Exchange Rates and Sovereign Risk*†

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Abstract

We empirically investigate the relation between currency excess returns and sovereign risk, as measured by credit default swap (CDS) spreads. An increase in a country's CDS spread is accompanied by a contemporaneous depreciation of its exchange rate as well as an increase of its currency volatility and crash risk. The link between currency excess returns and sovereign risk is mainly driven by exposure to global sovereign risk shocks and also emerges in a predictive setting for currency risk premia. Sovereign risk forecasts excess returns to trading exchange rates, volatility and skewness, and is strongly priced in the cross-section of currencies. Moreover, we find that sovereign risk accounts for a large share of carry trade returns, and that carry and momentum strategies generate high (low) returns across countries with high (low) sovereign risk.

Keywords: Exchange rates, currency risk premium, sovereign risk, CDS spreads.

JEL Classification: F31, G12, G15.

This paper documents a strong link between currency excess returns and sovereign risk, as measured by the spreads on sovereign credit default swaps (CDS). These contracts allow investors to buy protection against the event of a sovereign default at a market price (the CDS spread) that reflects the state of the local and the global economy as well as investor risk aversion (e.g., Longstaff et al., 2011). We show that the information embedded in sovereign CDS spreads matters for the distribution of exchange rates, even for countries with floating exchange rates that are far from default.

As an illustrative example, consider the period preceding the widely anticipated UK credit rating downgrade on February 22 2013.[1] Figure 1 shows that from 1 December 2012 onwards the spread on UK government credit default swaps (CDS) increased from 31 to 52 basis points, with the pound (GBP) depreciating by more than 5% against the US dollar (USD). In derivatives markets, investors positioned against the GBP, with net speculator positions changing from about 30,000 contracts long to 30,000 contracts short. The implied volatilities of USD/GBP options surged, and more so for put relative to call options, reflecting the market's perception of tail risks and increased cost of crash insurance. Notably, the downgrade was only one notch down from AAA, so the UK was far away from actually defaulting on its debt.

Figure 1 about here

While this simple example suggests that sovereign risk matters for exchange rates, research on how sovereign risk relates to exchange rates and currency risk premia is scant. A straightforward explanation could be a risk-based channel where an increase in the sovereign risk of a country leads investors to demand a higher risk premium for holding that currency. The economic rationale behind this channel is similar to that used by Avramov et al. (2012) in their empirical study of international equity markets and in line with the

[1] For coverage in the financial press, see e.g., "Sterling hits two-year low on downgrade", Financial Times, 22 February 2013; "UK is stripped of triple-A rating", Wall Street Journal, 22 February 2013; "Sterling falls, bruised by UK credit rating downgrade", Reuters, 25 February 2013.

equilibrium implications derived by Gomes and Schmid (2012): while consumption-based models tend to perform poorly in pricing global returns, sovereign credit risk endogenously produces a countercyclical risk premium which is associated with (or forecasts) future GDP and consumption growth. Put another way, sovereign risk captures good and bad states of nature more precisely than low-frequency macroeconomic data and should therefore be informative for future asset returns. Consistent with this notion, the present paper provides extensive empirical evidence that currencies of countries with high sovereign risk offer higher expected returns than countries with low sovereign risk.

Specifically, we investigate the relationship between sovereign risk and currency excess returns as well as higher-order moments of exchange rates implied by currency option data. Using a broad set of 20 exchange rates of developed and emerging countries against the USD from January 2003 to November 2013, we present the following key findings. First, the currencies of countries that experience increasing sovereign risk show a significant *contemporaneous* depreciation as well as higher volatility, more negative skewness, and higher kurtosis implied by currency option data. Second, currency excess returns are strongly correlated with changes in global sovereign risk whereas innovations in local sovereign risk play a minor role. Third, countries' currency exposures to global sovereign risk are related to their external asset-liability position, inflation rate, and interest rate level, lending support to the notion that sovereign risk captures fundamental information that is relevant to currency markets. Fourth, sovereign risk is priced in the cross-section of currencies and *forecasts* future currency excess returns and the excess returns to trading on volatility and skewness. Finally, we provide evidence that sovereign risk also matters for excess returns of benchmark strategies, by showing that sovereign risk accounts for a large share of carry trade returns and showing that carry and momentum trades are significantly more profitable in high CDS countries than in low CDS countries.

To explore the relation between currency excess returns and sovereign risk, we rely on sovereign CDS data and document a strong inverse relation between *contemporaneous* changes in sovereign CDS spreads and currency excess returns at the daily, weekly, and monthly frequency. For example, in a pooled regression using monthly data we find a significantly negative slope coefficient, with the economic effect being that a 50 basis points increase in the CDS spread is associated with an exchange rate depreciation of approximately 3.8%. The regression R^2 is about 25% and orders of magnitude higher than the R^2 of about 0.2% from a similar regression of currency excess returns on changes in interest rate differentials.

We confirm the link between currency excess returns and CDS spread changes in individual country regressions and show that *global* shocks play a key role for the contemporaneous link between currency excess returns and sovereign risk. Regressions of currency excess returns on changes in global sovereign risk (measured as the cross-country average CDS spread) generate significantly negative slope estimates and high R^2s for all countries except Japan. Country-specific sovereign risk matters much less and only for a subset of countries, which are mainly emerging markets. These results line up with previous findings that sovereign CDS spreads have a strong common component (Longstaff et al., 2011) and that exposure to global factors matters for exchange rates (e.g., Lustig, Roussanov, and Verdelhan, 2011; Verdelhan, 2015). Moreover, we show that innovations in sovereign risk are also related to the higher moments of the exchange rate return distribution: using option-implied measures of currency volatility, skewness and kurtosis, we find that an increase in sovereign risk is accompanied by higher foreign exchange (FX) volatility, a shift in skewness such that FX crash insurance becomes more expensive, as well as fattening tails of the FX distribution.

A risk-based explanation of the link between sovereign risk and exchange rates would furthermore suggest that a country's sovereign risk *forecasts* excess returns to holding that currency, as investors in high risk currencies should be compensated for bearing this risk. To test this conjecture, we form currency portfolios based on countries' exposures to global sovereign risk (measured by rolling betas of currency excess returns on global CDS spread changes), based on countries' CDS spread levels, as well as sovereign ratings. We find that these portfolios deliver significantly positive excess returns with high Sharpe ratios for trading exchange rates, FX volatility, and FX skewness. We carry out formal cross-sectional asset pricing tests, and find that global sovereign risk is priced in a cross-section of portfolio returns obtained from sorting currencies on CDS spreads, interest rates, and inflation rates. Moreover, we provide evidence that the information embedded in CDS spreads also matters for the performance of other benchmark trading strategies: a substantial share of carry trade returns can be attributed to sovereign risk, and carry and momentum strategies are significantly more profitable when applied to currencies of high CDS countries than for currencies of low CDS countries. Taken together, these results imply that sovereign CDS spreads are informative for currency risk premia.

We conduct extensive robustness checks that corroborate our conclusions and present additional empirical results, including the following. Our measure of global default risk contains substantially more currency-relevant information than the VIX, which is commonly used as a measure of global uncertainty or risk aversion. Moreover, we provide evidence that sovereign CDS spreads are also related to the dynamics of currency demand, so that increases in sovereign risk are associated with contemporaneous and subsequent reductions of speculators' positions in FX derivative markets. We also show that our results are robust to accounting for transaction costs and when changing the base currency. Finally, we also discuss the relation between sovereign CDS spreads and international equity returns.

The remainder of the paper unfolds as follows. Section 1 provides our motivation and discusses related literature. Section 2 describes our data, instruments, and trading strategies. Section 3 reports results related to the contemporaneous link between sovereign risk and exchange rates. Section 4 reports results for currency excess return predictability and asset pricing tests designed to assess the pricing power of sovereign risk in the cross-section of currencies. Section 5 provides additional results and robustness checks, and the last section concludes. The Appendix contains technical details, and an Internet Appendix presents additional analyses and robustness checks.

1. Motivation and Related Literature

There is little research on how exchange rates and currency risk premia relate to sovereign risk. To fill this gap, we empirically test the conjecture that countries with high sovereign risk compensate investors with higher expected currency excess returns than countries with low sovereign risk. To motivate our empirical analysis, we discuss how sovereign risk may matter for exchange rates through a credit risk channel as in Gomes and Schmid (2012) and how previously documented properties of currency risk premia call for an investigation of this channel in currency markets.

Gomes and Schmid (2012) present a general equilibrium framework that implies a close relation between credit spreads, expected asset returns, and future macroeconomic growth. In their model, credit risk demands a counter cyclical risk premium, because high credit risk assets tend to perform poorly in bad states of the economy when consumption is low and marginal utility is high, and vice versa. As a consequence, the high credit risk premium in bad times depresses (costly) borrowing, investments, productivity, and, ultimately, GDP growth as well as consumption growth. Consistent with the notion of such a credit risk channel, Avramov et al. (2012) find that countries' exposures to global sovereign risk predict excess returns in international stock markets. More specifically, they find that a world credit risk factor, defined as the high-minus-low returns of sovereign rating-sorted equity portfolios, is priced in a broad cross-section of country returns.[2] Along the same lines, the present paper provides extensive empirical evidence that sovereign risk matters for the time series behavior of bilateral exchange rates and for the cross section of currency excess returns.

While there is a vast literature on currency risk premia, there is little research on the relation between exchange rates and sovereign risk.[3] Several key properties of currency

[2]Their results strengthen earlier evidence that country ratings have predictive ability for international equity returns presented by, for instance, Erb, Harvey, and Viskanta (1995, 1996).

[3]Research on the general link between sovereign risk and exchange rates is scant, but recent papers have reported a few specific empirical results. Carr and Wu (2007b) propose a valuation framework for sovereign CDS contracts that takes information in currency option prices into account and discuss implications for

risk premia documented by earlier studies, however, may be indicative for a sovereign risk-based channel in the spirit of Gomes and Schmid (2012). First, risk premia on currencies are time-varying and counter-cyclical (e.g., Sarno, Schneider, and Wagner, 2012; Lustig, Roussanov, and Verdelhan, 2014), thereby matching the general business cycle properties of credit spreads (e.g., Avramov et al., 2012; Gilchrist and Zakrajsek, 2012) required by the theory of Gomes and Schmid (2012). Second, interest rate differentials predict excess returns in the cross section of currencies (e.g., Lustig and Verdelhan, 2007; Burnside et al., 2011; Lustig, Roussanov, and Verdelhan, 2011). Given that interest rates can be thought of as comprising a riskfree as well as a default risk component (see, e.g., Duffie, Pedersen, and Singleton, 2003), a natural question is to what extent the predictive ability for currency risk premia is due to the credit risk component. Third, currency risk premia compensate for exposure to global factors (e.g., Lustig, Roussanov, and Verdelhan, 2011; Verdelhan, 2015) and, similarly, sovereign CDS spreads exhibit a strong common component (Longstaff et al., 2011; Doshi, Jacobs, and Zurita, 2015). These observations provide a solid motivation for an empirical analysis of the relationship between exchange rates and sovereign risk.

Moreover, historical evidence shows that *actual sovereign defaults* have often been followed by currency crises, associated with severe currency depreciations (or devaluations), and heightened uncertainty about the exchange rate (e.g., Reinhart, 2002; Mano, 2013). These findings suggest that *default expectations* embedded in sovereign CDS spreads should not only convey information for currency excess returns but also for currency volatility and skewness, i.e., the higher moments of the exchange rate distribution. Indeed, our empirical results suggest a strong link between sovereign risk and currency options-based insurance against volatility, skewness, and (to some extent) kurtosis risk, as well as the returns of currency portfolios that mimic higher moment risks. These findings complement earlier

default probabilities and credit spreads in Brazil and Mexico from 2002 to early 2005. Pu and Zhang (2012) and Mano (2013) compare USD- and EUR-denominated sovereign CDS spreads for Eurozone countries to investigate whether the differential (the quanto CDS) conveys information for the EUR, with Mano (2013) focussing on expected depreciations given the default of member countries. We control for potential CDS quanto effects in our empirical analysis and we study the EUR in robustness checks. Tse and Wald (2013) find that using sovereign CDS spreads sheds some light on the forward premium puzzle but argue that CDS spreads have no explanatory power for carry trade returns.

evidence on the properties of variance and skewness risk in exchange rates (e.g., Carr and Wu, 2007a; Bakshi, Carr, and Wu, 2008; Du, 2013; Della Corte, Ramadorai, and Sarno, 2016; Londono and Zhou, 2016) and also relate our paper to recent work on crash risk in currency markets (see, e.g., Brunnermeier, Nagel, and Pedersen, 2008; Chernov, Graveline, and Zviadadze, 2016; Jurek, 2014; Farhi et al., 2015; Farhi and Gabaix, 2016; Daniel, Hodrick, and Lu, 2016). The link between sovereign risk, higher exchange rate moments, and currency crash risk suggested by our empirical results is also consistent with the literature on asset pricing implications of rare event risk for credit spreads and option prices, recently surveyed by Tsai and Wachter (2015).[4]

Our finding that sovereign risk matters for exchange rates contributes to the the emerging literature on currency risk premia in the cross-section pioneered by Lustig and Verdelhan (2007).[5] We also show, more specifically, that the performance of carry and momentum trades, two benchmark strategies in FX markets (e.g., Lustig, Roussanov, and Verdelhan, 2011; Menkhoff et al., 2012b), is related to sovereign risk. Furthermore, we provide evidence that the predictive ability of sovereign credit spreads for international equity returns (e.g., Avramov et al., 2012) appears to mostly operate through the equity returns' currency component, at least in our sample. When we use a factor model to control cross-country equity returns for currency risk (in the spirit of, e.g., Ferson and Harvey, 1993, 1994; Dumas and Solnik, 1995; Brusa, Ramadorai, and Verdelhan, 2015), we find that the FX factor, constructed as sovereign risk-weighted currency portfolio, absorbs the predictive ability of sovereign risk for equity returns. These results suggest that understanding the link between exchange rates and sovereign risk is also important for international asset allocation on a more general level.

[4]Bhamra and Strebulaev (2011), Gourio (2013), Seo and Wachter (2016b), and Seo (2016) link disaster risk to credit spreads. Backus, Chernov, and Martin (2011) and Seo and Wachter (2016a) discuss the asset pricing implications for equity index options.

[5]Other recent papers that follow their cross-sectional approach are, for instance, Barroso and Santa-Clara (2015), Burnside et al. (2011), Farhi et al. (2015), Lettau, Maggiori, and Weber (2014), Lustig, Roussanov, and Verdelhan (2011, 2014), Menkhoff et al. (2012a,b, 2016b), Verdelhan (2015), and Lustig, Stathopoulos, and Verdelhan (2016).

2. Data, Descriptive Statistics, and FX Trading Strategies

In this section we describe the data, present some summary statistics, and discuss the trading strategies that we use in the empirical analysis to explore whether sovereign risk matters for currency returns.

2.1 Data and sample construction

In the empirical analysis, we use sovereign CDS spreads to measure sovereign risk. Sovereign CDS spreads represent timely market information and allow for a more accurate assessment of sovereign risk compared to sovereign credit ratings or sovereign bond yield spreads as sovereign CDS markets are typically more liquid than corresponding bond markets (see, e.g., Duffie, Pedersen, and Singleton, 2003; Pan and Singleton, 2008; Longstaff et al., 2011; Palladini and Portes, 2011; Augustin, 2013; Mano, 2013).[6]

The core analysis on the link between sovereign risk and currency excess returns requires daily data on sovereign CDS spreads, spot and forward exchange rates, as well as currency options. From the merged sample, we eliminate countries with fixed or quasi-fixed exchange rate regimes as well as countries that impose restrictions to their capital account and thus limit the actual trading of their currencies.[7] Applying these filters and requiring at least 12 months of consecutive data results in a sample from January 2003 to November 2013 (limited by CDS data not being available earlier) that covers 20 developed and emerging countries and exchange rates against the US Dollar (USD): Australia (AUD), *Brazil*

[6]Other advantages of using CDS data, also discussed in the literature on corporate CDS, include the comparability of CDS spreads across reference entities because of standardized CDS contract specifications (in terms maturities, cash flows, default definitions, etc.) as well as avoidance of bond-specific effects related to covenants, taxes, and liquidity. They also present other arguments that favor the use of sovereign CDS data over using sovereign credit ratings, for instance, the fact that ratings are only updated at low frequencies and often represent stale measures of credit risk for sovereign issuers.

[7]Specifically, we only keep observations of countries at times when their capital account openness index has a value greater than or equal to zero (Chinn and Ito, 2006) and the exchange rate regime according to the IMF coarse classification is 3 or 4. These regimes comprise currencies which are in a pre-announced crawling band that is wider than or equal to $+/-2\%$, a *de facto* crawling band that is narrower than or equal to $+/-5\%$, a moving band that is narrower than or equal to $+/-2\%$, a managed float, or a free float.

(BRL), Canada (CAD), *Chile* (CLP), *Colombia* (COP), *Czech Republic* (CZK), *Hungary* (HUF), *Indonesia* (IDR), *Israel* (ILS), Japan (JPY), *South Korea* (KRW), *Mexico* (MXN), New Zealand (NZD), Norway (NOK), *Poland* (PLN), *Singapore* (SGD), Sweden (SEK), Switzerland (CHF), *Turkey* (TRY), and the UK (GBP), where italic fonts indicate the 12 countries that we refer to as emerging economies. Below we describe the data on sovereign CDS spreads, exchange rates, and currency options. Other data that we use in supplementary empirical analysis and robustness checks are discussed *ibidem*.

2.1.1 Sovereign CDS data

CDS contracts provide insurance against the event that a reference entity, in our case a sovereign, defaults on its debt.[8] The buyer of a credit protection pays typically a semi-annual premium, the CDS spread, over the contract's tenor as long as no default occurs. In the event of a default, the protection seller compensates the protection buyer for the loss given default and the contract terminates. We refer to Pan and Singleton (2008) for a detailed discussion of the contractual provisions of sovereign CDS contracts such as events that trigger defaults, delivery and settlement upon default

We collect data on sovereign CDS spreads from Markit. For most of the analysis, we use CDS contracts with a tenor of 5 years, "complete restructuring" clause (docclause CR), and USD as currency of denomination. This represents the most liquid segment of the sovereign CDS market. We also conduct various robustness checks, including the use of CDS contracts denominated in other currencies. Additionally, we obtain data on sovereign ratings from Markit.

2.1.2 Exchange rate data

We obtain daily spot and 1-month forward exchange rates from BBI and WM/Reuters via Datastream. All exchange rates are relative to the USD and defined as units of USD per

[8] Depending on contract specifications, a credit event may also be restructuring or rescheduling of debt.

unit of foreign currency, i.e., we take the perspective of a US investor and a rising exchange rate represents a foreign currency appreciation.

2.1.3 Currency option data

We use over-the-counter (OTC) one-month currency option data from JP Morgan. The OTC market for currency options is characterized by specific trading conventions in that options are quoted in terms of Garman and Kohlhagen (1983) implied volatility (IV) on baskets of plain vanilla options, at fixed deltas (δ), and with constant maturities. For a given maturity, quotes are typically available for five different option combinations: delta-neutral straddle, 10δ and 25δ risk-reversals, and 10δ and 25δ butterfly spreads.[9] The delta-neutral straddle is constructed from a long call and a long put option with the same absolute delta such that the total delta is zero (0δ) and the IV of this strategy equals the at-the-money (ATM) IV quoted in the market. In a risk reversal, the trader buys an out-of-the money (OTM) call and sells an OTM put with symmetric deltas (25δ or 10δ). The butterfly spread combines a long strangle (similar to a straddle but with δ-symmetric OTM options) with a short delta-neutral straddle, and is equivalent to the difference between the average IV of the OTM call and OTM put minus the IV of the straddle. From these data, one can recover the implied volatility smile ranging from a 10δ put to a 10δ call. Appendix A describes the procedure to convert deltas into strike prices and implied volatilities into option prices to obtain IVs and currency option prices for five plain-vanilla European call and put options for currency pairs vis-a-vis the USD.

2.1.4 Macro data

Turning to macroeconomic data, we obtain annual data series on foreign (or external) assets and liabilities from Lane and Milesi-Ferretti (2007), available on Philip Lane's website. Foreign assets are measured as the dollar value of assets a country owns abroad, while

[9] In line market conventions, a 10δ (25δ) call option is a call with a delta of 0.10 (0.25) and a 10δ (25δ) put option is a put with a delta equal to -0.10 (-0.25).

foreign liabilities refer to the dollar value of domestic assets owned by foreigners. We extend the dataset until the end of 2013 using the IMF's International Financial Statistics database. In addition, we also use quarterly data on the investor holdings of sovereign debt compiled by Arslanalp and Tsuda (2014a,b) and available on the IMF's website. Finally, we collect year-on-year monthly inflation data from Datastream.

2.2 Descriptive statistics

Table 1 reports the time periods and descriptive statistics for CDS spreads, forward discounts, and ATM option IVs for each of the 20 countries covered in our sample, after applying the data filtering procedure described above. At first glance, emerging countries seem to have higher CDS spreads and forward discounts than developed countries (in the median) but dispersion is much lower for (median) option IVs. Taking a closer look reveals that the cross-country variation in CDS spreads, forward discounts, and option IVs is not perfectly correlated across instruments, neither within developed or emerging markets, nor across all countries.

For instance, comparing Mexico and Sweden over the full sample period shows that MXN has substantially higher CDS spreads (112 *bps* vs 15 *bps*) and forward discounts (32 *bps* vs 7 *bps*) but that its median option IV is lower (9.7% vs 11.3%). As another example, NOK has a lower CDS spread than JPY (14 *bps* vs 19 *bps*) but a substantially higher forward discount (11 *bps* vs -9 *bps*) and higher IV (11.3% vs 9.86%). This last example also illustrates how CDS spreads may convey different information for exchange rates compared to forward discounts, which reflect differences in aggregate interest rates, thus comprising a riskless plus a default risk component.

Table 1 about here

2.3 FX trading strategies across moments

We explore the empirical relation between sovereign risk and exchange rates and report results on three aspects of this relation. First, we analyze the contemporaneous link between sovereign CDS spread changes and currency excess returns as well as changes in the higher moments of the FX distribution (volatility, skewness, kurtosis). Second, we report results on the existence of a sovereign risk premium in currency markets and that global sovereign risk is priced in the cross-section of currencies. Third, we evaluate the predictive ability of sovereign risk for excess returns on currency investments across the first four moments of the FX distribution. Below we describe how we construct the relevant FX strategies from spot and forward exchange rates and currency option IVs.

2.3.1 Currency spot/forward strategies

Let $s_{i,t}$ and $f_{i,t}$ denote the logs of spot and 1-month forward exchange rates at time t, respectively, for the foreign currency i relative to the USD. We compute the excess return from buying a unit of foreign currency in the forward market at time t and selling the position in the spot market after one month as $rx_{i,t+1} = s_{i,t+1} - f_{i,t}$. Since covered interest rate parity typically holds even at fairly high frequencies (Akram, Rime, and Sarno, 2008), the 1-month forward discount $fd_{i,t} = s_{i,t} - f_{i,t}$ corresponds to the difference between the 1-month foreign and US interest rates, and the excess return can be rewritten as $rx_{i,t+1} = \Delta s_{i,t+1} + fd_{i,t}$, where $\Delta s_{i,t+1} = s_{i,t+1} - s_{i,t}$ denotes the 1-month log exchange rate return between times t and $t+1$. Given these standard definitions of FX returns and excess returns, we present empirical evidence that sovereign risk matters for *contemporaneous* and *future currency excess returns*.

2.3.2 Currency option trading strategies

In addition to trading in traditional instruments such as spot and forward contracts, investors also trade in the currency option market in order to hedge against or get exposure to currency volatility, skewness and kurtosis. More generally, investors do not only care about (excess) returns but also about higher moment risk in FX markets. Following Beber, Breedon, and Buraschi (2010), we use option data to construct proxies for the (risk-neutral) higher moments of the exchange rate return distribution.

In general, an investor buys a delta-neutral straddle to seek protection against volatility risk, sells a risk reversal to hedge against a sharp currency depreciation (skewness or crash risk), and sells a butterfly spread to obtain insurance against extreme exchange rate changes in either direction (kurtosis risk). Specifically, we consider an investor that goes long a 1-month delta-neutral straddle at time t to insure herself against volatility risk of the foreign currency i (relative to the USD) between times t and $t+1$. We refer to the implied volatility of this contract as $st_{i,t}$. Moreover, our investor will also buy protection against skewness risk of the foreign currency i over the course of the next month by selling at time t a 1-month risk reversal based on 25δ options. This is equivalent to going long a 25δ put option and short a 25δ call option (i.e., the opposite of how the risk-reversal is quoted in the OTC option market). We label the implied volatility of this short position as $rr_{i,t}$. Finally, our investor will hedge against kurtosis risk of the foreign currency i between times t and $t+1$ by selling at time t a 1-month butterfly spread based on 25δ options. This corresponds to a short position on a delta-neutral straddle coupled with a long position on 25δ call and put option (i.e., the opposite of how the butterfly spread is quoted in the OTC option market). We denote the implied volatility on a long butterfly spread as $bf_{i,t}$.[10]

To complement our analysis of whether sovereign risk *forecasts* currency excess returns consistent with the notion of sovereign risk premia, we also compute the excess returns to trading FX volatility, FX skewness, and FX kurtosis as in Burnside et al. (2011). We present the technical details in Appendix B. If currency investors care about sovereign risk, they should be willing to pay a premium (i.e., to accept negative excess returns) when entering the protection strategies based on delta-neutral straddle, risk reversal and

[10]In our core analysis we use 25δ options with a maturity of one month but results are robust to using 10δ options as well as maturities up to five years.

butterfly spread. In turn, selling insurance against higher moment risk should provide positive excess returns, and we empirically test this in Section 4.

3. Sovereign Risk and Currencies: Contemporaneous Relation

In this section, we document a strong *contemporaneous* relation between sovereign CDS spreads and currency excess returns. Specifically, we find that an increase in the sovereign risk of a country is associated with a negative excess return, an increase in exchange rate volatility, as well as a shift in currency skewness reflecting increased costs of crash insurance. We also show that this link is largely driven by global CDS shocks. These global shocks contain substantial information beyond that contained in the VIX, and countries' FX exposures to global CDS spread shocks are related to their external asset-liability positions, inflation, and interest rates.

3.1 Sovereign risk and currency excess returns

We start by running the following country-by-country regressions over the full sample period:

$$rx_{i,t} = a_i + b_i \Delta C^{\star}_{i,t} + e_{i,t}, \tag{1}$$

where $rx_{i,t}$ is the currency excess return for currency i relative to the USD between times $t-1$ and t, and $\Delta C^{\star}_{i,t}$ is the change in the 5-year CDS spread denominated in USD for country i measured over the same time interval. We will omit the subscript i throughout the discussion of the results for simplicity.

Table 2 about here

Table 2 reports the estimation results of these regressions. At the monthly frequency we find a significantly negative slope b for all currencies except Japan, where we find a statistically insignificant slope and a zero R^2. For the other 19 countries the R^2s range from 10% (Canada) to 65% (Hungary). These results remain qualitatively unchanged when using higher frequencies such as weekly and daily.

To get a summary measure of the link between currency excess returns and sovereign risk, the last four rows of Table 2 also report results for pooled regressions using all 20 countries. We regress currency excess returns on changes in foreign country CDS spreads (as above) as well as on changes in the differential between foreign country and US sovereign CDS spreads, $\Delta(C_t^\star - C_t)$. At the monthly frequency, we find highly significant slope estimates of -7.52 and -7.57 associated with R^2s of 25% and 23%, respectively. These results also indicate a high degree of economic significance, with the coefficient estimates suggesting that, on average, an increase in a country's CDS spread by 50 basis points is accompanied by a sizeable depreciation of its currency of about 3.8%.

Moreover, we also estimate the pooled regressions using changes in k-month interest rate differentials, $\Delta(i_{t,k}^\star - i_{t,k})$, as independent variable. Interest rates are the most commonly used fundamental in the exchange rate literature and, conceptually, they comprise a riskfree as well as a default risk component (see, e.g., Duffie, Pedersen, and Singleton, 2003). We consider short-term rates ($k = 1$ month, consistent with the recent carry trade literature) and longer-term rates ($k = 60$ months, computed from swap rates, to match the maturity of CDS contracts). The results in the last two rows of Table 2 show that slope coefficients are typically not significant and that R^2s never exceed 1%. This is an order of magnitude lower compared to the CDS spread regressions, suggesting that the information captured by the default component embedded in interest rates (which we proxy by CDS spreads) matters most for exchange rates. All these results are robust to using different panel regression specifications, subsamples, or CDS denomination currencies.[11]

[11] We provide additional estimates on the link between excess returns and shocks to sovereign risk (as well as interest rate changes) in the Internet Appendix in Table IA.1 and Table IA.2. Table IA.1 shows pooled regression results for the full sample as well as pre-crisis and crisis subsamples. We find a significant link between sovereign risk and exchange rates, both, before and during the crisis whereas we find no link between interest rate changes and currency returns in either subsample. Given that our results also extend to the pre-crisis period, it seems unlikely that a potential confounding of sovereign and (interbank) counterparty risk, which both increased during the crisis, explains our findings. Moreover, we present results based on local currency CDS spreads to show that our findings are not driven by CDS-quanto effects; see e.g., Mano (2013). Table IA.2 shows results for regressions of currency excess returns on CDS

3.2 Higher moments implied by currency option IVs

If investors care about currency risk, they may want to hedge against exchange rate changes in FX option markets. More specifically, in our context they should be willing to pay more for the insurance strategies described in Section 2.3 when the foreign country's sovereign risk increases. We evaluate this conjecture by exploring the relation between changes in sovereign risk and changes in the implied volatility of delta-neutral straddles, risk reversals and butterfly spreads.

Table 3 reports pooled contemporaneous regressions of changes in $st_{i,t}$, $rr_{i,t}$, and $bf_{i,t}$ on CDS spread changes and interest rate changes, i.e., we run regressions like $\Delta st_{i,t} = a + b\Delta C^{\star}_{i,t} + e_{i,t}$, where $\Delta st_{i,t}$ is the change in the implied volatility of a delta-neutral straddle on currency i between times $t-1$ and t. We also report results for individual currencies in the Internet Appendix (Tables IA.3 - IA.5).

TABLE 3 ABOUT HERE

The regression results in Table 3 show that changes in sovereign risk are highly correlated with movements in higher FX moments at all frequencies. Consistent with economic intuition, an increase in sovereign risk is related to: (i) higher exchange rate volatility, (ii) more (negative) skewness and higher cost of crash insurance (i.e., OTM puts more expensive than OTM calls), and (iii) higher butterfly spreads, suggesting that market participants are concerned about extreme events (i.e., OTM options more expensive than ATM options). The regression coefficients are highly significant across moments and across frequencies, and associated with sizeable regression R^2s, thereby strongly supporting a link between sovereign risk and higher FX moments as well. By contrast, but similar to the

changes (and interest rate changes) based on cross-sectional regressions (Fama and MacBeth, 1973), panel regressions with country fixed effects (denoted FE), panel regressions with time fixed effects (TE), as well as panel regressions with both country and time fixed effects ($FETE$). Our findings are robust to all these specifications.

evidence for currency excess returns reported above, the relation between interest rates and currency options appears much weaker.

3.3 Global versus local sovereign risk and exchange rates

To better understand the relation between sovereign CDS spreads and exchange rates, we explore whether it is driven solely by a link between *local* sovereign risk and exchange rates or whether shocks to *global* sovereign risk matter for currencies. We do so by running regressions of bilateral currency excess returns on simple measures of global and local shocks to sovereign risk,

$$rx_{i,t} = a_i + b_i^{loc} \Delta C_{i,t}^{\star loc} + b_i^{glob} \Delta \overline{C_t^{\star}} + e_{i,t}, \tag{2}$$

where $\Delta C_{i,t}^{\star loc}$ denotes the local for country i and $\Delta \overline{C_t^{\star}}$ is the global shock. We compute the global shock as the change in the equally-weighted average of CDS spreads across all countries except country i.[12] Local shocks are orthogonalized with respect to global shocks.

The results in Table 4 (left panel ("Global and local shocks") are comparable to those based on country-by-country regressions in Table 2. The slope coefficients for global shocks are all significantly negative with the single exception of Japan. The coefficient estimates for local shocks are almost all negative as well but tend to be significant only in developing and emerging countries. Overall our findings suggest that local shocks matter for some countries but that global shocks play the major role in the link between sovereign risk and currency excess returns. Another way to show that global shocks are the dominant driver of the link between sovereign risk and currency returns is to run regressions of currency

[12] This procedure follows Verdelhan (2015) and serves to rule out potential mechanical effects resulting from country i affecting the global CDS spread. For example, in a regression of AUD exchange rate changes on the global sovereign risk factor, we compute the global sovereign risk factor as the average innovation in CDS spreads of all countries except Australia. Empirical results are qualitatively identical and quantitatively very similar when including country i in the computation of the global CDS spread. It should also be noted that we have a "dollar effect" as in Verdelhan (2015), in the sense that all the exchange rates in the sample are against the USD. Hence, if global sovereign risk is correlated with broad USD movements, our regressions will pick up this dollar effect. In our robustness checks, we show that our conclusions remain unchanged when we choose a different base currency.

excess on global shocks only. In the Internet Appendix (Table IA.6), we show that the R^2s of such a purely global specification are only slightly lower compared to the specification that also accounts for local shocks; for instance, in the pooled regression, the adjusted R^2 is 25.56% compared to 30.78%.

These results are in line with Longstaff et al. (2011) who find that sovereign risk of individual countries is mainly driven by global systematic factors, and Verdelhan (2015) who shows that global risk matters for a large share of variation in bilateral exchange rates. Finally, it seems noteworthy that we also find a significantly negative estimate for global shocks for the Swiss franc, suggesting that the relation between sovereign risk and exchange rate changes is not just capturing "flight-to-safety" episodes (e.g., Ranaldo and Söderlind, 2010), typically characterized by CHF appreciations.

Table 4 about here

The right part of Table 4 presents results for a regression in which we specify the slope coefficient on global CDS changes to be a function of lagged local CDS spreads,

$$\Delta rx_{i,t} = a_i + (b_i^{glob} + b_i^{glob\times loc} C^{\star}_{i,t-1}) \Delta \overline{C^{\star}_t} + e_{i,t}. \quad (3)$$

This specification is similar to the instrumental variable approach of Ferson and Harvey (1998) in their study of international equity returns, and allows us to further check the empirical importance of global sovereign risk as the key risk factor. While we find that estimates of several interaction terms are statistically significant, we also find that most slope coefficients on global CDS spread changes remain significantly negative, and that the explanatory power for currency excess is similar to that of the local-global specification in Eq. (3), reported in the left panel of the table. Overall, the results in Table 4 suggest that global, not local, sovereign risk is most important to understand the variation in currency excess returns in our sample.

3.3.1 Global CDS shocks and the VIX

A recent literature argues that the VIX can be interpreted as a global measure of risk aversion and uncertainty (e.g., Bekaert, Hoerova, and Lo Duca, 2013) and captures global financial cycles (Miranda-Agrippino and Rey, 2014). Hence, it seems natural to ask whether movements in the VIX subsume the information in global CDS spreads. We explore the extent to which changes in the VIX are contemporaneously related to excess returns and global CDS spread changes. First, we run regressions of excess returns on VIX log changes. Specification (i) in Panel A of Table 5 presents pooled regression evidence that currency excess returns significantly relate to VIX changes; however, the R^2 of 13.05% is much lower than the pooled-R^2s reported above. As a result, adding a local CDS component (orthogonalized to VIX changes) in specification (ii) more than doubles the R^2 and the coefficient is highly significant, suggesting that the VIX does not capture as much common variation across countries as global CDS spread shocks do. Similarly, we show in specification (iii) of Panel B that adding the global CDS component (orthogonalized to VIX changes) doubles the R^2 as compared to the VIX to 26.92% and it further increases in specification (iv) with a significant local component (orthogonalized to VIX and global CDS) to 31.88%. Accordingly, Panel C shows that global CDS shocks (orthogonalized to VIX) and local shocks (orthogonalized to VIX and global CDS changes) capture around 19% of the variation in currency excess returns. In contrast, the VIX orthogonalized to global CDS changes is not significant and has a very low R^2 of 1.35%. Overall, global CDS spread changes appear to be related to changes in the VIX to some extent but they contain substantial currency-relevant information beyond the VIX.

Table 5 about here

3.4 FX exposures to sovereign risk and country fundamentals

While it is not the purpose of this paper to explicitly identify the macroeconomic mechanism that drives the relation between sovereign risk and exchange rates, this section presents some evidence on the link between countries' FX exposure to sovereign risk and their fundamentals. Figure 2 present results on these linkages for macro variables that are related to government debt financing and hence relevant for sovereign risk.[13]

First, we plot countries' FX exposures to global sovereign risk, as defined in the previous subsection, against measures of their external financial position: (i) the average ratio of foreign total assets to liabilities, which represents a proxy for the countries' vulnerability to external shocks, (ii) the average ratio of foreign debt assets to liabilities, and (iii) the average ratio of foreign holdings to total holdings of government debt.[14] Recalling that the relation between a country's FX exposure and sovereign risk is negative, the patterns documented in Figure 2 are economically intuitive: countries with a worse external position are more sensitive (in absolute terms) to global CDS spread shocks. This holds for both total assets (i) as well as for debt instruments only (ii). Similarly, countries with a larger share of government debt held by foreign investors have a higher FX sensitivity to global CDS spread shocks (iii). Additionally, we find that currencies of countries with higher inflation rates are also more exposed to global sovereign risk shocks (iv).

Figure 2 about here

These results speak to an economic link between exchange rate exposure and macro fundamentals, which offers the following interpretation: net-creditor countries, countries with a lower share of foreign debt, and countries with lower inflation have lower exposures to global shocks because they are less dependent on foreign debt financing and have a lower

[13] It is worth noting that a general pattern in the results for all macro variables is that we do not find different tales for developed versus emerging markets (marked by blue bullets and red crosses, respectively).

[14] We standardize global CDS spread changes in the exposure regressions by their sample means and standard deviations to facilitate comparability and interpretation.

probability of experiencing a credit event. In other words, such a reasoning is consistent with the notion that external asset positions can serve as collateral and thereby reduce foreign investors' loss in the event of a default (see, e.g., Bussiere and Fratzscher, 2006; Greenlaw et al., 2013).[15]

Finally, we provide evidence that interest rates capture country-differentials in currency exposures to global sovereign risk shocks. Panels (v) and (vi) in Figure 2 show that higher one-month and five-year interest rates are associated with a more negative relation between exchange rates and sovereign risk. These results are consistent with the notion that interest rates comprise a default risk component and interesting in the light of previous evidence that interest rate differentials forecast the cross section of currency returns generated by carry trades. In the next section, we study the out-of-sample predictive ability of sovereign CDS spreads for currency excess returns and show that sovereign risk indeed accounts for a large share of carry trade returns.

4. The Sovereign Risk Premium and FX Predictability

The findings above reveal a strong link between contemporaneous changes in sovereign CDS spreads and currency excess returns. To test whether sovereign risk is priced in exchange rates, we now examine the predictive relation between sovereign risk and currency excess returns and also conduct formal cross-sectional asset pricing tests. We find that currency portfolios sorted by sovereign risk forecast excess returns to trading currencies, FX volatility, and FX skewness. The results of the asset pricing tests suggest that a global sovereign risk factor is priced in the cross-section of exchange rates. Moreover, we find that the link between sovereign risk and currency risk premia also matters for the performance of benchmark trading strategies. Specifically, we show that around half of carry trade returns

[15] Bussiere and Fratzscher (2006) examine a set of 20 open emerging markets and show that a high current account deficit and decelerating growth make a country more vulnerable to crises. Greenlaw et al. (2013) study 20 advanced economies and find that the average nominal yield on long-term government debt is sensitive to both lagged debt and the current-account deficit. They suggest that a country will start paying a premium to foreign debt-holders as compensation for default or inflation risk when the government is not able to run a sufficiently high primary surplus.

can be attributed to sovereign risk and that both carry and momentum strategies generate high returns across countries with high sovereign risk but significantly lower returns across countries with low sovereign CDS spreads.

4.1 Sovereign risk portfolios

If sovereign risk is priced in exchange rates, the currencies of high risk countries should earn returns in excess of low risk currencies. To empirically test this conjecture, we form currency portfolios based on three alternative measures of sovereign risk: we measure a country's sovereign risk by its currency's exposure to global sovereign CDS shocks, by the level of its sovereign CDS spreads, and by its sovereign rating. Below we discuss these measures, the construction of the currency portfolios, and present the portfolios' performance, which shows that sovereign risk forecasts the first three moments of the exchange rate distribution.

4.1.1 Ex-ante measures of sovereign risk

The results above suggest that the link between exchange rates and sovereign risk is dominated by global CDS changes. In our analysis of risk premia in the cross-sections of currencies, we should therefore find that countries with high (low) exposures of their sovereign risk to global shocks earn high (low) currency excess returns. We measure country i's exposure to global sovereign risk from rolling regressions of currency excess returns on global CDS spread changes,

$$\Delta rx_{i,t-1y;t} = \alpha_i + \beta_{i,t} \Delta \overline{C^{\star}_{t-1y;t}} + \varepsilon_{t-1y;t}, \tag{4}$$

where we use a one-year rolling window ($[t-1y;t]$) based on weekly data to estimate the slope coefficients for each country i. By re-estimating this regression every month, we obtain real-time estimates of countries' systematic sovereign risk, $\beta_{i,t}$.

Alternatively, we measure the sovereign risk of a country by the level of its sovereign

CDS spread or by its sovereign rating. Both measures share the advantage of being readily available at time t, not requiring any estimation, and allowing us to study a longer time period (because no data has to be reserved for the initial exposure estimation). Among these two measures, the advantage of using the prices of CDS contracts is that they immediately reflect any information available to market participants, whereas ratings are only updated infrequently.

4.1.2 Portfolio construction

To reduce the potential impact of outliers in our portfolio results, we use rank weights as in Asness, Moskowitz, and Pedersen (2013) to compute the portfolio weight of currency i for the period from t to $t+1$ as

$$w_{i,t} = c_t(\text{rank}(K_{i,t}) - \sum_i \text{rank}(K_{i,t})/N_t), \tag{5}$$

where $K_{i,t}$ denotes the conditioning variable used to determine portfolio weights. N_t denotes the number of currencies available at time t. The scaling factor c_t is chosen such that the portfolio is one dollar long and one dollar short at the time of portfolio construction; thus, the portfolio is dollar-neutral. The excess return to this rank portfolio is given by $r_{t+1} = \sum_i w_{i,t} rx_{i,t+1}$ and we update the portfolio weights at the end of each month. Using these portfolio weights, we evaluate the portfolio excess returns of various currency trading strategies. Specifically, RX denotes a currency strategy that uses at time t the measures of sovereign risk described in Section 4.1.1 as conditioning variable to trade between times t and $t+1$ the spot/forward currency excess returns defined in Section 2.3.1. This means that an investor will buy a given amount of foreign currency i at time t in the forward market and reverse the position in the spot market at time $t+1$ when the portfolio weight is positive, and viceversa when the portfolio weight is negative. We also consider an investment strategy that buys delta-neutral straddles (ST), sells risk reversals (RR) and sells butterfly spreads (BF) at time t using the same conditioning variables. We provide a detailed description of how to construct the excess returns of these option strategies on each currency i between times t and $t+1$ in Appendix B. Notice that when the portfolio weights are negative, these option strategies will involve selling straddles, buying risk reversals and buying butterfly spreads, respectively. To sum up, we evaluate the performance of different portfolios using CDS-betas ($\beta_{i,t}$), CDS spreads ($C^{\star}_{i,t}$), or sovereign ratings as conditioning variable $K_{i,t}$ in order to quantify the sovereign risk premium in currency markets and examine its empirical properties.

4.1.3 Returns to sovereign risk portfolios

Table 6 reports the results for sovereign risk portfolios based on global CDS exposures in Panel A, for portfolios based on CDS spreads in Panel B, and for portfolios based on country ratings in Panel C. The common finding is that trading on sovereign risk with currency forwards as well as by selling insurance against FX volatility and crash risk generates positive excess returns.

For the CDS-beta portfolios, we find that trading the first and third moment of exchange rate changes (RX and RR) delivers significantly positive excess returns and high Sharpe ratios. Investors earn 6.25% *p.a.* for buying high and selling low sovereign risk currencies and the corresponding Sharpe ratio is 0.71. Selling crash insurance of high against low risk sovereigns yields 4.70% *p.a.* (RR) with a Sharpe ratio of 0.99. There is no significant excess return to trading volatility (ST) and kurtosis (BF) for portfolios based on currency exposures to global CDS spreads.

Table 6 about here

The results for the currency portfolios based on lagged sovereign CDS spread levels (Panel B) are qualitatively the same for the first and third moment but here we also find a positive return of 4.32% *p.a.* (Sharpe ratio of 0.85) for trading on volatility. Moreover, the excess returns and Sharpe ratios of the RX and RR portfolios are higher compared to those of the portfolios based on lagged exposures. The difference in exposure- compared to spread-sorted portfolio performance mostly stems from the fact that we do not have to estimate exposures and that we do not have to reserve any data for the estimation of initial exposures. The results for ratings-sorted portfolios are similar in that we find significant returns to trading on the first three moments of exchange rates, but quantitatively somewhat less pronounced.

Hence, the overall conclusion from this exercise is that sovereign risk forecasts the excess returns to trading currencies (spot-forward trades), FX volatility, and FX skewness.

4.2 Sovereign risk in carry trades and higher FX moment portfolios

Our results above suggest that sovereign risk predicts excess returns to trading currencies, FX volatility, and FX skewness in portfolios sorted by sovereign CDS spreads.[16] Now, we explore to what extent the returns of standard carry trades as well as the returns of portfolios mimicking higher FX moment risks are related to sovereign risk.

We start with the carry trade, a simple and popular strategy which buys high and sells low interest rate currencies. From the earlier literature we know that carry, i.e., the interest differential or forward discount, is a strong predictor of currency excess returns and that carry trades generate positive excess returns. From the previous subsection we also know that currency portfolios sorted by sovereign CDS spreads perform well, and from a conceptual point of view, these results could be related because sovereign interest rates can be expressed as the sum of a riskfree and a credit risk component (see Duffie, Pedersen, and Singleton, 2003). Moreover, we have shown above that the sovereign risk exposure of currencies increases with the level of interest rates (see Section 3.4, Figure 2). Therefore, a natural question is whether the predictive information in carry is related to sovereign

[16]Given that the performance of exposure-, CDS spread-, and rating sorted currency portfolios is very similar, we subsequently use CDS spread-sorted portfolios, which allow for a longer sample period compared to using exposures and are updated at a higher frequency than ratings.

risk. Sovereign interest rates, however, are also directly connected to inflation rates and the same is true for countries' FX exposures to sovereign risk. Hence, the more specific question is whether the predictive information in carry is related to sovereign risk once the role of inflation is taken into account.

To provide some evidence on this question, we proceed in two steps. First, we decompose forward discounts into three components: a component related to sovereign CDS spreads, a component related to inflation, and a residual carry component which is not related to either CDS spreads or inflation. Second, we generate carry and carry component portfolios such that the return of the carry portfolio exactly equals the sum of the three component portfolios' returns at every point in time t. To mimic the portfolio exercise above, we run this decomposition in the cross-section of countries similar to Menkhoff et al. (2016a), who decompose real exchange rates in the cross-section of currencies.

To allow for a generic out-of-sample analysis, we implement the decomposition by running *cross-sectional* regressions of forward discounts on CDS spreads and inflation rates, separately for each month t,

$$fd_{i,t} = \alpha_t + \beta_t C^{\star}_{i,t} + \gamma_t \pi^{\star}_{i,t} + \varepsilon_{i,t}, \tag{6}$$

where $fd_{i,t}$ denotes the forward discount, $C^{\star}_{i,t}$ is the foreign CDS spread, and $\pi^{\star}_{i,t}$ is the foreign country's inflation rate. Based on this regression, the time-t forward discount of country i can be expressed as the sum of a sovereign risk component ($\beta_t C^{\star}_{i,t}$, i.e., the common cross-sectional variation in interest rates and sovereign CDS spreads), an inflation component ($\gamma_t \pi^{\star}_{i,t}$), and a country-specific residual component unrelated to sovereign risk and inflation ($\alpha_t + \varepsilon_{i,t}$).

To construct carry component portfolios that on aggregate generate the same returns as the original carry portfolio, we use linear portfolio weights based on signals $K_{i,t}$ (rather than the ranks of signals, as we have done above), computed as

$$w_{i,t} = c_t(K_{i,t} - \overline{K}_t), \tag{7}$$

where $\overline{K}_t$ denotes the time-t average of K_{it} across countries. For the original carry portfolio the signal is the forward discount, i.e., $K_{it} = fd_{it}$, and the scaling factor $c_t = 2/\sum_j |fd_{i,t} - \overline{fd}_t|$ such that the positive and negative weights sum to one and minus one, respectively. To construct the three carry component portfolios we use the signals computed from the regression in Eq. (6) and apply the same scaling factor. Comparing the performance of the carry component portfolios to each other and to the original carry portfolio will provide some indication about the role of sovereign risk.

Finally, we also study the importance of sovereign risk for higher FX moments, based on factor mimicking portfolios for FX volatility (VOL), skewness ($SKEW$) and kurtosis ($KURT$). To construct these portfolios and the corresponding sovereign, inflation, and residual component portfolios, we apply Eqs. (6) and (7) using the implied volatility of straddles, risk reversals and butterfly spreads on currency i at time t as signals, respectively.[17]

Table 7 about here

Panel A of Table 7 reports average excess returns (i.e., unconditional risk premia) for the carry and higher moment portfolios. We find that all four have positive returns but the return of the volatility portfolio is not significant. Panel B presents the results for the component portfolios. The sovereign risk components of the carry, skewness, and kurtosis portfolios generate significantly positive excess returns. The inflation component and the residual carry component portfolios generate significant excess returns only for the carry trade. The last three rows of the table present the relative contribution of the three

[17] For instance, we decompose the conditioning variable for the FX volatility factor using the regression $st_{i,t} = \alpha_t + \beta_t C^{\star}_{i,t} + \gamma_t \pi^{\star}_{i,t} + \varepsilon_{i,t}$.

components to the overall return. For the three strategies that deliver significant returns (RX, $SKEW$, $KURT$), we find that the component related to sovereign risk is the most important in terms of its relative contribution to the overall return. For the carry trade, for instance, our results suggest that almost half of its 13.22% *p.a.* return can be attributed to the sovereign risk component with an excess return of 6.49% *p.a.*, corresponding to 49% of the strategy's overall return. The inflation component portfolio earns 4.19% *p.a.*, thereby contributing 32% of the carry trade return, and the residual carry return is 2.55% *p.a.*, which accounts for 19% of the overall return.

4.3 Asset pricing tests

We also run cross-sectional asset pricing tests to examine the pricing power of sovereign risk for the cross-section of currency excess returns. To construct the set of test assets, we build on our analysis above and compute the returns of quintile portfolios sorted by carry, CDS spreads, and inflation rates. This gives us a cross-section of 15 portfolios that we can use as test assets.

We start by defining the risk factors as the high-minus-low portfolios of the carry, CDS, and inflation quintile portfolio cross-sections and refer to them as carry factor (HML_{FX}, as in Lustig, Roussanov, and Verdelhan, 2011), the sovereign risk factor (HML_{CDS}) and the inflation factor (HML_{INF}). Following Lustig, Roussanov, and Verdelhan (2011), we also build a dollar risk factor (DOL) which is the average excess return of all currencies against the USD.

We are interested in the SDF slope parameters based on the standard Euler equation,

$$\mathbb{E}[m_t r_{i,t}] = 0, \tag{8}$$

where $r_{i,t}$ denotes the excess return on portfolio i, and $m_t = 1 - b'(h_t - \mu)$ is a linear SDF with a vector of risk factors h. b is the vector of SDF slopes and μ denotes the means of the risk factors. We estimate Eq. (8) via the generalized method of moments (GMM) of

Hansen (1982).[18] This approach is identical to that used in related research on the cross-section of currency returns, e.g., Lustig, Roussanov, and Verdelhan (2011) or Menkhoff et al. (2012a).

Eq. (8) also implies a beta pricing model where expected excess returns depend on factor risk prices λ and quantities of risk β_i. The latter are the betas from a regression of portfolio excess returns on the risk factors,

$$\mathbb{E}\left[r_i\right] = \lambda' \beta_i, \tag{9}$$

for each portfolio i (see e.g., Cochrane, 2005). The relationship between the factor risk prices in Eq. (9) and the SDF parameters in Eq. (8) is given by $\lambda = \Sigma_h b$.

Table 8 reports SDF loadings (b, in Panel A) and risk prices (λ, in Panel B) for various specifications; Panel C reports the monthly means and volatilities of the risk factors, to assess whether risk factors carry an unconditional risk premium. All specifications include the dollar factor (DOL), which, in line with the extant literature (e.g., Lustig, Roussanov, and Verdelhan, 2011), does not generate a significant mean return and is not priced in the cross-section of currency excess returns.

Specifications (i) to (iii) present results for two-factor models that include either the carry, sovereign risk, or inflation factor; all three risk factors HML_{FX}, HML_{CDS}, and HML_{INF} are associated with an unconditional risk premium, i.e., the mean returns in Panel C are significant. Each of the three factors is significantly priced in the cross-section of the 15 carry, sovereign risk, and inflation portfolios, a finding to be expected. On the one hand, we have discussed above that there has to be a relation between carry, sovereign CDS spreads, and inflation rates as well as the returns on currency portfolios sorted by these variables above; on the other hand, we know that carry portfolios can be priced by a single factor (Lustig, Roussanov, and Verdelhan, 2011). For the same reason, it is

[18] We employ a pre-specified weighting matrix in the estimation and employ unconditional moments, using as instruments only a vector of ones. Factor means are estimated simultaneously with the SDF parameters by adding the corresponding moment conditions to the asset pricing moment conditions implied by Eq. (8).

not surprising that using all three risk factors jointly in specification (iv) renders the SDF slope coefficients insignificant.[19] In terms of model fit, we find that the J-test rejects all specifications except for specification (ii), which uses HML_{CDS} as the risk factor.

Table 8 about here

To take the relation between sovereign risk, interest rates, and inflation into account, we draw on the carry decomposition procedure from Eq. (6) and repeat the asset pricing tests. More specifically, we now use the sovereign risk component ("CDS-carry"), the inflation component ("INF-carry"), and the residual carry ("Carry$^{\perp}$") as risk factors instead of HML_{CDS}, HML_{INF}, and HML_{FX}. We first verify that residual carry prices the cross-section of currency portfolios in specification (v). In specification (vi), we add the sovereign risk and inflation factors, and find that sovereign risk and residual carry are jointly priced in the cross section, whereas the inflation factor is not significant.

Taken together, our empirical results suggest that sovereign CDS spreads contain information for exchange rates that is priced in the cross-section of currency excess returns. In the Internet Appendix (Table IA.8), we also report results for a larger cross-section of test assets that includes the higher-moment risk factor mimicking portfolios, and our conclusions with respect to the role of sovereign risk for exchange rates remain unchanged.

4.4 Sovereign risk, carry, and momentum

While our results above already suggest that carry returns are related to sovereign risk, we now study their relation from a different angle by conducting sequential portfolio sorts. In other words, we compare the performance of carry trades implemented for currencies of countries with high sovereign risk to that of carry trades across low risk countries.

[19] The risk prices in Panel B remain significant, of course, as risk prices only address the question if a factor is priced individually (see, e.g., Cochrane, 2005).

We complement this exercise by conducting a similar analysis for currency momentum strategies as well.[20]

Every month, we sort currencies by their sovereign risk in the first step and by carry or momentum in the second step. More specifically, we assign currencies to the high or low CDS portfolio based on their CDS spread being above or below the cross-country median CDS spread at time t. Within the high CDS and the low CDS portfolios, we then form portfolios of high and low carry currencies and portfolios of high and low momentum currencies. Thus, we have four portfolios double-sorted on sovereign risk and carry and four portfolios double-sorted on sovereign risk and momentum.

Table 9 about here

Table 9 presents the results for these double sorted portfolios. We find that both carry and momentum strategies are significantly more profitable when implemented among currencies of high sovereign risk countries compared to low CDS countries. A carry strategy among currencies with high CDS spreads generates an average excess return of 9.6% *p.a.* (significant) with a Sharpe ratio of 1.09, whereas the carry trade among low CDS currencies only generates 2.3% *p.a.* (not significant) with a Sharpe ratio of 0.34. Likewise, momentum yields an excess return of 8.8% *p.a.* (significant) and a Sharpe ratio of 1.10 in high sovereign risk currencies compared to 1.1% *p.a.* (not significant) and a Sharpe ratio of 0.18 in low CDS currencies.[21] All these results are qualitatively the same for other double sort specifications.[22] Moreover, we find that buying high CDS and selling low CDS currencies

[20]Momentum is based on lagged 1-month returns, which is the most profitable momentum strategy specification in Menkhoff et al. (2012b).

[21]Interestingly, our finding that momentum returns are high and significant in countries with high sovereign risk but much lower and not statistically different from zero in countries with low sovereign risk appears akin to the results of Avramov et al. (2007); they find that equity momentum profitability is large among low-grade firms but non-existent among high-grade firms.

[22]More specifically, we always find that carry and momentum strategies have significantly higher excess returns and Sharpe ratios among countries with high CDS spreads compared to countries with low CDS spreads. For instance, when we sequentially sort portfolios that first condition on carry or momentum and subsequently on sovereign risk, we find that carry (momentum) returns are 13.3% (7.3%) for high CDS

generates an excess return of around 10.5% to 10.7% *p.a.* (significant) among high carry and high momentum currencies with Sharpe ratios of around 1.3, whereas the high minus low CDS returns are only 3% to 3.2% (marginally significant) with Sharpe ratios slightly above 0.5 among low carry and low momentum currencies.

These results provide further evidence that sovereign risk matters for currency excess returns. More specifically, sovereign CDS spreads appear to convey information that is relevant for the profitability of benchmark strategies in currency markets such as carry trades and momentum.

5. Additional results and robustness checks

While the focus of our paper is to explore the role of sovereign risk in currency markets, we now also present some results on the relation between sovereign risk and international equity returns. Moreover, we present additional evidence that (i) sovereign risk matters for speculator activity in FX derivative markets and that (ii) there is a link between sovereign risk and the Euro as well. While we discuss these findings in the paper, we delegate the tables with empirical results to the Internet Appendix to conserve space. Furthermore, extensive robustness checks suggest that our conclusions remain unchanged across different sample periods and base currencies, after accounting for transaction costs, and for other FX instruments such as volatility risk premia generated by volatility swaps. We briefly summarize these results at the end of the section but refer to the Internet Appendix for a detailed discussion.

countries and 2.8% (-0.3%) for low CDS countries. When we conduct unconditional double sorts, i.e., we independently sort countries into high and low sovereign risk, carry, and momentum portfolios, we find that carry (momentum) returns are 10.9% (4.9%) for high CDS countries and 1.9% (0.6%) for low CDS countries.

5.1 Sovereign risk and equity returns

Avramov et al. (2012) find that a world credit risk factor, defined as the high-minus-low returns of sovereign rating-sorted equity portfolios, is priced in a broad cross-section of country equity returns. Given that our motivation for studying sovereign risk in currency markets is similar to their rationale for sovereign ratings being informative about subsequent equity returns, we also conduct an empirical analysis of the contemporaneous and predictive links between sovereign CDS spreads and equity excess returns. Using the same set of countries and sample period as in our main analysis, we take the perspective of a U.S. investor and compute USD equity returns as well as currency-hedged equity returns (buy foreign currency spot, invest in the equity market in local currency, and sell the local currency one-month forward, essentially assuming a perfect FX hedge) based on MSCI country index data.

First, we run regressions of equity returns on contemporaneous changes in CDS spreads and report results in Panel A of Table 10. We find a significantly negative slope coefficient for both USD as well as currency-hedged equity excess returns, implying that an increase in sovereign risk is associated with a decrease of stock prices. Similar to our results in currency markets, the explanatory power of interest rate changes for excess returns is much lower.

Table 10 about here

Panel B of Table 10 presents results for the predictive analysis by summarizing the performance of equity portfolios with rank-weights determined by (lagged) sovereign CDS spreads and sovereign ratings; the portfolio weights are thus identical to those of the currency portfolios reported in Panels B and C of Table 6, and we use these currency portfolio returns as currency risk factor below. We find that USD returns of equity portfolios based on CDS spreads are positive with an average excess return of 6.99% *p.a.*, a t-statistic of 1.89, and a Sharpe ratio of 0.58. While these results suggest that sovereign CDS spreads are informative for future equity returns, we note that the correlation of equity returns with the corresponding currency risk factor is relatively high ($\rho^{FX} = 0.55$). Controlling for the world equity market return (based on the MSCI global index), we find that the equity portfolio alpha is around 6% *p.a.* and almost as significant as the raw excess return. The beta estimate is small ($\beta^{W} = 0.12$), marginally significant, and the world market return explains around 2% of the variation of the equity portfolio returns as judged by the regression's adjusted-R^2. When we add the currency risk factor to this regression, we find that α and β^{W} become insignificant, the currency-beta is significantly positive ($\beta^{FX} = 0.96$), and that the adjusted-R^2 is close to 29%. The results based on sovereign ratings are qualitatively similar to those based on CDS spreads but quantitatively less pronounced, which may reflect that CDS spreads contain more timely information compared to less frequently updated ratings. These findings suggest that, in our sample period and cross-section of countries, sovereign CDS spreads predict international stock returns mainly through the currency component of equity portfolios.[23] In line with this interpretation, we do not find that sovereign risk predicts excess returns of currency-hedged equity portfolios.

On balance, the empirical evidence on the link between sovereign CDS spreads and country equity returns is somewhat mixed. The contemporaneous regressions suggest a strong inverse relation, even when currency risk is hedged, implying that equity prices drop when sovereign risk increases. The predictive ability of sovereign CDS spreads for equity returns, however, is completely absorbed by the FX risk factor. In the context of research on the pricing of currency risk in equity returns (see, e.g., Ferson and Harvey, 1993, 1994; Dumas and Solnik, 1995; Brusa, Ramadorai, and Verdelhan, 2015), our results suggest that linkages between sovereign risk and exchange rates should be taken into account in empirical studies of international asset returns.

[23]Note that our findings are not directly comparable to the results in Avramov et al. (2012) because we use a different sample period, set of countries, portfolio-weighting scheme, and currency risk factor, which in our empirical application exactly tracks the weights of the equity portfolio.

5.2 FX speculator positions

If currency investors indeed care about sovereign risk, we should find that shocks to sovereign risk lead to portfolio adjustments. As an empirical proxy for such portfolio adjustments, we compute net speculator positions in currency futures and options markets based on commitment of traders data provided by the CFTC. Following the literature (see, e.g., Moskowitz, Ooi, and Pedersen, 2012), we compute net speculator positions as the difference of long and short positions by non-commercial traders, scaled by open interest. For the sample of countries used in this paper, data is available for AUD, CAD, CHF, GBP, JPY, MXN, and NZD (all against USD) at a weekly frequency. We run a sequence of pooled regressions of changes in net speculator positions on changes in CDS spreads for forecast horizons of $k = 0, 1, 2, 3, 4$ weeks, using

$$\Delta p_{i,t+k} = \alpha_k + \beta_k \Delta C^{\star}_{i,t} + \gamma_{1,k} \Delta s_{i,t} + \gamma_{2,k} \Delta s_{i,t-1} + \varepsilon_{i,t+k},$$

where $\Delta p_{i,t+k}$ denotes the k-week change in net speculator positions with lagged exchange rate changes ($\Delta s_{i,t}, \Delta s_{i,t-1}$) as controls to rule out any momentum trading explanations.[24] The results in Table IA.9 show that the relation between changes in net positions and CDS spreads is significantly negative contemporaneously ($k = 0$) as well as for a forecast horizon of one week ($k = 1$). This finding is consistent with speculators reducing their FX derivative positions in currencies of countries that experience an increase in their sovereign risk and lends support to the view that CDS spreads contain information that is not subsumed by exchange rate changes themselves.

5.3 Sovereign risk and the Euro

We do not include the Eurozone in the core analysis above for the reason that it consists of multiple countries with individual sovereign risk (and CDS contracts) but a common

[24] Including further lags of CDS spread changes or exchange rates does not change the conclusions from these regressions.

currency. Since there is no CDS contract for the Eurozone as such, we use the itraxx Western Europe SovX index as a (admittedly imperfect) proxy for the sovereign risk in the Eurozone. This index starts in 2009 and averages many countries from the Eurozone (Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain) but also some European countries which are not Eurozone members (Denmark, Norway, Sweden, United Kingdom); from 2012, Cyprus and Greece are excluded. We generate a series that synthetically replicates the SovX from 2003 onwards and use the generic SovX series as soon as it becomes available. Despite the SovX clearly being an imperfect proxy, we find that linking the EUR exchange rate to the SovX confirms our main results. Table IA.10 reports results for contemporaneous regressions of exchange rate changes, changes in delta-neutral straddle, risk reversal, and butterfly spread IVs, confirming that increases in the SovX are associated with EUR depreciations as well as increases in EUR volatility and EUR crash risk.

5.4 Discussion of further robustness checks

This subsection contains a brief overview of some additional robustness checks that corroborate our findings. While we present these results in detail in the Internet Appendix, the findings can be summarized as follows. Tables IA.3 to IA.5 present country results of regressing changes in option-implied FX moments on sovereign CDS spread changes which confirm the pooled regression evidence that increases in sovereign risk are associated with increases in the volatility, skewness, and kurtosis of exchange rate changes. Table IA.11 shows that the returns of CDS-sorted portfolios (presented in Table 6 above) are not wiped out by transaction costs. Additionally, we consider volatility swaps as an alternative instrument for trading higher-moment risk and show that FX volatility risk premia are predicted by sovereign CDS spreads but not by interest rates (Table IA.7). Furthermore, we also discuss the factor structure of sovereign risk portfolio returns (Table IA.12) and robustness to choosing a different base currency (Table IA.13). Finally, we present time-series predictability results to show that lagged CDS spread innovations Granger-cause exchange rate changes (Figure IA.1).

6. Conclusion

Using data on credit default swaps (CDS) for a broad set of countries, we show that sovereign risk is priced in currency markets. Sovereign risk matters for currency excess returns as well as for the higher moments of the exchange rate distribution such as volatility and skewness. Our findings suggest that the information embedded in sovereign CDS spreads is powerful both in capturing the time-series behavior of currency excess returns and for understanding risk premia in the cross-section of currencies. The returns to currency investments strongly comove with changes in sovereign risk at a daily to monthly frequency, and the variation in CDS spreads across countries forecasts currency excess returns to trading on the first three moments of returns. Sovereign risk also matters for currency risk premia captured by carry and momentum trades; both strategies generate significantly higher excess returns when trading the currencies of high CDS countries compared to low CDS countries.

We also find that the relation between currency excess returns and sovereign CDS spreads is mostly driven by countries' exposures to global sovereign risk, whereas purely local sovereign risk matters much less. While shocks to global sovereign risk are related to changes in the VIX (often used as a measure of global uncertainty), currency excess returns are much more closely related to innovations in global sovereign risk than to VIX changes. The extent to which currencies are exposed to shocks to global sovereign risk is related to measures of countries' financial vulnerability such as their external position.

Overall, sovereign risk appears to be an important, but so far neglected, source of risk in currency markets. While our findings are economically intuitive and withstand extensive robustness checks, our understanding of the relation between sovereign credit risk and currency markets requires further work. Given the evidence reported in this paper, a formal theoretical model that links (the term structure of) sovereign risk to the distribution of currency excess returns seems to be an important avenue for future macro-finance research.

Appendix

A. Extracting Strike Prices from FX Option IVs

To compute currency option prices and returns, we first convert the implied volatility of straddles, risk reversals, and butterfly spreads (see Section 2.1) into the implied volatility of ATM, 25δ call and 25δ put options, and then extract the strike prices. Recall that, according to market convention, over-the-counter options on developed currencies (i.e., AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, and SEK) up to a 1-year maturity are quoted using the spot delta whereas the forward delta is used for all other currency-maturity combinations. We summarize the key formulae below while dropping the currency subscript i to easy notation.

When options are quoted using spot deltas, the strike price (X) of 1-month ATM, 25δ call and 25δ put options are computed, respectively, as

$$X_{ATM,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{ATM,t}\right], \tag{A.1}$$

$$X_{25C,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{25C,t} - N^{-1}(0.25 \cdot \exp(i^\star_{t,1} \cdot \tau)) \cdot IV_{25C,t} \cdot \sqrt{\tau}\right], \tag{A.2}$$

$$X_{25P,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{25P,t} + N^{-1}(0.25 \cdot \exp(i^\star_{t,1} \cdot \tau)) \cdot IV_{25P,t} \cdot \sqrt{\tau}\right]. \tag{A.3}$$

where F_t is the 1-month forward exchange rate at time t defined as units of US dollar per unit of foreign currency, IV_{ATM}, IV_{25C} and IV_{25P} are the implied volatilities in annual terms at time t on ATM, 25δ call and 25δ put options with 1-month maturity, respectively, $i^\star_{t,1}$ is the 1-month foreign interest rate in annual terms, and τ equals the number of calendar days in a given month divided by 365.

For forward delta options, the corresponding strike prices are given by

$$X_{ATM,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{ATM,t}\right], \tag{A.4}$$

$$X_{25C,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{25C,t} - N^{-1}(0.25) \cdot IV_{25C,t} \cdot \sqrt{\tau}\right], \tag{A.5}$$

$$X_{25P,t} = F_t \cdot \exp\left[\frac{\tau}{2} \cdot IV^2_{25P,t} + N^{-1}(0.25) \cdot IV_{25P,t} \cdot \sqrt{\tau}\right]. \tag{A.6}$$

These formulae refer to options on exchange rates where the USD is both the pricing currency for the underlying exchange rate and the premium currency for the option. When the USD is the base currency for the underlying exchange rate, the procedure to extract strike prices is numerical. See Reiswich and Wystup (2010) for more details.

B. Excess Returns of FX Option Strategies

We provide details on the computation of excess returns for option-based strategies aimed at trading currency volatility, skewness, and kurtosis. We use these excess returns in Section 4.1.2.

To compute excess returns on delta-neutral straddles, 25δ risk reversals, and 25δ butterfly spreads, we first extract the strike prices described in Appendix A, and then compute option prices following Garman and Kohlhagen (1983). We denote by $C_{\delta,t}$ and $P_{\delta,t}$ the prices of these one-month European call and put options with $\delta \in \{ATM, 25\}$. We drop the currency subscript i to easy notation. Following Burnside et al. (2011), we calculate the excess returns on long and short positions in call options (LC and SC) and put options (LP and SP) as follows:

$$rx^{LC}_{\delta,t+1} = \frac{\max(S_{t+1} - X_t, 0) - C_{\delta,t}(1 + i_{t,1} \cdot \tau)}{F_t}, \tag{B.1}$$

$$rx^{LP}_{\delta,t+1} = \frac{\max(X_t - S_{t+1}, 0) - P_{\delta,t}(1 + i_{t,1} \cdot \tau)}{F_t}, \tag{B.2}$$

$$rx^{SC}_{\delta,t+1} = \frac{\min(X_t - S_{t+1}, 0) + C_{\delta,t}(1 + i_{t,1} \cdot \tau)}{F_t}, \tag{B.3}$$

$$rx^{SP}_{\delta,t+1} = \frac{\min(S_{t+1} - X_t, 0) + P_{\delta,t}(1 + i_{t,1} \cdot \tau)}{F_t}. \tag{B.4}$$

where S_t (F_t) is the spot (1-month forward) exchange rate at time t defined as units of US dollar per unit of foreign currency, $i_{t,1}$ is the 1-month US interest rate at time t in annual terms, and τ equals the number of calendar days in a given month divided by 365. Note that we scale the net option payoffs by the forward rate so that all positions are fully collateralized (i.e., we assume no leverage).

We then compute the excess return on our option strategies as follows. A long position in a delta-neutral straddle is equivalent to buying an ATM call option and an ATM put option, and the excess return between times t and $t+1$ is given by

$$rx_{t+1} = rx^{LC}_{ATM,t+1} + rx^{LP}_{ATM,t+1}. \tag{B.5}$$

A short position on a 25δ risk-reversal corresponds to buying a 25δ put option and selling a 25δ call option, and the excess return between times t and $t+1$ is given by

$$rx_{t+1} = rx^{LP}_{25P,t+1} + rx^{SC}_{25C,t+1}. \tag{B.6}$$

Finally, a short position on a 25δ butterfly spread consists of short position on a delta-neutral straddle combined with a long position on a 25δ call and 25δ put options. It follows that the excess return between times t and $t+1$ is given by

$$rx_{t+1} = rx^{SP}_{ATM,t+1} + rx^{SC}_{ATM,t+1} + rx^{LC}_{25C,t+1} + rx^{LP}_{25P,t+1}. \tag{B.7}$$

In our empirical analysis, we investigate whether sovereign risk-motivated selling of insurance against volatility, skewness, and kurtosis risk, i.e., being short the above strategies, generates positive excess returns.

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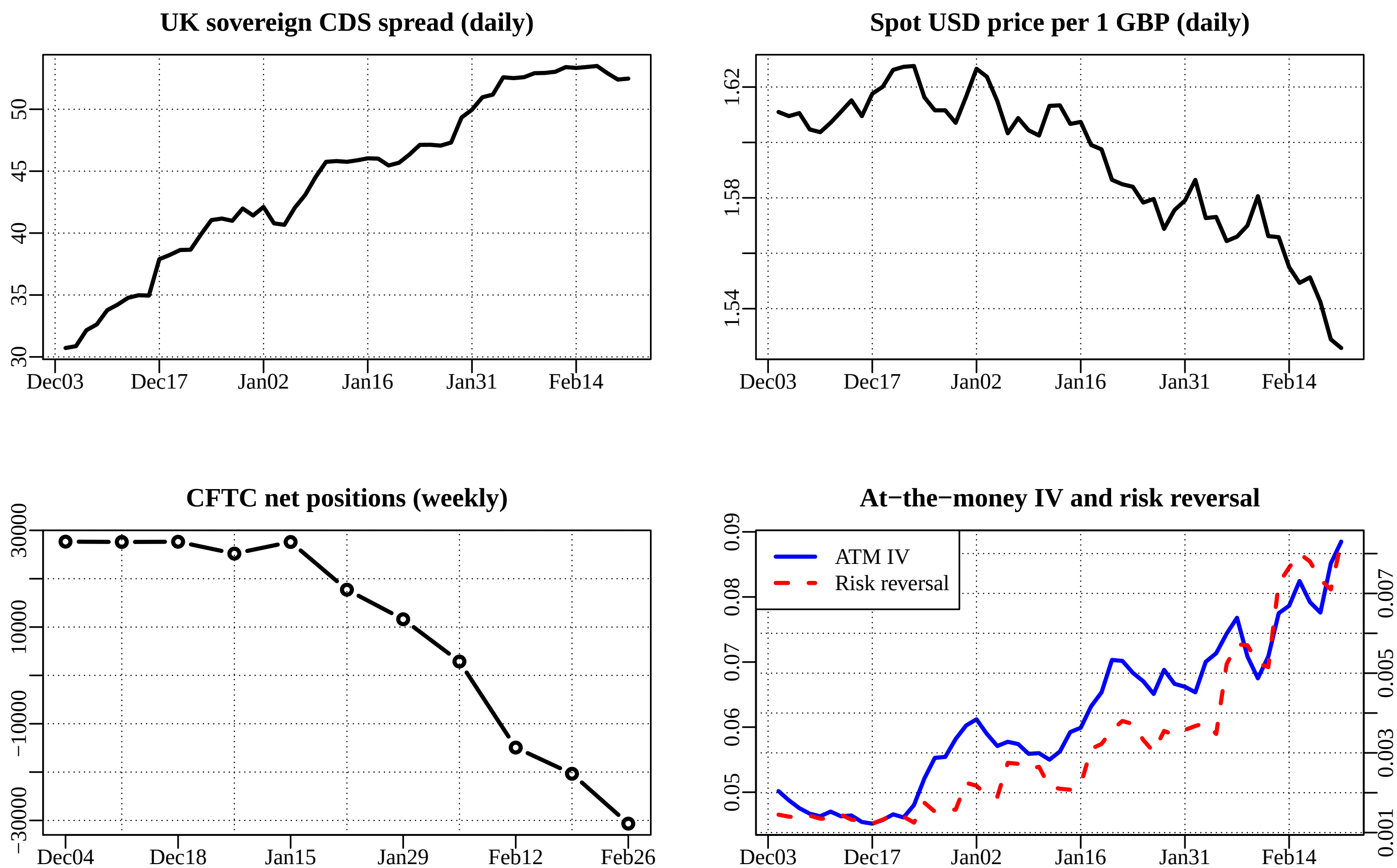

Figure 1: Sovereign CDS spreads and foreign exchange markets around the UK downgrade in February 2013

This figure summarizes data on sovereign CDS spreads and currency markets for the three months prior to the UK sovereign credit rating downgrade on 22 February 2013. The top left panel plots the evolution of the 5-year UK sovereign CDS spread and the top right panel displays the USD/GBP spot exchange rate quoted as USD price per one GBP. The lower left panel presents the net positions (long minus short) of non-commercial traders in USD/GBP currency futures and options as reported by the US Commodity Futures Trading Commission (CFTC) on a weekly basis. The lower right panel plots the at-the-money implied volatility (IV) of USD/GBP options (solid line in blue, left y-axis) and the difference between 25δ out-of-the-money IVs for put and call options, i.e., the negative of the 25δ risk reversal (dashed line in red, right y-axis).

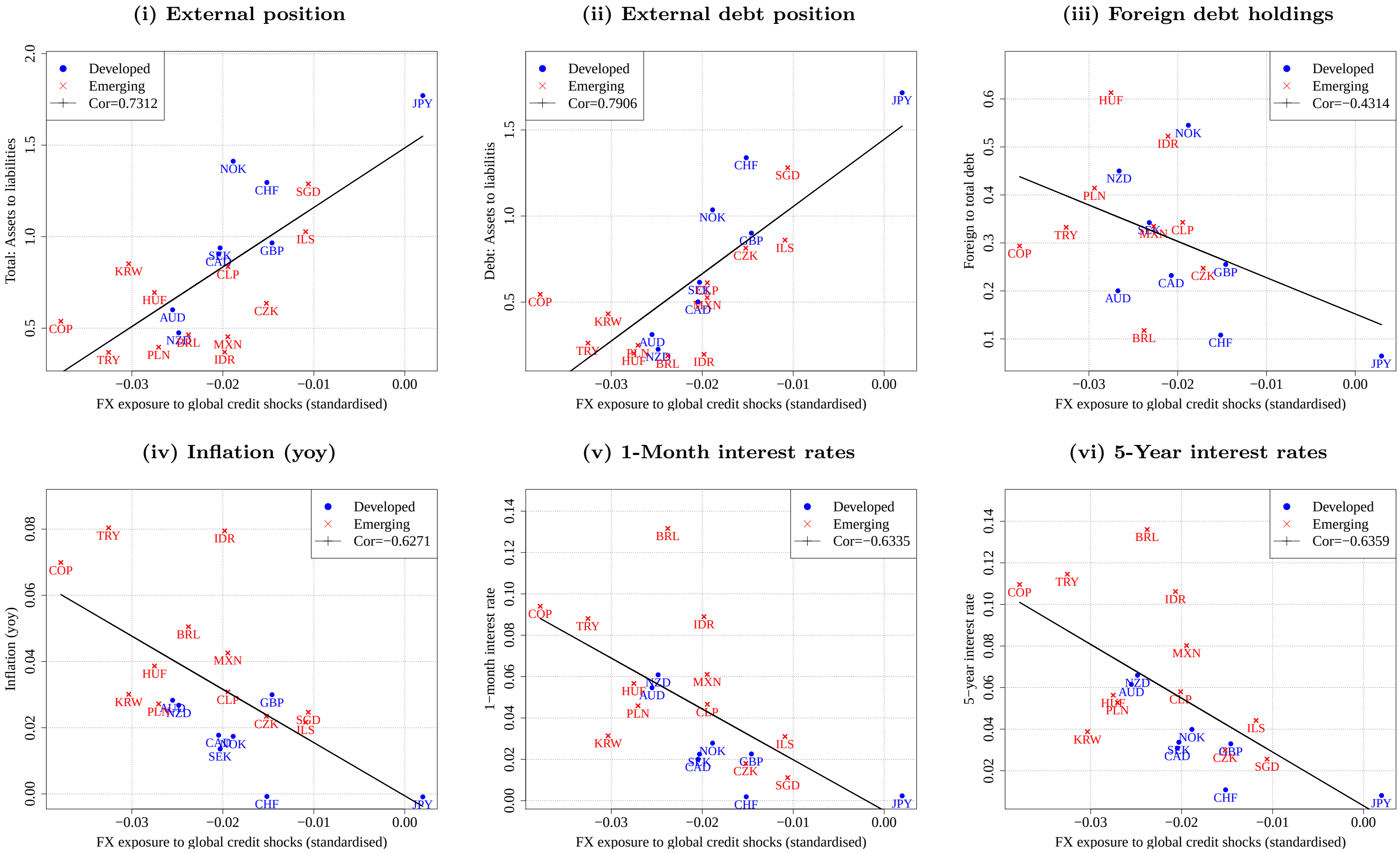

Figure 2: FX exposures to global default risk shocks

This figure plots the slope coefficient from regressing exchange rate changes on global CDS spread changes against the average (i) ratio between foreign assets and liabilities, (ii) ratio between foreign debt assets and liabilities, (iii) ratio between foreign holdings of the government debt and total holdings of government debt, (iv) inflation rate, and foreign 1-month (v) and 5-year (vi) interest rates. The sample runs from 2003 to 2013 (depending on data availability). Blue bullets and red crosses indicated developed and emerging markets, respectively.

Table 1: Descriptive statistics

	Sample		CDS Spread (bps)			Forward Discount (%)			ATM IV (% $p.a.$)		
	start	end	min	med	max	min	med	max	min	med	max
AUD	30/04/2003	19/08/2010	1.60	3.42	196.66	-0.52	0.23	1.03	5.95	11.23	46.00
BRL	03/01/2005	31/12/2010	61.14	132.72	594.54	-0.02	0.68	1.59	6.00	14.30	69.00
CAD	11/09/2003	29/11/2013	1.60	24.61	133.50	-0.22	0.04	0.48	4.49	8.80	27.00
CHF	05/06/2007	29/11/2013	1.44	46.00	176.49	-0.32	-0.03	0.90	5.12	10.80	23.85
CLP	29/03/2004	29/11/2013	12.53	66.87	315.95	-0.46	0.06	0.82	4.94	10.70	45.00
COP	02/01/2008	31/12/2008	114.56	184.00	600.25	0.36	0.62	0.89	9.50	18.00	35.00
CZK	02/01/2003	29/11/2013	4.69	37.61	350.14	-0.80	0.02	0.21	5.96	11.26	39.07
GBP	20/03/2006	29/11/2013	1.20	52.23	164.63	-0.45	0.02	0.52	4.52	8.81	30.50
HUF	03/01/2012	29/11/2013	241.64	318.69	736.35	0.17	0.39	0.52	9.83	13.56	24.20
IDR	25/09/2003	31/12/2010	91.82	220.00	1246.75	-10.05	0.73	15.99	3.69	8.89	67.34
ILS	29/03/2004	29/11/2013	16.92	109.79	285.00	-0.19	0.06	0.29	3.43	7.62	20.69
JPY	02/01/2003	29/11/2013	2.45	19.11	159.31	-0.84	-0.09	0.72	5.80	9.86	38.00
KRW	02/01/2008	29/11/2013	46.80	103.21	708.64	-1.40	0.15	0.25	4.28	11.47	73.56
MXN	02/01/2003	29/11/2013	28.51	112.01	587.88	0.11	0.32	1.35	4.80	9.70	95.00
NOK	24/10/2003	29/11/2013	1.17	14.34	63.63	-1.58	0.11	1.14	6.40	11.30	33.45
NZD	31/07/2003	19/08/2010	1.92	11.50	247.72	-1.49	0.23	0.64	8.30	13.00	40.00
PLN	02/01/2003	29/11/2013	7.53	58.50	418.56	-0.37	0.25	0.50	7.14	12.73	51.38
SEK	02/01/2003	29/11/2013	1.31	15.14	158.44	-1.73	0.07	1.28	6.45	11.30	32.70
SGD	18/07/2003	26/03/2012	2.00	11.00	103.50	-0.93	-0.04	0.19	2.90	5.51	15.92
TRY	02/01/2008	29/11/2013	110.37	201.52	820.55	0.27	0.57	1.56	4.47	12.27	52.09

This table shows descriptive statistics and sample coverage for all 20 countries in our data set. We report the median (*med*), minimum (*min*), and maximum (*max*) value of the 5-year sovereign CDS spreads (in basis points), one-month forward discounts computed as log spot minus log forward exchange rate (i.e., the foreign country minus US interest rate) in percentage per month, and one-month at-the-money (ATM) option-implied volatility (IV) in percentage per annum.

Table 2: CDS spread changes and currency excess returns

	Monthly		Weekly		Daily	
	b	R^2	b	R^2	b	R^2
AUD	-16.43^{***}	20.26	-12.78^{***}	14.71	-8.41^{***}	3.92
BRL	-7.07^{***}	39.58	-5.39^{***}	50.13	-5.81^{***}	30.50
CAD	-18.09^{***}	10.07	-5.25^{***}	0.74	-2.59^{**}	0.24
CHF	-13.05^{***}	15.53	-3.51	1.33	-1.12	0.08
CLP	-10.76^{***}	28.15	-6.31^{***}	20.38	-5.93^{***}	11.50
COP	-9.16^{***}	45.47	-1.94^{***}	14.95	-2.35^{***}	13.53
CZK	-9.00^{***}	20.57	-7.09^{***}	14.87	-7.52^{***}	10.98
GBP	-13.34^{***}	25.79	-9.11^{***}	13.79	-7.60^{***}	6.80
HUF	-6.22^{***}	64.66	-5.18^{***}	34.50	-5.47^{***}	30.58
IDR	-4.19^{***}	19.66	-0.45	1.82	-0.87^{***}	6.51
ILS	-5.33^{***}	15.29	-4.46^{***}	10.10	-3.22^{***}	4.20
JPY	-0.01	-0.78	5.60^{**}	3.28	2.68^{***}	0.73
KRW	-7.73^{***}	48.13	-3.75^{***}	43.88	-4.94^{***}	27.87
MXN	-7.58^{***}	50.38	-4.37^{***}	41.83	-4.52^{***}	24.62
NOK	-33.35^{***}	17.53	-18.91^{***}	5.80	-12.60^{***}	2.90
NZD	-10.03^{***}	10.90	-7.48^{***}	7.77	-4.53^{**}	2.52
PLN	-11.54^{***}	42.58	-8.97^{***}	34.31	-9.04^{***}	24.31
SEK	-18.24^{***}	27.41	-14.46^{***}	17.17	-11.53^{***}	5.34
SGD	-9.78^{***}	20.36	-5.26^{**}	6.49	-2.35^{**}	1.09
TRY	-8.08^{***}	62.50	-4.52^{***}	60.87	-4.78^{***}	44.02
$\Delta C_t^\star$	-7.52^{***}	25.09	-3.42^{***}	13.84	-3.80^{***}	9.52
$\Delta(C_t^\star - C_t)$	-7.57^{***}	22.74	-3.17^{***}	11.65	-3.40^{***}	8.15
$\Delta(i_{t,1}^\star - i_{t,1})$	0.06	-0.05	0.01	-0.01	0.13	0.05
$\Delta(i_{t,60}^\star - i_{t,60})$	-0.41	0.16	-0.55	0.41	-0.51^{*}	0.62

This table presents estimates from contemporaneous regressions of currency excess returns on foreign country sovereign CDS spread changes. The exchange rates are defined as units of US dollars per unit of foreign currency. The CDS contracts are denominated in US dollar and have a 5-year maturity. We report estimates of the slope coefficients b and adjusted-R^2 from regressions conducted on a daily, weekly, and monthly data frequency. Standard errors for individual country estimates are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last four rows reports results for pooled regressions of currency excess returns on changes in sovereign risk and interest rates, where $C_t^\star$ (C_t) denotes the 5-year foreign (US) sovereign CDS spread in US dollar, $i_{t,1}^\star$ ($i_{t,1}$) is the 1-month foreign (US) interest rate, $i_{t,60}^\star$ ($i_{t,60}$) is the 5-year foreign (US) interest rate, and Δ indicates the change of a variable (one unit of time). Standard errors are clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample period is from January 2003 to November 2013.

Table 3: CDS spread changes and changes in currency option implied volatilities

	monthly			weekly			daily		
	b		R^2	b		R^2	b		R^2
Panel A: Delta-neutral straddles									
$\Delta C_t^\star$	7.18***	[3.68]	32.34	4.78***	[3.08]	20.61	4.35***	[3.90]	14.14
$\Delta(C_t^\star - C_t)$	7.96***	[4.07]	34.02	4.79***	[2.98]	19.74	4.01***	[3.97]	12.63
$\Delta(i_{t,1}^\star - i_{t,1})$	0.96	[0.65]	2.20	0.27	[0.41]	0.08	−0.03	[−0.28]	−0.00
$\Delta(i_{t,60}^\star - i_{t,60})$	1.15**	[2.30]	2.26	1.48**	[2.16]	2.26	0.60**	[2.17]	1.00
Panel B: Risk reversals									
$\Delta C_t^\star$	2.85***	[3.22]	29.74	1.25***	[5.24]	14.60	1.11***	[3.27]	6.67
$\Delta(C_t^\star - C_t)$	3.10***	[3.31]	30.23	1.22***	[5.09]	13.91	1.01***	[3.25]	6.07
$\Delta(i_{t,1}^\star - i_{t,1})$	0.31	[0.66]	1.33	0.08	[0.55]	0.07	−0.02	[−0.99]	0.01
$\Delta(i_{t,60}^\star - i_{t,60})$	0.40	[1.35]	1.55	0.30*	[1.73]	0.96	0.12**	[2.12]	0.28
Panel C: Butterfly spreads									
$\Delta C_t^\star$	0.26***	[3.00]	22.93	0.07***	[3.13]	3.84	0.06***	[5.26]	1.06
$\Delta(C_t^\star - C_t)$	0.28***	[2.85]	21.79	0.07***	[2.96]	3.54	0.06***	[5.04]	0.98
$\Delta(i_{t,1}^\star - i_{t,1})$	0.05	[1.05]	3.84	0.01	[0.48]	0.02	0.00	[0.00]	−0.00
$\Delta(i_{t,60}^\star - i_{t,60})$	0.03	[1.49]	0.99	0.01	[1.28]	0.08	0.01***	[1.97]	0.03

This table displays results from contemporaneous pooled regressions of changes in the one-month implied volatility of delta-neutral straddles (Panel A), 25δ risk reversals (Panel B), and 25δ butterfly spreads (Panel C) on CDS spread changes. $C_t^\star$ (C_t) denotes the 5-year foreign (US) sovereign CDS spread in US dollar, $i_{t,1}^\star$ ($i_{t,1}$) is the 1-month foreign (US) interest rate, $i_{t,60}^\star$ ($i_{t,60}$) is the 5-year foreign (US) interest rate, and Δ indicates the change of a variable (one unit of time). We report estimates of the slope coefficients b (with t-statistics based on standard errors clustered by currency and time in brackets) and adjusted-R^2 for regressions conducted on a daily, weekly, and monthly data frequency. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample period is from January 2003 to November 2013.

Table 4: Bilateral excess returns and global sovereign risk

	Global and local shocks			Global shocks and local interaction		
	b_{glob}	b_{loc}	R^2	b_{glob}	$b_{glob\times loc}$	R^2
AUD	-12.37^{***}	-1.03	40.13	-13.19^{***}	140.42	40.27
BRL	-11.99^{***}	-6.14^{***}	39.06	-19.46^{***}	310.06^{***}	30.46
CAD	-10.69^{***}	-4.16	49.62	-7.89^{***}	-938.25^{**}	51.33
CHF	-8.83^{***}	-2.41	24.54	-15.72^{***}	803.80^{***}	29.28
CLP	-9.83^{***}	-7.22	28.40	-16.57^{***}	549.92^{*}	29.49
COP	-12.75^{***}	-13.11^{***}	41.60	-75.36	3106.46	34.64
CZK	-7.07^{***}	-6.97^{***}	21.09	-3.43	-428.57^{**}	17.97
GBP	-6.79^{***}	-7.34^{**}	30.33	-9.57^{***}	386.60	27.85
HUF	-23.27^{***}	-5.27^{***}	64.42	19.46^{***}	-940.26^{***}	48.81
IDR	-12.04^{***}	-2.70^{**}	20.22	-10.89	-27.98	17.07
ILS	-5.51^{***}	-2.37	17.46	-4.83	-48.85	16.33
JPY	0.80	-1.44	-0.91	0.81	-1.33	-1.14
KRW	-13.77^{***}	-6.15^{***}	47.76	-8.33^{***}	-259.45^{**}	44.20
MXN	-9.36^{***}	-6.83^{***}	50.14	-12.42^{***}	149.60	41.41
NOK	-9.28^{***}	-7.31	29.52	-8.02^{**}	-519.81	29.35
NZD	-11.46^{***}	6.22	30.39	-10.98^{***}	-61.13	28.54
PLN	-12.76^{***}	-8.17^{***}	45.21	-9.10^{***}	-288.80	37.30
SEK	-8.97^{***}	-9.97^{***}	37.08	-5.72^{**}	-882.06^{**}	36.82
SGD	-5.16^{***}	-0.74	34.58	-3.11^{***}	-427.32	37.35
TRY	-14.50^{***}	-4.37^{**}	64.92	-28.11^{***}	439.65^{***}	65.90
pooled	-8.98^{***}	-4.50^{***}	30.78	-7.09^{***}	-156.75^{**}	26.65

On the left side, this table reports results for regressions of bilateral currency excess returns (all against the USD as base currency) on global CDS spread changes and local CDS spread changes, where the global CDS spread is computed as an equally-weighted average of all other countries' CDS spreads and local CDS spread changes are orthogonalized with respect to global CDS spread changes. On the right side, we report results from regressing bilateral currency excess returns on global CDS spread changes and on an interaction term of global CDS spread changes and lagged local CDS spreads. We report estimates of the slope coefficients b and adjusted-R^2 from regressions conducted at a monthly data frequency. Standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last row reports results for a pooled regression with standard errors clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample period runs at monthly frequency from January 2003 to November 2013.

Table 5: Global sovereign risk and the VIX

	b_{loc}		b_{glob}		b_{vix}		R^2
Panel A: VIX changes as global shocks							
(i)					-0.07^{***}	[−4.51]	13.05
(ii)	-6.39^{***}	[−9.50]			-0.07^{***}	[−5.85]	28.72
Panel B: VIX changes and global CDS shocks							
(iii)			-7.72^{***}	[−6.26]	-0.07^{***}	[−5.54]	26.92
(iv)	-4.39^{***}	[−5.91]	-7.72^{***}	[−7.51]	-0.07^{***}	[−6.06]	31.88
Panel C: Incremental information exclusively in CDS shocks or VIX changes							
(v)	-4.39^{***}	[−5.34]	-7.72^{***}	[−5.57]			18.80
(vi)					−0.03	[−1.62]	1.35

The table reports results for pooled regressions of excess returns on local CDS spreads changes, global CDS spread changes and VIX changes. In the regression specifications (i)-(v), we orthogonalize global and local CDS spread changes with respect to VIX changes (and orthogonalize local CDS spread changes with respect to global CDS spread changes if both are included jointly). In specification (vi) we orthogonalize VIX changes with respect to CDS spread changes. We report estimates of the slope coefficients b (with t-statistics based on standard errors clustered by currency and time in brackets) and adjusted-R^2. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from from January 2003 to November 2013.

Table 6: Sovereign risk portfolios

	RX	ST	RR	BF
Panel A: Exposure to global sovereign risk				
Mean	6.25**	2.52	4.70***	−0.59
	[2.10]	[1.55]	[2.86]	[−1.34]
SR	0.71	0.49	0.99	−0.31
Panel B: Sovereign CDS spreads				
Mean	9.05***	4.32**	7.08***	0.24
	[3.79]	[2.17]	[4.08]	[0.36]
SR	1.35	0.85	1.67	0.13
Panel C: Sovereign ratings				
Mean	6.68***	3.04*	5.10***	0.19
	[3.65]	[1.95]	[3.86]	[0.33]
SR	1.25	0.67	1.41	0.12

This table reports excess returns for rank-weighted portfolios based on (lagged) rolling CDS exposures (exposure of country CDS changes to global CDS changes) in Panel A, for rank-weighted portfolios based on (lagged) CDS spread levels in Panel B, and for rank-weighted portfolios based on (lagged) sovereign ratings in Panel C. We report results for currency portfolios investing in spot/forward exchange rates (RX), delta-neutral straddles (ST), 25δ risk reversals (RR), and 25δ butterfly spreads (BF). For each portfolio, we report annualized mean returns, t-statistics, and annualized Sharpe Ratios (SR). t-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The samples runs at monthly frequency from December 2003 to November 2013.

Table 7: Return decomposition

	RX	VOL	$SKEW$	$KURT$
Panel A: Portfolio returns				
Mean	13.22***	1.60	5.72**	5.59***
	[3.93]	[0.84]	[2.34]	[2.88]
Panel B: Decomposition of returns				
Sovereign risk	6.49***	0.69	4.72**	8.28***
	[3.51]	[0.30]	[2.43]	[3.13]
Inflation	4.19**	0.96	1.78	−2.11
	[2.07]	[0.54]	[1.23]	[−1.42]
Residual	2.55**	−0.05	−0.78	−0.58
	[2.30]	[−0.03]	[−0.53]	[−0.56]
% Sovereign risk	49.06	42.97	82.54	148.08
% Inflation	31.67	59.98	31.16	−37.77
% Residual	19.27	−2.95	−13.70	−10.31

This table reports descriptive statistics for currency excess returns of signal-weighted portfolios sorted by (lagged) carry, at-the-money implied volatility, 25δ risk reversals, and 25δ butterfly spreads, serving factor mimicking portfolios for the first four moments of the currency return distribution. We first report annualized mean portfolio excess returns and then decompose returns into a sovereign risk component, an inflation component, and a residual component. To do so, we run cross-sectional regressions of the corresponding conditioning variables on sovereign CDS spreads and inflation in each month and compute the sovereign risk component as the estimated slope times the CDS spread, the inflation component as the estimated slope times inflation, and the residual component of the conditioning variable as the regression intercepts plus residuals. We report mean excess returns for signal-weighted portfolios based on the three components of the above decomposition. Average excess returns of the three components sum to the overall excess return and the lower panel shows the contribution of the three components to the overall excess return. t-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The samples runs at monthly frequency from December 2003 to November 2013.

Table 8: Asset pricing tests

				Panel A: SDF loadings (b)					
	DOL	HML_{FX}	HML_{CDS}	HML_{INF}	$Carry^{\perp}$	CDS-$carry$	INF-$carry$	R^2	J
(i)	-0.008	0.136						0.946	24.958
	(0.05)	(0.02)							(0.02)
(ii)	-0.014		0.143					0.953	13.518
	(0.05)		(0.03)						(0.41)
(iii)	-0.008			0.150				0.950	29.403
	(0.05)			(0.03)					(0.01)
(iv)	-0.010	0.039	0.041	0.065				0.957	13.220
	(0.05)	(0.05)	(0.09)	(0.08)					(0.28)
(v)	-0.078				0.329			0.762	27.773
	(0.05)				(0.13)				(0.01)
(vi)	-0.018				0.125	0.115	-0.035	0.948	33.165
	(0.05)				(0.05)	(0.05)	(0.09)		(0.00)
				Panel B: Risk prices (λ)					
(i)	0.301	1.244							
	(0.30)	(0.25)							
(ii)	0.304		1.168						
	(0.32)		(0.25)						
(iii)	0.302			1.145					
	(0.32)			(0.22)					
(iv)	0.302	1.167	1.124	1.086					
	(0.32)	(0.24)	(0.23)	(0.24)					
(v)	0.294				2.130				
	(0.28)				(0.83)				
(vi)	0.307				1.022	0.961	-0.074		
	(0.33)				(0.43)	(0.33)	(0.66)		
				Panel C: Factor mean returns					
	0.370	1.335	1.259	1.247	0.692	0.998	0.601		
	(0.23)	(0.28)	(0.27)	(0.26)	(0.24)	(0.26)	(0.27)		

This table reports SDF loadings (with standard errors in parentheses), cross-sectional R^2s and J-stats (with p-values in parentheses) in Panel A, risk prices in Panel B, and factor mean returns (monthly) in Panel C. Results are based on carry, CDS, and inflation portfolios as test asstes (five portfolios each). Risk factors include the dollar risk factor (DOL), carry (HML_{FX}), CDS and/or inflation high-minus-low portfolios (HML_{CDS} and HML_{INF}, respectively). "Pure carry", "CDS-carry", "INF-carry" denote risk factors based on the decomposition of carry into a pure carry component, CDS component, and inflation component. Standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The sample runs at monthly frequency from December 2003 to November 2013.

Table 9: Sovereign risk, carry, and momentum

		High CDS	Low CDS	HML CDS
Panel A: CDS spreads and carry				
High Carry	Mean	13.00***	2.47	10.53***
		[2.70]	[0.59]	[3.23]
	SR	1.09	0.22	1.28
Low Carry	Mean	3.37	0.14	3.23*
		[0.95]	[0.05]	[1.93]
	SR	0.35	0.02	0.53
HML Carry	Mean	9.63***	2.32	
		[2.89]	[0.92]	
	SR	1.09	0.34	
Panel B: CDS spreads and momentum				
High Mom	Mean	12.58***	1.86	10.73***
		[2.78]	[0.69]	[3.12]
	SR	1.18	0.21	1.31
Low Mom	Mean	3.78	0.78	3.00*
		[1.04]	[0.20]	[1.75]
	SR	0.36	0.08	0.51
HML Mom	Mean	8.80***	1.07	
		[3.10]	[0.48]	
	SR	1.10	0.18	

This table reports currency excess returns for two-by-two sequential portfolio sorts that condition on sovereign risk in the first step and on carry (Panel A) or momentum (Panel B) in the second step. Portfolios are updated every month; within portfolios all currencies are equally-weighted. We report average excess returns in percentage per annum, t-statistics based Newey and West (1987) standard errors with Andrews (1991) optimal lag selection in brackets, and annualized Sharpe Ratios (SR). Rows labeled by "HML Carry" ("HML Momentum") present results of buying high and selling low carry (momentum) currencies among high CDS and low CDS countries. Likewise, "HML CDS" reports results of buying high and selling low CDS currencies among high and low carry (momentum) countries in Panel A (Panel B). The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Table 10: Sovereign risk and equity returns

Panel A: CDS spread changes and equity excess returns				
	USD returns		FX-hedged equity returns	
	b	R^2	b	R^2
$\Delta C_t^\star$	-19.39^{***}	37.52	-12.75^{***}	27.02
	[−12.92]		[−10.38]	
$\Delta(C_t^\star - C_t)$	-19.24^{***}	32.23	-12.51^{***}	22.99
	[−11.28]		[−9.39]	
$\Delta(i_{t,1}^\star - i_{t,1})$	−1.37	0.67	−1.55	1.50
	[−0.52]		[−0.79]	
$\Delta(i_{t,60}^\star - i_{t,60})$	-3.74^{***}	3.85	-3.24^{***}	4.84
	[−2.86]		[−3.88]	
Panel B: Equity portfolio excess returns				
	CDS spreads	Ratings	CDS spreads	Ratings
Mean	6.99^{*}	3.14	−2.75	−3.97
	[1.89]	[0.94]	[−0.74]	[−1.21]
SR	0.58	0.32	−0.28	−0.48
ρ^{FX}	0.55	0.51	−0.04	−0.07
α	5.93^{*}	3.28	−2.87	−3.71
	[1.81]	[0.99]	[−0.78]	[−1.14]
β^W	0.12^{*}	−0.02	0.01	−0.03
	[1.74]	[−0.35]	[0.24]	[−0.70]
R^2	1.83	−0.78	−0.80	−0.52
α	−1.18	−2.10	−1.78	−2.51
	[−0.31]	[−0.61]	[−0.50]	[−0.72]
β^W	0.02	−0.02	0.02	−0.03
	[0.31]	[−0.44]	[0.42]	[−0.63]
β^{FX}	0.96^{***}	0.91^{***}	−0.07	−0.10
	[5.88]	[5.63]	[−0.46]	[−0.63]
R^2	28.69	24.36	−1.42	−0.98

This table displays results on the relation between sovereign risk and MSCI country index data. Panel A presents contemporaneous pooled regressions estimates of equity excess returns on sovereign CDS spread changes and interest rate differentials. $C_t^\star$ (C_t) is the 5-year foreign (US) sovereign CDS spread in US dollar, $i_{t,1}^\star$ ($i_{t,1}$) is the 1-month foreign (US) interest rate, $i_{t,60}^\star$ ($i_{t,60}$) is the 5-year foreign (US) interest rate, and Δ indicates the change of a variable. We use (logs) USD returns and FX-hedged returns (i.e., the local currency return on the MSCI country index plus the corresponding currency forward discount minus the one-month US riskfree rate). We report estimates of the slope coefficients b (with t-statistics based on standard errors clustered by country and time in brackets) and adjusted-R^2. Panel B presents results for rank-weighted equity portfolios based on (lagged) CDS spread levels and (lagged) sovereign ratings. We report mean returns and Sharpe ratios (SR), the correlation with the corresponding currency portfolio ρ^{FX} (i.e., RX of Table 6), and results of the international CAPM regressions, where β^W is the coefficient on the MSCI world index (the global market factor) and β^{FX} is the coefficient on the currency return of sovereign risk portfolios (i.e., RX of Table 6). t-statics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Internet Appendix to

“Exchange Rates and Sovereign Risk”

(not for publication)

Abstract

This appendix presents supplementary results not included in the main body of the paper.

IA.A. Higher FX moment regressions for individual countries

We repeat the empirical analysis from Section 3.2 on the individual country level by regressing changes in option-implied higher FX moments on sovereign CDS spread changes. The results reported in Tables IA.3 to IA.5 confirm the pooled regression evidence that increases in sovereign risk are associated with increases in the volatility, skewness, and kurtosis of exchange rate changes.

IA.B. Transaction costs

We show that our results for excess returns to sovereign risk portfolios are robust to accounting for transaction costs. We obtain data on quoted bid-ask spreads, which are typically much higher than effective spreads due to the fact that dealers usually quote conservative numbers and since actual trades take place at the lowest quoted spread and not at the average. Gilmore and Hayashi (2011) show that actual spreads in FX markets are of the order of 25% of quoted spreads. To be conservative, we use 50% of the quoted spread in the computation of excess returns and present portfolio returns net of bid ask spreads in Table IA.11.[25] The average return to buying high and selling low sovereign risk currencies (RX) is 6.10% per annum with a Sharpe ratio of 0.88. In general, the results exhibit patterns similar to those in Table 6 in the main text. A notable difference is that straddle returns become statistically insignificant but remain positive and generate a reasonably high Sharpe Ratio (0.58) such that the performance still seems economically significant.

[25]We adjust long and short positions separately for transaction costs. For long positions, we go long at the ask and sell the position after one month at the bid; for short positions, we go short at the bid and close the position at the ask after one month (see, e.g., Lustig, Roussanov, and Verdelhan, 2011). Bid and ask prices for options are computed from bid and ask option IVs.

IA.C. Volatility risk premia

To provide further evidence that higher FX moments are related to sovereign risk, we compute volatility risk premia generated by currency volatility swaps. [26] A long position in a 1-month volatility swap contract pays out the difference between the volatility realized over the next month (floating leg) and the ex-ante 1-month implied volatility (fixed leg). The fixed leg (SV_t) is given by the risk-neutral expectation of future realized volatility and can be computed model-free based on a portfolio of 1-month OTM put and OTM call options as in (see, e.g., Britten-Jones and Neuberger, 2000; Jiang and Tian, 2005; Carr and Wu, 2009). The floating leg (RV_{t+1}) is computed using daily squared log exchange rate returns between times t and $t+1$. The excess return from trading a volatility swap between times t and $t+1$ (while dropping the currency subscript i for easy notation) is given by

$$rx_{t+1} = \frac{RV_{t+1} - SV_t}{RV_t}, \tag{IA.C.1}$$

showing that it depends on the extent to which the exchange rate path exhibits volatility.

In line with the other derivative strategies, we compute the returns of selling volatility insurance by forming currency portfolios on the basis of CDS spreads.[27] Table IA.7, shows that the sovereign risk portfolios capture significant volatility risk premia amounting to 9.72% per year. This finding suggests that sovereign CDS spreads contain information relevant for FX volatility risk premia.

[26] Academic research on risk premia associated with the second moment of returns typically focuses on variance swaps. In currency markets, however, there is an active market for volatility swaps whereas the market for variance swaps is far less liquid. Both, conceptually as well as empirically, it makes no difference whether we use the former or the latter.

[27] Volatility risk premia generally have standard deviations exceeding unity. To make the returns of this strategy comparable to those of the other currency investments discussed in the paper, we scale the excess returns of volatility swaps by their lagged rolling standard deviation. Our scaling procedure is inspired by Moskowitz, Ooi, and Pedersen (2012) and does not change the quality of results compared to using unscaled returns because, essentially, we only allow for a deleveraging of the strategy.

IA.D. The factor structure of CDS-sorted portfolio returns

As noted above, we find that returns to rank portfolios trading on the four moments of exchange rates are less than perfectly correlated. We report correlation coefficients of all four portfolios' excess returns in Panel A of Table IA.12. As expected, there is a high correlation between RX and RR but the other portfolio returns have a low or even negative correlation (e.g., ST and RR). Panel B reports results of a principal components analysis which shows that the first principal component only explains about one half of the overall variance. Hence, there are significant gains from diversification across moments of the exchange rate distribution.

IA.E. Changing the base currency

The majority of sovereign CDS contracts is denominated in USD. For the 20 foreign countries covered in our sample, the Markit database coverage of 5-year CDS contracts with restructuring clause CR up to November 2013 (with different starting dates) comprises 52,213 daily observations. For the other sample currencies, we find the second highest coverage when using the JPY as base currency with 24,524 daily observations for Japan and 11 foreign countries. We use this data to repeat the empirical analysis on the contemporaneous link between sovereign risk and exchange rate changes as well as higher moments of the FX distribution from the perspective of a JPY investor.

Using JPY exchange rates and foreign country CDS spreads, we find that our results do not depend on the choice of base currency. The results in Table IA.13 show that an increase in sovereign risk is associated with currencies depreciation, higher FX volatility, and more expensive crash risk insurance. At the monthly frequency, the estimated slope coefficients are highly significant and the associated R^2s are sizeable with values of 33%, 23%, and 16% for exchange rate changes and changes in ATM IV and skewness, respectively. The results are less pronounced or not significant for the butterfly spread and higher frequencies, with the comparably less liquid market for JPY-denominated CDS contracts being a potential reason for the latter finding.

IA.F. Predictive regressions: Further results

Our results in Section 3 establish a strong contemporaneous link between CDS spread innovations and exchange rate returns and our findings in Section 4 show that sovereign CDS spreads *predict* exchange rate changes. This Section provides evidence that CDS spread innovations Granger-cause exchange rate changes whereas there is no evidence that exchange rate changes forecast changes in CDS spreads. Below, we present results for predictive regressions and vector autoregressive models (VARs) for exchange rate changes and CDS spread changes estimated on daily data.

The upper two panels of Figure IA.1 directly show the cumulative change in the exchange rate as predicted by lagged changes in the CDS spread and the predicted change in the CDS spread due to lagged changes in exchange rate changes. More specifically, we run (pooled) predictive regressions of the form

$$\Delta x_{i,t+1;t+k} = \alpha_k + \beta_{1,k}\Delta C^{\star}_{i,t} + \beta_{2,k}\Delta C^{\star}_{i,t-1} + \gamma_{1,k} rx_{i,t} + \gamma_{2,k} rx_{i,t-1} + \varepsilon_{i,t+k},$$

where $\Delta x_{i,t;t+k}$ is either the cumulative CDS spread change or currency excess return from $t+1$ to $t+k$ and where we let k range from 1 to 15 trading days. Confidence intervals (95%) are based on a block bootstrap with blocks of 20 trading days (roughly one month). The left panel of Figure IA.1 shows that changes in CDS spreads forecast currency returns up to one week (5 trading days) which is in line with our evidence for speculator positions above. The right panel shows that positive excess return of the foreign currency has no immediate forecast power for CDS spread changes but that sovereign risk eventually declines somewhat after about two weeks. Overall, this finding suggests that sovereign risk Granger-causes exchange rates in a way that is consistent with our finding for quantities above.

Finally, We also run the same experiment with a conventional (pooled) VAR (2 lags) and cumulative impulse-response functions are shown in the two lower panel of Figure IA.1 and corroborate our findings based on predictive regressions discussed above. A 100 basis point rise in CDS spread changes forecasts a cumulative change in currency excess returns of about -1.25% whereas we find basically no evidence of sovereign risk predictability by means of lagged excess returns.

Table IA.1: CDS spread changes and currency excess returns: Pooled regressions

	monthly			weekly			daily		
	b		R^2	b		R^2	b		R^2
Panel A: Full sample (01/2003 - 11/2013)									
$\Delta C_t^\star$	-7.52^{***}	$[-9.06]$	25.09	-3.42^{***}	$[-3.10]$	13.84	-3.80^{***}	$[-3.64]$	9.52
$\Delta(C_t^\star - C_t)$	-7.57^{***}	$[-7.77]$	22.74	-3.17^{***}	$[-3.06]$	11.65	-3.40^{***}	$[-3.85]$	8.15
$\Delta\widehat{C}_t^\star$	-6.91^{***}	$[-8.08]$	31.65	-2.94^{***}	$[-3.03]$	17.70	-2.59^{***}	$[-4.14]$	9.53
$\Delta(\widehat{C}_t^\star - \widehat{C}_t)$	-7.11^{***}	$[-7.05]$	28.89	-2.82^{***}	$[-2.99]$	15.55	-2.44^{***}	$[-4.18]$	8.57
$\Delta(i_{t,1}^\star - i_{t,1})$	0.06	$[0.06]$	-0.05	0.01	$[0.03]$	-0.01	0.13	$[1.35]$	0.05
$\Delta(i_{t,60}^\star - i_{t,60})$	-0.41	$[-0.56]$	0.16	-0.55	$[-1.02]$	0.41	-0.51^{*}	$[-1.78]$	0.62
Pre-Crisis Subsample (01/2003 - 06/2007)									
$\Delta C_t^\star$	-5.78^{***}	$[-13.91]$	6.13	-5.38^{***}	$[-10.06]$	5.01	-3.83^{***}	$[-2.80]$	2.56
$\Delta(C_t^\star - C_t)$	-5.41^{***}	$[-9.02]$	6.20	-5.45^{***}	$[-9.23]$	5.43	-4.08^{***}	$[-2.85]$	3.01
$\Delta\widehat{C}_t^\star$	-8.48^{***}	$[-3.85]$	12.55	-9.48^{***}	$[-14.08]$	10.27	-8.59^{***}	$[-5.52]$	8.96
$\Delta(\widehat{C}_t^\star - \widehat{C}_t)$	-8.41^{***}	$[-3.89]$	12.59	-9.68^{***}	$[-12.80]$	11.45	-8.91^{***}	$[-5.74]$	10.21
$\Delta(i_{t,1}^\star - i_{t,1})$	-1.13	$[-1.04]$	1.02	-0.08	$[-0.26]$	-0.03	0.05	$[0.40]$	-0.00
$\Delta(i_{t,60}^\star - i_{t,60})$	-1.16^{*}	$[-1.76]$	2.32	-0.39	$[-1.00]$	0.33	-0.14	$[-0.75]$	0.10
Panel C: Crisis Subsample (07/2007 - 11/2013)									
$\Delta C_t^\star$	-7.67^{***}	$[-9.24]$	30.92	-3.36^{***}	$[-3.02]$	16.12	-3.80^{***}	$[-3.63]$	11.06
$\Delta(C_t^\star - C_t)$	-7.80^{***}	$[-8.20]$	26.96	-3.11^{***}	$[-2.98]$	13.14	-3.37^{***}	$[-3.85]$	9.16
$\Delta\widehat{C}_t^\star$	-6.87^{***}	$[-7.80]$	33.86	-2.92^{***}	$[-3.01]$	18.52	-2.56^{***}	$[-4.09]$	9.84
$\Delta(\widehat{C}_t^\star - \widehat{C}_t)$	-7.08^{***}	$[-6.80]$	30.77	-2.79^{***}	$[-2.97]$	16.15	-2.41^{***}	$[-4.13]$	8.79
$\Delta(i_{t,1}^\star - i_{t,1})$	0.32	$[0.30]$	0.12	0.05	$[0.10]$	-0.01	0.14	$[1.27]$	0.06
$\Delta(i_{t,60}^\star - i_{t,60})$	-0.01	$[-0.01]$	-0.08	-0.62	$[-0.92]$	0.41	-0.76^{**}	$[-2.52]$	1.00

This table reports results from contemporaneous pooled regressions of currency excess returns on CDS spread changes and interest rate differentials. $C_t^\star$ (C_t) denotes the 5-year foreign (US) sovereign CDS spread in US dollar, $\widehat{C}_t^\star$ ($\widehat{C}_t$) denotes the 5-year foreign (US) sovereign CDS spread in foreign currency, $i_{t,1}^\star$ ($i_{t,1}$) is the 1-month foreign (US) interest rate, $i_{t,60}^\star$ ($i_{t,60}$) is the 5-year foreign (US) interest rate, and Δ indicates the change of a variable (one unit of time). Panel A shows results for the full sample period whereas Panel B (Panel C) reports results for the pre-crisis (crisis) subsample. We report estimates of the slope coefficients b (with t-statistics based on standard errors clustered by currency and time in brackets) and R^2 for regressions conducted on a daily, weekly, and monthly data frequency. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table IA.2: CDS spread changes and currency excess returns: Panel regressions

Panel A: Full sample (01/2003 - 11/2013)								
	XS		FE		TE		FETE	
$\Delta C_t^\star$	-5.90^{***}	$[-5.14]$	-7.48^{***}	$[-8.29]$	-3.76^{***}	$[-4.58]$	-3.61^{***}	$[-4.41]$
$\Delta(C_t^\star - C_t)$	-4.78^{***}	$[-8.26]$	-7.52^{***}	$[-7.20]$	-3.72^{***}	$[-4.45]$	-3.58^{***}	$[-4.32]$
$\Delta(i_{t,1}^\star - i_{t,1}$	-0.08	$[-0.15]$	0.08	$[0.08]$	-0.03	$[-0.06]$	0.02	$[0.05]$
$\Delta(i_{t,60}^\star - i_{t,60})$	-0.33	$[-0.85]$	-0.42	$[-0.57]$	-0.76^{**}	$[-2.18]$	-0.73^{**}	$[-2.12]$
Pre-Crisis Subsample (01/2003 - 06/2007)								
$\Delta C_t^\star$	-8.53^{***}	$[-2.80]$	-5.00^{***}	$[-7.16]$	-5.48^{***}	$[-6.28]$	-4.41^{***}	$[-5.83]$
$\Delta(C_t^\star - C_t)$	-6.11^{**}	$[-2.08]$	-4.61^{***}	$[-5.87]$	-5.33^{***}	$[-6.71]$	-4.35^{***}	$[-5.54]$
$\Delta(i_{t,1}^\star - i_{t,1})$	-0.73	$[-0.80]$	-0.90	$[-0.80]$	-1.27	$[-1.10]$	-0.91	$[-0.74]$
$\Delta(i_{t,60}^\star - i_{t,60}$	-1.26^{**}	$[-2.14]$	-1.03	$[-1.63]$	-1.86^{***}	$[-3.74]$	-1.63^{***}	$[-3.53]$
Panel C: Crisis Subsample (07/2007 - 11/2013)								
$\Delta C_t^\star$	-4.03^{***}	$[-5.94]$	-7.70^{***}	$[-9.09]$	-3.40^{***}	$[-3.63]$	-3.40^{***}	$[-3.61]$
$\Delta(C_t^\star - C_t)$	-4.03^{***}	$[-5.94]$	-7.82^{***}	$[-8.08]$	-3.40^{***}	$[-3.63]$	-3.40^{***}	$[-3.61]$
$\Delta(i_{t,1}^\star - i_{t,1}$	0.39	$[0.82]$	0.31	$[0.30]$	0.41^{*}	$[1.73]$	0.38^{*}	$[1.68]$
$\Delta(i_{t,60}^\star - i_{t,60})$	0.33	$[0.74]$	-0.05	$[-0.06]$	-0.23	$[-0.64]$	-0.25	$[-0.68]$

This table reports results from contemporaneous regressions of currency excess returns on CDS spread changes and interest rate differentials. $C_t^\star$ (C_t) denotes the 5-year foreign (US) sovereign CDS spread in US dollar, $i_{t,1}^\star$ ($i_{t,1}$) is the 1-month foreign (US) interest rate, $i_{t,60}^\star$ ($i_{t,60}$) is the 5-year foreign (US) interest rate, and Δ indicates the change of a variable (one unit of time). We report estimates of the slope coefficients b (with t-statistics based on standard errors clustered by currency and time in brackets) from cross-sectional regressions (XS) and panel regressions with country-fixed effects (FE) or time-fixed effects (TE) pr both (FETE) conducted at a monthly frequency. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Panel A shows results for the full sample period whereas Panel B (Panel C) reports results for the pre-crisis (crisis) subsample.

Table IA.3: Changes in CDS spread and delta-neutral straddle IV: Country regressions

	monthly		weekly		daily	
	b	R^2	b	R^2	b	R^2
AUD	7.55	5.08	7.97*	7.23	7.18***	4.49
BRL	4.44**	15.18	9.54***	57.94	7.48***	32.31
CAD	10.41***	7.30	4.78***	1.71	2.32***	0.51
CHF	4.93**	7.93	5.17*	8.30	2.28**	1.56
CLP	12.06***	50.08	3.63***	10.12	4.59***	9.76
COP	8.62***	34.74	0.43	−0.59	0.65	1.21
CZK	9.23***	57.44	4.30***	16.72	4.38***	11.40
GBP	5.80***	8.20	5.62**	8.75	6.01***	8.07
HUF	2.57*	32.33	2.23***	25.72	1.94***	21.34
IDR	9.58***	61.71	1.81***	9.00	1.98	8.36
ILS	1.53*	5.47	1.28**	3.58	1.32***	2.89
JPY	2.34	0.64	10.16**	13.39	6.68***	5.55
KRW	8.87***	44.02	4.38***	23.02	6.19***	24.99
MXN	6.12**	32.70	12.86***	48.20	10.17***	39.62
NOK	13.64	6.76	9.52	4.11	3.54	0.72
NZD	6.81	9.39	4.43	3.14	3.50***	2.21
PLN	7.42***	42.27	6.16***	32.99	4.11***	12.41
SEK	6.68**	9.07	3.15	2.24	4.47***	2.63
SGD	5.65	11.71	2.48	1.44	2.16*	1.36
TRY	6.18***	44.87	4.69***	65.06	4.25***	35.92
pooled	7.18***	32.34	4.78***	20.61	4.35***	14.14

This table presents results from contemporaneous regressions of changes in delta-neutral straddle implied volatility on changes in CDS spread. We report estimates of the slope coefficient b and adjusted-R^2 using daily, weekly, and monthly observations. The standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last row reports results for a pooled regression based on standard errors clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Table IA.4: Changes in CDS spread and risk reversal IV: Country regressions

	monthly		weekly		daily	
	b	R^2	b	R^2	b	R^2
AUD	0.63	−0.66	1.89	5.74	2.03***	4.33
BRL	2.37*	15.50	2.30***	36.10	1.71***	17.64
CAD	3.20**	8.45	1.42***	1.63	0.66***	0.50
CHF	1.04	2.07	1.40**	5.32	0.31	0.22
CLP	4.16***	33.30	0.47	1.00	0.77*	1.52
COP	2.27***	33.02	−0.16	−0.08	0.05	−0.31
CZK	1.84***	26.86	1.35***	12.97	1.06***	5.84
GBP	1.92***	13.01	1.93***	15.69	1.63***	10.09
HUF	0.89**	45.37	0.86***	28.52	0.55***	13.56
IDR	4.43***	54.65	0.81***	12.55	0.40	1.93
ILS	0.81***	18.47	0.54***	7.41	0.33***	1.77
JPY	−0.11	−0.76	−2.79**	6.52	−1.80***	3.16
KRW	3.62***	38.32	2.44***	26.02	3.38***	19.39
MXN	3.09**	28.47	1.82***	30.77	1.59***	15.88
NOK	4.53***	12.21	3.01*	3.97	1.49***	1.42
NZD	0.85	0.16	1.86**	8.32	1.16**	2.76
PLN	2.39***	35.89	1.61***	18.43	1.22***	7.54
SEK	1.16***	4.15	1.94***	8.52	1.56***	3.33
SGD	2.07	10.25	1.38	3.03	0.31	0.11
TRY	2.41***	60.25	0.99***	37.65	1.09***	26.41
pooled	2.85***	29.74	1.25***	14.60	1.11***	6.67

This table presents results from contemporaneous regressions of changes in 25δ risk reversal implied volatility on changes in CDS spread. We report estimates of the slope coefficient b and adjusted-R^2 using daily, weekly, and monthly observations. The standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last row reports results for a pooled regression based on standard errors clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Table IA.5: Changes in CDS spread and butterfly spread IV: Country regressions

	monthly		weekly		daily	
	b	R^2	b	R^2	b	R^2
AUD	0.15	2.16	0.26*	10.51	0.15**	2.56
BRL	0.22	7.30	0.09***	3.41	0.08***	0.93
CAD	0.26*	3.74	0.07	0.14	0.04	0.05
CHF	0.04	−1.49	0.11**	4.36	0.01	−0.04
CLP	0.32**	16.28	0.01	−0.19	0.12*	1.08
COP	0.19*	47.80	−0.02**	0.92	0.02	0.76
CZK	0.25***	17.60	0.05	0.74	0.01	−0.02
GBP	0.35**	17.11	0.11	4.93	0.05**	0.98
HUF	0.02***	7.76	0.02**	−0.33	−0.01	−0.21
IDR	0.37***	47.60	0.09***	16.30	0.06**	3.40
ILS	0.03	0.14	−0.03	0.18	0.01	−0.03
JPY	0.05	−0.33	0.27*	7.58	0.22**	4.83
KRW	0.43***	48.41	0.09***	4.51	0.14***	4.58
MXN	0.32***	35.79	0.06***	5.61	0.08***	3.58
NOK	0.75**	17.25	0.20	1.74	0.05*	0.07
NZD	0.13	2.52	0.18	7.46	0.06**	0.95
PLN	0.21*	22.39	0.02	0.03	0.03	0.10
SEK	0.30*	16.10	0.13*	4.34	0.07**	0.01
SGD	0.16	3.79	0.28	7.82	0.02	−0.02
TRY	0.17***	28.73	0.04	3.75	0.03***	1.03
pooled	0.26***	22.93	0.07***	3.84	0.06***	1.06

This table presents results from contemporaneous regressions of changes in 25δ butterfly spread implied volatility on changes in CDS spread. We report estimates of the slope coefficient b and adjusted-R^2 using daily, weekly, and monthly observations. The standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last row reports results for a pooled regression based on standard errors clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Table IA.6: Bilateral excess returns and global sovereign risk

	Global shocks		Local and global shocks			
	b	R^2	b_{loc}	b_{glob}	R^2	R^2_{loc}
AUD	-12.37^{***}	40.83	-1.03	-12.37^{***}	40.13	-1.19
BRL	-11.99^{***}	29.68	-6.14^{***}	-11.99^{***}	39.06	8.82
CAD	-10.69^{***}	49.67	-4.16	-10.69^{***}	49.62	-0.61
CHF	-8.83^{***}	25.66	-2.41	-8.83^{***}	24.54	-1.57
CLP	-9.83^{***}	26.17	-7.22	-9.83^{***}	28.40	1.98
COP	-12.75^{***}	29.20	-13.11^{***}	-12.75^{***}	41.60	8.24
CZK	-7.07^{***}	15.16	-6.97^{***}	-7.07^{***}	21.09	5.77
GBP	-6.79^{***}	27.09	-7.34^{**}	-6.79^{***}	30.33	2.89
HUF	-23.27^{***}	41.85	-5.27^{***}	-23.27^{***}	64.42	19.36
IDR	-12.04^{***}	18.03	-2.70^{**}	-12.04^{***}	20.22	1.95
ILS	-5.51^{***}	17.01	-2.37	-5.51^{***}	17.46	0.30
JPY	0.80	-0.35	-1.44	0.80	-0.91	-0.55
KRW	-13.77^{***}	43.52	-6.15^{***}	-13.77^{***}	47.76	3.54
MXN	-9.36^{***}	40.84	-6.83^{***}	-9.36^{***}	50.14	8.91
NOK	-9.28^{***}	29.65	-7.31	-9.28^{***}	29.52	-0.37
NZD	-11.46^{***}	29.66	6.22	-11.46^{***}	30.39	0.24
PLN	-12.76^{***}	35.79	-8.17^{***}	-12.76^{***}	45.21	9.06
SEK	-8.97^{***}	32.23	-9.97^{***}	-8.97^{***}	37.08	4.53
SGD	-5.16^{***}	35.29	-0.74	-5.16^{***}	34.58	-1.12
TRY	-14.50^{***}	62.09	-4.37^{**}	-14.50^{***}	64.92	1.88
pooled	-8.98^{***}	25.56	-4.50^{***}	-8.98^{***}	30.78	5.20

This table reports estimates from contemporaneous regressions of bilateral currency excess returns against the USD on (i) global CDS spread change (left side), and (ii) both global and local CDS spread changes (right side). The global component is computed as an equally-weighted average of country-specific CDS spread changes. The local component is computed by regressing the country-specific CDS spread change on the global CDS spread change. We report estimates of the slope coefficients b and adjusted-R^2. We denote as R^2_{loc} the difference in adjusted-R^2s of the specification with local and global shocks to the specification with global shocks only. The standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The last row reports results for a pooled regression with standard errors clustered by currency and time. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2003 to November 2013.

Table IA.7: Sovereign risk and FX volatility risk premia

Panel A: CDS spread portfolio		Panel B: Carry rank portfolio	
Mean	9.72***	Mean	4.48
	[2.84]		[1.33]
Std	8.47	Std	8.30

This table reports annualized volatility risk premia from a rank-weighted portfolio based on sovereign CDS spreads (Panel A) and forward discounts (Panel B). t-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Std denotes the standard deviation of volatility risk premia. The sample runs at monthly frequency from January 2004 to November 2013.

Table IA.8: Asset pricing tests: Higher moment hedges

	DOL	HML_{FX}	HML_{CDS}	HML_{INF}	$Carry^{\perp}$	CDS-$carry$	INF-$carry$	R^2	J
Panel A: SDF loadings (b)									
(i)	-0.005	0.128						0.891	100.786
	(0.04)	(0.03)							(0.00)
(ii)	-0.010		0.132					0.883	85.321
	(0.05)		(0.03)						(0.00)
(iii)	-0.006			0.142				0.895	90.327
	(0.05)			(0.03)					(0.00)
(iv)	-0.003	0.090	-0.080	0.128				0.901	90.633
	(0.05)	(0.09)	(0.09)	(0.09)					(0.00)
(v)	-0.067				0.301			0.720	184.842
	(0.05)				(0.11)				(0.00)
(vi)	-0.019				0.106	0.085	0.028	0.893	146.568
	(0.06)				(0.03)	(0.03)	(0.06)		(0.00)
Panel B: Risk prices (λ)									
(i)	0.300	1.174							
	(0.30)	(0.28)							
(ii)	0.303		1.092						
	(0.32)		(0.27)						
(iii)	0.301			1.093					
	(0.32)			(0.24)					
(iv)	0.299	1.153	1.016	1.079					
	(0.31)	(0.25)	(0.24)	(0.26)					
(v)	0.299				1.963				
	(0.28)				(0.73)				
(vi)	0.304				0.805	0.874	0.409		
	(0.35)				(0.21)	(0.26)	(0.42)		
Panel C: Factor mean returns									
	0.370	1.335	1.259	1.247	0.692	0.998	0.601		
	(0.23)	(0.28)	(0.27)	(0.26)	(0.24)	(0.26)	(0.27)		

This table reports SDF loadings (with standard errors in parentheses), cross-sectional R^2s and J-stats (with p-values in parentheses) in Panel A, risk prices in Panel B, and factor mean returns (monthly) in Panel C. Results are based on carry, CDS, inflation, straddle, RR, and BF portfolios as test assets (five portfolios each). Risk factors include the dollar risk factor (DOL), carry (HML_{FX}), CDS and/or inflation high-minus-low portfolios (HML_{CDS} and HML_{INF}, respectively). “Pure carry”, “CDS-carry”, “INF-carry” denote risk factors based on the decomposition of carry into a pure carry component, CDS component, and inflation component. Standard errors are based on Newey and West (1987) with Andrews (1991) optimal lag selection. The sample runs at monthly frequency from December 2003 to November 2013.

Table IA.9: Sovereign risk and net speculator positions

	Forecast horizon				
	0	1	2	3	4
β_k	-9.33^{***}	-9.71^{***}	-0.94	3.01	-1.63
	[−2.72]	[−4.25]	[−0.49]	[1.59]	[−0.84]
$\gamma_{1,k}$	0.83^{***}	0.44^{***}	-0.05	-0.13	-0.25^{**}
	[6.08]	[4.39]	[−0.46]	[−1.45]	[−2.29]
$\gamma_{2,k}$	0.03	-0.07^{***}	-0.07^{***}	-0.06^{**}	-0.05^{**}
	[0.99]	[−2.77]	[−2.81]	[−2.36]	[−2.13]
R^2	3.18	1.50	0.38	0.47	0.53

This table reports results from the following pooled regression

$$\Delta p_{i,t+k} = \alpha_k + \beta_k \Delta C^{\star}_{i,t} + \gamma_{1,k}\Delta s_{i,t} + \gamma_{2,k}\Delta s_{i,t-1} + \varepsilon_{i,t+k},$$

where $\Delta p_{i,t+k}$ denotes the k-week change in net speculator positions, $\Delta C^{\star}_{i,t}$ is the change is the CDS spread between times t and $t+1$, $\Delta s_{i,t}$ is the change in the log-spot exchange rate between times t and $t+1$, $\Delta s_{i,t-1}$ is the lagged exchange rate return, and i denotes the currency pair against the USD. p is measured as the net position of non-commercial traders on currency options and futures scaled by the open interest from the CME's commitment of traders. The sample of currencies comprises the AUD, CAD, CHF, GBP, JPY, MXN, and NZD. We report results for contemporaneous regressions for $k = 0$ and for predictive regressions for $k = 1, \ldots, 4$ weeks. t-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection are reported in brackets. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample is weekly from January 2004 to November 2013.

Table IA.10: Sovereign risk and the Euro

Panel A: Currency Excess Returns									
	monthly			weekly			daily		
	b		R^2	b		R^2	b		R^2
$\Delta C_t^\star$	-6.75^{***}	[−4.36]	17.90	-3.32^{***}	[−3.47]	6.98	-3.16^{***}	[−4.30]	4.97
$\Delta(C_t^\star - C_t)$	-6.66^{***}	[−3.91]	16.92	-2.86^{***}	[−2.98]	5.04	-2.56^{***}	[−4.42]	3.91
Panel B: Delta-neutral Straddles									
$\Delta C_t^\star$	3.44^{***}	[6.08]	12.35	2.48^{***}	[3.12]	8.25	2.33^{***}	[4.55]	5.95
$\Delta(C_t^\star - C_t)$	3.41^{***}	[6.12]	11.03	2.30^{***}	[2.88]	6.36	1.80^{***}	[4.03]	4.01
Panel C: Risk Reversals									
$\Delta C_t^\star$	0.77^{***}	[3.43]	8.57	0.90^{***}	[3.57]	11.02	0.65^{***}	[5.15]	5.47
$\Delta(C_t^\star - C_t)$	0.89^{***}	[3.32]	10.97	0.81^{***}	[3.24]	8.09	0.50^{***}	[4.62]	3.80
Panel D: Butterfly Spreads									
$\Delta C_t^\star$	0.11^{**}	[2.37]	9.63	0.06^{**}	[2.50]	5.73	0.03^{**}	[2.31]	1.07
$\Delta(C_t^\star - C_t)$	0.11^{**}	[2.36]	8.18	0.05^{**}	[2.12]	3.30	0.02^{*}	[1.71]	0.54

This table reports estimates of the slope coefficients b (with t-statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection in brackets) and R^2 from regressions of the USD/EUR currency excess returns (Panel A), changes in the 1-month implied volatility of delta-neutral straddles (Panel B), 25δ risk reversals (Panel C), and 25δ butterfly spreads (Panel D) on changes in a Eurozone sovereign risk index (itraxx Western Europe SovX). The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. We report results for daily, weekly, and monthly observations from January 2003 to November 2013.

Table IA.11: Sovereign risk portfolios: Transaction costs

	RX	ST	RR	BF
Mean	6.71^{**}	2.41	5.74^{***}	-1.69^{**}
	[2.56]	[1.23]	[2.60]	[−2.05]
SR	1.01	0.45	1.28	−0.83

This table is similar to Table 6 but here we report average annualized returns, t-statistics, and Sharpe Ratios for returns after adjusting for transaction costs. The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The sample runs at monthly frequency from January 2004 to November 2013.

Table IA.12: Sovereign risk portfolios: Transaction costs

Panel A: Return correlations				
	RX	ST	RR	BF
RX	1.000	-0.117	0.850	0.022
ST	-0.117	1.000	-0.297	-0.747
RR	0.850	-0.297	1.000	0.069
BF	0.022	-0.747	0.069	1.000
Panel B: Principal components				
	1	2	3	4
RX	0.521	-0.481	0.388	0.588
ST	-0.492	-0.497	0.610	-0.373
RR	0.577	-0.398	-0.265	-0.662
BF	0.392	0.602	0.639	-0.276
Cum %	0.517	0.905	0.973	1.000

This table reports return correlations (Panel A) for currency portfolios based on CDS spreads where we consider investing in spot/forward exchange rates (RX), straddles (ST), 25δ risk reversals (RR), and 25δ butterfly spreads (BF). Panel B shows results for a principal components analysis where the last row reports the cumulative R^2. The sample runs at monthly frequency from January 2004 to November 2013.

Table IA.13: Using the JPY as base currency

	monthly			weekly			daily		
	b		R^2	b		R^2	b		R^2
Panel A: Currency Excess Returns									
$\Delta C^\star_t$	-7.98^{***}	[−6.60]	33.37	-8.12^{***}	[−3.04]	18.08	−4.51	[−1.07]	1.42
$\Delta(C^\star_t - C_t)$	-8.98^{***}	[−6.90]	32.92	-8.42^{***}	[−3.33]	23.88	−1.94	[−0.66]	0.46
Panel B: Delta-neutral Straddles									
$\Delta C^\star_t$	6.19^{***}	[4.82]	22.58	2.14	[0.78]	1.29	3.06	[0.75]	0.57
$\Delta(C^\star_t - C_t)$	6.75^{***}	[4.50]	20.89	0.62	[0.24]	−0.12	0.42	[0.11]	−0.10
Panel C: Risk Reversals									
$\Delta C^\star_t$	4.26^{**}	[2.30]	16.10	3.96^{**}	[2.45]	6.07	1.29	[0.36]	0.01
$\Delta(C^\star_t - C_t)$	5.21^{***}	[3.05]	18.78	5.32^{***}	[2.81]	13.69	1.31	[0.41]	0.15
Panel D: Butterfly Spreads									
$\Delta C^\star_t$	−0.86	[−0.87]	0.91	−2.83	[−1.61]	3.57	−0.31	[−0.08]	−0.12
$\Delta(C^\star_t - C_t)$	-1.31^{*}	[−1.77]	1.72	-4.15^{**}	[−2.21]	9.82	−0.91	[−0.27]	0.01

This table reports estimates of the slope coefficients b (with t -statistics based on Newey and West (1987) standard errors with Andrews (1991) optimal lag selection) and R^2 from regressions of the USD/JPY excess returns (Panel A), changes in the 1-month implied volatility of delta-neutral straddles (Panel B), 25δ risk reversals (Panel C), and 25δ butterfly spreads (Panel D) on changes in foreign sovereign CDS spreads ($\Delta C^\star_t$) and changes in differentials of foreign minus Japanese CDS spreads ($\Delta(C^\star_t - C_t)$). The superscripts *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. We report results for daily, weekly, and monthly observations from January 2003 to November 2013.

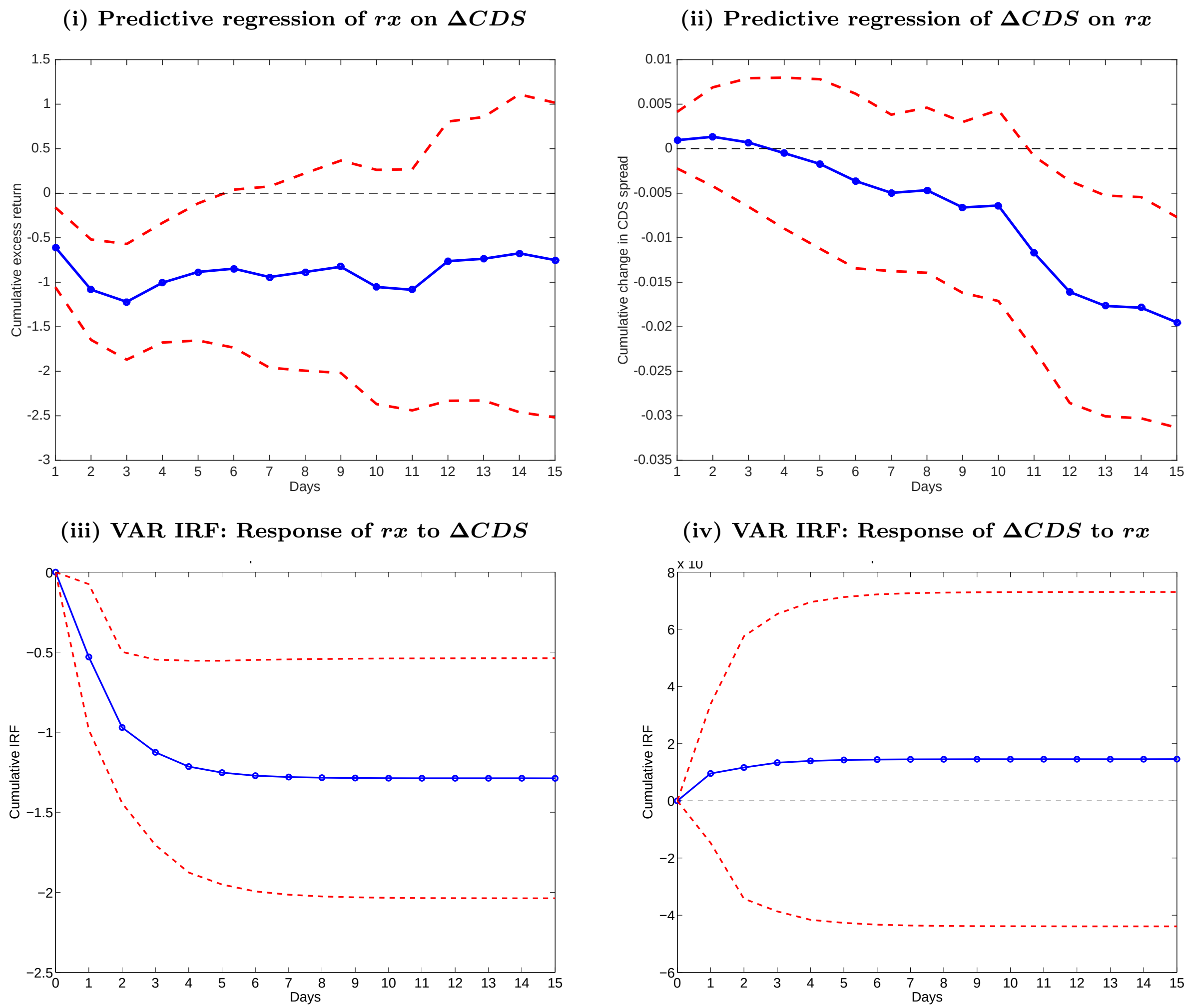

Figure IA.1: CDS changes and excess returns in a predictive setting

This figure shows responses of currency excess returns and CDS spread changes to lagged currency excess returns or CDS spread changes. The top-left (top-right) panel shows the predictive regression using the cumulative currency excess returns (CDS spread changes) as dependent variable and the lagged CDS spread changes (currency excess returns) as predictor for a forecast horizon up to 15 days. The bottom-left and bottom-right panels present the impulse response functions (IRF) using a pooled VAR with two lags. The 95% confidence intervals are based on a block bootstrap (20 day blocks) with 5,000 repetitions.