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SNB Working Papers
17/2018

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SWISS NATIONAL BANK

Legal Issues

ISSN 1660-7716 (printed version)
ISSN 1660-7724 (online version)

Carry trade and forward premium puzzle from the perspective of a safe-haven currency *

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December 14, 2018

Abstract

Swiss franc exchange rates exhibit features ("safe-haven characteristics") that suggest a close link between the forward premium puzzle and the profitability of the carry trade. However, recent evidence based on US dollar exchange rates suggests that the two phenomena are distinct from each other. Our empirical analysis of Swiss franc exchange rates supports this view. In contrast to US dollar evidence, persistent exposures to two different global shocks appear to be the underlying drivers of the two phenomena in Swiss franc exchange rates. This finding highlights the importance of incorporating two separate global shocks in asset pricing models of exchange rates. Moreover, we find tentative evidence suggesting that expected average Swiss franc exchange rate changes exhibited countercyclical features during the

*We are grateful to an anonymous referee of the SNB working paper series, Helmut Elsinger (discussant), Petra Gerlach, and participants in the SNB Brown Bag Seminar and the annual BuBa-OeNB-SNB Workshop 2018 (Vienna) for helpful comments and suggestions. Substantial parts of this research project have been conducted while David R. Haab was at the Swiss National Bank. Any errors and omissions are our own. The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the authors. They do not necessarily reflect the views of the Swiss National Bank. The Swiss National Bank does not take responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper.

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period of the minimum Swiss franc exchange rate against the euro, but not in the rest of the sample period.

JEL: F31, G12, G15

KEYWORDS: currency return, exchange rate, forward premium, interest rate differential, UIP

1 Introduction

Deviations from the uncovered interest parity (UIP) condition occur in the form of profitable foreign currency investment strategies, such as the carry trade (CT), and the forward premium puzzle (FPP). The CT is profitable because exchange rates do not sufficiently adjust to balance the interest rate differential that results from investing in high interest rate currencies and borrowing in low interest rate currencies. The FPP refers to the stylized fact that forward exchange rates provide a biased forecast of future nominal spot exchange rates, such that the forward premium - the difference between forward and spot exchange rates - tends to forecast subsequent exchange rate appreciations when UIP implies a subsequent depreciation and vice versa.[1] One strand of the foreign exchange rate literature argues that the FPP arises from an omitted variable bias in the regressions that are usually used to document this puzzle. The omitted variable is a risk premium that investors require in order to be induced to invest abroad and take the foreign exchange rate risk. From that perspective, the FPP and the profitability of currency investment strategies, such as the CT, are intimately linked. Engel (2014) provides an excellent recent survey of this and other strands of the foreign exchange rate literature dealing with violations of the UIP condition.

However, Hassan and Mano (2017) show that the CT and the FPP require separate explanations. They propose a unified, multicurrency framework to decompose returns on foreign currency portfolios and the elasticity of currency returns to the forward premium into three different dimensions: a cross-currency, a cross-time and a cross-currency-and-time dimension. Only the cross-currency-and-time dimension is common to both CT and FPP.

The authors focus on US dollar (USD) exchange rates and find that the CT primarily reflects the cross-currency dimension of UIP violations, i.e., persistent cross-sectional differences in interest rates. By contrast, the FPP

[1] Lothian and Wu (2011) highlight that this feature of the data is largely confined to the post-Bretton Woods period.

mainly reflects the cross-time dimension, i.e., the time variation in interest rate differentials. The FPP is linked to a recently proposed "dollar trade" strategy that exploits the time variation of the average interest rate difference between the US and the rest of the world as a sign of taking long or short positions in foreign currencies (Lustig et al., 2014). The common element of CT and FPP - the cross-currency-and-time dimension - plays no significant role in explaining either of the two phenomena.

Against this background, we apply the Hassan and Mano (2017) multi-currency framework to Swiss franc (CHF) exchange rates with nine other major currencies. We focus on CHF exchange rates because the literature has identified features of CHF exchange rates and interest rates that, at first glance, suggest an intimate link between currency investment strategies and the FPP. Hence, it is not clear whether the main conclusions of Hassan and Mano (2017) hold for CHF exchange rates. One of these features is the perception of the CHF as a safe haven for global investors (e.g. Grisse and Nitschka, 2015; Hoffmann and Suter, 2010; Kugler and Weder, 2005; Ranaldo and Söderlind, 2010). The CHF tends to appreciate in times of financial stress and thus delivers a "safety premium." This safety premium appears to be a distinct feature of CHF exchange rates, which is fundamentally different from the insurance value provided by the USD in times of global financial stress (Leutert, 2018). In addition, Swiss interest rates tend to be relatively low. This feature of Swiss interest rates could be observed over many decades (Baltensberger and Kugler, 2016). Hence, low interest rates have long made the CHF an attractive funding currency in carry trades or other currency investment strategies. The insurance value of CHF investments in times of severe stress potentially explains the on-average low level of Swiss interest rates as well (Kugler and Weder, 2002, 2004). Taken together, these features of CHF exchange rates and interest rates appear to be linked by global investors' risk-return tradeoffs. This suggests that the FPP and risk premia on foreign currency investments reflect the same underlying drivers.

Our empirical analysis uses monthly CHF data. The sample period runs from January 1985 to October 2016. We follow Hassan and Mano (2017) and assess the elasticity of currency returns to the forward premium using currency portfolios and regressions. We directly compare our findings from the analysis of CHF data with the corresponding results for USD exchange rates to highlight similarities and differences.

Similar to Hassan and Mano (2017), we find that the cross-currency dimension in the forward premium is mainly responsible for the profitability of the CT. Analogous to the USD evidence, the FPP is intimately linked to a "CHF" trade strategy that goes long foreign currencies whenever the average forward premium is positive and goes short foreign currencies whenever the average forward premium is negative. The similarity in terms of what dimension of the forward premium determines the CT is not surprising because it is well established that the portfolio-based CT is independent from a base currency (Lustig et al., 2011). The CT reflects persistent differences in exposures to global shocks. However, the FPP is dependent on which currency's perspective we take. Therefore, it is interesting that we also find that a "CHF" trade (or more generally the "base currency" trade) is the main driver of the FPP in CHF exchange rates.

The major difference between CHF and USD exchange rates in the context of the Hassan and Mano (2017) framework shows up in the underlying driver of the "base currency" trade. The difference is reflected in the observation that the average Swiss interest rate difference vis-à-vis the rest of the world varies minimally over time and Swiss interest rates tend to be persistently lower than average interest rates in the rest of the world. By contrast, the average US forward premium varies more and exhibits countercyclical dynamics. We use the reduced form model of exchange rate determination by Lustig et al. (2014) to interpret and highlight the implications of this finding for the CHF trade and thus the FPP in CHF exchange rates.[2] In a nutshell, our evidence is consistent with the view that the CHF trade mainly reflects persistent exposure to a global shock. Hence, both CT and FPP in CHF exchange rates reflect global drivers. This finding is consistent with Kugler and Weder (2002, 2004) who point out that Swiss-specific shocks cannot explain the persistent deviations of CHF exchange rates from UIP and the persistently low Swiss interest rate levels. Taken together, these findings are also in line with Lustig et al. (2014) and Verdelhan (2018), who argue that models of exchange rate determination should feature two global shocks to make sense of the profitability of the CT and the base currency trade at the same time. Our results reinforce this point as CT and FPP in CHF exchange rates are clearly different from each other but both appear to reflect persistent exposure to global shocks.

A byproduct of our analysis is the assessment of the (in-sample) predictive ability of global and country-specific economic conditions for average currency returns and exchange rate changes. We find weak predictive power of Swiss-specific macroeconomic conditions for future currency returns during the period of the minimum Swiss franc exchange rate against the euro. By contrast, there is no sign of countercyclicality in expected currency returns in the rest of the sample period.

The remainder of this paper is as follows. The second section introduces the Hassan and Mano (2017) framework. Section 3 briefly describes the

[2]The Lustig et al. (2011, 2014) model is based on no-arbitrage conditions. One might argue that such a model is not well suited to describe Swiss franc exchange rate behaviour in the latter part of our sample period because the Swiss National Bank has directly intervened in foreign exchange markets since 2009/2010, which may have introduced arbitrage opportunities. We think this model is nonetheless a useful theoretical workhorse to consider the underlying drivers of CHF exchange rates because a major part of the foreign exchange market interventions were used to enforce the minimum exchange rate of the Swiss franc against the euro (EURCHF). Our sample of currencies, however, does not feature the EURCHF. In addition, our empirical analyses account explicitly for the possibility that the main, i.e., full sample results, might have been affected by the minimum EURCHF period.

data. Section 4 presents the empirical results, and section 5 concludes. The appendix provides additional results and robustness checks.

2 Hassan-Mano decomposition of the elasticity of currency returns to the forward premium

2.1 Background

The usual starting point of assessments of the UIP condition is a regression of realized, bilateral spot exchange rate changes between t and $t+1$ on the forward premium observed in t (Fama, 1984; Hansen and Hodrick, 1980; Tryon, 1979)[3]

$$\Delta s_{i,t+1} = a_i + \beta_i(f_{it} - s_{it}) + \varepsilon_{i,t+1} \tag{1}$$

or a regression of bilateral currency returns on the forward premium

$$cr_{i,t+1} = a_i + \gamma_i(f_{it} - s_{it}) + \varepsilon_{i,t+1} \tag{2}$$

in which f_{it} denotes the log forward rate of currency i at time t, s_{it} denotes the log spot exchange rate of currency i at time t, the currency return is $cr_{i,t+1} = f_{it} - s_{i,t+1}$ (or currency excess return in the terminology of Lustig et al. (2011). We use both terms interchangeably.) and changes in spot exchange rates are denoted as $\Delta s_{i,t+1} = s_{i,t+1} - s_{it}$. $f_{it} - s_{it}$ is the forward premium, fp_{it}.

[3]Under the assumption that covered interest parity (CIP) holds, the forward premium is equivalent to the interest rate differential. This assumption was uncontroversial before the global financial crisis (Akram et al., 2008) but is currently the topic of active debate. Du et al. (2017) find that there have been systematic violations of the CIP since the global financial crisis. Sushko et al. (2016) argue that this evidence is associated with a combination of financial institutions' demand to hedge foreign currency risk in forward exchange rate markets and binding constraints from balance sheet costs. Rime et al. (2017) argue that the documented CIP deviations reflect money market segmentation rather than arbitrage opportunities. They conclude that the CIP in fact holds remarkably well.

UIP predicts point estimates of $\beta_i = 1$ and thus $\gamma_i = 0$. Even though there are variations in estimates of β_i and γ_i across different currency samples and sample periods, estimates of β_i tend to be smaller than one or even negative and estimates of γ_i to be larger than zero or even larger than one. Hassan and Mano (2017) present recent estimates of these regression coefficients for USD exchange rates. Grisse and Nitschka (2015) report estimates for CHF exchange rates.

These observations suggest that differences in interest rates between currency areas are not balanced by subsequent exchange rate changes. Investment strategies exploiting cross-sectional differences in interest rates as sign of future currency returns are hence profitable on-average. The FPP, reflected in estimates of β_i and γ_i, and on average positive returns on the strategy shorting portfolios of currencies from economies with low interest rates and buying currencies of high interest rate economies - the CT - appear intimately linked.

2.2 Decomposition of the elasticity of currency returns to the forward premium

Hassan and Mano (2017) argue that the CT and the FPP reflect different dimensions of the violation of the UIP condition. To assess this hypothesis empirically, they propose a multicurrency framework to study UIP violations in returns on currency portfolios and in regression analysis. Key to their analysis is the decomposition of the unconditional sensitivity of currency returns to the forward premium into three different dimensions. We present their decomposition first in the context of currency portfolios and then in the context of regressions of currency returns on the forward premium.

2.2.1 Portfolio returns

CT and FPP reflect different dimensions of the forward premium. Figure (1) illustrates the main argument from the perspective of a US investor.[4] An investor following the CT strategy borrows in low interest rate economies and invests in high interest rate economies. Over the period from 1995 to 2010, interest rate levels in Japan were always lower than interest rates in New Zealand. A CT investor would have always borrowed in Japan (and thus have taken a short position in Japanese yen) and invested in New Zealand (and thus have taken a long position in New Zealand dollar) as illustrated in the left panel of figure (1). What is relevant for the CT is the cross-currency dimension of the forward premium. Expressing the FPP as an investment strategy, the US investor would have gone long (short) the Japanese yen or the New Zealand dollar whenever the currency-specific forward premium was unusually high (low). Hence, an investor could simultaneously be short or long both currencies in such a "forward premium puzzle" trade (FPP trade). What is relevant for the FPP trade is the cross-time dimension of the country-specific forward premium, i.e., whether the country-specific forward premium is higher or lower than usual (Bekaert and Hodrick, 2008). This strategy is illustrated in the right panel of figure (1).

[figure (1) about here]

Throughout the paper we follow the notational conventions of Hassan and Mano (2017) and denote means in different dimensions of the data by overlines and leaving the subscript of the dimension in which the mean has been taken. For example, $\overline{fp_i} \equiv \frac{1}{T}\sum_{t=1}^{T} fp_{it}$ denotes the time series average of currency i's forward premium and $\overline{fp_t} \equiv \frac{1}{N}\sum_{n=1}^{N} fp_{it}$ denotes the cross-sectional mean of the forward premium at each time t. Variables without subscripts and an overline denote averages over time and across currencies.

[4] We are grateful to Tarek Hassan for providing us with the original figure.

$\sum_{i,t}$ denotes a double-sum over currency i and time t. The superscript e indicates expectations.

There are many different ways to implement a CT strategy (e.g., Burnside et al., 2011; Barroso and Santa Clara, 2015). Hassan and Mano (2017) propose to look at a CT that weights each currency return by the difference between the currency-specific forward premium and the average of all foreign premia at each point in time. The expected return on this CT portfolio is given by $\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp_t})]$. Following the reasoning of the implementation of a trade that exploits the FPP, the expected return on this "forward premium" trade portfolio is $\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_i^e)]$.

The CT is neutral with respect to the base currency, i.e., it does not matter from which investor's perspective we form the CT portfolio. Moreover, the weights sum to zero. It is a "zero cost portfolio". Taking long or short positions in a foreign currency depends on whether the forward premium of that currency is higher or lower than the average forward premium in the rest of the world at a given point in time. By contrast, the FPP trade is not independent of the base currency, i.e., whether we take the perspective of a US or Swiss investor, because the signal to borrow or invest in a specific currency is the level of the forward premium relative to its currency-specific "usual" level. In addition, the investor has to form beliefs about this "usual" level of the currency-specific forward premium i.e., $\overline{fp}_i^e$, ex ante.

The use of linear portfolio weights in forming the portfolio returns, and tying the weights to the forward premium, allows us to directly compare the evidence based on portfolio returns with evidence from regressions of currency returns on the different dimensions of the forward premium.

Hassan and Mano (2017) show that the expected returns on the portfolios following CT or the FPP trade strategy exploit three different dimensions of the violation of UIP. One of these three dimensions is the cross-sectional difference between interest rates ("static trade"). Trading on this cross-currency dimension of the UIP violation means that an investor takes a long position in currencies that are expected to have a high forward premium in the future and short currencies that are expected to have a low forward premium in the future. The investor forms beliefs about the future forward premium, weights the currencies in the portfolio accordingly at the time of the investment, and never updates the weights until the end of the investment horizon. The return on a portfolio exploiting this strategy is $\sum_{i,t}[cr_{i,t+1}(\overline{fp}_i^e - \overline{fp}^e)]$. The second dimension is related to the cross-currency-and-time variation in the forward premium. Implementing a trading strategy ("dynamic trade") that exploits this variation requires taking long positions in currencies that are expected to exhibit a high forward premium relative to the rest of the world and at the same time are characterized by high a forward premium relative to their currency-specific mean. The return on a portfolio exploiting this dynamic trade obeys $\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t - (\overline{fp}_i^e - \overline{fp}^e))]$. Lastly, investors could exploit the time variation of the unconditional average interest rate difference between the base currency (in this paper USD or CHF) and the rest of the world as a signal of taking long or short positions in foreign currencies (Lustig et al., 2014). The return on the portfolio exploiting this base currency trade is $\sum_{i,t}[cr_{i,t+1}(\overline{fp}_t - \overline{fp}^e)]$.

The return on the CT portfolio is the sum of the return on the static trade portfolio and the return on the dynamic trade portfolio, i.e.,

$$\begin{aligned}\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t)] = &\sum_{i,t}[cr_{i,t+1}(\overline{fp}_i^e - \overline{fp}^e)] \\ &+ \sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t - (\overline{fp}_i^e - \overline{fp}^e))]\end{aligned} \tag{3}$$

The return on the FPP trade portfolio is the sum of the return on the base currency trade portfolio and the return on the dynamic trade portfolio, i.e.,

$$\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_i^e)] = \sum_{i,t}[cr_{i,t+1}(\overline{fp}_t - \overline{fp}^e)] + \sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t - (\overline{fp}_i^e - \overline{fp}^e))] \tag{4}$$

The return on the dynamic trade portfolio is the common element among the CT and the FPP trade. Hence, if the two phenomena are linked, then we expect the return on the dynamic trade portfolio to be the main driver of the expected returns on both CT and FPP trade portfolio.

In the subsequent empirical part, we follow the baseline case in Hassan and Mano (2017) and assume that past average values of the currency-specific forward premium are the investor's best guess for future currency-specific forward premiums. Hassan and Mano (2017) examine different alternatives to model expectations about currency-specific forward premium. These alternatives deliver very similar results to the baseline case.

2.2.2 Regression coefficients

Analyzing returns on portfolios formed according to different dimensions of UIP violations helps to assess their economic significance for the CT and the FPP. Regression analysis allows one to assess the statistical significance of the different dimensions of UIP violations for the CT and the FPP.

Hassan and Mano (2017) show how to rewrite the relationships between the different portfolio returns into regression form. In general, the regressions boil down to running pooled regressions of currency returns on the dimension of the forward premium that is used to compute portfolio weights and adjusting standard errors accordingly.

The static trade regression takes the following form

$$cr_{i,t+1} - \overline{cr}_{t+1} = \gamma^{static}(\overline{fp}_i^e - \overline{fp}^e) + \varepsilon_{i,t+1}^{static} \tag{5}$$

while the corresponding regression for the base currency trade is

$$cr_{i,t+1} - \overline{cr}_{t+1} = \gamma^{base}(\overline{fp_t} - \overline{fp}^e) + \varepsilon^{base}_{i,t+1} \tag{6}$$

The common element of the CT and the FPP trade is the dynamic trade. We assess the statistical significance of this dimension of UIP violation with the regression

$$cr_{i,t+1} - \overline{cr}_{t+1} = \gamma^{dyn}(fp_{it} - \overline{fp_t} - (\overline{fp}^e_i - \overline{fp}^e)) + \varepsilon^{dyn}_{i,t+1} \tag{7}$$

The FPP trade regression is given by

$$cr_{i,t+1} - \overline{cr}_{t+1} = \gamma^{fpp}(fp_{it} - \overline{fp}^e_i) + \varepsilon^{fpp}_{i,t+1} \tag{8}$$

and we assess the statistical significance of the CT trade in regression

$$cr_{i,t+1} - \overline{cr}_{t+1} = \gamma^{carry}(fp_{it} - \overline{fp_t}) + \varepsilon^{carry}_{i,t+1} \tag{9}$$

3 Data

In the empirical analysis, we use spot and one-month forward exchange rate data provided by Reuters and Barclays and downloaded from Thompson Reuters Eikon. The data frequency is monthly and the sample period runs from January 1985 to October 2016. We focus on CHF exchange rates against the other "G10 currencies", i.e., the Australian dollar (AUD), Canadian dollar (CAD), British pound (GBP), Japanese yen (JPY), Norwegian krone (NOK), New Zealand dollar (NZD), Swedish krona (SEK) and the US dollar (USD). We use the Danish krone (DKK) as a stand-in for the euro area because it has been closely linked to either the Deutschmark (before the introduction of the euro area) or the euro. The same currencies are used in the corresponding robustness checks from the US point of view. We compute the CHF exchange rates from cross-rates of USD and GBP exchange rates.

Moreover, we assess whether USD or CHF currency returns exhibit countercyclical features. To this end, we use the amplitude adjusted OECD composite leading indicator (CLI) of the countries under study to empirically approximate their economic conditions. This indicator is interpretable as a sign of business cycle turning points and closely related to deviations from industrial production indices from trend (OECD, 2009). The CLI data are publicly available on the website of the OECD.

To conserve space, we focus on the sample that uses December 1998 as end date of the formation of beliefs about the expected forward premium. We chose this date because the euro was introduced in January 1999, which constituted a major event on foreign exchange markets. We report robustness checks using different end dates of the belief formation in the appendix. These robustness checks qualitatively confirm the baseline results presented in the subsequence.

4 Empirical results

This section presents all of the main results. The appendix provides additional results and robustness checks.

4.1 Hassan-Mano decomposition

We focus first on the evidence from foreign currency portfolios and then turn to the regression analysis.

4.1.1 Portfolio returns

Table (1) summarizes the outcome of the portfolio formation outlined in section 2.2.1. The first three lines of table (1) give the mean currency returns on the static, dynamic and base currency trade portfolios. The last two lines present the returns on the CT and FPP trade portfolio along with the percentage of the mean return that is explained by the static trade in the case of the CT or the base currency trade in the case of the FPP trade.

The CHF evidence is similar to the main results of Hassan and Mano (2017). The returns on the static trade are responsible for approximately 80% of the return on the CT. The base currency trade, i.e., the CHF trade, explains 72% of the return on the portfolio following an investment strategy that exploits the FPP.

The corresponding evidence based on USD exchange rates is very similar. The CT return primarily reflects the return on the static trade portfolio. The base currency trade is mainly responsible for the return on the portfolio exploiting the FPP.

Taken together, the CHF evidence based on returns on currency portfolios confirms Hassan and Mano (2017). The main driver of the CT is the cross-currency dimension of the CHF forward premium, which is reflected in the static trade portfolio. The main driver of the FPP in CHF exchange rates is the cross-time dimension of the forward premium, which is reflected in the base currency portfolio.

[table (1) about here]

4.1.2 Baseline regression analysis

This section assesses the statistical significance of the decomposition of the returns on the currency portfolios. We use the regression setup outlined in equations (9) to (6) for that purpose. Table (2) summarizes the results. The standard errors of the CT, the FPP trade and the dynamic trade are Newey-West (Newey and West, 1987) corrected using a lag length of 12 months. The standard errors of the static trade regression are clustered by currency, whereas the standard errors of the base currency trade are clustered by time (Hassan and Mano, 2017).

The regression analysis corroborates the impression left by the analysis of the portfolio returns. Economic significance goes hand in hand with statistical significance. Irrespective of the base currency (CHF or USD), currency returns load significantly on the cross-currency dimension of the forward premium, i.e., the static trade. The regression coefficients of γ^{static} are significantly different from zero. The regression coefficient for CHF currency returns is 0.6 with a standard error of 0.24. The corresponding estimate for USD currency returns is 0.5 with a standard error of 0.2. Moreover, we find significant estimates of γ^{base} ranging between 1.3 and 1.5 for CHF and USD currency returns respectively. By contrast, estimates of γ^{dyn} are indistinguishable from zero. Hence, the significance of the CT and the FPP trade estimates reflect different underlying drivers. CT and FPP are different phenomena.

Analogous to the decomposition of the portfolio returns, Hassan and Mano (2017) show that γ^{carry} is a linear combination of γ^{static} and γ^{dyn} while γ^{fpp} is a linear combination of γ^{base} and $\gamma^{dynamic}$. These relations allow us to calculate partial R^2 that illustrates how much of the variation in the CT and the FPP trade is related to one of their two components.[5] The partial R^2 of the static trade is 0.93 in the case of CHF exchange rates and 0.79 in the case of USD exchange rates. We also find that the base currency trade explains most of the variation in the FPP trade. The partial R^2 of the base currency trade is close to unity for both CHF and USD exchange rates.

Taken together, the regression results corroborate that FPP and CT are separate phenomena. The common element of the two phenomena, the dynamic dimension of the forward premium, does not explain much of the variation in returns on the CT and the FPP trade. This observation pertains to

[5] We follow Hassan and Mano (2017) and calculate the partial R^2 of the static trade in the CT regression as the explained sum of squares (ESS) of the static trade divided by the sum of the ESS of the static and the dynamic trade. Correspondingly, the partial R^2 of the base currency trade in the FPP trade is the ESS of the base currency trade divided by the sum of the ESS of the base currency and the dynamic trade.

CHF and USD exchange rates.

[table (2) about here]

The regression results also show that the empirical evidence suggesting that the FPP in CHF exchange rates is less pronounced than the link between currency returns and the forward premium in the CT regressions.

The appendix provides the corresponding results when we use different end dates of the belief formation about future currency-specific forward premium. In addition, the appendix provides CHF estimates of the baseline regressions when we end the sample period in August 2011, i.e., when we exclude the period since the introduction of the minimum CHF exchange rate against the euro (EURCHF).[6] The baseline regression results are qualitatively unaltered, but the robustness checks show that the evidence in support of the presence of the FPP varies over time. This finding has been highlighted by Hassan and Mano (2017), and we corroborate it in our setting.

4.2 A closer look at the base currency trade from the perspective of a no-arbitrage model of exchange rates

At first glance, the finding that the FPP in both CHF and USD exchange rates is driven by the base currency trade suggests that the underlying drivers of the FPP are the same. However, the base currency trade depends on the time variation of the average forward premium, i.e., the time variation in the difference between the base currency's interest rate and the average interest rate of the rest of the world. In our sample of currencies, we observe strong differences between the average forward premium of CHF exchange rates and USD exchange rates as depicted in figure (2). The CHF average forward premium varies minimally compared with its USD counterpart. It has almost always been positive for the past twenty years. This fact implies that the CHF

[6] The minimum EURCHF rate was introduced on 6 September 2011 to counter a massive appreciation of CHF exchange rates amid the sovereign debt crisis in the euro area.

trade amounted to persistently taking long positions in foreign currencies. By contrast, we observe more variation in the USD average forward premium. It varies between negative and positive values and thus temporarily takes long or short positions in foreign currencies.

What does this difference between the USD and the CHF average forward premium imply for the underlying drivers of the base currency trade and thus the FPP? The starting point of this discussion is the link between (real) log bilateral exchange rate changes (Δq_{t+1}) and log stochastic discount factors (m_{t+1}) in the home and foreign country (Backus et al., 2001). In the absence of perfect risk sharing,

$$\Delta q_{i,t+1} = m_{t+1} - m_{i,t+1} \tag{10}$$

in which superscript i indicates the foreign country. Shocks that drive the discount factors also drive (real) interest rates because a bond with price b obeys $b_t = E_t m_{t+1}$, such that net interest rates, r, follow $r_t = -log(b_t) = -log\ E_t m_{t+1}$. Consequently, shocks that drive the volatility of the stochastic discount factors are also reflected in movements of the (bilateral) forward premium because of covered interest rate parity, i.e.,

$$f_{it} - s_{it} = log\ E_t m_{i,t+1} - log\ E_t m_{t+1} \tag{11}$$

in which m_{t+1} is the stochastic discount factor of the home country and inflation terms are neglected.

Lustig et al. (2014) and Verdelhan (2018) highlight that the profitability of the CT and the profitability of the USD trade can only be reconciled in an exchange rate model which features stochastic discount factors with two state variables and three shocks. The state variables are country-specific, $z_{i,t}$, and global, $z_{w,t}$. The shocks driving the volatility of the stochastic discount factors are also country-specific and global. In the model framework of Lustig et al. (2014) the log stochastic discount factor of country i obeys

$$-m_{i,t+1} = a + \chi z_{i,t} + \sqrt{\gamma z_{i,t}} u^{i}_{t+1} + \tau z_{w,t} + \sqrt{\delta^{i} z_{w,t+1}} u^{w}_{t+1} + \sqrt{\kappa z_{i,t}} u^{g}_{t+1} \quad (12)$$

The two global shocks are distinct from each other. Countries exhibit persistent differences in exposures to the first type of global shocks, u^{w}_{t+1}. The second type of global shocks, u^{g}_{t+1}, is characterized by the following features. On average, all countries exhibit equal exposure to u^{g}_{t+1} but their exposures, $\sqrt{\kappa z_{i,t}}$, to u^{g}_{t+1} vary over time. The time-varying exposures to the second global shock depend on country-specific economic conditions, $z_{i,t}$.

Hence, the unconditional CT - going long in currencies with on average high interest rates and going short currencies with on average low interest rates - reflects the persistent differences in exposures to u^{w}_{t+1}. Implementing the CT with portfolios of currencies, the country-specific shocks and the heterogeneity with respect to the second global shock wash out when the number of currencies in the portfolio is sufficiently large (Lustig et al., 2011). By contrast, the base currency trade - exploiting time variation in the average forward premium - depends on the country-specific shocks and the time-varying exposures to the second global shock because time variation in the average forward premium from the perspective of country i reflects country-specific economic conditions (Lustig et al., 2014; Verdelhan, 2018). More formally, the average forward premium - the difference between average interest rates in the rest of the world ($\overline{r}_t$) and the country-specific interest rate (r_t) - follows

$$fp_t = (\overline{r}_t - r_t) = (\chi - \frac{1}{2}(\gamma + \kappa))(\overline{z}_t - z_t) + \frac{1}{2}(\delta - \overline{\delta}) z_{w,t} \quad (13)$$

In the case of the US, the average forward premium varies over time and takes negative and positive values, which suggests that the US is not different from the average country in our sample, i.e., $\delta^{US} = \overline{\delta}$ with $\overline{\delta}$ the cross-country average of δ^{i}. In that case, the dollar trade reflects time-varying exposure to a global shock. This time variation is dependent on US-specific economic conditions, z_t^i (Lustig et al, 2014). By contrast, the Swiss average forward premium varied minimally and has been persistently positive over the past twenty years. This suggests that Switzerland exhibits relatively high exposure to the global state variable, i.e., $\delta^{CH} > \overline{\delta}$. Hence, the CHF trade and thus the FPP in CHF exchange rates does not necessarily reflect Swiss-specific economic conditions. This reasoning is in line with Kugler and Weder (2002, 2004), who argue that persistently low interest rates in Switzerland and UIP deviations cannot be explained by Swiss-specific variables.

Consistent with the theoretical framework discussed above, Lustig et al. (2014) show that the average forward premium tends to be low/negative in economic booms in the US and high/positive during recessions in the US. This countercyclicality of the average forward premium leads to predictive power of the average forward premium for future USD currency returns. By contrast, we do not observe strong variability of the Swiss average forward premium. Hence, we would not expect to see any forecast ability of the average forward premium for CHF currency returns.

We assess this hypothesis by running time series regressions of the average currency returns (and average changes in spot exchange rates) from the US and Swiss perspectives on the respective average forward premium (Lustig et al., 2014), i.e.,

$$\overline{cr}_{t+1} = \mu + \gamma \overline{fp}_t + \varepsilon_{t+1} \tag{14}$$

and

$$-\Delta \overline{s}_{t+1} = \mu + \delta \overline{fp}_t + \varepsilon_{t+1} \tag{15}$$

with $\Delta \overline{s}_{t+1}$, the average spot exchange rate change from t to $t+1$. To be consistent with the baseline regression results presented above, we run this regression for the time period from January 1999 to October 2016.

Table (3) summarizes the results. We confirm the original results of

Lustig et al. (2014) for the US. The average forward premium significantly predicts average currency returns one-month ahead. The R^2 is 2%. The evidence is weaker for changes in spot exchange rates, but we do observe a marginally significant regression coefficient as indicated by the bootstrapped p-values. US dollar excess returns vary over time and are predictable. By contrast, we find no evidence of predictive ability of the average forward premium for CHF currency returns. The R^2 statistic is zero and none of the regression coefficients is statistically significantly different from zero. This finding suggests that expected excess returns on Swiss franc exchange rates are constant. We find no evidence of predictability in CHF spot exchange rate changes.

[table (3) about here]

4.3 Expected average currency returns and macroeconomic conditions

4.3.1 USD versus CHF evidence

The average forward premium predicts average USD currency returns. According to Lustig et al. (2014), this evidence reflects the countercyclical nature of USD currency returns. We can directly test the countercyclicality of currency returns by a regression of average currency returns and exchange rate changes on global and country-specific macroeconomic variables. As a proxy of economic conditions in the respective countries under study, we use the OECD composite leading indicator (CLI). The CLI is closely related to deviations of industrial production indices from trend and thus a sign of the business cycle. To distinguish between common and idiosyncratic macroeconomic dynamics, we first run a regression of either the US or the Swiss CLI on the first principal component of all the other countries' CLIs.[7] The

[7]The first principal component explains about 60% of the common variation in CLIs. The first three principal components explain more than 80% of the common variation. The

residual of this regression is the idiosyncatic part, CLI_t^{idio}, and the fitted value, CLI_t^{common}, reflects common macroeconomic fluctuations.

To assess the countercyclicality of currency returns from the US and Swiss perspectives, we run the following time series regressions of the average currency returns (or average changes in spot exchange rates) on the common and idiosyncratic components of the OECD's composite leading indicators, additionally controlling for the average forward premium, i.e.,

$$\overline{cr}_{t+1} = \mu + \delta \overline{fp}_t + \zeta CLI_t^{common} + \eta CLI_t^{idio} + \varepsilon_{t+1} \tag{16}$$

and

$$-\Delta \overline{s}_{t+1} = \mu + \delta \overline{fp}_t + \zeta CLI_t^{common} + \eta CLI_t^{idio} + \varepsilon_{t+1} \tag{17}$$

The sample period for this regression runs again from January 1999 to October 2016.

The results from regressions (16) and (17) are reported in table (4). The USD evidence is similar to the results reported in Lustig et al. (2014), who use changes in industrial production as proxy of economic conditions. The idiosycratic part of the OECD's CLIs forecasts both currency returns and spot exchange rate changes one month ahead. The R^2 is approximately 3% and 2% respectively. The estimates of the regression coefficient η in regressions (16) and (17) are statistically significantly different from zero. The negative sign reflects that a US business cycle peak predicts low average returns on foreign currencies and vice versa. This observation is evidence of countercyclical features in USD currency returns.

We also observe negative coefficients in the regressions with CHF currency returns, but they are not significantly different from zero at conventional significance levels. Neither CHF currency excess returns nor CHF exchange rates exhibit countercyclical features. From the perspective of both currencies, global macroeconomic risk does not explain currency returns or spot

results are qualitatively unaffected by the choice of the number of principal components to proxy for common macroeconomic dynamics.

exchange rate changes one month ahead. This is in line with the Lustig et al. (2014) model.

[table (4) about here]

4.3.2 The impact of the minimum EURCHF exchange rate period

The previous section highlighted that macroeconomic conditions reflected in the OECD CLIs did not predict future average CHF currency returns (exchange rate changes) over the sample period from January 1999 to October 2016. A potential explanation of this finding could be that this sample period is dominated by crisis periods which led to CHF movements that were not necessarily related to economic conditions. For example, the exchange rate of the CHF against the euro (EURCHF) fell from approximately 1.50[8] in December 2009 to almost 1 in August 2011 amid the intensification of the euro area sovereign debt crisis. The CHF also appreciated against the USD by approximately 25% over that time period. To halt this massive appreciation of the CHF and the associated risks to price stability and the Swiss economy, the Swiss National Bank (SNB) introduced a minimum EURCHF rate of 1.20 on 6 September 2011. When necessary, the SNB defended this minimum exchange rate with direct foreign exchange market interventions. These interventions were one-sided in the sense that the SNB mitigated appreciation pressure that would have resulted in a breach of the 1.20 minimum exchange rate, but it did not prevent the Swiss franc from depreciating against the euro. Hence, the minimum EURCHF rate did not constitute an exchange rate peg. The SNB discontinued the minimum EURCHF rate on 15 January 2015.

Against this background, we would expect that the link between current economic conditions and future average CHF currency returns differ between the period of the minimum EURCHF rate and the rest of the sample period.

[8] One euro bought 1.5 Swiss francs

The minimum EURCHF dampened the overall volatility of CHF exchange rates that was caused by crisis-related appreciation periods. This feature of the data supposedly makes it easier to find evidence of countercyclicality in average CHF returns in the period of the minimum EURCHF rate than in the rest of the sample period.

To assess this hypothesis, we modify the regressions (16) and (17) by multiplying $\overline{fp}$ as well as the common and idiosyncratic parts of the Swiss CLI with two dummies. The first dummy, D_t^{mr}, indicates the time period of the EURCHF minimum rate. It takes values of one from September 2011 to December 2014. The second dummy, D_t^{rest}, indicates the rest of the sample period. It takes values of zero from September 2011 to December 2014 and takes values of one in all other months of the sample period. The regressions take the following form:

$$\begin{aligned} \overline{cr}_{t+1} = \mu &+ \delta^{mr} D_t^{mr} \overline{fp}_t + \delta^{rest} D_t^{rest} \overline{fp}_t \\ &+ \zeta^{mr} D_t^{mr} CLI_t^{common} + \zeta^{rest} D_t^{rest} CLI_t^{common} \\ &+ \eta^{mr} D_t^{mr} CLI_t^{idio} + \eta^{rest} D_t^{rest} CLI_t^{idio} + \varepsilon_{t+1} \end{aligned} \tag{18}$$

and

$$\begin{aligned} -\Delta \overline{s}_{t+1} = \mu &+ \delta^{mr} D_t^{mr} \overline{fp}_t + \delta^{rest} D_t^{rest} \overline{fp}_t \\ &+ \zeta^{mr} D_t^{mr} CLI_t^{common} + \zeta^{rest} D_t^{rest} CLI_t^{common} \\ &+ \eta^{mr} D_t^{mr} CLI_t^{idio} + \eta^{rest} D_t^{rest} CLI_t^{idio} + \varepsilon_{t+1} \end{aligned} \tag{19}$$

in which the estimates of ζ^{mr} and η^{mr} directly indicate whether common or Swiss-specific macroeconomic conditions predict (in-sample) average CHF currency returns (exchange rate changes) during the period of EURCHF minimum rate. Accordingly, estimates of ζ^{rest} and η^{rest} signal whether macroeconomic conditions predicted average CHF currency returns in the rest of the sample period.

Table (5) summarizes the regression results. The left panel gives the estimates of δ^{mr},ζ^{mr} and η^{mr} and the right panel the corresponding information about δ^{rest}, ζ^{rest} and η^{rest}. In line with our hypothesis, we observe a closer link between expected average CHF returns and both common and idiosyncratic components of the Swiss CLI during the period of the minimum EURCHF rate. The point estimates of ζ^{mr} and η^{mr} are negative. The estimates of η^{mr} in the regressions of currency excess returns and exchange rate changes are significant at the 10% level. By contrast, we find no significant link between expected currency returns and common and Swiss-specific economic conditions in the rest of the sample period.

The minimum EURCHF rate appears to have altered both average currency returns and average spot exchange rate changes (through the level-shift in EURCHF at the introduction of the minimum rate) as well as the covariation with macroeconomic variables. In the language of the Lustig et al. (2014) model, the minimum EURCHF appears to have made Switzerland more similar to the average country in our sample, such that exposure to global shocks varied over time with Swiss-specific economic conditions during this specific period.

[table (5) about here]

5 Conclusions

In line with recent evidence (Hassan and Mano, 2017), this paper has highlighted that the CT and the FPP are distinct features of CHF exchange rates. The CT - borrowing in low interest rate currencies and investing in high interest rate currencies - is profitable because of persistent cross-sectional differences in interest rates. The FPP is closely linked to an investment strategy that takes a long position in foreign currencies when home interest rates are higher than in the rest of the world and short positions in foreign currencies when home interest rates are lower than in the rest of the world.

Despite the similarities that we find between USD and CHF exchange rates, the drivers of the FPP in the US and Switzerland are different. Our argument is based on a reduced-form, no-arbitrage model of exchange rates (Lustig et al., 2011, 2014) and suggests that the FPP in CHF exchange rates rather reflects persistent exposure to global shocks than Swiss-specific economic conditions. By contrast, the FPP in USD exchange rates is driven by time-varying exposure to global shocks. This time-varying exposure reflects US-specific economic conditions.

As a byproduct of our analysis we find evidence suggesting that expected average Swiss franc exchange rate changes exhibited countercyclical features during the period of the minimum Swiss franc exchange rate against the euro, but not in the rest of the sample period.

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Tables

Table 1: Average Returns on currency portfolios (in % p.a.)

	Dec 1998	
	CHF	USD
Static Trade	2.37	2.25
$\sum_{i,t}[cr_{i,t+1}(\overline{fp}_i^e - \overline{fp}^e)]$		
Dynamic Trade	0.72	0.63
$\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t - (\overline{fp}_i^e - \overline{fp}^e))]$		
Base currency trade	1.90	2.84
$\sum_{i,t}[cr_{i,t+1}(\overline{fp}_t - \overline{fp}^e)]$		
Forward premium trade	2.62	3.47
$\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_i^e)]$		
% Base currency trade	72%	82%
Carry trade	3.09	2.88
$\sum_{i,t}[cr_{i,t+1}(fp_{it} - \overline{fp}_t)]$		
% static trade	77%	78%

This table provides mean returns on currency portfolios that reflect static, dynamic, base currency, forward premium and carry trade strategies. The returns are expressed in % p.a. Dividing the maximum of the mean return on the static (base currency) trade and zero by the mean return on the carry (forward premium) trade gives the contribution of the static (base currency) trade to the mean return on the carry (forward premium) trade. The column heading "Dec 1998" indicates that beliefs about the future forward premium are formed until December 1998. CHF and USD denote Swiss franc and US dollar exchange rates respectively.

Table 2: Regression Decomposition: belief formation up to December 1998

	CHF	USD
γ^{static}	0.61**	0.49**
	(0.24)	(0.21)
γ^{base}	1.34**	1.47***
	(0.55)	(0.52)
$\gamma^{dynamic}$	0.21	0.35
	(0.44)	(0.34)
γ^{fpp}	0.93*	1.76***
	(0.54)	(0.54)
% ESS base trade	98	97
γ^{carry}	0.90**	0.79**
	(0.38)	(0.35)
% ESS static trade	93	79
Observations	1926	1926

This table provides regression coefficients from pooled regressions of currency returns on the dimension of the forward premium that are used to weight currency returns in the static, dynamic, base currency, carry trade and forward premium trade presented in equations (9) to (6). The partial R^2 of the static trade in the carry trade regression is the explained sum of squares (ess) of the static trade divided by the sum of the ess of the static and the dynamic trade. The partial R^2 of the base currency trade in the forward premium trade is the ess of the base currency trade divided by the sum of the ess of the base currency and the dynamic trade.
Standard errors (in parentheses) for the carry trade, the forward premium trade and the dynamic trade are Newey-West (Newey and West, 1987) corrected using a lag length of 12 months. The standard errors of the static trade regression are clustered by currency. The standard errors of the base currency trade are clustered by time. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively.

Table 3: Predictability of currency returns with average forward premium

	CHF		USD	
	γ	adj R^2 (%)	γ	adj R^2 (%)
Excess returns	0.83	0.26	2.36***	2.45
(NW t-stat)	(1.14)		(2.63)	
[p-value (one-sided)]	[0.15]		[0.01]	
	δ	adj R^2 (%)	δ	adj R^2 (%)
Exchange Rates	-0.18	-0.24	1.36*	0.66
(NW t-stat)	(-0.25)		(1.52)	
[p-value (one-sided)]	[0.59]		[0.07]	

This table presents coefficient estimates from regressions of average currency returns (spot exchange rate changes) from t to t+1 on the average forward premium in time t. Below the point estimates are Newey-West (Newey and West, 1987) corrected t-statistics in parenthesis and in brackets p-values from a one-sided t-test of the null of no predictability against the alternative of $\gamma > 0$ and $\delta > 0$ using bootstrapped (10000 draws) Newey-West corrected standard errors. The sample period of the in-sample forecast regression is January 1999 to October 2016. *, ** and *** denote statistical significance according to the bootstrapped p-values at the 10%, 5% and 1% level respectively.

Table 4: Predictability of currency returns with macroeconomic variables

	CHF			
	δ	ζ	η	adj R^2 (%)
Excess returns	1.59	-0.06	-0.18	-0.29
(NW t-stat)	(0.70)	(-0.50)	(-1.09)	
[p-value (one-sided)]	[0.28]	[0.37]	[0.16]	
Exchange Rates	0.58	-0.05	-0.18	-0.72
(NW t-stat)	(0.26)	(-0.50)	(-1.06)	
[p-value (one-sided)]	[0.42	[0.38]	[0.17]	

	USD			
	δ	ζ	η	adj R^2 (%)
Excess returns	3.09**	0.03	-0.64**	3.18
(NW t-stat)	(1.70)	(0.13)	(-2.10)	
[p-value (one-sided)]	[0.05]	[0.54]	[0.03]	
Exchange Rates	2.09	0.03	-0.64**	2.18
(NW t-stat)	(1.10)	(0.13)	(-2.10)	
[p-value (one-sided)]	[0.14]	[0.54]	[0.03]	

This table presents coefficient estimates from regressions of average currency returns (spot exchange rate changes) from t to t+1 on the average forward premium (δ), the common (ζ) and idiosyncratic (η) components of the OECD's composite leading indicators of Switzerland and the US observed in time t. Below the point estimates are Newey-West (Newey and West, 1987) corrected t-statistics in parenthesis and in brackets p-values from a one-sided t-test of the null of no predictability against the alternative of $\delta > 0$, $\eta < 0$ and $\zeta < 0$, using bootstrapped (10000 draws) Newey-West corrected standard errors. The sample period of the in-sample forecast regression is January 1999 to October 2016. *, ** and *** denote statistical significance according to the bootstrapped p-values at the 10%, 5% and 1% level respectively. Point estimates of ζ and η are multiplied by 100.

Table 5: Predictability of average CHF currency returns with macroeconomic variables in the minimum EURCHF period?

	Minimum rate period			Rest of sample period		
	δ^{mr}	ζ^{mr}	η^{mr}	δ^{rest}	ζ^{rest}	η^{rest}
Excess returns	7.21*	-0.48	-0.82*	2.19	-0.05	-0.15
(NW t-stat)	(1.54)	(-1.43)	(-1.51)	(0.85)	(-0.44)	(-0.86)
[p-value (one-sided)]	[0.09]	[0.12]	[0.10]	[0.24]	[0.38]	[0.23]
Exchange Rates	6.14	-0.48	-0.82*	1.17	-0.05	-0.15
(NW t-stat)	(1.31)	(-1.44)	(-1.52)	(0.46)	(-0.43)	(-0.83)
[p-value (one-sided)]	[0.14]	[0.12]	[0.10]	[0.35]	[0.39]	[0.23]

This table presents coefficient estimates from regressions of average currency excess returns (spot exchange rate changes) from t to t+1 on the average forward premium (δ), the common (ζ) and idiosyncratic (η) components of the OECD's composite leading indicators of Switzerland in time t. We additionally distinguish between the period during which the EURCHF minimum exchange rate was in place (from September 2011 to December 2014) and the rest of the sample period. Below the point estimates are Newey-West (Newey and West, 1987) corrected t-statistics in parentheses and in brackets p-values from a one-sided t-test of the null of no predictability against the alternative of $\delta > 0$, $\eta < 0$ and $\zeta < 0$, using bootstrapped (10000 draws) Newey-West corrected standard errors. The sample period of the in-sample forecast regression is January 1999 to October 2016. *, ** and *** denote statistical significance according to the bootstrapped p-values at the 10%, 5% and 1% level respectively. Point estimates are multiplied by 100.

Figures

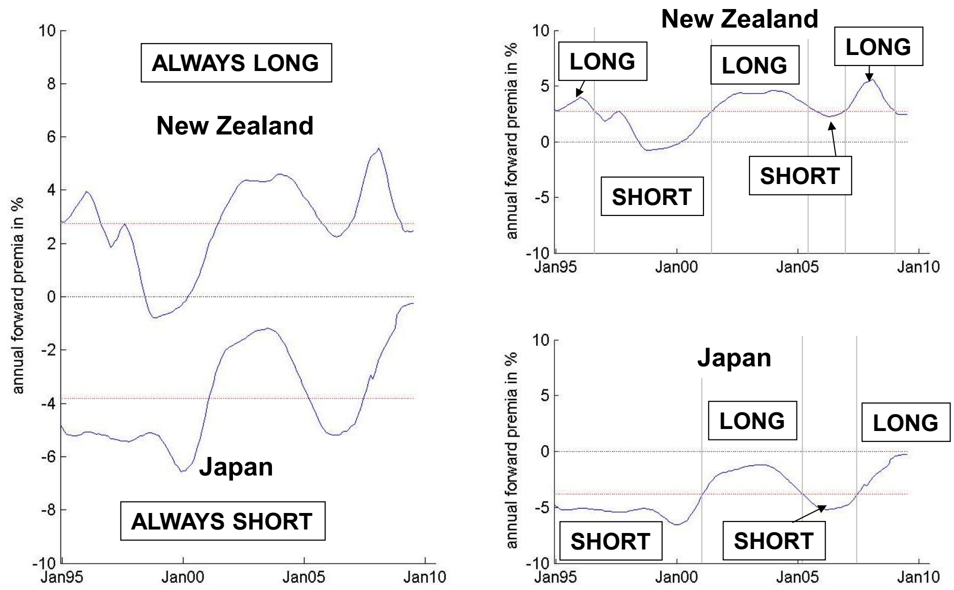

Figure 1: Carry trade (left panel) and forward premium trade (right panel). Source: Hassan and Mano (2017)

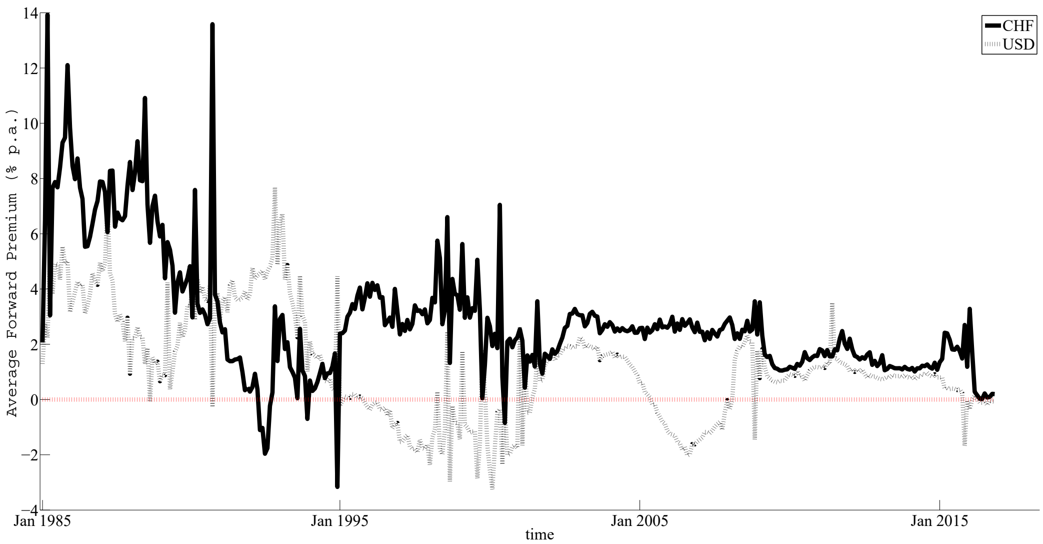

Figure 2: Average forward premium (one-month horizon): CHF and USD

A Robustness of regression-based analysis

A.1 Did the EURCHF minimum exchange rate period affect the results?

The Swiss National Bank introduced a minimum exchange rate of the Swiss franc against the euro in September 2011. The minimum exchange rate served to mitigate appreciation pressure on the Swiss franc amid the euro area sovereign debt crisis. Did the minimum rate affect our estimates of the elasticities of currency returns to the different dimensions of the forward premium? We report below estimates of the baseline regressions for CHF exchange rates and the corresponding regression estimates when we end the sample period in August 2011, i.e., in the month before the introduction of the minimum exchange rate. It turns out that the results are very similar. The basic conclusions from the baseline analysis still hold.

Table 6: Regression decomposition: belief formation until December 1998 and sample end in August 2011

	Baseline (sample end Oct 2016)	sample end Aug 2011
γ^{static}	0.61**	0.78***
	(0.24)	(0.29)
γ^{base}	1.34**	1.29**
	(0.55)	(0.61)
$\gamma^{dynamic}$	0.21	-0.07
	(0.44)	(0.52)
γ^{fpp}	0.93*	0.88**
	(0.54)	(0.43)
% ESS base trade	98	99
γ^{carry}	0.90**	0.88
	(0.38)	(0.59)
% ESS static trade	93	99
Observations	1926	1368

This table provides regression coefficients from pooled regressions of currency returns on the dimension of the forward premium that is used to weight currency returns in the static, dynamic, base currency, carry trade and forward premium trade presented in equations (5) to (9) in the main body of the paper. The left panel repeats the baseline results. The right panel gives the estimates when we end the sample period in August 2011, i.e., before the introduction of the Swiss franc minimum exchange rate against the euro. The partial R^2 of the static trade in the carry trade regression is the explained sum of squares (ess) of the static trade divided by the sum of the ess of the static and the dynamic trade. Correspondingly, the partial R^2 of the base currency trade in the forward premium trade is the ess of the base currency trade divided by the sum of the ess of the base currency and the dynamic trade.

Standard errors for the carry trade, the forward premium trade and the dynamic trade are Newey-West (Newey and West, 1987) corrected using a lag length of 12 months. The standard errors of the static trade regression are clustered by currency, whereas the standard errors of the base currency trade are clustered by time. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively.

A.2 Different time periods for belief formation

Our analysis of the statistical significance of the static, dynamic and base currency trade for the carry trade and the forward premium trade is not particularly sensitive to the choice of end date for the formation of beliefs about the expected forward premium. In the baseline results, we use December 1998 as end date for the belief formation. In the table below, we present the corresponding regression results for different time periods to form beliefs about the future forward premium. The qualitative conclusions drawn in the main text remain the same. The carry trade is mainly driven by the static trade. The forward premium trade is primarily driven by the base currency trade. There is no statistically significant link between currency returns and the dynamic component of the forward premium, which is the common component in carry trade and forward premium trade.

As mentioned in the main text and highlighted by Hassan and Mano (2017), the evidence in support of the forward premium puzzle varies over time. The regression estimates based on the time period from January 2002 to October 2016 (belief formation up to December 2001) suggest that there is no systematic relation between currency returns and the cross-time dimension of the forward premium. This finding pertains to both CHF and USD exchange rates. However, this picture changes when we look at a shorter sample period in order to form beliefs about the forward premium. Nonetheless, the main results pertain. The common component of the carry trade anomaly and the forward premium puzzle explains little of the covariation of currency returns with the forward premium in the forward premium puzzle regression and the carry trade regression.

Table 7: Regression decomposition: different periods to form beliefs

	up to Dec 1995		up to Dec 2001	
	CHF	USD	CHF	USD
γ^{static}	0.48**	0.48**	0.75***	0.53**
	(0.21)	(0.19)	(0.28)	(0.25)
γ^{base}	1.13***	1.27***	1.22*	0.96
	(0.43)	(0.41)	(0.73)	(0.63)
$\gamma^{dynamic}$	0.05	0.24	0.48	0.42
	(0.26)	(0.25)	(0.48)	(0.84)
γ^{fpp}	0.71**	1.33**	0.72	0.08
	(0.35)	(0.54)	(0.79)	(0.70)
% ESS base trade	99	98	92	90
γ^{carry}	0.64*	0.60**	0.99*	0.85*
	(0.33)	(0.30)	(0.51)	(0.46)
% ESS static trade	99	86	83	78
Observations	2250	2250	1602	1602

This table provides regression coefficients from pooled regressions of currency returns on the dimension of the forward premium that are used to weight currency returns in the static, dynamic, base currency, carry trade and forward premium trade presented in equations (5) to (9) in the main body of the paper. The partial R^2 of the static trade in the carry trade regression is the explained sum of squares (ess) of the static trade divided by the sum of the ess of the static and the dynamic trade. Correspondingly, the partial R^2 of the base currency trade in the forward premium trade is the ess of the base currency trade divided by the sum of the ess of the base currency and the dynamic trade.
Standard errors for the carry trade, the forward premium trade and the dynamic trade are Newey-West (Newey and West, 1987) corrected using a lag length of 12 months. The standard errors of the static trade regression are clustered by currency, whereas the standard errors of the base currency trade are clustered by time. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively.

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