Sovereign yields and the risk-taking channel of currency appreciation*

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Abstract

Currency appreciation against the US dollar is associated with the compression of emerging market economy (EME) sovereign yields. We find that this yield compression is due to reduced risk premiums rather than expectations of interest rates already priced into forward rates. We explore a model which ties together dollar credit to EME corporates, sovereign tail risks and global investor portfolio adjustments driven by economic capital constraints. Consistent with our model, we find no empirical association between currency appreciation and sovereign spreads when we use the trade-weighted effective exchange rate that is unrelated to the US dollar.

JEL codes: G12, G15, G23.

Keywords: bond spread, capital flow, credit risk, emerging market, exchange rate.

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1 Introduction

What is the macroeconomic impact of currency appreciation? Is it expansionary or contractionary? The answer from traditional arguments in the spirit of the Mundell-Fleming model (Mundell (1963), Fleming (1962)) is that currency appreciation is contractionary. An appreciation is associated with a decline in net exports and a contraction in output, other things being equal.

The other side of the argument appeals to the empirical regularity that currency appreciation often goes hand in hand with rapid credit growth on the back of more permissive financial conditions (Kaminsky and Reinhart (1999), Borio and Lowe (2002), Reinhart and Reinhart (2009)). The boom may be accompanied by the build-up of financial vulnerabilities. The combination of a rapid increase in leverage and a sharp appreciation of the currency commonly emerges as the most reliable indicator of financial vulnerability and of subsequent crises (see, for instance, Gourinchas and Obstfeld (2012)).

Our paper contributes to this debate by exploring the connection between exchange rates and sovereign bond yields for emerging market economies (EMEs). Given the tight links between sovereign yields and domestic lending rates to corporates and households, our exploration sheds light on the relationship between exchange rates and domestic financial conditions more broadly.

We make two contributions in our paper.

The first is empirical. We lay out the evidence on the relationship between currency appreciation and EME sovereign yield indicators, including the spreads of local currency and foreign currency sovereign yields over the corresponding US Treasury yield, and the sovereign credit default swap (CDS) spread. Currency appreciation, defined as appreciation of an EME currency against the US dollar, is associated with the compression of the EME's sovereign spreads and is accompanied by portfolio inflows into EME bond funds.

Delving deeper, we find that these fluctuations in spreads are due to shifts in the risk premium, rather than in the forward currency premium. We examine the local currency risk spread measure due to Du and Schreger (2015), defined as the spread of the yield on EME local currency government bonds achievable by a dollar-based investor over the equivalent US Treasury security. The definition takes account of hedging of currency risk through cross-currency swaps. We find strong evidence that currency appreciation against the US dollar is associated with a compression of the Du-Schreger spread. In contrast, the forward currency premium is not significantly affected. These results suggest that the local currency sovereign spread is driven primarily by shifts in the risk premium and point to the importance of risk taking and portfolio adjustments in generating our findings.

Crucially, the relevant exchange rate for our finding is the bilateral exchange rate against the US dollar rather than the trade-weighted effective exchange rate. Our results go away when we consider the orthogonalised component of the effective exchange rate that is unrelated to the US dollar; we find no evidence that a currency appreciation unrelated to the bilateral US dollar exchange rate is associated with loosening of financial conditions. Indeed, we actually find the opposite result for some measures of financial conditions.

Our second contribution is to shed further light on the mechanism behind the empirical findings. We outline a model of global portfolio adjustment in sovereign bonds with two elements. The first is dollar borrowing by EME corporate borrowers which injects valuation mismatch on private sector balance sheets that spills over to government fiscal positions, and the second is global investors' portfolio choice in EME sovereign bonds driven by an economic capital constraint, which caps EME sovereign exposures with a tail risk measure. The modelling choice is motivated by the empirical findings that sovereign yield fluctuations are driven primarily by risk premium shifts, and that the compression of EME sovereign yields is accompanied by portfolio inflows into EME bond funds. The combination of these two features points to the importance of understanding credit supply by portfolio investors, as well as credit demand by sovereign borrowers themselves.

The importance of the bilateral exchange rate against the US dollar stems from the role of the dollar as the international funding currency that denominates debt contracts globally. McCauley, McGuire and Sushko (2015) estimate that the outstanding US dollar-denominated debt of non-banks outside the United States stood at $9.8 trillion as of June 2015. Of this total, $3.3 trillion was owed by non-banks in EMEs, which is more than twice the pre-crisis total. For EME borrowers who have borrowed dollars but hold local currency assets, the valuation mismatch comes from naked currency mismatches. For EME commodity producers, the valuation mismatch comes from the empirical regularity that commodity prices tend to be weak when the dollar is strong (see Akram (2009) and Aastveit, Bjornland and Thorsrud (2015)).

Our model is built around the *risk-taking channel of currency appreciation*, introduced by Bruno and Shin (2015a, 2015b) in the context of cross-border bank capital flows, which operates through the supply of dollar credit. In the presence of currency mismatch, a weaker dollar flatters the balance sheet of dollar borrowers whose liabilities fall relative to assets. From the standpoint of creditors, the stronger credit position of the borrowers creates spare capacity for credit extension even with a fixed exposure limit. Credit supply to corporates in dollars expands as a consequence, expanding the set of real projects that are financed and raising economic activity, thereby improving the fiscal position of the government. If the corporate borrowing in dollars happens through state-owned enterprises in the oil and gas sector as is the case in many EMEs, then the fiscal impact may include the direct impact through the dividends that are paid to government coffers.

In a period when the US dollar is weak, the risk-taking channel operates across the set of EMEs, and a diversified investor in EME sovereign bonds sees reductions in tail risks, allowing greater portfolio positions for any given exposure limit stemming from an economic capital constraint. As a consequence, a weaker dollar goes hand in hand with reduced sovereign tail risks and increased portfolio flows into EME sovereign bonds. Note that this mechanism holds whether the sovereign bonds are denominated in domestic currency or in foreign currency.

However, when the dollar strengthens, these same relationships go into reverse and conspire to tighten financial conditions. Borrowers' balance sheets look weaker. Their creditworthiness declines. Creditors' capacity to extend credit declines for any exposure limit, and credit supply tightens, serving to dampen economic activity and the government fiscal position. The deteriorating fiscal position increases tail risks for a diversified investor in sovereign bonds, which is then met by reductions in overall portfolio positions in EME sovereign bonds. In this way, a stronger dollar coincides with portfolio outflows from EME sovereign bonds.

Our model sheds light on why it is the bilateral exchange rate against the US dollar that drives our result on sovereign yields. This is because the risk-taking channel has to do with leverage and risk taking, in contrast to the net exports channel which revolves around trade and the effective exchange rate. The wedge between the bilateral US dollar exchange rate and the trade-weighted effective exchange rate provides a window for a reconciliation of the risk-taking channel with the net exports channel, and permits an empirical investigation that disentangles the two channels.

Related literature

On the macroeconomic impact of currency depreciation, Krugman (2014) appeals to the net exports channel in the Mundell-Fleming model to argue that a "sudden stop" is expansionary under floating exchange rates. In contrast, Blanchard et al. (2015) acknowledge that the empirical evidence points to the contrary, and modify the Mundell-Fleming model by introducing two classes of assets. In their extended model, currency appreciation may be expansionary. Bussière, Lopez and Tille (2015) analyse the impact of currency appreciations on growth for a large sample of advance economies and EMEs, using the propensity score matching method to disentangle the direction of causality from appreciation to growth, and find that currency appreciation associated with a capital surge is significant in the case of emerging countries.

Our paper is related to the literature on monetary spillovers. Rey (2013, 2014) argues that monetary policy shocks from advanced economies (AEs) spill over into financial conditions elsewhere even in a regime of floating exchange rates. Plantin and Shin (2016) examine a global game with floating exchange rates where the unique equilibrium exhibits two regimes in monetary conditions. In one, currency appreciation goes hand in hand with lower domestic interest rates, capital inflows and higher credit growth. However, when the economy crosses the equilibrium threshold, currency depreciation goes hand in hand with higher domestic interest rates, capital outflows and a contraction in credit.

The feedback effect of currency appreciation is strengthened if domestic monetary policy responds to the appreciation pressure by lowering domestic short-term rates to track global short-term interest rates. Hofmann and Takáts (2015) find evidence of such co-movement of short-term rates. The term "risk-taking channel" was coined by Borio and Zhu (2012) in the broader context of the transmission of monetary policy, and the lessons from our paper bear on this larger issue.

Earlier papers on the risk-taking channel focused on banking sector flows, as in Bruno and Shin (2015a, 2015b) and Cerutti, Claessens and Ratnovski (2014). Recent studies have extended the findings to bond markets (see Sobrun and Turner (2015) and Feyen et al. (2015)). The aggregate cross-country evidence on credit supply is complemented by micro-empirical studies based on firm- and issuance-level data which suggest that credit supply fluctuations are key to understanding financial conditions (Morais, Peydró and Ruiz (2015)). Based on evidence from loan-level data in Turkey, Baskaya et al. (2015) show that domestic loan growth and the cost of borrowing, are strongly influenced by global financing conditions proxied by the VIX and banking inflows. Mian, Sufi and Verner (2015) provide additional cross-country evidence, and Agénor, Alper and Pereira da Silva (2014) examine broader implications for financial stability.

Currency mismatch on EME corporate balance sheets has been a recurring theme. Krugman (1999) and Céspedes, Chang and Velasco (2004) examine models with corporate currency mismatch where currency appreciation increases the value of collateral and hence relaxes borrowing constraints on EME corporates.[1] In contrast, our focus is on credit supply fluctuations arising from constraints on the investors' portfolio due to shifts in tail risks. The resulting portfolio shifts can be large, even if the probability of default undergoes only small changes. In this respect, our approach differs from Du and Schreger (2014), who tie spread

[1] Bacchetta and Banerjee (2000, 2004) also examine currency crisis models featuring currency mismatch on corporate balance sheets and the implied negative impact of currency depreciations on their balance sheets.

changes to shifts in default probability.

A number of papers have looked at the impact of changes in financial conditions on exchange rates. Gabaix and Maggiori (2015) analyse the determination of exchange rates based on capital flows in imperfect financial markets. In their theoretical model, capital flows drive exchange rates by altering the risk-bearing capacity of financiers, which in turn affects their required compensation for holding currency risk, thus affecting both the level and volatility of exchange rates. In an empirical paper, Della Corte et al. (2015) present evidence suggesting that a decrease in sovereign risk, captured by the CDS spread, is associated with an appreciation of the bilateral exchange rate against the US dollar across EMEs and AEs. The authors interpret their finding as showing how an exogenous increase in sovereign default probability leads to a depreciation of the exchange rate. In contrast, our narrative goes in the opposite direction. For us, there is an economic impact of exchange rate changes on the real economy, which in turn leads to portfolio shifts. Nevertheless, the two narratives are complementary, and the interaction of the two effects could potentially lead to amplification effects that elicit sizeable moves in exchange rates and sovereign spreads. In the empirical exercise, our focus will be on disentangling these two narratives.

The outline of our paper is as follows. In section 2, we begin by documenting some stylised facts that motivate our empirical analysis. Section 3 outlines our model of the risk-taking channel. In section 4 we conduct a more systematic empirical investigation of the determinants of financial conditions and portfolio flows. We conclude in section 5 by recapping the findings and by posing additional questions that are thrown up by our analysis.

2 A first look at the evidence

By way of motivation, we begin by outlining a number of stylised facts on the link between the bilateral exchange rate against the US dollar and financial conditions in EMEs. Specifically, we will document some unconditional correlations between the bilateral US dollar exchange rate and EME financial conditions. We will conduct a systematic empirical investigation in section 4 where the preliminary evidence reported in this section is revisited.

Consider first the association between the bilateral US dollar exchange rate and bond fund flows and bond prices in EME local currency bond markets. We use data from EME local currency bond funds available from the EPFR database and for which data on their respective benchmarks are available from JP Morgan Chase every month from January 2011 to July 2015. In total, we use data on 36 funds consisting of 33 global EME local currency bond funds and three regional EME local currency bond funds. Appendix 1 provides the list of 36 funds and their respective benchmarks. These data develop the data on EME bond flows in Shek, Shim and Shin (2015). Here, we focus on (i) the relationship between the FX return of a specific bond fund and investor flows into the bond fund, and (ii) the relationship between the FX return on a bond fund and the local currency-denominated return on bond holdings by the bond fund. We estimate the FX return by using benchmark weights as a proxy for actual asset allocation weights of each fund.

Figure 1 shows scatter plots of fund flows relative to net asset value (NAV) against the FX return for each of the 36 funds. We find that the slope is positive for 31 funds. This means that investor flows in EME local currency bond markets increase when EME currencies appreciate against the US dollar.

Next, we consider the relationship between the change in EME local currency yields and, respectively, the US dollar and the local currency returns of the bond funds (Figure 2). The left-hand panel shows the relationship for individual funds. The right-hand panel is a larger version of the scatter chart for one of the funds — Fund 31. The blue scatter is the local currency return (in per cent) against the domestic bond yield change (in percentage points), while the red scatter is the US dollar-denominated return against the yield change.

The scatter plots reveal a negative relationship between EME currency appreciation against the US dollar and domestic interest rates. In all the panels in Figure 2, the slope for the red line for red dots is steeper than that for the blue line for blue dots. The right-hand half of each of the scatter plots corresponds to the region where local currency sovereign bond yields have risen — that is, where domestic financial conditions are tighter, associated with higher interest rates. In these states of the world, the red line is below the blue line, which is to say that dollar returns tend to be lower than local currency returns, implying that the local currency is depreciating against the dollar. In short, when domestic interest rates rise, the domestic currency tends to depreciate.[2] Conversely, the left-hand half of each of the scatter panels corresponds to the situation where domestic interest rates have fallen, and so represent more permissive domestic financial conditions. There, we see that the blue line lies below the red line, implying that the domestic currency tends to appreciate against the dollar. In short, when domestic interest rates fall, the local currency tends to appreciate against the dollar.

The relationship between exchange rates and EME bond market conditions in Figures 1 and 2 captures the essence of the "risk-taking channel" of currency appreciation, in which the domestic financial conditions fluctuate in unison with the exchange rate. Among other things, the scatter charts in Figure 2 show that the returns in dollars and local currency do

[2]The same relationship is found in papers investigating the impact of monetary policy on EME exchange rates. See, for example, Kohlscheen (2014) and Hnatkovska, Lahiri and Vegh (2016).

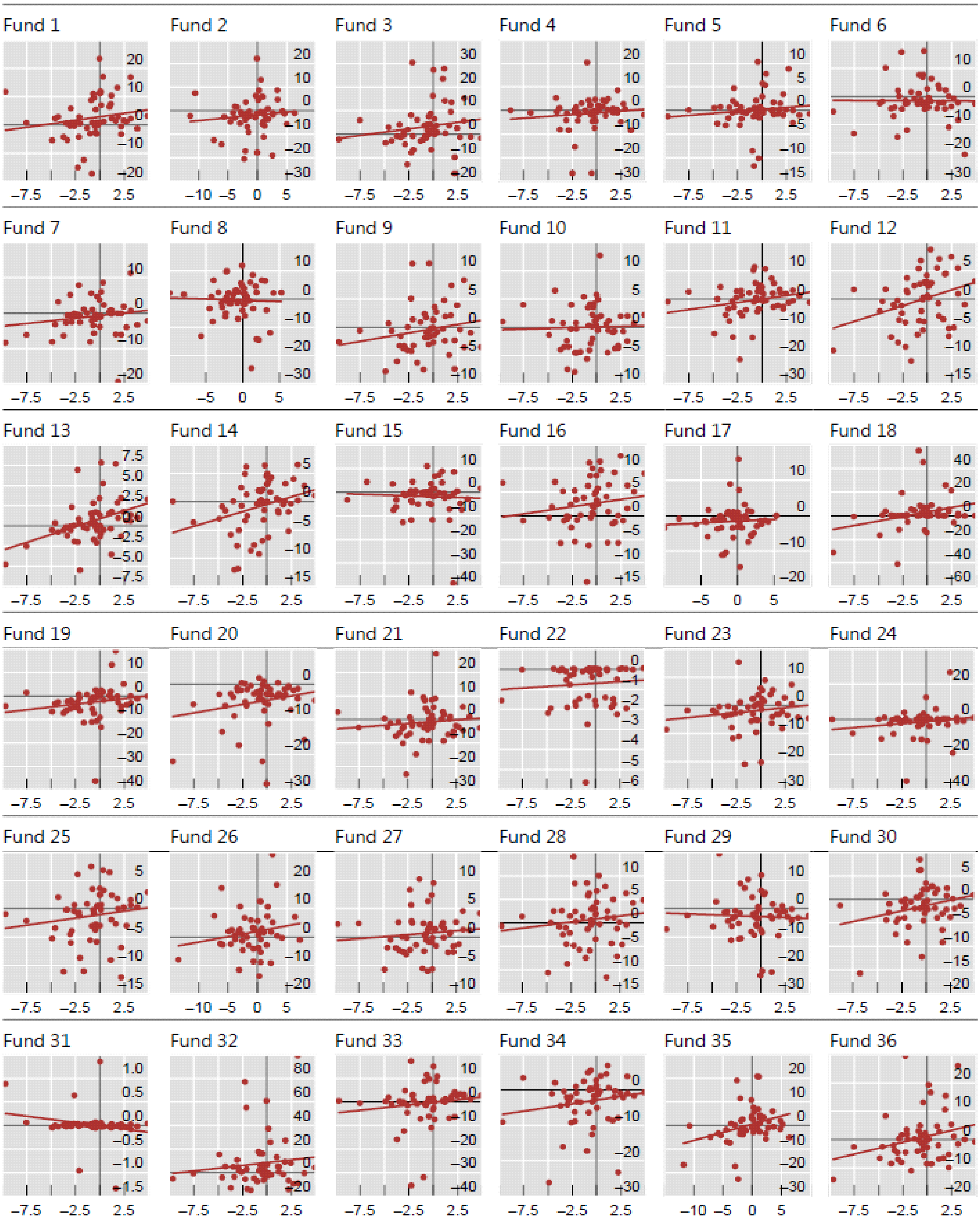


Figure 1. **Scatter plots of normalised flows to EME local currency bond funds to FX returns.** The vertical axis represents investor flows into each fund during a month as a percentage of the beginning-of-the-period NAV, and the horizontal axis monthly FX returns of the benchmark index for each fund during the same month. Two outlier observations for Fund 18 and one outlier observation for Fund 31 are excluded from the sample. Source: EPFR Global.

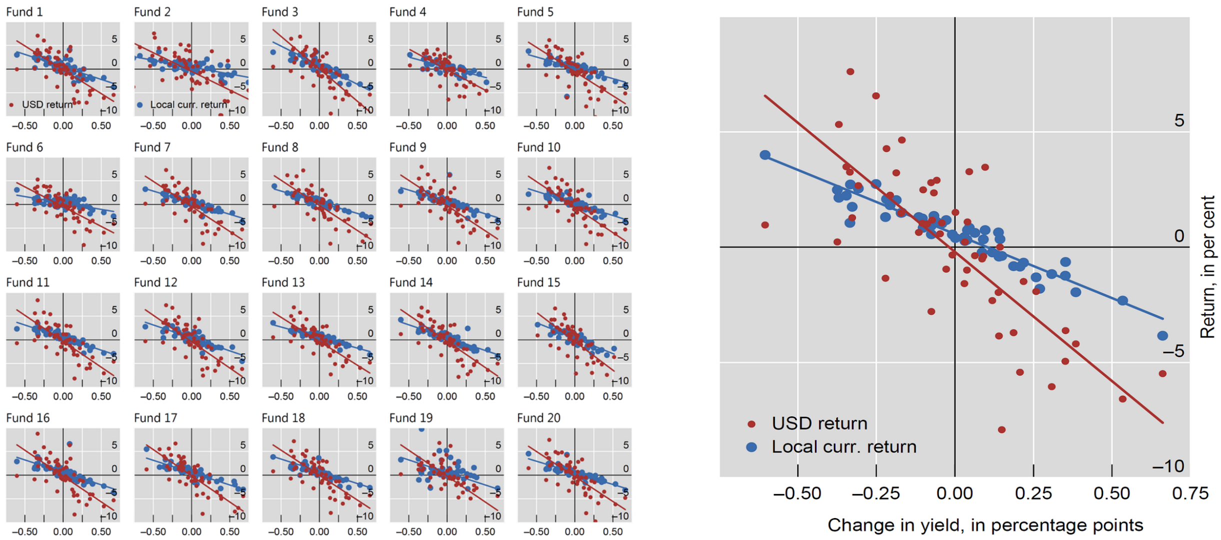


Figure 2. **Dollar and local currency returns on EME local currency sovereign bond funds.** The left-hand panel shows monthly returns on 20 EME local currency sovereign bond funds over the period of January 2011 to July 2015. Blue scatter is local currency return (in per cent) against the domestic bond yield change (in percentage points). Red scatter is US dollar return against the yield change. The right-hand panel magnifies the scatter chart for Fund 31. Source: EPFR Global.

not coincide.[3] Dollar returns are lower when EME financial conditions are tight, while local currency returns are lower when EME financial conditions are loose. Currency appreciation and looser financial conditions therefore go hand in hand.

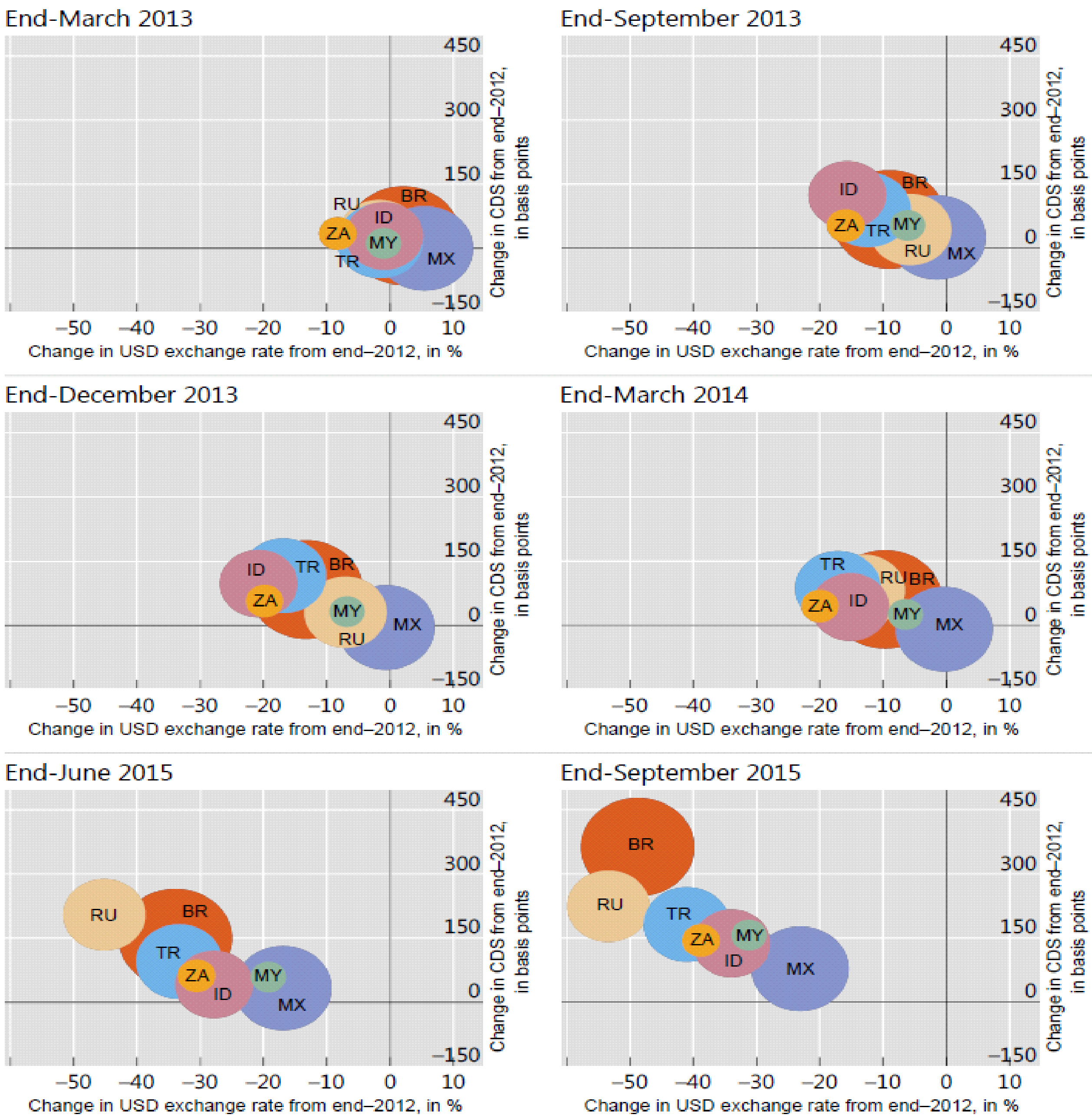
Consider next the association between shifts in US dollar-denominated EME CDS spreads and changes in the EME currency exchange rate vis-à-vis the US dollar. The focus here is on the relationship between the risk premium embedded in the CDS spread for the US dollar sovereign bonds and how the risk premium co-moves with the US dollar exchange rate.[4]

The bubble charts in Figure 3 are from Avdjiev, McCauley and Shin (2015) and show how the sovereign CDS spreads have moved with shifts in the bilateral exchange rate against the US dollar between the end of 2012 and September 2015, a period characterised by a large depreciation of many EME currencies against the US dollar, including the US Federal Reserve announcement of a tapering of its asset purchases. The horizontal axis in each panel is the percentage change in the bilateral exchange rate of the EME against the US dollar from the end of 2012. The vertical axis gives the change in the local currency 5-year sovereign CDS spread minus the US Treasury CDS spread over the same period. The size of the bubbles indicates the total dollar-denominated debt owed by nonbanks in the country.

We see from Figure 3 that there is both a time series and cross-section relationship

[3]See Bacchetta (2012) for a survey of papers on the related phenomenon of deviations from uncovered interest parity (UIP).

[4]For example, Amstad, Remolona and Shek (2016) do not include India and Singapore in their sample of EMEs since they lack actively traded sovereign CDS contracts after August 2009 and March 2012, respectively.



BR = Brazil; ID = Indonesia; MX = Mexico; MY = Malaysia; RU = Russia; TR = Turkey; ZA = South Africa. The size of the bubbles indicates the size of dollar debt in Q2 2015.

Sources: Markit; national data; BIS.

Figure 3. **Co-movement of the bilateral US dollar exchange rate and the five-year sovereign CDS spread in EMEs.** The horizontal axis in each panel is the percentage change in the bilateral exchange rate of the EME against the US dollar from the end of 2012. The vertical axis gives the change in the US dollar-denominated 5-year sovereign CDS spread minus the US Treasury CDS spread over the same period. The size of the bubbles indicates the total dollar-denominated debt owed by nonbanks in the country.

	Dependent variable				
	LC spread	CDS spread	FC spread	DS spread	Bond flows
ΔBER$_t$	−0.047***	−0.053***	−0.057***	−0.024***	0.346***
	[−3.88]	[−11.97]	[−9.95]	[−2.86]	[10.35]
N	20	20	13	14	20
N×T	2483	2430	1617	1608	2400
Within R^2	0.100	0.276	0.256	0.050	0.155

Table 1. **Preliminary panel regressions.** This table reports monthly panel regressions with country fixed effects for various EME sovereign bond market indicators. ΔBER is the log change in the bilateral US dollar exchange rate; positive ΔBER is an appreciation of the EME currency. Dependent variables are: (i) the change in the spread of the 5-year local currency bond yield over the corresponding US Treasury yield (LC spread); (ii) the change in difference between the 5-year CDS spread and the corresponding US CDS spread (CDS spread); (iii) the change in the spread of the JP Morgan EMBI yield over the 5-year US Treasury yield (FC spread); (iv) the change in the Du-Schreger local currency sovereign risk spread defined as the spread of the 5-year local currency bond yield over a synthetic risk-free rate calculated as the 5-year US Treasury yield adjusted for the forward currency premium constructed from cross-currency and interest rate swap rates (DS spread); and (v) aggregate investor flows to EME bond funds as a percentage of net asset value (Bond flows). t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

between the CDS spread and the bilateral dollar exchange rate. In the cross-section, the bubbles line up along a downward-sloping line, indicating that those countries that have depreciated more against the US dollar tend to have CDS spreads that are higher. Over time, as the US dollar appreciates, the bubbles move in the north-west direction. In other words, as the domestic currency weakens against the US dollar, EME sovereign CDS spreads rise.

The bubble chart for September 2015 (lowest-right panel) shows that EME borrowers faced challenges due to the stronger dollar. In particular, between end-2012 and September 2015, Brazil and Russia saw their currencies depreciate by more than 50% against the US dollar and their sovereign CDS spreads rise by more than 250 basis points, even though the domestic interest rates in Brazil and Russia increased significantly during the period. Less sizeable changes are evident for the other EMEs (Indonesia, Malaysia, Mexico, South Africa and Turkey). But even for these countries, there have been currency depreciations of between 20% and 50% against the dollar, associated with CDS spread increases of between 70 and 180 basis points.

The association between different measures of EME financial conditions and the US dollar exchange rate suggested by Figures 1, 2 and 3 also holds up in preliminary diagnostic regressions. Using monthly data for up to 20 EMEs over the period January 2005 to August 2015, we regress different measures of EME bond spreads and EME credit risk spreads as well as bond fund flows to EMEs on the change in the bilateral exchange rate against the US dollar, controlling only for country fixed effects (see Appendix 1 and section 4 for more details on the data).

The results shown in Table 1 confirm that an appreciation of the bilateral exchange against the US dollar is associated with significantly lower EME bond spreads, significantly lower EME sovereign credit risk spreads and significantly higher inflows into EME sovereign bond markets.

Of course, these unconditional correlations raise more questions than they answer. In particular, the associations suggested by Figures 1, 2 and 3 and the regression analysis in Table 1 are contemporaneous associations and may reflect common factors driving both variables, or reverse causality as lower risk spreads and higher bond inflows may lead to appreciation of the currency. The first question is whether there are theoretical reasons suggesting that exchange rate appreciation might lead to lower sovereign bond spreads and higher bond portfolio inflows. This question is addressed in the following section 3. The second question is whether there is evidence that the unconditional association between exchange rate appreciation and easier financial conditions reflects at least in part a conditional causal effect running from the exchange rate to financial conditions, rather than conversely. This question will be addressed in section 4.

3 Model

In this section, we develop a model of global portfolio adjustment in sovereign bonds with two elements. The first is dollar borrowing by EME corporate borrowers which introduces currency mismatch on private sector balance sheets that spills over to government fiscal positions. The second is global investors' portfolio choice in EME sovereign bonds driven by an economic capital constraint, which caps EME sovereign exposures with a tail risk measure. The modelling choice is motivated by the empirical findings that sovereign yield fluctuations are driven by risk premium shifts, and that yield compression is driven by the supply of credit through portfolio flows.

3.1 Credit demand in dollars

There is a continuum of potential borrowers. Borrowers are penniless risk-neutral entrepreneurs with access to a project that needs 1 dollar of fixed investment and one unit of labour input. Denote by r the interest rate on the loan, so that the borrowers must repay $1 + r$.

The disutility of the labour input is distributed in the population according to cumulative distribution function $H(\cdot)$ with support on $[0, \infty)$. Credit is granted at date 0 and the project realisation and repayment is due at date 1.

The entrepreneurs bear currency risk. The dollar value of the project depends on the

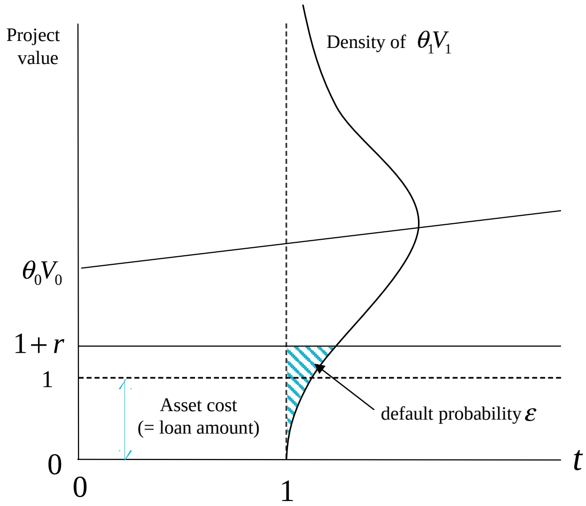


Figure 4. **The borrower defaults when $\theta_1 V_1$ falls short of the notional debt $1 + r$.**

bilateral exchange rate vis-à-vis the US dollar. Figure 4 depicts the outcome density of the borrowers' project. Denote by V_t the local currency value of the project at date t and by θ_t the value of the local currency with respect to the US dollar, so that an increase in θ_t denotes the *appreciation* of local currency. The dollar value of the borrowers' project at date 1 follows the Merton (1974) model of credit risk, and is the random variable:

$$\theta_1 V_1 = \theta_0 V_0 \exp\left\{\mu - \frac{s^2}{2} + sW_j\right\}, \tag{1}$$

where W_j is a standard normal, and μ and $s > 0$ are constants. Since the borrowers are risk-neutral and have limited liability, borrower j with effort cost e_j undertakes the project if

$$E\left(\max\left\{0,\, \theta_1 V_1 - (1 + r)\right\}\right) - e_j \geq 0. \tag{2}$$

Denote by $e^*(r)$ the threshold cost level where (2) holds with equality when the interest rate is r. Credit demand is the mass of entrepreneurs with effort cost below $e^*(r)$. Denoting by $C_d(r)$ the credit demand at interest rate r, we have

$$C_d(r) = H(e^*(r)). \tag{3}$$

Since $H(\cdot)$ has full support on $[0, \infty)$, $C_d(r) > 0$ for all $r > 0$ and is strictly decreasing in r.

3.2 Corporate credit risk

The lender is a bank who can diversify across many borrowers and so can diversify away idiosyncratic risk. Credit risk follows the Vasicek (2002) model, a many borrower generalisation of Merton (1974). The standard normal W_j in (1) is given by the linear combination:

$$W_j = \sqrt{\rho} Y + \sqrt{1 - \rho} X_j, \tag{4}$$

where Y and X_j are mutually independent standard normals. Y is the common risk factor while each X_j is the idiosyncratic risk facing borrower j. The parameter $\rho \in (0,1)$ determines the weight given to the common factor Y.

The borrower defaults when the project realisation is less than the repayment amount of the loan, $1+r$. We assume that the recovery value is zero when default occurs. Default occurs when $\theta_1 V_1 < 1+r$, which can be written as

$$\sqrt{\rho}Y + \sqrt{1-\rho}X_j < -d_j, \tag{5}$$

where d_j is the *distance to default:*

$$d_j = \frac{\ln\left(\frac{\theta_0 V_0}{1+r}\right) + \mu - \frac{s^2}{2}}{s}. \tag{6}$$

Thus, borrower j repays the loan when $Z_j \geq 0$, where Z_j is the random variable:

$$\begin{aligned} Z_j &= d_j + \sqrt{\rho}Y + \sqrt{1-\rho}X_j \\ &= -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y + \sqrt{1-\rho}X_j, \end{aligned} \tag{7}$$

where ε is the probability of default of borrower j, defined as $\varepsilon = \Phi(-d_j)$, and Φ is the standard normal c.d.f.

Conditional on Y, defaults are independent. In the limit where the number of borrowers becomes large, the realised value of 1 dollar face value of loans can be written as a deterministic function of Y, by the law of large numbers. The realised value per one dollar face value of loans is the random variable $w(Y)$ defined as:

$$\begin{aligned} w(Y) &= \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)\,|Y\right) \\ &= \Phi\left(\frac{Y\sqrt{\rho} - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right). \end{aligned} \tag{8}$$

The c.d.f. of w is then given by

$$\begin{aligned} \Pr(w \leq z) &= \Pr\left(Y \leq w^{-1}(z)\right) \\ &= \Phi\left(w^{-1}(z)\right) \\ &= \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\Phi^{-1}(z)}{\sqrt{\rho}}\right). \end{aligned} \tag{9}$$

Figure 5 plots the density over realised values of loans with one dollar face value, and shows how the density shifts to changes in the default probability ε (left-hand panel) or to changes in ρ (right-hand panel). From (9), the c.d.f. of w is increasing in ε, so that higher values of ε imply a first degree stochastic dominance shift left for the asset realisation density. Since ε decreases with local currency appreciation (that is, an increase in θ_0), therefore exchange rates have a direct impact on the credit environment in our model.

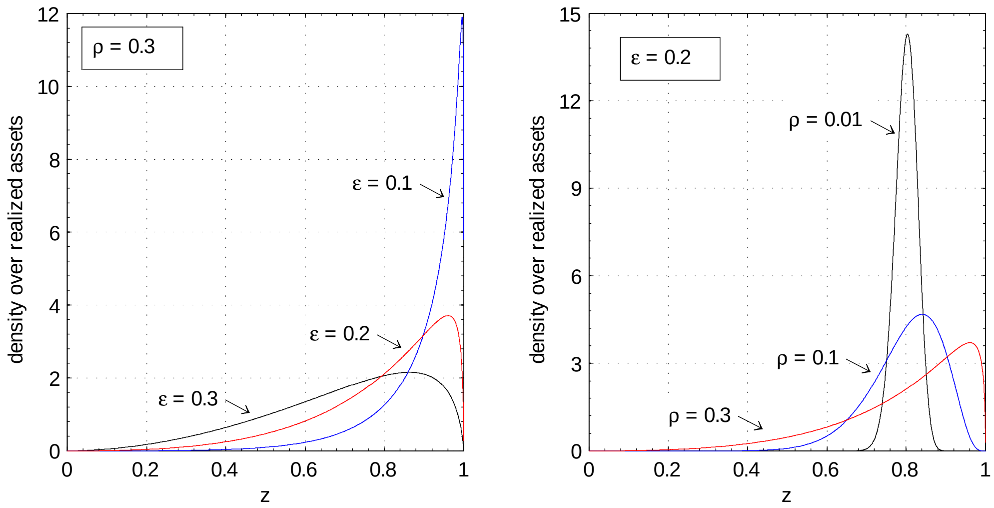


Figure 5. **Densities over realized values of loans with 1 dollar face value.** The left-hand charts plots densities when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right-hand chart plots densities when $\varepsilon = 0.2$ and ρ varies from 0.01 to 0.3.

3.3 Lender to corporates

Our model of credit supply to corporates is a simplified version of Bruno and Shin (2015a) where banks lend to corporates subject to a Value-at-Risk (VaR) constraint. Denote by C_s the credit supplied by global banks at date 0 (in dollars). Since the interest rate is r, the payoff of the bank at date 1 is given by the random variable:

$$(1 + r) C_s \cdot w. \tag{10}$$

Denote by E the book equity of the bank and by L the dollar funding raised by the bank and denote by f the dollar funding cost, which we assume is constant for simplicity.[5]

The bank is risk-neutral, and aims to maximise expected profit subject only to its VaR constraint that stipulates that the probability of default is no higher than some fixed constant $\alpha > 0$. The bank remains solvent as long as the realised value of $w(Y)$ is above its notional liabilities at date 1. Since the funding rate on liabilities is f, the notional liability of the bank at date 1 is $(1 + f) L$. Since the bank is risk-neutral, its VaR constraint binds:

$$\Pr\left(w < \frac{(1+f) L}{(1+r) C_s}\right) = \Phi\left(\frac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}\left(\frac{(1+f)L}{(1+r)C_s}\right)}{\sqrt{\rho}}\right) = \alpha. \tag{11}$$

Re-arranging (11), we can write the ratio of notional liabilities to notional assets as follows:

[5] See Bruno and Shin (2015a) for a more complete model where the dollar funding cost f is determined in the interbank market.

$$\frac{\text{Notional liabilities}}{\text{Notional assets}} = \frac{(1+f)\,L}{(1+r)\,C_s} = \Phi\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right). \tag{12}$$

We will use the shorthand:

$$\varphi(\alpha, \varepsilon, \rho) \equiv \Phi\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right). \tag{13}$$

Clearly, $\varphi \in (0,1)$. From (12) and the balance sheet identity $E + L = C_s$, we can solve for the bank's supply of dollar credit. We have[6]

$$C_s = \frac{E}{1 - \frac{1+r}{1+f} \cdot \varphi}. \tag{14}$$

The loan interest rate r is determined by market clearing that equates loan demand (3) with loan supply (14). Since φ is decreasing in ε, which in turn is decreasing in the current exchange rate θ_0, we conclude from our expression for dollar credit supply given in (14) that dollar credit supply is increasing in θ_0. In other words, dollar credit supply to corporates is increasing in the value of the domestic currency against the dollar today. For any fixed demand curve for dollar credit by entrepreneurs, increased dollar credit results in more projects being financed. We summarise this interim result as follows:

Lemma 1 *Aggregate investment by the corporate sector is increasing in the value of the domestic currency against the dollar.*

3.4 Sovereign bond investors

We now address the spillovers from the corporate sector to the sovereign bond market. The global lender is a bond fund manager who can diversify across many EME sovereign borrowers. Each sovereign borrower has a corporate sector that borrows in dollars, and for which Lemma 1 applies.

We assume that each EME government has a fixed amount of local currency sovereign bonds outstanding, and that the probability of default follows the Vasicek (2002) model, whereby EME government j defaults on its domestic currency sovereign bonds if

$$-\Phi^{-1}(\eta) + \sqrt{\beta}G + \sqrt{1-\beta}R_j < 0, \tag{15}$$

where $\eta > 0$ is the probability of default of government j, G and R_j are mutually independent standard normal random variables and $\beta \in (0,1)$ is the parameter weight to the global factor G in default outcomes.

Our key assumption is that the probability of default η is decreasing in corporate investment in EMEs.

[6]Since $E > 0$ and $C_s > 0$, we need r, f and φ such that $\left(1 - \frac{1+r}{1+f} \cdot \varphi\right) > 0$.

Assumption. *η is decreasing in the aggregate investment undertaken by corporate borrowers.*

Our assumption is motivated by the fact that the sovereign's fiscal position depends on underlying economic activity — at least in the short run — and that the sovereign's creditworthiness is increasing in the aggregate scale of investment undertaken by its corporate sector. This follows both from the broader macroeconomic effects, but is especially apposite for EME governments that rely on state-owned oil and gas companies which contribute directly to government coffers from their net income.

Conditional on the global factor G, defaults are independent across sovereigns. In the limit where the number of sovereign borrowers becomes large, the realised value of one unit of a diversified portfolio of local currency sovereign bonds is the random variable $v(G)$ defined as:

$$\begin{aligned} v(G) &= \Pr\left(\sqrt{\beta}G + \sqrt{1-\beta}R_j \geq \Phi^{-1}(\eta)\,|G\right) \\ &= \Phi\left(\tfrac{G\sqrt{\beta}-\Phi^{-1}(\eta)}{\sqrt{1-\beta}}\right). \end{aligned} \tag{16}$$

3.5 Fund managers

Denote by B the credit supplied by local currency bond investors at date 0. Here, B could be denominated in either local currency or foreign currency, and our results will not be sensitive to the currency denomination of the bond portfolio. The key is that the exchange rate impacts on fiscal positions, and that this has a bearing on the tail risk of a diversified portfolio of sovereign bonds.

Denote by y the yield on the sovereign bonds. The payoff of the bond investor at date 1 is given by the random variable:

$$(1+y)\,B\cdot v \tag{17}$$

The fund manager is risk-neutral and maximises expected return, but the portfolio decision is governed by an economic capital constraint — an analogue of the VaR constraint for non-leveraged investors.

Denote by E the *economic capital* of the fund manager. The fund manager's economic capital constraint stipulates that the probability that the loss from the bond portfolio defined as $B-(1+y)B\cdot v$ exceeds E is no more than some known constant $\alpha>0$. Formally, the economic capital constraint is

$$\Pr\left(v<\frac{B-E}{(1+y)\,B}\right)=\Phi\left(\frac{\Phi^{-1}(\eta)+\sqrt{1-\beta}\,\Phi^{-1}\left(\frac{B-E}{(1+y)B}\right)}{\sqrt{\beta}}\right)\leq\alpha. \tag{18}$$

Since the fund manager is risk-neutral, this constraint binds with equality. Re-arranging, we have

$$\frac{B-E}{(1+y)\,B}=\Phi\left(\frac{\sqrt{\beta}\Phi^{-1}(\alpha)-\Phi^{-1}(\eta)}{\sqrt{1-\beta}}\right) \tag{19}$$

Using the shorthand:

$$\psi\equiv\Phi\left(\frac{\sqrt{\beta}\Phi^{-1}(\alpha)-\Phi^{-1}(\eta)}{\sqrt{1-\beta}}\right), \tag{20}$$

and re-arranging, we can solve for the supply of credit by the bond fund manager:[7,8]

$$B=\frac{E}{1-(1+y)\,\psi}. \tag{21}$$

The yield y can be obtained from the market clearing where bond credit supply (21) is equated to the fixed supply of local currency bonds outstanding, denoted by S. We have

$$1+y=\frac{1-E/S}{\psi}. \tag{22}$$

Gathering together our earlier steps, we can thus state our main comparative statics result in terms of θ_0, the current value of the local currency against the dollar.

Proposition 1 *The yield on EME sovereign bonds is decreasing in* θ_0.

The proof follows from our earlier steps in derivation. From our assumption that default probability η is decreasing in corporate investment, and from Lemma 1, η is decreasing in θ_0. From (20), we know that ψ is decreasing in η. Therefore, from (22), an appreciation of the local currency against the dollar is associated with a higher ψ, and hence with lower y. This proves the proposition.

As well as our result on the yield y, our model also has a prediction regarding the size of the local currency EME sovereign bond portfolio held by the global bond investor. The expression for the demand for bonds by the investor given by (21) means that currency appreciation gives rise to larger local currency bond holdings. We therefore have the following corollary:

Corollary 1 *The holding of EME bonds by the global investor is increasing in* θ_0.

The proof follows straightforwardly from the expression for the demand for bonds (21) and the fact that ψ is increasing in θ_0.

[7] Since $E>0$ and $B>0$, we need y and ψ such that $1-(1+y)\psi>0$ holds.

[8] We can define the loss more generally as $(1+k)B-(1+y)B\cdot v$. In this case, equation (21) becomes $B=\frac{E}{(1+k)-(1+y)\psi}$, and k, f and ψ should satisfy $(1+k)-(1+y)\psi>0$.

With Proposition 1 and Corollary 1, we have the key features unearthed by our empirical investigation of the risk-taking channel. Currency appreciation in EMEs is associated with lower local currency sovereign bond yields, higher global investment in sovereign bonds, and more buoyant economic conditions in EMEs underpinned by dollar-financed corporate investment.

Note, moreover, that the investment positions that result from the economic capital constraint operate in a manner similar to the VaR constraint for the banks. As the dollar depreciates against EME currencies, the tail risk is curtailed for the portfolio of local currency sovereign bonds, and lower tail risks are associated with larger portfolio positions. In this respect, the operation of the mechanism outlined in our paper depicts shifts in risk appetite of the investor. The fact that our empirical findings hold with respect to the Du and Schreger (2015) spreads is indicative of the mechanism working through fluctuations in the risk premium associated with local currency sovereign bonds.

4 Empirical investigation

Based on the key findings in the model, we proceed to a more systematic empirical investigation in this section.

In the existing literature, EME financial conditions are commonly modelled as a function of business cycle indicators as well as of indicators of a country's fiscal and external position and its indebtedness (see, eg, Bellas, Papaioannou and Petrova (2010) and Du and Schreger (2015)). The exchange rate is usually not considered.[9] Here we delve deeper into the risk-taking channel and extend this literature by considering the role of the exchange rate for EME financial conditions explicitly. The hypothesis is that the estimated impact of the exchange rate on EME financial conditions indicates the existence of a risk-taking channel that affects credit supply to these economies. When the exchange rate of EMEs appreciates, EME borrowers look more creditworthy and, at the same time, lenders' lending capacity increases.

We start out by illustrating the two-way relationship between the exchange rate and sovereign bond and risk spreads based on daily panel predictive regressions, controlling for domestic and global financial factors. In the next step, we then zoom in on the impact of the exchange rate on sovereign spreads based on a monthly data set, controlling for a large range of domestic and global macro-financial factors.

[9] An exception is the BIS study by Gadanecz, Miyajima and Shu (2014) who focus on exchange rate risk measured by implied exchange rate volatility rather than on movements in the exchange rate itself.

4.1 The two-way link between exchange rates and sovereign spreads

In order to assess the predictive link between sovereign bond and risk spreads and exchange rates in EMEs, we estimate two types of panel forecasting regressions over horizons (h) of up to 30 trading days:

$$e_{i,t+h} - e_{i,t} = \alpha_i^1 + \rho^1 \Delta e_{i,t-1} + \beta^1 \Delta y_{i,t-1} + \Gamma^1 Z_{i,t-1} + \varepsilon_{i,t+h}. \tag{23}$$

$$y_{i,t+h} - y_{i,t} = \alpha_i^2 + \rho^2 \Delta y_{i,t-1} + \beta^2 \Delta e_{i,t-1} + \Gamma^2 Z_{i,t-1} + \eta_{i,t+h}. \tag{24}$$

The first equation is the predictive regression for the exchange rate e, while the second is that for the change in sovereign bond or risk spread y. We consider four measures of sovereign spreads: the 5-year local currency bond spread, the US dollar-denominated 5-year CDS spread, the 5-year foreign currency (ie US dollar-denominated) bond spread and the 5-year local currency sovereign credit risk spread measure proposed by Du and Schreger (2015).

Local currency bond spreads reflect both credit risk premia and long-term forward premia. In order to isolate the link between the exchange rate and the credit risk component, through which the risk-taking channel would work, we consider three credit risk spread measures. The CDS spread and the foreign currency bond spread are standard measures of sovereign credit risk. Both are, however, derived from US dollar denominated instruments and are thus only imperfect gauges of local currency credit risk. We therefore also consider the Du-Schreger (2015) measure of local currency sovereign credit risk which is given by the spread of the local currency sovereign bond yield over a "synthetic" local currency risk-free rate. This risk-free rate is calculated as the US Treasury yield adjusted for the forward currency premium constructed from cross-currency and interest rate swap rates.

For the exchange rate e we consider three different measures: (i) the bilateral US dollar exchange rate (*BER*); (ii) the nominal effective exchange rate (*NEER*); and (iii) the wedge between the *NEER* and the *BER.* The latter is obtained by regressing for each country separately the change in the *NEER* on the change in the *BER*, and retaining the residuals as the part of the *NEER* change that is unrelated to the change in the *BER.* The exchange rates are defined such that an increase is an appreciation of the domestic currency.

Z is a set of control variables including the log change in the VIX, the change in the US short-term interest rate (3-month money market rate), and the change in the domestic short-term interest rate (3-month money market rate). The control variables should capture factors that affect EME financial conditions and possibly also exchange rates at the same time. The interactions between exchange rates and EME sovereign spreads that we uncover through our regressions are conditional on these control variables and should therefore not just reflect common factors driving both exchange rates and spreads, such as a shift in investor risk appetite or changes in global or domestic monetary conditions.

The sample period of the regressions is 1 January 2005 to 31 August 2015. The sample of countries covers up to 20 EMEs except for the regressions with the foreign currency bond spreads and the Du-Schreger credit risk spreads where the sample is, respectively, reduced to 13 and 14 countries because of more limited data availability. More details on the data and their sources are provided in Appendix 1. Statistical inference is consistently based on cluster-robust standard errors.

The results from the predictive regressions (equation (23)) show that changes in EME sovereign spreads Granger-cause changes in exchange rates, both the *BER* and the *NEER* (Figure 6). Specifically, a 100 basis points increase in spreads is followed by a depreciation of the *BER* of between 5% and 12% over the next 30 trading days, with larger effects coming from the local currency spreads than from the foreign currency spreads. This result is, however, not new, as Della Corte et al. (2015) have already established a significant effect of CDS spreads on US dollar exchange rates in advanced and emerging market economies. The results reported in Figure 6 show that the link holds more broadly for a larger range of sovereign spreads. For the *NEER*, there are also significant effects over the next 4-10 trading days, but not consistently across all spreads, and they become insignificant after 18 trading days.

Our focus, however, is on whether exchange rates Granger-cause EME sovereign spreads as a consequence of the risk-taking channel. The results from the predictive regressions (equation (24)) suggest that in particular changes in the *BER* have a strongly negative and statistically highly significant impact on future bond and risk spreads (Figure 7, left column). Specifically, a 1% appreciation of the *BER* reduces all four risk spreads by about 2 basis points over the next 30 trading days. By contrast, there is no significant effect of the *BER* on the cross-currency swap rate (Figure 7, bottom-left panel), which reflects the forward currency premium embedded in local currency bond spreads (see Du and Schreger (2015)). This implies that the effect of the US dollar exchange rate on the local currency bond spread works only through the credit risk spread component, or in other words, through the risk-taking channel.

An appreciation of the effective exchange rate has very similar effects, albeit they are somewhat smaller in magnitude (Figure 7, middle column). However, when we consider the wedge between the effective and the bilateral exchange rates (Figure 7, right column) and the

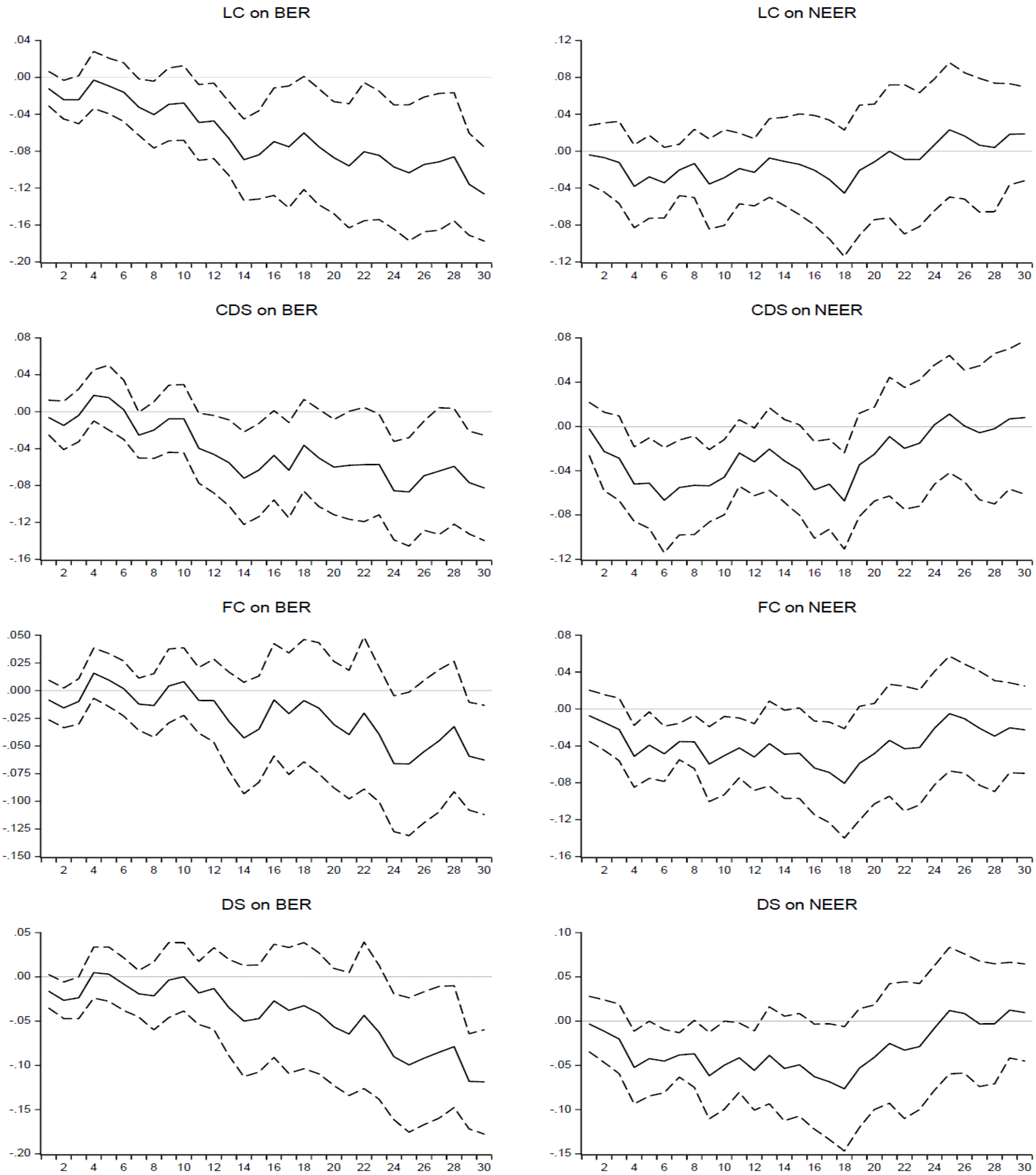


Figure 6. **Impact of sovereign spreads on exchange rates.** The figure shows the impact of the lagged change in sovereign spreads on the change in the log exchange rate over the next h = 1,..,30 trading days. *BER* is the bilateral exchang rate against the US dollar, *NEER* is the nominal effective exchange rate, both defined such that an increase is an appreciation. *LC* is the 5-year local currency sovereign bond spread, *CDS* is the 5-year sovereign CDS spread, *FC* is the 5-year foreign currency sovereign bond ypread and *DS* is the Du-Schreger local currency sovereign credit risk spread. Control variables included are the log change in the VIX and the change in the US and the domestic 3-month money market rates. Broken lines are two standard error bands. Standard errors are cluster robust.

specifications where both the bilateral and the effective exchange rates are included (Figure 8), we see that it is the US dollar exchange rate that matters for sovereign bond and risk spreads. The impact of the wedge is either not statistically significant, or, in the case of the foreign currency spreads, significantly positive. This indicates that an appreciation of the effective exchange rate that is unrelated to an appreciation of the US dollar exchange rate increases EME bond spreads. In the regressions where both the bilateral and the effective exchange rates are included, we get the same result: an appreciation of the bilateral US dollar exchange rate is associated with lower bond and risk spreads, while an appreciation of the effective exchange rate leads to higher spreads (Figure 8). The latter result probably reflects the standard textbook trade channel-type effects where an appreciation of the effective exchange rate has a negative effect on trade and, through this channel, also on the wider economy, which may in turn adversely affect perceptions of sovereign credit risk and hence credit supply.

4.2 The impact of exchange rates on EME bond market conditions

Having illustrated the significant two-way lead-lag relationship between exchange rates and sovereign spreads in EMEs, we explore the evidence for the exchange rate risk-taking channel in EME bond markets in more detail, considering both price- and quantity-based indicators of EME sovereign bond market conditions using a monthly dataset. We run monthly predictive panel regressions similar to the daily regressions in section 4.1, controlling for domestic and global macroeconomic and financial factors. Moreover, we also assess the impact of exchange rate shocks on bond market conditions based on panel VARs.

4.2.1 Panel regressions

In the monthly panel predictive regressions, we regress the sovereign bond market indicators y on their own lag as well as on the (log) change in the exchange rate (Δe) and a set of control variables (Z) which now also include domestic and global macroeconomic variables:

$$y_{i,t} = \alpha_i + \lambda y_{i,t-1} + \beta \Delta e_{i,t-1} + \Gamma Z_{i,t-1} + \varepsilon_{i,t}. \tag{25}$$

For the indicators of sovereign bond market conditions y, we consider the change in the four sovereign bond and risk spreads analysed in the previous section, ie the change in local currency bond spread, the change in US dollar-denominated CDS spread, the change in foreign currency (ie US dollar-denominated) bond spread and the change in Du-Schreger local currency sovereign credit risk spread. On the quantity side, we consider investor flows to a

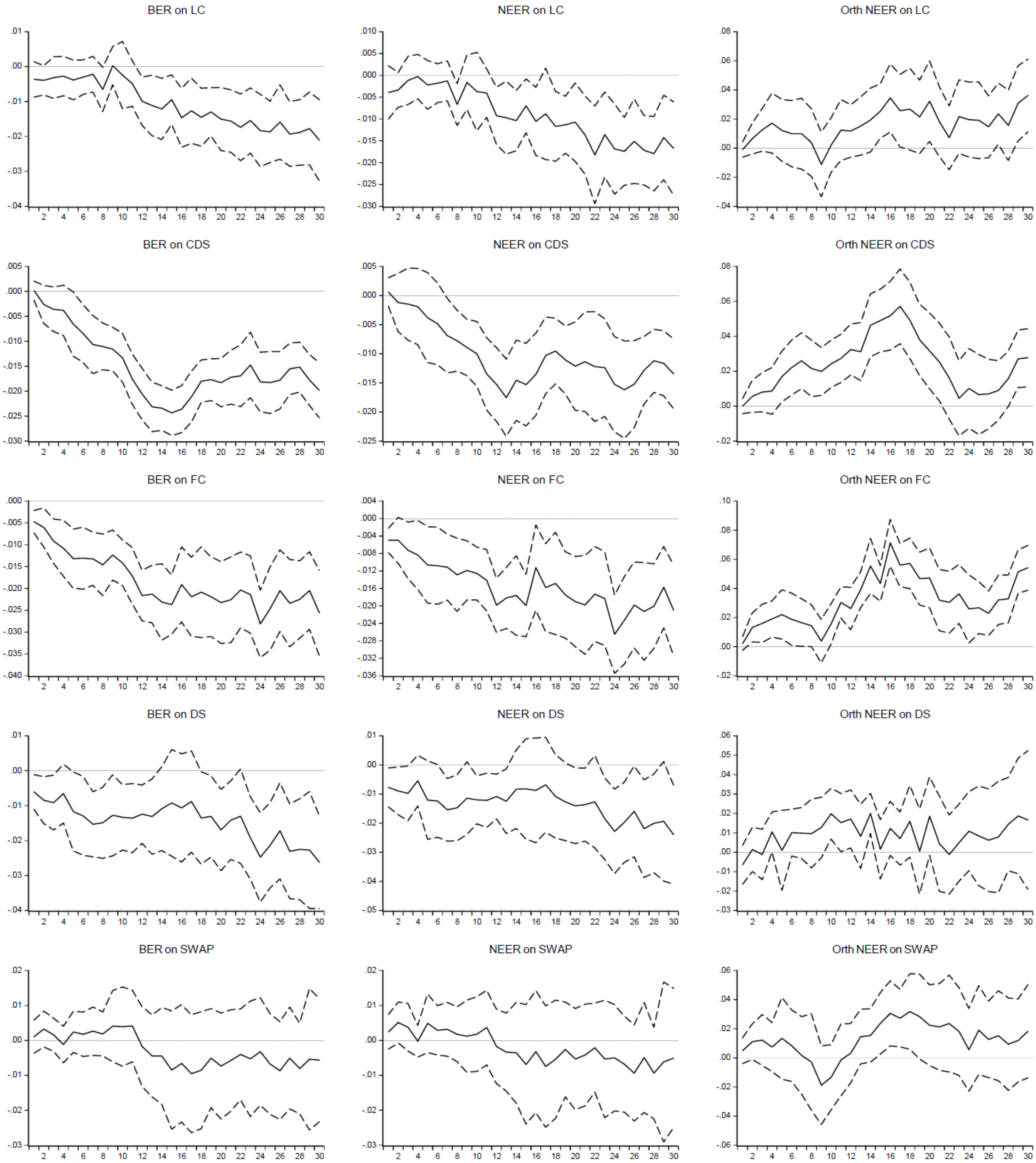


Figure 7. **Impact of exchange rates on sovereign spreads.** The figure shows the impact of the lagged log change in exchange rates on the change in sovereign spreads over the next h = 1,..,30 trading days. *BER* is the bilateral exchang rate against the US dollar, *NEER* is the nominal effective exchange rate, both defined such that an increase is an appreciation. *Orth NEER* is the residual from the regression of the change in *NEER* on the change in *BER*. *LC* is the 5-year local currency sovereign bond spread, *CDS* is the 5-year sovereign CDS spread, *FC* is the 5-year foreign currency sovereign bond spread, *DS* is the Du-Schreger local currency sovereign credit risk spread and *SWAP* is the 5-year cross-currency swap rate. Control variables included are the log change in the VIX and the change in the US and the domestic 3-month money market rates. Broken lines are two standard error bands. Standard errors are cluster robust.

Figure 8. **Impact of exchange rates on sovereign spreads.** The figure shows the impact of the lagged log change in exchange rates on the change in sovereign spreads over the next h = 1,..,30 trading days when both the bilateral exchang rate against the US dollar (*BER*) and the nominal effective exchange rate (*NEER*) are included in the regression. *LC* is the 5-year local currency sovereign bond spread, *CDS* is the 5-year sovereign CDS spread, *FC* is the 5-year foreign currency sovereign bond spread, *DS* is the Du-Schreger local currency sovereign credit risk spread and *SWAP* is the 5-year cross-currency swap rate. Control variables included are the log change in the VIX and the change in the US and the domestic 3-month money market rates. Broken lines are two standard error bands. Standard errors are cluster robust.

country's bond market through EME sovereign bond funds (henceforth, "aggregate bond fund flows"). In section 2 we have already provided scatter plots showing the relationship between FX return, local currency return and investor flows for 36 EME local currency bond funds and established a significant unconditional positive relationship between an appreciation of the *BER* and bond flows. Here we conduct a panel regression analysis in which the dependent variable is investor flows to each country via bond mutual funds and exchange-traded funds (ETFs) collected by EPFR Global. Since new EME bond funds are added to the EPFR database over the sample period, we need to control for potential bias created by new funds' entering the database. We use flows normalised by NAV, and we consider investor flows to a country by any fund that is covered by the EPFR database at a point in time.[10]

In order to assess which exchange rate matters for EME financial conditions, we run the regressions in five different specifications: (i) with the bilateral US dollar exchange rate (*BER*); (ii) with the nominal effective exchange rate (*NEER*); (iii) with the wedge between the *NEER* and the *BER;* (iv) including both the *BER* and the *NEER;* and (v) including both the *BER* and the wedge between the *NEER* and the *BER.* The wedge between the *NEER* and the *BER* is obtained by regressing for each country separately the change in the *NEER* on the change in the *BER*, and retaining the residuals as the part of the *NEER* change that is unrelated to the change in the *BER.*

The set of control variables Z now includes the log change in the VIX, the log change in the US consumer price index (CPI), the log change in US industrial production, the change in the US short-term interest rate (3-month money market rate), the log change in the domestic CPI, the log change in domestic industrial production and the change in the domestic short-term interest rate (3-month money market rate).[11]

As already discussed in section 2, endogeneity is an important issue we need to address in the empirical analysis. The results presented in the previous subsection suggest that exchange rate appreciation loosens financial conditions and lowers risk spreads, but that higher bond inflows and lower risk spreads may in turn drive up the value of the domestic currency. The existence of a strong two-way link between the two variables was indeed demonstrated in the previous subsection. One way to address endogeneity is to use an instrumental variable estimator. This approach is, however, plagued by the problem of finding good instruments for the exchange rate (and any other endogenous variable in the regression). For this reason,

[10] An alternative approach is to fix a subset of bond funds for which complete monthly data are available throughout the sample period. The scatter charts in Section 2 were generated in this way.

[11] We do not include control variables capturing a country's fiscal and external position or its indebtedness as such variables are mostly available only at a lower frequency (quarterly or even annual) than the monthly one adopted in the analysis here.

we adopt a different approach and address endogeneity by lagging all explanatory variables by one month.

The inclusion of the lagged dependent variable in the regression controls for endogeneity that may arise from persistence in the dynamics of the dependent variable. If the dependent variable is autocorrelated, then omission of the lagged dependent variable could give rise to endogeneity bias as the effect of the lagged regressors might just reflect the correlation between the lagged regressor and the omitted lagged dependent variable.

However, while controlling for this potential source of endogeneity, the inclusion of the lagged dependent variable gives rise to other potential econometric issues. Fixed-effects estimators of dynamic panels can be biased in panels with small time dimensions (Nickell (1981)) and if there is heterogeneity in the slope coefficients across countries (Pesaran and Smith (1995)). With more than 100 monthly observations, the time dimension of our panel is relatively large so that the Nickell bias is less of concern. This notion is confirmed by the fact that the results are very similar when re-running the regressions with the lagged dependent variable excluded, at least as far as the impact of the exchange rate is concerned. In order to assess the caveat of a potential bias stemming from coefficient heterogeneity, we have also re-run all the regressions using the mean group estimator proposed by Pesaran and Smith (1995). This involves estimating the equation country by country and constructing a panel estimate of the slope coefficients by averaging across the country coefficients. While this addresses the slope heterogeneity issue, it comes at the cost of reduced efficiency. The results of this exercise, which we do not report because of space constraint (but which are available upon request) turned out to be very similar to the standard fixed-effect panel regression results.

The results confirm that an appreciation of the local currency against the US dollar is associated with a significant reduction in EME sovereign bond and risk spreads. Specifically, the estimates suggest that a 1% appreciation of an EME's local currency against the US dollar decreases the local currency bond spread of a country by about 1.8 basis points and the effect is significant at the 1% level (Table 2). The coefficient on the lagged dependent variable is 0.23, which implies a long-run multiplier for the change in the *BER* of about 2.3 basis points.

An appreciation of the effective exchange rate has a very similar effect. However, the impact of the wedge between the effective and the bilateral exchange rates is not statistically significant. In the regressions where both exchange rates are included, the US dollar exchange rate always has a negative impact that is significant at the 1% level, while the impact of the effective exchange rate variables is always positively signed. Thus, it is the US dollar exchange rate that matters for local currency sovereign bond spreads.

Table 2 further suggests that besides the exchange rate also changes in inflation are important drivers of EME bond spreads. Specifically, across the different specifications, we find that US and domestic inflation have a significantly positive impact on EME local currency bond spreads.

The results for the specification where the CDS spread, the foreign currency bond spread, the Du-Schreger spread and the cross-currency swap rate are respectively included as the dependent variable, which are reported in Tables 3, 4, 5 and 6, suggest that the impact of the US dollar on EME local currency bond spreads works through credit risk spreads. For all three measures, we find that an appreciation of the *BER* significantly lowers credit risk spreads, while the effect on the cross-currency swap rate is not significantly different from zero. In contrast, an appreciation of the *NEER* that is not driven by an appreciation against the US dollar does not lower risk spreads.

More specifically, a 1% appreciation of the local currency against the US dollar is estimated to decrease the 5-year CDS spreads by roughly 1.5 basis points (Table 3). The effect is highly significant, with a t-statistic of 5.3. A similar result obtains for the foreign currency bond spread. Here, a 1% appreciation of the US dollar exchange rate lowers the spread by roughly 1.9 basis points and the effect is also statistically significant at the 1% level with a t-statistic of 4.2 (Table 4).

For both the CDS spread and the foreign currency spread, an appreciation of the *NEER* is also associated with lower risk spreads. But the effects are smaller and less significant. The coefficient on the wedge between the *NEER* and the *BER* is positive and significant at the 1% level. This indicates that an appreciation of the effective exchange rate that is unrelated to an appreciation of the US dollar exchange rate increases EME bond spreads. In the specifications where both the bilateral and the effective exchange rates are included we get the same results: an appreciation of the bilateral US dollar exchange rate is associated with lower risk spreads, while an appreciation of the effective exchange rate leads to higher spreads. This result underscores the conjecture made in the previous section, that changes in the effective exchange rate that are not related to changes in the US dollar exchange rate probably give mainly rise to standard textbook trade channel effects, as opposed to financial risk-taking channel effects.

For the Du-Schreger spread, we find that an increase in the *BER* lowers local currency credit risk by about 1.5 basis points in a statistically significant way with a t-statistic of 2.6 (Table 5). An appreciation of the *NEER* also lowers risk spreads by a similar magnitude, but the effect is only marginally significant at the 10% level. The effect of the wedge between the

Dependent variable: change in 5 yr LC spread over US Treasuries					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.018***			−0.034***	−0.019***
	[−4.21]			[−4.91]	[−4.52]
$\Delta NEER_{t-1}$		−0.015**		0.021**	
		[−2.40]		[2.02]	
Orth $\Delta NEER_{t-1}$			0.011		0.017
			[0.88]		[1.427]
y_{t-1}	0.230***	0.235***	0.260***	0.237***	0.235***
	[7.17]	[6.60]	[7.38]	[6.94]	[6.81]
ΔVIX_{t-1}	−0.000	0.000	0.001*	−0.000	−0.000
	[−0.25]	[1.03]	[1.87]	[−0.67]	[−0.60]
$\Delta CPIUS_{t-1}$	0.170***	0.138***	0.140***	0.193***	0.186***
	[4.48]	[3.89]	[3.22]	[4.31]	[4.20]
$\Delta IPUS_{t-1}$	−0.012	−0.014	−0.019	−0.013	−0.013
	[−0.96]	[−1.14]	[−1.45]	[−1.00]	[−1.00]
$\Delta IRUS_{t-1}$	−0.014	0.014	0.014	−0.034	−0.026
	[−0.53]	[0.55]	[0.59]	[−1.37]	[−1.07]
ΔCPI_{t-1}	0.049***	0.052***	0.056***	0.050**	0.049**
	[2.58]	[2.75]	[3.05]	[2.56]	[2.53]
ΔIP_{t-1}	0.000	−0.000	0.000	0.000	0.000
	[0.02]	[−0.03]	[0.04]	[0.09]	[0.06]
ΔIR_{t-1}	0.029	0.033	0.037	0.027	0.026
	[0.75]	[0.88]	[0.85]	[0.69]	[0.66]
N	20	20	20	20	20
N×T	2429	2429	2429	2429	2429
Within R^2	0.113	0.107	0.102	0.116	0.115

Table 2. **Local currency sovereign bond spreads.** This table reports monthly country fixed-effects panel regressions; dependent variable is the change in the spread of the 5-year local currency sovereign bond yield over the corresponding US Treasury yield. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

Dependent variable: change in 5 yr CDS spread					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.015***			−0.042***	−0.018***
	[−5.29]			[−5.96]	[−6.29]
$\Delta NEER_{t-1}$		−0.007**		0.035***	
		[−2.16]		[4.86]	
Orth $\Delta NEER_{t-1}$			0.030***		0.037***
			[4.55]		[5.68]
y_{t-1}	0.049	0.096**	0.109***	0.033	0.029
	[1.13]	[2.53]	[2.92]	[0.80]	[0.68]
ΔVIX_{t-1}	0.002***	0.002***	0.002***	0.002***	0.002***
	[5.33]	[5.45]	[5.22]	[5.04]	[5.02]
$\Delta CPIUS_{t-1}$	0.133***	0.106***	0.129***	0.171***	0.171***
	[7.46]	[6.29]	[6.01]	[7.38]	[7.54]
$\Delta IPUS_{t-1}$	−0.063***	−0.066***	−0.069***	−0.062***	−0.063***
	[−8.17]	[−8.48]	[−8.76]	[−8.21]	[−8.18]
$\Delta IRUS_{t-1}$	−0.002	0.026*	0.003	−0.043**	−0.039**
	[−0.15]	[1.77]	[0.13]	[−2.26]	[−2.15]
ΔCPI_{t-1}	−0.029	−0.026	−0.023	−0.028	−0.029
	[−1.50]	[−1.37]	[−1.38]	[−1.57]	[−1.60]
ΔIP_{t-1}	0.001	0.001	0.001	0.001	0.001
	[0.63]	[0.73]	[1.03]	[0.91]	[0.79]
ΔIR_{t-1}	0.089***	0.093***	0.098***	0.094***	0.091***
	[3.87]	[4.03]	[3.57]	[3.58]	[3.44]
N	20	20	20	20	20
N×T	2377	2377	2377	2377	2377
Within R^2	0.127	0.114	0.120	0.141	0.140

Table 3. **Sovereign CDS spreads.** This table reports monthly country fixed-effects panel regressions; dependent variable is the change in the spread of the US dollar-denominated 5-year CDS spread over the corresponding US CDS spread. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

NEER and the *BER* is not statistically significant. In the regressions where both exchange rate variables are included, it is always only the coefficient on the US dollar exchange rate that comes out significantly negative. Thus, also for local currency credit risk, it is the US dollar exchange rate that matters.

The regression results reported in Tables 3, 4 and 5 show that the VIX also has a positive and mostly highly significant impact on the different risk spreads. An increase in investor risk aversion leads to a tightening of credit conditions for EMEs. For the other control variables, no clear patterns across the different regressions emerge.

The results reported in Table 6 show that an appreciation of the *BER* (and also of the *NEER*) has an insignificant effect on the change in the cross-currency swap rate, in line with the results from the daily regressions. This underscores the notion that the negative exchange rate impact on the local currency bond spread works through the credit risk spread, or the risk-taking channel.

Finally, also for the regressions with the bond fund flows we find that the impact of the bilateral US dollar exchange rate is both economically and statistically more significant than that on the trade-weighted exchange rate. In particular, an increase in the log of the exchange rate against the US dollar (ie an appreciation of the local currency of an EME against the US dollar) has a highly significant positive impact on flows. Table 7 shows that, when an EME's exchange rate appreciates by 1% in a month against the US dollar, the ratio of flows to NAV during the next month increases by about 4 basis points. The effect is highly significant, with a t-statistic of 3.2. With a coefficient on the lagged dependent variable of 0.62, the long-run impact is 11 basis points. When we run the same regressions using the *NEER* instead of the *BER*, the coefficients are also positive, but smaller and less significant. The impact of the *NEER* not driven by the *BER* is again insignificant.

Overall, the results confirm the notion that it is the US dollar exchange rate and not the effective exchange rate that matters for the exchange rate risk-taking channel in EMEs. The impact of an appreciation of the US dollar is significant at the 1% level throughout, while an appreciation of the *NEER* that does not reflect a likewise movement in the US dollar exchange rate is never found to significantly lower risk spreads or increase bond flows. Importantly, the significant impact of the US dollar exchange rate on EME sovereign bond market conditions obtains despite controlling for a large number of variables that significantly affect those conditions and that presumably also affect the exchange rate. The significant association between the exchange rate and bond market conditions thus does not seem to merely capture common factors but appears to represent an independent amplifying channel of transmission.

Dependent variable: change in 5 yr FC spread over US Treasuries					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.019***			−0.063***	−0.021***
	[−4.20]			[−7.43]	[−4.91]
ΔNEER_{t-1}		−0.008		0.058***	
		[−1.12]		[4.96]	
Orth ΔNEER_{t-1}			0.055***		0.061***
			[4.55]		[5.65]
y_{t-1}	0.083**	0.135***	0.146***	0.069**	0.064**
	[2.57]	[4.06]	[5.75]	[2.41]	[2.32]
ΔVIX_{t-1}	0.003***	0.003***	0.003***	0.003***	0.003***
	[6.13]	[6.63]	[6.28]	[5.62]	[5.57]
ΔCPIUS_{t-1}	0.190***	0.159***	0.206***	0.250***	0.248***
	[8.75]	[8.23]	[6.89]	[8.65]	[8.41]
ΔIPUS_{t-1}	−0.066***	−0.072***	−0.075***	−0.066***	−0.066***
	[−6.30]	[−6.80]	[−8.18]	[−6.75]	[−6.88]
ΔIRUS_{t-1}	−0.122***	−0.081***	−0.139***	−0.201***	−0.195***
	[−4.37]	[−3.66]	[−4.21]	[−6.82]	[−6.99]
ΔCPI_{t-1}	0.001	0.000	−0.002	−0.000	−0.002
	[0.03]	[0.01]	[−0.11]	[−0.01]	[−0.08]
ΔIP_{t-1}	0.003*	0.004*	0.004**	0.003**	0.003**
	[1.65]	[1.87]	[2.48]	[2.13]	[2.09]
ΔIR_{t-1}	0.079***	0.083***	0.080***	0.076***	0.073***
	[3.03]	[3.28]	[3.07]	[2.97]	[2.78]
N	13	13	13	13	13
N×T	1566	1566	1566	1566	1566
Within R^2	0.171	0.155	0.173	0.198	0.196

Table 4. **Foreign currency bond spreads.** This table reports monthly country fixed-effects panel regressions; dependent variable is the change in the spread of the JP Morgan EMBI yield over the 5-year US Treasury yield. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

Dependent variable: change in Du-Schreger risk spread					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.015***			−0.029**	−0.015***
	[−2.58]			[−2.23]	[−2.64]
ΔNEER_{t-1}		−0.013*		0.019	
		[−1.67]		[1.07]	
Orth ΔNEER_{t-1}			0.003		0.007
			[0.20]		[0.40]
y_{t-1}	0.071***	0.081***	0.090***	0.067***	0.071***
	[3.14]	[3.06]	[2.94]	[2.97]	[3.10]
ΔVIX_{t-1}	0.001	0.001	0.002**	0.001	0.001
	[0.98]	[1.26]	[2.04]	[0.94]	[0.99]
$\Delta \text{CPIUS}_{t-1}$	0.120***	0.094***	0.089**	0.140***	0.126***
	[3.68]	[3.50]	[2.32]	[3.23]	[3.06]
ΔIPUS_{t-1}	−0.008	−0.010	−0.013	−0.008	−0.008
	[−0.68]	[−0.80]	[−1.09]	[−0.68]	[−0.68]
ΔIRUS_{t-1}	−0.104*	−0.081	−0.095	−0.130**	−0.112*
	[−1.67]	[−1.33]	[−1.48]	[−2.03]	[−1.75]
ΔCPI_{t-1}	0.021	0.022	0.024	0.021	0.021
	[0.92]	[0.96]	[1.14]	[0.98]	[0.92]
ΔIP_{t-1}	0.004**	0.004**	0.005**	0.004**	0.004**
	[2.10]	[2.10]	[2.45]	[2.16]	[2.10]
ΔIR_{t-1}	0.028	0.033	0.039	0.027	0.027
	[0.80]	[0.94]	[1.21]	[0.78]	[0.80]
N	14	14	14	14	14
N×T	1548	1548	1548	1548	1548
Within R^2	0.058	0.051	0.044	0.061	0.058

Table 5. **Du-Schreger local currency sovereign risk spreads.** This table reports monthly country fixed-effects panel regressions; dependent variable is the change in the spread of the 5-year local currency bond yield over a synthetic risk-free rate calculated as the 5-year US Treasury yield adjusted for the forward currency premium constructed from cross-currency and interest rate swap rates. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

Dependent variable: change in cross-currency swap rate					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.005			−0.024*	−0.006
	[−0.98]			[−1.92]	[−1.16]
ΔNEER_{t-1}		−0.001		0.025	
		[−0.14]		[1.27]	
Orth ΔNEER_{t-1}			0.029		0.030
			[1.41]		[1.53]
y_{t-1}	0.147**	0.148**	0.156**	0.154**	0.154**
	[2.32]	[2.20]	[2.33]	[2.25]	[2.31]
ΔVIX_{t-1}	−0.000	0.000	0.000	−0.000	−0.000
	[−0.06]	[0.16]	[0.13]	[−0.18]	[−0.20]
ΔCPIUS_{t-1}	0.100*	0.088*	0.113*	0.126*	0.129**
	[1.95]	[1.76]	[1.68]	[1.93]	[2.01]
ΔIPUS_{t-1}	0.001	−0.001	−0.002	0.000	0.000
	[0.05]	[−0.04]	[−0.11]	[0.03]	[0.01]
ΔIRUS_{t-1}	0.056	0.062	0.034	0.027	0.027
	[0.88]	[1.02]	[0.61]	[0.50]	[0.48]
ΔCPI_{t-1}	0.048	0.049	0.048	0.047	0.047
	[1.32]	[1.35]	[1.22]	[1.25]	[1.21]
ΔIP_{t-1}	−0.002	−0.002	−0.002	−0.002	−0.002
	[−0.63]	[−0.61]	[−0.57]	[−0.62]	[−0.61]
ΔIR_{t-1}	−0.006	−0.003	−0.009	−0.011	−0.013
	[−0.16]	[−0.07]	[−0.19]	[−0.27]	[−0.32]
N	14	14	14	14	14
N×T	1587	1587	1587	1587	1587
Within R^2	0.033	0.032	0.035	0.036	0.037

Table 6. **Cross-currency swap rates.** This table reports monthly country fixed-effects panel regressions; dependent variable is the difference between the change in the 5-year local currency sovereign bond spread and the change in the 5-year Du-Schreger spread, which is equivalent to the change in the 5-year cross-currency swap rate. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

Dependent variable: aggregate bond fund flows					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	0.041***			0.077***	0.043***
	[3.21]			[3.11]	[3.66]
$\Delta NEER_{t-1}$		0.032*		−0.049	
		[1.69]		[−1.37]	
Orth $\Delta NEER_{t-1}$			−0.029		−0.048
			[−0.74]		[−1.31]
y_{t-1}	0.624***	0.631***	0.635***	0.620***	0.620***
	[57.37]	[59.83]	[83.26]	[63.61]	[62.31]
ΔVIX_{t-1}	0.000	−0.001	−0.001*	0.000	0.000
	[0.09]	[−0.89]	[−1.65]	[0.32]	[0.34]
$\Delta CPIUS_{t-1}$	−0.413***	−0.346***	−0.355***	−0.464***	−0.459***
	[−8.80]	[−8.43]	[−8.14]	[−12.89]	[−12.51]
$\Delta IPUS_{t-1}$	0.587***	0.585***	0.590***	0.590***	0.590***
	[22.60]	[22.76]	[23.24]	[22.95]	[22.82]
$\Delta IRUS_{t-1}$	−0.349***	−0.416***	−0.396***	−0.292***	−0.302***
	[−4.53]	[−6.01]	[−6.96]	[−5.09]	[−5.23]
ΔCPI_{t-1}	−0.081	−0.087	−0.097*	−0.083	−0.081
	[−1.51]	[−1.61]	[−1.91]	[−1.59]	[−1.55]
ΔIP_{t-1}	−0.003	−0.003	−0.004	−0.003	−0.003
	[−0.39]	[−0.41]	[−0.50]	[−0.43]	[−0.41]
ΔIR_{t-1}	0.015	0.001	−0.027	0.012	0.015
	[0.25]	[0.02]	[−0.42]	[0.19]	[0.25]
N	20	20	20	20	20
N×T	2502	2502	2502	2502	2502
Within R^2	0.544	0.543	0.543	0.545	0.545

Table 7. **Aggregate bond fund flows.** This table reports monthly country fixed-effects panel regressions; dependent variable is the bond fund flows into each EME's bonds as a percentage of the beginning-of-period net asset value. ΔBER is the log change in the bilateral exchange rate against the US dollar; positive ΔBER is an appreciation of the EME currency. ΔNEER is the log change in the nominal effective exchange rate, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. y(t-1) is the lagged dependent variable. ΔVIX is the log change in the VIX index, ΔCPIUS is the log change in US CPI, ΔIPUS is the log change in US industrial production, ΔIRUS is the change in US 3-month money market rate, ΔCPI is the log change in domestic CPI, ΔIP is the log change in domestic industrial production, and ΔIR is the change in domestic 3-month money market rate. t-statistics reported in brackets are calculated based on cluster-robust standard errors. *, ** and *** denote, respectively, significance at the 10 percent, 5 percent and 1 percent level.

But how important is the impact of the US dollar exchange rate on EME bond and credit risk spreads economically? With magnitudes of between 1.5 to 2.3 basis points long-run spread reductions for a 1% appreciation, the economic impact seems small. However, we need to put these estimated effects into perspective against the background of observed exchange rate fluctuations. Across the 20 economies covered by our analysis, the average standard deviation of the change in the US dollar exchange rate over the sample period is about 2.5 percentage points. This means that a standard change in the exchange rate moves EME spreads by roughly 4–6 basis points. It is also instructive to do a back-of-the-envelope calculation to assess the cumulative effect of the considerable exchange rate movements that we have observed since 2013. Since the beginning of 2013, the EME currencies covered in our analysis depreciated against the US dollar by on average about 30%. Our estimations suggest that this might have added some 45 to 70 basis points to EME bond and credit risk spreads through the risk-taking channel of exchange rate appreciation.

4.2.2 Panel VAR analysis

As a robustness check for the results of the daily and monthly predictive regressions, we assess in this subsection the impact of exchange rate fluctuations on sovereign yields and bond flows based on a panel vector autoregression (VAR) analysis. The panel VARs take the form:

$$Y_{i,t} = A_i + B(L)Y_{i,t-1} + \varepsilon_{i,t}. \tag{26}$$

where Y is a vector of endogenous variables comprising the log change in US industrial production and US CPI, the log change in the VIX, the change in the US 3-month money market rate, the log change in domestic industrial production, the log change in the domestic CPI, the change in the domestic 3-month interest rate, an indicator of sovereign bond market conditions, and the log change in the exchange rate. The lag order of the VARs is three, determined based on the Schwarz-Bayes information criterion where up to six lags were considered. We estimate VARs separately for the four measures of sovereign bond and credit risk spreads, the swap rate and the bond flows and the three different exchange rates (the *BER*, the *NEER* and the wedge between the *BER* and the *NEER*) as described in the previous subsection. We thus estimate in total 18 VARs.

Based on these VARs, we assess the dynamic impact of an exchange rate shock. The shock is identified using a standard Cholesky scheme with the exchange rate ordered last in the system. In other words, we assume that the exchange rate can respond immediately to all the shocks in the system, but that an exchange rate shock can affect the other variables only with a lag. Through this identification scheme, we endogenise the exchange rate as much as possible, thus minimising any potential remaining endogeneity issues in the estimated effect of exchange rates on sovereign bond markets to the extent possible.

Figures 9 to 11 show the accumulated impulse response functions (IRFs) of the four EME sovereign bond and credit risk spreads to a one standard deviation shock to the change in the exchange rate. The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

The results confirm those of the regression analysis in the previous subsection. Specifically, the accumulated impulse responses are similar to impact of the exchange rates found in the panel regressions. The accumulated effect of a one standard deviation shock to the *BER* (Figure 9) is significantly different from zero at conventional levels. The peak magnitude of the impact is similar to the impacts of a one standard deviation change in the *BER* obtained from the panel regressions, ranging between 4 and 6 basis points in the case of the bond and risks spreads, and 10 basis points in the case of the bond flows. The impact on the swap rates is again insignificant. But we have to bear in mind that these are very conservative estimates as we have endogenised the exchange rate as much as possible.

In line with the findings of the preceding section, we also find that the impact of a shock to the *NEER* is significant, but smaller than that of the *BER* (Figure 10). The impact of the wedge between the *BER* and the *NEER* on EME bond and credit risk spreads is either statistically insignificant or significantly positive (Figure 11).

5 Conclusions

We have explored the risk-taking channel of currency appreciation which stands in contrast to the traditional Mundell-Fleming analysis of currency appreciation operating through net exports. Unlike the traditional model, the risk-taking channel can render a currency appreciation expansionary through loosening of monetary conditions.

The risk-taking channel operates through the balance sheets of both borrowers and lenders. For borrowers who have net liabilities in dollars, an appreciation of the domestic currency makes borrowers more creditworthy. In turn, when borrowers become more creditworthy, the lenders find themselves with greater lending capacity. Through the impact on the government's fiscal position, dollar lending to corporates for investment and portfolio holding of domestic sovereign bonds go hand in hand, injecting a positive relationship between currency appreciation and the compression of domestic long-term interest rates.

We have shown that the main predictions of the risk-taking channel are borne out in the

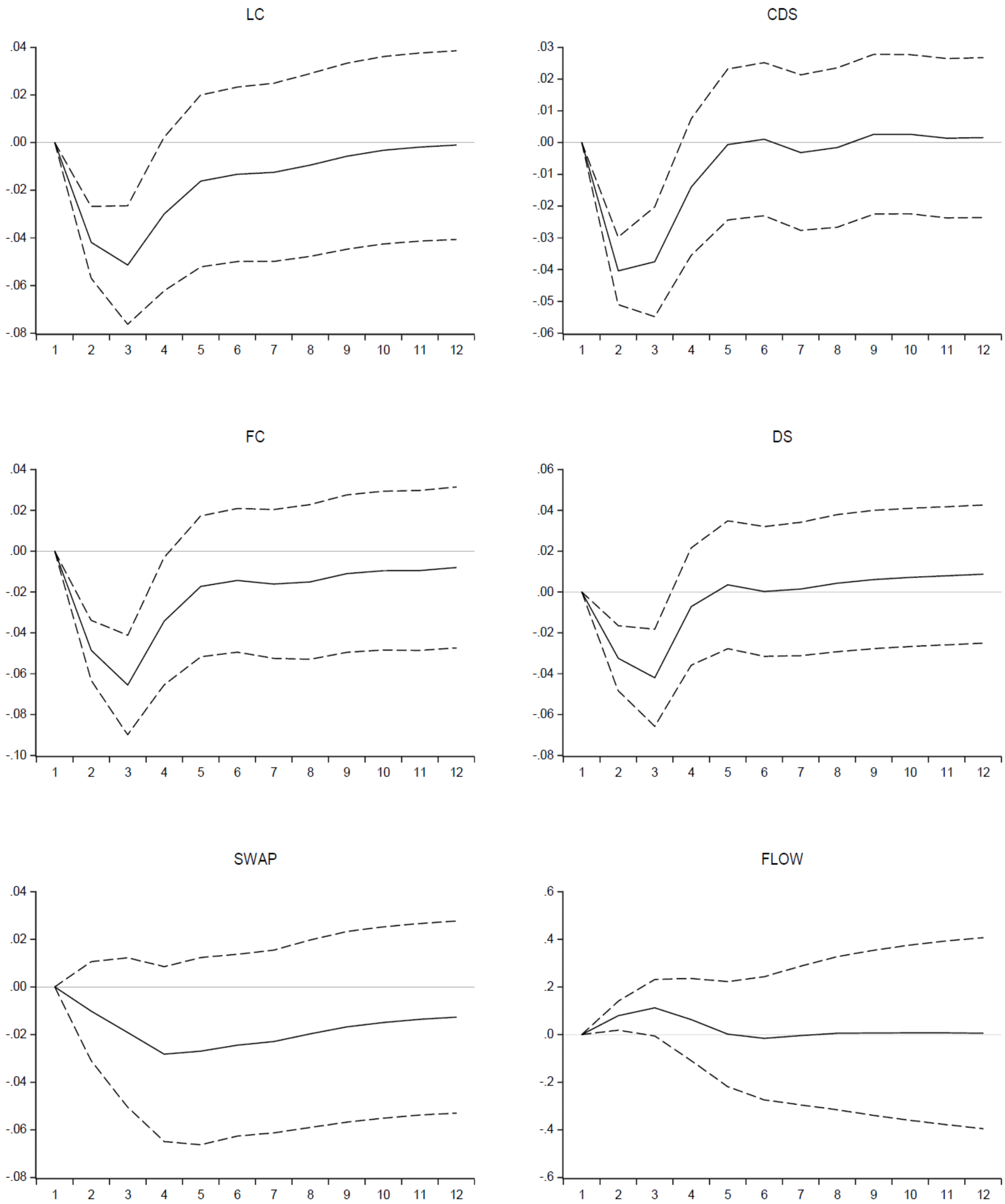


Figure 9. **Impulse response functions (IRFs) to a one standard deviation shock to the change in the bilateral exchange rate against the US dollar.** The upper-left panel shows the IRF of the 5-year local currency sovereign bond spread. The upper-right panel shows the IRF of the 5-year sovereign CDS spread. The middle-left panel shows the IRF of the 5-year foreign currency sovereign bond spread. The middle-right panel shows the IRF of the change in the Du-Schreger local currency sovereign risk spread. The lower-left panel shows the IRF for the swap rate. The lower-right panel shows the IRF for the bond flows. The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

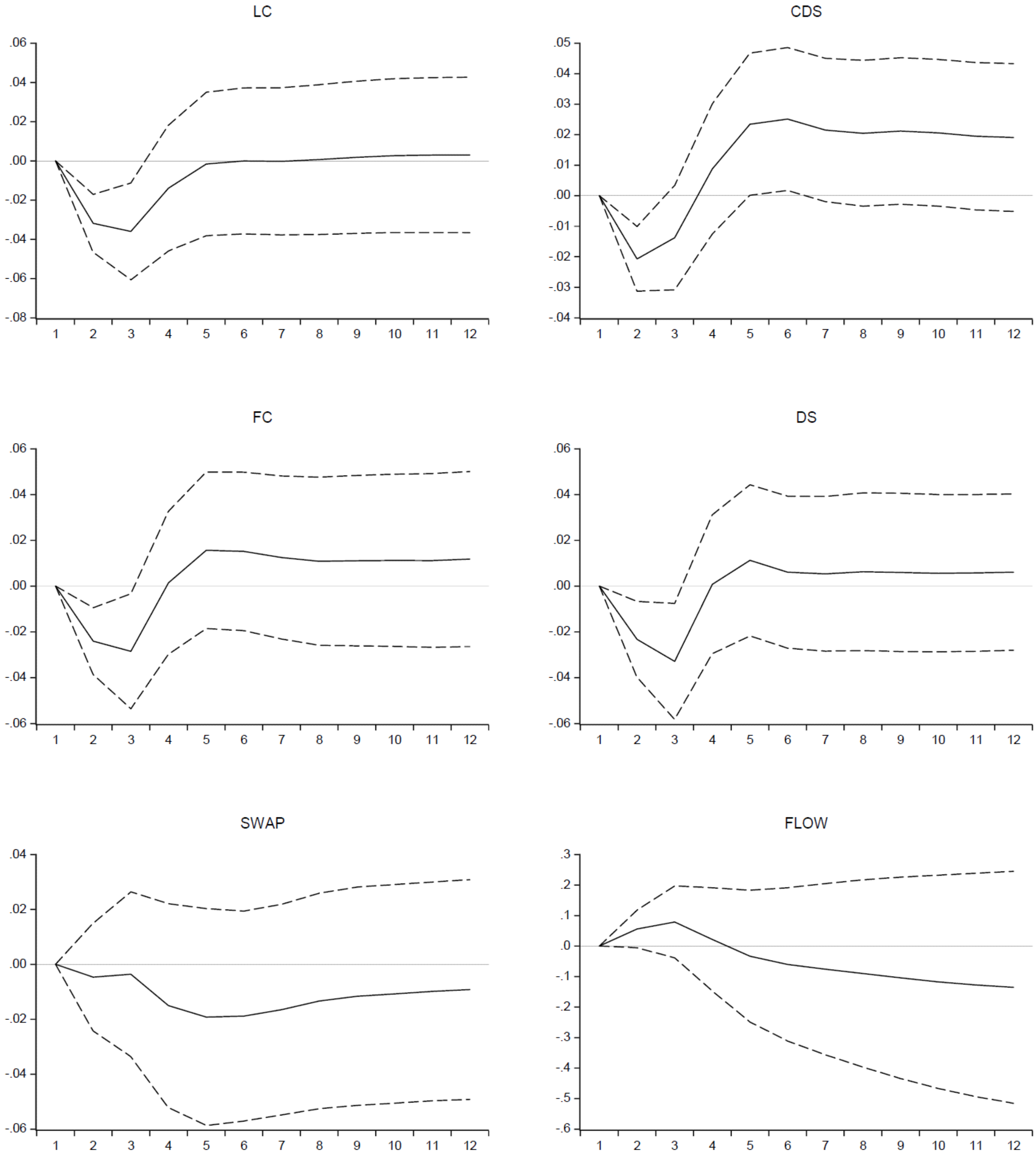


Figure 10. **Impulse response functions (IRFs) to a one standard deviation shock to the nominal effective exchange rate.** The upper-left panel shows the IRF of the 5-year local currency sovereign bond spread. The upper-right panel shows the IRF of the 5-year sovereign CDS spread. The middle-left panel shows the IRF of the 5-year foreign currency sovereign bond spread. The middle-right panel shows the IRF of the change in the Du-Schreger local currency sovereign risk spread. The lower-left panel shows the IRF for the swap rate. The lower-right panel shows the IRF for the bond flows. The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

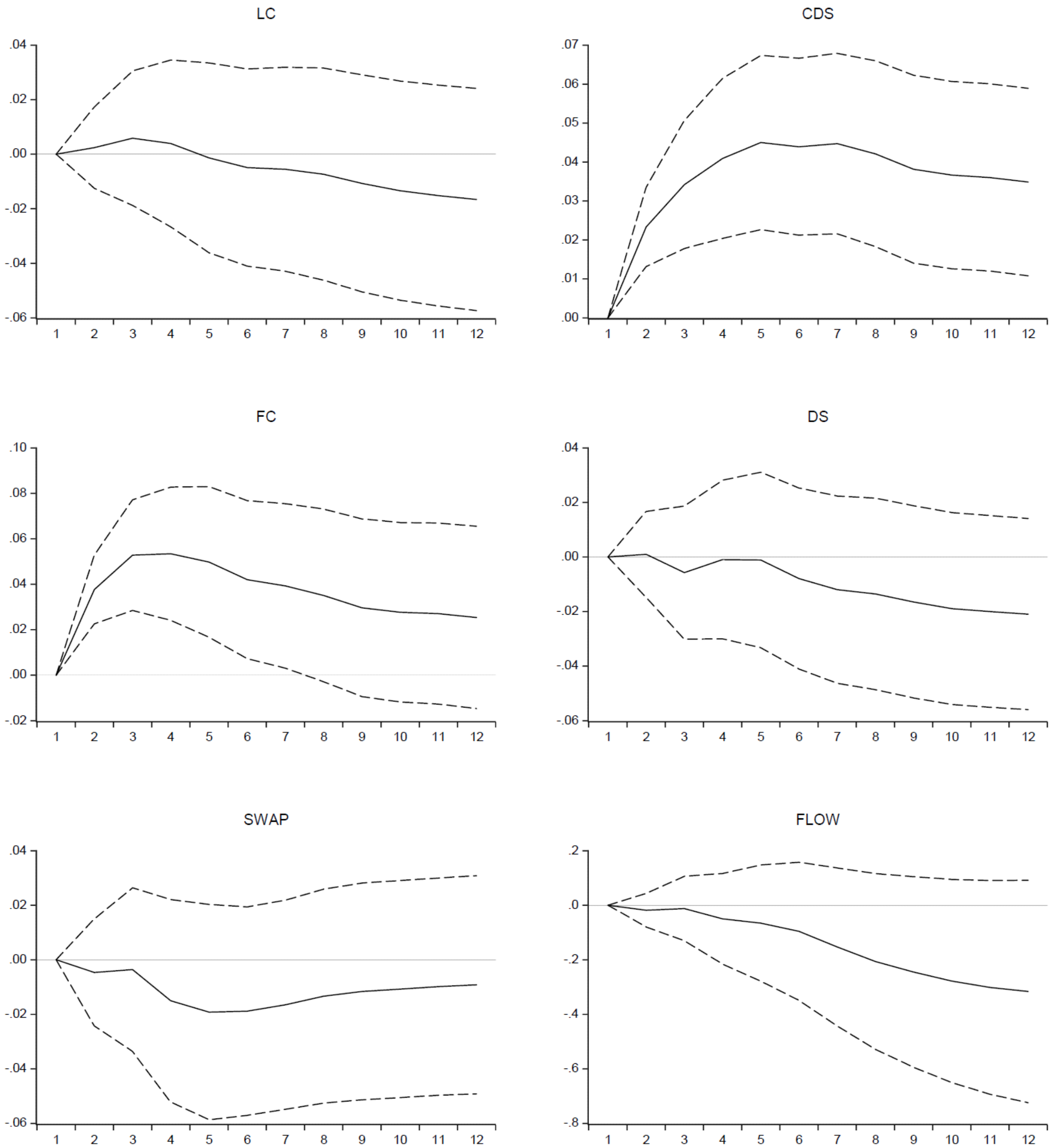


Figure 11. **Impulse response functions (IRFs) to a one standard deviation shock to the wedge between the change in the nominal effective exchange rate and the change in the bilateral exchange rate.** The upper-left panel shows the IRF of the 5-year local currency sovereign bond spread. The upper-right panel shows the IRF of the 5-year sovereign CDS spread. The middle-left panel shows the IRF of the 5-year foreign currency sovereign bond spread. The middle-right panel shows the IRF of the change in the Du-Schreger local currency sovereign risk spread. The lower-left panel shows the IRF for the swap rate. The lower-right panel shows the IRF for the bond flows. The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

empirical investigation for our spread-based measures of domestic monetary conditions as well as for bond portfolio flows.

A key implication of the paper is that currency appreciation is associated with increased investment, corporate borrowing in dollars, improved government fiscal position and diminished tail-risk of default and greater supply of bond credit. These effects reverse when the currency depreciates. Together with the evidence that lower sovereign risk pushes up the exchange rate as reported in this paper as well as in earlier studies (see, eg, Della Corte et al. (2015)), this implies that self-reinforcing feedback loops between exchange rate appreciation (depreciation) and financial easing (tightening) can develop.

Our analysis addresses the procyclicality stemming from portfolio flows that depend sensitively on tail risk, and hence which transmit financial conditions through global markets. In this respect, our paper adds to the debate on the cross-border transmission of financial conditions, recently galvanised by the findings in Rey (2013, 2014) that monetary policy has cross-border spillover effects on financial conditions even in a world of freely floating currencies. Similarly, Obstfeld (2015) has shown that financial globalisation worsens the trade-offs monetary policy faces in navigating among multiple domestic objectives, which makes additional tools of macroeconomic and financial policy more valuable. The potential spillover effects may be amplified if EME central banks attempt to insulate domestic financial conditions from spillovers by shadowing global policy rates through direct interest rate spillover effects (Hofmann and Takáts (2015)).

We have not addressed the detailed policy implications of our findings here. Broadly, however, our analysis suggests that attention may be paid to three areas: (i) policy actions to restrict the degree of valuation mismatch on the balance sheet of corporates, which is the source of the problem; (ii) ex ante prudential measures on FX exposures to discourage excessive risk taking during boom periods accompanied by EME local currency appreciation, such as price-based measures (taxes or capital requirements on FX borrowing) or quantity-based measures (aiming to slow down the speed of foreign borrowing by corporates and sovereigns, ie capital flow management measures targeting banking and bond inflows); and (iii) ex post measures during bust periods accompanied by EME local currency depreciation, such as loosening quantity constraints on foreign borrowing or relaxing price-based measures to lower borrowing costs.

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Appendix 1: Detailed description of data

Appendix Table 1.1: 20 EMEs in the sample

Africa and the Middle East (3)	Israel, Turkey, South Africa
Emerging Asia (8)	China, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand
Emerging Europe (4)	Czech Republic, Hungary, Poland, Russia
Latin America and the Caribbean (5)	Brazil, Chile, Colombia, Mexico, Peru

Appendix Table 1.2: 14 EMEs for which the Du-Schreger spread is available

Africa and the Middle East (3)	Israel, Turkey, South Africa
Emerging Asia (5)	Indonesia, Korea, Malaysia, Philippines, Thailand
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

Appendix Table 1.3: 13 EMEs for which foreign currency bond yield is available

Africa and the Middle East (3)	Israel, Turkey, South Africa
Emerging Asia (4)	Indonesia, Korea, Malaysia, Philippines
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

Appendix Table 1.4: 36 EME local currency bond funds

No	Fund name	Benchmark
1	Aberdeen Global - Emerging Markets Local Currency Bond	JPM GBI-EM Global Diversified
2	Aberdeen Global II - Emerging Europe Bond Fund	JPM GBI-EM Global Diversified Europe
3	Ashmore SICAV Emerging Markets Local Currency Bond Fund	JPM GBI-EM Global Diversified
4	Aviva Investors - Emerging Markets Local Currency Bond Fund	JPM GBI-EM Broad Diversified
5	BankInvest Hojrentelande lokalvaluta	JPM GBI-EM Global Diversified
6	BlackRock Global Funds Emerging Markets Local Currency Bond Fund	JPM GBI-EM Global Diversified
7	BNY Mellon Emerging Markets Debt Local Currency Fund	JPM GBI-EM Global Diversified
8	Dreyfus Emerging Markets Debt Local Currency Fund	JPM GBI-EM Diversified
9	Eaton Vance Emerging Markets Local Income Fund	JPM GBI-EM Global Diversified
10	Goldman Sachs Growth & Emerging Markets Debt Local Portfolio	JPM GBI-EM Global Diversified
11	Goldman Sachs Local Emerging Markets Debt Fund	JPM GBI-EM Global Diversified
12	Invesco Emerging Local Currencies Debt Fund	JPM GBI-EM Global Diversified
13	Invesco Emerging Market Local Currency Debt Fund	JPM GBI-EM Global Diversified
14	Investec GSF Emerging Markets Local Currency Debt Fund	JPM GBI-EM Global Diversified
15	ISI Emerging Market Local Currency Bonds Fund	JPM GBI-EM Broad Diversified
16	JPMorgan Funds - Emerging Markets Local Currency Debt Fund	JPM GBI-EM Global Diversified
17	Jyske Invest Emerging Local Market Bonds	JPM GBI-EM Diversified
18	Lazard GIF Emerging Markets Local Debt Fund	JPM GBI-EM Global Diversified
19	LO Funds - Emerging Local Currency Bond Fundamental	JPM GBI-EM Global Diversified
20	MFS Investment Funds - EM Local Currency Debt Fund	JPM GBI-EM Global Diversified
21	MFS Meridian Funds - EM Debt Local Currency Fund	JPM GBI-EM Global Diversified
22	Morgan Stanley Emerging Markets Domestic Debt Fund	JPM GBI-EM Global Diversified
23	Morgan Stanley Investment Funds - Emerging Markets Domestic Debt	JPM GBI-EM Global Diversified
24	Natixis Intl Fds (Lux) Loomis Sayles Emerging Debt & Currencies Fund	JPM GBI-EM Global Diversified
25	Pictet - Emerging Local Currency Debt	JPM GBI-EM Global Diversified
26	Pictet - Latin American Local Currency Debt	JPM GBI-EM Global Latin America
27	PIMCO Emerging Local Bond Fund	JPM GBI-EM Global Diversified
28	PIMCO GIS Emerging Local Bond Fund	JPM GBI-EM Global Diversified
29	PineBridge Global Emerging Markets Local Currency Bond Fund	JPM GBI-EM Global Diversified
30	Pioneer Funds - Emerging Markets Bond Local Currencies	JPM GBI-EM Global Diversified
31	T Rowe Price SICAV Emerging Local Markets Bond Fund	JPM GBI-EM Global Diversified
32	TCW Emerging Markets Local Currency Income Fund	JPM GBI-EM Global Diversified
33	Threadneedle Emerging Market Local Fund	JPM GBI-EM Global Diversified
34	UBAM - Local Currency Emerging Market Bond	JPM GBI-EM Global Diversified
35	Vontobel Fund - Eastern European Bond	JPM GBI-EM Global Europe
36	WisdomTree Emerging Markets Local Debt Fund	JPM GBI-EM Global Diversified

Appendix Table 1.5: Description of variables used in regression analyses

Variable	Description	Unit	Sources
Local currency bond spread	5-year local currency sovereign bond yields over 5-year US Treasury yield	Percentage points	Bloomberg, Datastream, Global Financial Data, national data
CDS spread	5-year US dollar sovereign CDS spread	Percentage points	Markit
Foreign currency bond spread	EMBI country-level yield over 5-year US Treasury yield	Percentage points	Datastream, JP Morgan Chase
Du-Schreger spread	5-year local currency bond yield over a synthetic risk-free rate calculated as the US Treasury yield adjusted for the forward currency premium constructed from cross-currency and interest rate swap rates	Percentage points	Du and Schreger (2015): "Local currency sovereign risk"
VIX	CBOE volatility index	Percentage points	Bloomberg
CPI	CPI inflation (seas. adjusted)	2000 Q1 = 100	National data
IP	Industrial production (seas. adjusted)	2000 Q1 = 100	National data
IR	3-month money market rate	Per cent	Bloomberg, Datastream, IMF International Financial Statistics, national data
BER	Exchange rate against the US dollar	US dollars per unit of local currency	National data
NEER	Nominal effective exchange rate, broad index	2000 Q1 = 100	National data