed market currencies exhibit completely different pattern. Contrary to the carry trading condition, the relationships for these market currencies imply that higher-yielding currency in associated with more short positions and vice versa. This pattern is indeed a "fundamentals-based" trading style which is line the condition of the uncovered interest parity. We argue that the simultaneous advanced currencies-USD low interest rate differentials along with the increased uncertainty over the period after the recent financial crisis for these markets are possible reasons for this anti-carry pattern.

In sum, these findings suggest that over the recent period of the ultra-loose US monetary policy, FX traders could have the tendency to engage in USD carry trading against emerging currencies but not against advanced currencies where they are found to follow a completely different trading style. The findings also provide more direct evidence on carry trades by explicitly relating forward positions to the carry. One of the most important implications of currency carry trades is their effect on the FX market stability especially in times of unwinding carry positions. So, tracking carry trades is important because it can provide us with a better understanding of the FX market volatility dynamics. Moreover, tracking carry trades is relevant to potential target countries that usually tend to take actions against the undesirable influences of such speculative activities. These actions may include capital flow restrictions, foreigners-investment taxations and foreigners-holding limitations. In this sense, evaluating and examining the alternative measures which can be taken along with their effectiveness can be the focus of future research.

Finally, we evaluate the realized payoffs of the actual USD positions against every emerging market currency. We find five out of six currency pairs yield positive Sharpe ratios, with the two cases of INR/USD and MYR/USD produce Sharpe ratios larger than the Sharpe ratio of a value-weighted portfolio of US stock market. In addition, the payoff distributions for all cases exhibit high kurtosis and negative skewness, similarly to previous studies that employed synthetic currency carry trade positions.

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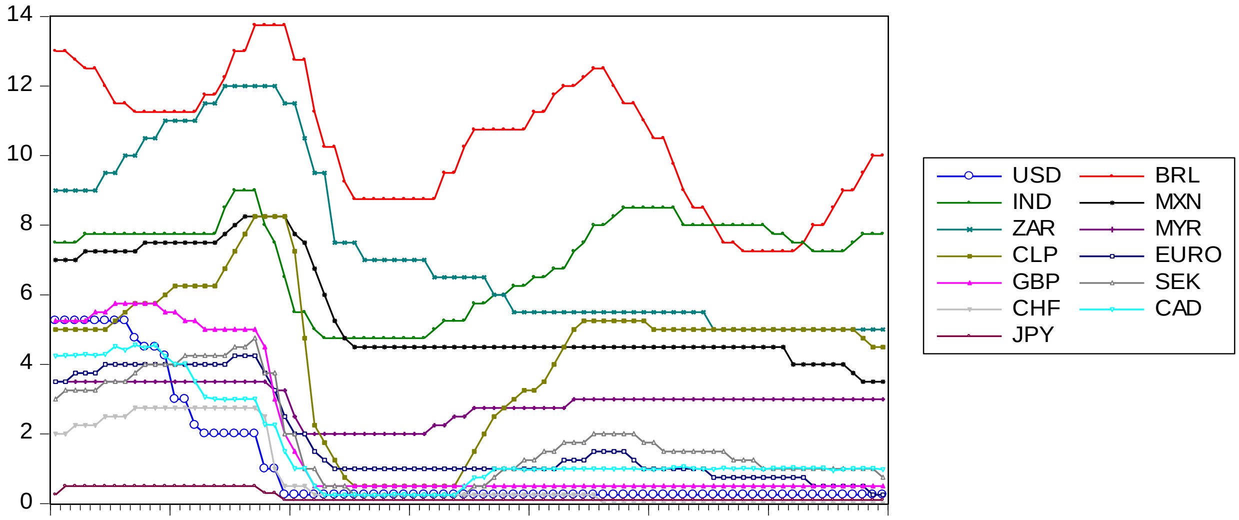
Table 1. Descriptive Statistics

Currency Pair	Sample Period	NP				$\Delta s\%$				$fp\%$			
		Mean	STD	Min	Max	Mean	STD	Skewness	Kurtosis	Mean	STD	Skewness	Kurtosis
INR/USD	07/09/2007 - 06/11/2013	-0.73	8.93	-114.27	44.60	0.03	0.55	0.16	6.45	0.58	0.71	3.52	48.67
BRL/USD	02/01/2007 - 06/11/2013	-0.48	9.25	-83.95	152.54	0.004	1.01	0.56	13.35	0.60	0.67	0.23	11.20
MYR/USD	03/04/2008 - 06/11/2013	-1.14	9.69	-107.40	52.30	0.000	0.44	-0.25	5.68	0.21	0.20	0.63	5.80
ZAR/USD	05/01/2007 - 06/11/2013	-0.02	0.94	-8.62	9.23	0.02	1.11	0.51	8.47	0.17	0.59	1.34	16.93
CLP/USD	02/01/2007 - 06/11/2013	-0.54	8.56	-67.30	72.53	-0.002	0.73	0.85	10.24	0.35	0.49	0.54	4.35
MXN/USD	09/07/2007 - 06/11/2013	-0.06	1.54	-14.85	10.42	0.01	0.81	0.69	13.44	0.13	0.51	-1.96	43.39
EURO/USD	30/08/2006 - 06/11/2013	0.08	5.71	-42.52	36.93	-0.003	0.66	-0.14	6.58	-0.02	0.32	1.20	26.42
JPY/USD	30/08/2006 - 06/11/2013	0.11	5.03	-33.24	34.92	-0.01	0.71	-0.23	7.44	-0.06	0.38	-3.34	42.12
GBP/USD	30/08/2006 - 06/11/2013	-0.12	6.29	-64.56	37.65	0.01	0.66	0.09	7.92	0.005	0.28	-0.56	11.01
CHF/USD	30/08/2006 - 06/11/2013	0.05	4.18	-20.83	27.60	-0.02	0.73	0.69	16.73	-0.05	0.34	-0.95	13.44
SEK/USD	30/08/2006 - 06/11/2013	0.004	1.99	-15.62	16.77	-0.01	0.89	-0.20	6.20	0.01	0.40	-0.32	11.60
CAD/USD	30/08/2006 - 06/11/2013	-0.20	4.44	-31.63	28.72	-0.003	0.70	-0.09	8.22	0.02	0.32	0.11	8.88

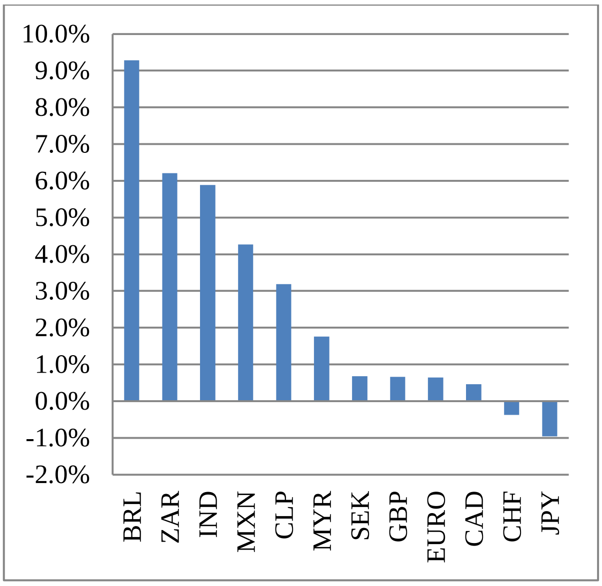
Notes: USD is the base currency. NP is daily-aggregated net position in millions of USD, calculated as USD long positions minus USD short positions against every other currency. Δs is spot rate change in log difference. fp is calculated as (LogF-LogS)*100.

Figure 1. Benchmark Policy Rates over the sample period



Notes: End of month value of benchmark policy interest rate for every currency obtained from DataStream.

Figure 2. Average interest rate differentials



Notes: Interest rate differential is calculated as other currency interest rate minus USD interest rate.

Table 2. Stationarity Tests for Emerging Markets

	CNP		*LogF*		*LogS*		
	Con	Con&Trend	Con	Con&Trend	Con	Con&Trend	
ADF Test							INR/USD
Level	0.8675	0.8878	0.8714	0.7839	0.9063	0.8699	
First Diff	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	
PP Test							
Level	0.8618	0.8673	0.8741	0.7739	0.8722	0.7921	
First Diff	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	
ADF Test							BRL/USD
Level	0.4607	0.8153	0.5680	0.5619	0.4920	0.4926	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.4735	0.8538	0.5054	0.5023	0.4716	0.4801	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							MYR/USD
Level	0.8950	0.9328	0.5510	0.5297	0.5722	0.5526	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.8908	0.9116	0.5708	0.5482	0.5819	0.5630	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							ZAR/USD
Level	0.3851	0.4011	0.5504	0.7716	0.5849	0.8036	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.3712	0.3548	0.6198	0.8240	0.6027	0.8167	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							CLP/USD
Level	0.8543	0.2683	0.2045	0.4759	0.1673	0.4082	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.8808	0.3659	0.1634	0.3949	0.1744	0.4083	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							MXN/USD
Level	0.7920	0.1669	0.1522	0.4128	0.1831	0.4796	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.7988	0.1502	0.1570	0.4230	0.1697	0.4501	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Notes: this table reports P-values of Augmented Dickey-Fuller; ADF and Phillips-Perron; PP tests. Con is constant. P-values are based on MacKinnon (1996).

Table 3. Stationarity Test for Developed Markets

	CNP		*LogF*		*LogS*		
	Con	Con&Trend	Con	Con&Trend	Con	Con&Trend	
ADF Test							EUR/USD
Level	0.9283	0.7269	0.1220	0.1901	0.1291	0.2026	
First Diff	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.9315	0.7337	0.1048	0.1617	0.1050	0.1663	
First Diff	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							JPY/USD
Level	0.1326	0.0803	0.4403	0.9726	0.4417	0.9678	
First Diff	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	
PP Test							
Level	0.1573	0.1104	0.4614	0.9822	0.4625	0.9824	
First Diff	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	
ADF Test							GBP/USD
Level	0.0574	0.0081	0.4506	0.7471	0.4624	0.7667	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.1266	0.0589	0.4787	0.7866	0.4660	0.7637	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							CHF/USD
Level	0.1001	0.0577	0.4672	0.3058	0.4641	0.2996	
First Diff	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.1349	0.0769	0.4761	0.3039	0.4781	0.2983	
First Diff	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							SEK/USD
Level	0.0628	0.0420	0.1664	0.3988	0.1555	0.3801	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.1438	0.1414	0.1967	0.4441	0.2011	0.4558	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
ADF Test							CAD/USD
Level	0.7648	0.1328	0.1861	0.3838	0.1689	0.3499	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
PP Test							
Level	0.8044	0.2187	0.1718	0.3495	0.1624	0.3298	
First Diff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Notes: this table reports P-values of Augmented Dickey-Fuller; ADF and Phillips-Perron; PP tests. Con is constant. P-values are based on MacKinnon (1996).

Table 4. Johansen Cointegration Test Results

Currency Pair	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value 95% (Trace)	P.Val	Max-Eigen Statistic	Critical Value 95% (Max-Eigen)	P.Val
INR/USD	None	0.0870	127.755***	29.797	0.0000	123.825***	21.132	0.0001
	At most 1	0.0026	3.930	15.495	0.9091	3.551	14.265	0.9035
BRL/USD	None	0.0668	103.891***	29.797	0.0000	95.419***	21.132	0.0000
	At most 1	0.0043	8.472	15.495	0.4163	5.909	14.265	0.6250
MYR/USD	None	0.2123	274.263***	29.797	0.0001	261.789***	21.132	0.0001
	At most 1	0.0111	12.473	15.495	0.1356	12.231	14.265	0.1023
ZAR/USD	None	0.0659	102.145***	29.797	0.0000	97.194***	21.132	0.0000
	At most 1	0.0025	4.951	15.495	0.8140	3.522	14.265	0.9060
CLP/USD	None	0.0446	68.142***	29.797	0.0000	61.161***	21.132	0.0000
	At most 1	0.0049	6.980	15.495	0.5799	6.525	14.265	0.5468
MXN/USD	None	0.1165	182.167***	29.797	0.0001	175.708***	21.132	0.0001
	At most 1	0.0038	6.459	15.495	0.6412	5.364	14.265	0.6953
EUR/USD	None	0.2485	514.586***	29.797	0.0001	506.851***	21.132	0.0001
	At most 1	0.0043	7.736	15.495	0.4941	7.599	14.265	0.4210
JPY/USD	None	0.0979	194.033***	29.797	0.0001	182.670***	21.132	0.0001
	At most 1	0.0053	11.362	15.495	0.1902	9.432	14.265	0.252
GBP/USD	None	0.1578	330.252***	29.797	0.0001	296.696***	21.132	0.0001
	At most 1	0.0179	33.556***	15.495	0.0000	31.210***	14.265	0.0001
	At most 2	0.0014	2.346	3.841	0.1256	2.346	3.841	0.1256
CHF/USD	None	0.1024	191.293***	29.797	0.0001	179.600***	21.132	0.0001
	At most 1	0.0055	11.693	15.495	0.1723	9.187	14.265	0.2709
SEK/USD	None	0.2102	413.578***	29.797	0.0001	401.338***	21.132	0.0001
	At most 1	0.0045	12.240	15.495	0.1458	7.655	14.265	0.4149
CAD/USD	None	0.1239	241.475***	29.797	0.0001	232.717***	21.132	0.0001
	At most 1	0.0041	8.758	15.495	0.3882	7.254	14.265	0.4595

Notes: The trace statistic tests the null hypothesis that there is r cointegrating vectors against the alternative that there is generally more than r cointegrating vectors. While in maximum eigenvalue test the null hypothesis is that there is r against the alternative $r+1$ cointegrating vectors. CE is cointegrating equation. P.Val is P-value. *** denotes to 1% significance level. P-values are based on MacKinnon-Haug-Michelis (1999). We select number of lags as follows: a Vector Autoregressive model (VAR) is estimated for the levels of the three variables, and then the optimal number of lags is evaluated based on information criteria including sequential modified LR test statistic; final prediction error; Akaike information criterion; Schwarz information criterion; Hannan-Quinn information criterion. Finally the optimal lag length is chosen where the majority of the information criteria indicate the same number of lags. This also holds for cointegration results in other tables.

Table 5. Co-integration coefficients normalized on CNP

Panel A: Co-integration Coefficients	*CNP*	*LogF*	*LogS*	Cons	Panel B: Co-integration Coefficients Significance Test	*CNP*	*LogF*	*LogS*
INR/USD	1.00	152.41	-154.66	8.399	Chi-square	42.28***	208.16***	208.21***
		[16.87]	[-16.61]		P.Value	0.0000	0.0000	0.0000
BRL/USD	1.00	328.22	-332.72	1.288	Chi-square	6.15**	89.49***	89.51***
		[10.17]	[-10.18]		P.Value	0.0131	0.0000	0.0000
MYR/USD	1.00	563.10	-562.53	-1.223	Chi-square	43.99***	249.34***	249.55***
		[18.49]	[-18.73]		P.Value	0.0000	0.0000	0.0000
ZAR/USD	1.00	14.49	-14.60	0.226	Chi-square	8.52***	93.66***	93.66***
		[10.38]	[-10.40]		P.Value	0.0035	0.0000	0.0000
CLP/USD	1.00	109.58	-110.93	8.357	Chi-square	28.54***	54.51***	54.63***
		[10.48]	[-10.69]		P.Value	0.0000	0.0000	0.0000
MXN/USD	1.00	59.47	-59.64	0.391	Chi-square	11.13***	170.29***	170.34***
		[14.02]	[-14.01]		P.Value	0.0008	0.0000	0.0000
EUR/USD	1.00	-717.16	713.63	-1.189	Chi-square	2.94*	499.18***	499.10***
		[-24.22]	[24.20]		P.Value	0.0863	0.0000	0.0000
JPY/USD	1.00	-132.30	131.68	2.622	Chi-square	9.45***	173.22***	173.22***
		[-14.11]	[14.12]		P.Value	0.0021	0.0000	0.0000
GBP/USD	1.00	559.64	-557.65	1.137	Chi-square	1.184	265.46***	265.47***
		[17.97]	[-17.95]		P.Value	0.2765	0.0000	0.0000
CHF/USD	1.00	-86.50	86.34	-0.110	Chi-square	6.92***	170.41***	170.39***
		[-13.98]	[14.01]		P.Value	0.0085	0.0000	0.0000
SEK/USD	1.00	-57.46	57.09	0.730	Chi-square	10.40***	393.68***	393.67***
		[-21.47]	[21.45]		P.Value	0.0013	0.0000	0.0000
CAD/USD	1.00	1203.25	-1199.55	-0.209	Chi-square	2.67	555.52***	555.65***
		[25.72]	[-25.74]		P.Value	0.1023	0.0000	0.0000

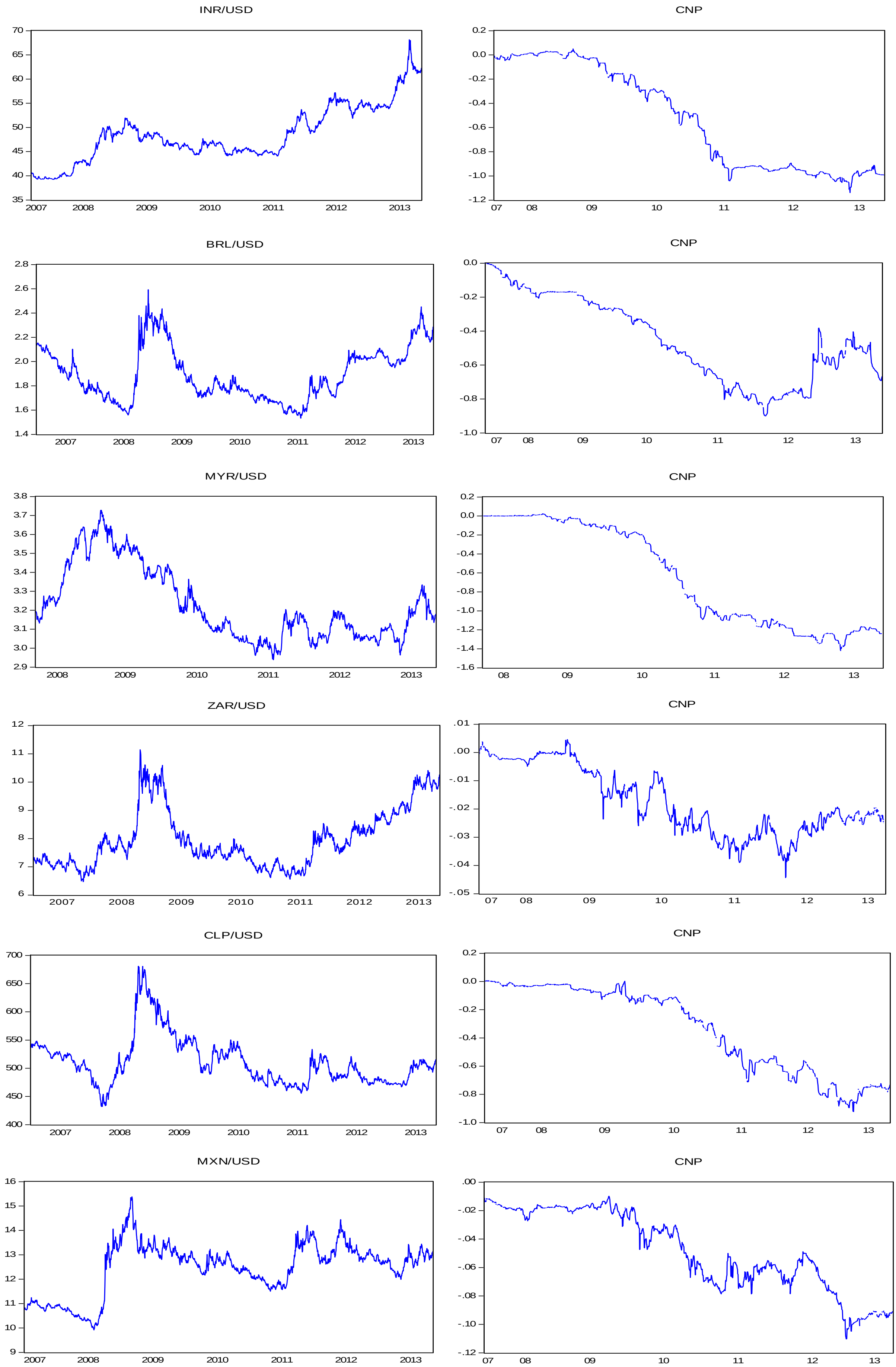
Notes: Panel A: cointegrating coefficients are normalised on CNP, Cons is constant, t-statistics in brackets. Panel B: ***,**,* denote 1%, 5%,10% significance levels, respectively. USD is the base currency.

Table 6. Co-integration equation corresponding to Table 5.

INR/USD:	$CNP = 154.66\ LogS - 152.41\ LogF - 8.399$ $CNP = 152.41\ (LogS - LogF) + 2.24\ LogS - 8.399$ $CNP = 152.41\ Log(S/F) + 2.24\ LogS - 8.399$
BRL/USD:	$CNP = 332.72\ LogS - 328.22\ LogF - 1.288$ $CNP = 328.22\ (LogS - LogF) + 4.5\ LogS -1.288$ $CNP = 328.22\ Log(S/F) + 4.5\ LogS - 1.288$
MYR/USD:	$CNP = 562.53\ LogS - 563.10\ LogF + 1.223$ $CNP = 562.53\ (LogS - LogF) - 0.57\ LogF + 1.223$ $CNP = 562.53\ Log(S/F) - 0.57\ LogF + 1.223$
ZAR/USD:	$CNP = 14.60\ LogS - 14.49\ LogF - 0.226$ $CNP = 14.49\ (LogS - LogF) + 0.11\ LogS - 0.226$ $CNP = 14.49\ Log(S/F) + 0.11\ LogS - 0.226$
CLP/USD:	$CNP = 110.93\ LogS - 109.58\ LogF - 8.357$ $CNP = 109.58\ (LogS - LogF) + 1.35\ LogS - 8.357$ $CNP = 109.58\ Log(S/F) + 1.35\ LogS - 8.357$
MXN/USD:	$CNP = 59.64\ LogS - 59.47\ LogF - 0.391$ $CNP = 59.47\ (LogS - LogF) + 0.17\ LogS - 0.391$ $CNP = 59.47\ Log(S/F) + 0.17\ LogS - 0.391$
EUR/USD:	$CNP = 717.16\ LogF - 713.63\ LogS + 1.189$ $CNP = 713.63\ (LogF - LogS) + 3.53\ LogF +1.189$ $CNP = 713.63\ Log(F/S) + 3.53\ LogF + 1.189$
JPY/USD:	$CNP = 132.30\ LogF - 131.68\ LogS - 2.622$ $CNP = 131.68\ (LogF - LogS) + 0.62\ LogF - 2.622$ $CNP = 131.68\ Log(F/S) + 0.62\ LogF - 2.622$
GBP/USD:	$CNP = 557.65\ LogS - 559.64\ LogF - 1.137$ $CNP = 557.65\ (LogS - LogF) - 1.99\ LogF - 1.137$ $CNP = 557.65\ Log(S/F) - 1.99\ LogF - 1.137$
CHF/USD:	$CNP = 86.50\ LogF - 86.34\ LogS + 0.110$ $CNP = 86.34\ (LogF - LogS) + 0.16\ LogF +0.110$ $CNP = 86.34\ Log(F/S) + 0.16\ LogF + 0.110$
SEK/USD:	$CNP = 57.46\ LogF - 57.09\ LogS - 0.730$ $CNP = 57.09\ (LogF - LogS) + 0.37\ LogF - 0.730$ $CNP = 57.09\ Log(F/S) + 0.37\ LogF - 0.730$
CAD/USD:	$CNP = 1199.55\ LogS - 1203.25\ LogF + 0.209$ $CNP = 1199.55\ (LogS - LogF) - 3.7\ LogF + 0.209$ $CNP = 1199.55\ Log(S/F) - 3.7\ LogF + 0.209$

Notes: See notes toTable 4.

Figure 3. Spot exchange rate and corresponding *CNP*



Notes: Left hand-side graphs are spot rates. Right hand-side graphs are the corresponding cumulative net positions in billions of USD; CNP. USD is the base currency in all cases.

Table 7. Drivers of Net positions

	INR		BRL		MYR		ZAR		CLP		MXN	
C	-0.51	-0.37	0.01	0.17	-1.17***	-0.43	0.00	-0.01	-0.38	-0.31	-0.06	-0.07*
	(-1.59)	(-1.23)	(0.02)	(0.43)	(-2.75)	(-1.18)	(-0.07)	(-0.29)	(-1.32)	(-1.06)	(-1.35)	(-1.65)
$Carry_{-1}$	-0.37	-0.04	-0.81**	-0.77**	0.14	2.67	-0.09**	-0.10**	-0.48	-0.65	0.00	0.04
	(-1.43)	(-0.10)	(-2.21)	(-2.09)	(0.10)	(1.58)	(-2.02)	(-2.40)	(-0.99)	(-1.23)	(0.06)	(0.50)
Δs_{-1}		1.32***		0.44*		2.26***		0.10***		0.94***		0.22***
		(4.05)		(1.81)		(3.78)		(4.40)		(3.39)		(3.98)
NP_{-1}		0.14***		0.16***		0.16***		0.04*		0.29***		0.03
		(3.80)		(5.83)		(4.35)		(1.72)		(11.07)		(1.17)
$Carry_{-2}$		-0.46		-0.19		-5.17***		0.04		0.44		0.08
		(-1.23)		(-0.48)		(-2.66)		(0.86)		(0.82)		(0.85)
$\bar{R}^2$	0.000	0.028	0.003	0.028	-0.001	0.046	0.002	0.020	0.000	0.092	-0.001	0.016

	EUR		JPY		GBP		CHF		SEK		CAD	
C	0.10	0.11	0.14	0.14	-0.11	-0.08	0.08	0.09	0.00	0.00	-0.20*	-0.14
	(0.77)	(0.80)	(1.15)	(1.19)	(-0.74)	(-0.55)	(0.75)	(0.88)	(0.06)	(-0.02)	(-1.92)	(-1.37)
$Carry_{-1}$	1.08**	1.08**	0.59*	0.62**	0.87*	1.02**	0.60**	0.60**	0.13	0.15	0.32	0.61*
	(2.55)	(2.56)	(1.87)	(1.96)	(1.87)	(2.19)	(1.97)	(2.00)	(1.07)	(1.21)	(0.95)	(1.96)
Δs_{-1}		0.25		0.61***		-0.17		0.03		0.14**		0.26*
		(1.12)		(3.37)		(-0.74)		(0.17)		(2.53)		(1.67)
NP_{-1}		-0.10***		-0.03		0.19***		-0.20***		0.11***		0.36***
		(-4.31)		(-1.21)		(4.27)		(-8.25)		(4.48)		(15.93)
$Carry_{-2}$		-0.27		-0.17		-0.40		0.06		0.03		-0.09
		(-0.59)		(-0.50)		(-0.76)		(0.17)		(0.21)		(-0.27)
$\bar{R}^2$	0.003	0.012	0.001	0.007	0.001	0.037	0.002	0.040	0.000	0.017	0.000	0.129

Notes: the table reports the OLS estimation results for the regression of net positions, NP, (in millions of USD) against lagged carry, $Carry_{-1}$, (lagged forward premium), lagged spot return, Δs_{-1}, lagged net position, NP_{-1}, second lagged carry, $Carry_{-2}$. t-statistic in parentheses.

Table 8. Estimates of VECM (3)-(5)

Adjustment Coefficients

	ΔCNP	$\Delta LogF$	$\Delta LogS$
INR/USD	**-0.00098**	**-0.00274**	**0.00052**
	[-2.71]	[-8.89]	[2.18]
BRL/USD	**-0.00046**	**-0.00080**	**0.00094**
	[-1.74]	[-2.38]	[3.28]
MYR/USD	**-0.00076**	**-0.00063**	**0.00048**
	[-2.06]	[-3.21]	[2.53]
ZAR/USD	-0.00089	-0.00295	**0.03272**
	[-1.35]	[-0.33]	[4.08]
CLP/USD	-0.00010	-0.00101	**0.00185**
	[-0.13]	[-1.21]	[2.40]
MXN/USD	**0.00106**	**-0.00867**	**0.00739**
	[2.85]	[-4.05]	[4.11]

Notes: VECM is estimated as described by equations (3)-(5) in the methodology sections, t-statistics in brackets. Boldface denotes significance at, at least, 10% msl.

Table 9. VAR Granger Causality/Block Exogeneity Wald Tests

INR/USD:

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	0.71	0.7020
	$\Delta LogS$	4.18	0.1238
	Both	16.28	0.0027
$\Delta LogF$	ΔCNP	0.37	0.8312
	$\Delta LogS$	85.22	0.0000
	Both	85.75	0.0000
$\Delta LogS$	ΔCNP	3.00	0.2230
	$\Delta LogF$	29.87	0.0000
	Both	32.85	0.0000

BRL/USD

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	7.23	0.4054
	$\Delta LogS$	7.13	0.4157
	Both	17.97	0.2080
$\Delta LogF$	ΔCNP	2.79	0.9037
	$\Delta LogS$	35.77	0.0000
	Both	37.98	0.0005
$\Delta LogS$	ΔCNP	2.21	0.9470
	$\Delta LogF$	337.66	0.0000
	Both	344.12	0.0000

MYR/USD

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	8.45	0.0036
	$\Delta LogS$	1.54	0.2139
	Both	19.24	0.0001
$\Delta LogF$	ΔCNP	0.83	0.3616
	$\Delta LogS$	1.22	0.2690
	Both	2.14	0.3424
$\Delta LogS$	ΔCNP	2.31	0.1283
	$\Delta LogF$	35.48	0.0000
	Both	37.91	0.0000

ZAR/USD

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	7.25	0.4030
	$\Delta LogS$	1.51	0.9821
	Both	103.47	0.0000
$\Delta LogF$	ΔCNP	4.11	0.7665
	$\Delta LogS$	16.77	0.0190
	Both	21.00	0.1015
$\Delta LogS$	ΔCNP	6.00	0.5398
	$\Delta LogF$	255.73	0.0000
	Both	260.21	0.0000

CLP/USD

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	3.19	0.8673
	$\Delta LogS$	3.42	0.8440
	Both	23.97	0.0462
$\Delta LogF$	ΔCNP	5.05	0.6536
	$\Delta LogS$	53.42	0.0000
	Both	59.30	0.0000
$\Delta LogS$	ΔCNP	5.28	0.6253
	$\Delta LogF$	112.87	0.0000
	Both	117.48	0.0000

MXN/USD

Dependent variable	Excluded	Chi-sq	P.Value
ΔCNP	$\Delta LogF$	12.75	0.0472
	$\Delta LogS$	4.87	0.5599
	Both	45.85	0.0000
$\Delta LogF$	ΔCNP	2.66	0.8498
	$\Delta LogS$	55.38	0.0000
	Both	57.99	0.0000
$\Delta LogS$	ΔCNP	5.32	0.5030
	$\Delta LogF$	413.72	0.0000
	Both	422.12	0.0000

Notes: The test details are described in the methodology section; see equations (3)-(5). 'Both' is lags of the respective independent variables taken together.

Table 10. Payoff Descriptive Statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera P.Value	Sharpe Ratio	Sortino Ratio
INR/USD	0.333	15.430	-5.602	113.142	0.0000	0.022	0.026
BRL/USD	0.008	0.824	-6.605	179.587	0.0000	0.010	0.013
MYR/USD	0.026	0.684	-2.425	57.954	0.0000	0.039	0.053
ZAR/USD	-0.010	0.396	-1.096	60.922	0.0000	-0.026	-0.035
CLP/USD	1.162	157.299	-1.586	77.512	0.0000	0.007	0.010
MXN/USD	0.010	1.041	-4.860	124.774	0.0000	0.009	0.012
US Stock market	0.031	1.487	-0.118	10.554	0.0000	0.021	0.029

Notes: Payoffs are in millions of quote currency (USD is the base currency). US Stock market is market premium $\left(Mkt-RF\right)$ on value weighted portfolio of US stock markets obtained from French's data library.

Appendix: Test of restriction on cointegrating vector

Panel A:	Co-integration Coefficients				Panel B:	Test of the restriction
	LogF	*LogS*	*CNP*	Cons		
INR/USD	1.00	-1.0148 [-301.15]	0.0066 [7.36]	0.0551	Chi-square P.Value	**17.78** 0.0000
BRL/USD	1.00	-1.0137 [-390.82]	0.0030 [2.61]	0.0039	Chi-square P.Value	**21.68** 0.0000
MYR/USD	1.00	-0.9990 [-454.78]	0.0018 [7.34]	-0.0022	Chi-square P.Value	0.20 0.6536
ZAR/USD	1.00	-1.0078 [-440.87]	0.0690 [3.08]	0.0156	Chi-square P.Value	**10.31** 0.0013
CLP/USD	1.00	-1.0123 [-195.38]	0.0091 [7.18]	0.0763	Chi-square P.Value	**4.83** 0.0280
MXN/USD	1.00	-1.0028 [-620.76]	0.0168 [3.44]	0.007	Chi-square P.Value	2.93 0.0871
EURO/USD	1.00	-0.9951 [-747.70]	-0.0014 [-1.72]	0.0017	Chi-square P.Value	**13.15** 0.0003
JPY/USD	1.00	-0.9953 [-1226.27]	-0.0076 [-3.21]	-0.0198	Chi-square P.Value	**27.72** 0.0000
GBP/USD	1.00	-0.9964 [-823.33]	0.0018 [0.98]	0.0020	Chi-square P.Value	**7.66** 0.0056
CHF/USD	1.00	-0.9981 [-824.01]	-0.0116 [-2.75]	0.0013	Chi-square P.Value	2.39 0.1220
SEK/USD	1.00	-0.9934 [-927.74]	-0.0174 [-3.30]	-0.0127	Chi-square P.Value	**34.11** 0.0000
CAD/USD	1.00	-0.9969 [-949.56]	0.0008 [1.64]	-0.0002	Chi-square P.Value	**8.35** 0.0039

Panel A in the table above reports the cointegrating coefficients normalized on the LogF variable. Then we test for the restriction of (1,-1) on LogF and LogS coefficients. Panel B reports the Wald test statistic At 5% significance level, the restriction cannot be rejected for the cases of MYR/USD, MXN/USD and CHF/USD. In the other cases the restriction is significantly rejected, although LogS coefficients are economically close to -1.