On financial risk and the safe haven characteristics of Swiss franc exchange rates

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On financial risk and the safe haven characteristics of Swiss franc exchange rates

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Abstract

We analyse bilateral Swiss franc exchange rate returns in an asset pricing framework to evaluate the Swiss franc's safe haven characteristics. A "safe haven" currency is a currency that offers hedging value against global risk, both on average and in particular in crisis episodes. To explore these issues we estimate the relationship between exchange rate returns and risk factors in augmented UIP regressions, using recently developed econometric methods to account for the possibility that the regression coefficients may be changing over time. Our results highlight that in response to increases in global risk the Swiss franc appreciates against the euro as well as against typical carry trade investment currencies such as the Australian dollar, but depreciates against the US dollar, the Yen and the British pound. Thus, the Swiss franc exhibits safe-haven characteristics against many, but not all other currencies. We find statistically significant time variation in the relationship between Swiss franc returns and risk factors, with this link becoming stronger in times of stress.

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Keywords: exchange rate, monetary policy, risk factors, safe haven, Swiss franc, uncovered interest rate parity

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1 Introduction

The recent crisis in the euro area has led to a massive appreciation of the Swiss franc. prompting the Swiss National Bank (SNB) to implement unconventional policy measures, including foreign exchange interventions and the introduction of an exchange rate floor against the euro.² In this context, the usual explanation put forward for the strong Swiss franc appreciation is the status of the Swiss franc as the typical safe haven currency.³ Safe haven assets provide a hedge against risk on average. This characteristic is amplified in severe crises episodes during which safe haven assets particularly gain in value. High frequency analysis of Swiss franc exchange rate movements indeed leaves the impression of safe haven characteristics of the Swiss franc in several crises events (Ranaldo and Söderlind, 2010). In this paper we argue that the Swiss franc exhibits safe haven asset characteristics against some currencies – such as the euro – but not against other major currencies, such as the US dollar and the Yen. We draw this conclusion from studying Swiss franc exchange rate changes in an asset pricing framework, using recently developed econometric methods to assess time variation in the relation between exchange rates and risk factors. A steadily growing literature argues that (ex post) deviations from the uncovered interest rate parity condition (UIP) can be rationalized by the covariation of exchange rate changes with risk factors (e.g. Bansal and Shaliastovich, 2010; Farhi and Gabaix, 2011; Lustig and Verdelhan, 2006, 2007; Lustig et al., 2011; Menkhoff et al., 2012; Ranaldo and Söderlind, 2010; Sarno et al., 2012; Verdelhan, 2010, 2012). Safe haven characteristics imply a close link to financial risk factors. It is hence natural to analyse Swiss franc exchange rate changes in this framework. We adopt the asset pricing framework of Verdelhan (2012), based on Backus et al. (2001) and Lustig et al. (2011), to analyse 11 bilateral Swiss franc exchange rate pairs

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²In the 3 years leading up to the introduction of the exchange rate floor against the euro in September 2011 the Swiss franc appreciated almost 40% against the euro.

³See Habib and Stracca (2011) for an empirical assessment of the factors that determine a safe haven.

during the time period from January 1990 to August 2011. This framework features one Swiss franc-specific and one global risk factor.

Our results highlight that the Swiss franc is a safe haven relative to many, but not all currencies: in response to increases in global risk the franc appreciates against the euro as well as against typical carry trade investment currencies such as the Australian dollar, but depreciates against the US dollar, the Yen and the British pound. Exploiting insights of Müller and Petalas (2010) on the estimation of time-varying regressions coefficients we find statistically significant time variation in the relationship between Swiss franc returns and risk factors, with this link becoming stronger in times of stress. For instance, on average a one percent increase in the VIX index – our baseline proxy for global risk – is associated with 0.04% Swiss franc appreciation against the Australian dollar, and a 0.03% depreciation against the US dollar. Around the period of the Lehman bankruptcy, the change in the VIX index was associated with a more than 0.2% appreciation against the Australian dollar, and a more than 0.2% depreciation against the US dollar.

The remainder of the paper is organized as follows. Section 2 provides information about the conceptual background of this study. Section 3 describes the data sources. Section 4 presents the econometric framework and the main empirical results. Section 5 concludes.

2 Conceptual background

This section motivates the use of an asset pricing framework to explain exchange rate changes. It provides some basic, theoretical background and introduces recent advances in the formulation of empirical currency risk models that form the backbone of our empirical analysis.

2.1 Financial risk factor augmented UIP regressions

UIP states that under the assumption of rational expectations and risk-neutrality the expected exchange rate change reflects the previous period's interest rate differential between the home and foreign country, i.e.

$$E_t(\Delta s_{t+1}^k) = i_t^k - i_t \tag{1}$$

where i_t^k is the country k interest rate, i_t its home country counterpart, Δs_{t+1}^k the change in the log spot exchange rate of country k relative to the home currency and E is the expectation operator. An increase in s corresponds to an appreciation of the home and depreciation of the foreign currency. Hence, UIP implies that high-interest rate currencies should depreciate.

Interest rate differentials are approximately equal to forward discounts at least at the monthly frequency that we consider (e.g. Akram et al., 2008), such that

$$i_t^k - i_t \approx f_t^k - s_t^k \tag{2}$$

with f_t^k the log forward exchange rate. The standard UIP regression for the bilateral exchange rate with country k then has the following form:

$$\Delta s_{t+1}^{k} = \alpha^{k} + \beta^{k} (f_{t}^{k} - s_{t}^{k}) + \varepsilon_{t+1}^{k}$$
(3)

According to the UIP condition, the regression coefficient β should be equal to unity and the constant term, α , should be equal to zero.

However, starting with Tryon (1979), Hansen and Hodrick (1980) and Fama (1984), support for the UIP condition remains rather scarce. A potential explanation for the lack of empirical support is the presence of a risk premium required by market participants for a foreign currency investment (e.g. Bansal and Shaliastovich, 2010; Farhi and Gabaix, 2011; Lustig and Verdelhan, 2006, 2007; Lustig et al., 2011; Menkhoff et al., 2012; Ranaldo and Söderlind, 2010; Sarno et al., 2012; Verdelhan, 2010, 2012).

According to this asset pricing view on exchange rate determination, UIP regressions, such as (3), should be augmented by incorporating currency risk factors (Verdelhan, 2012). Such regressions could then take the following form

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⁴ Bansal and Dahlquist (2000) find that UIP holds for high inflation countries. Meredith and Chinn (2005) use long-term government bond yields as a proxy for risk-free rates to assess UIP at long horizons. They find that UIP holds quite well for horizons of 5 years or more. Lothian and Wu (2005) provide evidence that UIP holds over the long-term if we exclude the 1980s from the sample. Huisman et al. (1998) use a panel setup to show that UIP is violated but with significant, non-negative regression coefficients.

$$\Delta s_{t+1}^{k} = \alpha^{k} + \beta_{0}^{k} (f_{t}^{k} - s_{t}^{k}) + \beta_{1}^{k} \psi_{t+1}^{1} + \beta_{2}^{k} \psi_{t+1}^{2} + \dots + \beta_{n}^{k} \psi_{t+1}^{n} + \varepsilon_{t+1}^{k}$$

$$\tag{4}$$

where n denotes the numbers of risk factors in a currency risk premium model, k represents currency k and ψ denotes a currency risk factor. This regression can be easily derived from a basic asset pricing model when interpreting the standard UIP relation as a (zero net) investment strategy and additionally assuming that the investor's discount factor is a linear function of the risk factors ψ . Note that such regressions assess exchange rate changes (or, in general, asset returns) in "risky" or "less risky" times as measured by the factors. Therefore, the exchange rate changes are regressed on contemporaneously measured factors (Verdelhan, 2012). We know at least since Meese and Rogoff (1983) that exchange rate changes are notoriously hard to predict. The asset pricing framework under study does not alter this conclusion. We remain agnostic whether this indeed constitutes a major puzzle for international finance (Bacchetta and van Wincoop, 2006) or whether it should not be too surprising (Engel and West, 2005).

2.2 Risk factor model(s) of exchange rate changes

This subsection highlights the line of thought that led to recent empirical asset pricing models on which we base our empirical analysis.

2.2.1 Fama's conditions

Typically, the β coefficients in regressions of the type of equation (3) are found to be negative whereas UIP predicts estimates of $\beta = 1$. If a risk premium is the explanation of the negative regression coefficient, then i) the covariance between the risk premium and the expected exchange rate change must be negative and ii) the variance of the risk premium must be higher than the variance of the expected exchange rate change (Fama, 1984). To see this, decompose the forward discount from equation (3) into a risk premium and expected exchange rate change component, i.e.

$$f_{t} - s_{t} = (f_{t} - E_{t}(s_{t+1})) + (E_{t}(s_{t+1}) - s_{t})$$

$$f_{t} - s_{t} = rp_{t} + \Delta s_{t}$$
(5)

with $rp_t = f_t - E_t(s_{t+1})$ interpreted as the risk premium and the expected depreciation denoted by $\Delta s_t = E_t(s_{t+1}) - s_t$. This implies for the regression coefficient β in the typical UIP regression, equation (3), that

$$\beta = \frac{\text{cov}(\Delta s_t, rp_t + \Delta s_t)}{\text{var}(rp_t + \Delta s_t)} = \frac{\text{cov}(\Delta s_t, rp_t) + \text{var}(\Delta s_t)}{\text{var}(rp_t + \Delta s_t)}$$
(6)

If the risk premium is constant, then $\beta = 1$ as predicted by UIP. To generate a negative coefficient, the two Fama conditions mentioned above must be satisfied.

2.2.2 Fama's conditions and pricing models of exchange rate changes: some theoretical background

Satisfying the Fama conditions remains a high hurdle for all asset pricing models of exchange rates. Backus et al. (2001) illustrate this in the context of affine models of the term structure of interest rates. They consider two countries. In each country, a local currency denominated asset is priced via the basic asset pricing equation

$$1 = E_{t}(m_{t+1}R_{t+1})$$

$$1 = E_{t}(m_{t+1}^{*}R_{t+1}^{*})$$
(7)

where the asterisk denotes a foreign variable, R is the gross return on an asset denominated in local currency and m denotes the stochastic discount factor.

The home discount factor should be useful to value the return on the foreign asset converted into home currency. Under the assumption of complete markets

$$1 = E_t(m_{t+1}(S_{t+1}/S_t)R_{t+1}^*)$$
(8)

and

$$E_{t}(m_{t+1}^{*}R_{t+1}^{*}) = E_{t}(m_{t+1}(S_{t+1}/S_{t})R_{t+1}^{*})$$
(9)

such that

$$m_{t+1}^* / m_{t+1} = S_{t+1} / S_t \tag{10}$$

with $S = \exp(s)$, the spot exchange rate in levels.

In addition, suppose that the price of a bond, b, obeys $b_t = E_t m_{t+1}$ and hence the (net) interest rate on this bond is given by $r_t = -\log b_t = -\log E_t m_{t+1}$. Then we can express the covered interest rate parity condition, equation (2), in terms of discount factors.

$$f_{t} - s_{t} = \log E_{t} m_{t+1}^{*} - \log E_{t} m_{t+1}$$
(11)

Backus et al. (2001) then show the implications of these derivations for the two components of the Fama (1984) decomposition of the forward discount. From equation (10) and (11) we know that the expected exchange rate change equals the difference in conditional means of the logarithms of the home and foreign discount factor, i.e. it is only affected by the first moments of the discount factors

$$E_t s_{t+1} - s_t = E_t \log m_{t+1}^* - E_t \log m_{t+1}$$
 (12)

while the risk premium term reflects higher moments of the joint distribution of the discount factors because

$$rp_{t} = (\log E_{t} m_{t+1}^{*} - E_{t} \log m_{t+1}^{*}) - (\log E_{t} m_{t+1} - E_{t} \log m_{t+1})$$
(13)

Under the assumption that the discount factors (means and variances) are governed by idiosyncratic and common state variables, Backus et al. (2001) highlight, in the context of term structure models such as Cox et al. (1985), that we can then distinguish two cases that deliver an asset pricing model potentially satisfying the Fama conditions.

In the first case, the discount factors are equally affected by the common state variable. Only idiosyncratic factors drive discount factors. In this case, we must allow for negative nominal interest rates to account for the negative regression coefficient in the UIP regressions. In the second case, the home and foreign discount factors differ in their dependence on a common state variable. If this difference is large enough, then such a model can generate the forward premium puzzle of a negative UIP regression coefficient. However, based on bilateral exchange rates, Backus et al. (2001) show that neither case gives a satisfying solution to the ex post deviation of the uncovered interest rate parity condition.

2.2.3 Fama's conditions and pricing models of exchange rate changes: recent empirical advances

Recently, Lustig et al. (2011) show that the two first principal components in portfolios of foreign currency risk premia, sorted according to currencies' forward discounts (interest rate differentials), correspond to a country-specific and a global risk factor of currency excess returns (ex post deviations from UIP) from the U.S. investor's perspective. Differences in the exposure to the global factor determine the average risk premium on the currency portfolios. The exposures of these currency portfolios to the country-specific factor are almost equal. Lustig et al. (2011) further show that their empirical model reflects an extension of the two-country framework of Backus et al. (2001) to a multi-country, global context. In this model, the idiosyncratic factors play no role in the determination of currency risk premia. By forming portfolios of foreign currencies, Lustig et al. (2011) are able to ensure empirically that this is the case, i.e. average out idiosyncrasies of currency excess returns.

In addition, Lustig et al. (2011) in the context of currency excess returns and Verdelhan (2012) in the context of exchange rate changes show that these risk factors, extracted from portfolios of currency excess returns, are also informative about time series as well cross-sectional variation in bilateral excess returns and bilateral exchange rate changes. Therefore we adopt this model as our baseline specification to study Swiss franc exchange rate returns.

3 Data

Our baseline sample period spans the time period from January 1990 to August 2011. The beginning of the sample period is limited by the availability of data for our proxies of (global) currency risk, while the end of the sample reflects the introduction of the minimum rate against the euro by the SNB in September 2011. We consider Swiss franc exchange rates relative to the Australian dollar, the Canadian dollar, the euro, the Japanese yen, the New Zealand dollar, the Norwegian krone, the Singaporean dollar, the South African rand, the

Swedish krona, the British pound and the US dollar. Before the introduction of the euro in January 1999, we use the European Currency Unit (ECU) as proxy for the euro exchange rate. We obtain these exchange rates from cross-rates of US dollar exchange rates. The source of the respective end-of-month spot exchange rate data and the one-month forward rates are Barclays and WM/Reuters, available via Datastream. The sample of exchange rates is limited by the availability of exchange rate data over the entire sample period.

We focus on data at the monthly frequency because the augmented UIP regressions feature forward discounts as approximation of interest rate differentials. Hence, we assume that covered interest rate parity holds. This relation only holds at weekly or lower frequencies (e.g. Akram et al., 2008). Despite this limitation the use of forward discounts instead of interest rate differentials has some advantages. First, forward discounts are actually traded while money market rates, as e.g. Libor rates, do not necessarily reflect actual transactions. Second, UIP requires that interest rates reflect the same "riskiness". Again, the use of money market rates or even government bond yields could lead to violations of this requirement.

Moreover, we employ changes and levels in the CBOE option-implied volatility index of the S&P 500, VIX, based on end of month close prices as a proxy of global currency risk. The VIX series is obtained directly from the CBOE website. As an additional check for euro area specific risks we use the yield spread (in percentage points p.a.) between Italian and German government bonds with constant 10-year maturity from Datastream. The sample period for this data is April 1991 to August 2011. Furthermore, we employ the TED spread, i.e. the spread between a 3-month US Treasury bill and the 3-month Eurodollar deposit rate in percentage points p.a., as measure of funding liquidity risk and hence as additional control variable in our robustness checks (Brunnermeier et al., 2009).

4 Econometric framework and empirical results

Taking currency risk factors into account enhances our understanding of exchange rate dynamics. Section 4.1 provides evidence supporting that point. Section 4.2 assesses the time variation in the exchange rate – risk factor relation.

4.1 (Augmented) UIP regressions

This section highlights the usefulness of the asset pricing view of exchange rates for studying Swiss franc returns. We start by showing the results of standard UIP regressions for the Swiss franc which provide the motivation to use empirical models augmented by currency risk factors. The second subsection presents the results for these models. The third subsection summarizes a series of robustness checks.

4.1.1 UIP regressions

This section documents the well-known lack of empirical support for the uncovered interest rate parity condition in the context of the Swiss franc exchange rates under study. Table 1 provides estimates of α^k and β_0^k from monthly UIP regressions

$$\Delta s_{t+1}^{k} = \alpha^{k} + \beta_{0}^{k} (f_{t}^{k} - s_{t}^{k}) + \varepsilon_{t+1}^{k}$$
(14)

where k denotes one of bilateral Swiss franc exchange rates and s and f represent log spot exchange rate changes and 1-month log forward rates respectively. Newey-West (Newey and West, 1987) corrected standard errors appear below the point estimates in parentheses. The R^2 statistic is adjusted for the number of regressors. The Durbin-Watson statistic (DW) indicates if there is autocorrelation in the regression residuals. The sample period runs from January 1990 to August 2011.

The results summarized in Table 1 show that UIP is typically violated ex post, i.e. the point estimates of β_0^k are significantly different from unity. Exceptions are the Swedish krona and the Singaporean dollar. In most cases, however, the point estimates are negative albeit not always significantly different from zero, i.e. lagged forward discounts explain little of the

time variation in Swiss franc exchange rate changes. The respective measures of fit range from 0% to 4%. Since the negative point estimate could be the reflection of a risk premium on foreign currency investment, we augment the standard UIP regression with currency risk factors and evaluate the potential covariation of the Swiss franc exchange rate changes with these risk factors in the subsequent section.

[about here Table 1]

4.1.2 Augmented UIP regressions

In this subsection, we assess if the consideration of potential currency risk factors helps to better understand exchange rate dynamics. In our baseline specification, we closely follow Verdelhan (2012) and Lustig et al. (2011) and adopt their asset pricing framework to the Swiss franc exchange rate context. We consider different specifications as robustness checks and summarize these results in a separate, subsequent subsection.

Our baseline currency pricing model consists of two risk factors (Lustig et al., 2011). The first factor is the average Swiss franc exchange rate change. It is a currency-specific factor as shown by Lustig et al. (2011). We exclude the exchange rate whose dynamics we evaluate from the calculation of the currency-specific factor as recommended by Verdelhan (2012). For example, when we examine the Swiss franc - euro exchange rate changes in the augmented UIP regressions, we use the arithmetic average of the other 10 Swiss franc exchange rate changes as first risk factor. Verdelhan (2012) shows that this average of exchange rate changes indeed corresponds to a risk factor on currency markets. He shows that, from the perspective of a US investor, returns on currencies sorted in portfolios according to their exposure to this factor reveal strong cross-sectional differences.

As a second risk factor, we employ returns in the VIX index. This second risk factor is a measure of global risk on currency markets. We exploit that the empirical proxy of the global risk factor by Lustig et al. (2011), differences in the returns on high and low forward discount sorted currency baskets, is positively correlated with innovations in global equity market

volatility. VIX returns are our proxy of innovations in global equity market volatility and hence our approximation of the global factor in the original Lustig et al. (2011) model. This VIX index is also highly positively correlated with volatility indices of other equity markets. The use of this equity market volatility series as proxy of global risk helps to avoid potential double counting in the augmented UIP regressions. The global factor in Lustig et al. (2011) is constructed from currency portfolios sorted on forward discounts/ interest rate differentials. Hence, including this factor directly in a regression together with the bilateral forward discount rate of the exchange rate under study could create econometric issues since that particular currency pair or a cross rate is included in the Lustig et al. (2011) global risk factor. We therefore prefer to use a global risk factor proxy that is neither constructed from interest rate differentials / forward discounts nor from exchange rate data.

The augmented UIP regressions then take the following form

$$\Delta s_{t+1}^{k} = \alpha^{k} + \beta_{0}^{k} (f_{t}^{k} - s_{t}^{k}) + \beta_{1}^{k} AFX_{t+1} + \beta_{2}^{k} \Delta VIX_{t+1} + \varepsilon_{t+1}^{k}$$
(15)

with AFX abbreviating average Swiss franc exchange rate changes excluding currency k and ΔVIX representing log changes in the CBOE option-implied volatility index, VIX. The regression results are summarized in Table 2. Again Newey-West (Newey and West, 1987) corrected standard errors appear below the point estimates in parentheses. The sample period runs from January 1990 to August 2011.

Several observations are noteworthy. First, the coefficients on the forward discount remain in most cases not statistically significant. Second, we observe pronounced variation in the sensitivity to the Swiss franc-specific currency risk factor, AFX. The estimates range from 1.4 for the Canadian dollar to 0.4 for the euro. One potential reason why Swiss franc-euro returns are less strongly related to Swiss franc movements against other currencies may be the fact that the Swiss economy is closely linked to the euro area, dominating the effects from the "rest-of-the-world". Recall that the respective AFX series do not include the bilateral exchange rates that we evaluate in the respective regression. Third, the covariation of Swiss

franc exchange rates with VIX returns shows that the Swiss franc exhibits safe haven characteristics against many, but not against all other currencies. The coefficient β_2^k reflects both the Swiss franc's status as a safe haven and the franc's role as a typical funding currency in currency carry trades. Negative coefficient estimates indicate that the Swiss franc appreciates against the respective currency when the VIX, i.e. global risk, increases. This is the case for the Swiss franc exchange rates against the typical investment currencies in carry trades such as the Australian dollar, the New Zealand dollar or the South African rand. By contrast, significant positive coefficients signal that the Swiss franc depreciates against the respective currency when global risk increases. This is the case for the Swiss franc exchange rates against the Japanese Yen, the British pound and the US dollar. On average, these currencies provide a better hedge against global risk than the Swiss franc. Finally, corroborating Verdelhan (2012), the augmented UIP regressions provide a better fit of the data than the standard UIP regressions. The R^2 statistics range from 20% to 70% compared with 0% to 4% in the standard UIP regressions.

[about here Table 2]

A potential, general critique of our approach is that there could be structural breaks during the sample. In particular, one might argue that the foreign exchange interventions undertaken by the SNB since 2009 have changed the underlying "true" asset pricing relationship that determines Swiss franc exchange rate changes, and that ideally one should somehow control for SNB policy measures, for example by including a measure of the size of interventions as an additional control variable in the regression. However, the relevance of uncovered interest parity and the underlying risk-return relationship (15) for investors is unaltered by the presence of central bank interventions. Central bank interventions could, however, have changed the magnitude of the regression coefficients and thus have changed the exchange rate change – risk factor relation over time. We analyse potential time variation in section 4.2.

4.1.3 Robustness Checks

To check the robustness of our baseline specification we conduct a number of additional analyses summarized below. To conserve space, we do not report the detailed results but all of them are available upon request.

First, we add the spread (in levels or changes) between Italian and German 10-year government bond yields as a control variable for specific euro area risks to the baseline regression setup. Since the Swiss economy is closely related to the euro area, one might argue that it is not necessarily Swiss-specific or global risk but the materialization of euro area risks that influences Swiss franc exchange rate changes. The Italian-German bond yield spread appears to be a good proxy for these risks. The spread is particularly high in the early to mid-1990s when the European exchange rate mechanism experienced a crisis episode and in the recent past reflecting the euro area sovereign debt issues. It turns out that the regression coefficients of the bond spread in almost all regressions (even in the euro regression) are not statistically significant. Including the bond spread does not change any of the estimates of the baseline specification and does not improve the regression fit.

Second, we assess if our baseline results hold once we include a measure of funding liquidity risk. We use the TED spread (in levels or changes), proposed by Brunnermeier et al. (2009), for that purpose. The TED spread is commonly thought of as a measure of investors' funding liquidity risk. If the spread is low there is little funding liquidity risk, while a large and negative spread indicates funding liquidity risk. Brunnermeier et al. (2009) show that the TED spread is a good explanatory variable for carry trade returns. Although we find significant comovement between Swiss franc exchange rate returns and the TED spread, none of the baseline specification estimates is altered.

As a third robustness check, we use the level of VIX instead of changes in VIX in the augmented UIP regressions. For instance, Ranaldo and Söderlind (2010) use the level of VIX in their high frequency assessment of safe haven currencies as one potential risk factor.

Interestingly, we find only little covariation between monthly exchange rate returns and the level of VIX. At this relatively low frequency returns in the VIX index seem to be a better proxy of global risk, which is in line with Lustig et al. (2011) and the finding that their global risk factor is highly correlated with innovations in global equity market volatility rather than with volatility levels.

Finally, we follow Engel et al. (2012) and extract principal components from the Swiss franc exchange rates under study. We then use these principal components as proxy of risk factors. Since a direct link between exchange rate changes and macroeconomic aggregates is difficult to detect in the data, Engel et al. (2012) argue that the principal components could be interpreted as reflection of fundamental determinants of exchange rate changes. In our context, the first three principal components explain about 80% of the common variation in the Swiss franc exchange rate changes. On the first principal component all Swiss franc exchange rates load positively. It is closely correlated with the average exchange rate return. Interestingly, the third principal component could reflect carry trade risk as we observe clear differences in the loading on that principal component between typical funding currencies such as the Yen and US dollar and investment currencies such as the Australian dollar or the South African rand. Regressions of Swiss franc returns on the three principal components provide a slightly better fit, in terms of R^2 statistics, than our baseline specification. However, this better fit comes at the cost of an unclear economic interpretation of the principal components, which is particularly the case for the second principal component.

4.2 Time variation in the exchange rate – risk factor relation

The previous section analysed the Swiss franc's safe-haven characteristics by estimating the relationship between bilateral Swiss franc exchange rate returns and risk factors. However, it is intuitive that this relationship is likely to be changing over time. First, safe haven assets typically provide hedging value against risk events on average, but in particular also in times of financial stress (e.g. Ranaldo and Söderlind, 2010). Thus the comovement between returns

on safe-haven assets and risk factors can be expected to increase in financial crisis episodes (when risk factors are elevated). Second, as discussed above, the SNB's FX interventions in 2008-2011 could potentially have affected the link between Swiss franc movements and risk factors. To explore these issues we employ recently developed econometric methods to estimate the time variation in the coefficients of the baseline augmented-UIP regression (15), using log returns in the VIX index as the baseline measure of global risk. Our analysis is complementary to that of Ranaldo and Söderlind (2010): while they allow for nonlinearities in the relationship between safe haven assets and risk factors we instead estimate directly how this relationship has changed over time. ⁵

We begin by reporting statistical tests for joint stability of the parameters in regression (15). To do this we employ the quasi-local-level test proposed by Elliott & Müller (2006). The advantage of this test is that it is equivalent in large samples to the optimal tests for a wide range of possible statistical processes for time variation. Therefore we do not have to make specific assumptions about the particular process for time variation considered in the alternative hypothesis. The null of joint stability of the coefficients in (15) is rejected if the test statistic is smaller (more negative) than the critical values. We find that except for the CAD, SAR and GBP regressions the null of parameter stability can be rejected for all other currency pairs at the 5% level.

We then proceed to estimate the parameter paths for the coefficients, focusing on those bilateral rates where the null of parameter stability was rejected. To do this we use the method proposed by Müller and Petalas (2010) which provides an approximation to the sample

.

⁵ Hoffmann and Suter (2010) study five Swiss franc exchange rates in a conditional asset pricing framework over the period from 1990 to 2009. They regress these exchange rate returns on a global risk factor and an interaction term between the global risk factor and the respective currency pair's interest rate differential to study the Swiss franc's role as a safe haven. The interaction term captures the time variation in potential safe haven characteristics. Hoffmann and Suter (2010) argue that interest rate differentials are good signals of the safe haven status of a currency. While this is a natural starting point, Habib and Stracca (2011) point out that there are a couple of other macroeconomic variables that potentially signal the safe haven status of currencies. In addition, the importance of these macroeconomic variables as signals of safe haven status could also vary over time. The method that we use instead allows to estimate directly how this relationship varies over time without relying on instrumental variables.

⁶ This test has so far only been used in few applied papers, including Goldberg and Klein (2011).

information about the parameter path that is accurate and efficient in large samples, independent from the precise nature of the underlying process of time variation. Since we know from the currency risk factor literature that differences in the sensitivities to the proxy of global risk determine differences in exchange rate changes, we focus on the presentation of the time-varying path of the global risk measure coefficients. Figure 1 reports the results for selected currency pairs.

[about here Figure 1]

The largest movements in coefficients occur during financial crisis episodes, with coefficients peaking around the period of the Lehman bankruptcy and (for USD and JPY) during the period of the Asian-Russian financial crises in 1997-1998. Responses to movements in the risk factor are much larger in times of financial stress. For example, Table 2 reported that a 1% monthly increase in the VIX index is associated with a 0.04% appreciation of the Swiss franc versus the Australian dollar on average over the sample. In contrast, allowing for time variation shows that at the height of the global financial crisis in late 2008 a 1% increase in the VIX led to a 0.2% CHF appreciation against AUD, more than 5 times larger than the average effect. Confirming the findings from Table 2 for average comovements between Swiss franc returns and risk factors, during episodes of financial stress the negative relationship between Swiss franc returns against AUD, NZD and EUR and risk factors – with the Swiss franc appreciating in response to increases in the VIX index – becomes stronger: the Swiss franc's safe-haven role is particularly pronounced during crisis episodes. Conversely, the Swiss franc depreciates more sharply against USD and JPY in response to increases in the risk factor when risk is elevated. Thus the finding from the baseline regressions that the Swiss franc can be a considered a safe haven, in terms of its average hedging value, relative to EUR, AUD and NZD, but not relative to USD and JPY carries over to the definition of "safe haven" as an asset that gains in value in high-risk episodes.

5 Conclusions

This paper estimates an asset pricing model relating bilateral Swiss franc exchange rate returns to alternative risk factors. We also explore how the influence of the risk factors changes over time, in particular between risk episodes and tranquil periods. We find that the Swiss franc does not behave like a safe haven asset against all currencies. The US dollar, the yen and the pound provide a better hedge against global risk than the Swiss franc. This finding could reflect the limited size of Swiss franc-denominated asset markets and hence limited market liquidity. Nevertheless, we find that the Swiss franc appreciates against many currencies, including the euro, when measures of global risk increase. This is the case both on average and in particular in times of financial stress. The safe haven characteristics of the Swiss franc-euro exchange rate are most clearly present since the onset of financial market stress in the euro area. This finding is in line with the view that peso problems or crash risk explain exchange rate dynamics as proposed by Burnside et al. (2011) and Farhi et al. (2009). The expectation of a small probability, but potentially catastrophic, event in the euro area could be an explanation of the Swiss franc's safe haven property relative to the euro in the recent past.

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Tables

Table 1: UIP regressions

	$lpha^{\scriptscriptstyle k}$	$\boldsymbol{\beta}_0^{\scriptscriptstyle k}$	R^2	DW
AUS	-0.00 $_{(0.01)}$	0.13	0.00	1.94
CND	-0.00 $_{(0.00)}$	-0.75 $_{(-1.37)}$	0.00	2.11
EURO	-0.00 $_{(0.00)}$	-1.54 (1.15)	0.01	2.29
JPN	0.00	-1.71* (0.72)	0.01	1.98
NZL	-0.00 (0.00)	-0.12 (0.89)	0.00	1.90
NOR	-0.00 (0.00)	-0.96 (1.05)	0.01	2.21
SIN	-0.00 (0.00)	0.56	0.00	1.95
SA	-0.01*	$-0.42* \atop {}_{\tiny{(0.10)}}$	0.04	1.99
SWE	-0.00 $_{(0.00)}$	1.07	0.01	2.10
UK	$-0.01* \atop {}_{(0.00)}$	-1.30 (0.83)	0.00	1.99
US	-0.00 $_{(0.00)}$	-1.54 (1.09)	0.01	1.91

Notes: This table presents estimates from regressions of Swiss franc exchange rate returns (Swiss franc relative to Australian dollar, Canadian Dollar, euro, Japanese yen, New Zealand dollar, Norwegian krone, Singaporean dollar, South African rand, Swedish krona, British pound and US dollar) on a constant and the respective forward discount, i.e.

$$\Delta s_{t+1}^{k} = \alpha^{k} + \beta_0^{k} (f_t^{k} - s_t^{k}) + \varepsilon_{t+1}^{k}$$

where k denotes the currency pairs and s and f represent log spot exchange rates and 1-month log forward rates, respectively. Newey-West (Newey and West, 1987) corrected standard errors appear below the point estimates in parentheses. The R^2 statistic is adjusted for the number of regressors. An asterisk indicates that estimates are significantly different from zero at 95% confidence level. We report the Durbin-Watson statistic for the autocorrelation of the regression residuals under the column "DW". The sample period runs from January 1990 to August 2011.

Table 2: Augmented UIP regressions

	$\alpha^{\scriptscriptstyle k}$	$oldsymbol{eta}_0^k$	$oldsymbol{eta}_1^k$	$oldsymbol{eta}_2^k$	R^2	DW
	(constant)	$(f_t^k - s_t^k)$	(AFX_{t+1})	(ΔVIX_{t+1})		
AUS	0.00	0.26	1.29 *	- 0.04 *	0.65	2.01
CND	0.00	-0.55 (0.55)	1.37 *	-0.00 $_{(0.00)}$	0.71	2.24
EURO	-0.00 $_{(0.00)}$	-0.95 (0.93)	0.35*	-0.01 $_{(0.00)}$	0.33	2.19
JPN	0.00	-1.44 *	0.64 *	0.03 *	0.18	1.91
NZL	0.00	0.09	1.04 *	-0.02 *	0.50	1.98
NOR	-0.00 $_{(0.00)}$	-0.31 $_{(0.82)}$	0.59 *	-0.01	0.36	2.14
SIN	0.00	0.71 *	1.09 *	0.02 *	0.73	1.84
SA	-0.01 *	-0.39 *	1.08 *	-0.05*	0.43	2.06
SWE	-0.00 $_{(0.00)}$	0.22	0.54 *	-0.02 *	0.30	1.90
UK	-0.00 $_{(0.00)}$	-0.78 $_{(0.53)}$	0.81 *	0.02 *	0.42	1.97
US	-0.00 $_{(0.00)}$	-0.23 (0.56)	1.20 *	0.03 *	0.60	1.70

Notes: This table presents estimates from regressions of Swiss franc exchange rate changes (Swiss franc relative to Australian dollar, Canadian Dollar, euro, Japanese yen, New Zealand dollar, Norwegian krone, Singaporean dollar, South African rand, Swedish krona, British pound and US dollar) on a constant, the respective forward discount and two contemporaneously measured risk factors, i.e.

discount and two contemporaneously measured risk factors, i.e.
$$\Delta s_{t+1}^k = \alpha^k + \beta_0^k (f_t^k - s_t^k) + \beta_1^k AFX_{t+1} + \beta_2^k \Delta VIX_{t+1} + \varepsilon_{t+1}^k$$

with AFX abbreviating average Swiss franc exchange rate returns excluding currency k and ΔVIX representing log changes in the CBOE option-implied volatility index, VIX. k denotes the currency pairs and s and f represent log spot exchange rate and 1-month log forward rates respectively. Newey-West (Newey and West, 1987) corrected standard errors appear below the point estimates in parentheses. The R^2 statistic is adjusted for the number of regressors. An asterisk indicates that estimates are significantly different from zero at 95% confidence level. We report the Durbin-Watson statistic for the autocorrelation of the regression residuals under the column "DW". The sample period runs from January 1990 to August 2011.

Figures

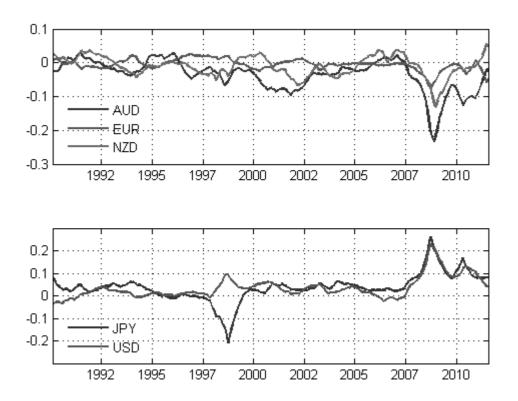


Figure 1: Estimates of the parameter paths of the coefficients from financial risk factor augmented UIP regression (15) for Swiss franc returns against the Australian dollar, the euro and the New Zealand dollar in the upper panel and against the Japanese Yen and the US dollar in the lower panel, computed following Müller and Petalas (2010).

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