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

Boris Hofmann
Bank for International Settlements

Ilhyock Shim
Bank for International Settlements

Hyun Song Shin
Bank for International Settlements

October 19, 2016

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 the forward premium. 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.

*We thank Enrique Alberola, Yavuz Arslan, Fernando Avalos, Ryan Banerjee, Claudio Borio, Valentina Bruno, Stjin Claessens, Jon Clark, Erik Feyen, Andrew Filardo, Ben Friedman, Zhiguo He, Peter Hoerdahl, Sebnem Kalemli-Ozcan, Jonathan Kearns, Enisse Kharroubi, Emanuel Kohlscheen, Aytek Malkhozov, Aaron Mehrotra, Madhusudan Mohanty, Robert McCauley, Patrick McGuire, Jonathan Ostry, Luiz Pereira da Silva, Lucrezia Reichlin, Phurichai Rungcharoenkitkul, Andreas Schrimpf, Chang Shu, Suresh Sundaresan, Vladyslav Sushko, Lars Svensson, Bruno Tissot, Philip Turner, Christian Upper, James Yetman and Feng Zhu for comments, and Jimmy Shek and Agne Subelyte for their excellent research assistance. We thank participants at presentations at the Central Bank of the Republic of Turkey, the Bank of Japan and the Bank for International Settlements, and at the Federal Reserve Board conference on "Monetary policy implementation and transmission in the post-crisis period". The views presented here are solely those of the authors and do not necessarily represent those of the Bank for International Settlements.

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.

In this paper we lay out the evidence on the relationship between currency appreciation and EME bond market conditions, including both quantity based (bond fund flows) and price based (bond yield spreads). Currency appreciation, defined as appreciation of an EME currency against the US dollar, is associated with higher portfolio inflows into EME bond funds and a compression of the EME's sovereign spreads.

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. In contrast, the results hold up when we consider the orthogonalised component of the bilateral US dollar exchange rate (ie the movements of the US dollar exchange rate that is unrelated to movements in the effective exchange rate).

We posit that 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)).

We interpret our results as reflecting 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 working paper version of this paper (Hofmann, Shim and Shin (2016)), we develop a simple model of the risk-taking channel for cross-border bond flows to EMEs. The core mechanism is the presence of currency mismatch, which leads to a weaker dollar flattering 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 the economy in dollars expands as a consequence, expanding the set of real projects that are financed and raising economic activity, and improving the fiscal position of the government.

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 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 tail risks and increased portfolio flows into EME bonds. Note that this mechanism holds whether the 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. This increases tail risks for a diversified bond investor, which is then met by reductions in overall portfolio positions on EMEs. In this way, a stronger dollar coincides with portfolio outflows from EME sovereign bonds.

These considerations shed 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 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

[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.

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. In section 3 we conduct a more systematic empirical investigation of the determinants of financial conditions and portfolio flows. In section 4, we provide a case study in which an exogenous change in the exchange rate against the US dollar was followed by changes in bond spread and bond fund 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 3 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 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]

[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).

[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.

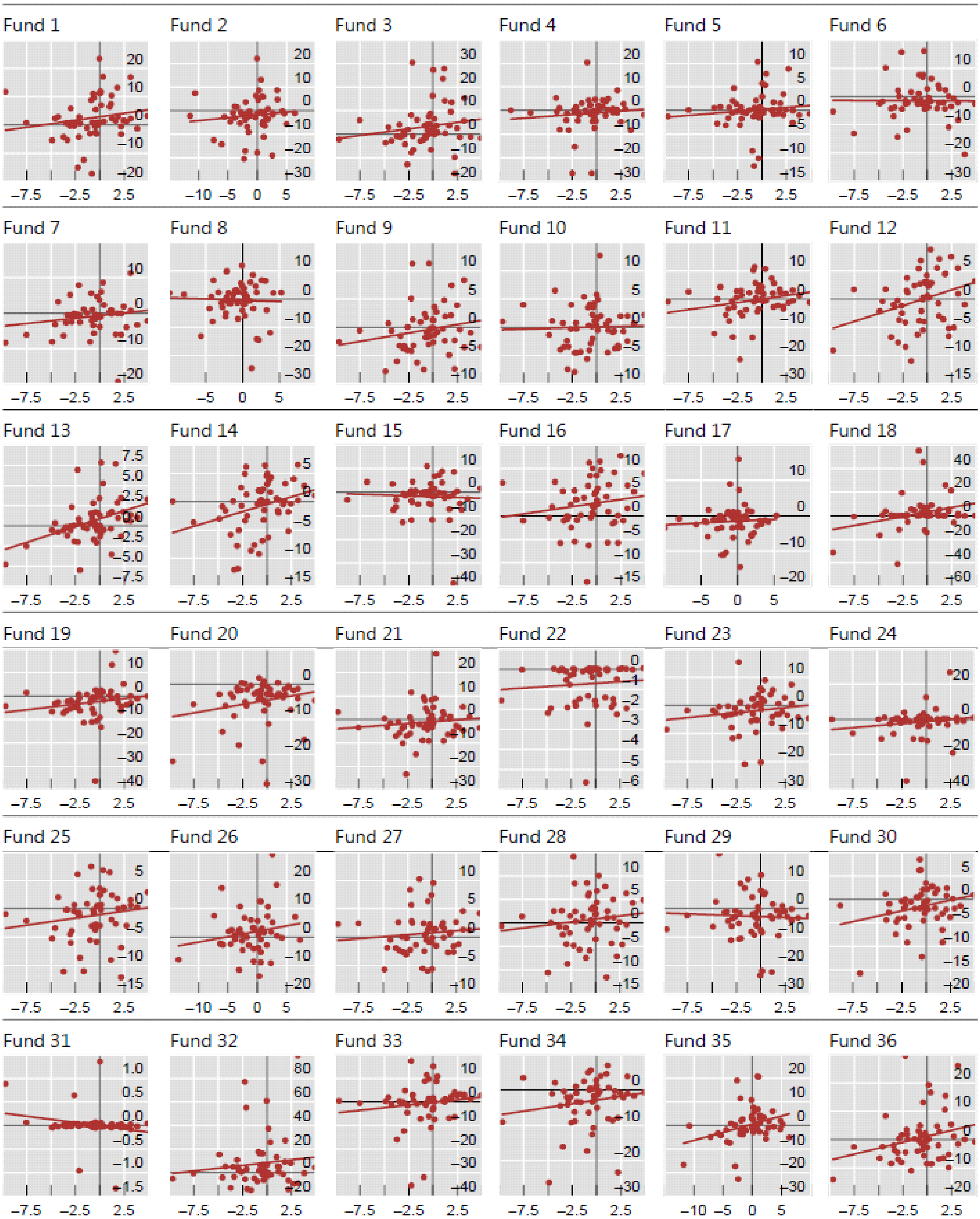


Figure 1. **Scatter plots of normalised flows to EME local currency bond funds to FX returns.** The vertical axis represents investor flows into each fund during a month as a percentage of the beginning-of-the-period NAV, and the horizontal axis monthly FX returns of the benchmark index for each fund 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.

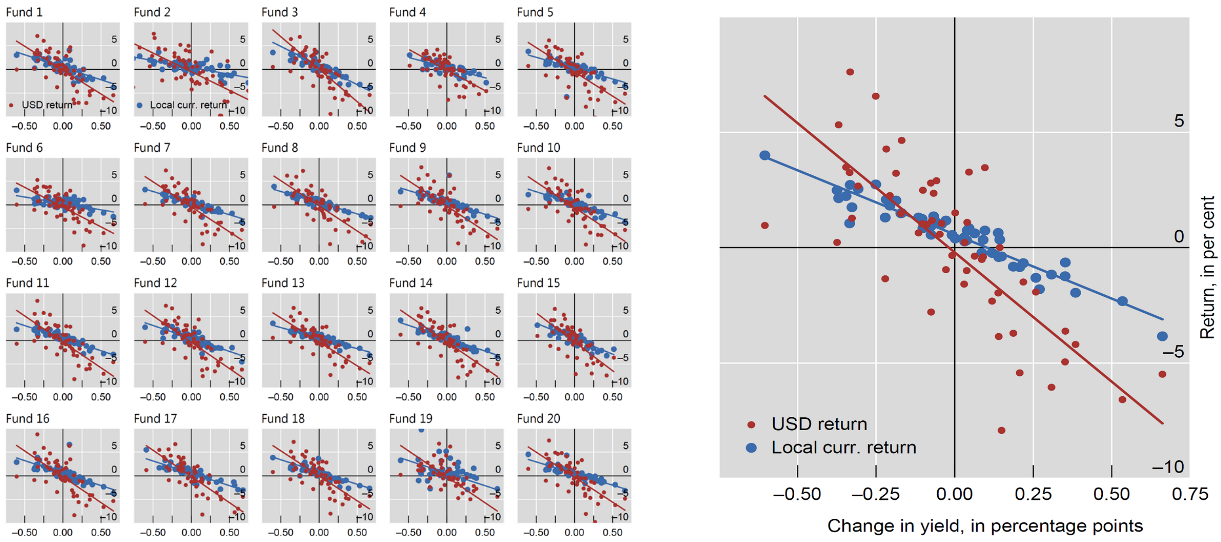
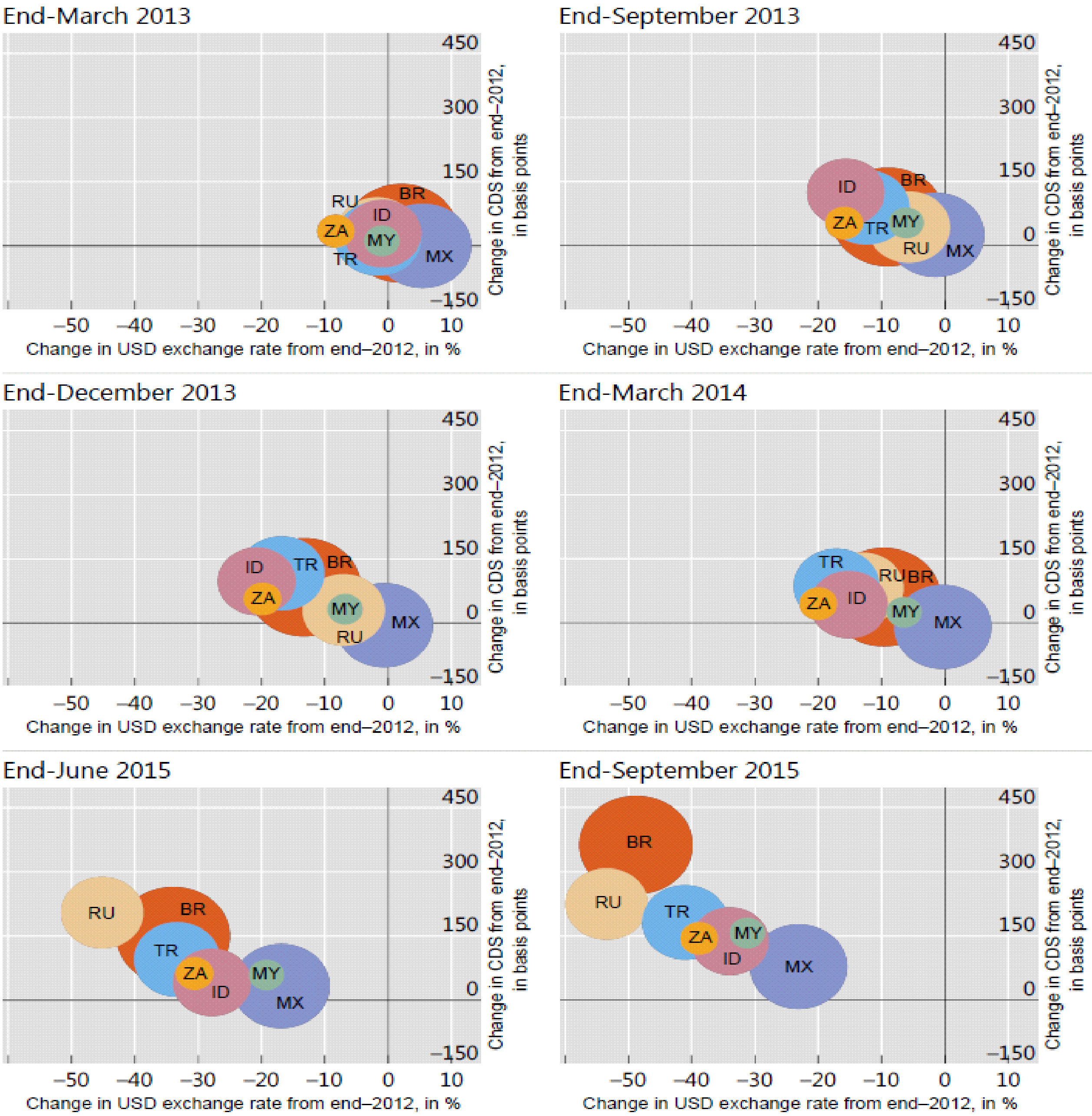


Figure 2. **Dollar and local currency returns on EME local currency sovereign bond funds.** The left-hand panel shows monthly returns on 20 EME local currency sovereign bond funds over the period of January 2011 to July 2015. Blue scatter is local currency return (in per cent) against the domestic bond 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.

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 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



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.

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.

Of course, these unconditional correlations raise more questions than they answer. In particular, the associations suggested by Figures 1, 2 and 3 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 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 the next section.

3 Empirical investigation

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.[5] 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.

Against the background of the stylised facts established in the previous section, we proceed to a more systematic empirical investigation in this section. Specifically, consider the association between the US dollar exchange rate and EME bond market conditions using daily and monthly data for 20 EMEs over the period January 2005 to December 2015. We consider both quantity and price-based indicators of bond market conditions. For the former, we use monthly data for investor flows to individual EMEs via bond mutual funds and exchange-traded funds (ETFs) collected by EPFR Global.[6] For price-based measures we

[5] 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.

[6] Since new EME bond funds are added to the EPFR database over the sample period, we need to

look at daily and monthly data on the spread of the 5-year local currency bond yield over the 5-year Treasury yield. In order to shed light on the channel through which the exchange rate affects the bond spread, specifically whether the effect works through risk spreads or the forward premium, we dissect this indicator into a local currency risk premium component and a forward premium following Du and Schreger (2015). If exchange rates affect bond market conditions through a risk taking channel, we would expect to see in particular a significant link between exchange rate changes and risk premium measures. Due to data limitations, this part of the analysis covers only 14 EMEs. As a cross-check we also consider the CDS spread as an alternative and widely used (dollar-demoniated) indicator of sovereign risk. CDS spreads are available for all 20 EMEs initially covered by our analysis. Appendix 1 provides more details on the data.

Preliminary regressions suggest that 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 when looking at unconditional contemporaneous correlations in our dataset. Specifically, when regressing different measures of EME bond market conditions on the change in the bilateral exchange rate against the US dollar (ΔBER), controlling only for country fixed effects, we find a highly significant positive correlation between bond flows and ΔBER, while the correlation is significantly negative for local currency bond spreads (Table 1, second and third columns). The latter reflects primarily a negative association between the change in the exchange rate and the local currency risk spread (fourth column), while the negative association is only marginally significant in the case of the change in cross-currency swap rates (fifth coulumn). Also for the change in the 5-year CDS spread and ΔBER we find a strong negative association (sixth column).

These results confirm the notion that an appreciation of the bilateral exchange against the US dollar is associated with significantly higher inflows into EME sovereign bond markets and significantly lower EME bond spreads, reflecting in particular lower credit risk spreads. There are, however, several caveats that limit the indicativeness of these findings in Table 1 with respect to the empirical relevance of a risk-taking channel of currency appreciation.

First, as already discussed in section 2, endogeneity is a major issue. Exchange rate appreciation may loosen financial conditions and lower risk spreads, but higher bond inflows and lower risk spreads may in turn drive up the value of the domestic currency (Della Corte et al. (2015)). Second, the association between bond market conditions and the US

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. 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.

	Dependent variable				
	Bond flows	LC spread	DS spread	Swap rate	CDS spread
ΔBER_t	0.332***	−0.047***	−0.025***	−0.027*	−0.053***
	[10.00]	[−3.98]	[−3.03]	[−1.81]	[−12.14]
N	20	20	14	14	20
N×T	2,400	2,483	1,608	1,608	2,430
Within R^2	0.155	0.100	0.050	0.031	0.276

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) aggregate investor flows to EME bond funds as a percentage of net asset value (Bond flows); (ii) the change in the spread of the 5-year local currency bond yield over the corresponding US Treasury yield (LC spread); (iii) 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); (iv) the change in the 5-year cross-currency swap rates (Swap rate) as a measure of the forward currency premium; and (v) the change in difference between the 5-year CDS spread and the corresponding US CDS spread (CDS spread); 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.

dollar exchange rate may reflect common factors, financial or macroeconomic, moving both variables at the same time. And third, the bilateral exchange rate probably moves closely with the nominal effective exchange rate, so that the correlations found may not be indicative of financial channels at work, but may as well reflect the usual trade channels.

In the following empirical analysis, we try to address these issues to the extent possible. We try to address the endogeneity issue by running panel predictive regressions, addressing edogeneity by lagging the explanatory variables,[7] and by doing impulse response analysis in panel VARs. We further include a large range of macroeconomic and financial control variables, trying to control for common factors that might drive the unconditional association between bond market conditions and exchange rates. Finally, we perform the analysis considering both the bilateral USD exchange rate and the nominal effective exchange rate, trying to shed light on the underlying financial or real transmission channels at work.

3.1 Predictive regressions

We start by assessing the impact of exchange rate changes on EME bond market conditions based on monthly and daily predictive regressions estimated by standard panel fixed effects. In the monthly panel predictive regressions, we regress the sovereign bond market indicators Δy on their own lag as well as on the (log) change in the exchange rate (Δe) and a set of

[7] Another way to address endogeneity would be to use an instrumental variable estimator. This approach would, however, be plagued by the problem of finding good instruments for the exchange rate (and any other endogenous variable in the regression).

control variables (Z):

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

For the exchange rate e we consider four different measures: (i) the bilateral US dollar exchange rate (*BER*); (ii) the nominal effective exchange rate (*NEER*); (iii) the wedge between the *BER and* the *NEER* obtained by regressing for each country separately the change in the *BER* on the change in the *NEER*, and retaining the residuals as the part of the *BER* change that is unrelated to the change in the *NEER* (*orth BER*); and (iv) the wedge between the *NEER* and the *BER* 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* (*orth NEER*). The wedge measures serve the purpose of filtering out the correlation between *BER* and *NEER* in order to isolate specific changes in the respective exchange rate measures. The exchange rates are defined such that an increase is an appreciation of the domestic currency.

The set of control variables Z includes the log change in the VIX, the change in year-on-year domestic and US consumer price index (CPI) inflation, the change in year-on-year domestic and US industrial production growth and the change in the domestic and the US 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.[8]

For the price-based bond market conditions indicators where daily data are available, we complement the monthly regressions with daily panel predictive regressions of the form:

$$\Delta y_{i,t+h} = \alpha_i + \rho \Delta y_{i,t-1} + \beta \Delta e_{i,t-1} + \Gamma Z_{i,t-1} + \eta_{i,t+h} \quad (2)$$

where we link the change in the bond market indicator to the lagged change in the exchange rate over horizons (h) of up to 30 trading days. The vector of control variables here includes only the change in the domestic and the US short-term interest rates, the log change in the VIX as the macroeconomic controls are not available in daily frequency.

In order to assess which exchange rate matters for EME financial conditions, we run the regressions in five different specifications: (i) including only the bilateral US dollar exchange

[8] 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.

rate (*BER*); (ii) including only the nominal effective exchange rate (*NEER*); (iii) including the *BER* and the wedge between the *NEER* and the *BER* (*orth NEER*); (iv) including the *NEER* and the wedge between the *BER* and the *NEER* (*orth BER*); and (v) including both the *BER* and the *NEER.*

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 are available upon request, are very similar to the standard fixed-effect panel regression results.

Bond flows and bond spreads

We start out by assessing the impact of exchange rate changes on bond fund flows and the change in the local currency bond spread The results suggest that an appreciation of the *BER* is followed by a significant increase in bond inflows and a significant drop in bond spreads, ie. a loosening of EME financial conditions. This results obtains even when controlling for or filtering out movements in the *NEER*. For appreciations of the *NEER*, in contrast, we do find that it is followed by a loosening of financial conditions once the movements of the *BER* are controlled for.

Specifically, for the regressions with the bond fund flows (Table 2) we find that the impact of the bilateral US dollar exchange rate is both economically and statistically highly significant. An increase in the *BER* (ie an appreciation of the local currency of an EME against the US dollar) increases the ratio of flows to NAV during the next month by about 5 basis points and the effect is significant at the 1% level (second column). The change in the *NEER*, in contrast, does not have a significant effect on bond flows (third column). When the change in the *NEER* and the wedge between the *BER* and the NEER (ie. the changes in the *BER* that are unrelated to changes in the *NEER*) are included in the regressions, the latter comes out significant at the 1% level, while the former is only marginally significant at the 10% level (fifth column). And in the regressions where we include the change in the *BER* with either the wedge between the *NEER* and the *BER* or the actual change in the *NEER*, it is also always the change in the *BER* that has a positive effect which is significant at the 1% level, while the effect of the change in the *NEER* is even estimated significantly negative, ie an appreciation in the *NEER* is estimated to be followed by an outflow of bond funds (fourth and sixth columns).

Dependent variable: aggregate bond fund flows					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	0.047***		0.049***		0.11***
	[3.81]		[4.09]		[4.18]
ΔNEER_{t-1}		0.031		0.032*	−0.082**
		[1.62]		[1.74]	[−2.28]
Orth ΔBER_{t-1}				0.083***	
				[2.64]	
Orth ΔNEER_{t-1}			−0.073*		
			[−1.93]		
N	20	20	20	20	20
N×T	2,502	2,502	2,502	2,502	2,502
Within R^2	0.544	0.543	0.543	0.545	0.545

Table 2. **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, ΔNEER is the log change in the nominal effective exchange rate, Orth ΔBER is the residual from the regression of ΔBER on ΔNEER, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. A positive ΔBER and ΔNEER is an appreciation of the EME currency. The control variables include the lagged dependent variable, the log change in the VIX index, the change in domestic and US year-on-year CPI inflation, the change in domestic and US year-on-year industrial production growth and the change in the domestic and the US 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.

For the local currency bond spreads, we find that an appreciation of the local currency against the US dollar is followed by a significant reduction in EME spreads of about 1.7 basis points and the effect is significant at the 1% level (Table 3). An appreciation of the effective exchange rate has a very similar, albeit somewhat smaller and less significant effect. However, in the regressions where both exchange rates are included, the US dollar exchange

Dependent variable: change in 5 yr LC spread over US Treasuries					
	(1)	(2)	(3)	(4)	(5)
ΔBER_{t-1}	−0.017***		−0.017***		−0.029***
	[−4.25]		[−4.22]		[−4.64]
$\Delta NEER_{t-1}$		−0.015**		−0.013**	0.016
		[−2.29]		[−2.30]	[1.62]
Orth ΔBER_{t-1}				−0.025***	
				[−4.56]	
Orth $\Delta NEER_{t-1}$			0.012		
			[1.25]		
N	20	20	20	20	20
N×T	2,429	2,429	2,429	2,429	2,429
Within R^2	0.113	0.107	0.102	0.116	0.115

Table 3. **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, ΔNEER is the log change in the nominal effective exchange rate, Orth ΔBER is the residual from the regression of ΔBER on ΔNEER, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. A positive ΔBER and ΔNEER is an appreciation of the EME currency. The control variables include the lagged dependent variable, the log change in the VIX index, the change in domestic and US year-on-year CPI inflation, the change in domestic and US year-on-year industrial production growth and the change in the domestic and the US 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.

rate always has a negative impact that is significant at the 1% level. The estimated impact of the effective exchange rate variables is positively signed, but not statistically significant, in the specification where the actual changes of both exchange rates are included.

The results from the daily predictive regressions for the change in the local currency bond spread confirm those of the monthly analysis. Figure 4 shows the exchange rate coefficient from estimating equation (2) for forecast horizon of 1 to 30 trading days in two standard error bands. A 1% appreciation of the *BER* reduces bond spreads by about 3 basis points over the next 30 trading days. An appreciation of the effective exchange rate has very similar effects, albeit they are somewhat smaller in magnitude. However, when we consider the wedge between the effective and the bilateral exchange rates and the specifications where both the bilateral and the effective exchange rates are included, we see also here that it is the US dollar exchange rate that matters for sovereign bond spreads. The impact of the wedge is not statistically significant.[9] In the regressions where both the bilateral and the effective exchange rates are included, we find that an appreciation of the bilateral US dollar exchange rate is associated with lower bond and risk spreads, while an appreciation of the

[9] The impact of the wedge (*orth NEER*) on the foreign currency bond spread is 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.

effective exchange rate leads to higher spreads.

Overall, these results suggest that it is the US dollar exchange rate that matters for bond flows and for local currency sovereign bond spreads. An appreciation of the *BER* is followed by a loosening of EME financial conditions. The change in the *NEER* is always smaller and less significant, and in some specifications even comes out with a sign suggesting that an appreciation is followed by a tightening of EME financial conditions. This 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.

Decomposing bond spreads

Du and Schreger (2015) have shown that the local currency bond spread can be decomposed into a local currency credit risk premium and a forward premium which can be approximated through cross-currency swap rates. Based on this decomposition we assess in this subsection whether the link between the bilateral exchange rate against the US dollar and the local currency bond spread established above runs through the credit risk component as a consequence of a risk-taking channel, or through the forward premium by affecting expectations of future exchange rates. To this end, we run the monthly and daily predictive regressions using the Du-Schreger (2015) measure of local currency sovereign credit risk and the change in the cross-currency swap rate which serves as a proxy for the forward currency premium, the other component of the local currency bond spread. As a cross-check, we also run the regressions using the (dollar denominated) 5-year CDS spread. The results support the notion of a risk-taking channel of currency appreciation being at work in EME bond markets. Specifically, we find that an appreciation of the domestic currency against the US dollar is followed by significant reduction in credit risk measures. Appreciations of the nominal effective exchange rate generally do not significantly lower risk spreads. For the swap rates, exchange rate effects are generally insignificant.

The results of the monthly regressions show that an appreciation of the *BER* lowers the credit risk spread in a statistically significant way across all specifications (Table 4). The estimated magnitude of the effects ranges from 1.3 to 2.5 basis points. The impact of a change in the *NEER* is never statistically significant. For the change in the swap rates, the impact of exchange rates are generally insignificant (Table 5). Only in two specifications we obtain a marginally significant negative effect of the change in the *BER* on the swap rates. These results suggest that it is the US dollar exchange rate that influences EME sovereign spreads primarily through the risk spread that is embedded in them.

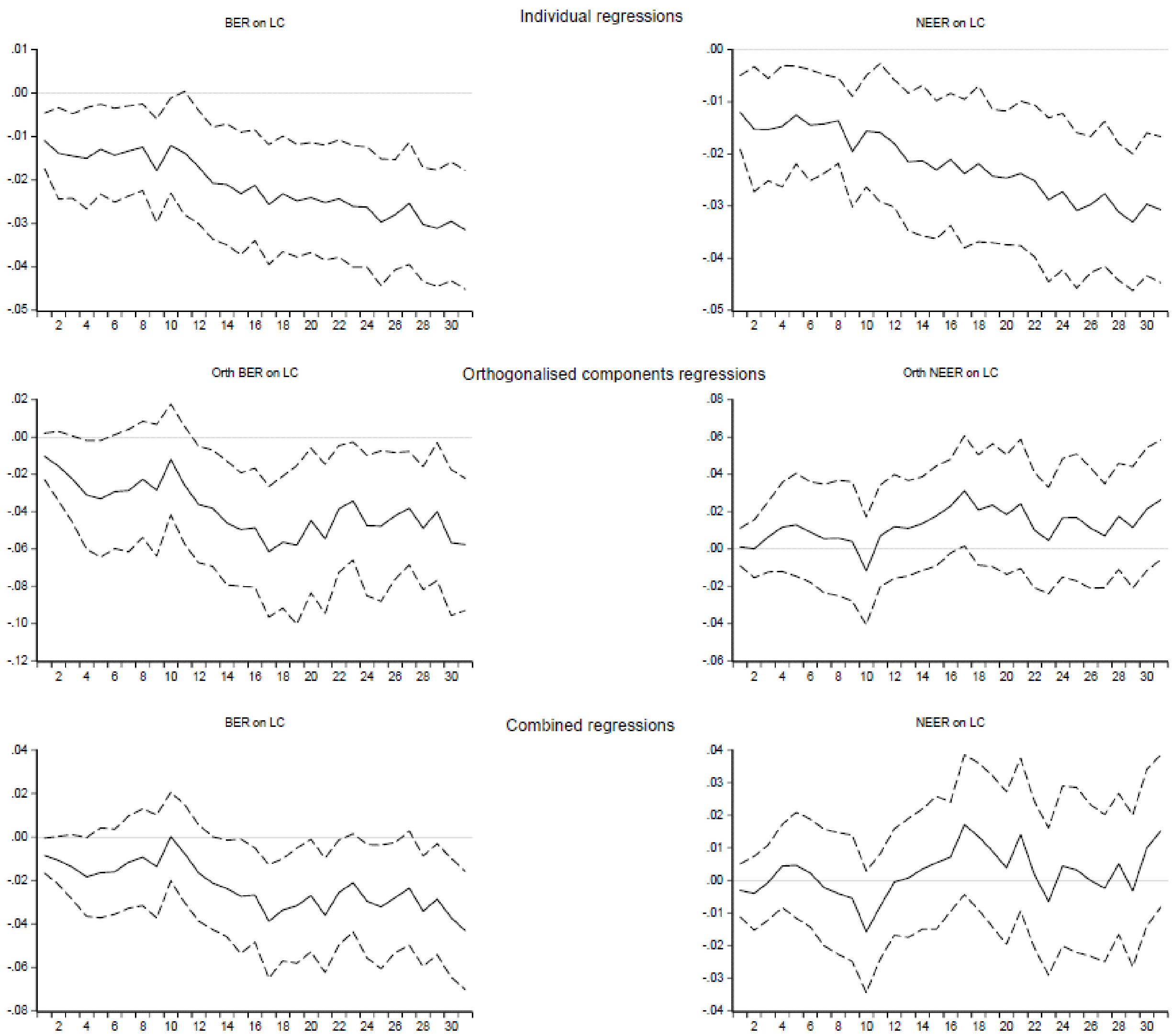


Figure 4. **Impact of exchange rates on 5-year local currency bond spreads.** The figure shows the impact of the lagged change in the bilateral exchange rate against the US dollar (BER) and the nominal effective exchange rate (NEER) on the change in the local currency sovereign bond spread (LC) over the next h = 1,..,30 trading days. 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.

Dependent variable: change in Du-Schreger risk spread					
	(1)	(2)	(3)	(4)	(5)
ΔBER$_{t-1}$	−0.013**		−0.012**		−0.025**
	[−2.39]		[−2.37]		[−2.18]
ΔNEER$_{t-1}$		−0.010		−0.010	0.018
		[−1.46]		[−1.42]	[1.10]
Orth ΔBER$_{t-1}$				−0.020**	
				[−2.00]	
Orth ΔNEER$_{t-1}$			0.005		
			[0.25]		
N	14	14	14	14	14
N×T	1,548	1,548	1,548	1,548	1,548
Within R^2	0.058	0.051	0.044	0.061	0.058

Table 4. **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, ΔNEER is the log change in the nominal effective exchange rate, Orth ΔBER is the residual from the regression of ΔBER on ΔNEER, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. A positive ΔBER and ΔNEER is an appreciation of the EME currency. The control variables include the lagged dependent variable, the log change in the VIX index, the change in domestic and US year-on-year CPI inflation, the change in domestic and US year-on-year industrial production growth and the change in the domestic and the US 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$_{t-1}$	−0.006		−0.006		−0.021*
	[−0.98]		[−1.09]		[−1.87]
ΔNEER$_{t-1}$		−0.001		−0.002	0.020
		[−0.14]		[−0.28]	[1.10]
Orth ΔBER$_{t-1}$				−0.021*	
				[−1.82]	
Orth ΔNEER$_{t-1}$			0.022		
			[1.32]		
N	14	14	14	14	14
N×T	1,587	1,587	1,587	1,587	1,587
Within R^2	0.033	0.032	0.035	0.036	0.037

Table 5. **Cross-currency swap rates.** This table reports monthly country fixed-effects panel regressions; dependent variable is the change in the 5-year cross-currency swap rate, which is equivalent to the 5-year forward premium. ΔBER is the log change in the bilateral exchange rate against the US dollar, ΔNEER is the log change in the nominal effective exchange rate, Orth ΔBER is the residual from the regression of ΔBER on ΔNEER, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. A positive ΔBER and ΔNEER is an appreciation of the EME currency. The control variables include the lagged dependent variable, the log change in the VIX index, the change in domestic and US year-on-year CPI inflation, the change in domestic and US year-on-year industrial production growth and the change in the domestic and the US 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}	-0.016^{***}		-0.017^{***}		-0.018^{***}
	[−5.42]		[−5.66]		[−6.29]
ΔNEER_{t-1}		-0.008^{**}		-0.009^{***}	0.037^{***}
		[−2.21]		[−2.63]	[5.68]
Orth ΔBER_{t-1}				-0.040^{***}	
				[−5.44]	
Orth ΔNEER_{t-1}			0.034^{***}		
			[5.34]		
N	20	20	20	20	20
N×T	2,377	2,377	2,377	2,377	2,377
Within R^2	0.127	0.114	0.120	0.141	0.140

Table 6. **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, ΔNEER is the log change in the nominal effective exchange rate, Orth ΔBER is the residual from the regression of ΔBER on ΔNEER, and Orth ΔNEER is the residual from the regression of ΔNEER on ΔBER. A positive ΔBER and ΔNEER is an appreciation of the EME currency. The control variables include the lagged dependent variable, the log change in the VIX index, the change in domestic and US year-on-year CPI inflation, the change in domestic and US year-on-year industrial production growth and the change in the domestic and the US 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.

This assessment is supported by the daily regressions. Here we find that the US dollar bilateral exchange rate Granger-causes EME sovereign risk spreads over all forecast horizons (Figure 5). The estimated effects are somewhat larger than those obtained from the monthly regressions, with a peak impact of between 3 and 5 basis points. The change in the *NEER* has no significant effect once the change in the *BER* is filtered out or controlled for. In contrast, there is no significant effect of neither the *BER* nor the *NEER* on the cross-currency swap rate (Figure 6).

The results for the CDS spread, which are reported in Table 6 (monthly regressions) and Figure 7 (daily regressions), further support the conjecture that the impact of the US dollar on EME bond spreads works through credit risk spreads. We find that an appreciation of the *BER* lowers CDS spreads in a highly significant way. In the monthly regressions, the estimated impact ranges between 1.6 and 4 basis points. The estimated effect is larger when we control for the influence of the change in the *NEER*. This reflects the fact that the estimated impact of the *NEER* is strongly and significantly positive, so that an appreciation raises CDS spreads, probably reflecting trade-channel type effects mentioned before. As a consequence, the estimated negative effect of a change in the *BER* is larger when we filter out or control for movements in the *NEER*.

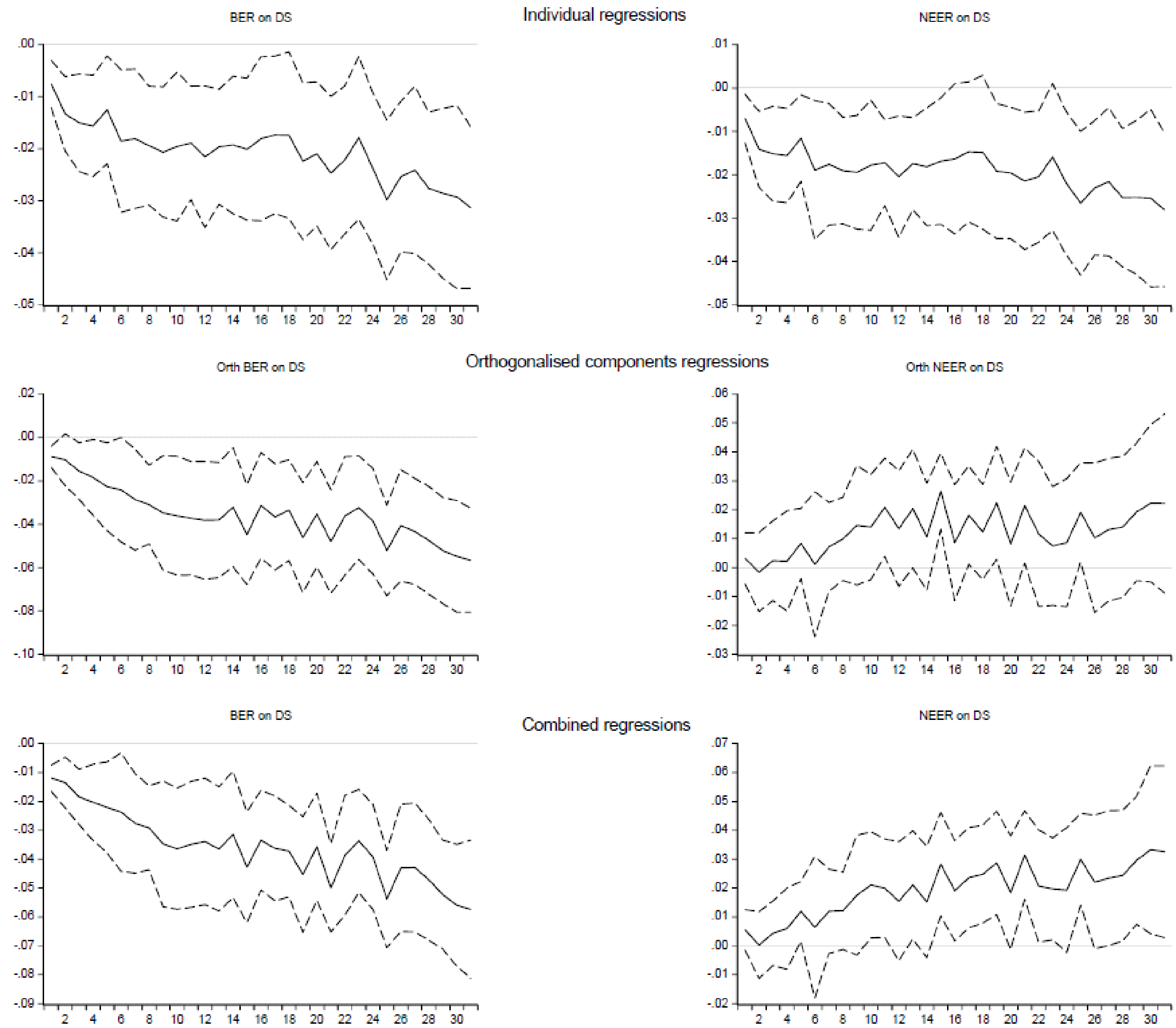


Figure 5. **Impact of exchange rates on 5-year local currency sovereign risk spreads.** The figure shows the impact of the lagged change in the bilateral exchange rate against the US dollar (BER) and the nominal effective exchange rate (NEER) on the change in the local currency sovereign risk spread (DC) over the next h = 1,..,30 trading days. 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.

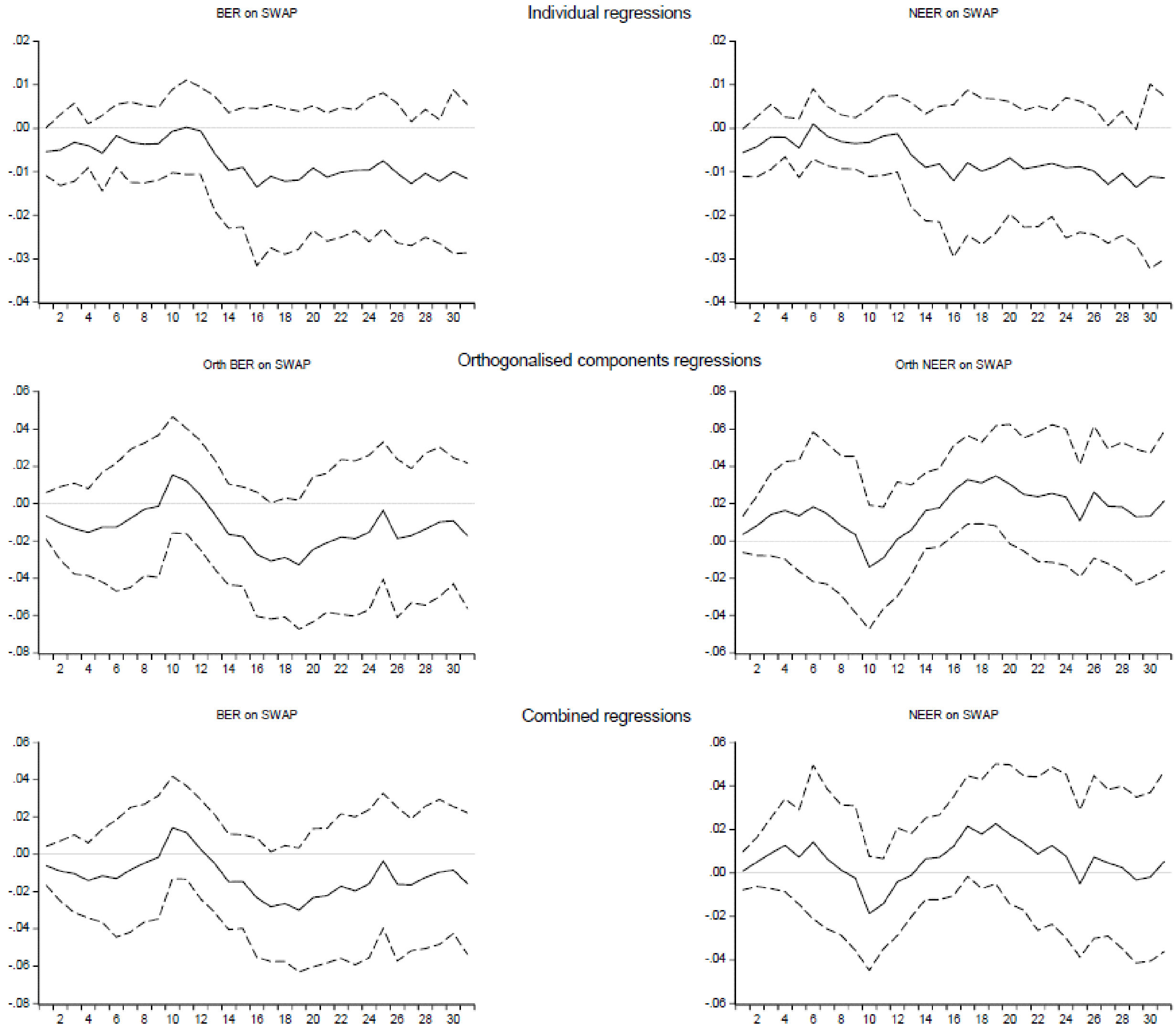


Figure 6. **Impact of exchange rates on 5-year forward premiums (cross-currency swap rates).** The figure shows the impact of the lagged change in the bilateral exchange rate against the US dollar (BER) and the nominal effective exchange rate (NEER) on the change in the 5-year cross-currency swap rate (Swap)) over the next h = 1,..,30 trading days. 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.

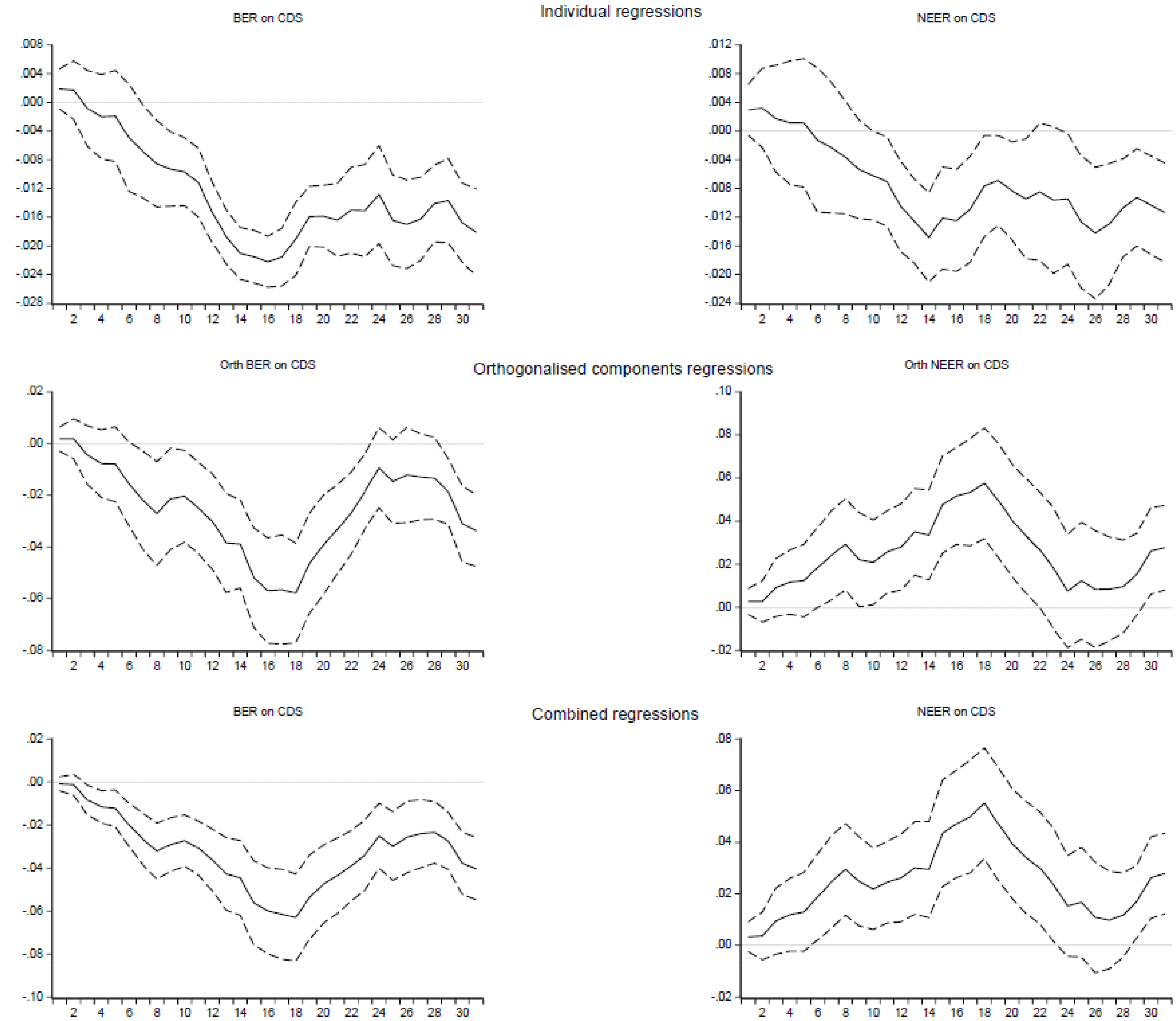


Figure 7. **Impact of exchange rates on 5-year CDS spreads.** The figure shows the impact of the lagged change in the bilateral exchange rate against the US dollar (BER) and the nominal effective exchange rate (NEER) on the change in the CDS spread (DC) over the next h = 1,..,30 trading days. Control 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.

Overall, the results confirm the notion that an appreciation of the bilateral exchange rate against the US dollar loosens financial conditions in EMEs through a risk-taking channel, ie by lowering credit risk spreads. The results further suggest that it is the US dollar exchange rate that works through these financial channels, and not the effective exchange rate. An appreciation of the latter is instead often followed by higher bond and risks spreads. This suggests that the *NEER* seems to work instead through the classical trade channels whereby an appreciation leads to higher bond and risk spreads due to the adverse economic effects of the associated loss in trade competitiveness.

It is worthwhile highlighting that 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 presumably also 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.

But how important is the impact of the US dollar exchange rate on EME bond and credit risk spreads economically? According to the monthly regressions, which yield smaller and hence more conservative estimates, a 1% appreciation of the domestic currency against the US dollar lowers local currency bond and risk spreads by between 1.5 to 3 basis points, depending on the specification. Taken at face value, the economic impact therefore 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 3.7–7.5 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. Over this period, 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 90 basis points to EME bond and credit risk spreads through the risk-taking channel of exchange rate appreciation.

3.2 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:

$$Y_{i,t} = A_i + B(L)Y_{i,t-1} + C(L)X_{i,t-1} + \varepsilon_{i,t}. \tag{3}$$

where Y is a vector of endogenous variables comprising 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. X is a vector of exogenous variables comprising the log change in US industrial production and US CPI, the log change in the VIX and the change in the US 3-month money market rate. The lag order of the VARs is two, determined based on the Schwarz-Bayes information criterion where up to six lags were considered. We estimate VARs separately for the five measures of sovereign bond market conditions (bond fund flows, 5-year local currency bond spread, 5-year Du-Schreger local currency credit risk spread, 5-year cross currency swap rate and 5-year CDS spread). The VARs are estimated first with the *BER* and the *NEER* entering separately, and then with the two exchange rates jointly. We thus estimate in total 15 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. In the VAR where both exchange rates enter jointly, we apply two different identification schemes, respectively ordering the exchange rate whose shock impact is analysed last. In other words, when we investigate the impact of a shock to the change in the *BER*, then that exchange rate is ordered last and the change in the *NEER* is ordered second to last. When we investigate the impact of a shock to the change in the *NEER*, this order is reversed. We thus consistently endogenise the exchange rate we look at to the maximum extent by putting it last in the recursive system when we identify the shock.

Figures 8 to 12 show the accumulated impulse response functions (IRFs) of the five EME bond market conditions indicators 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. The accumulated impulse responses are similar to the impact of the exchange rates found in the

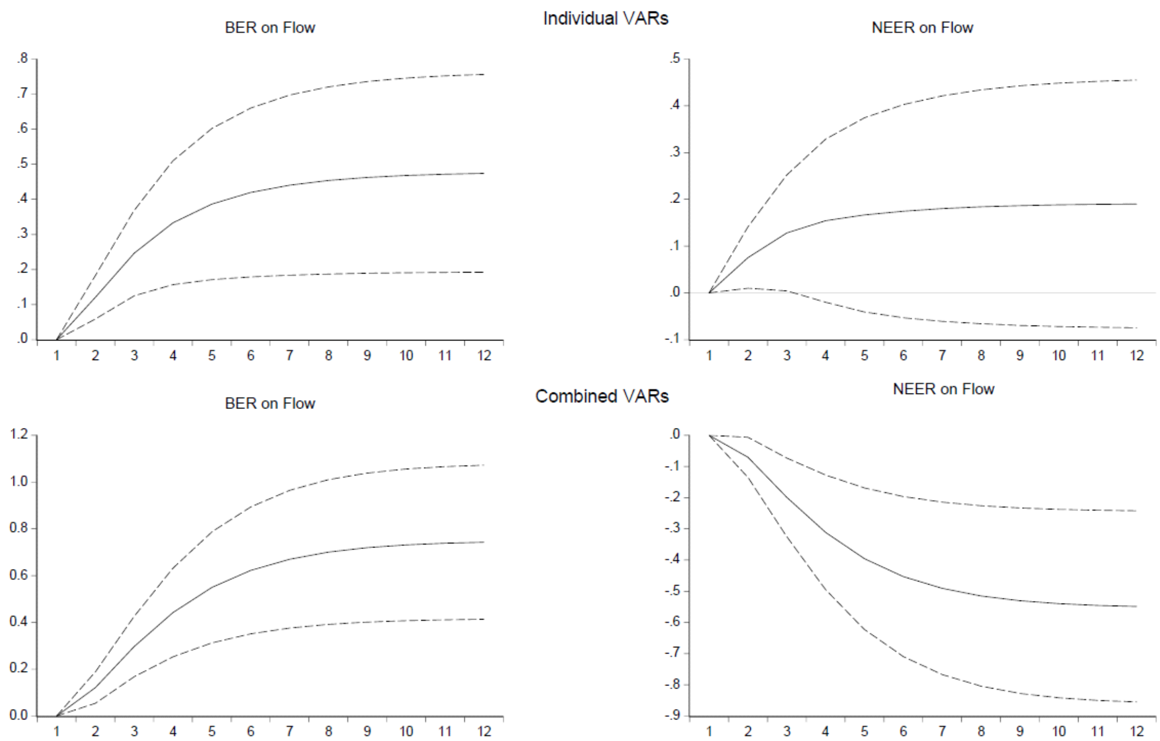


Figure 8. **Impulse response functions (IRFs) of bond fund inflows to a one standard deviation exchange rate shock.** The upper panels show IRFs to exchange rate shocks from panel VARs estimated with each exchange rate included separately. The lower panels show IRFs from panel VARs with both exchange rates included. The exchange rate for which the IRF is shown is respectively ordered last in the system. BER refers to the bilateral exchange rate against the US dollar, NEER to the nominal effective exchange rate (NEER). The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

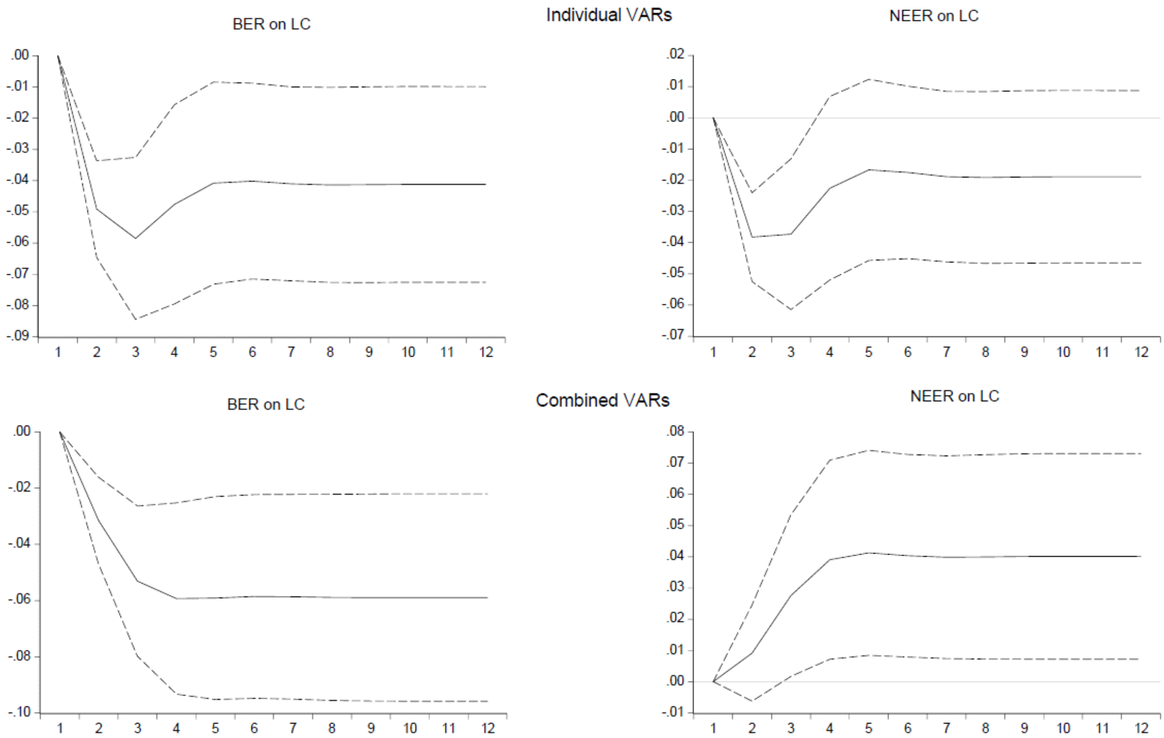


Figure 9. **Impulse response functions (IRFs) of 5-year local currency bond spreads to a one standard deviation exchange rate shock.** The upper panels show IRFs to exchange rate shocks from panel VARs estimated with each exchange rate included separately. The lower panels show IRFs from panel VARs with both exchange rates included. The exchange rate for which the IRF is shown is respectively ordered last in the system. BER refers to the bilateral exchange rate against the US dollar, NEER to the nominal effective exchange rate (NEER). The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

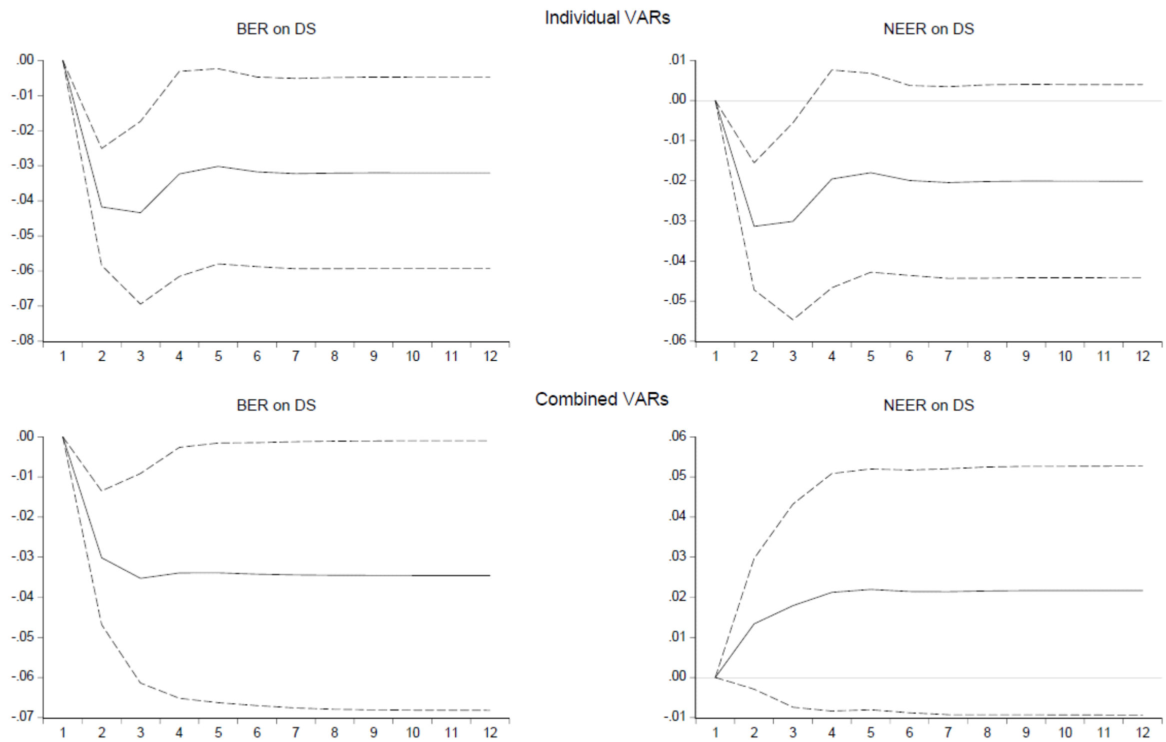


Figure 10. **Impulse response functions (IRFs) of 5-year local-currency sovereign risk spreads (Du and Schreger (2015)) to a one standard deviation exchange rate shock.** The upper panels show IRFs to exchange rate shocks from panel VARs estimated with each exchange rate included separately. The lower panels show IRFs from panel VARs with both exchange rates included. The exchange rate for which the IRF is shown is respectively ordered last in the system. BER refers to the bilateral exchange rate against the US dollar, NEER to the nominal effective exchange rate (NEER). The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

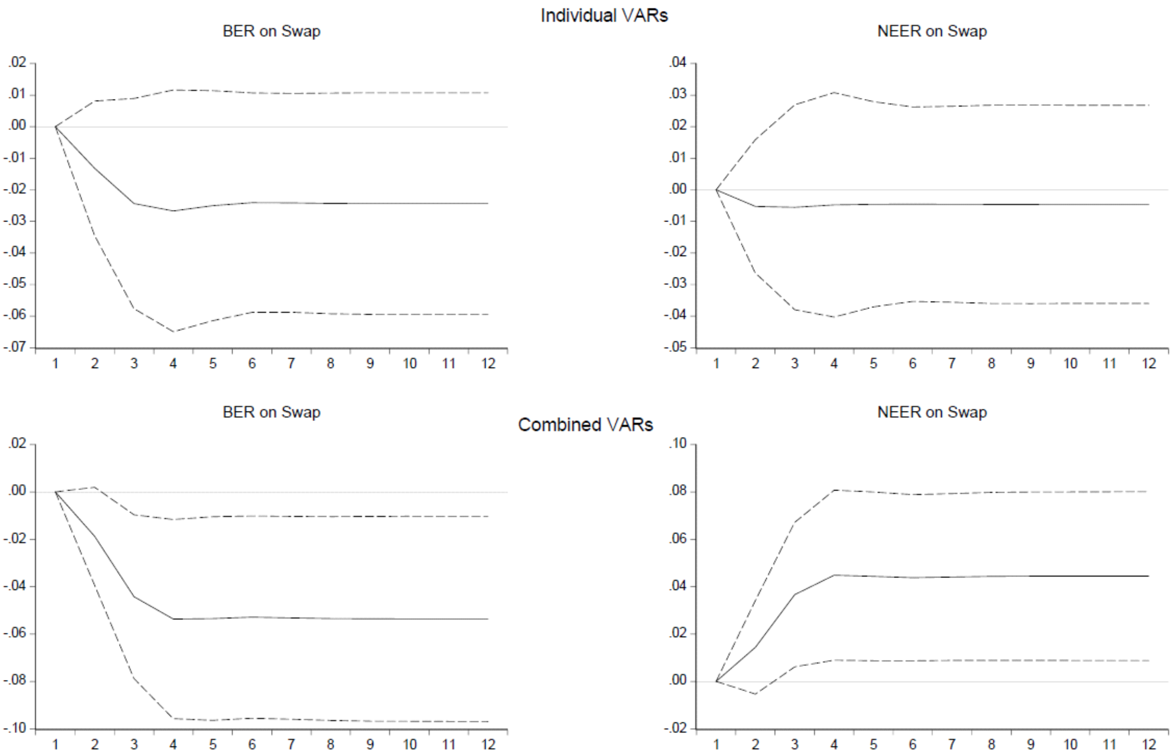


Figure 11. **Impulse response functions (IRFs) of 5-year forward premiums (cross-currency swap rates) to a one standard deviation exchange rate shock.** The upper panels show IRFs to exchange rate shocks from panel VARs estimated with each exchange rate included separately. The lower panels show IRFs from panel VARs with both exchange rates included. The exchange rate for which the IRF is shown is respectively ordered last in the system. BER refers to the bilateral exchange rate against the US dollar, NEER to the nominal effective exchange rate (NEER). The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

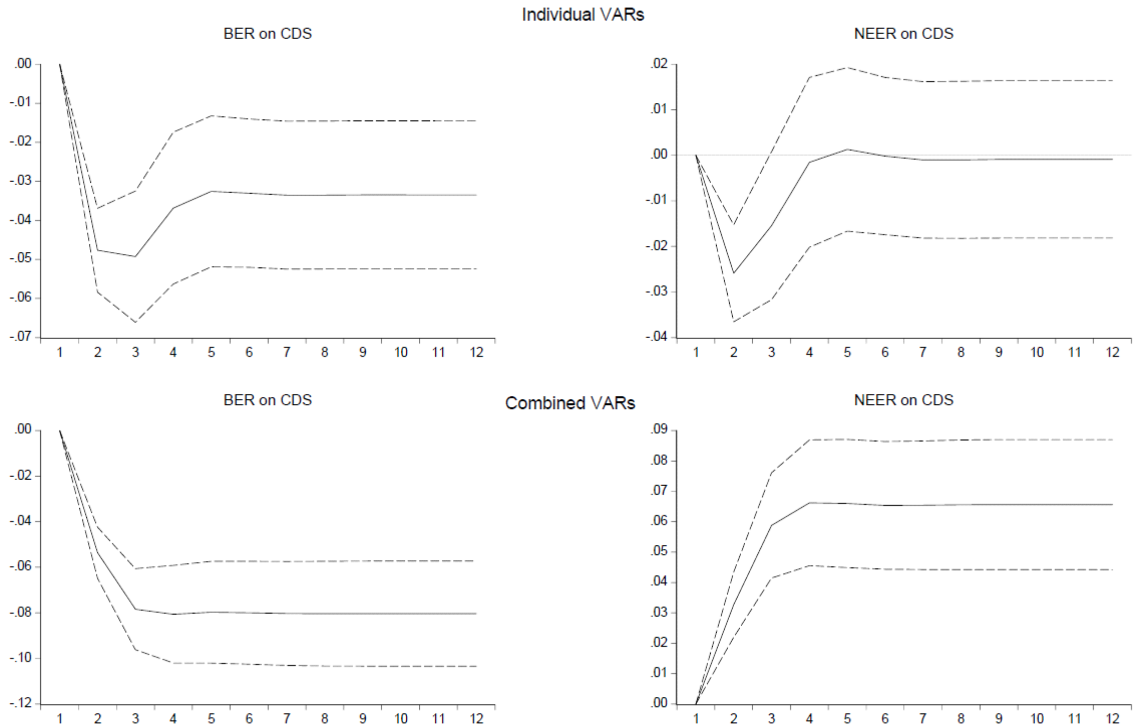


Figure 12. **Impulse response functions (IRFs) of 5-year CDS spreads to a one standard deviation exchange rate shock.** The upper panels show IRFs to exchange rate shocks from panel VARs estimated with each exchange rate included separately. The lower panels show IRFs from panel VARs with both exchange rates included. The exchange rate for which the IRF is shown is respectively ordered last in the system. BER refers to the bilateral exchange rate against the US dollar, NEER to the nominal effective exchange rate (NEER). The broken lines denote the two-standard error bands around the IRF, obtained from a Monte Carlo simulation with 1,000 replications.

panel regressions. The accumulated effect of a one standard deviation shock to the *BER* consistently increases bond flows and lowers bond and credit risk spreads in a statistically significant way. Specifically, in both the VARs where the two exchange rates enter separately and in those where both are included, a shock to the *BER* significantly increases bond flows (Figure 8) and significantly lower local currency bond spreads (Figure 9). The magnitudes of the shock effects are similar to those estimated in the predictive regressions.

The results further show that a shock to the *BER* consistently lowers credit risk spreads, both the local currency variant (Figure 10) and the CDS spread (Figure 12). The impact on the swap rate is not clear cut, with a significant negative impact obtaining only from the VAR where both exchange rates are included (Figure 11).

The effects of a shock to the *NEER* goes in the same direction as those of a shock to the *BER* when the *NEER* enters the VAR alone (top right panels in Figures 8–12). However, when both exchange rates are include in the VAR and innovations to the *BER* are filtered out of the *NEER* shock, then the impact goes in the opposite direction (bottom right panels in Figures 8–12). This confirms the conjecture made above that movements in the *NEER* that are unrelated to changes in the *BER* affect financial conditions through standard trade channels so that an appreciation yields a tightening of financial conditions. This contrasts with the loosening of financial conditions that is brought about by an appreciation against the US dollar as a result of financial risk-taking channels.

4 A case study

An alternative way of looking for evidence for a risk-taking channel of currency appreciation are case studies. This requires finding an event where the exchange rate changed for exogenous reasons, eg. as a result of a deliberate policy decision. The trajectory of bond flows and bond spreads around this date would then be indicative of the presence of a risk-taking channel. The difficulty lies of course in finding truly exogenous changes in the exchange rate.

One event in our sample that fulfils this requirement is the People's Bank of China's (PBC) announcement of major changes to its foreign exchange policy on 11 August 2015. In particular, although the renminbi would continue to trade against the US dollar in a +/− 2% daily band, the PBC decided that the central parity around which the band is set would be determined by the previous day's closing market rate rather than a preset target rate. This change led to volatility in the foreign exchange markets. The renminbi slipped by 2.8% against the US dollar in the two days after the surprise announcement.

This sharp depreciation is an example of a sudden, unexpected and exogenous change in the bilateral exchange rate of a local currency against the US dollar. The left-hand panel

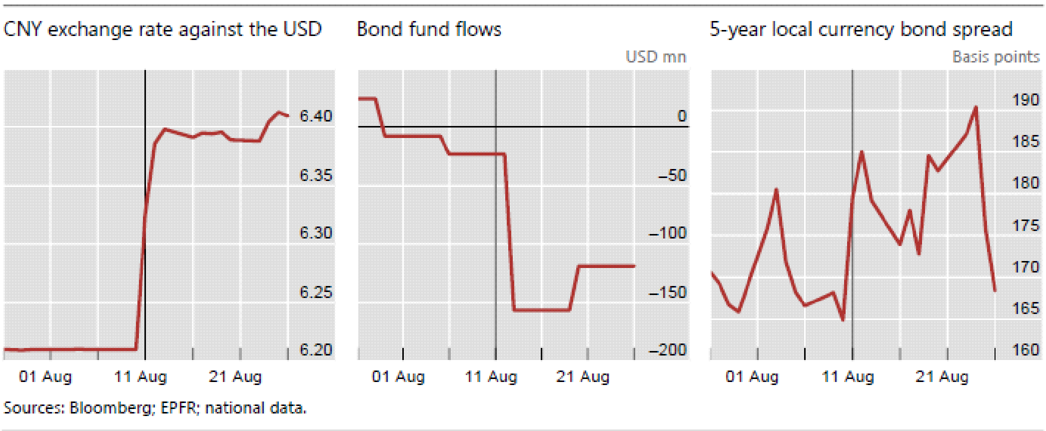


Figure 13. **Impact of a depreciation of Chinese yuan on bond spreads and bond fund flows.**

of Figure 13 shows the magnitude of the sudden depreciation of Chinese yuan against the US dollar. The centre panel shows that bond fund flows to China has significantly dropped immediately after the deprecation. Finally, the right-hand panel shows that China's local currency government bond spread has also spiked up on 11 August and remained at elevated levels afterwards.

Overall, therefore, the case study of the PBC's announcement on 11 August 2015 yields evidence that is indicative of a risk-taking channel being at work in EME bond markets. Here, a depreciation of the domestic currency against the US dollar was followed by a significant drop in bond inflows and rising sovereign bond spreads.

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. Specifically, 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.

We have shown that the main predictions of the risk-taking channel are borne out in the 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 against the US dollar is associated with greater bond fund flows and lower bond spreads as a consequence of lower credit risk spreads. These effects reverse when the currency depreciates. Together with the evidence that lower sovereign risk pushes up the exchange rate as reported 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, hence 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.

References

Aastveit, Knut Are, Hilde C. Bjornland and Leif Anders Thorsrud (2015): "What drives oil prices? Emerging versus developed economies", *Journal of Applied Econometrics*, vol 30(7), pp 1013-1028.

Agénor, Pierre-Richard, Koray Alper and Luiz Pereira da Silva (2014): "Sudden floods, macroprudential regulation and stability in an open economy", *Journal of International Money and Finance*, vol 48, pp 68–100.

Aghion, Philippe, Philippe Bacchetta and Abhijit Banerjee (2000): "A simple model of monetary policy and currency crises", *European Economic Review*, vol 44, pp 728–738.

Aghion, Philippe, Philippe Bacchetta and Abhijit Banerjee (2004): "A corporate balance-sheet approach to currency crises", *Journal of Economic Theory*, vol 119, pp 6–30.

Akram, Qaiser Farooq (2009): "Commodity prices, interest rates and the dollar", *Energy Economics*, vol 31, pp 838–851.

Amstad, Marlene, Eli Remolona and Jimmy Shek (2016): "How do global investors differentiate between sovereign risks? The new normal versus the old", *Journal of International Money and Finance*, forthcoming.

Avdjiev, Stefan, Robert McCauley and Hyun Song Shin (2015): "Breaking free of the triple coincidence in international finance", *BIS Working Papers* no 526, October.

Bacchetta, Philippe (2012): "Explaining deviations from uncovered interest rate parity", Chapter 23 in G. Caprio (ed.), *Handbook of Safeguarding Global Financial Stability: Political, Social, Cultural, and Economic Theories and Models*, Academic Press.

Baskaya, Yusuf Soner, Julian di Giovanni, Sebnem Kalemli-Ozcan, José-Luis Peydró and Mehmet Fatih Ulu (2015): "Capital flows, credit cycle and investment: the role of macroprudential policy", paper presented at the CBRT-BIS-IMF conference on Macroprudential Policy: Effectiveness and Implementation Challenges, Istanbul, 26–27 October 2015.

Bekaert, Geert, Marie Hoerova and Marco Lo Duca (2013): "Risk, uncertainty and monetary policy", *Journal of Monetary Economics*, vol 60, pp 771–788.

Bellas, Dimitri, Michael Papaioannou and Iva Petrova (2010): "Determinants of emerging market sovereign bond spreads: fundamentals vs financial stress", *IMF Working Papers* WP/10/281, December.

Blanchard, Olivier, Jonathan Ostry, Atish Ghosh and Marcos Chamon (2015): "Are capital inflows expansionary or contractionary? Theory, policy implications and some evidence", *NBER Working Paper* no 21619.

Borio, Claudio and Philip Lowe (2002): "Assessing the risk of banking crises", *BIS Quarterly Review*, December, pp 43–54.

Borio, Claudio and Haibin Zhu (2012): “Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism?” *Journal of Financial Stability*, vol 8(4), pp 236–251.

Bruno, Valentina and Hyun Song Shin (2015a): “Cross-border banking and global liquidity”, *Review of Economic Studies*, vol 82(2), pp 535–564.

Bruno, Valentina and Hyun Song Shin (2015b): “Capital flows and the risk-taking channel of monetary policy”, *Journal of Monetary Economics*, vol 71, pp 119–132.

Bussière, Matthieu, Claude Lopez and Cédric Tille (2015): “Do real exchange rate appreciations matter for growth?” *Economic Policy*, January, pp 5–45.

Cerutti, Eugenio, Stijn Claessens and Lev Ratnovski (2014): “Global liquidity and drivers of cross-border bank flows”, *IMF Working Papers* WP/14/69.

Céspedes, Luis Felipe, Roberto Chang and Andrés Velasco (2004): “Balance sheets and exchange rate policy”, *American Economic Review*, vol 94(4), pp 1183–1193.

Della Corte, Pasquale, Lucio Sarno, Maik Schmeling and Christian Wagner (2015): “Exchange rates and sovereign risk”, unpublished manuscript.

Du, Wenxin and Jesse Schreger (2014): “Sovereign risk, currency risk and corporate balance sheets”, unpublished manuscript.

Du, Wenxin and Jesse Schreger (2015): “Local currency sovereign risk”, *Journal of Finance*, forthcoming.

Feyen, Erik H.B., Swati R. Ghosh, Katie Kibuuka and Suika Farazi (2015): “Global liquidity and external bond issuance in emerging markets and developing economies”, *World Bank Policy Research Working Paper* WPS7363.

Fleming, J. Marcus (1962): “Domestic financial policies under fixed and floating exchange rates”, *IMF Staff Papers*, vol 9, pp 369–379.

Gabaix, Xavier and Matteo Maggiori (2015): "International liquidity and exchange rate dynamics", *The Quarterly Journal of Economics*, vol. 130(3), pp. 1369-1420.

Gadanecz, Blaise, Ken Miyajima and Chang Shu (2014): “Exchange rate risk and local currency sovereign bond yields in emerging markets”, *BIS Working Papers* no 474, December.

Gourinchas, Pierre-Olivier and Maurice Obstfeld (2012): “Stories of the twentieth century for the twenty-first”, *American Economic Journal: Macroeconomics*, vol 4(1), pp 226–265.

Hnatkovska, Viktoria, Amartya Lahiri and Carlos A. Vegh (2016): “The exchange rate response to monetary policy innovations”, *American Economic Journal: Macroeconomics*, forthcoming.

Hofmann, Boris and Előd Takáts (2015): “International monetary spillovers”, *BIS Quarterly Review*, September, pp 105–118.

Hofmann, Boris, Ilhyock Shim and Hyun Song Shin (2015): "Sovereign yields and the risk-taking channel of currency appreciation", *BIS Working Papers* no 538, January.

Kaminsky, Graciela L. and Carmen M. Reinhart (1999): "The twin crises: the causes of banking and balance-of-payments problems", *American Economic Review*, vol 89, pp 473–500.

Kohlscheen, Emanuel (2014): "The impact of monetary policy on the exchange rate: a high frequency exchange rate puzzle in emerging economies", *Journal of International Money and Finance*, vol 44, pp 69–96.

Krugman, Paul (1999): "Balance sheets, the transfer problem and financial crises," in P. Isard, A. Razin, and A.K. Rose (eds.), *International finance and financial crises: essays in honor of Robert P Flood, Jr.* Boston: Kluwer Academic, pp 31–44.

Krugman, Paul (2014): "Currency regimes, capital flows and crises", *IMF Economic Review*, vol 62(4), pp 470–493, Mundell-Fleming Lecture, November 2013.

McCauley, Robert N., Patrick McGuire and Vladyslav Sushko (2015): "Global dollar credit: links to US monetary policy and leverage", *Economic Policy*, vol 30(82), pp 187–229, April.

Merton, Robert C. (1974): "On the pricing of corporate debt: the risk structure of interest rates", *Journal of Finance*, vol 29, pp 449–470.

Mian, Atif, Amir Sufi and Emil Verner (2015): "Household debt and business cycles worldwide", *NBER Working Paper* no 21581, September.

Mundell, Robert A. (1963): "Capital mobility and stabilisation policy under fixed and flexible exchange rates", *Canadian Journal of Economic and Political Science*, vol 29(4), pp 475–485.

Morais, Bernardo, José-Luis Peydró and Claudia Ruiz (2015): "The international bank lending channel of monetary policy rates and quantitative easing", *World Bank Policy Research Working Paper* WPS7216.

Nickell, Stephen (1981): "Biases in dynamic models with fixed effects", *Econometrica*, vol 49(6), pp 1417–26.

Obstfeld, Maurice (2015): "Trilemmas and trade-offs: living with financial globalisation", *BIS Working Papers* no 480, January.

Plantin, Guillaume and Hyun Song Shin (2016): "Exchange rates and monetary spillovers", *BIS Working Papers* no 537, January.

Pesaran, M. Hashem and Ronald P. Smith (1995): "Estimating long-run relationships from dynamic heterogeneous panels", *Journal of Econometrics*, vol 68(1), pp 79–113.

Reinhart, Carmen M. and Vincent Reinhart (2009): "Capital flow bonanzas: an encompassing view of the past and present", *NBER Macroeconomics Annual*, University of Chicago Press.

Rey, Hélène (2013): "Dilemma not trilemma: the global financial cycle and monetary policy independence", proceedings of the Federal Reserve Bank of Kansas City Economic Symposium at Jackson Hole.

Rey, Hélène (2014): "International channels of transmission of monetary policy and the Mundellian trilemma", Mundell-Fleming Lecture at the fifteenth Jacques Polak Annual Research Conference on Cross-Border Spillovers, November 2014.

Shek, Jimmy, Ilhyock Shim and Hyun Song Shin (2015): "Investor redemptions and fund manager sales of emerging market bonds: how are they related?" *BIS Working Papers* no 509, August.

Sobrun, Jhuvesh and Philip Turner (2015): "Bond markets and monetary policy dilemmas for the emerging markets", *BIS Working Papers* no 508, August.

Vasicek, Oldrich (2002): "The Distribution of Loan Portfolio Value" *Risk*, December, http://www.moodyskmv.com/conf04/pdf/papers/dist_loan_port_val.pdf

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