Currency Carry Trades -

Speculating against International Parity Conditions and the Risk of Exchange Rate Reversion

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Abstract

Investors have repeatedly benefited from currency carry trades (CCT) in the past, but only during short periods. Therefore, timing is essential and short-term indicators might be helpful. The highest risk of CCT is the volatility of exchange rates. CCT is only possible while the covered interest rate parity CIRP does not hold. We throw further light on the functioning of foreign exchange markets in particular and financial markets in general. Therefore, we discuss different short- and long-term indicators that influence exchange rate movements. Our paper focuses on the opportunity to profit from a higher-yielding currency without currency loss. We analyze whether short-term indicators, especially interest rates, spot rates and their volatility, help to identify trend reversals and allow investors to open, hold or close CCT positions. Besides, we discuss the effect of irrational herd behaviour on CCT strategies.

1. Introduction

There is no obligation to report currency trades. Therefore, no official statistics exist, but exchange rate developments repeatedly show that investors are pushing exchange rates against their theoretical value by switching to higher-yielding currencies. The desire to profit from higher yields in different currency areas drives these trades. Investors borrow money in a low-interest currency, such as the EUR nowadays, and exchange it at the spot rate on the foreign exchange market into higher-yielding currency, for example currently the USD, in order to get a higher return on investment, both on the money or capital market. This is called **currency carry trade** (CCT). Similarly, investments on the stock market might lead to a higher expected return on investment. Assuming the same risk premium, the total return promises to be higher, due to higher interest rates (Gubler, 2014).

Whether a carry trade actually leads to a profit depends on the further development of the foreign exchange rate as well as the difference between the interest paid for the loan and the return received in the investment. Therefore, timing is essential and short-term indicators might be helpful. Studies show that a **trend reversal** cannot be predicted reliably (e.g. Cenedese et al., 2014). This is not surprising since speculative motives must be assumed for the vast majority of the daily trading volume. The beginning of a rising interest rate differential between two hard currencies and the onset of first carry trade activities is often followed by herding behavior of other investors within a short time and subsequent exchange rate movements.

It has been shown repeatedly (e.g. Hossfeld et al., 2014) that an increase in the number of investors wishing to exploit the interest rate differential meant a rising demand for the higher-yielding currency, thus strengthening this currency. This exchange rate development contradicts short run theorems such as the **covered interest rate parity** (CIRP) as well as long run theorems such as the purchasing power parity. International parity conditions use economic theory and link diverse factors like price levels and interest rates to estimates about future exchange rate developments. Theoretically, a higher-yielding currency tends to devalue. In reality, this is often not the case, which provides opportunities for successful CCTs. Our paper considers this tension between market expectations and theoretical equilibrium in CCT periods.

2. Predictability of Exchange Rates

The CCT strategy proposes the highest profit if an investor can predict changes in exchange rates. Rossi (2013) analyzes a number of previous studies and identifies a random walk without drift as the best describing benchmark for future exchange rate developments. However, she also points out that the predictability of exchange rates largely depends on the choice of the indicators, on the forecast horizon, the sample period, the model, and the forecast evaluation method. In this chapter, we first discuss different indicators before we focus on interest rates.

2.1 Exchange Rates, Fundamentals, and Predictive Ability

The list of indicators that might influence exchange rate movements seems to be endless. Schultheiß et al. (2017) conduct a survey of 20 financial institutions that trade large amounts in foreign exchange markets. These institutions do not rely on forward rates when assessing the short run development of foreign exchange rates. Instead, they identify a set of indicators for forecasts with short run or long-term horizon (table 1). Rossi (2013) discusses some of these indicators with theoretical approach.

Table 1
Short-term and long-term indicators identified by Schultheiß et al. (2017).

Short-Term Indicators	Long-Term Indicators
•difference in interest rates	•difference in inflation rates
•relative stock market trend	•difference in productivity
•global stock market trends	•periods of trade
•commodity price development	•leverage of a currency area
•current account balance	•current account balance
•unemployment rate	•interest rate

Differences in inflation rates lead to **purchasing power parity** (PPP), which Rogoff (1996) calls a puzzle due to its empirical inconsistency. Later studies discuss possible explanations for this inconsistency, such as an underestimation of the uncertainty around point estimates (Rossi 2005) and heterogeneity in disaggregate data (Imbs et al. 2005). Differences in productivity and monetary models show very little evidence, neither on the short horizon nor on a longer horizon (Cheung et al., 2005). Therefore, investors cannot rely on the predictive ability of these indicators. Besides, they are not immediately published and therefore are not available on a daily basis. Balassa (1964) and Samuelson (1964) argue that differences in **productivity** might be other long-term indicators. Based on the PPP they combine differences in consumer prices with productivity and find systematic differences in these indicators between more or less developed countries. Cheung et al. (2005) measure differences in productivity by labor productivity indices (real GDP per employee). However, they cannot forecast better than a random walk, and the data are rarely published and only available with delays. Therefore, investors are not protected from currency risk and close CCT. Rossi (2013) discusses cumulated current **account balance differentials** as a possible indicator for exchange rate movements. Some other data might be cumulated trade balance differentials or government debt. However, these data do not result in better forecasts than the random walk (Cheung et al. 2005). Turning to account balance differentials Gourinchas et al. (2007) argue that the current account should be expanded by further indicators such as changes in net exports, foreign asset holdings, and the return on net foreign assets. They all influence future current account imbalances because they indicate possible future trade surpluses or deficits. As we mentioned before, these indicators might have an influence on exchange rate movements, but not on the short run.

Other indicators are **commodity prices**, which are published daily and therefore might help to predict spot rate movements in the short run. Investors can observe commodity price indices or oil prices. Ready et al. (2017) find that "commodity currencies" are on average higher-yielding, while countries that export finished goods tend to have lower-yielding currencies. They argue that commodity currency exchange rates and risk premiums increase with differences in productivity and with more trade frictions. The latter finding applies to the long run. Abhyankar et al. (2005) note that exchange rate forecasts across a range of horizons based on a **fundamentals** model are better than random walk forecasts. Bartolini et al. (2000) do not commit exchange rate expectations to unobservable fundamentals, which leads to predictions based on volatility tests of asset prices. Dick et al. (2012) find that chartists' forecasts appear to be more accurate than those based on fundamentals in the short run.

Chernov et al. (2012) argue that the probability that the USD depreciates increases with rises in its interest rate. But McCauley et al. (2009) state that, amidst the crisis, the **global flight** into US Treasury bills as a safe haven as well as investors closing CCT strengthened the USD. In addition, the increase in USD funding costs provided price incentives for corporates to switch to another currency to pay back the debt in USD. Banks and institutional investors outside the United States ended up with overhedged USD books. Nevertheless, Chernov et al. (2012) associate big exchange rate changes with **macro-economic** or **political events**.

2.2 Interest Rate Differences, Swap Rates and Covered Interest Rate Arbitrage (CIRP)

As some of the economic indicators that might influence market expectations are not available for single days, weeks, or even one month (e.g., GDP growth), we focus on yields and swap rates. Schultheiß et al. (2017) show that professional traders interpret differences in interest rates as a signal for CCT activities in the short run and therefore expect an appreciation of the currency with the higher interest rate. This is in accordance with McCauley et al. (2009) but contradicts the **covered interest rate parity** (Taylor 1987). Taylor tests the CIRP by using high-frequency, contemporaneously sampled data gathered in the London foreign exchange market. His results strongly support the market efficiency hypothesis. Lothian et al. (2011) analyze an ultra-long time series that span two centuries. They conclude that interest rate differences have forecasting power for future spot rates, but larger interest rate differentials send a significantly stronger signal than the smaller ones.

Cheung et al. (2005) argue with the **uncovered interest rate parity** (UIRP) and find that there is no difference in the poor performance of the exchange rate forecasts, regardless of using random walk or UIRP. Molodtsova et al. (2009) find that at short horizons UIRP fits slightly better to predict exchange rate movements for some countries. MacDonald et al. (2015) argue that yield differences lead to forecast errors and interpret this as evidence against UIRP. As a result, the existence of CCT depends on a negative correlation between exchange rate changes and yield differences.

Du et al. (2018) point out that deviations from CIRP open up large, persistent, and systematic arbitrage opportunities in the foreign exchange market. They show that credit risk or transaction costs cannot explain away CCP opportunities. Especially for banks, **arbitrage opportunities** open up. Iida et al. (2018) conclude that professional investors supply more USD in the foreign exchange swap market. Schlegel et al. (2017) identify unilateral hedging demand, regulatory costs, and liquidity premiums due to central bank requirements as possible indicators for ongoing CCT opportunities between USD and EUR. Eichenbaum et al. (2017) add that changes in the foreign demand for USD denominated bonds are the key factors that influence exchange rates and their correlation with inflation.

3. CCT Strategies

MacDonald (2015) identifies CCT opportunities as a negative relationship between the exchange rate change and the interest rate spread. A usual CCT strategy means to purchase foreign assets by selling assets of a low-yielding currency, thus leading to an increase in demand for the foreign currency, and a depreciation of the lower-yielding currency. Frankel (2007) completes that an investor needs not to borrow. A simple shift of the portfolio out of the lower-yielding currency and into the higher-yielding currency is a CCT, too. In the past, investors **repeatedly had the opportunity to profit from higher interest rates in foreign currencies** without hedging. The best-known examples are Yen/USD carry trades, e.g. from summer 1995 to October 1998 or from late 2005 until the middle of 2007 (Gagnon et al. 2007). Accominotti et al. (2017) base their empirical findings on nearly a century of trading activity in the foreign exchange market. The authors identify excess returns of 3.36% to 7.66% and choose the Sharpe Ratio as a measure for risk. It is about 0.55 for the entire century, which means that a surplus was possible, but the excess return was not necessarily adequate for the risk taken. Du et al. (2018) not only ask if an investor can borrow and lend at interbank rates, they also consider if an investor takes on credit risk or even counterparty risk when entering a CCT strategy.

3.1 Safe Haven and Herd Behavior

Already 30 years ago, Froot et al. (1990) stated that the paradigm of rational and efficient markets does not provide a satisfactory explanation for CCT. They have another simple explanation: One is to define a currency as a "**safe haven**". Schultheiß et al. (2017) argue that corresponding to deteriorating expected returns on the global stock market, investors prefer to switch to safe currencies. Hossfeld et al. (2014) identify a negative correlation between the returns of such a currency and the returns of a reference portfolio (e.g. the global stock market), especially in times of heightened tension in international financial markets. Kugler et al. (2005) argue that investors are willing to pay a premium for holding safe haven currencies when expecting that, in a severe crisis, this currency would appreciate. They base their findings on a long time series for the CHF/USD beginning in 1880. Haab et al. (2018) focus on the CHF as well, coming to the same result: A safe haven currency tends to appreciate in times of financial stress and thus delivers a safety premium.

Hammerschmid et al. (2018) assume that investors are loss averse and overweight alternatives with low probabilities. They call this combination crash-o-phobia. They estimate a non-linear and risk neutral crash-o-phobia model to price developed and emerging market currencies, and identify significant differences in loss aversion between countries. Pierdzioch et al. (2010) supplement this argument by stating that exchange rates are more volatile than underlying macroeconomic fundamentals. A possible explanation might be **herd behavior**. Belke (2004) differentiates between rational and irrational herding. Information cascades, fixed costs of acquiring information and reputational concerns cause rational herding. Information costs can explain irrational herding. Alternatively, investors might disregard their own information and imitate their peers. They copy the asset structure of other funds. As long as CCTs have a positive return, we observe momentum trading strategies, which is a result of irrational herd behavior. It is difficult to predict the changing point because these arguments might lead to large and unpredictable exchange-rate swings.

But the momentum trading strategy does not necessarily imply high exchange-rate volatility. Engel (1996) explains herd behavior by asking why no rational investors bet against CCT until all CCT opportunities are eliminated? He argues that these rational investors are risk averse as well. It requires a substantial uncovered position to drive the exchange rate back to its theoretical equilibrium and **risk averse** investors are apparently not willing to take on this risk. Brunnermeier et al. (2009) provide evidence consistent with a hypothesis that large exchange rate movements are related to funding constraints of investors trying to exploit CCT opportunities. They base their study on quarterly changes in exchange rates to identify terms with CCT opportunities. The cumulated excess return is 2.2% on average with a standard deviation of 6.8% and a Sharpe ratio of 0.654. McCauley (2009) considers safe haven, unwinding of CCTs, and funding in USD as the main causes of exchange rate movements.

3.2 Timing of CCT

Burnside et al. (2010) study the properties of CCT strategies. They generate excess returns, which are uncorrelated with traditional risk factors. Galati et al. (2007) define CCT as a leveraged cross-currency position designed to take advantage of interest rate differentials and low volatility. The strategy is only profitable as long as **exchange rate movements** in the short-term do not overwhelm the gains from interest rate differentials. As discussed in 2.2, CIRP does not hold. Deutsche Bank G10 Currency Fund Harvest Index (Deutsche Bank 2019) tries to profit from the CCT strategy. The fund manager invests in the three highest-yielding G10 currencies and goes short in the three lowest-yielding G10 currencies. He identifies the yield based on London Interbank Offered Rates (LIBOR) with three-month maturity and invests in three-month forwards. This CCT strategy lead to an average excess return of 1.47% over the last ten years. It is easy to identify the opening of a CCT opportunity. Christiansen et al. (2011) explain the CCT performance by using an asset pricing model with time-varying systematic risk. They calculate possible excess returns with monthly data. They define the excess return as the difference between two subtrahends: 1) the log of the difference between the interest of a foreign currency and the USD and 2) the log of the difference between changes in the spot rate.

Even a slight depreciation of the investment currency can erase the profit from interest rate differentials and thus lead to a turnaround. Curucu et al. (2010) identify exchange rate volatility as the main risk for CCT investors. Akram et al. (2008) show that the **duration** of CCT opportunities is often long enough to allow investors to profit from the conditions. Based on short-term tick data, they justify the unpredictability of CCT opportunities – the closing is even more difficult than the opening. Samanta (2009) explains the risk of an **unpredictable ending** of CCT opportunities with the YEN/USD CCT until the middle of 2007. Investors borrowed in very low-yielding YEN and purchased other higher-yielding currencies like the USD. A high profit was possible for a long time. However, after the YEN constantly appreciated and the FED reduced funds rates, the scenario changed completely. CCT was no longer profitable (Gagnon et al. 2007). Brunnermeier et al. (2009) conjecture that sudden exchange rate moves are caused by the unwinding of CCTs when investors dissolve their commitment.

4. Empirical Relationship between Carry Trades and Swap Rates

As we have no access to other short-term indicators, we analyze exchange rate changes and interest rates to identify CCT opportunities between USD and EUR in accordance with Du et al. (2018).

4.1 Data

For a first overview, we use data on monthly interest rates of USD and EUR over the past twenty years as well as the USD/EUR spot rate. We take the monthly spot rate of USD/EUR and the 1-month LIBOR reference rates for both currencies to identify CCT opportunities. Hassan et al. (2014) link their discussion of the profitability of a CCT strategy to the forward premium puzzle (see Fama 1984). The forward premium as the difference between forward and spot rate is equal to the interest rate differential between the two currencies. Therefore, the CCT excess return is the interest rate differential **plus** the rate of appreciation of the foreign currency. They calculate a mean excess return of 4.95% and a Sharpe ratio of 0.54 for the USD against 15 other currencies from December 1990 to June 2010. Lustig et al. (2014) base their findings on monthly data from 1983 to 2010 and find an average excess return of the USD against 38 other currencies of 5.6% with a standard deviation of 8.53% and a Sharpe ratio of 0.66. Ackermann et al. (2016) find that mean-variance analysis can work well for currency markets. They state that interest rates are **less volatile** and known a priori and are not subject to estimation errors. The mean-variance analysis using the interest rate as expected return leads to a Sharpe ratio of 0.91. By extending the estimated expected return to the exchange rate component, the performance lowers to a Sharpe ratio of 0.83. Former studies show that investors profit from CCT for only a short time. Evans et al. (2017) analyze weekly CCT positions. They show that the effects of global CCT are primarily concentrated in bond markets. In a second step, we add weekly data in order to identify influencing factors on short-term changes of CCT opportunities. Therefore, we focus on weekly data of spot rates, ending Friday.

4.2 Monthly Data and Excess Return

We got our data from FRED Federal Reserve Economic Data (www.fred.stlouisfed.org) 1-month LIBOR for USD, EUR, and monthly exchange rates (USD to EUR) all from the first of each month. According to the interest rate parity and in case of higher interest rates for USD, the swap rate must be positive (USD/EUR). A CCT will be only successful if the actual spot rate is below the calculated forward rate one month ago. The difference must be positive. We identify 73 periods in which an unhedged change from EUR to USD and investing in the higher-yielding USD provides a positive return. There were CCT opportunities by changing from USD to EUR as well. In this case, a negative swap rate was necessary, due to the higher interest rates of the EUR. The forward rate is now below the spot rate (USD/EUR). The currency trade is successful if the difference between the forward rate for the following month and the spot rate for the month observed is negative. We identify 58 periods that match these conditions. In total, currency carry trades between USD and EUR were profitable in 131 of the 242 month in our sample (54%).

After this short overview, we calculate the excess return that was possible during the last 20 years between USD and EUR based on monthly data. First we separate between excess return due to differences in interest rates ($i_{t-1}^{EUR} - i_{t-1}^{USD}$), then due to changes in spot rates ($q_t^k - q_{t-1}^k$) and finally due to both effects in combination r_t^k. Christiansen et al. (2011) define excess return as (all data as log):

$$r_t^k = -(q_t^k - q_{t-1}^k) - (i_{t-1}^{EUR} - i_{t-1}^{USD}) \qquad (4.2.1)$$

A CCT in USD is successful if the USD interest rate is higher than the EUR interest rate, and the USD spot rate is below the forward rate. On the other hand, a CCT in EUR is profitable if the EUR interest rate is the higher one and the EUR spot rate is above the forward rate. Table 2 shows our findings.

During the months with CCT opportunities in USD, an average excess return of 1.3% was possible due to interest rate differentials. As interest rates are less volatile, the standard deviation is 0.27% and leads to a high Sharpe ratio of 4.9. The excess return due to interest rate differences for CCTs in EUR is a little lower with an average of 0.9% and an even lower standard deviation of 0.16% and therefore a higher Sharpe ratio of 5.75. Most studies focus on excess returns caused by differences in interest rates (e.g. Koijen 2018, Lustig et al 2014, Hassan et al. 2014). As Christiansen et al. (2011) show, an excess return of CCT means an excess return due to interest rate differentials and exchange rate movements in favor of an investor's position. The excess return, due to spot rate changes during a CCT in USD, leads to an annualized return of 21.5% with a higher standard deviation of 5% and a Sharpe ratio of 4.3. Taken together both effects by months we reach a calculated excess return of 28.5%, a standard deviation of 5% and a Sharpe ratio of 5.7. The excess return due to spot rate changes during CCT in EUR leads to an even higher rate: 32.4%, with a standard deviation of 7% and a Sharpe ratio of 4.6. Again, the combined calculation with both effects gives us an excess return of 25.6%, the same standard deviation of 7% and a Sharpe ratio of 3.7.

Table 2

Summary statistics. These four tables list the annualized log excess return for interest rates, changes in exchange rates and the CCT strategy (profit from interest rate differences and spot rate changes) based on data of 242 months. CCT are possible in USD and EUR. A comparison with all data shows that CCT does not always make sense.

CCT in USD rates in % (73 months)	return interest rate	return exchange rate	return CCT strategy
mean p.m.	0.109	2.002	2.111
st. deviation p.m.	0.077	1.441	1.432
mean p.a.	1.315	21.544	28.484
st. deviation p.a.	0.268	4.992	4.959
Sharpe ratio	4.914	4.315	5.7438

CCT in EUR rates in % (58 months)	return interest rate	return exchange rate	return CCT strategy
mean p.m.	0.075	2.364	2.439
st. deviation p.m.	0.045	2.026	2.025
mean p.a.	0.901	32.367	25.644
st. deviation p.a.	0.157	7.018	7.013
Sharpe ratio	5.753	4.612	3.656

no CCT possible (111 months) in %	return interest rate	return exchange rate	return CCT strategy
mean p.m.	-0.035	-0.034	0.069
st. deviation p.m.	0.103	2.964	2.898
mean p.a.	-0.422	-0.405	0.832
st. deviation p.a.	0.356	10.267	10.041
Sharpe ratio	-1.185	-0.039	0.083

CCT strategy all (242 months) in %	return interest rate	return exchange rate	return CCT strategy
mean p.m.	-0.031	-0.053	0.084
st. deviation p.m.	0.108	2.856	2.862
mean p.a.	-0.373	-0.630	1.010
st. deviation p.a.	0.374	9.894	9.915
Sharpe ratio	-0.997	-0.064	0.102

The return rates caused by spot rate movements seem to be large, compared with other investment opportunities, e.g. share indices as STOXX 500. This is because we calculate (log) month rates for one year over 242 months in all without including the months without CCT opportunities. To show this, we calculate the values for all months in our sample. We get Sharpe ratios of -1.0 for interest rate differentials, -0.06 for exchange rate changes and 0.1 for both effects. For an investor, these findings mean that it does not make sense to run an unchanged CCT strategy during the entire time without opening or closing CCT positions. Focusing the months without any CCT opportunity the Sharpe ratios almost look the same: -1.2 for interest rate differentials, -0.04 for exchange rates and 0.08 taken together. We do not calculate the effect of generating high excess returns by combining interest rate difference and spot rate changing effects based on weekly data. Annualizing weekly date results in unrealistic and extreme returns. Therefore, we omitted these results.

4.3 No Turning Hint from Weekly Data

Based on the findings of excess returns of a CCT strategy, we analyze weekly data of the spot rate between USD and EUR as well as the interest rate of each currency for a 1054 week sample, starting in 1999. First, we separate weeks in periods with and without CCT opportunities. A CCT will success as long as the spot rate of a week does not depreciate below its forward rate, calculated in accordance to the covered interest rate parity. The period transition is of particular interest, so we defined seven periods (see table 3). Then we examine the excess return of a CCT strategy, either in USD or in EUR. Table 3 presents a summary statistic for the excess returns as a result of the difference between the interest rates. During period 0, no CCT opportunity exists. Period1 and 3 focus on CCT in USD with the higher yields. The annualized excess returns are on average 1.3% and 1.4% and the Sharpe ratios 1.4 and 1.5. Although the interest rate of the USD in period 5 is still higher (difference of 1.4%) and the standard deviation has not changed (0.9%, Sharpe ratio 1.5), one should close the investment position due to the change in the spot rate. Periods 2 and 4 examine the excess return of a CCT in EUR, which is now higher yielding. The return is lower than the annualized excess return of a CCT in USD with 0.9%. Due to lower standard deviation (0.6%), the Sharpe ratio climbs to 1.6 and 1.4. At last, period 6 indicates to stop CCT in EUR because the spot rate change will lead to a loss compared with the forward rate (almost unchanged values: return 0.9%, standard deviation 0.6%, Sharpe ratio 1.4). As there is almost no difference in excess rates due to interest rate differentials in different periods, we cannot derive any signals for opening or closing CCT positions.

Table 3: Summary statistics. Annualized mean excess return in percent due to weekly differences in interest rates and a Sharpe ratio (calculated with log data).

No.	weeks	Excess return		Sharpe ratio	Period
		Mean	St.dev.		
0	496	0.37	1.3		no CCT possible
1	199	1.29	0.92	1.4	keep CCT in USD
2	146	0.89	0.55	1.64	keep CCT in EUR
3	125	1.38	0.93	1.48	open CCT in USD
4	88	0.87	0.62	1.4	open CCT in EUR
5	125	1.39	0.92	1.5	close CCT in USD
6	88	0.86	0.61	1.41	close CCT in EUR

Both profits and losses are possible when exchange rates move. Thus, for each period, we examine the mean exchange rate development using weekly data period (table 4). **Spot rates are more volatile** than interest rates. Thus, their annualized standard deviation is higher. Moreover, a higher standard deviation means a higher risk and promises a higher return. Table 4 shows the weekly changes in spot rates. In period 1, 3, and 5 the USD appreciates against the EUR (direct quotation). In period 1, an investor can profit from higher interest rates and an exchange rate movement of annualized 54% (standard deviation 8.1%). Period 3 opens the opportunity to profit from CCT with an annualized excess return of 47% (standard deviation 7.8%). Period 5 means to close CCT in USD and change the investment back to EUR. Now the mean (29%) indicates that investors realize a profit from the appreciation of the USD (standard deviation 7.1%). As discussed before, we expect the volatility to rise in period 5 as a signal to close CCT positions. In fact, it is not. The exit is a consequence of the covered

interest rate parity: the forward rate now eliminates the profit from the difference in interest rates. As argued above, we do not calculate the Sharpe ratio because annualizing the weekly rates might indicate a high profit throughout the year, which is not possible, because each period typically lasts only a few weeks.

Table 4: Summary statistics. Annualized change of spot rates in percent, based on weekly data. The annualized values only serve comparability and cannot be realized permanently.

No.	weeks	Annualized EX Rate Change in %	
		Mean	St.dev.
0	283	1.66	10.65
1	199	54.3	8.14
2	146	69.6	8.45
3	125	46.8	7.85
4	88	37.3	8.42
5	125	28.7	7.14
6	88	58.8	9.10

If EUR is the target currency (periods 2 and 4), a positive mean of the weekly changes in spot rates stands for an appreciation of the EUR against the USD (depreciation of the USD). The findings are similar to the ones of CCT in USD, but CCT in EUR means greater changes in spot rates and higher standard deviation. Period 2 indicates CCT and exchange rate profit (return 70%; standard deviation 8.5%). In period 6, an investor should close the CCT position because the forward rate eliminates the interest rate difference from now on, but an exchange rate profit can be realized (return 59%, standard deviation 9.1%). Now the volatility is rising, but too slight to serve as a signal for closing CCT positions. Period 4 includes the weeks during which an investor can open CCT positions in EUR (return 37%; standard deviation 8.4%). According to Iida et al. (2018), the global financial crisis, December 2007 through June 2009, started with an exit from CCT in USD, followed by spells of a few or just single weeks with CCT opportunities in EUR. During the euro-zone sovereign debt crisis (May 2011 through June 2012), there were also some spells (single or a few weeks long) of CCT opportunities in EUR. We gain no further insight by separating these periods.

Period 0 is the one with the highest standard deviation but the smallest change in spot rates (table 4). This indicates that the spot market does not send a clear signal of whether a CCT opportunity appears or not. Small changes in the spot market might stand for a sideway drift, and it is not clear whether a CCT period opens up. This leads us to another indicator. If changes in the sport rate quotation do not provide signals to whether it is beneficial to open, hold or close CCT positions, we observe changes in interest rates of a target currency itself. Table 5 shows changes in annualized interest rates of USD and EUR. It is difficult to identify a pattern. First, during every period, interest rates rise or decline in both currencies simultaneously, except for period 1 (ongoing CCT in USD). Nevertheless, it makes sense because the USD interest rate rises while the EUR interest rate is decreasing. Most surprising is the mean of the EUR interest rate in period 4: it decreases by 1.56% p.a. Even the simultaneous decline of the USD interest rate with 0.32% does not explain more. We cannot derive a clear statement from changes in interest rates.

Table 5: Summary statistics. Annualized interest rate changes of USD and EUR in %.

No.	weeks	Change i_{USD} p.a.		Change i_{EUR} p.a.	
		mean	St.dev.	mean	St.dev.
0	283	0.02	3.8	0.04	5.8
1	199	0.45	1.4	-0.03	21.3
2	146	-0.68	2.8	-0.29	3.5
3	125	0.59	2.3	0.66	8.9
4	88	-0.32	5.3	-1.56	4.9
5	125	0.77	3.0	0.39	14.4
6	88	-1.81	9.3	-1.02	3.9

4.4 Regression and Correlation

Hassan et al. (2014) use a simple linear regression model to estimate the impact of the difference of forward rates (f_t) and spot rate (s_t) on the log currency return rx_{t+1} between time t and t+1. The difference between forward and spot rates is the forward premium and corresponds to the swap rate sw_t in our sample. Similarly, we estimate the impact of the swap rate sw_t on the log currency return based on weekly data. Appendix 1 shows our results. Only period 0, which offers no CCT opportunity, has a coefficient of determination at 0.41. These are the weeks during which CIRP seems to hold and swap rates indicate the direction of exchange rate changes. The Pearson correlation coefficient of 0.64 confirms this finding (table 6). In all other periods, swap rates do not help to identify CCT opportunities or changes on the currency market in the following week.

Table 6

Summary statistics. Pearsons Correlation between swap rates and log currency return based on weekly data.

	0	1	2	3	4	5	6	all
Pearson	0.64	0.07	0.01	-0.12	0.20	0.10	-0.26	-0.02

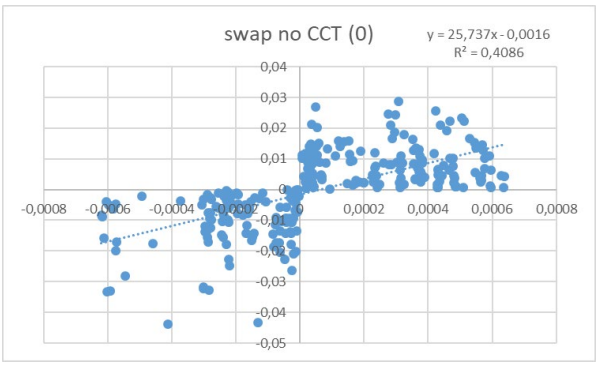
5. Conclusion

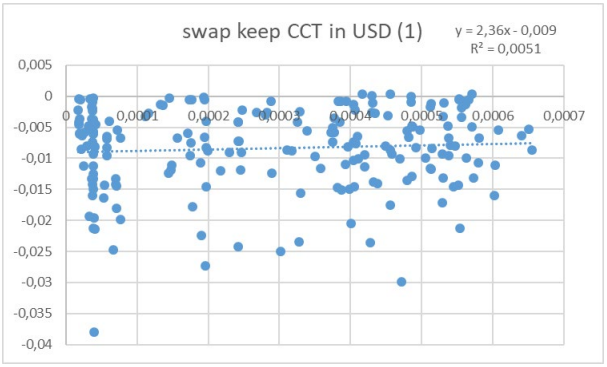
In chapter 2, we discuss the existing literature on the predictability of exchange rates and the role of interest rates and their differentials on international markets. We identify a list of indicators that might influence exchange rate movements in the short and the long run PPT and CIRP tell us that the higher-yielding currency will tend to depreciate. However, CCT strategies profit from the contrary, as we present in chapter 3. The existence of CCT opportunities depends on a negative correlation between exchange rate changes and yield differences. Opening a CCT position might be some days too late, but the risk is to hold CCT positions and to miss the day to close it. We explain this with the unpredictable ending of CCT opportunities. In chapter 4, we present our data. We use spot rates and interest rates for USD and EUR based both on one month and one week over the past 20 years. First, we identify CCT opportunities between USD and EUR. We define a CCT as successful if the actual spot rate was below the calculated forward rate one month ago and the target currency is higher yielding. Table 2 lists the annualized log excess return for interest rates, changes in exchange rates and the CCT strategy. The excess return an investor can realize is attractive.

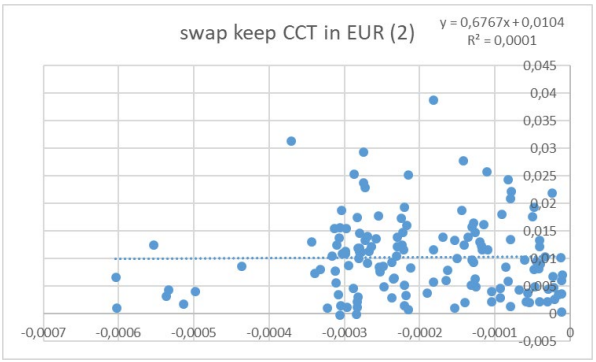
Based on the findings of the excess return of a CCT strategy, we analyze weekly data of the spot rate between USD and EUR as well as the interest rate of each currency. As a result, we can not identify any significant determinants for exchange rate movements. This is puzzling because even regression analysis between swap and exchange rates, as well as Pearson correlation cannot help to explain changes in CCT opportunities or spot rates. In summary, generally available short run data like interest rates and spot rate movements as well as their volatility fail to predict opportunities for CCT. Combining the results of our sample, we conclude that there are more indicators with important influence. We state that exchange rates change more frequently than interest rates and the difference between them. Unfortunately, we did not have access to other short-term data to test other indicators. Our results are in line with other research that tried and failed to identify market data that predict ongoing CCT opportunities. These results raise important issues for further empirical and theoretical research in international finance. Our sample leads to the conclusion that soft facts like herding behavior might have greater influence on how long CCT opportunities last. Further research should expand on this by a vast survey of investors.

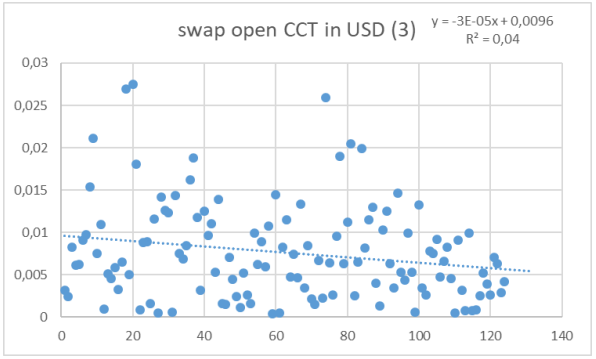
Appendix 1

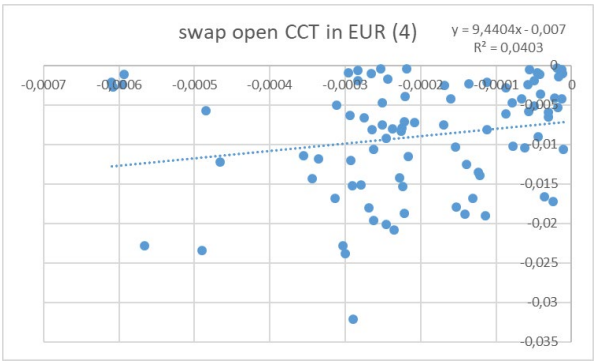
Regression between the swap rate and the log currency return based on the weekly data.

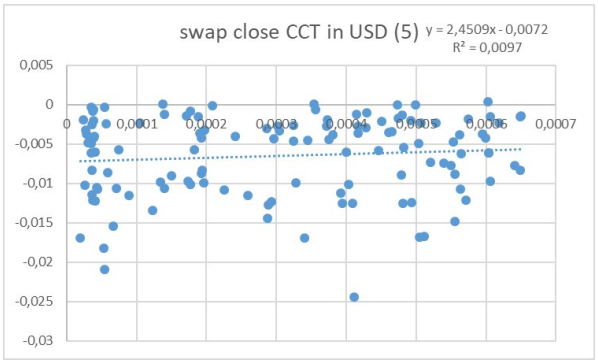


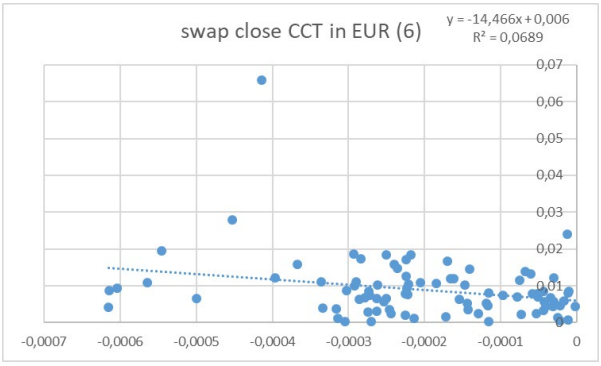


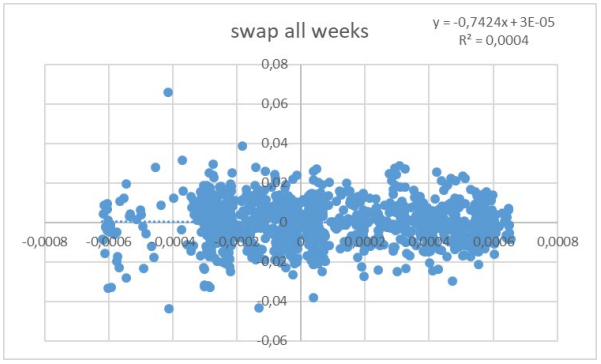












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