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The Forward Premium Bias, Carry Trade Return and the Risks of Volatility and Liquidity¹

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Abstract

In this paper, we analyse the relationship between the currency carry return and volatility and liquidity risk factors. We find that both categories of risk factors are relevant to understanding and explaining carry return, with an outperformance for volatility ones especially the global FX volatility risk factor. Consistent with the poor performance of currency carry trades during high FX volatility regime, we also show that the well-established negative slope coefficient in the Fama regression tends to be more positive and even above unity in times of high FX volatility. The paper, overall, contributes to the risk-based solution of the forward premium bias puzzle.

Key words: FX rates, Currency carry trade, Forward-bias puzzle, FX risk premium

JEL Classification: F31, F41, G11, G15, E44

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1 Introduction

The forward premium bias (FPB) puzzle is the well-established regularity of finding significantly less than unity or, more often, negative slope coefficient in the standard unbiasedness hypothesis (UH) test regression; the regression in which the realized future spot exchange rate changes are regressed against the current forward premium⁵.

For the UH to hold, the slope coefficient in this regression must be unity, implying that forward premium-quoted currencies are predicted to appreciate against forward discount-quoted currencies at a rate equal to the forward premium or discount. The implication of the UH is that the forward exchange market return is expected to be zero, i.e. the absence of the opportunity of achieving any currency excess returns by trading on currency interest rate differences. But, the downward bias in the UH predictions implies that positive forward market return can be achieved through some speculative strategies which aim at exploiting and trading on interest rate differentials. One of the most popular strategies is currency carry trading. Currency carry trades involve that investors go long high-yield currencies and short low-yield currencies. This strategy is found to produce high return with attractive Sharpe ratios (see e.g. Pojarliev, 2005; Burnside et al., 2006; Gilmore and Hayashi, 2011; Hochradl and Wanger, 2010). In this paper, we study the trade-off between currency carry trade return and volatility and liquidity risk factors. The findings of the paper are supportive to the view that currency carry return can be understood as a compensation for the exposure to these risk factors.

The FPB is subject to be investigated from many different angles, and several explanations of this longstanding puzzle are proposed in the literature (for useful surveys see e.g. Engel, 1996; Sarno, 2005; Chinn, 2006). The overall picture suggests that; 1) forward exchange rates are, to large extent, consistently downward-biased predictors of future spot exchange rates for several bilateral exchange rates, over different sample periods and for various forecast horizons ranging from one day to, at least, twelve months⁶; 2) there is no agreement on one conclusive explanation⁷.

⁵For example, Froot and Thaler (1990) report an average slope coefficient β of -0.88 for 75 published studies.

⁶Snaith et al. (2013) test the UH for forecast horizons ranging from 1-month to 10-year for five major currencies against the US dollar over the period 1980-2006. They find that the FPB disappears at 3-year forecast horizon and beyond.

⁷Frankel and Poonawala (2010) argue that most of the existing explanations belong, generally, to one of two categories. Under the assumption of rational forward exchange markets, the first category attributes the forward bias to the existence of time-varying risk premium component in the forward exchange rates (see e.g., Fama,

Although the risk-based explanations are among those of the most plausible ones, the outstanding question is that what sort of systematic risk factors, which currency returns are exposed to, can account for the existence of the FPB. As the profitability of currency carry trades is the flip-side of the FPB, researchers focus on studying the performance of currency carry trades in relation to different risk factor candidates to answer this question.

This paper is built on and related to the research dedicated to examining the risk-return profile of currency carry trades. Burnside et al. (2006); Burnside (2012) find no correlation between currency carry returns and a wide set of traditional risk factors. However, Daskalakis and Swinkels (2015) study the performance of currency carry trades over sample period spans 112 years from 1900 to 2012 with a sample of 20 currencies. They find considerable carry trade losses over some sub-sample periods and so suggest that these episodes can be related to some risk factors. Farhi and Gabaix (2008) provide the existence of peso problem as an explanation of the performance of currency carry trades. Nevertheless, Burnside et al. (2011) dismiss this explanation as even with accounting for peso problem by constructing hedged carry trading strategies, a substantial carry return remains unexplained. Brunnermeier et al. (2008) argue that high-interest rate currencies are subject to currency crash risk which arises in times of high risk aversion and low funding liquidity, and that investors tend to unwind their carry positions in periods of high liquidity constraints which results in carry trade losses. Moore and Roche (2012) relate carry trade performance to monetary volatility. They find that currency carry trades perform poorly in periods of high monetary volatility as the FPB tends to disappear. Christiansen et al. (2011) find that currency carry trading performance is exposed to traditional risk factors (stock and bond market returns), but this exposure is time-varying. That is, currency carry trades are more exposed to these risk factors in volatile periods than in tranquil periods.

Recently, the asset pricing methods, with different variables as systematic risk factors, have been employed with an emphasis on explaining the cross-section returns on portfolios

1984; Hodrick and Srivastava, 1986; Frankel and Chinn, 1993; Engel, 1996; Verdelhan, 2010; Moore and Roche, 2012). On the other hand, under the assumption of risk neutrality, the second category attributes the forward bias to the existence of systematic errors in the market participants' expectations of future spot exchange rates (see e.g., Froot and Frankel, 1989; Kaminsky, 1993; Campbell, et al., 2007; Yu, 2013). Moreover, another main category can be added to these two where the forward bias is attributed to the existence of econometrical and statistical problems in the UH test regression and in the attributes of the included variables (see e.g. Baillie and Bollerslev, 2000; Baillie and Kiliç, 2006; Gospodinov, 2009; Pippenger, 2011). Furthermore, some recent studies approach the FPB puzzle from a market microstructural point of view by relating the FPB to currency carry trade activities and the way by which investors in financial markets manage their portfolios of currency positions (see e.g. Bacchetta and van Wincoop, 2010; Spronk et al., 2013; Breedon et al., 2014).

constructed according to currency interest rates. Lustig and Verdelhan (2007) were the first to follow this approach. They introduce the consumption growth risk as the relevant priced risk factor which can explain currency carry return. Their findings suggest that high-interest rate currencies have higher exposure to the consumption growth risk than low-interest rate currencies so that provide higher returns. However, Burnside (2011) finds that consumption growth risk cannot explain the high currency carry return. This is because currency portfolios have statistically insignificant and economically small exposure (betas) to consumption risk. He also argues that consumption risk is unable to explain the variation in the cross-sectional expected returns of currency portfolios. Lustig et al. (2011) identify two common risk factors in currency markets. Namely, the average currency excess return as a level factor, and the carry trade risk factor as a slope factor. They show that high-interest rate currencies load positively on the latter factor while low-interest rate currencies load negatively on it. They find that these different loadings are able to account for a large proportion of the variation in the average returns on high and low-interest rate currency portfolios. Menkhoff et al. (2012) introduce the global FX volatility as the systematic risk factor which is able to explain more than 90% of the spread in the average return on their interest rate-sorted currency portfolios. They find that high-yielding currencies tend to depreciate in times of unexpected high volatility, whereas low-yielding currencies tend to appreciate so that serve as a hedge. Dobrynskaya (2014) suggests that currency carry trades are exposed to the risk factor of the global downside market as measured by the times of disasters or when the global stock market falls. She concludes that the high return on carry trades is a reasonable reward to their high exposure to the downside market risk.

In this paper, we analyse the relationship between currency carry return and volatility and liquidity risk factors. Namely, the global FX volatility, VIX, the global FX bid-ask spread and TED spread. For this purpose, we construct a number of currency-specific carry trades as well as a set of carry trade portfolios which are compatible with typical carry portfolios in practice. Our currency sample includes both advanced and emerging market currencies against the USD as the base currency, and the sample period extends from December 1996 to September 2014.

We find that both volatility and liquidity risks are relevant to understanding and explaining currency carry returns, with the superiority of volatility risks especially the global FX volatility innovations. We show that our carry trade portfolios systematically have a poor and even negative return in times of unexpected high volatility and low liquidity. Moreover,

in the regression of portfolios' returns against risk factors, we find that the four risk factors tend to have significantly negative coefficients, with a reasonable explanatory power for the volatility risk factors. We also find that volatility risk factors are able to explain a substantial proportion of the variation in the cross-sectional average returns of the currency-specific carry trades, and to less extent are the liquidity risk factors. The paper also shows that in times of high FX volatility the so-called Fama regression tends to produce more positive and even greater than unity slope coefficients, confirming the poor performance of carry trades in turbulent periods.

The findings of the paper contribute to the risk-based solution of the FPB by providing more insights on what sort of systematic risks can be relevant in driving risk premium in the foreign exchange market. Our findings also suggest that it is empirically important for future research to consider volatility and liquidity risks when analysing the determination of exchange rates.

The rest of the paper is organized as follows: Section 2 presents and explains the data sets employed in this study. Section 3 presents and discusses the results and findings. Section 4 provides the main findings and conclusions of the paper.

2 Data

In this section, we first begin by describing the spot and forward exchange rates data, next we describe the construction and calculation of the currency carry trades and their returns for individual currencies and portfolios, and then we provide a description of the risk factors.

2.1 Spot and Forward Exchange Rates

The data set of the spot and forward exchange rates is collected from DataStream. It consists of the World Market Reuters (WMR) series of the mid bilateral spot exchange rates and the 1, 3, 6, and 12-month forward exchange rates for 21 currencies against the US dollar (USD). The USD is the base currency in the quotation of the spot and forward exchange rates in all cases (i.e. other currency units per 1USD). So the increase in the exchange rate means USD appreciation and vice versa.

The sample of the 21 currencies consists of 10 advanced market (AM) currencies and 11 emerging market (EM) currencies. The AM currencies include Australia (AUD), Canada (CAD), Switzerland (CHF), Denmark (DKK), EURO, U.K. (GBP), Japan (JPY), Norway (NOK), New Zealand (NZD) and Sweden (SEK). The EM currencies include Czech Republic (CZK), Hong Kong (HKD), Hungary (HUF), India (INR), Kuwait (KWD)⁸, Mexico (MXN), Singapore (SGD), Thailand (THB), Turkey (TRY), Taiwan (TWD) and South Africa (ZAR).

The sample period of the data covers the period from December 1996, where data on the forward rates is available, to September 2014. The starting point of the sample period for the EURO, HUF and INR are exceptions because of the availability of data. It is from January 1999 in the case of the EURO and from October 1997 in the cases of HUF and INR.

From the daily series of the variables, we create monthly observations by taking the quotes of the spot and forward rates at the end (last working day) of each month to keep the match between the forward rate and the corresponding future spot rate. We divide the whole sample period into non-crisis period which starts from the beginning of the sample to December 2006, and crisis period which starts from January 2007 to the end of the sample.

Tables 1 and 2 report the means and standard deviations of the spot exchange rate changes and forward premium for the different forecast horizons for the advanced and

⁸In the case of KWD data is not available on the 6 and 12-month forward rates.

emerging markets, respectively. Over the whole sample period, the mean of the changes in the spot exchange rates shows that the USD has, on average, depreciated against all AM currencies for all change horizons (i.e. 1, 3, 6, and 12-month changes), except for the one month change in the cases of GBP, NOK and SEK. In contrast, the USD has, on average, appreciated against all EM currencies for all change horizons, except for the three cases of CZK, KWD and SGD.

For both advanced and emerging markets, the standard deviation of the 1, 3, 6 and 12-month forward premium is smaller over the crisis period compared to the non-crisis period, except for the cases of INR and KWD. Moreover, by comparing the standard deviation of the spot exchange rate changes and forward premium, we note that the former is much more variant.

2.2 Currency Carry Trade Return

Currency carry trading strategies are basically motivated by the existence of the FPB. As the FPB suggests that high-interest rate currency is expected to depreciate at a rate smaller than interest rate differential between currencies or even to appreciate rather than depreciate (against low-interest rate currency), carry traders attempt to benefit from this directional prediction by borrowing low-interest rate currency (funding currency) to finance investments in high-interest rate currency (investment or target currency). In so doing, the return on carry trades comes from the interest rate differential between the funding and target currency (i.e. the carry) which is not completely offset by the exchange rate movement or from the carry and exchange rate movement in the case of the appreciation of the target currency. In spot markets, carry traders can convert the borrowed sums of the lower-yielding currency to the target currency and then invest in the higher-yielding currency assets. Under the assumption of the CIP where interest rate differential is assumed to be equal to forward premium, currency carry trades can be executed in the forward FX market by selling forward lower-yielding currencies (currencies which are traded at a forward premium) and buys forward higher-yielding currencies (currencies which are traded at a forward discount). In effect, these two alternatives are equivalent; even though the latter is more profitable because of the lower transaction costs (see e.g., Bilson, 2013; Burnside et al., 2006).

From our data on the spot and 1-month forward exchange rates, we construct currency carry trades on currency-specific and portfolio basis with the USD being the base currency. We set the investment horizon to be one month. So, for currency-specific carry trades one-month short or long USD forward position is taken at the end of every month t based on whether the USD is quoted at forward premium or discount against the other currency. Similarly, by sorting currencies according to the forward premium at the end of every month t , carry trade portfolios are rebalanced monthly by allocating positions based on the USD forward premium/discount against the constituent currencies of the respective portfolio.

The one month forward premium (the carry) is calculated as:

$$fp_t^{1M} = (f_t^{1M} - s_t) * 100\%$$

where: s and f^{1M} are the natural log of the spot and one-month forward exchange rates respectively. When $fp_t^{1M} > 0$, which means that the USD is at a forward premium, short one-month USD forward position is taken against the respective currency. Conversely, when $fp_t^{1M} < 0$, which means that the USD is at a forward discount against the respective currency, long one-month USD forward position is taken. All positions are standardized to one unit.

The carry return on short positions is calculated as:

$$CR_{t+1M}^S = (f_t^{1M} - s_{t+1M}) * 100\% \equiv fp_t^{1M} - \Delta s_{t+1M}$$

where $\Delta s_{t+1M} = (s_{t+1M} - s_t) * 100\%$. On the other hand, the carry return on long positions is calculated as:

$$CR_{t+1M}^L = (s_{t+1M} - f_t^{1M}) * 100\% \equiv \Delta s_{t+1M} - fp_t^{1M}$$

We then come up with 21 currency-specific carry trades and construct five different equally-weighted carry trade portfolios. The first portfolio (CTPAM) is confined to advanced market (AM) currencies. For this portfolio, 1-month long (short) USD positions are taken at the end of every month against all other AM currencies which are at a forward premium (discount) against the USD. The second portfolio (CTPEM) is confined to emerging market (EM) currencies. For this portfolio, 1-month long (short) USD positions are taken at the end of every month against all other EM currencies which are at a forward premium (discount) against the USD. The third portfolio (CTP3CAM) includes AM currencies only. For this

portfolio, 1-month long (short) USD positions are taken at the end of every month against the three AM currencies which have the smallest (largest) forward premium (discount) against the USD. The fourth portfolio (CTP3CALLM) includes all market (ALLM) currencies. For this portfolio, 1-month long (short) USD positions are taken at the end of every month against the three currencies which have the smallest (largest) forward premium (discount) against the USD. Finally, the fifth portfolio (CTPALLM) includes ALLM currencies. For this portfolio, 1-month long (short) USD positions are taken at the end of every month against all other currencies which are at a forward premium (discount) against the USD. The monthly return on each portfolio is the average return on the positions taken at the end of every month according to the portfolio specifications.

Table 3 provides descriptive statistics for the monthly carry return on the 21 currency-specific carry trades. Except for CHF, GBP and TWD, Sharpe ratios (annualised) are positive. For AM it ranges from as low as -0.03 for GBP to as high as 0.52 for SEK. For EM it ranges from as low as -0.20 for TWD to as high as 1.27 for HKD. Standard deviation is not much higher for EM than for AM. Almost all carry returns are negatively skewed and have high kurtosis, especially for EM. Currency-specific carry returns are on average positively correlated across all markets, and this correlation is relatively stronger across AM. The first-order autocorrelation is low, particularly for AM. The USD is on average at a forward premium against other currencies over the sample period, except for CHF, DKK, EUR, JPY, SEK, HKD, SGD and TWD.

Table 4 provides descriptive statistics for the monthly carry return on our five portfolios over the whole sample period (1996M12-2014M09). Sharpe ratios are all positive with an average of 0.64 p.a. across the five carry portfolios. All Portfolios' carry returns have negative skewness and relatively high kurtosis. CTP3CALLM has the lowest negative skewness and kurtosis and the highest Sharpe ratio of 0.96 p.a. CTPEM has smaller standard deviation than CTPAM, so, given that the difference in their mean is quite tiny, it produces higher Sharpe ratio (0.60) compared to CTPAM (0.49). By comparing the performance of carry portfolios with that of the currency-specific carry trades, we note that carry portfolios have lower standard deviations on average. For the five portfolios, the first-order autocorrelation of the carry return is positive but relatively very low.

Figure 1 depicts the cumulative monthly carry return for each portfolio. Overall, even though carry trading can generate positive (and relatively high) return on average, the figure

shows that over some periods carry trades are subject to considerable losses. Generally, an upward trend can be noticed from the beginning of the sample till 2006, but with some downward movements as in late 1997 and 1998. Coinciding with the peak of the recent global financial crisis we can note a considerable downturn movement in 2008. Over the period from 2009 to the end of the sample period the trend is noticeably much more flat with downward movements as in 2010, 2011 and 2013. The correlation across the five portfolios is high with an average of 0.70. The bottom right graph in the figure, which depicts the monthly average carry return for each portfolio over the whole sample period, shows that the variation in mean carry return across portfolios is quite low, except for the CTP3CALLM which has the highest mean return.

2.3 Risk Factors

In this paper, we employ four risk factors. They can be classified into two broad categories: volatility-related factors and liquidity-related factors. The former category includes global FX volatility (GFXV) and VIX, and the latter one includes global FX bid-ask spread (GBAS) and TED spread.

The use of the GFXV is motivated by the work of Menkhoff et al. (2012). They introduce the GFXV as the priced risk factor which is able to explain more than 90% of the variation in the cross-sectional returns on currency portfolios sorted based on interest rates. They find that in periods of high FX volatility the portfolio of low-interest rate currencies perform well while the portfolio of high-interest rate currencies performs poorly. In other words, it is suggested that the value of low (high) interest rate currencies are positively (negatively) associated with the FX market volatility. In this sense, currency carry trade return can be understood as a compensation for the exposure to the volatility of the FX market. The monthly GFXV is calculated as:

$$GFXV_t = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{\kappa \in K_\tau} \left(\frac{|r_\tau^\kappa|}{K_\tau} \right) \right]$$

where: $|r_\tau^\kappa|$ is the absolute daily log spot return for each currency κ on each day τ in the sample, K_τ is the number of included currencies on day τ , T_t is the total number of trading days in month t .

Besides the GFXV as FX market-focused volatility-related risk factor, we also make use of VIX as a proxy for the global financial markets situation. VIX volatility index is calculated by Chicago Board Options Exchange (CBOE); it is based on the implied volatility of the S&P500 index options for the next 30 days. As discussed by Coudert and Mignon (2013), the strong spillovers of volatility in equity markets worldwide make the S&P500 situation representative of the global financial markets. In addition to equity markets, VIX is also regarded as an indicator of the investors' attitude toward risk on other financial markets; it is a decent proxy for investors' risk aversion in general. We extract the monthly data on VIX from DataStream.

The motivation behind the study of the potential role of liquidity risk is mainly based on the work of Brunnermeier et al. (2008) and Brunnermeier and Pedersen (2009). In the former paper, the authors demonstrate that carry traders are subject to funding liquidity constraints and that in periods of high liquidity constraints carry traders are likely to reverse their carry positions in their quest to a “cash cushion” against market instability. This course of action, i.e. “the rush to exist”, in turn, results in carry trade losses because of the increased demand (supply) of low (high) interest rate currency. The latter paper demonstrates how market and funding liquidity affect each other, i.e. “liquidity spirals”. It shows that traders are less likely to take positions when funding liquidity is tight, resulting in low market liquidity. On the other hand, low market liquidity worsens the risk associated with trade financing.

Our first liquidity-related risk factor is based on the bid and ask quotes of our bilateral exchange rates; it is the classical liquidity measure from the market microstructure point of view. Menkhoff et al. (2012) called this variable the global FX liquidity. We calculate the monthly series of the GBAS as:

$$GBAS_t = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{\kappa \in K_\tau} \left(\frac{BAS_\tau^\kappa}{K_\tau} \right) \right]$$

where: BAS_τ^κ is the percentage of the bid-ask spread of currency κ on day τ . Specifically,

$$BAS_\tau^\kappa = \frac{(Ask_\tau^\kappa - Bid_\tau^\kappa)}{(Ask_\tau^\kappa + Bid_\tau^\kappa) / 2}$$

Our second measure of liquidity is the TED spread. We get the data on the monthly TED spread from DataStream; it is calculated as the difference between the 3-month USD

LIBOR rate and the 3-month US Treasury bills interest rate. This difference serves as an indicator to the readiness of banks to provide funding in the interbank money market. In this sense, the TED spread is a proxy for the funding liquidity/illiquidity which is of interest for carry traders.

For the two volatility measures, an increase in the GFXV and VIX means higher volatility. The two measures of liquidity are indeed illiquidity measures, so an increase in the GBAS means lower FX market liquidity, and an increase in the TED spread means lower funding liquidity. Throughout our empirical analysis, rather than employing the levels of variables, we employ the innovations in the variables as the unexpected or non-traded risk factors (see Menkhoff et al., 2012). Two possible ways are available to proxy variable innovations; the first one is to take the first difference of the variable level, and the second way is to take the residuals which result from an AR(1) regression of the variable level. We adopt the second way, and the specification of the AR(1) regression for each variable is

$$y_t = \mu + \pi y_{t-1} + \varepsilon_t$$

where: y is either the GFXV, VIX, GBAS or TED spread, μ and π are the constant and slope coefficients respectively and ε is an error term. The series of innovations for each variable (y_Innov) is then given by $\hat{\varepsilon}_t = y_t - \hat{y}_t = y_t - \hat{\mu} - \hat{\pi}y_{t-1}$.

Table 5 Panel A provides descriptive statistics for the four risk variables. By looking at the minimum and maximum values, we note considerable range over the sample period. Except for GBAS, the maximum values materialised during the peak of the recent financial crisis 10-11/2008. The first-order autocorrelation is quite high for all variables. Panel B1 shows that GFXV and VIX in levels have the highest correlation; $\rho_{GFXV,VIX} = 0.71$, followed by $\rho_{VIX,TED} = 0.52$ and $\rho_{GFXV,TED} = 0.45$. The correlation between variable innovations (Panel B2) is lower; $\rho_{GFXV_{Innov},VIX_{Innov}} = 0.55$, $\rho_{VIX_{Innov},TED_{Innov}} = 0.44$ and $\rho_{GFXV_{Innov},TED_{Innov}} = 0.39$.

Figure 2 depicts the time-series of the variables along with their innovations. We note that noticeable positive spikes are in line with major financial events, like Asian and Russian financial crisis 1997/1998, global financial crisis 2007-2009 and European sovereign debt crisis 2010-2013. By looking at Figure 1 and Figure 2, we can note that these spikes are coincident with downward movements in cumulative portfolio carry returns.

3 Empirical Analysis and Results

We first begin the empirical analysis by studying the relationship between the monthly currency carry trade returns and the four risk factors, and then we move to what so-called Fama regression.

3.1 Carry Trade Return and Risk Factors

In line with the literature, our analysis of carry returns shows that such strategies are able to produce relatively high Sharpe ratios which are comparable with (or even better) than those of other financial markets, e.g. stock and bond markets (see e.g. Hochradl and Wanger, 2010; Gilmore and Hayashi, 2011; Burnside et al., 2008). The question is then that what do explain the performance of currency carry trade return? Financial theory tells us that an asset return should be a compensation for bearing risk. In this sense, for carry trade return to being thought of as a compensation for exposure to risk, it should exhibit a significant correlation with risk factor candidates. In order to investigate this issue, this section proceeds as follows: firstly, we look at the carry trade performance conditional on the quartiles of our risk factors; secondly, we study the significance of our risk factors in explaining carry returns over time; thirdly, we examine to what extent the cross-sectional mean returns of the currency-specific carry trades can be explained by the exposure to risk factors; and finally, we investigate the effect of the recent global financial crisis on carry trade performance.

3.1.1 Carry Return Conditional on Risk Factors Quartiles

We first begin by demonstrating how our five carry trade portfolios perform differently during the high and low periods of volatility and liquidity. We proxy these periods by dividing the series of risk factors into four subsamples (quartiles) based on the value of the volatility and liquidity variables' innovations. The analysis focuses on carry trade portfolios because it is more likely for market practitioners to engage in carry trading with baskets of currencies. In addition, as each portfolio has long and short USD positions simultaneously, they can be diversified against a systematic USD movement against the portfolio constituent currencies.

Table 6 reports the mean carry return (% p.a.) on each portfolio for the four quartiles of each risk factor. "High" stands for the quartile that contains the 25% months which are

associated with the highest realized values of the respective risk factor, and “Low” stands for the quartile that contains the 25% months which are associated with the lowest realized values of the respective risk factor. For volatility risk factors (GFXV and VIX) “High” means months of highest volatility, and for liquidity risk factors (GBAS and TED spread) it means months of lowest liquidity.

By looking at the mean return for “High” and “Low” quartiles, the main message of the table is that the performance of currency carry trades is substantially different during the times of high and low volatility and liquidity; that is, periods of high volatility and illiquidity innovations are associated with poor performance of currency carry trading, and vice versa. The table also suggests that currency carry trades appear to be more exposed to volatility risk than to liquidity risk over our whole sample period.

Specifically, in the cases of GFXV and VIX the mean return on the five portfolios is negative for the “High” quartile; with an average, across the five portfolios, of -5.06% p.a. in the case of GFXV and -3.70% p.a. in the case of VIX. For the 2, 3 and “Low” quartiles, the mean return on all portfolios is positive; with an average, across quartiles and portfolios, of 6.22% p.a. in the case of GFXV and 5.83% p.a. in the case of VIX. For CTPEM and CTP3CAIIM the mean return increases consistently as we move to the “Low” quartile in the case of GFXV. The same pattern holds for all portfolios in the case of VIX, except for CTP3CAM.

For liquidity risk factors, the average return across portfolios for the “High” quartile is -0.02% p.a. in the case of GBAS and it is -1.46% p.a. in the case of TED spread. For this quartile, we note that CTPAM and CTP3CAIIM in the case of GBAS, and CTPEM and CTP3CAIIM in the case of TED spread have a positive mean return. However, the difference is considerable as we move to the lower quartiles. For the 2, 3 and “Low” quartiles the mean return is positive on all portfolios; with an average, across quartiles and portfolios, of 4.58% p.a. in the case of GBAS and 5.07% p.a. in the case of TED spread.

3.1.2 Time-series Regression Analysis

The absence of significant correlation between carry trade return and risk factors can make it hard to provide a convincing risk-based explanation for what could justify the relatively high currency carry returns. Through the analysis below we investigate to what extent portfolios

carry returns co-move with our risk factors over time. To this end, we employ the regression of:

$$CTR_{t+1M}^j = \alpha + \beta F_{t+1M}^k + \varepsilon_{t+1M}$$

where: CTR_{t+1M}^j is the monthly carry trade return on the j^{th} portfolio (CTPAM, CTPEM, CTP3CAM, CTP3CAIIM or CTPAIIM), F_{t+1M}^k is the k^{th} risk factor, or a combination of risk factors, (volatility and liquidity variables' innovations), ε_{t+1M} is an error term and α and β are parameters to be estimated (multiple β coefficients in the case of a combination of risk factors).

Tables 7-11 report the regression estimates with different specifications for the five portfolios. In the first four specifications, portfolio carry return is regressed against each one of the risk factors one-at-a-time. GFXV and VIX are always significantly negative for all portfolios. The \bar{R}^2 for the GFXV regressions ranging from as low as 16% (CTPEM) to as high as 21% (CTPAIIM), and from as low as 15% (CTPAM and CTPEM) to as high as 19% (CTP3CAIIM and CTPAIIM) for the VIX regressions, which is fairly high. GBAS is significantly negative only in the cases of CTPEM and CTP3CAIIM with very low \bar{R}^2 of 3%. TED spread is significantly negative for all cases, except for CTPEM, with \bar{R}^2 ranging from as low as 7% (CTP3CAIIM and CTPAIIM) to as high as 11% (CTPAM). The finding that the TED spread is significant for CTPAM and CTP3CAM while GBAS is not, and that GBAS is significant for CTPEM while TED spread is not can be interpreted that the portfolios of advanced market currencies are more sensitive to funding liquidity than to market liquidity. In contrast, the portfolio of emerging market currencies is more sensitive to market liquidity than to funding liquidity.

In the 5, 6 and 7 specifications, the portfolio carry return is regressed on different combinations of risk factors. The estimation results show evidence that adding volatility risk factors to liquidity risk factors make the latter insignificant or less significant. In the specification 7 where carry return is regressed against all volatility and liquidity risk factors together, we note that the \bar{R}^2 is somewhat enhanced; it is ranging from as low as 21% (CTPEM) to as high as 26% (CTPAIIM). These figures of \bar{R}^2 suggest that it is empirically relevant to account for volatility and liquidity factors in describing exchange rate movements.

In the last three specifications, namely 8, 9 and 10, we include the dollar risk factor (DOLF) to the regressions. DOLF is introduced by Lustig et al. (2011) as a level risk factor in

explaining currency excess return (it is the average currency excess return). DOLF is the return on the portfolio of investing in (short USD against) all other currency regardless of the forward premium/discount. It represents the risk premium on borrowing the USD and investing in foreign currencies unconditionally. Over our whole sample period and for all currencies, the annualized average of the unconditional excess return, DOLF, is 1.51%.

DOLF is significantly positive for all portfolios, and the \bar{R}^2 is substantially enhanced with the inclusion of DOLF. Most importantly, the results show that even after accounting for this risk premium, volatility and liquidity risk factors are still significant. By looking at the magnitudes of the DOLF coefficients and the relative improvement in \bar{R}^2 s across the five portfolios, we note that emerging market currencies are much more sensitive to this risk premium. In specification 10, where the regression includes our four risk factors along with DOLF, we note that GFXV is always significant for all portfolios.

To sum up, volatility and liquidity risks are relevant in explaining the behaviour of carry trade return over time, with a superiority for volatility risk factors especially GFXV. The significantly negative coefficients on our risk factors imply that currency carry trades perform poorly in periods of unexpected high volatility and/or illiquidity. These results corroborate our findings in the previous sub-section (Table 6). This means that the exposure of carry trading strategies to volatility and liquidity risks plays a role in understanding currency carry trade returns.

3.1.3 Currency-Specific Carry Return and Risk Factors

In addition to the significant correlation between carry return and risk factor movements over time, it is important to show whether risk factors can explain the cross-sectional differences in carry return. By reviewing the mean return on currency-specific carry trade in Table 3, we see noticeable variation across currencies. The mean carry return is ranging from as low as -0.28% p.a. for GBP to as high as 6.59% p.a. for AUD for the sample of AM currencies, and from as low as -1.12% p.a. for TWD to as high as 12.69 p.a. for TRY for the sample of EM currencies. In this sub-section, we investigate to what extent this variation can be explained by different exposures of currencies to each one of our risk factors.

To achieve this we run the cross-section regressions of:

$$CR_i = \mu + \gamma\beta_i^{F^k} + \epsilon_i$$

where: CR_i is the monthly mean return on the i^{th} currency-specific carry trade over the whole sample period, $\beta_i^{F^k}$ is the exposure of the i^{th} currency-specific carry return to the F^k th risk factor, ϵ_i is an error term and μ and γ are coefficient to be estimated. We are mainly interested in the estimates of γ s.

β s in the regression above are computed by running time-series regressions for each currency-specific carry trade return against each risk factor individually over the whole sample period. Table 12 reports the estimation results for these regressions. For the sample of AM currencies, the coefficients on GFXV, VIX and TED, (F^k β s), are significantly negative for all currencies at the conventional significance levels, except for CHF in the cases of GFXV and TED and for CHF and EUR in the case of VIX. In the case of GBAS only AUD has significantly negative β . For the sample of EM currencies, out of 11 currencies 6, 7, 3 and 4 have significant β s in the cases of GFXV, VIX, GBAS and TED respectively. Table 12 also reports panel regression estimation results which serve as averages given that explanatory variables are the same. For all currency samples (AM, EM and AllM) β estimates are all significantly negative for all risk factors.

The cross-section regressions are performed for each one of risk factors one-at-a-time. Figure 3 summarizes the estimation results for the sample of all currencies. The slope coefficients (γ s) on risk factor β s are all negative and significant, except for GBAS where γ is insignificant. These negative γ s are consistent with the return-risk trade-off, that is, the higher the exposure to the risk, the higher the compensation return. In the cases of GFXV and VIX constant coefficients are insignificant, while they are significant in the cases of GBAS and TED spread. The exposure to volatility risk factors is able to explain up to 48% of the differences in the mean carry returns amongst currencies. This ability is substantially lower for the market and funding liquidity risk measures. For all risk factors we note that TRY is the most prominent outlier.

Similarly, Figure 4 summarizes the cross-section regression estimation results for the sample of AM currencies only. γ coefficients are significantly negative for all risk factors, and constant coefficients are all insignificant except for GBAS. \bar{R}^2 s are higher for the four regressions. The different exposures to GFXV can explain up to 60% of the cross-sectional differences in the mean returns of currency-specific carry trades for the AM currencies. VIX

and TED spread have almost the same performance with \bar{R}^2 s of 55% for the former and 54% for the latter.

The better performance of TED spread compared to GBAS in terms of \bar{R}^2 s for both currency samples (AllM and AM) can indicate that currency-specific carry trade returns are more sensitive to funding liquidity than to market liquidity, especially for the AM currencies. In addition, the higher \bar{R}^2 s for all risk factors when EM currencies are excluded can imply that EM currencies may be more exposed to other risk factors, such as default and political risk factors (see e.g. Coudert and Mignon, 2013; Mehl and Cappiello, 2009).

3.1.4 The Global Financial Crisis and Carry Trade Return

In section 3.1.1 we show the differences in the performance of currency carry trades in high and low volatility and liquidity regimes by dividing our risk factors' series into quartiles. In this sub-section, we intend to have a closer look at the effect of the recent financial crisis, 2007-2008, and its aftermaths on currency carry trading performance; the crisis which has been described as volatility and liquidity crisis. By looking at Figure 2, we note that the peak of the crisis in 2008 is associated with major positive spikes in both volatility and liquidity risk measures. In addition, during the period 2010-2013, which has seen the European sovereign debt crisis, we also see noticeable hikes in the risk factors particularly the volatility ones.

Table 13 provides descriptive statistics for our five carry trade portfolios over different sub-sample periods. Panel A covers the period 1996M12-2006M12, non-crisis period; Panel B covers the period 2007M01-2014M09, crisis period; and in Panel C we exclude the period 2008M09-2009M09, which identified by Coudert and Mignon (2013) as the most affected period by the crisis, from our whole sample period.

Over the non-crisis period, all portfolios produce Sharpe ratios (SR) greater than unity. The highest SR of 1.83 p.a. is for CTP3CAIIM and the lowest SR of 1.10 p.a. is for CTP3CAM. The average SR for all portfolios is 1.44 p.a. The difference in SR between the non-crisis period and whole sample period (the last column in the table) is positive is considerably large for all portfolios, with an average of 132% across the portfolios.

On the other hand, SR is either very low or negative for all portfolios over the crisis period. CTPAM produces the lowest SR of -0.13 p.a., and the highest SR of 0.13 p.a. is for

CTPEM. The average SR across all portfolios is 0.03 p.a. The difference in SR between the crisis period and whole sample period is negative and substantially large for the five portfolios, with an average of -97%. We also note higher standard deviation, more negative skewness and higher kurtosis for the crisis period compared to the non-crisis period.

With the exclusion of the period 2008M09-2009M09 from the whole sample period (Panel C), we note that the mean return is higher for all portfolios. We also note lower standard deviation, less negative skewness and lower kurtosis compared to the whole sample period. The difference in SR is also positive with an average of 26% p.a. across the five portfolios.

Figure 5 depicts the rolling annual performance of the five portfolios. The series represents the rolling average of the monthly carry return over 12 months window size. By comparing the behaviour of these rolling average series over the non-crisis and crisis periods, we can note that the crisis period is associated with very low or negative average return most of the time for the five portfolios.

Figure 6 depicts the monthly mean carry return on the five portfolios year-by-year. By looking at these mean returns, the time-varying performance of currency carry trading is obvious. By matching this figure with Figure 2, we note that the years which have seen hikes in volatility and/or liquidity risk measures are associated with low or negative carry return; the most prominent cases are the years of 1998, 2008, 2011 and 2013.

The bottom right graph in the figure depicts the mean return for the non-crisis and crisis periods. The five portfolios have systematically poor return over the crisis period. A comparison of mean returns across portfolios over the crisis period shows that the poorest performance is that of CTPAM, CTP3CAM and CTPAIIIM, which can suggest that carry trades against AM currencies are more affected by the crisis and its consequences.

3.2 Fama Regression: Revisit

Fama regression is generally the standard method which often used for testing the UH or the FPB. It involves regressing the realized future spot exchange rate changes against the current forward premium. In this section, we restate our findings and results in the previous sections in the context of this regression. We run this regression for the 1, 3, 6 and 12-month forward

rates at a monthly frequency over different sample periods; namely, the whole sample period, the non-crisis period and the crisis period as a representative of turbulent periods which are associated with high volatility and/or illiquidity innovations. We first provide the regression estimation results on a country-by-country basis, and next we provide the regression estimation results based on pooled data.

3.2.1 Country-by-Country Analysis

The following workhorse regression⁹ is estimated for every currency against the USD;

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

where s_t (s_{t+k}) is the natural log of the spot exchange rate at time t ($t + k$), f_t^k is the natural log of the k -period forward exchange rate at time t , ε_{t+k} is the error term and k is 1, 3, 6 or 12 month. α and β are the coefficients to be estimated. The reported standard errors of the parameter estimates are the Newey-West robust standard errors which are corrected for the serial correlations in residuals¹⁰. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at August 2014, June 2014, March 2014 and September 2013, respectively.

In practice, investigating the FPB involves mainly the test of the null hypothesis that $\beta = 1$ ¹¹. Tables 14-17 report the estimation results for the various countries, sample periods and forecast horizons. Over the whole sample period, β estimates are negative for the most of currencies, especially for the AM currencies. The average β for the AM currencies is -0.81, -1.01, -0.94 and -1.16 for the 1, 3, 6, and 12-month forward rates respectively, and it is 0.22,

⁹This regression, in difference specifications, was first introduced by Tryon (1979), but became extensively in use after the influential work of Fama (1984).

¹⁰As the data analysis is at monthly frequency, in the cases of the 3, 6 and 12-month horizon the residuals will have a moving average (MA) term of order $k-1$ (i.e. MA(2), MA(5) and MA(11) for the 3, 6, and 12-month horizon, respectively) because of the overlapping observations problem (see e.g., Chinn and Meredith, 2005; Frankel and Poonawala, 2010; Lee, 2011).

¹¹However, Appendix A reports the estimates of the constant term α . At the conventional significance levels, we note that, over the whole sample period, it is significantly negative (positive) in 1 (2) case(s) for the 1,3 and 6-month forward rates, and in 3 (1) cases for the 12-month forward rate. Over the non-crisis period it is significantly negative (positive) in 1 (5) case(s) for the 1and 3-month forward rates, in 6 (5) cases for the 6-month forward rate and in 8 (3) cases for the 12-month forward rate. Over the crisis period, it is significantly negative (positive) in 3 (0) cases for the 1 and 3-month forward rates, in 5 (0) cases for the 6-month forward rate and in 7 (2) cases for the 12-month forward rate.

0.10, -0.05 and -0.01 for the EM currencies. We also note that β is more often significantly less than unity for the EM currencies¹².

The extremely different results over the non-crisis and crisis periods are particularly interesting. Over the non-crisis period β estimates are much more negative especially for the AM currencies, and they are significantly negative or less than unity for the most of currencies. The average β for the AM currencies is -3.42, -3.64, -3.73 and -3.74 for the 1, 3, 6 and 12-month forward rates respectively, and it is -0.06, -0.22, -0.19 and -0.07 for the EM currencies.

On the other hand, The FPB is either completely disappeared or alleviated over the crisis period for the vast majority of currencies. Most importantly, we notice a pattern that β estimates tend to take values significantly greater than unity, particularly for the AM currencies. The average β for the AM currencies is 9.69, 9.54, 11.00 and 8.30 for the 1, 3, 6, and 12-month forward rates respectively, and it is 0.97, 1.39, 1.59 and 1.56 for the EM currencies.

These results are indeed consistent with our analysis of the performance of currency carry trades in the previous sections. The existence of the FPB over the whole sample period and more evidently over the non-crisis period is in line with the positive and high carry trade return. This is because the tendency of high (low) interest rate currencies to appreciate (depreciate) in non-crisis periods, as implied by negative β s, results in a large violation of the UH and so large return on currency carry trades. Note that, for example, the more pronounced FPB over the non-crisis period compared to the whole sample period is reflected by much higher carry return over the former period.

On the other hand, the disappearance of the FPB and the tendency of β estimates to take values greater than unity over the crisis-period are in line with the very poor and negative performance of currency carry trades. This is because the more positive and greater than unity β s suggest that low (high) interest rate currencies tend to appreciate (depreciate) at rates much larger than implied by the UH ($\beta = 1$), resulting in negative return on carry trade positions.

¹²It is important to mention that these results should be taken with caution because of the large standard errors of the parameter estimate, especially for AM currencies.

With the intention of rigorously presenting these results in the context of the risk factor of GFXV, given its superiority over the other risk factors, we run Fama regression for the 1-month forward rate conditional on the high and low global FX volatility regimes. Depending on the GFXV innovation values, we define the low FX volatility environment as the periods which belong to the first quartile of the innovation values, and the high FX volatility environment as the periods which belong to the fourth quartile of the innovation values.

The estimations results are reported in Table 18 for each currency cross. β estimates in the low and high FX volatility regimes are highly consistent with those obtained over the non-crisis and crisis periods. In the low FX volatility regime β estimates are negative for the majority of currencies with an average of -1.88 across all currencies. Note that these negative β estimates are well-matched with the high carry portfolio returns in the “Low” quartile of the GFXV which reported in Table 6. On the other hand, β estimates are more positive in the high FX volatility regime with a tendency for taking values above unity. The average β for all currencies in the high volatility regime is 2.25. Again this pattern is compatible with the negative carry portfolio returns in the “High” quartile of the GFXV.

These negative β s in the low FX volatility environment and the more positive and greater than unity β s in the high FX volatility environment implies that high-interest rate currencies tend to perform well in calm periods but poorly in turbulent periods, whereas low-interest rate currencies tend to perform well in turbulent periods but poorly in calm periods. This in turn corroborates that currency carry trade positions are exposed to the risk of movements of the FX market volatility.

3.2.2 Pooled Data Analysis

In order to increase the sample size so that parameters in the regression equation can be estimated with more accuracy, in this sub-section, we employ the pooled data regressions where the cross-currency and time series information are incorporated¹³. We estimate the balanced pooled time-series, cross-section regression of:

$$s_{i,t+k} - s_{i,t} = \alpha + \beta(f_{i,t}^k - s_{i,t}) + \varepsilon_{i,t+k}$$

¹³Chinn (2012) states that it is difficult to obtain precise parameter estimates from the pure time series as they are oftentimes uninformative.

where $s_{i,t}$ ($s_{i,t+k}$) is the natural log of the spot exchange rate of the i th currency against the USD at time t ($t+k$), $f_{i,t}^k$ is the natural log of the k -period forward exchange rate of the i th currency against the USD at time t , $\varepsilon_{i,t+k}$ is the error term, and k is 1, 3, 6 or 12 month. α and β are the coefficients to be estimated¹⁴. Following Grossmann et al. (2014), the reported standard errors of the parameter estimates are the White period standard errors which are robust to arbitrary heteroscedasticity and serial correlation in the residuals.

Table 19 reports the regression estimation results for the sample of all currencies, and Table 20 reports the results for the samples of AM and EM currencies separately. This separation can help in relaxing the strong assumption of the pooled data regression of having one single slope coefficient for all currencies. The results are extremely consistent with and supportive to those we have based on the country-by-country analysis.

For the samples of AllM and EM currencies, the FPB exists for the whole sample period and non-crisis period. β coefficient is significantly negative for the 1-month forward rate. For the longer forward rates, although β s are positive, i.e. in line with the UH in terms of the directional change of the spot rate, they are significantly less than unity and closer to zero. On the other hand, the FPB does not exist and the UH tends to hold for all forward rates over the crisis period. The hypothesis of $\beta = 1$ cannot be rejected. One exception is the 1-month forward rate for the EM currencies sample where the hypothesis that the β coefficient of 0.70 is not significantly different from unity can be rejected, but only at 10% significance level.

For the sample of the AM currencies, (Tables 20 Panel A), the FPB exists over the whole sample period and non-crisis period, and it is much more pronounced over the non-crisis period. By comparing the estimation results for the AM and EM currency samples, we note that the FPB is much more pronounced for the AM. We also can note that the FPB tend to be less pronounced for the longer forecast horizons for the sample of EM currencies; the pattern which cannot be identified for the sample of AM currencies. Over the crisis period the results are in line with those obtained by analysing currencies individually, that is, the FPB does exist and all β coefficients are significantly positive and greater than unity.

¹⁴The analysis is thoroughly maintained with balanced pooled data, so that the estimation period starts either from January 1999 whenever EURO is included, or from October 1997 whenever HUF and/or INR are included but not the EURO.

Overall, these results again mirror the varying performance of currency carry trades. Specifically, the existence of the FPB over non-crisis periods is matched with an attractive performance of currency carry trades, whereas the vanishing of the FPB and the pattern of greater than unity β s over crisis periods is matched with unpleasant or negative carry returns¹⁵.

4 Conclusions

For more than 30 years now, the FPB puzzle is one of the most heavily researched topics. However, there is less agreement on one definite explanation for its existence. Although risk-based explanations are appealing, there is no consensus on what systematic risk factors are related to the finding of the FPB. In order to answer this question, an ample research is devoted to examining the risk-return trade-off for currency carry trades; the trading strategy which is basically the consequent of the FPB existence.

Built on and motivated by this research, we analyse the correlation between currency carry trade return and some volatility and liquidity risk factors. To this end, we construct a number of currency-specific and portfolios of carry trading from a currency sample including both advanced and emerging market currencies. Our carry trade portfolios are constructed to match typical carry portfolios. Our proxies for volatility risk factors are the innovations in the global FX volatility and the VIX. For liquidity risk, our proxies are the innovations in the global FX bid-ask spread, which stands for market liquidity, and the innovations in TED spread, which stands for funding liquidity. The sample period of the paper extends from 1996M12 to 2014M09.

We first document that carry trading portfolios systematically perform poorly in times of unexpected high volatility and low liquidity compared to periods of low volatility and high liquidity. This is done by analysing the performance of the portfolios' returns in the different quartiles of the risk factors. In the time-series regressions of portfolios' returns against the risk factors, the four risk factors exhibit significant and negative covariance with portfolios' returns. Up to 20% of the over-time variation of the portfolios' carry return is found to be explained by the movements of volatility risk measures.

¹⁵Appendices B and C report pooled data estimates with Fixed-effect. To large extent, the results qualitatively did not change.

On a cross-section basis, we find that the cross-sectional variation in the mean returns of the currency-specific carry trades can be largely explained by the exposure to volatility risk factors, and to a lesser degree to liquidity risk factors. For example, the exposure to global FX volatility risk factor can explain up to 48% of this variation for the sample of all market currencies, and up to 60% for the sample of advanced market currencies. The results, overall, show that both volatility and liquidity risk factors are important in explaining currency carry return, with the superiority of volatility ones especially the global FX volatility. The results also show that to some extent these risk factors tend to be more relevant to advanced market currencies than to emerging market ones, especially the TED spread.

A revisit to Fama regression confirms that the FPB tend to exist in tranquil periods but it tends to fade away in times of turmoil. We also replicate these results in the context of the global FX volatility by performing the regression conditional on the low and high FX volatility periods. The results show that the estimates of the regression slope coefficient are FX market volatility regime-dependent. Specifically, we find that the estimates of the slope coefficient β are noticeably negative in times of low FX volatility, whereas β estimates are more positive and even above unity in times of high FX volatility.

Overall, the results of the paper imply that currency carry trade positions are exposed to the movements of volatility and liquidity risk factors. This is because high-interest rate currencies tend to perform well in times of low volatility and high liquidity but poorly in times of high volatility and low liquidity, whereas low-interest rate currencies tend to perform well in times of high volatility and low liquidity but poorly in times of low volatility and high liquidity. Consequently, carry trade return can be understood as a reward for bearing such risks. In other words, volatility and liquidity risk factors can constitute important players in driving risk premium in the FX market.

Moreover, this co-movement of exchange rates, in relation with the volatility and liquidity risk measures, suggests that it is empirically important for future research to account for such risk factors in order to obtain a better and deeper understanding of the exchange rate determination.

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Table 1 Descriptive Statistics: Advanced Markets

		1-Month					3-Month					6-Month					12-Month				
	Period	N	ΔS		fp		N	ΔS		fp		N	ΔS		fp		N	ΔS		fp	
			Mean%	SD%	Mean%	SD%		Mean%	SD%	Mean%	SD%		Mean%	SD%	Mean%	SD%		Mean%	SD%	Mean%	SD%
AUD	Whole ¹	213	-0.05	3.73	0.18	0.15	211	-0.23	6.66	0.52	0.45	208	-0.50	9.98	1.03	0.90	202	-1.19	13.89	2.00	1.78
	Non-Crisis ²	121	0.02	2.94	0.11	0.15	121	-0.04	5.12	0.31	0.43	121	-0.23	7.61	0.61	0.85	121	-1.16	12.28	1.15	1.62
	Crisis ³	92	-0.13	4.59	0.27	0.10	90	-0.48	8.33	0.81	0.29	87	-0.88	12.59	1.61	0.57	81	-1.23	16.08	3.27	1.15
CAD	Whole	213	-0.10	2.47	0.004	0.09	211	-0.31	4.15	0.01	0.25	208	-0.67	6.17	0.02	0.48	202	-1.44	8.39	0.04	0.92
	Non-Crisis	121	-0.12	1.88	-0.02	0.10	121	-0.38	3.29	-0.05	0.28	121	-1.00	4.77	-0.10	0.55	121	-2.61	6.86	-0.18	1.03
	Crisis	92	-0.06	3.10	0.03	0.05	90	-0.21	5.11	0.09	0.15	87	-0.21	7.71	0.18	0.30	81	0.29	10.06	0.38	0.60
CHF	Whole	213	-0.16	3.12	-0.16	0.13	211	-0.60	5.06	-0.46	0.38	208	-1.31	6.95	-0.91	0.74	202	-2.79	9.35	-1.85	1.40
	Non-Crisis	121	-0.06	2.78	-0.22	0.13	121	-0.34	4.86	-0.64	0.37	121	-0.76	6.33	-1.28	0.72	121	-1.86	8.84	-2.52	1.35
	Crisis	92	-0.29	3.53	-0.07	0.08	90	-0.94	5.33	-0.20	0.22	87	-2.07	7.70	-0.41	0.39	81	-4.19	9.95	-0.85	0.68
DKK	Whole	213	0.000	2.94	-0.03	0.12	211	-0.12	5.13	-0.08	0.33	208	-0.37	7.30	-0.16	0.64	202	-1.01	10.06	-0.33	1.21
	Non-Crisis	121	-0.02	2.64	-0.05	0.13	121	-0.22	4.92	-0.15	0.37	121	-0.63	6.81	-0.31	0.72	121	-1.88	10.32	-0.66	1.34
	Crisis	92	0.03	3.31	0.01	0.09	90	0.03	5.41	0.02	0.22	87	-0.02	7.96	0.05	0.41	81	0.28	9.58	0.15	0.78
EURO	Whole	188	-0.06	2.99	-0.02	0.11	186	-0.27	5.21	-0.07	0.32	183	-0.72	7.37	-0.14	0.64	177	-1.67	10.27	-0.32	1.22
	Non-Crisis	96	-0.14	2.64	-0.04	0.14	96	-0.55	5.00	-0.14	0.40	96	-1.36	6.71	-0.29	0.77	96	-3.30	10.54	-0.66	1.43
	Crisis	92	0.03	3.33	0.000	0.07	90	0.03	5.45	0.01	0.19	87	-0.02	8.02	0.04	0.37	81	0.26	9.64	0.10	0.71
GBP	Whole	213	0.03	2.44	0.08	0.09	211	-0.01	4.37	0.22	0.27	208	-0.06	6.76	0.45	0.54	202	-0.06	9.10	0.87	1.03
	Non-Crisis	121	-0.11	2.17	0.10	0.10	121	-0.43	3.24	0.30	0.30	121	-0.92	4.77	0.58	0.60	121	-1.96	7.03	1.07	1.14
	Crisis	92	0.20	2.75	0.04	0.07	90	0.56	5.51	0.12	0.19	87	1.15	8.71	0.26	0.38	81	2.80	10.97	0.56	0.73
JPY	Whole	213	-0.03	3.12	-0.23	0.19	211	-0.18	5.50	-0.68	0.54	208	-0.45	7.73	-1.39	1.06	202	-0.94	10.65	-2.93	2.03
	Non-Crisis	121	0.03	3.26	-0.33	0.15	121	-0.004	5.50	-0.98	0.45	121	-0.02	7.61	-1.97	0.88	121	-0.26	9.77	-4.02	1.67
	Crisis	92	-0.11	2.94	-0.10	0.14	90	-0.41	5.52	-0.29	0.39	87	-1.04	7.90	-0.59	0.72	81	-1.97	11.84	-1.29	1.30
NOK	Whole	213	0.003	3.26	0.09	0.17	211	-0.05	5.77	0.26	0.50	208	-0.26	8.24	0.50	0.98	202	-0.81	10.98	0.92	1.84
	Non-Crisis	121	-0.02	2.89	0.06	0.21	121	-0.14	4.96	0.18	0.62	121	-0.52	6.48	0.32	1.18	121	-1.84	9.73	0.53	2.18
	Crisis	92	0.03	3.70	0.12	0.08	90	0.07	6.75	0.37	0.24	87	0.10	10.24	0.75	0.47	81	0.74	12.52	1.51	0.89
NZD	Whole	213	-0.05	3.87	0.22	0.14	211	-0.24	6.61	0.65	0.39	208	-0.55	10.19	1.28	0.75	202	-1.34	14.79	2.51	1.41
	Non-Crisis	121	0.02	3.13	0.19	0.16	121	-0.02	5.86	0.57	0.45	121	-0.22	9.06	1.12	0.85	121	-1.03	14.65	2.15	1.55
	Crisis	92	-0.14	4.68	0.26	0.09	90	-0.53	7.54	0.75	0.25	87	-1.02	11.62	1.49	0.50	81	-1.80	15.07	3.03	0.97
SEK	Whole	213	0.03	3.25	-0.01	0.14	211	-0.03	5.77	-0.03	0.42	208	-0.25	8.56	-0.06	0.82	202	-0.78	11.77	-0.09	1.55
	Non-Crisis	121	0.02	2.84	-0.05	0.16	121	-0.06	4.97	-0.16	0.46	121	-0.36	7.00	-0.32	0.89	121	-1.18	11.04	-0.59	1.65
	Crisis	92	0.04	3.73	0.05	0.09	90	0.01	6.73	0.15	0.27	87	-0.09	10.40	0.30	0.53	81	-0.18	12.83	0.65	1.01

Notes: The table reports the mean and standard deviation; SD, of 1, 3, 6 and 12-month spot exchange rate changes; ΔS , and forward premium; fp . $\Delta S = s_{t+k} - s_t$, $fp = f_t^k - s_t$ where s is the natural log of spot exchange rate, f is the natural log of forward rate and k is 1, 3, 6, or 12 month. US dollar is the base currency. N is the number of monthly observations. 1: from the beginning of the sample period 1996M12 (except Euro from 1999M01) to the end of the sample period 2014M09. 2: from 1996M12 (except Euro from 1999M01) to 2006M12. 3: from 2007M01 to the end of the sample period. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at 2014M08, 2014M06, 2014M03 and 2013M09, respectively. End of month quotes of spot and forward exchange rates are taken to generate monthly observations.

Table 2

Descriptive Statistics: Emerging Markets

		1-Month					3-Month					6-Month					12-Month				
	Period	N	Δs		fp		N	Δs		fp		N	Δs		fp		N	Δs		fp	
			Mean%	SD%	Mean%	SD%		Mean%	SD%	Mean%	SD%		Mean%	SD%	Mean%	SD%		Mean%	SD%		
CZK	Whole	213	-0.10	3.72	0.10	0.35	211	-0.40	6.63	0.27	0.85	208	-1.03	9.60	0.49	1.54	202	-2.61	12.41	0.90	2.88
	Non-Crisis	121	-0.19	3.36	0.18	0.45	121	-0.67	6.05	0.47	1.06	121	-1.62	8.32	0.85	1.90	121	-4.40	11.30	1.52	3.53
	Crisis	92	0.01	4.15	-0.004	0.09	90	-0.03	7.36	-0.01	0.26	87	-0.20	11.14	-0.01	0.49	81	0.07	13.54	-0.02	0.89
HKD	Whole	213	0.00	0.12	-0.004	0.12	211	0.00	0.20	-0.01	0.30	208	0.00	0.25	0.03	0.64	202	0.01	0.30	0.17	1.37
	Non-Crisis	121	0.01	0.11	0.01	0.15	121	0.02	0.17	0.05	0.38	121	0.04	0.23	0.17	0.80	121	0.07	0.30	0.49	1.68
	Crisis	92	-0.01	0.14	-0.03	0.03	90	-0.02	0.23	-0.09	0.08	87	-0.05	0.26	-0.17	0.15	81	-0.09	0.28	-0.30	0.24
HUF	Whole	203	0.12	4.12	0.51	0.28	201	0.28	7.19	1.46	0.78	198	0.37	10.27	2.81	1.48	192	0.46	13.18	5.24	2.66
	Non-Crisis	111	0.01	3.02	0.63	0.31	111	-0.10	5.28	1.78	0.87	111	-0.48	7.51	3.40	1.67	111	-1.56	12.15	6.18	3.02
	Crisis	92	0.24	5.16	0.37	0.15	90	0.75	9.01	1.06	0.39	87	1.46	12.93	2.06	0.68	81	3.22	14.08	3.96	1.20
INR	Whole	203	0.261	2.17	0.37	0.24	201	0.70	3.96	1.04	0.64	198	1.36	5.63	1.94	1.20	192	2.61	8.36	3.50	2.20
	Non-Crisis	111	0.18	1.24	0.28	0.20	111	0.39	2.33	0.82	0.57	111	0.50	3.70	1.64	1.15	111	0.24	5.79	3.25	2.37
	Crisis	92	0.36	2.92	0.48	0.24	90	1.09	5.32	1.30	0.63	87	2.45	7.28	2.33	1.15	81	5.85	10.11	3.84	1.91
KWD	Whole	213	-0.02	0.74	0.05	0.11	211	-0.08	1.32	0.15	0.30										
	Non-Crisis	121	-0.03	0.37	0.06	0.05	121	-0.11	0.62	0.18	0.15										
	Crisis	92	0.00	1.04	0.047	0.15	90	-0.04	1.89	0.12	0.42										
MXN	Whole	213	0.25	2.85	0.63	0.52	211	0.74	5.13	1.88	1.51	208	1.46	7.29	3.75	2.86	202	2.98	9.29	7.41	5.24
	Non-Crisis	121	0.28	2.36	0.87	0.58	121	0.84	3.84	2.57	1.67	121	1.61	5.27	5.06	3.10	121	3.15	7.42	9.74	5.61
	Crisis	92	0.21	3.41	0.33	0.16	90	0.60	6.49	0.96	0.40	87	1.24	9.44	1.93	0.72	81	2.72	11.59	3.94	1.16
SGD	Whole	213	-0.04	1.79	-0.08	0.13	211	-0.16	3.03	-0.16	0.24	208	-0.37	4.16	-0.51	0.65	202	-0.93	5.94	-1.05	1.22
	Non-Crisis	121	0.08	1.70	-0.10	0.15	121	0.198	3.07	-0.22	0.27	121	0.34	3.91	-0.68	0.72	121	0.21	5.78	-1.38	1.34
	Crisis	92	-0.20	1.91	-0.04	0.09	90	-0.65	2.93	-0.08	0.16	87	-1.36	4.31	-0.27	0.44	81	-2.63	5.82	-0.56	0.81
THB	Whole	213	0.110	3.38	0.21	0.45	211	0.31	6.57	0.55	1.01	208	0.66	9.68	0.98	1.70	202	0.49	12.62	1.76	2.90
	Non-Crisis	121	0.25	4.22	0.27	0.58	121	0.72	8.24	0.69	1.28	121	1.47	12.11	1.21	2.13	121	1.39	15.50	2.14	3.57
	Crisis	92	-0.07	1.75	0.13	0.14	90	-0.24	3.12	0.36	0.39	87	-0.46	4.31	0.66	0.68	81	-0.86	6.08	1.20	1.19
TRY	Whole	213	1.43	4.84	-0.65	13.37	211	4.18	9.81	3.76	13.65	208	8.21	15.48	10.31	16.03	202	15.94	24.98	23.49	24.69
	Non-Crisis	121	2.12	5.35	-1.70	17.70	121	6.18	10.97	4.97	17.94	121	11.86	17.66	14.67	19.90	121	21.60	29.50	33.55	27.57
	Crisis	92	0.52	3.91	0.72	0.27	90	1.49	7.19	2.13	0.80	87	3.13	9.84	4.25	1.57	81	7.49	11.89	8.46	3.06
TWD	Whole	213	0.05	1.62	-0.08	0.28	211	0.13	3.12	-0.25	0.62	208	0.25	4.51	-0.52	1.06	202	0.31	6.33	-1.03	1.77
	Non-Crisis	121	0.15	1.70	-0.02	0.29	121	0.45	3.32	-0.10	0.65	121	0.89	4.73	-0.22	1.14	121	1.39	6.82	-0.52	1.94
	Crisis	92	-0.09	1.52	-0.15	0.25	90	-0.31	2.79	-0.45	0.49	87	-0.65	4.04	-0.93	0.77	81	-1.32	5.14	-1.80	1.12
ZAR	Whole	213	0.41	4.65	0.59	0.25	211	1.23	8.25	1.71	0.71	208	2.50	11.85	3.31	1.32	202	4.97	17.39	6.38	2.41
	Non-Crisis	121	0.36	4.56	0.64	0.31	121	1.15	8.32	1.83	0.86	121	2.29	12.21	3.50	1.60	121	4.20	18.80	6.65	2.88
	Crisis	92	0.48	4.79	0.53	0.14	90	1.35	8.19	1.54	0.37	87	2.79	11.39	3.04	0.72	81	6.12	15.07	5.97	1.38

Notes: The table reports the mean and standard deviation; SD, of 1, 3, 6 and 12-month spot exchange rate changes; Δs , and forward premium; fp . The sample period for HUF and INR starts from 1997M10. Data on 6 and 12-month forward rates is not available for KWD. Everything else is the same as in the notes to Table 1.

Table 3

Currency-Specific Carry Trade Return: Descriptive Statistics

Panel A: AM	Carry Return: Annualized						Average Correlation With			Carry Ann.Mean%
	Mean%	Std. Dev.	Skew.	Kurt.	SR	F_AC	AM	EM	AllM	
AUD	6.59	12.87	-0.82	5.58	0.51	0.05	0.39	0.31	0.35	2.16
CAD	1.13	8.58	-0.79	6.92	0.13	0.01	0.36	0.24	0.29	0.08
CHF	-0.07	10.84	-0.13	4.54	-0.01	-0.05	-0.34	-0.19	-0.26	-1.83
DKK	3.35	10.18	-0.27	3.87	0.33	0.03	0.42	0.24	0.32	-0.25
EUR	3.32	10.34	-0.33	3.94	0.32	0.04	0.44	0.25	0.33	-0.21
GBP	-0.28	8.43	-0.45	4.51	-0.03	0.07	0.31	0.22	0.26	0.94
JPY	2.55	10.81	-0.46	5.25	0.24	0.00	0.04	0.02	0.03	-2.74
NOK	3.75	11.28	-0.50	4.14	0.33	0.00	0.43	0.27	0.35	1.09
NZD	4.73	13.36	-0.43	4.65	0.35	-0.01	0.35	0.29	0.32	2.66
SEK	5.76	11.18	-0.31	3.70	0.52	0.03	0.46	0.29	0.37	-0.08
Panel B: EM										
CZK	3.00	12.85	-0.27	3.35	0.23	-0.03	0.34	0.12	0.23	1.21
HKD	0.71	0.56	1.50	16.55	1.27	0.21	-0.04	-0.07	-0.05	-0.05
HUF	4.73	14.35	-1.10	6.62	0.33	0.01	0.34	0.24	0.29	6.05
INR	1.67	7.55	-0.33	5.59	0.22	0.11	0.27	0.24	0.26	4.47
KWD	0.32	2.45	-1.58	16.66	0.13	-0.07	0.25	0.16	0.21	0.64
MXN	4.61	10.08	-1.13	6.92	0.46	0.07	0.37	0.24	0.31	7.52
SGD	1.10	6.28	0.33	5.36	0.18	-0.03	-0.09	-0.11	-0.10	-0.90
THB	4.68	11.59	-0.65	18.97	0.40	0.17	0.24	0.12	0.18	2.53
TRY	12.69	13.99	-0.49	7.38	0.91	0.13	0.27	0.20	0.23	26.07
TWD	-1.12	5.66	-0.26	6.44	-0.20	0.03	-0.08	-0.12	-0.10	-0.94
ZAR	2.17	16.24	-0.51	3.96	0.13	0.04	0.26	0.20	0.23	7.11

Notes: The table reports relevant descriptive statistics for the monthly carry trade returns for every currency against the USD. At the end of every month, long (short) 1-month forward USD position is taken when the USD is at a forward discount (premium) against the respective currency. Carry return, CR, is calculated as $CR_{t+1M}^{1M} = (s_{t+1M} - f_t^{1M}) * 100\%$ for long positions, and $-(s_{t+1M} - f_t^{1M})$ for short positions. s and f are the log of spot and forward exchange rates respectively. USD is the base currency. Average correlation is the average correlation of the currency i CR with the other currencies CR. Carry is the monthly USD forward premium (the interest rate differential under the assumption of the CIP); and it is calculated as $fp_t^{1M} = (f_t^{1M} - s_t) * 100\%$. SR is Sharpe Ratio. F_AC is the first order autocorrelation. AM, EM and AllM stand for advanced markets, emerging markets and all markets, respectively.

Table 4

Carry Trade Portfolios Return - Descriptive Statistics

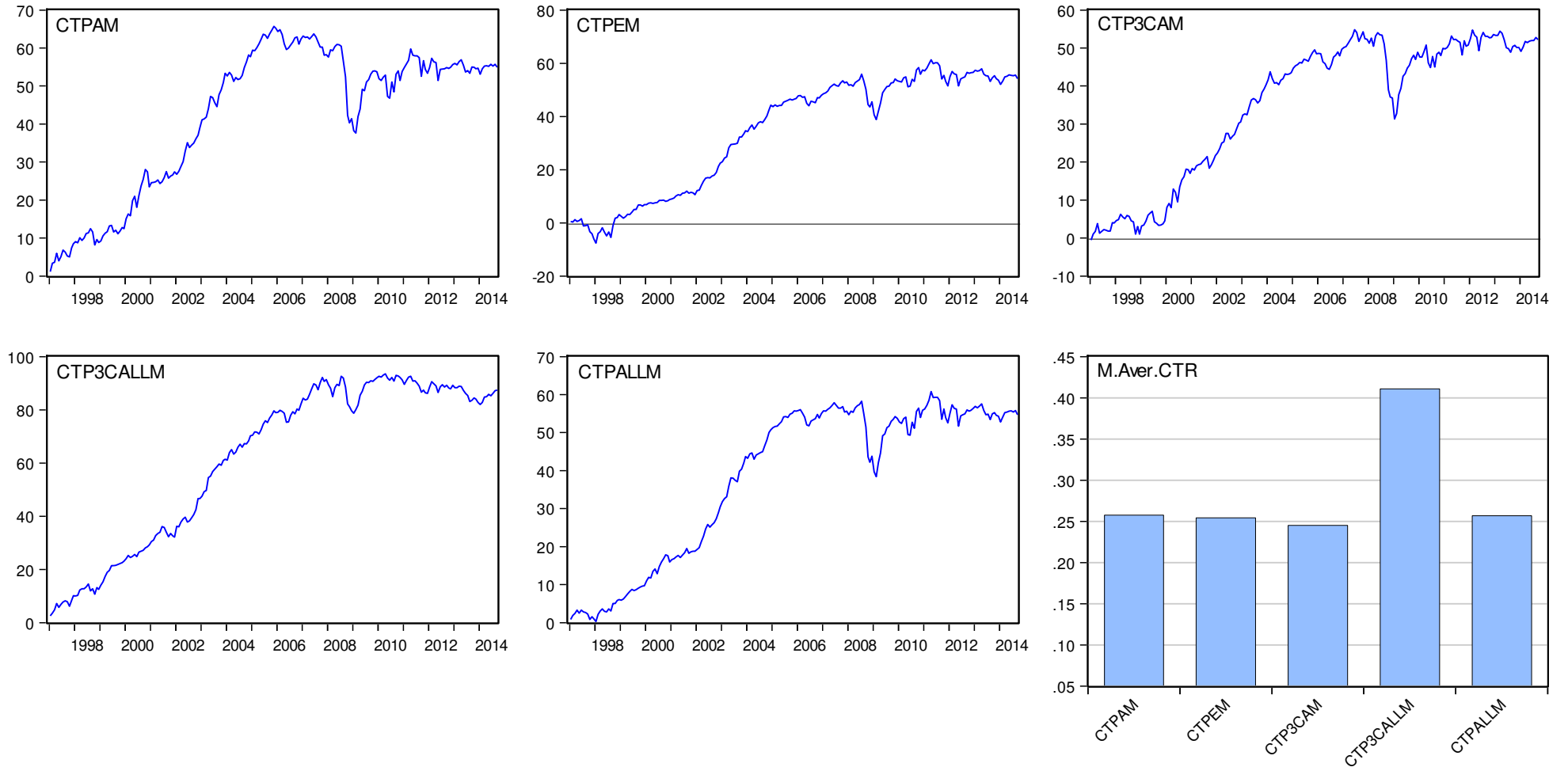
Whole Sample Period 1996M12-2014M09

	CTPAM	CTPEM	CTP3CAM	CTP3CALLM	CTPALLM
Mean%	3.09	3.05	2.94	4.93	3.08
Median	5.17	3.67	4.26	6.16	4.74
Std. Dev.	6.26	5.10	5.66	5.11	5.04
Skewness	-1.12	-0.69	-0.82	-0.45	-1.25
Kurtosis	8.34	5.63	6.35	4.76	8.85
F_AC	0.08	0.09	0.04	0.13	0.11
N	213	213	213	213	213
Sharpe Ratio	0.49	0.60	0.52	0.96	0.61

Notes: The table reports relevant descriptive statistics (annualized) for the monthly carry trade returns on the five equally-weighted carry trade portfolios (CTP). CTPAM portfolio is confined to advanced market (AM) currencies. For this portfolio, 1^M long (short) USD positions are taken against all other AM currencies which are at a forward premium (discount) against the USD at the end of every month. CTPEM Portfolio is confined to emerging market (EM) currencies. For this portfolio, 1^M long (short) USD positions are taken against all other EM currencies which are at a forward premium (discount) against the USD at the end of every month. CTP3CAM portfolio is confined to AM. For this portfolio, 1^M long (short) USD positions are taken against the three AM currencies which have the smallest (largest) forward premium (discount) against the USD at the end of every month. CTP3CALLM portfolio includes all market (ALLM) currencies. For this portfolio, 1^M long (short) USD positions are taken against the three currencies which have the smallest (largest) forward premium (discount) against the USD at the end of every month. CTPALLM portfolio includes ALLM currencies. For this portfolio, 1^M long (short) USD positions are taken against all other currencies which are at a forward premium (discount) against the USD at the end of every month. F_AC is the first order autocorrelation. N is the number of observations. For the calculation of the carry trade return see notes to table 1.

Figure 1

Cumulative Return of Carry Trade Portfolios



Notes: the figure depicts the cumulative monthly carry trade return for each carry trade portfolio. The bottom right graph depicts the monthly average carry trade return (M.Aver.CTR) for each portfolio over the whole sample period. For the definition of carry trade portfolios and the calculation of carry trade returns see notes to tables 3 and 4.

Table 5

Risk Factors - Descriptive Statistics

<u>Panel A: Descriptive Statistics</u>									
	<u>N</u>	<u>Mean</u>	<u>Median</u>	<u>Std. Dev.</u>	<u>Skew.</u>	<u>Kurt.</u>	<u>Min</u>	<u>Max</u>	<u>F_AC</u>
GFXV	214	0.42	0.40	0.14	2.54	13.63	0.19	1.37	0.75
VIX	214	21.55	20.21	8.28	1.75	8.09	10.82	62.64	0.88
GBAS	214	0.08	0.08	0.02	0.58	3.08	0.05	0.14	0.89
TED	214	0.51	0.39	0.42	2.62	13.79	0.12	3.38	0.87

<u>Panel B: Correlation Coefficients</u>									
	<u>B1: Variable Levels</u>					<u>B2: Variable Innovations</u>			
	<u>GFXV</u>	<u>VIX</u>	<u>GBAS</u>	<u>TED</u>		<u>GFXV</u>	<u>VIX</u>	<u>GBAS</u>	<u>TED</u>
<u>GFXV</u>	1.00	0.71	0.09	0.45	<u>GFXV</u>	1.00	0.55	0.20	0.39
<u>VIX</u>	0.71	1.00	0.26	0.52	<u>VIX</u>	0.55	1.00	0.14	0.44
<u>GBAS</u>	0.09	0.26	1.00	-0.06	<u>GBAS</u>	0.20	0.14	1.00	0.00
<u>TED</u>	0.45	0.52	-0.06	1.00	<u>TED</u>	0.39	0.44	0.00	1.00

Notes: the table reports relevant descriptive statistics for the monthly time-series of the risk factors (Panel A) and the correlation coefficients among

their levels and innovations (Panel B). GFXV is global foreign exchange volatility. It is calculated as, $GFXV_t = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{\kappa \in K_\tau} \left(\frac{|r_\tau^\kappa|}{K_\tau} \right) \right]$ where, $|r_\tau^\kappa|$

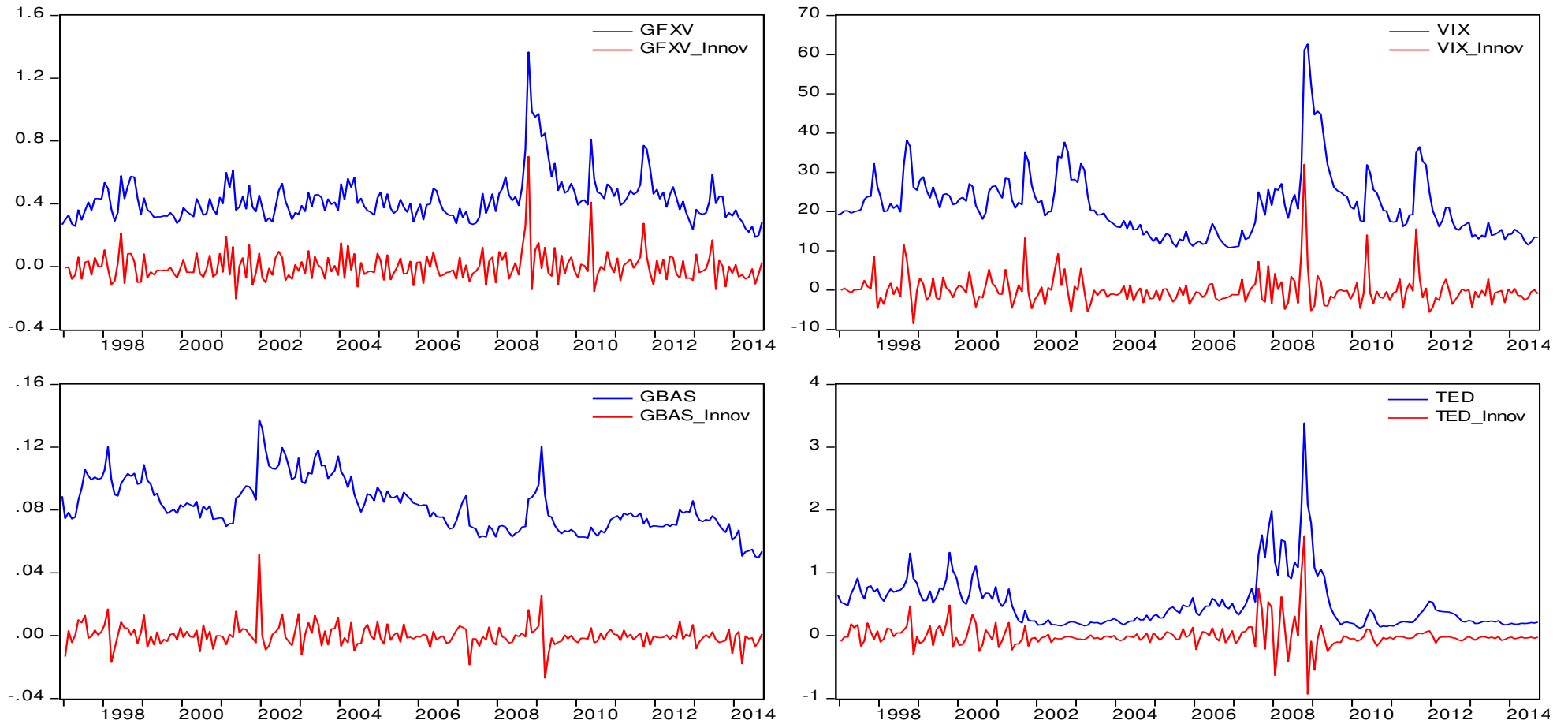
is the absolute daily log spot return for each currency κ on each day τ in the sample, K_τ is the number of included currencies on day τ , T_t is the

total number of trading days in month t . GBAS is global bid-ask spread. It is calculated as, $GBAS_t = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{\kappa \in K_\tau} \left(\frac{BAS_\tau^\kappa}{K_\tau} \right) \right]$ where, BAS_τ^κ is

the percentage of the bid-ask spread of currency κ on day τ . TED is TED spread. It is calculated as the difference between 3-month USD LIBOR rate and 3-month US Treasury bills interest rate. VIX is the CBOE volatility index. It is based on the prices of options on the S&P 500 index. N is the number of observations. F_AC is first-order autocorrelation.

Figure 2

Risk Factors and Risk Factors Innovations



Notes: the figure depicts the monthly time-series of the risk factors and their innovations (Innov). Innovations of the risk factors are calculated as the residuals which result from the estimation of AR(1) for the level of each risk factor. For the definitions of the risk factors see notes to table 5.

Table 6
Carry trades Performance Conditional on the Risk Factors Quartiles

		CTPAM	CTPEM	CTP3CAM	CTP3CAIIM	CTPALLM
GFXV	High	-4.56	-3.96	-7.08	-5.40	-4.32
	2	2.52	1.80	3.60	5.40	2.16
	3	8.64	6.96	8.40	8.64	7.80
	Low	5.76	7.32	6.72	11.04	6.48
VIX	High	-4.44	-3.60	-4.08	-2.40	-3.96
	2	5.40	3.24	2.64	2.40	4.32
	3	5.40	4.32	6.96	9.84	4.80
	Low	6.12	8.40	6.36	9.96	7.32
GBAS	High	1.20	-1.68	-0.24	0.72	-0.12
	2	1.56	3.60	0.00	4.44	2.52
	3	6.36	4.80	6.84	5.40	5.64
	Low	3.36	5.64	5.04	9.12	4.44
TED	High	-4.80	0.84	-3.84	2.16	-1.68
	2	6.48	3.00	4.32	4.92	4.68
	3	1.56	3.24	2.64	3.84	2.64
	Low	9.36	5.16	8.64	8.64	6.96

Notes: the table reports the (annualized) monthly average return (%) on each carry trade portfolio conditional on the four quartiles of the risk factors innovations. “High” represents the quartile of the highest values of the respective risk factor innovations. “Low” represents the quartile of the lowest values of the respective risk factor innovations. For the definition of carry trade portfolios and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 7

Regression of Carry Trade Return on Risk Factors: Portfolio of Advanced Market Currencies - CTPAM

	1	2	3	4	5	6	7	8	9	10
C	0.26** (2.17)	0.26** (2.17)	0.26* (1.82)	0.26** (2.09)	0.26** (2.31)	0.26** (2.27)	0.26** (2.37)	0.21** (2.08)	0.21** (2.01)	0.21** (2.12)
GFXV	-7.95*** (-3.53)				-6.18*** (-3.58)		-4.62*** (-3.24)	-3.80*** (-2.95)		-3.30*** (-2.64)
VIX		-0.18*** (-3.28)				-0.13*** (-2.87)	-0.09** (-2.11)		-0.06** (-1.97)	-0.03 (-1.10)
GBAS			-24.87 (-0.99)		-8.44 (-0.37)	-14.36 (-0.76)	-5.79 (-0.27)	0.31 (0.02)	-4.60 (-0.32)	1.00 (0.06)
TED				-2.98*** (-3.35)	-1.89*** (-3.12)	-1.87*** (-2.74)	-1.45** (-2.08)	-1.76*** (-3.01)	-1.90*** (-2.97)	-1.60** (-2.45)
DOLF								0.37*** (3.28)	0.38*** (3.44)	0.36*** (3.22)
\bar{R}^2	0.17	0.15	0.00	0.11	0.20	0.19	0.22	0.35	0.33	0.35

Notes: the table reports the OLS estimation of regressing the monthly carry trade return on CTPAM portfolio on the risk factors innovations. t-statistics based on HAC Newey-West robust standard errors are in parentheses. DOLF is the USD risk factor. It is the unconditional excess return on an equally-weighted portfolio of going short in the USD against all other currencies. It represents the risk premium on borrowing the USD and investing in foreign currencies regardless of the USD forward premium/discount. C is constant. ***, ** and * means significant at 1%, 5% and 10% significance level. For the definition of the carry trade portfolio and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 8

Regression of Carry Trade Return on Risk Factors: Portfolio of Emerging Market Currencies - CTPEM

	1	2	3	4	5	6	7	8	9	10
C	0.25*** (2.74)	0.25*** (2.76)	0.25** (2.38)	0.25** (2.43)	0.25*** (2.71)	0.25*** (2.72)	0.25*** (2.80)	0.18*** (3.28)	0.18*** (3.13)	0.18*** (3.29)
GFXV	-6.41*** (-5.66)				-6.14*** (-4.88)		-4.43*** (-3.55)	-2.40*** (-3.94)		-2.29*** (-3.54)
VIX		-0.14*** (-5.56)				-0.14*** (-5.98)	-0.09*** (-4.15)		-0.03** (-2.04)	-0.01 (-0.50)
GBAS			-40.94** (-2.19)		-24.46 (-1.25)	-29.78** (-1.96)	-21.55 (-1.21)	-10.68 (-1.41)	-14.41** (-2.38)	-10.53 (-1.40)
TED				-0.98 (-1.14)	0.11 (0.22)	0.19 (0.38)	0.59 (1.24)	0.31 (1.28)	0.14 (0.60)	0.34 (1.47)
DOLF								0.58*** (13.62)	0.59*** (13.05)	0.58*** (12.94)
\bar{R}^2	0.16	0.15	0.03	0.01	0.17	0.16	0.21	0.74	0.73	0.74

Notes: the table reports the OLS estimation of regressing the monthly carry trade return on CTPEM portfolio on the risk factors innovations. t-statistics based on HAC Newey-West robust standard errors are in parentheses. DOLF is the USD risk factor. It is the unconditional excess return on an equally-weighted portfolio of going short in the USD against all other currencies. It represents the risk premium on borrowing the USD and investing in foreign currencies regardless of the USD forward premium/discount. C is constant. ***, ** and * means significant at 1%, 5% and 10% significance level. For the definition of the carry trade portfolio and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 9

Regression of Carry Trade Return on Risk Factors: Portfolio of 3-Advanced Market Currencies - CTP3CAM

	1	2	3	4	5	6	7	8	9	10
C	0.25*** (2.47)	0.25*** (2.47)	0.25** (2.01)	0.25** (2.26)	0.25*** (2.60)	0.25*** (2.56)	0.25*** (2.69)	0.21** (2.33)	0.21** (2.24)	0.21** (2.40)
GFXV	-7.74*** (-5.19)				-6.30*** (-4.56)		-4.77*** (-3.54)	-4.54*** (-4.07)		-3.83*** (-3.05)
VIX		-0.17*** (-4.60)				-0.13*** (-3.78)	-0.08*** (-2.53)		-0.08*** (-2.75)	-0.05 (-1.48)
GBAS			-29.35 (-1.37)		-12.57 (-0.63)	-18.82 (-1.15)	-9.97 (-0.54)	-6.08 (-0.40)	-11.60 (-0.89)	-5.11 (-0.35)
TED				-2.55*** (-3.19)	-1.43* (-1.86)	-1.43** (-2.01)	-1.01 (-1.24)	-1.34* (-1.78)	-1.46** (-2.17)	-1.11 (-1.48)
DOLF								0.27*** (3.20)	0.28*** (3.20)	0.25*** (3.00)
\bar{R}^2	0.20	0.17	0.01	0.10	0.22	0.19	0.24	0.32	0.29	0.32

Notes: the table reports the OLS estimation of regressing the monthly carry trade return on CTP3CAM portfolio on the risk factors innovations. t-statistics based on HAC Newey-West robust standard errors are in parentheses. DOLF is the USD risk factor. It is the unconditional excess return on an equally-weighted portfolio of going short in the USD against all other currencies. It represents the risk premium on borrowing the USD and investing in foreign currencies regardless of the USD forward premium/discount. C is constant. ***, ** and * means significant at 1%, 5% and 10% significance level. For the definition of the carry trade portfolio and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 10

Regression of Carry Trade Return on Risk Factors: Portfolio of 3-All Market Currencies - CTP3CALLM

	1	2	3	4	5	6	7	8	9	10
C	0.41 ^{***} (4.19)	0.41 ^{***} (4.12)	0.41 ^{***} (3.57)	0.41 ^{***} (3.71)	0.41 ^{***} (4.18)	0.41 ^{***} (4.08)	0.41 ^{***} (4.27)	0.39 ^{***} (4.12)	0.39 ^{***} (3.97)	0.40 ^{***} (4.19)
GFXV	-7.13 ^{***} (-5.97)				-6.02 ^{***} (-5.27)		-4.38 ^{***} (-3.77)	-5.14 ^{***} (-4.45)		-4.00 ^{***} (-3.42)
VIX		-0.16 ^{***} (-6.81)				-0.14 ^{***} (-6.06)	-0.09 ^{***} (-4.02)		-0.11 ^{***} (-4.76)	-0.07 ^{***} (-3.29)
GBAS			-38.12 ^{***} (-2.75)		-22.05 [*] (-1.88)	-27.40 ^{***} (-3.08)	-19.27 [*] (-1.81)	-18.84 [*] (-1.81)	-24.05 ^{***} (-2.71)	-17.27 [*] (-1.73)
TED				-1.96 ^{***} (-3.19)	-0.89 ^{**} (-2.13)	-0.83 ^{**} (-2.19)	-0.44 (-1.02)	-0.85 ^{**} (-2.01)	-0.84 ^{**} (-2.25)	-0.48 (-1.13)
DOLF								0.14 ^{***} (2.77)	0.13 ^{***} (2.50)	0.10 ^{**} (2.08)
\bar{R}^2	0.20	0.19	0.03	0.07	0.22	0.20	0.25	0.25	0.23	0.27

Notes: the table reports the OLS estimation of regressing the monthly carry trade return on CTP3CALLM portfolio on the risk factors innovations. t-statistics based on HAC Newey-West robust standard errors are in parentheses. DOLF is the USD risk factor. It is the unconditional excess return on an equally-weighted portfolio of going short in the USD against all other currencies. It represents the risk premium on borrowing the USD and investing in foreign currencies regardless of the USD forward premium/discount. C is constant. ***, ** and * means significant at 1%, 5% and 10% significance level. For the definition of the carry trade portfolio and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 11

Regression of Carry Trade Return on Risk Factors: Portfolio of All Market Currencies - CTPALLM

	1	2	3	4	5	6	7	8	9	10
C	0.26*** (2.74)	0.26*** (2.75)	0.26** (2.25)	0.26*** (2.46)	0.26*** (2.81)	0.26*** (2.78)	0.26*** (2.91)	0.20*** (2.97)	0.20*** (2.80)	0.20*** (3.01)
GFXV	-7.16*** (-4.49)				-6.18*** (-4.42)		-4.54*** (-3.74)	-3.08*** (-3.91)		-2.79*** (-3.57)
VIX		-0.16*** (-4.24)				-0.14*** (-4.23)	-0.09*** (-3.27)		-0.04*** (-2.47)	-0.02 (-1.20)
GBAS			-32.85 (-1.56)		-16.32 (-0.80)	-21.96 (-1.37)	-13.53 (-0.73)	-4.90 (-0.47)	-9.23 (-1.05)	-4.50 (-0.44)
TED				-1.93** (-2.28)	-0.83* (-1.75)	-0.78 (-1.54)	-0.37 (-0.75)	-0.67* (-1.92)	-0.82** (-2.23)	-0.57 (-1.51)
DOLF								0.48*** (7.12)	0.49*** (7.31)	0.47*** (7.04)
\bar{R}^2	0.21	0.19	0.02	0.07	0.22	0.20	0.26	0.62	0.60	0.62

Notes: the table reports the OLS estimation of regressing the monthly carry trade return on CTPALLM portfolio on the risk factors innovations. t-statistics based on HAC Newey-West robust standard errors are in parentheses. DOLF is the USD risk factor. It is the unconditional excess return on an equally-weighted portfolio of going short in the USD against all other currencies. It represents the risk premium on borrowing the USD and investing in foreign currencies regardless of the USD forward premium/discount. C is constant. ***, ** and * means significant at 1%, 5% and 10% significance level. For the definition of the carry trade portfolio and the calculation of carry trade returns see notes to tables 3 and 4. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2.

Table 12

Currency-Specific Carry Return and Risk Factors

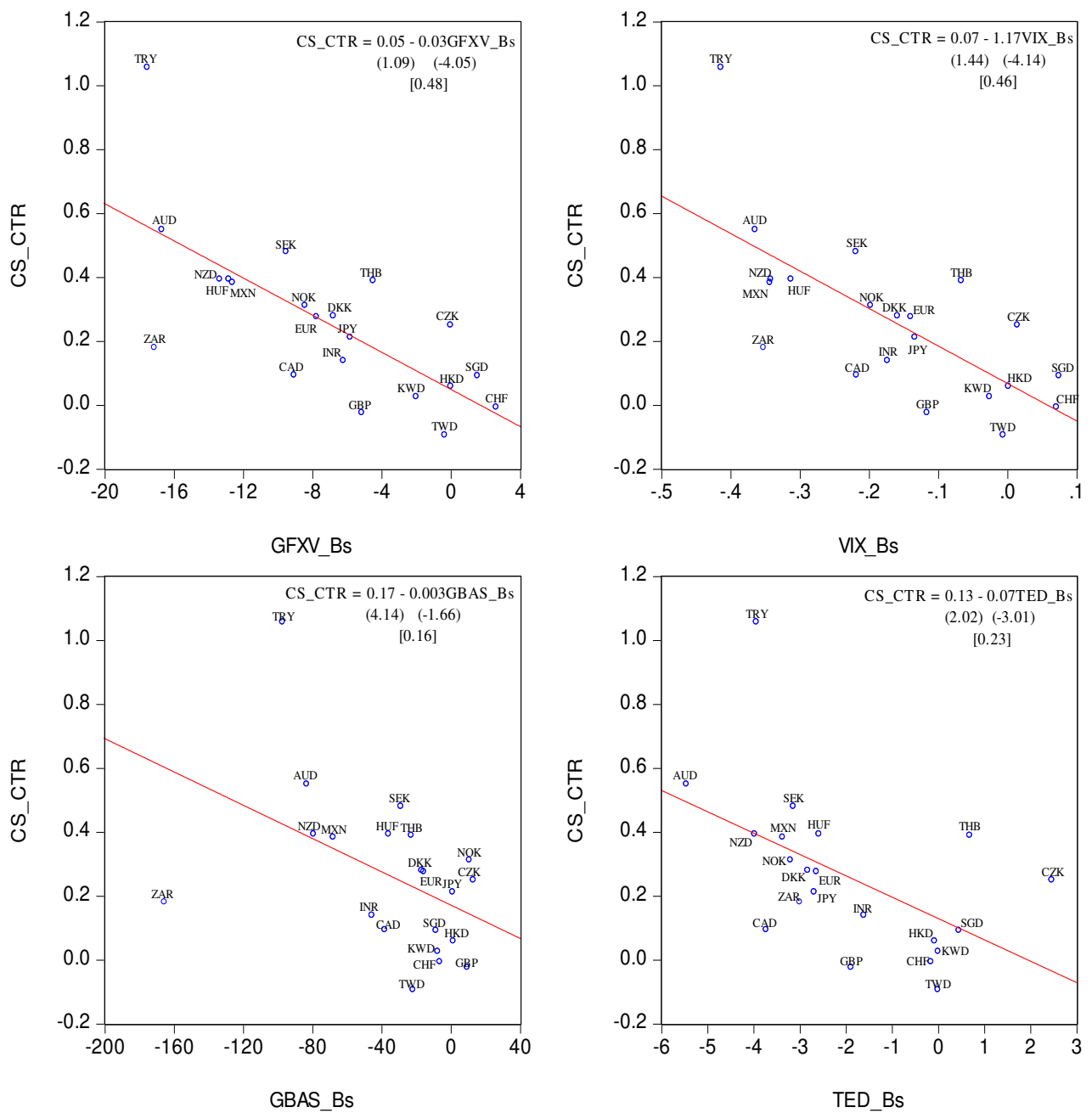
		GFXV			VIX			GBAS			TED		
		β	t-stat	\bar{R}^2	β	t-stat	\bar{R}^2	β	t-stat	\bar{R}^2	β	t-stat	\bar{R}^2
Panel A: AM	AUD	-16.71***	(-4.66)	0.18	-0.36***	(-4.00)	0.15	-83.39**	(-2.06)	0.02	-5.46***	(-3.22)	0.09
	CAD	-9.06***	(-3.29)	0.11	-0.22***	(-3.12)	0.12	-38.28	(-1.32)	0.01	-3.73***	(-4.68)	0.09
	CHF	2.61	(0.91)	0.00	0.07	(1.08)	0.00	-6.45	(-0.25)	0.00	-0.16	(-0.16)	0.00
	DKK	-6.80**	(-2.15)	0.04	-0.16**	(-2.26)	0.04	-17.04	(-0.59)	0.00	-2.83**	(-2.28)	0.04
	EUR	-7.76**	(-2.47)	0.06	-0.14	(-1.60)	0.03	-15.78	(-0.49)	0.00	-2.64*	(-1.91)	0.03
	GBP	-5.15*	(-1.78)	0.04	-0.12*	(-1.66)	0.03	9.40	(0.33)	0.00	-1.89**	(-2.18)	0.02
	JPY	-5.82***	(-3.07)	0.03	-0.13**	(-2.51)	0.02	0.90	(0.02)	0.00	-2.69**	(-2.40)	0.03
	NOK	-8.43**	(-2.06)	0.06	-0.20*	(-1.91)	0.05	10.63	(0.29)	0.00	-3.20**	(-2.01)	0.04
	NZD	-13.36***	(-4.98)	0.10	-0.34***	(-5.94)	0.12	-79.35	(-1.64)	0.02	-3.98**	(-2.51)	0.04
	SEK	-9.53***	(-3.02)	0.07	-0.22***	(-3.05)	0.07	-29.00	(-0.54)	0.00	-3.14**	(-2.11)	0.04
Panel Reg.		-8.00***	(-11.32)	0.06	-0.18***	(-10.86)	0.05	-24.97**	(-2.58)	0.00	-2.97***	(-9.24)	0.04
Panel B: EM	CZK	-0.03	(-0.01)	0.00	0.01	(0.16)	0.00	12.78	(0.31)	0.00	2.46*	(1.67)	0.01
	HKD	-0.02	(-0.12)	0.00	0.00	(0.26)	0.00	1.28	(1.06)	0.00	-0.08	(-1.19)	0.01
	HUF	-12.84***	(-2.97)	0.08	-0.31***	(-4.07)	0.09	-36.08	(-0.75)	0.00	-2.59	(-1.08)	0.01
	INR	-6.22	(-4.20)	0.07	-0.17***	(-5.36)	0.10	-45.77**	(-2.05)	0.02	-1.61*	(-1.96)	0.02
	KWD	-2.01*	(-1.77)	0.07	-0.03	(-1.26)	0.02	-7.72	(-0.95)	0.00	0.00	(-0.01)	0.00
	MXN	-12.63***	(-4.46)	0.16	-0.34***	(-7.08)	0.22	-68.12	(-1.56)	0.02	-3.37**	(-2.40)	0.05
	SGD	1.53	(0.91)	0.00	0.07**	(2.45)	0.02	-8.73	(-0.42)	0.00	0.45	(0.64)	0.00
	THB	-4.50***	(-2.84)	0.01	-0.07*	(-1.85)	0.00	-22.92	(-0.71)	0.00	0.68	(0.62)	0.00
	TRY	-17.54***	(-4.83)	0.16	-0.41***	(-4.87)	0.16	-97.34*	(-1.76)	0.02	-3.94*	(-1.90)	0.04
	TWD	-0.36	(-0.22)	0.00	-0.01	(-0.18)	0.00	-21.98	(-1.16)	0.00	-0.01	(-0.01)	0.00
ZAR	-17.13***	(-5.21)	0.11	-0.35***	(-4.37)	0.09	-165.60***	(-3.40)	0.06	-3.00	(-1.38)	0.01	
Panel Reg.		-6.46***	(-9.87)	0.04	-0.14***	(-9.30)	0.04	-41.03***	(-4.57)	0.01	-0.99***	(-3.29)	0.00
Panel Reg. All		-7.20***	(-14.98)	0.05	-0.16***	(-14.24)	0.04	-33.26***	(-5.05)	0.01	-1.94***	(-8.79)	0.02

Notes: the table reports time-series OLS estimation results (HAC Newey-West standard errors) where currency-specific carry returns are regressed against risk factors individually over the whole sample period. β is the slope coefficient for each risk factor. Regression specification includes constant but not reported. ***, ** and * means significant at 1%, 5% and 10% significance level. For the calculation of carry trade returns see notes to table 3. For the definitions of the risk factors and their innovations see notes to table 5 and figure 2. Panel Reg. denotes to panel regression estimation results.

Figure 3

Cross-Section Regression of the Average Currency-Specific Carry Return Versus Currency-Specific Carry

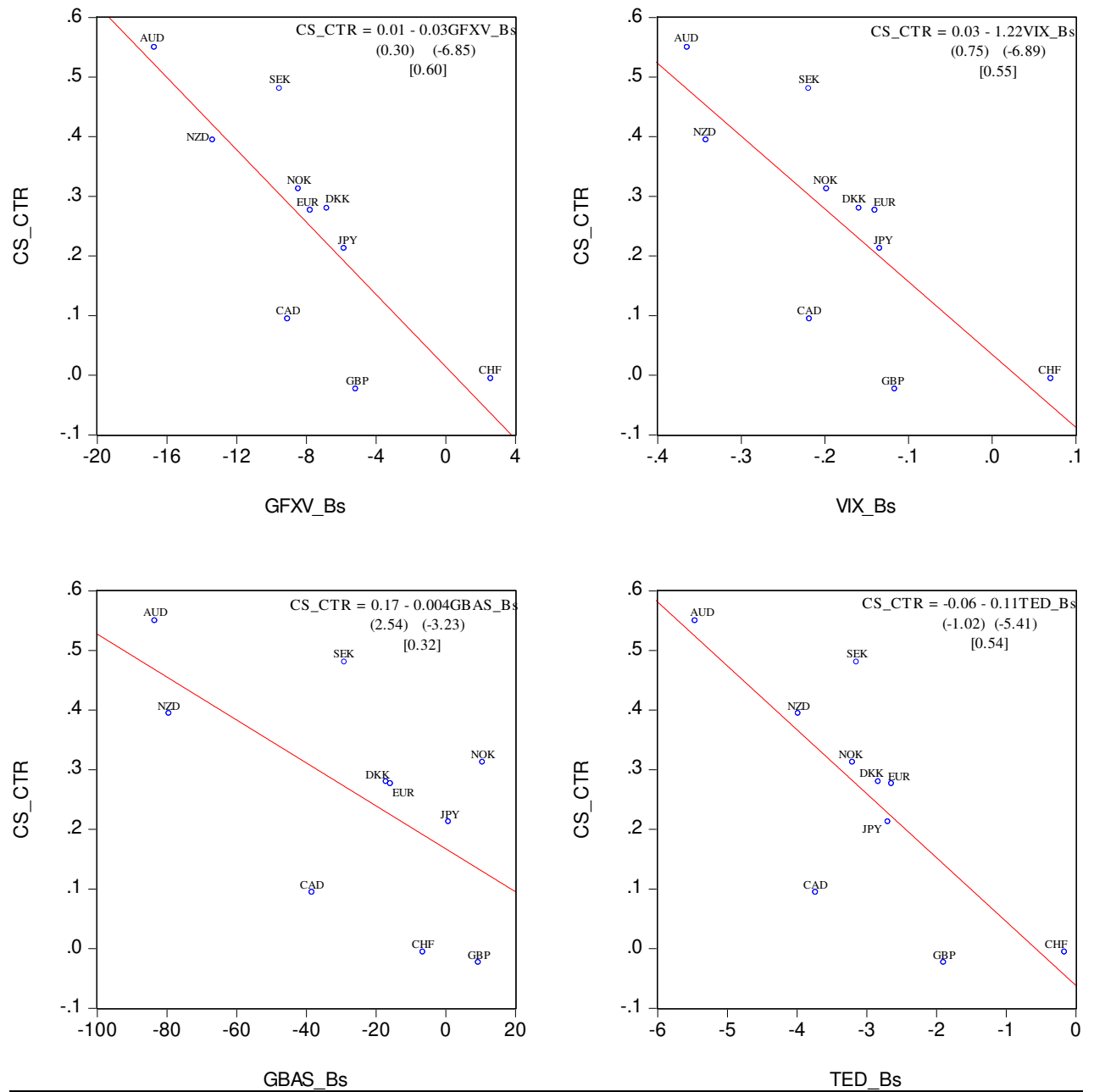
Return Betas



Notes: the figure summarises the cross-section regressions of the average currency-specific carry returns on the currency-specific carry return Betas. The vertical axis is the average currency-specific carry return over the whole sample period. The horizontal axis is the slope coefficients (Betas) which result from the time-series regressions of currency-specific carry return on the risk factors over the whole sample period. For the definition of currencies and the calculation of carry returns see notes to table 3. For the definition of risk factors see notes to table 5 and figure 2. t-statistics based on HAC Newey-West robust standard errors are in parentheses. \bar{R}^2 in brackets.

Figure 4

Cross-Section Regression of the Average Currency-Specific Carry Return Versus Currency-Specific Carry Return Betas: AM Currencies



Notes: the figure summarises the cross-section regressions of the average currency-specific carry returns on the currency-specific carry return Betas. The vertical axis is the average currency-specific carry return over the whole sample period. The horizontal axis is the slope coefficients (Betas) which result from the time-series regressions of currency-specific carry return on the risk factors over the whole sample period. For the definition of currencies and the calculation of carry returns see notes to table 3. For the definition of risk factors see notes to table 5 and figure 2. t-statistics based on HAC Newey-West robust standard errors are in parentheses. \bar{R}^2 in brackets.

Table 13

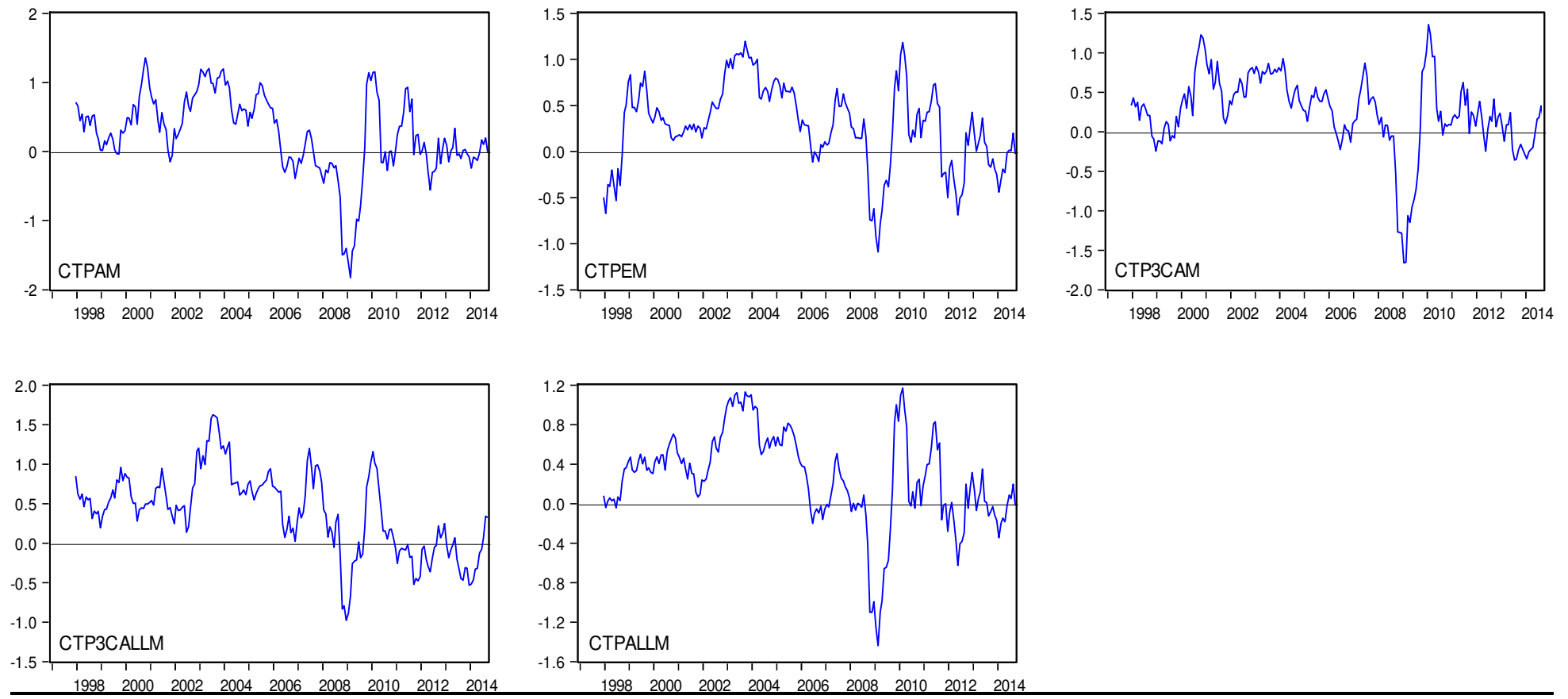
Carry Trade Portfolios Performance – The Effect of the Recent Global Financial Crisis, 2007-2008

	N	Mean%	Median	Std. Dev.	Skew.	Kurt.	SR	SR_Diff%
<u>Panel A: 1996M12-2006M12</u>								
CTPAM	120	6.24	8.32	4.83	-0.44	3.49	1.29	163.27
CTPEM	120	4.80	3.82	3.93	0.15	4.74	1.22	103.33
CTP3CAM	120	4.97	5.44	4.51	-0.09	4.37	1.10	111.54
CTP3CALLM	120	8.22	9.17	4.50	-0.12	4.15	1.83	90.63
CTPALLM	120	5.50	6.00	3.11	-0.13	3.34	1.77	190.16
<u>Panel B: 2007M01-2014M09</u>								
CTPAM	93	-0.96	0.49	7.59	-1.03	7.43	-0.13	-126.53
CTPEM	93	0.79	2.92	6.25	-0.73	4.40	0.13	-78.35
CTP3CAM	93	0.33	1.00	6.82	-0.86	5.44	0.05	-90.38
CTP3CALLM	93	0.68	0.85	5.60	-0.47	4.63	0.12	-87.50
CTPALLM	93	-0.04	3.29	6.67	-0.91	5.85	-0.01	-101.64
<u>Panel C: Excl. 2008M09-2009M09</u>								
CTPAM	200	3.50	5.17	5.46	-0.51	4.65	0.64	30.61
CTPEM	200	3.30	3.66	4.55	-0.41	5.22	0.72	20.00
CTP3CAM	200	3.37	4.22	4.94	-0.23	4.03	0.68	30.77
CTP3CALLM	200	5.31	6.11	4.75	-0.03	3.27	1.12	16.67
CTPALLM	200	3.40	4.63	4.27	-0.79	6.46	0.80	31.15

Notes: The table reports relevant descriptive statistics (annualized) for the monthly carry trade returns on the different equally-weighted carry trade portfolios (CTP) over different sub-sample periods. In Panel C the period 2008M09-2009M09 is excluded from the whole sample period. The last column reports the difference between the Sharpe Ratio (SR) over the respective sub-sample period and the SR over the whole sample period as reported in table 2. N is the number of observations. For the definition of carry trade portfolios and the calculation of carry trade returns see notes to tables 3 and 4.

Figure 5

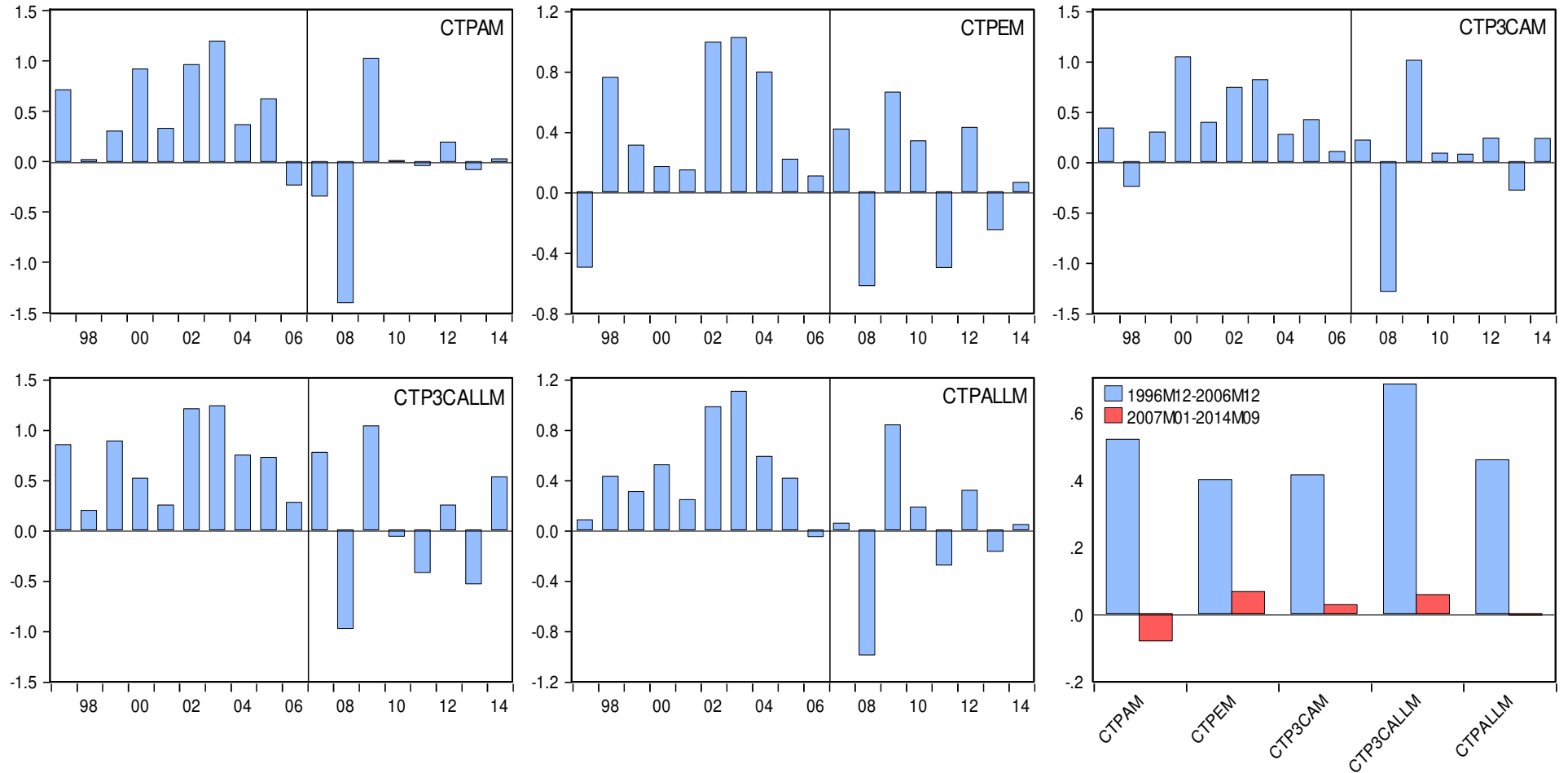
Rolling Annual Performance of Carry Trade Portfolios



Notes: the figure depicts the rolling annual performance of the different equally-weighted carry trade portfolios. The observations are the rolling average of the monthly carry trade return over 12 month window size. The first observation is the monthly average carry trade return over the period 1997M01-1997M12. The last observation is the monthly average carry trade return over the period 2013M10-2014M09. For the definition of carry trade portfolios and the calculation of carry trade returns see notes to tables 3 and 4.

Figure 6

Year-by-Year Average Return of Carry Trade Portfolios



Notes: the figure depicts the monthly average of carry trade return on the different equally-weighted portfolios for every year of the sample period. The bottom right graph depicts the monthly average of carry trade return over the two sub-periods of 1996M12-2006M12 and 2007M01-2014M09. For the definition of carry trade portfolios and the calculation of carry trade returns see notes to tables 3 and 4.

Table 14

1-Month Unbiasedness Hypothesis Test; $s_{t+1M} - s_t = \alpha + \beta(f_t^{1M} - s_t) + \varepsilon_{t+1M}$

		Panel A				Panel B				Panel C						
		Whole Period 1996M12-2014M09 [§]				Non-crisis Period 1996M12-2006M12 [§]				Crisis Period 2007M01-2014M09						
		<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2
Advanced Markets	AUD	213	-2.14 (1.469)	4.58**		0.00	121	-4.65** (1.914)	8.71***		0.05	92	3.11 (4.153)	0.26		-0.01
	CAD	213	-0.69 (1.627)	1.08		0.00	121	-3.33** (1.675)	6.68**		0.02	92	12.57*** (4.534)	6.51**		0.03
	CHF	213	-2.01 (1.372)	4.80**		0.00	121	-3.97** (1.786)	7.74***		0.03	92	4.49 (3.112)	1.26		0.00
	DKK	213	-1.61 (1.894)	1.90		0.00	121	-4.51** (1.749)	9.94***		0.04	92	7.62** (3.642)	3.31*		0.02
	EURO	188	-1.22 (2.201)	1.02		0.00	96	-4.61** (1.917)	8.56***		0.05	92	13.36*** (5.014)	6.07**		0.06
	GBP	213	1.23 (2.277)	0.10		0.00	121	-1.69 (1.813)	2.20		0.00	92	15.34** (7.647)	3.52*		0.11
	JPY	213	0.40 (1.219)	0.24		0.00	121	-1.33 (1.727)	1.82		0.00	92	5.03** (2.485)	2.63		0.04
	NOK	213	-1.04 (1.378)	2.20		0.00	121	-2.49** (1.166)	8.94***		0.03	92	10.50** (4.585)	4.30**		0.05
	NZD	213	0.36 (2.470)	0.07		0.00	121	-3.84** (1.848)	6.85**		0.03	92	17.90*** (6.619)	6.52**		0.11
	SEK	213	-1.38 (1.658)	2.06		0.00	121	-3.81*** (1.434)	11.27***		0.04	92	6.98* (3.897)	2.35		0.02
Average			-0.81			0.00		-3.42			0.03		9.69			0.04
Emerging Markets	CZK	213	0.67 (0.493)	0.45		0.00	121	0.56 (0.475)	0.85		0.00	92	8.18* (4.729)	2.31		0.02
	HKD	213	-0.04 (0.042)	>99***		0.00	121	-0.06 (0.042)	>99***		0.00	92	0.13 (0.453)	3.72*		-0.01
	HUF	203	-0.62 (0.857)	3.60*		0.00	111	0.16 (0.821)	1.04		-0.01	92	-4.38 (3.041)	3.13*		0.00
	INR	203	0.10 (0.656)	1.89		0.00	111	-0.52 (0.627)	5.87**		0.00	92	0.30 (1.130)	0.38		-0.01
	KWD	213	2.91*** (0.634)	9.12***		0.17	121	0.34 (0.585)	1.29		-0.01	92	3.36*** (0.544)	18.92***		0.22
	MXN	213	-0.07 (0.318)	11.39***		0.00	121	-0.31 (0.344)	14.57***		0.00	92	2.66 (2.616)	0.40		0.01
	SGD	213	-0.03 (0.886)	1.34		0.00	121	0.11 (1.012)	0.77		-0.01	92	0.90 (2.254)	0.00		-0.01
	THB	213	0.96 (0.688)	0.00		0.01	121	0.91 (0.682)	0.02		0.01	92	1.38 (1.241)	0.09		0.00
	TRY	213	-0.02 (0.032)	>99***		0.00	121	-0.01(0.030)	>99***		-0.01	92	-0.92 (1.842)	1.08		-0.01
	TWD	213	0.54 (0.335)	1.92		0.00	121	0.25 (0.397)	3.55*		-0.01	92	0.84 (0.529)	0.09		0.01
ZAR	213	-1.97 (1.352)	4.83**		0.01	121	-2.06 (1.477)	4.29**		0.01	92	-1.80 (4.284)	0.43		-0.01	
Average			0.22			0.02		-0.06			0.00		0.97			0.02
Average All			-0.27			0.01		-1.66			0.01		5.12			0.02

Notes: OLS estimates of the regression of 1-month spot exchange rate changes on 1-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. *N* is the number of monthly observations. *F* is the *F*-statistic of the null hypothesis that $\beta=1$. ***, ** and * denote the significance of β and the rejection of the null hypothesis of $\beta=1$ at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1-month spot rate changes end at 2014M08. [§]: except EURO from 1999M01, and HUF and INR from 1997M10.

Table 15

3-Month Unbiasedness Hypothesis Test; $s_{t+3M} - s_t = \alpha + \beta(f_t^{3M} - s_t) + \varepsilon_{t+3M}$

	Panel A				Panel B				Panel C				
	Whole Period 1996M12-2014M09 [§]				Non-crisis Period 1996M12-2006M12 [§]				Crisis Period 2007M01-2014M09				
	<i>N</i>	β	<i>F</i> $\beta = 1$	\bar{R}^2	<i>N</i>	β	<i>F</i> $\beta = 1$	\bar{R}^2	<i>N</i>	β	<i>F</i> $\beta = 1$	\bar{R}^2	
Advanced Markets	AUD	211	-1.75 (1.772)	2.40	0.01	121	-4.96*** (1.845)	10.44***	0.17	90	6.77 (4.401)	1.72	0.04
	CAD	211	-1.22 (1.516)	2.15	0.00	121	-3.69** (1.480)	10.03***	0.09	90	8.74 (5.677)	1.86	0.06
	CHF	211	-1.70 (1.283)	4.43**	0.01	121	-4.10*** (1.528)	11.16***	0.09	90	6.72** (3.005)	3.62*	0.07
	DKK	211	-1.64 (1.959)	1.82	0.01	121	-4.68*** (1.520)	13.95***	0.12	90	8.99** (4.057)	3.88*	0.13
	EURO	186	-1.62 (2.107)	1.55	0.01	96	-4.89*** (1.592)	13.68***	0.14	90	12.20*** (4.254)	6.94***	0.17
	GBP	211	0.05 (1.844)	0.27	0.00	121	-2.20 (1.576)	4.12**	0.03	90	10.63** (5.042)	3.64*	0.12
	JPY	211	0.19 (1.128)	0.51	0.00	121	-1.46 (1.564)	2.47	0.01	90	4.63** (2.147)	2.86*	0.09
	NOK	211	-0.60 (1.418)	1.28	0.00	121	-2.25** (1.062)	9.35***	0.07	90	13.02** (5.287)	5.16**	0.21
	NZD	211	-0.39 (2.448)	0.32	0.00	121	-4.08** (1.676)	9.17***	0.09	90	16.02*** (5.781)	6.75**	0.28
	SEK	211	-1.41 (1.550)	2.41	0.01	121	-4.10*** (1.219)	17.47***	0.14	90	7.72** (3.409)	3.89*	0.09
Average		-1.01		0.01		-3.64		0.10		9.54		0.13	
Emerging Markets	CZK	211	0.66 (0.707)	0.23	0.00	121	0.59 (0.681)	0.37	0.00	90	6.34 (4.085)	1.71	0.04
	HKD	211	0.00 (0.046)	>99***	0.00	121	-0.04 (0.043)	>99***	0.00	90	0.71 (0.479)	0.36	0.05
	HUF	201	-0.18 (0.729)	2.6	0.00	111	0.29 (0.765)	0.86	-0.01	90	-1.18 (3.826)	0.33	-0.01
	INR	201	0.44 (0.631)	0.78	0.00	111	-0.19 (0.541)	4.82**	-0.01	90	0.75 (1.091)	0.05	0.00
	KWD	211	2.18** (0.699)	2.83*	0.24	121	-0.09 (0.479)	5.17**	-0.01	90	2.62*** (0.746)	4.71**	0.33
	MXN	211	-0.02 (0.302)	11.32***	0.00	121	-0.22 (0.310)	15.55***	0.00	90	3.13 (2.998)	0.51	0.03
	SGD	211	-0.82 (1.252)	2.11	0.00	121	-0.61 (1.497)	1.16	-0.01	90	0.63 (3.208)	0.01	-0.01
	THB	211	1.18 (1.674)	0.01	0.03	121	1.10 (1.755)	0.00	0.02	90	1.62 (1.116)	0.31	0.03
	TRY	211	0.09 (0.105)	74.53***	0.01	121	0.08 (0.096)	92.25***	0.01	90	-0.12 (2.159)	0.27	-0.01
	TWD	211	0.17 (0.542)	2.32	0.00	121	-0.29 (0.652)	3.92*	-0.01	90	0.69 (0.678)	0.21	0.00
ZAR	211	-2.58** (1.109)	10.39***	0.04	121	-3.03*** (1.143)	12.42***	0.09	90	0.05 (4.679)	0.04	-0.01	
Average		0.10		0.03		-0.22		0.01		1.39		0.05	
Average All		-0.43		0.02		-1.85		0.05		5.27		0.08	

Notes: OLS estimates of the regression of 3-month spot exchange rate changes on 3-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. *N* is the number of monthly observations. *F* is the *F*-statistic. Note that the series of monthly observations of the 3-month spot rate changes end at 2014M06. [§]: except EURO from 1999M01, and HUF and INR from 1997M10. Everything else is the same as in notes to Table 14.

Table 16

6-Month Unbiasedness Hypothesis Test; $s_{t+6M} - s_t = \alpha + \beta(f_t^{6M} - s_t) + \varepsilon_{t+6M}$

		Panel A Whole Period 1996M12-2014M09 [§]				Panel B Non-crisis Period 1996M12-2006M12 [§]				Panel C Crisis Period 2007M01-2014M09			
		<i>N</i>	β	<i>F</i> $\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i> $\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i> $\beta=1$	\bar{R}^2
Advanced Markets	AUD	208	-1.34 (1.701)	1.89	0.01	121	-4.95*** (1.549)	14.78***	0.30	87	8.57** (4.152)	3.33*	0.14
	CAD	208	-0.72 (1.437)	1.44	0.00	121	-3.60*** (1.230)	13.98***	0.17	87	10.80*** (3.145)	9.71***	0.17
	CHF	208	-1.88* (1.094)	6.92***	0.04	121	-4.07*** (1.129)	20.17***	0.21	87	7.28** (2.735)	5.27**	0.13
	DKK	208	-1.78 (1.769)	2.47	0.02	121	-4.80*** (1.204)	23.16***	0.25	87	9.40*** (3.021)	7.73***	0.23
	EURO	183	-1.58 (1.914)	1.81	0.01	96	-4.98*** (1.144)	27.32***	0.32	87	12.68*** (2.319)	25.36***	0.33
	GBP	208	1.24 (2.189)	0.01	0.01	121	-2.00 (1.349)	4.95**	0.06	87	16.04*** (4.145)	13.17***	0.47
	JPY	208	-0.19 (0.980)	1.47	0.00	121	-1.78 (1.198)	5.38**	0.03	87	4.34*** (1.382)	5.83**	0.15
	NOK	208	-0.35 (1.302)	1.07	0.00	121	-2.14** (0.875)	12.88***	0.15	87	14.53*** (3.902)	12.02***	0.44
	NZD	208	-0.78 (2.544)	0.49	0.00	121	-4.86*** (1.321)	19.64***	0.20	87	16.29*** (3.941)	15.05***	0.48
	SEK	208	-1.01 (1.560)	1.65	0.00	121	-4.08*** (1.075)	22.32***	0.26	87	9.98*** (3.427)	6.87**	0.25
	Average			-0.94		0.01		-3.73		0.20		11.00	
Emerging Markets	CZK	208	0.76 (0.781)	0.09	0.01	121	0.60 (0.737)	0.30	0.01	87	8.79*** (3.271)	5.67**	0.14
	HKD	208	0.04 (0.033)	>99***	0.00	121	0.00 (0.033)	>99***	-0.01	87	0.68 (0.322)	1.00	0.14
	HUF	198	0.31 (0.620)	1.25	0.00	111	0.60 (0.675)	0.35	0.01	87	1.88 (3.661)	0.06	0.00
	INR	198	0.42 (0.586)	0.97	0.00	111	0.01 (0.433)	5.21**	-0.01	87	0.46 (1.126)	0.23	-0.01
	MXN	208	-0.04 (0.280)	13.75***	0.00	121	-0.16 (0.279)	17.18***	0.00	87	1.33 (2.459)	0.02	0.00
	SGD	208	-0.70 (0.656)	6.72**	0.01	121	-0.56 (0.551)	7.99***	0.00	87	0.52 (2.132)	0.05	-0.01
	THB	208	0.69 (1.628)	0.04	0.01	121	0.58 (1.701)	0.06	0.00	87	1.18 (1.149)	0.02	0.02
	TRY	208	0.34 (0.121)	29.67***	0.12	121	0.28 (0.122)	34.46***	0.10	87	0.07 (1.757)	0.28	-0.01
	TWD	208	0.20 (0.546)	2.16	0.00	121	-0.25 (0.593)	4.44**	0.00	87	0.58 (0.776)	0.30	0.00
	ZAR	208	-2.51** (1.141)	9.48***	0.07	121	-2.98** (1.161)	11.75***	0.15	87	0.36 (4.165)	0.02	-0.01
Average			-0.05		0.02		-0.19		0.03		1.59		0.03
Average All			-0.50		0.02		-1.96		0.11		6.29		0.15

Notes: OLS estimates of the regression of 6-month spot exchange rate changes on 6-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. *F* is the *F*-statistic. *N* is the number of monthly observations. Note that the series of monthly observations of the 6-month spot rate changes end at 2014M03. [§]: except EURO from 1999M01, and HUF and INR from 1997M10. Everything else is the same as in notes to Table 14.

Table 17

12-Month Unbiasedness Hypothesis Test; $s_{t+12M} - s_t = \alpha + \beta(f_t^{12M} - s_t) + \varepsilon_{t+12M}$

		Panel A				Panel B				Panel C						
		Whole Period 1996M12-2014M09 [§]				Non-crisis Period 1996M12-2006M12 [§]				Crisis Period 2007M01-2014M09						
		<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2	<i>N</i>	β	<i>F</i>	$\beta=1$	\bar{R}^2
Advanced Markets	AUD	202	-1.55 (1.134)	5.07**		0.03	121	-4.79*** (1.133)	26.09***		0.39	81	4.86* (2.582)	2.24		0.11
	CAD	202	-0.78 (1.244)	2.05		0.00	121	-3.75*** (0.985)	23.20***		0.31	81	9.14*** (1.884)	18.67***		0.29
	CHF	202	-2.18*** (0.829)	14.73***		0.10	121	-4.04*** (0.778)	42.01***		0.38	81	6.08*** (1.520)	11.16***		0.16
	DKK	202	-1.88 (1.340)	4.63**		0.05	121	-4.72*** (0.958)	35.71***		0.37	81	7.80*** (1.424)	22.82***		0.39
	EURO	177	-1.75 (1.477)	3.46*		0.04	96	-4.86*** (0.919)	40.69***		0.43	81	9.36*** (1.322)	39.97***		0.47
	GBP	202	0.64 (1.583)	0.05		0.00	121	-1.73 (1.137)	5.74**		0.07	81	12.20*** (1.944)	33.23***		0.66
	JPY	202	-0.27 (0.831)	2.35		0.00	121	-1.93** (0.800)	13.44***		0.10	81	4.81*** (1.082)	12.37***		0.27
	NOK	202	-0.62 (0.900)	3.24*		0.01	121	-2.00*** (0.726)	17.07***		0.19	81	9.37*** (1.327)	39.79***		0.44
	NZD	202	-1.93 (2.136)	1.88		0.03	121	-5.60*** (1.001)	43.42***		0.34	81	11.69*** (1.864)	32.89***		0.56
	SEK	202	-1.28 (1.228)	3.45*		0.02	121	-3.99*** (0.989)	25.53***		0.35	81	7.71*** (1.738)	14.92***		0.36
Average			-1.16			0.03		-3.74			0.29		8.30			0.37
Emerging Markets	CZK	202	0.92* (0.552)	0.02		0.04	121	0.83* (0.480)	0.12		0.06	81	9.86*** (1.736)	26.04***		0.42
	HKD	202	0.06** (0.023)	>99***		0.07	121	0.04 (0.024)	>99***		0.04	81	0.66*** (0.128)	7.13***		0.32
	HUF	192	1.02* (0.524)	0		0.04	111	1.33** (0.567)	0.33		0.10	81	4.68* (2.496)	2.17		0.15
	INR	192	0.68 (0.507)	0.4		0.03	111	0.43 (0.350)	2.69		0.02	81	0.73 (1.157)	0.05		0.01
	MXN	202	0.03 (0.230)	17.64***		0.00	121	0.00 (0.237)	17.68***		-0.01	81	0.47 (1.859)	0.08		-0.01
	SGD	202	-0.84 (0.584)	9.92***		0.03	121	-0.71 (0.501)	11.58***		0.02	81	0.23 (1.656)	0.21		-0.01
	THB	202	0.12 (0.841)	1.09		0.00	121	0.01 (0.863)	1.30		-0.01	81	0.73 (0.928)	0.08		0.01
	TRY	202	0.47*** (0.103)	26.45***		0.21	121	0.45*** (0.135)	16.69***		0.17	81	-0.22 (0.948)	1.65		-0.01
	TWD	202	0.33 (0.540)	1.54		0.00	121	-0.11 (0.501)	4.88**		-0.01	81	0.88 (1.081)	0.01		0.02
	ZAR	202	-2.88*** (0.983)	15.57***		0.16	121	-2.95*** (1.069)	13.66***		0.20	81	-2.43 (2.127)	2.60		0.04
Average			-0.01			0.06		-0.07			0.06		1.56			0.09
Average All			-0.58			0.04		-1.90			0.18		4.93			0.23

Notes: OLS estimates of the regression of 12-month spot exchange rate changes on 12-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. *N* is the number of monthly observations. *F* is the *F*-statistic. Note that the series of monthly observations of the 12-month spot rate changes end at 2013M09. [§]: except EURO from 1999M01, and HUF and INR from 1997M10. Everything else is the same as in notes to Table 14.

Table 18

Fama Regression Conditional on Low and High FX Volatility					
		Low		High	
Panel A: AM	AUD	-5.15 ^{**}	(2.24)	3.01	(4.51)
	CAD	-2.96	(3.15)	1.38	(4.87)
	CHF	-2.73	(2.25)	5.65 [*]	(3.27)
	DKK	-6.58 [*]	(3.71)	8.05 [*]	(4.12)
	EUR	-5.86 ^{***}	(2.10)	7.30	(4.97)
	GBP	-2.69	(3.05)	2.96	(4.74)
	JPY	-1.75	(2.07)	1.63	(2.06)
	NOK	-5.17 ^{***}	(1.72)	2.86	(3.53)
	NZD	-2.08	(2.19)	5.65	(4.78)
	SEK	-3.04	(1.94)	3.78	(3.63)
Average		-3.80		4.23	
Panel B: EM	CZK	-0.24	(0.44)	1.70	(1.95)
	HKD	-0.29 ^{**}	(0.12)	-0.02	(0.06)
	HUF	-0.97	(0.97)	-2.23	(2.46)
	INR	0.30	(0.91)	1.45	(1.54)
	KWD	1.04	(0.86)	4.11 ^{***}	(1.47)
	MXN	-0.47 [*]	(0.26)	0.80	(0.87)
	SGD	-0.67	(1.78)	0.60	(1.53)
	THB	0.32	(0.65)	0.80	(1.09)
	TRY	-0.04 ^{**}	(0.02)	-0.02	(0.05)
	TWD	0.54	(0.45)	0.32	(0.66)
ZAR	-0.89	(2.84)	-2.60	(2.61)	
Average		-0.12		0.45	
Average All		-1.88		2.26	

Notes: the table reports the estimates of the slope coefficients for 1-month forward rate Fama regression. The regression has been run conditional on low and high FX volatility. “Low” is identified as the quartile of the lowest values of the GFXV innovations. “High” is identified as the quartile of the highest values of the GFXV innovations. For the definition of GFXV and its innovations see notes to table 5 and figure 2. Newey-West robust standard errors are in parentheses.

Table 19

Pooled Data Unbiasedness Hypothesis Test: All Markets; $s_{i,t+k} - s_{i,t} = \alpha + \beta(f_{i,t}^k - s_{i,t}) + \varepsilon_{i,t+k}$ Panel A: Whole Period 1999M01-2014M09

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	-0.04*** (0.001)	0.03*** (0.007)	0.25*** (0.026)	0.36*** (0.051)
$F \beta=1$	>99***	>99***	>99***	>99***
\bar{R}^2	0.00	0.00	0.01	0.03
N	3948	3906	3660	3540

Panel B: Non-Crisis Period 1999M01-2006M12

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	-0.04*** (0.004)	-0.01 (0.027)	0.17* (0.088)	0.27** (0.119)
$F \beta=1$	>99***	>99***	89.84***	37.34***
\bar{R}^2	0.00	0.00	0.01	0.03
N	2016	2016	1920	1920

Panel C: Crisis Period 2007M01-2014M09

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	1.06*** (0.226)	1.20*** (0.215)	1.31*** (0.241)	1.23*** (0.193)
$F \beta=1$	0.06	0.88	1.68	1.39
\bar{R}^2	0.01	0.02	0.05	0.09
N	1932	1890	1740	1620

Notes: Pooled time series, cross-section estimates with White period robust standard errors. The USD is the base currency. Standard errors in parentheses. F is the F-statistic of the null hypothesis that $\beta=1$. N is the number of observations. ***, ** and * denote the significance of β and the rejection of the null hypothesis of $\beta=1$ at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at 2014M08, 2014M06, 2014M03 and 2013M09, respectively. For the definition of the individual markets included see Tales 14-17. KWD is not included for the 6 and 12-Month forward rates as data is not available.

Table 20 Pooled Data Unbiasedness Hypothesis Test: Separate Samples of Advanced and Emerging Markets

Panel A: Advanced Markets					Panel B: Emerging Markets			
Panel A.1: Whole Period 1999M01-2014M09					Panel B.1: Whole Period 1997M10-2014M09			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	-0.29** (0.143)	-0.37*** (0.126)	-0.29** (0.116)	-0.46*** (0.112)	-0.03*** (0.001)	0.10*** (0.009)	0.35*** (0.026)	0.47*** (0.037)
$F \beta=1$	80.60***	>99***	>99***	>99***	>99***	>99***	>99***	>99***
\bar{R}^2	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.13
N	1880	1860	1830	1770	2233	2211	1980	1920
Panel A.2: Non-crisis Period 1999M01-2006M12					Panel B.2: Non-crisis Period 1997M10-2006M12			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	-1.88*** (0.335)	-2.01*** (0.357)	-2.03*** (0.342)	-1.94*** (0.285)	-0.03*** (0.001)	0.08*** (0.010)	0.33*** (0.036)	0.46*** (0.049)
$F \beta=1$	73.79***	70.68***	78.32***	>99***	>99***	>99***	>99***	>99***
\bar{R}^2	0.02	0.06	0.13	0.19	0.00	0.01	0.08	0.17
N	960	960	960	960	1221	1221	1110	1110
Panel A.3: Crisis Period 2007M01-2014M09					Panel B.3: Crisis Period 2007M01-2014M09			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	2.96*** (0.817)	2.93*** (0.734)	3.27*** (0.825)	2.33*** (0.637)	0.70*** (0.165)	0.85*** (0.129)	0.88*** (0.121)	0.94*** (0.136)
$F \beta=1$	5.76**	6.89***	7.61***	4.36**	3.39*	1.43	0.97	0.22
\bar{R}^2	0.00	0.04	0.08	0.10	0.00	0.02	0.03	0.09
N	920	900	870	810	1012	990	870	810

Notes: Pooled time series, cross-section estimates with White period robust standard errors. The USD is the base currency. Standard errors in parentheses. F is the F-statistic of the null hypothesis that $\beta=1$. N is the number of observations. ***, ** and * denote the significance of β and the rejection of the null hypothesis of $\beta=1$ at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at 2014M08, 2014M06, 2014M03 and 2013M09, respectively. For the definition of the individual advanced and emerging markets included see Tales 14-17. KWD is not included in the sample of emerging markets for the 6 and 12-Month forward rates as data is not available. 1: 1-Month forward rate. 2: 3-Month forward rate. 3: 6-Month forward rate. 4: 12-Month forward rate.

Appendix A

Unbiasedness Hypothesis Test: Constant Estimates α

		1-Month Forward Rate			3-Month Forward Rate		
		Whole ¹	Non-Crisis ²	Crisis ³	Whole ¹	Non-Crisis ²	Crisis ³
		α	α	α	α	α	α
Advanced Markets	AUD	0.34 (0.30)	0.53** (0.27)	-0.98 (1.33)	0.69 (0.83)	1.52** (0.69)	-5.94* (3.19)
	CAD	-0.09 (0.17)	-0.18 (0.17)	-0.11 (0.64)	-0.30 (0.46)	-0.58 (0.46)	-1.01 (1.19)
	CHF	-0.44 (0.32)	-0.94** (0.47)	0.05 (0.43)	-1.38 (0.87)	-2.99** (1.18)	0.42 (1.13)
	DKK	-0.09 (0.21)	-0.26 (0.25)	0.03 (0.35)	-0.25 (0.62)	-0.94 (0.64)	-0.15 (0.79)
	EURO	-0.12 (0.22)	-0.32 (0.29)	0.03 (0.34)	-0.34 (0.66)	-1.16 (0.71)	-0.09 (0.80)
	GBP	0.14 (0.28)	0.07 (0.26)	0.17 (0.50)	-0.02 (0.57)	0.23 (0.66)	-0.76 (1.01)
	JPY	0.07 (0.33)	-0.41 (0.56)	0.39 (0.38)	-0.04 (0.90)	-1.43 (1.49)	0.93 (1.03)
	NOK	0.10 (0.23)	0.14 (0.25)	-1.27*** (0.47)	0.11 (0.59)	0.26 (0.64)	-4.81*** (1.71)
	NZD	-0.13 (0.53)	0.76* (0.46)	-4.72*** (1.63)	0.02 (1.45)	2.31* (1.17)	-12.53*** (4.11)
	SEK	0.01 (0.24)	-0.19 (0.23)	-0.14 (0.43)	-0.07 (0.67)	-0.72 (0.57)	-1.13 (0.99)
Average		-0.02	-0.08	-0.65	-0.16	-0.35	-2.51
Emerging Markets	CZK	-0.16 (0.27)	-0.29 (0.31)	0.03 (0.46)	-0.58 (0.73)	-0.95 (0.81)	0.01 (1.23)
	HKD	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	0.00 (0.02)	0.02 (0.02)	0.04 (0.03)
	HUF	0.43 (0.56)	-0.09 (0.60)	1.87 (1.17)	0.53 (1.38)	-0.62 (1.59)	2.01 (3.56)
	INR	0.31 (0.29)	0.32 (0.30)	0.48 (0.67)	0.24 (0.72)	0.55 (0.75)	0.11 (1.59)
	KWD	-0.17*** (0.05)	-0.05 (0.03)	-0.16* (0.09)	-0.42*** (0.15)	-0.09 (0.08)	-0.36 (0.25)
	MXN	0.30 (0.28)	0.55* (0.31)	-0.66 (0.71)	0.77 (0.81)	1.41* (0.79)	-2.40 (2.28)
	SGD	-0.05 (0.15)	0.09 (0.22)	-0.17 (0.19)	-0.29 (0.40)	0.06 (0.63)	-0.60 (0.45)
	THB	-0.09 (0.18)	0.01 (0.31)	-0.26 (0.25)	-0.29 (0.57)	-0.03 (0.74)	-0.83 (0.65)
	TRY	1.42*** (0.42)	2.10*** (0.62)	1.18 (1.12)	3.83*** (1.34)	5.81*** (1.98)	1.75 (3.88)
	TWD	0.09 (0.13)	0.15 (0.18)	0.04 (0.21)	0.17 (0.41)	0.43 (0.52)	0.01 (0.62)
ZAR	1.59** (0.76)	1.69* (0.93)	1.43 (2.03)	5.63** (1.81)	6.70** (2.22)	1.27 (6.50)	
Average		0.33	0.41	0.34	0.87	1.21	0.09
Average All		0.16	0.18	-0.13	0.38	0.47	-1.15

Notes: OLS estimates of the regression of 1 and 3-month spot exchange rate changes on 1 and 3-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. ***, ** and * denote the significance of α at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1 and 3-month spot rate changes end at 2014M08 and 2014M06, respectively. 1: 1996M12-2014M09 (except EURO from 1999M01, and HUF and INR from 1997M10). 2: 1996M12-2006M12 (except EURO from 1999M01, and HUF and INR from 1997M10). 3: 2007M01-2014M09.

Appendix A: Continued

		6-Month Forward Rate			12-Month Forward Rate		
		Whole	Non-Crisis	Crisis	Whole	Non-Crisis	Crisis
		α	α	α	α	α	α
Advanced Markets	AUD	0.87 (1.62)	2.78 ^{**} (1.22)	-14.69 ^{**} (6.05)	1.92 (2.63)	4.35 ^{**} (2.15)	-17.15 [*] (8.74)
	CAD	-0.66 (0.81)	-1.37 [*] (0.74)	-2.18 (1.62)	-1.41 (1.21)	-3.30 ^{***} (1.01)	-3.17 (2.00)
	CHF	-3.03 ^{**} (1.47)	-5.96 ^{***} (1.59)	0.91 (1.93)	-6.83 ^{**} (2.18)	-12.04 ^{***} (2.20)	0.99 (2.63)
	DKK	-0.65 (1.08)	-2.12 ^{**} (0.92)	-0.53 (1.21)	-1.64 (1.56)	-4.98 ^{**} (1.31)	-0.90 (1.42)
	EURO	-0.89 (1.15)	-2.75 ^{***} (0.95)	-0.49 (1.18)	-2.17 (1.68)	-6.45 ^{***} (1.32)	-0.64 (1.35)
	GBP	-0.61 (0.88)	0.23 (1.18)	-3.08 ^{**} (1.28)	-0.61 (1.28)	-0.11 (1.94)	-4.03 ^{***} (1.34)
	JPY	-0.71 (1.61)	-3.52 (2.18)	1.52 (1.84)	-1.75 (2.89)	-8.02 ^{***} (2.68)	4.24 (3.27)
	NOK	-0.08 (0.95)	0.16 (1.01)	-10.79 ^{**} (2.89)	-0.24 (1.48)	-0.79 (1.63)	-13.36 ^{***} (2.52)
	NZD	0.44 (2.91)	5.22 ^{***} (1.93)	-25.32 ^{***} (5.79)	3.49 (4.88)	11.03 ^{***} (3.01)	-37.23 ^{***} (5.79)
	SEK	-0.31 (1.18)	-1.66 [*] (0.89)	-3.09 [*] (1.57)	-0.90 (1.71)	-3.54 ^{**} (1.38)	-5.19 ^{**} (2.13)
Average		-0.56	-0.90	-5.77	-1.01	-2.38	-7.64
Emerging Markets	CZK	-1.40 (1.25)	-2.13 [*] (1.28)	-0.07 (1.97)	-3.44 ^{**} (1.74)	-5.66 ^{***} (1.91)	0.26 (2.07)
	HKD	0.00 (0.03)	0.04 (0.04)	0.06 (0.04)	0.00 (0.04)	0.06 (0.06)	0.11 ^{**} (0.05)
	HUF	-0.49 (2.31)	-2.52 (2.72)	-2.42 (6.46)	-4.88 (3.20)	-9.76 ^{**} (4.12)	-15.29 [*] (9.09)
	INR	0.54 (1.38)	0.48 (1.29)	1.38 (3.03)	0.23 (2.47)	-1.14 (2.02)	3.05 (5.69)
	MXN	1.60 (1.47)	2.40 [*] (1.39)	-1.33 (3.70)	2.73 (2.19)	3.12 (2.27)	0.87 (6.26)
	SGD	-0.73 (0.61)	-0.04 (0.82)	-1.22 (0.77)	-1.82 [*] (0.97)	-0.77 (1.25)	-2.50 [*] (1.30)
	THB	-0.02 (1.03)	0.77 (1.37)	-1.25 (1.16)	0.27 (1.47)	1.36 (2.24)	-1.74 (1.71)
	TRY	4.69 [*] (2.60)	7.68 [*] (4.12)	2.84 (6.29)	4.84 (3.90)	4.84 (3.90)	9.32 (6.87)
	TWD	0.35 (0.73)	0.84 (0.90)	-0.11 (0.92)	0.65 (1.19)	1.34 (1.43)	0.26 (1.45)
ZAR	10.81 ^{***} (3.47)	12.73 ^{***} (4.01)	1.70 (11.54)	23.33 ^{***} (5.60)	23.82 ^{***} (6.40)	20.61 [*] (11.19)	
Average		1.54	2.03	-0.04	2.19	1.72	1.50
Average All		0.49	0.56	-2.91	0.59	-0.33	-3.07

Notes: OLS estimates of the regression of 6 and 12-month spot exchange rate changes on 6 and 12-month forward premium with Newey-West robust standard errors. The USD is the base currency. Standard errors in parentheses. ***, ** and * denote the significance of α at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 6 and 12-month spot rate changes end at 2014M03 and 2013M09, respectively. 1: 1996M12-2014M09 (except EURO from 1999M01, and HUF and INR from 1997M10). 2: 1996M12-2006M12 (except EURO from 1999M01, and HUF and INR from 1997M10). 3: 2007M01-2014M09.

Appendix B

Fixed-Effect Pooled Data Unbiasedness Hypothesis Test: All Markets

Panel A: Whole Period 1999M01-2014M09

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	-0.03 ^{***} (0.003)	-0.02 (0.018)	0.09 (0.060)	0.09 (0.109)
$F \beta=1$	>99 ^{***}	>99 ^{***}	>99 ^{***}	69.92 ^{***}
\bar{R}^2	0.00	0.01	0.03	0.07
N	3948	3906	3660	3540

Panel B: Non-Crisis Period 1999M01-2006M12

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	-0.03 ^{***} (0.004)	-0.03 (0.035)	0.00 (0.119)	-0.07 (0.216)
$F \beta=1$	>99 ^{***}	>99 ^{***}	70.60 ^{***}	24.50 ^{***}
\bar{R}^2	0.01	0.04	0.07	0.11
N	2016	2016	1920	1920

Panel C: Crisis Period 2007M01-2014M09

	1-Month Forward Rate	3-Month Forward Rate	6-Month Forward Rate	12-Month Forward Rate
β	1.88 ^{**} (0.872)	2.62 ^{***} (0.903)	3.13 ^{***} (1.157)	2.54 ^{**} (1.096)
$F \beta=1$	1.03	3.21 [*]	3.39 [*]	1.98
\bar{R}^2	0.00	0.03	0.07	0.13
N	1932	1890	1740	1620

Notes: Fixed-effect pooled data estimates with White period robust standard errors. The USD is the base currency. Standard errors in parentheses. F is the F-statistic of the null hypothesis that $\beta=1$. N is the number of observations. ***, ** and * denote the significance of β and the rejection of the null hypothesis of $\beta=1$ at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at 2014M08, 2014M06, 2014M03 and 2013M09, respectively. For the definition of the individual markets included see Tables 14-17. KWD is not included for the 6 and 12-Month forward rates as data is not available.

Appendix C

Fixed-effect Pooled Data Unbiasedness Hypothesis Test:
Separate Samples of Advanced and Emerging Markets

	<u>Panel A: Advanced Markets</u>				<u>Panel B: Emerging Markets</u>			
	<u>Panel A.1: Whole Period 1999M01-2014M09</u>				<u>Panel B.1: Whole Period 1997M10-2014M09</u>			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	-0.39 (0.299)	-0.55** (0.240)	-0.46** (0.228)	-0.81*** (0.208)	-0.02*** (0.001)	0.04*** (0.015)	0.22*** (0.052)	0.32*** (0.070)
$F \beta=1$	21.41***	42.00***	41.01***	75.21***	>99***	>99***	>99***	>99***
\bar{R}^2	0.00	0.00	0.00	0.01	0.01	0.04	0.08	0.16
N	1880	1860	1830	1770	2233	2211	1980	1920
	<u>Panel A.2: Non-crisis Period 1999M01-2006M12</u>				<u>Panel B.2: Non-crisis Period 1999M10-2006M12</u>			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	-3.28*** (0.450)	-3.55*** (0.472)	-3.64*** (0.490)	-3.54*** (0.491)	-0.02*** (0.001)	0.03* (0.018)	0.17*** (0.057)	0.28*** (0.080)
$F \beta=1$	90.34***	92.63***	89.83***	85.38***	>99***	>99***	>99***	80.82***
\bar{R}^2	0.02	0.09	0.20	0.30	0.03	0.08	0.15	0.21
N	960	960	960	960	1221	1221	1110	1110
	<u>Panel A.3: Crisis Period 2007M01-2014M09</u>				<u>Panel B.3: Crisis Period 2007M01-2014M09</u>			
	1M ¹	3M ²	6M ³	12M ⁴	1M ¹	3M ²	6M ³	12M ⁴
β	8.33*** (1.647)	8.69*** (1.361)	9.97*** (1.597)	7.64*** (0.949)	0.37 (0.594)	0.87** (0.439)	0.82** (0.409)	0.62 (0.624)
$F \beta=1$	19.79***	31.98***	31.53***	48.90***	1.12	0.09	0.19	0.37
\bar{R}^2	0.03	0.11	0.25	0.34	-0.01	0.01	0.03	0.09
N	920	900	870	810	1012	990	870	810

Notes: Fixed-effect pooled data estimates with White period robust standard errors. The USD is the base currency. Standard errors in parentheses. F is the F-statistic of the null hypothesis that $\beta=1$. N is the number of observations. ***, ** and * denote the significance of β and the rejection of the null hypothesis of $\beta=1$ at 1%, 5% and 10% significance levels, respectively. Note that the series of monthly observations of the 1, 3, 6 and 12-month spot rate changes end at 2014M08, 2014M06, 2014M03 and 2013M09, respectively. For the definition of the individual advanced and emerging markets included see Tables 14-17. KWD is not included in the sample of emerging markets for the 6 and 12-Month forward rates as data is not available. 1: 1-Month forward rate. 2: 3-Month forward rate. 3: 6-Month forward rate. 4: 12-Month forward rate.

