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Abstract

We study high-frequency exchange rate movements over the sample 1993–2006. We document that the (Swiss) franc, euro, Japanese yen and the pound tend to appreciate against the U.S. dollar when *(a)* S&P has negative returns; *(b)* U.S. bond prices increase; and *(c)* when currency markets become more volatile. In these situations, the franc appreciates also against the other currencies, while the pound depreciates. These safe haven properties of the franc are visible for different time granularities (from a few hours to several days), during both "ordinary days" and crisis episodes and show some non-linear features.

Keywords: high-frequency data, crisis episodes, non-linear effects

JEL Classification Numbers: F31, G15

1 Introduction

There is a remarkable disproportion between media coverage and financial market literature on safe-haven currencies. While the debate on which and why currencies represent safe-haven assets is burgeoning in the financial press, the scientific literature has been mostly silent. Furthermore, media views appear highly changeable and conflicting. A currency considered secure at one point in time may not be considered safe just few months

*The views expressed herein are those of the authors and not necessarily those of the Swiss National Bank, which does not accept any responsibility for the contents and opinions expressed in this paper.

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later. For instance, on 30 August 2002, the Straits Times run the title "(The) Greenback still a safe haven currency" and three months later the International Herald Tribune argued that "U.S. dollar loses its appeal as world's 'safe haven' currency." Similarly, at the end of May 1993, the Business Times highlighted that "(The) Mark loses shine as safe haven currency," but one year later the France Press Agency titled one of its reports on 26 May 1994 "Mark lifts as safe-haven currency."

There are several (related) ways to define a "safe haven" asset. For instance, Kaul and Sapp (2006) define it as an asset that investors purchase when uncertainty increases. Similarly, Upper (2000) defines a safe haven asset as an instrument that is perceived as having a low risk and being highly liquid. In this view, a safe haven asset is akin to any hedging asset, that is, an instrument which is uncorrelated or negatively correlated with its reference asset. Alternatively, Baur and Lucey (2006) define it as an asset that does not co-move with the other asset(s) *in times of stress*. In this study, we consider both definitions. More comprehensively, we define a safe haven asset as one that is generally characterised by a negative risk premium. This definition encompasses the traditional meaning—the unconditional lack of or negative correlation, and the more stringent definition—the lack of or negative correlation conditional on losses in the reference portfolio.

Our paper addresses two questions: first, which currencies can actually be considered safe-haven assets and, second, how safety effects materialise. To answer the first question, we provide an empirical analysis that relates currencies' risk-return profiles to equity and bond markets. Our empirical specification is meant to be parsimonious but still capture two important safe-haven drivers. First, it captures depreciations of safe-haven currencies due to gradual erosions of risk aversion inherent in phases of equity markets upturns. Second, it accounts for risk episodes of more extreme nature—when risk perception rises suddenly. To shed light on how safety effects materialise, our study looks into the characteristics and timing of the safe-haven mechanism. Our study shows systematic relations between risk increases, stock market downturns and safe-haven currencies' appreciations. By changing the time granularity of our analysis, we provide evidence that this risk-return transmission mechanism is operational from an intraday basis up to several days.

Our study is related to several fields of the financial literature. First, the literature on safe-haven currencies provides only limited and occasional evidence of this phenomenon. For instance, Kaul and Sapp (2006) show that the US dollar was used as a safe vehicle around the millennium change. Here, we provide empirical evidence that safe-haven effects override specific events and market conditions. Thus, sporadic loss and gain of safe-haven attributes of a given currency is only the visible part of an iceberg. Safe-haven quality might be latent.

Second, our paper contributes to the carry trade literature (e.g. Burnside, Eichenbaum, Kleshchelski, and Rebelo (2006) and Burnside, Eichenbaum, and Rebelo (2007)). Carry trade is the mirror-image of safe haven, and they are related in a mutually reinforcing mechanism. On the one hand, a reduction of safe haven effects corresponds to a rise in carry trade attractiveness. Lower risk aversion means lower values of safe-haven currencies. In a (vicious) circle, carry trade may then trigger demand-supply forces that further depreciate safe-haven currencies. Since volatility essentially represents the cost of carry trade, a decrease in perceived market risk goes hand-in-hand with a higher sell-pressure of funding currencies that are typically safe-haven currencies. On the other hand, sudden increases in market participants' risk aversion fuel flight to safety that in turn, may lead to abrupt unwinding of carry trade—boosting safe-haven currencies' appreciations. Our study shows how carry traders holding a short position in a safe-haven currency might incur large debt burdens in times of stock market downturn.

Third, our study provides empirical support to flight-to-quality and contagion phenomena. The flight-to-quality literature argues that an increase in perceived riskiness engenders conservatism and demand for safety (e.g. Caballero and Krishnamurthy (2007)). At the same time, the contagion literature shows that risk and market crashes spill over across countries, international markets and, possibly, asset classes (e.g. Hartmann, Straetmans, and De Vries (2001)). Here, we show that there exists a significant, systematic transmission among risk-performance payoffs of international currencies, equities and bond markets. These considerations are also relevant from a perspective of market liquidity. Although we do not explicitly examine market liquidity, episodes of reversal carry trade that lead to sharp appreciations of safe-haven currencies are notoriously exacerbated by severe liquidity drains—see, for instance, the case of unwinding yen-dollar carry trade in September 1998 (Bank for International Settlements (1999)). Therefore, our study deliver some insights about the recent literature on liquidity and price changes' commonality across asset classes (e.g. Chordia, Sarkar, and Subrahmanyam (2005)), adverse liquidity spirals between liquidity drains, wealth reduction and funding constraints (Brunnermeier and Pedersen (2007)), and market liquidity declines as volatility increases in the spirit of the "flight to liquidity" phenomenon.

Finally, our study adds to the empirical market microstructure field. The previous literature in this area has showed that order flow significantly determines exchange rates (e.g. Evans and Lyons (2002b)) and that there are important linkages across currency pairs (e.g. Evans and Lyons (2002a)). On the basis of a large and long high-frequency database, our work adds to this literature by showing that the price formation processes across forex, equity and bond markets are inter-connected even on an intraday basis. This sheds new light on parallel market forces and synchronised price discovery characterising different markets and investment categories. Furthermore, our study shows that realised volatility measures in the spirit of e.g. Bollerslev and Andersen (1998) are able to proxy for the perceived market risk and that transient market volatility has a significant role in determining the price formation process of safe-haven currencies.

Two main results emerge from our work. First, it shows that by its nature, the fortune of the US dollar goes hand-in-hand with risk appetite pervading financial markets. On the other hand, the Swiss franc and to a smaller extent, the Japanese yen and the euro have significant safe-haven characteristics and move inversely with international equity markets and risk perception. These results appear stable across time and they hold also after controlling for interest rate differentials or allocation into investment vehicles commonly considered safe assets. These effects are not only statistical but also economically significant. For instance, on 2% of the days in our sample 1993–2006 (that is, on around 60 days), the equity price drop is so large that our regression equation predict at least a 0.34% appreciation of the Swiss franc (against the US dollar). Similarly, on 2% of the days (not necessarily the same days as before), the increase in the currency market volatility is so large that the regressions predict at least a 1% percent appreciation. Second, our study delivers insights on how safe-haven effects materialise: the safe haven effects are evident in hourly as well as weekly data, but seem to be strongest at frequencies of one to two days.

The paper proceeds as follows: Section 2 presents some illustrative episodes, Section 3 presents the data sources, Section 4 discusses our econometric method, Section 5 presents the results and Section 6 concludes.

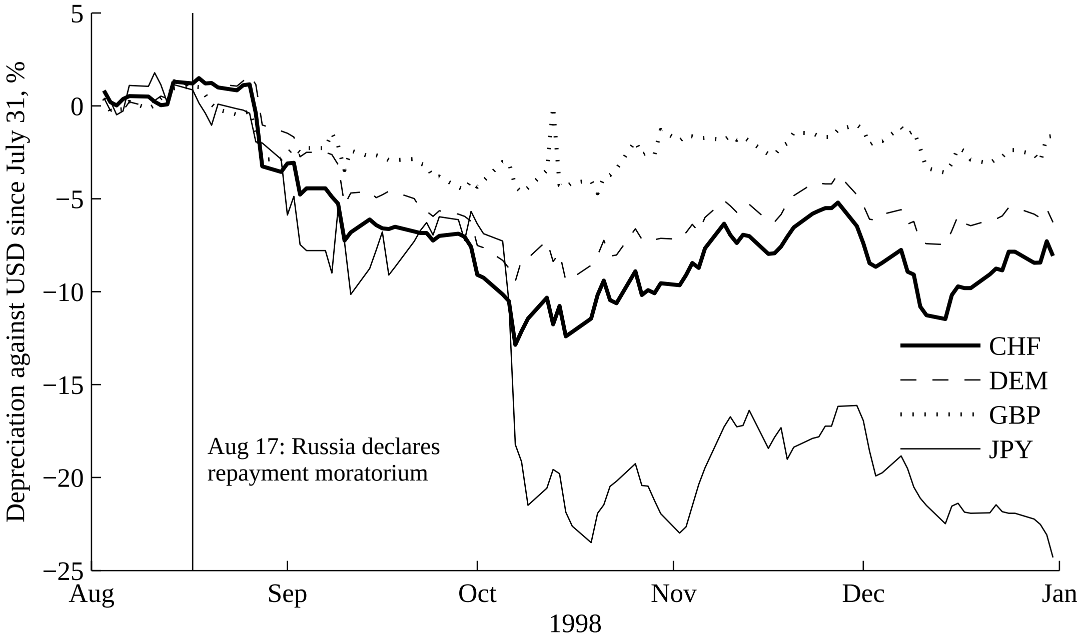

Figure 1: **Exchange rate development around the Russia crisis.**

2 Events

As a preliminary analysis, we present some illustrative episodes that notoriously affected international financial markets. On the basis of a subjective choice, we have selected three events that can undoubtedly be considered natural experiments to observe the foreign exchange market reaction to international shocks. In chronological order, the three events are the so-called "Russian financial crisis," "9/11" and "Madrid attacks."

The Russian crisis was preceded by a decline in world commodity prices. Being heavily dependent on raw materials, Russia experienced a sharp decrease in exports and government tax revenue. Russia entered a political crisis when the Russian president Boris Yeltsin suddenly dismissed Prime Minister Viktor Chernomyrdin and his entire cabinet on March 23, 1998. August 17 can be taken as the zenith of this critical phase. On that day, Russia declared a repayment moratorium. *Figure 1* shows the evolution of cumulative daily depreciations against the dollar starting from the beginning of August until the end of December 1998. Four exchange rates (against the US dollar) are shown, namely the Swiss franc, Deutsche mark, British pound and Japanese yen. The graph clearly shows

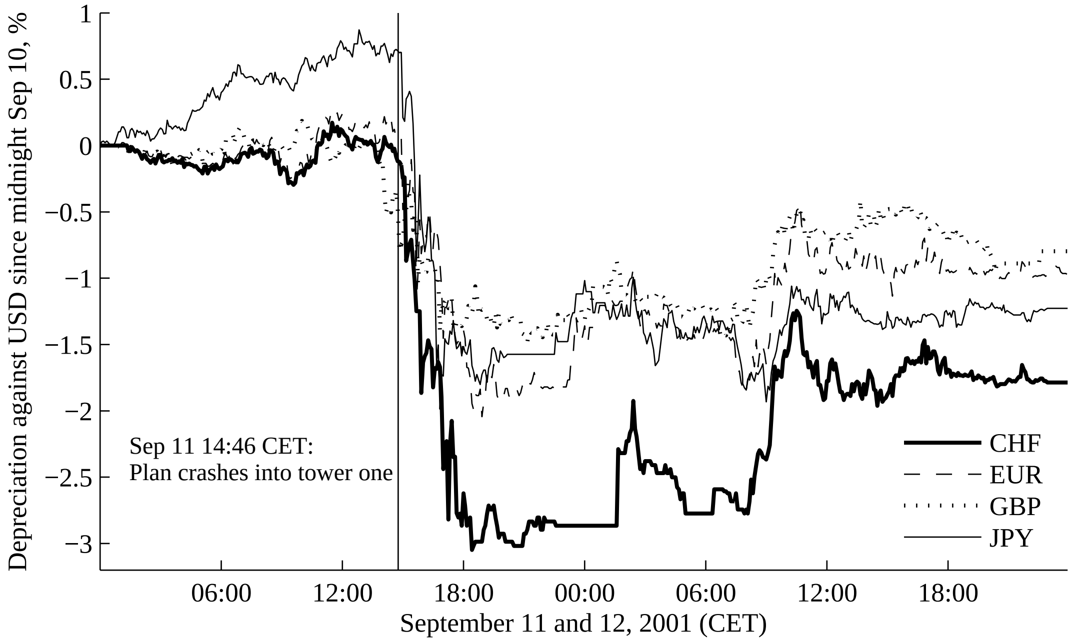

Figure 2: **Exchange rate development around 9/11.**

that all these currencies (and especially the yen) gained value against the dollar. The appreciations during the initial phase, say from mid-August to mid-October 1998, were pretty significant. The particular behaviour of the yen deserves some comments. There were two instances of sharp appreciation of the yen against the dollar: about 9% in the period between 31 August and 7 September, and then by a further 12% on 7 and 8 October. A Bank for International Settlements (1999) study and market commentaries at that time attributed these movements (at least partially) to the unwinding of yen carry trades by hedge funds and other institutional investors.

The two other events considered in this preliminary analysis are 9/11 and the Madrid bombings' attack. For these episodes, it is possible to go back to precise event-times that triggered financial price disruptions. Therefore, it is also possible to conduct an intraday event analysis. We consider a two-day event-window starting from the day of the terrorist attacks until the end of the day after (more precisely, 11–12 September 2001 and 11–12 March 2004). On the basis of five-minute data, *Figures 2* and *3* show the depreciations of same currencies as considered in the Russian crisis (the euro replacing the mark). In both cases, the Swiss franc experienced by far the strongest appreciation.

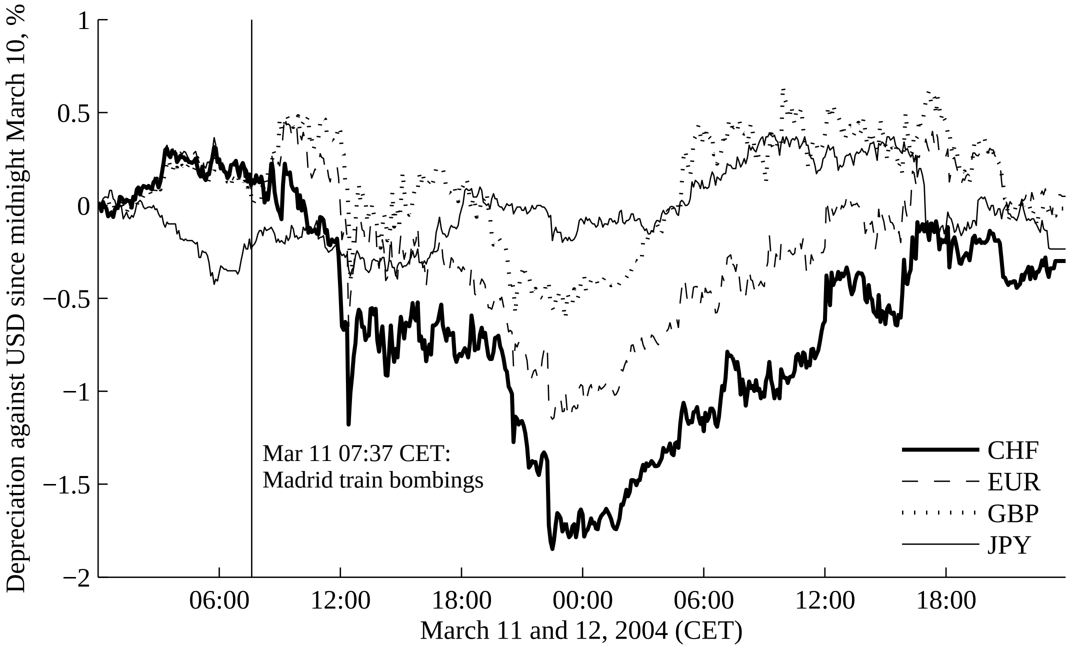

Figure 3: **Exchange rate development around the Madrid bombings.**

It appreciated by 3% within two hours after the first plan crash at 14:46 CET (08:46 a.m. EST). During 9/11 crisis, however, all the counter currencies of the US dollar appreciated significantly. During the Madrid attacks, only the Swiss franc and to some extent, the euro appreciated—and the response was slower. This may be due to the fact that it took longer than during the 9/11 event to get a comprehensive picture of the situation. For instance, as later reported, thirteen explosive devices were placed on the trains travelling between Alcalá de Henares and the Atocha station in Madrid.

These episodes give an intuitive picture of the safe haven effect. Below, we will analyse if the safe haven phenomenon is systematic and how it materialises.

3 Data

We analyse the link between foreign exchange rates, equity and bond markets by using high-frequency data for the period 1993–2006. We will report results for three-, six- and twelve-hour as well as one-, two- and four-day time frames.

The database was kindly provided by Swiss-Systematic Asset Management SA, Zurich (except the USD/GBP data which is from Olsen & Associates). It includes spot exchange rates for the following currency pairs: USD/CHF, USD/DEM, USD/EUR, USD/JPY and USD/GBP. On the basis of these exchange rates, we calculate various USD rates as well as cross rates. We construct a synthetic "EUR" series by splicing the DEM (1993–1998) with the EUR data (1999–2006).

A study of intraday market co-movements requires observations on synchronised and homogeneously spaced time series. We therefore organise our database in five-minute time intervals in which we keep records of the first, max, min and last traded or quoted price. Since the spot exchange rates are traded round-the-clock, we get 288 five-minute intervals for each day excluding weekends. The five-minute data is calculated from the tick-by-tick FXFX Reuters midquote price (the average price between the representative ask and bid quotes). Although indicative quotes have their shortcomings[1], the microstructure literature shows that FXFX indicative quotes match up very well with trading prices from electronic foreign exchange trading systems such as Reuters 2000-2 and the Electronic Brokerage System (see e.g. Goodhart, Ito, and Payne (1996)).

We track the equity and bond markets by means of futures contract data. We mainly analyse the futures contracts on the Standard & Poor's 500 Stock Price Index and 10-Year US Treasury notes, quoted on the Chicago Mercantile Exchange and Chicago Board of Trade, respectively.[2] The data contain the time stamp to the nearest second and transaction price of all trades that occurred during the sample period. We use the most actively traded nearest-to-maturity or cheapest-to-delivery futures contract, switching to the next-maturity contract five days before expiration. If no trades occur in a given 5-minute interval, we copy down the last trading price in the previous time interval (see Andersen, Bollerslev, Diebold, and Vega (2004) and Christiansen and Ranaldo (2007)).

These futures markets have overnight non-trading times. For the *intraday* analysis

[1]The Reuters quotes are the standard high-frequency data in the foreign exchange literature. Since the early studies in the high-frequency domain (for instance, Müller, Dacorogna, Olsen, Pictet, Schwarz, and Morgenegg (1990)), there is compelling empirical evidence that Reuters data are very representative for the forex trading activity. Lyons (1995) stresses three limitations related to "indicative" quotes: they are not tradable; they are representative only for the interbank market; during very fast markets, indicative quotes may be updated with a short delay. However, Lyons (2001, p. 115) concludes that Reuters indicative quotes are highly representative even if "...they lag the interdealer market slightly and spreads are roughly twice the size of interdealer spreads." All these supposed limitations have no substantial bearings on our main results since we use larger time frequencies than minutes and profitability is not our concern.

[2]We have also analysed S&P500 futures contract coming from the open-outcry auction system and the GLOBEX electronic trading platform. The inclusion or exclusion of GLOBEX data does not affect our results.

we try to fill the gaps as far as possible. Unfortunately, this proved difficult for the bond market data. However, for the equity market we were able to construct a nearly round-the-clock equity market time series by combining equity futures data from different regions. We do this by using futures contract prices on the DAX and NIKKEI 225 indices traded on the Eurex and Singapore exchanges. After considering daylight savings times and all market-specific characteristics (e.g. official holidays, early closing times and so on), we adapt all trading times by taking the Greenwich Mean Time (GMT) as reference daily clock time. The regular time length of a trading day for the "round-the-clock" equity index is as follows: from midnight to 8:00 a.m. (GMT) the NIKKEI futures, from 9:00 a.m. to 16:00 p.m. DAX futures and from 16:00 to 22:00 p.m. S&P futures. This leaves three hours uncovered.[3]

In our study, we analyse log price changes and realised volatility.[4] We investigate these over different time granularities, from a few hours to almost a week. Thus, for example, the three-hour time frame relies on the log return and realised volatility that occurred over the last three hours. We calculate realised volatility as the sum of consecutive squared log price changes. Since intraday realised volatility has a time-of-day seasonality, intraday realised volatility data have been adjusted for these patterns. We have considered different methods.[5] Here, we present our findings based on the simple method adjustment represented by $ARV_{i,t} = RV_{i,t}/\sum_{t=1}^{T} RV_{i,t}/T$, where $ARV_{i,t}$ is the adjusted realised volatility at intraday time i of day t where $t = 1, ..., T$. The denominator represents the regular (average) volatility at that intraday time.[6] In the regressions, we use the logarithm of the realised volatility since that assures a more Gaussian distribution and better statistical properties (see e.g. Andersen, Bollerslev, Diebold, and Labys (2003)).

[3]This corresponds to the shortest time length for a regular trading day at the beginning of our sample. Later in the nineties, all the three exchanges extended their trading sessions and today electronic trading platforms allow investors to trade 24 hours. The various structures and definitions of "round-the-clock" equity index we have tested provide us with similar and consistent findings. Here, we present the intraday findings based on the three-phase construction described above.

[4]Andersen, Bollerslev, Diebold, and Labys (2001) and Andersen, Bollerslev, Diebold, and Labys (2003), among others, provide empirical evidence that realised volatility is an accurate estimate of intraday volatility.

[5]Other adjustment techniques can be applied. However, as shown by Omrane and de Bodt (2007), the adjustment method based on intraday average observations succeeds in estimating periodicities almost perfectly.

[6]We have considered different definitions of T, in particular the last one up to six months and the whole sample. All these definitions provide similar results. Here, we show the findings based on the entire sample.

4 Method

An asset is often considered a safe haven if is does not co-move (positively) with the "market." We will consider two versions of this idea: the first focuses on the unconditional covariance (estimated by a linear regression), while the second studies if the covariance is different in different market situations (estimated by a non-linear regression). We also allow for time-varying market risk to directly affect the exchange rates. This means that the safe haven component does not necessarily emerge only in political turmoil but that it depends on anything that has some significant effect on risk.

Our goal is to study how exchange rates are related to equity and bond markets. We start the analysis by a linear factor model for the excess return from investing in a foreign money market instrument (R_t^e)

$$R_t^e = \beta' f_t + \alpha + u_t, \tag{1}$$

where f_t is a vector of factors and u_t are the residuals. The excess return R_t^e equals the depreciation of the domestic currency plus the interest rate differential (foreign minus domestic interest rate). The factors include returns on global equity and bond markets as well as proxies for time-varying risk.

We interpret this model as a linearised version of a "true" factor model. In this true model, the only factors are global equity and bond markets, but they have time-varying betas. We approximate this true (time-varying) model by specifying a time-invariant model with extra factors: the proxies for time-varying risk (from realised volatilities) and lags are meant to capture the movements in the true betas.[7]

Our focus is on understanding the short-run (from a few hours to almost a week) movements of exchange rates—the safe haven effects. This has two important implications. First, all our factors are financial. This is because financial factors are likely to dominate the short-run movements of exchange rates—and there is no high-frequency macro data. We therefore have little to say about long run movements of exchange rates, which are likely to be influenced also by macro factors (for instance, inflation, income growth and money supply). Second, we use the factor model only to estimate the betas—to study the safe haven effects (if any). We do not attempt to test the cross-sectional pricing implications (which would, anyway, require a larger cross-section of exchange

[7] See Mark (1988) for a GARCH-approach to time-varying betas on the FX market.

rates than we have).[8]

We have tried several different specifications of the factor model, but in the end we use the following form

$$\begin{aligned}\text{Depr}_t &= \beta_1\text{S\&P}_t + \beta_2\text{TreasNote}_t + \beta_3\text{FXVol}_t + \\ &\beta_4\text{S\&P}_{t-1} + \beta_5\text{TreasNote}_{t-1} + \beta_6\text{FXVol}_{t-1} + \beta_7\text{Depr}_{t-1} + \alpha + \varepsilon_t, \quad (2)\end{aligned}$$

where Depr_t is the depreciation (appreciation) of a counter (base) currency in period t, $\text{S\&P}_t$ is the return on a Standard and Poor's futures, TreasNote_t is the return on a Treasury note futures and FXVol_t is a measure of currency market volatility.[9] For the exchange rates, we use direct quotation so, for instance, CHF/USD denotes the number of Swiss francs per US dollar. Clearly, a higher CHF/USD rate means that the Swiss franc has depreciated. The dependent variable and the regressors are always measured over identical time intervals. For instance, when we study the 24-hour frequency, then the depreciation and the returns are measured over 24 hours and the FX volatility is the realised volatility over the same 24 hours. (For the x-hour frequency, substitute x for 24.)

The currency market volatility (FXVol_t) is defined as the first principal component of the logarithm of realised volatilities of the exchange rates (against the USD)—excluding the currency in the dependent variable (Depr_t). For instance, when CHF/USD is the dependent variable, then FXVol_t is based on the log realised volatilities of EUR/USD, JPY/USD and GBP/USD. The exchange rate quotes are stale on a few days, which creates large negative outliers in the log realised volatility. For that reason, we delete around 10 days. These days happen to lack other data as well, so in the end this procedure effectively cuts out only 3 days of data.

We arrived at the form (2) after noticing several things. First, the interest rate differential contributes virtually nothing (it is very stable compared to the depreciations), so it can safely be excluded from the regressions: the dependent variable is therefore the depreciation. We have also tried to include the interest rate differential as a regressor,

[8]The testable implication of (1) is that $\mathrm{E}\, R^e_t = \beta'\lambda$, where λ are the factor risk premia. To test this cross-sectional implication, we need more returns than factors. Such tests on exchange rates are done in, among others, McCurdy and Morgan (1991) and Dahlquist and Bansal (2000).

[9]For the daily analysis, we have replicated the regression analysis by using return data based on the underlying assets of the S&P index and Treasury notes rather than futures contract data. We also tried several definitions of return such as close-to-close and open-to-close returns. The results remain virtually the same.

but this had virtually no effect on the estimated coefficients. Second, other proxies for time-variation in risk were considered. High-frequency measures of realised volatility for the S&P index futures gave mixed results whereas option-based volatility indicators were even less successful. Third, alternative measures of currency market volatility (based on options) gave very similar results. Fourth, further lags were not significant.

We estimate (2) with ordinary least squares (and a few other methods)—for different currencies and data frequencies. The significance tests use the Newey-West estimator of the covariance matrix, which accounts for both heteroskedasticity and autocorrelation.

The linear factor model (2) allows us to study several aspects of safe haven effects: if the exchange rate is negatively correlated with stock returns and it if is positively correlated with market uncertainty—which would be typical patterns for a safe haven asset. We are more agnostic about how the Treasury notes (futures) returns ought to be correlated with a safe haven asset. It could be argued that the we should apply the same reasoning as for stock returns. Alternatively, it could be argued that Treasury notes are themselves considered safe havens, so other safe haven assets should be positively correlated with them.

To study non-linear effects (for instance, if the betas are different in dramatic down-markets) we also estimate a sequence of partial linear models, where one (at a time) of the regressors in (2) is allowed to have a non-linear effect of unknown form. This non-linear effect is estimated by a kernel method, using a gaussian kernel and a cross-validation technique to determine the proper band width (see Pagan and Ullah (1999)). We apply this by first allowing only the current S&P futures returns to have non-linear effects, then only the current Treasury notes futures returns and finally only the current currency market volatility.

Because of the restricted trading hours of the Treasury notes futures (before 2004), we have to make some adjustments when we use the *intraday* data (below, we report results for 3–,6– and 12–hour horizons, in addition to 1–,2– and 4–day horizons). (In contrast, for the equity market we are able to construct an almost round-the-clock series by using also the NIKKEI and DAX, see Section 3.) For instance, for the three-hour horizon, the Treasury note futures returns are only available for 4 of the 8 three-hour intervals of a day (and night), while the most of the other data is available for 7 or 8 intervals. To avoid loosing too much data in the intraday regressions, we do two things. First, the lagged Treasury note futures is excluded (that is, β_5 in (2) is restricted to zero). Second, we apply the Griliches (1986) two-step approach to handle the still missing data points of the Treasury note futures. Effectively, this means that we estimate the β_2 coefficient in (2) on the 4 three-hour intervals with complete data, but the other coefficients on the 7 or 8 three-hour intervals.

	CHF/USD	EUR/USD	JPY/USD	GBP/USD
S&P	0.14	0.12	0.04	0.06
	(11.44)	(9.43)	(2.84)	(6.91)
Treasury notes	−0.23	−0.18	0.02	−0.14
	(−6.45)	(−5.32)	(0.54)	(−5.13)
FX volatility	−1.07	−0.73	−0.92	−0.38
	(−3.59)	(−2.70)	(−3.13)	(−1.92)
S&P$_{t-1}$	−0.05	−0.06	−0.02	−0.04
	(−4.06)	(−5.12)	(−1.26)	(−4.36)
Treasury notes$_{t-1}$	−0.09	−0.08	−0.14	−0.06
	(−3.07)	(−2.72)	(−4.09)	(−2.60)
FX volatility$_{t-1}$	0.92	0.70	0.50	0.45
	(3.82)	(3.05)	(2.17)	(2.60)
Own lag	−0.06	−0.06	−0.01	−0.05
	(−2.73)	(−3.35)	(−0.28)	(−2.50)
Constant	−0.00	−0.00	−0.00	−0.00
	(−1.15)	(−0.50)	(−0.70)	(−1.38)
R^2	0.09	0.07	0.02	0.04
n obs	2906.00	2911.00	2942.00	2937.00

Table 1: **Regression results, depreciations of different exchange rates (in columns) as dependent variables.** The table shows regression coefficients and t-statistics (in parentheses) for daily data 1993–2006. The t-statistics are based on a Newey-West estimator with two lags. The data for S&P and Treasury notes are returns on futures; FX volatility is the first principal component of the realised volatilites for several exchange rate depreciations. Exchange rate xxx/yyy denotes the number off xxx units per yyy unit.

5 Results

Table 1 shows results from estimating the regression equation (2) on daily data. Different exchange rates (against USD) are shown in the columns. All these exchange rates show significant safe haven patterns: they tend to appreciate when *(a)* S&P has negative returns; *(b)* U.S. bond prices increase; and *(c)* when currency markets become more volatile. The perhaps strongest safe haven patterns are found for the CHF and EUR and the weakest for GBP. These effects appear to be partly reversed after a day: the lagged coefficients typically have the opposite sign and almost comparable magnitude. While the reversal of the effects from stocks and bonds is only partial, the reversal of the effect from FX volatility is almost complete.[10] In any case, this suggest that there is some predictability—and there is also some further predictability coming from the negative autoregressive coefficient. None of the constants are significant, so our analysis is silent on the issue of long-run movements in the exchange rates.

Quantile	β_1S&P	β_2Treasury notes	β_3FX Volatility
0.005	−0.46	−0.25	−0.29
0.010	−0.40	−0.22	−0.25
0.020	−0.34	−0.18	−0.21
0.980	0.32	0.21	0.15
0.990	0.41	0.27	0.17
0.995	0.52	0.33	0.18

Table 2: **Quantiles of "effect" of contemporaneous regressors on CHF/USD depreciation, %.** The table shows quantiles of regression coefficients times the demeaned contemporaneous regressors for 1993–2006. The regression coefficients are from Table 1.

The R^2 are low (9% for the CHF/USD is the largest), so most of the daily exchange rate movements are driven by other factors. This is not surprising, given the noisiness of FX markets on a daily basis. What is important is that Table 1 shows distinct and (statistically) significant safe haven effects—and that those effects also have economic significance. To illustrate the latter, *Table 2* shows selected quantiles of the "effect" of the contemporaneous regressors on the CHF/USD depreciation. That is, in terms of the regression equation (2) it shows quantiles of $\beta_1\text{S\&P}_t$ (demeaned), $\beta_2\text{TreasNote}_t$ (demeaned) and $\beta_3\text{FXVol}_t$ (demeaned). For instance, the results for the 0.02 quantile shows that on 2% of the days (around 60 days from our sample), the S&P returns (Treasury notes) are associated with at least a 0.34% (0.18%) appreciation of the CHF/USD exchange rate while the FX volatility is associated with at least a 0.21% appreciation. (It can be shown that adding the effect of the lagged regressor produces similar quantiles.)

[10] For stocks and bonds, the null hypothesis that the sum of the coeffcients of the contemporaneous and lagged regressors is zero can be rejected at any traditional significance level (except for the S&P coefficients in the JPY/USD regression). In contrast, the hypothesis cannot be rejected for for the FX volatility

	JPY/EUR	GBP/EUR	CHF/EUR	GBP/JPY	CHF/JPY	GBP/CHF
S&P	−0.08	−0.05	0.03	0.03	0.11	−0.08
	(−5.12)	(−4.91)	(4.30)	(1.71)	(7.49)	(−7.51)
Treasury notes	0.19	0.04	−0.06	−0.15	−0.24	0.10
	(4.32)	(1.59)	(−3.19)	(−3.69)	(−5.95)	(3.44)
FX volatility	−0.56	0.28	−0.41	1.06	0.53	0.71
	(−2.05)	(1.50)	(−3.11)	(3.44)	(1.64)	(3.62)
$S\&P_{t-1}$	0.05	0.03	0.01	−0.02	−0.04	0.02
	(3.13)	(2.56)	(1.73)	(−1.33)	(−2.70)	(1.72)
Treasury $notes_{t-1}$	−0.06	0.01	−0.01	0.07	0.05	0.03
	(−1.78)	(0.53)	(−0.86)	(2.11)	(1.60)	(1.06)
FX $volatility_{t-1}$	0.16	−0.12	0.32	−0.41	−0.13	−0.43
	(0.69)	(−0.69)	(2.32)	(−1.71)	(−0.51)	(−2.55)
Own lag	0.02	−0.05	−0.04	0.01	0.04	−0.04
	(0.78)	(−1.99)	(−0.87)	(0.48)	(1.49)	(−1.56)
Constant	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00
	(−0.27)	(−0.80)	(−1.00)	(−0.43)	(−0.18)	(−0.20)
R^2	0.03	0.02	0.02	0.02	0.05	0.04
n obs	2916.00	2911.00	2881.00	2904.00	2874.00	2906.00

Table 3: **Regression results, depreciations of different exchange rates (in columns) as dependent variables.** The table shows regression coefficients and t-statistics (in parentheses) for daily data 1993–2006. The t-statistics are based on a Newey-West estimator with two lags. See Table 1 for details on the data.

After looking at Table 1, one pertinent question is whether the dollar (rather than its counter currency) determines the results. That is, one can wonder whether the dollar has some pro-cyclical patterns rather than CHF or EUR conveying safe-haven effects. To address this question, *Table 3* shows results for all cross rates. Once again, the CHF shows safe haven patterns: it appreciates (significantly) against the other cross currencies in the same situations as it appreciates against the USD (negative S&P returns, U.S. bond price increases and currency market volatility). Also similar to the previous results, the GBP is perhaps the least safe haven. The EUR and JPY are mixed cases, since the JPY/EUR rate appreciates when the S&P strengthens and the Treasury note futures weakens (opposite to the CHF/EUR pattern), but it also appreciates when the currency market volatility increases (similar to the CHF/EUR pattern). It can also be noticed that the “reversal effect” (the day after) is somewhat weaker on these cross-rates, and that the autoregressive

coefficients. Details are are available upon request.

coefficient is typically insignificant (the significant negative autocorrelation seems to be a USD phenomenon).

These results seem to corroborate the traditional view of the Swiss franc as a safe-haven asset. Kugler and Weder (2004) find that Swiss franc denominated assets have lower returns than comparable assets denominated in other currencies. In the spirit of our study, this may be due to the safe-haven risk premium inherent in Swiss franc denominated assets. Campbell, Serfaty-de Medeiros, and Viceira (2007) also show the hedging quality of the Swiss franc. Another reason that might play a significant role for its appreciations during market turmoils is the so-called "(espresso) coffee cup effect," that is, the phenomenon whereby investors switch from a large to a small currency area, which has a greater impact on the small currency area than on the large one. This idea emphasises the relevance of an elastic supply of liquidity, especially in times of market turmoil.

Based on the finding that the CHF shows the most pronounced safe haven effects, we now zoom in on the CHF/USD exchange rate—and study how the safe haven effects look at different time frames, in different time periods, in crisis periods—and if there are any non-linear patterns.

Table 4 reports results from estimating the regression equation (2) (with CHF/USD as the dependent variable) for different horizons: from 3 hours up to 4 days. For the intraday data we use a global equity series (NIKKEI, DAX, and S&P) instead of only S&P to get an almost round-the-clock series (see Section 3) and apply the Griliches (1986) two-step approach to handle the still missing data points of the Treasury note futures (see Section 4). The safe haven effect is clearly visible on all these horizons, even if magnitude of the coefficients of S&P and currency market volatility is considerably smaller at the shorter horizons—and seem to peak around 1 to 2 days. Overall, these results suggest two main points. First, forex, equity and bond markets are effectively inter-connected even at high frequencies. These links appear significant in statistical and economic terms. For instance, on the three-hour horizon, a 1% increase of the S&P is associated with roughly four basis points depreciations of the CHF and a 1% increase of the Treasury notes with a thirty basis points appreciation. Second, currency market risk appears priced into the Swiss franc value at any time granularity. This suggests the genuine character for the Swiss franc as a safe asset.

Figure 4 shows regression results from different subsamples of daily data (with CHF/USD as the dependent variable). The importance of the regressors has changed somewhat over

	3 hours	6 hours	12 hours	1 day	2 days	4 days
S&P	0.04	0.04	0.04	0.14	0.11	0.11
	(12.11)	(9.66)	(7.10)	(11.44)	(5.51)	(2.99)
Treasury notes	−0.28	−0.30	−0.32	−0.23	−0.23	−0.25
	(−8.40)	(−6.81)	(−6.04)	(−6.45)	(−4.53)	(−3.06)
FX volatility	−0.10	−0.14	−0.56	−1.07	−1.32	−0.67
	(−2.93)	(−2.19)	(−4.35)	(−3.59)	(−3.40)	(−1.60)
S&P$_{t-1}$	0.00	0.00	0.01	−0.05	−0.03	0.02
	(0.31)	(0.23)	(1.35)	(−4.06)	(−1.62)	(0.70)
Treasury notes$_{t-1}$				−0.09	−0.07	−0.10
				(−3.07)	(−1.40)	(−1.18)
FX volatility$_{t-1}$	0.07	0.07	0.38	0.92	1.30	0.70
	(2.75)	(1.38)	(3.43)	(3.82)	(4.32)	(1.93)
Own lag	−0.00	−0.00	−0.02	−0.06	−0.04	0.03
	(−0.37)	(−0.08)	(−1.32)	(−2.73)	(−1.31)	(0.70)
Constant	−0.00	−0.00	0.00	−0.00	−0.00	−0.00
	(−0.26)	(−0.28)	(0.40)	(−1.15)	(−1.59)	(−0.66)
R^2	0.02	0.02	0.03	0.09	0.08	0.07
n obs	22407.00	11446.00	6378.00	2906.00	1210.00	424.00

Table 4: **Regression results, CHF/USD depreciation as dependent variable.** The table shows regression coefficients and t-statistics (in parentheses) for 1993–2006. The t-statistics are based on a Newey-West estimator with two lags. See Table 1 for details on the data. The regressions on hourly data do not include the lagged Treasure notes futures as a regressor, and apply Griliches (1986) two-step approach to handle the still missing data points for the Treasury notes.

time. In particular, it seems as if the S&P has recently had a smaller effect, while the Treasury notes has become increasingly important. However, the overall safe-haven effects appear reasonably stable across time.

Figure 5 shows results from partial linear models (from daily data, with CHF/USD as the dependent variable) where one regressor at a time is allowed to have a non-linear effect. The evidence suggest that both the S&P and Treasury notes returns have almost linear effects. This means, among other things, that the effects from S&P are similar in up and down markets. In contrast, there may be some non-linear effects of currency market volatility. In particular, it seems as if it takes a high currency volatility to affect the CHF/USD exchange rate, but that the effect is then much stronger than estimated by the linear model. The economic importance of this is non-trivial: while the linear

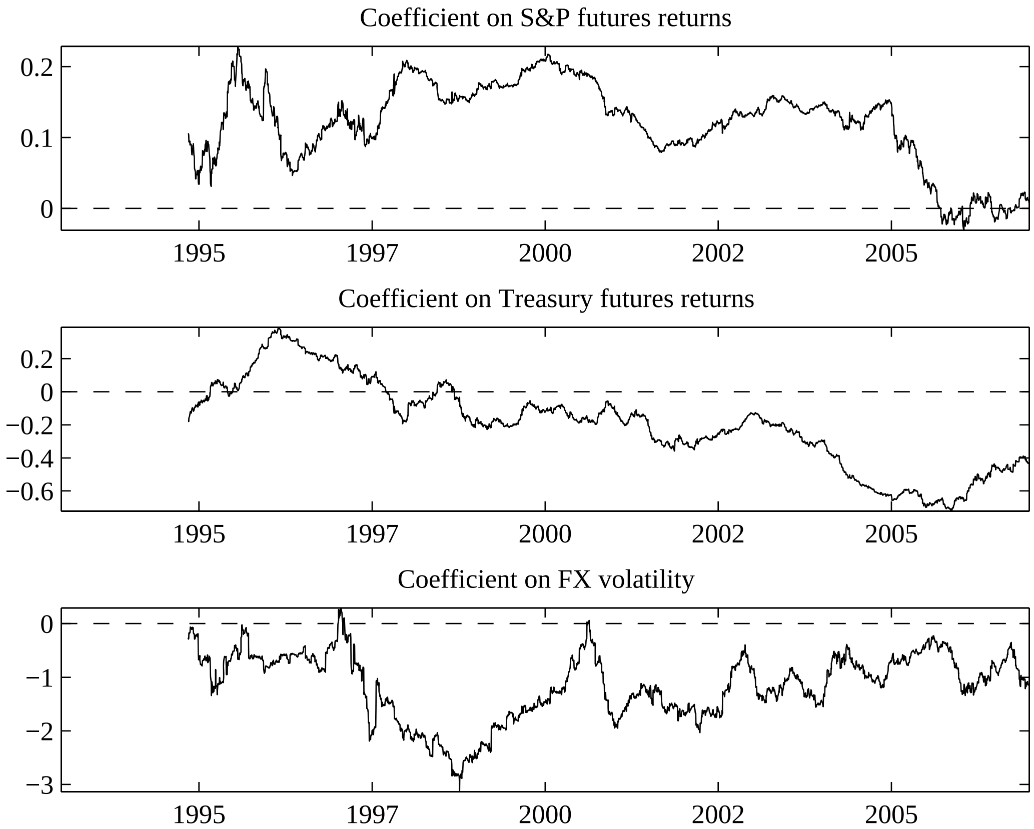

Figure 4: **Regression coefficients (with CHF/USD depreciation as the dependent variable) from a moving data window of 480 days.**

model showed that on 2% of the days the FX volatility is associated with at least a 0.21% appreciation of the CHF/USD exchange rate (see Table 2), the non-linear model would instead suggest at least a 0.8% appreciation.

The result presented so far demonstrate safe haven effects, and that they are fairly reasonably stable over time and linear (except possibly for FX volatility). This suggest that the safe haven effects are systematic and not driven by any particular episodes. To gain further insight into this, we re-run the regression for the CHF/USD exchange rate (daily data), but where all the regressors are also interacted with a dummy variable around large crisis episodes.

The episodes are chosen to represent major media headlines. We try to limit the

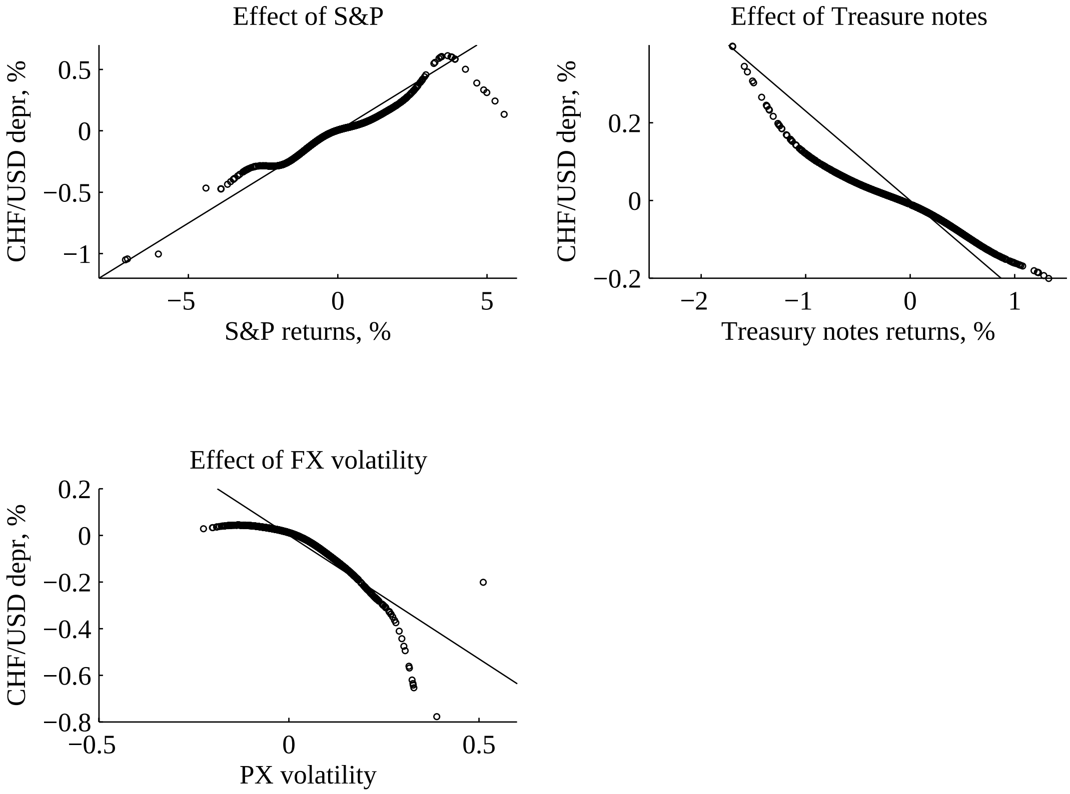

Figure 5: **Semiparametric estimates of effect on CHF/USD depreciation.** This figure shows results estimating a sequence partial linear models, $y_t = x_{1t}'\beta + g(x_{2t}) + u_t$, with the CHD/USD depreciations as the dependent variable (see Pagan and Ullah (1999)). The first subfigure shows the non-linear part, $g(x_{2t})$, where x_{2t} is the S&P returns and all other regressors are assumed to have linear effects. The second subfigure instead allows the Treasury futures returns to have nonlinear effects, while the third subfigure allows the FX volatility to have have nonlinear effects. The straight lines indicate the slopes in the fully linear model.

arbitrariness in the selection of episodes by using factiva.com. This is a Dow Jones' company that provides essential business news and information collected by more than 10,000 authoritative sources including the Wall Street Journal, the Financial Times, Dow Jones and Reuters newswires and the Associated Press, as well as Reuters Fundamentals, and D&B company profiles. The search of these news items was conducted by subject criteria and without any particular free text. We let this information provider order news bulletins by relevance for the following political and general news subjects: risk news including acts of terror, civil disruption, disasters/accidents and military actions. For the sake of comprehensiveness, we also included the most representative financial crises that had political origins (see “Tequila peso crisis”, “East Asian Crisis”, “Russian financial crisis”) and/or initiated by special economic circumstances (see “Global stock market crash”, “Dot-com bubble burst” and “Accounting scandals”). The selection of episodes is given in *Table 5*.[11]

Date	Event	Type
12/03/1993	Storm of the Century	Nature
20/12/1994	Tequila peso crisis	Finance
02/07/1997	East Asian Financial Crisis	Finance
27/10/1997	Global stock market crash	Finance
23/03/1998	Russian financial crisis	Finance
10/03/2000	Dot-com bubble burst	Finance
04/06/2001	2001 Atlantic hurricane	Nature
11/09/2001	WTC terrorist attacks	Terror&war
02/12/2001	Accounting scandals (Enron)	Finance
01/11/2002	SARS	Nature
20/03/2003	Second Gulf War	Terror&war
01/08/2003	European heat wave	Nature
11/03/2004	Madrid bombings	Terror&war
24/09/2004	Hurricane Rita	Nature
26/12/2004	Tsunami	Nature
07/07/2005	London bombings I	Terror&war
27/07/2005	London bombings II	Terror&war
23/08/2005	Hurricane Katrina	Nature
08/10/2005	Kashmir earthquake	Nature
12/07/2006	Lebanon War	Terror&war

Table 5: **Event dates**

We set the dummy variable to unity on the event days and the following 9 days (our “event window”) and re-run the regression for the CHF/USD exchange rate (daily data), but with all the regressors also interacted with the dummy variable. The results we report below are fairly robust to changes of the event window, although the statistical significance seems to vary a bit—which is not surprising given the low number of data points

[11] The Swiss franc showed safe haven properties during these episodes since the CHF/USD exchange rate appreciated (significantly) during each of these types of episodes—most during the “Terror&war” episodes when the average appreciation is 0.28% per day (the values for all the other types are 0.07% for both “Nature” and “Finance” and 0.13 for “All”).

in the episodes. For this reason, the results should be interpreted as indicative rather than conclusive. Still, several interesting results emerge. First, the results for the "old" regressors are virtually the same as before, so the results reported before indeed seem to represent the pattern on ordinary days. Second, there are some interesting "extra effects" during the episodes, as reported in *Table 6*.

	All	Nature	Finance	Terror&War
S&P × dummy	−0.06	−0.28	−0.04	0.03
	(−1.34)	(−3.71)	(−0.70)	(0.37)
Treasury notes × dummy	−0.10	0.01	−0.25	0.04
	(−0.71)	(0.07)	(−1.34)	(0.13)
FX volatility × dummy	−2.54	−3.03	−3.77	−2.11
	(−2.78)	(−1.76)	(−3.17)	(−0.88)
$S\&P_{t-1}$ × dummy	−0.04	0.14	−0.05	−0.05
	(−0.87)	(1.48)	(−0.99)	(−0.43)
Treasury $notes_{t-1}$ × dummy	0.03	−0.04	0.34	−0.08
	(0.30)	(−0.22)	(1.83)	(−0.20)
FX $volatility_{t-1}$ × dummy	2.01	3.03	1.98	2.46
	(2.34)	(1.69)	(1.79)	(1.33)
Own lag × dummy	0.09	0.36	0.22	−0.22
	(0.71)	(2.09)	(1.29)	(−1.10)
Constant × dummy	−0.00	−0.00	−0.00	−0.00
	(−1.63)	(−0.45)	(−0.33)	(−2.16)

Table 6: **Regression results, coefficients on interactive dummy variable, CHF/USD depreciation as dependent variable.** The table shows regression coefficients and t-statistics (in parentheses) for daily data 1993–2006. Only the results for the interactive dummy variable are shown. The dummy variable is set to unity on the event days defined in Table 5 and the following 9 days. The t-statistics are based on a Newey-West estimator with two lags. See Table 1 for details on the data.

When we combine all events into one dummy, most coefficients are small and insignificant. The only exception is the FX volatility variable. It seems as if the impact of FX volatility is much stronger around the crisis episodes than on other days. This squares well with the results from the non-linear estimation (see Figure 5), since these crisis episodes are also characterised by large increases in FX volatility. This pattern also holds when we look at the separate event types ("nature", "finance" and "terror&war"). In addition, it seems as if the S&P return loses its importance around natural disasters. This is a bit surprising, but of little economic importance since the average S&P return on those days is close to zero. There are also some indications that there is a stronger autocorrelation in the exchange rate around the natural disasters and that the Treasury notes returns play a larger role around financial episodes. Finally, the constant is at best border line significant (although negative), so it seems as if the movements in the S&P, Treasury notes and FX volatility can account for the systematic CHF/USD appreciations during crisis episodes.

6 Summary

This study has addressed two key questions: first, which currencies have safe haven properties and second, how the safe haven mechanism materialises. Our findings show that the Swiss franc carries the strongest safe haven attributes. Likewise, but to a smaller extent, the yen and euro have also been used as refuge currencies. The opposite picture holds for the US dollar that has behaved pro-cyclically with equity markets.

This study shows that the safe haven phenomenon proceeds is a dual, pass-through mechanism. On the one hand, safe haven currencies suffer during bull markets. Empirically, we observe a negative correlation between the performance of safe haven currencies and international equity markets. On the other hand, safe haven currencies appreciate as market risk rises. This relation is captured by measuring the perceived market risk with high-frequency realised volatility. These patterns are observed on data frequencies of a few hours up to almost a week. The effects are not only statistically but also economically significant. The study also shows that the safe haven phenomenon does not rely only on specific episodes—although it appears to be stronger during episodes that increase market uncertainty.

The findings in this paper should be insightful for both monetary authorities and financial investors. Since the exchange rate is an essential channel for inflation, monetary policy makers should carefully consider the state-dependent and time-varying nature of safe-haven risk premia. Overall, the link between exchange rate and its "fundamental value" depends on how market conditions determine currency risk premium. Furthermore, how forex, equity, bond markets are interconnected and how spillovers between return and risk propagate across markets relates to financial stability. On the other hand, the safe haven risk premium is crucial from a risk management and asset allocation standpoints. In spite the general conviction that exchange rates are disconnected with other markets, this study highlights the systematic and time-varying risk and hedging opportunities inherent in some currencies. It also enhances the understanding of the risk-return payoff in some speculative currency strategies such as carry trade.

Although fourteen years is a long period for a tick-by-tick data set, this time length can be seen as a relatively short period for an exhaustive analysis of foreign exchange markets. Further research should investigate the safe haven phenomenon over longer sample periods including other economic and financial market conditions as well as different monetary regimes. It should also explore the evidence of predictability ("reversals") around dramatic episodes. Finally, a recent econometric technique proposes a direct approach to identify the realised jumps inherent to realised volatility (Barndorff-Nielsen and Shephard, 2004, 2006). An extension of our study would address the decomposition of realised volatility into separate continuous and jump components, and their relations with safe haven currencies. We leave these questions for future research.

References

Andersen, T. G., T. Bollerslev, F. X. Diebold, and P. Labys, 2001, "The distribution of realized exchange rate volatility," *Journal of the American Statistical Association*, 96, 42–55.

Andersen, T. G., T. Bollerslev, F. X. Diebold, and P. Labys, 2003, "Modeling and forecasting realized volatility," *Econometrica*, 71, 579–625.

Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega, 2004, "Micro effects of macro announcements: real-time price discovery in foreign exchange," *American Economic Review*, 93, 38–62.

Bank for International Settlements, 1999, "International banking and financial market developments," BIS Quarterly Review.

Barndorff-Nielsen, O., and N. Shephard, 2004, "Power and bipower variation with stochastic volatility and jumps," *Journal of Financial Econometrics*, 2, 1–48.

Barndorff-Nielsen, O., and N. Shephard, 2006, "Econometrics of testing for jumps in financial economics using bipower variation," *Journal of Financial Econometrics*, 4, 1–30.

Baur, D. G., and B. M. Lucey, 2006, "Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold," Working Paper, Trinity College Dublin.

Bollerslev, T., and T. G. Andersen, 1998, "DM-Dollar volatility: intraday activity patterns, macroeconomic announcements, and longer run dependencies," *Journal of Finance*, 53, 219–265.

Brunnermeier, M. K., and L. H. Pedersen, 2007, "Market liquidity and funding liquidity," Working Paper 12939, National Bureau of Economic Research.

Burnside, C., M. Eichenbaum, I. Kleshchelski, and S. Rebelo, 2006, "The returns to currency speculation," Working Paper 12489, National Bureau of Economic Research.

Burnside, C., M. Eichenbaum, and S. Rebelo, 2007, "The returns to currency Speculation in emerging markets," Working Paper 12916, National Bureau of Economic Research.

Caballero, R. J., and A. Krishnamurthy, 2007, "Collective risk management in a flight to quality episode," Working Paper 12896, National Bureau of Economic Research.

Campbell, J. Y., K. Serfaty-de Medeiros, and L. M. Viceira, 2007, "Global currency hedging," Working Paper 13088, National Bureau of Economic Research.

Chordia, T., A. Sarkar, and A. Subrahmanyam, 2005, "An empirical analysis of stock and bond market liquidity," *Review of Financial Studies*, 18, 85–129.

Christiansen, C., and A. Ranaldo, 2007, "Realized bond-stock correlation: macroeconomic announcement effects," *Journal of Futures Markets*, 27, 439–469.

Dahlquist, M., and R. Bansal, 2000, "The forward premium puzzle: different tales from developed and emerging economies," *Journal of International Finance*, 51, 115–144.

Evans, M. D. D., and R. K. Lyons, 2002a, "Informational integration and FX trading," *Journal of International Money and Finance*, 21, 807–831.

Evans, M. D. D., and R. K. Lyons, 2002b, "Order flow and exchange rate determinants," *Journal of Political Economy*, 110, 170–180.

Goodhart, C., R. Ito, and R. Payne, 1996, "One day in June 1993: a study of the working of the Reuters 2000-2 Electronic Foreign Exchange Trading System," in J. Frankel, G. Galli, and A. Giovannini (ed.), *The microstructure of foreign exchange markets* . pp. 107–179, University of Chicago Press, IL.

Griliches, Z., 1986, "Economic data issues," in Zvi Griliches, and Michael D. Intriligator (ed.), *Handbooks in Econometrics III*, North-Holland, Amsterdam.

Hartmann, P., S. Straetmans, and C. De Vries, 2001, "Asset market linkages in crisis periods," Working Paper 71, European Central Bank.

Kaul, A., and S. Sapp, 2006, "Y2K fears and safe haven trading of the U.S. dollar," *Journal of International Money and Finance*, 25, 760–779.

Kugler, P., and B. Weder, 2004, "International portfolio holdings and Swiss franc asset returns," *Swiss Journal of Economics and Statistics*, 127, 301–325.

Lyons, R. K., 1995, “Tests of microstructural hypotheses in the foreign exchange market,” *Journal of Financial Economics*, 39, 321–351.

Lyons, R. K., 2001, *The microstructure approach to exchange rates*, MIT Press, Cambridge, Massachusetts.

Mark, N. C., 1988, “Time-varying betas and risk premia in the pricing of forward exchange contracts,” *Journal of Financial Economics*, 22, 335–354.

McCurdy, T. H., and I. G. Morgan, 1991, “Tests for a systematic risk component in deviations from uncovered interest rate parity,” *Review of Economic Studies*, 58, 587–602.

Müller, U., M. Dacorogna, R. Olsen, O. Pictet, M. Schwarz, and C. Morgenegg, 1990, “Statistically study of foreign exchange rates, empirical evidence of a price change scaling law and intradaily analysis,” *Journal of Banking and Finance*, 14, 1189–1208.

Omrane, W. B., and E. de Bodt, 2007, “Using self-organizing maps to adjust for intra-day seasonality,” *Journal of Banking and Finance*, 31, 1817–1838.

Pagan, A., and A. Ullah, 1999, *Nonparametric econometrics*, Cambridge University Press.

Upper, C., 2000, “How safe was the "safe haven"? Financial market liquidity during the 1998 turbulences,” Disucssion paper 1/00, Deutsche Bundesbank.

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