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Bond Risk Premia and The Exchange Rate

In emerging market economies, currency appreciation goes hand in hand with compressed sovereign bond spreads, even for local currency sovereign bonds. This yield compression comes from a reduction in the credit risk premium. Crucially, the relevant exchange rate involved in yield compression is the bilateral U.S. dollar exchange rate, not the trade-weighted exchange rate. Our findings highlight endogenous co-movement of bond risk premia and exchange rates through the portfolio choice of global investors who evaluate returns in dollar terms.

JEL codes: G12, G15, G23
Keywords: bond spread, capital flow, credit risk, emerging market, exchange rate

After the emerging market crises of the 1990s, policy efforts were focused on reducing vulnerabilities stemming from foreign currency debt. Perhaps the most notable transformation has been the growth of local currency sovereign bond markets in many emerging market economies (EMEs). These developments overcame "original sin," a term coined by Barry Eichengreen and Ricardo Hausmann (1999) for the inability of developing countries to borrow from abroad in their domestic currency. Many EME sovereigns now routinely borrow in their local currency. However, owing to their smaller domestic institutional investor base, they do so to a large extent from foreign portfolio investors (BIS 2019). As a result of the shift in the currency composition of the bond market, global investors increasingly

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hold a large share of EME bonds that are denominated in local currency. Since these investors measure their returns in terms of U.S. dollars or other major currencies, exchange rate movements amplify their gains and losses, thereby magnifying the risks they face in meeting obligations in their home currency.

In this sense, original sin may not have disappeared altogether, but rather may have shifted elsewhere within the financial system. The currency mismatch is no longer borne by the EME sovereign borrower but has migrated to the foreign holders of the bonds.[1] Carstens and Shin (2019) have coined the term "original sin redux" to refer to the fluctuations in risk appetite of global investors in EME bonds that arise endogenously from currency movements, thereby linking local currency yields with the exchange rate.

In this paper, we examine how the EME local currency bond credit risk premium fluctuates in tandem with the spot exchange rate, so that the spot exchange rate takes on the attributes of a risk measure. We find that exchange rates are an important component of financial conditions that influence investor risk taking and thus EME local currency bond spreads.

To illustrate this point, consider some descriptive evidence on the returns on EME local currency bond indexes. Figure 1 shows how, for a number countries, yield changes relate to returns in local currency terms (full circles) and in dollar terms (empty circles). The vertical axis in each panel measures the percentage return, and the horizontal axis the yield change, in percentage points. In the left half of each panel, investors gain from falling bond yields. However, the dollar returns are higher, suggesting that local currency appreciation tends to magnify the gains from a decline in yields to dollar-based investors. Conversely, in the right half of each panel, investors lose from the rise in yields, but the losses of the dollar-based investor are magnified by the depreciation of the local currency.

In Figure 1, the slopes of the regression lines represent the *duration* of the bond index, in that they show the ratio of percentage returns to yield changes. Dollar returns are more sensitive to yield changes (solid lines are steeper than dashed lines) as currency movements magnify the gains and losses from yield changes. The duration in dollar terms is longer than the duration in local currency terms, so that global investors are in effect more subject to risks associated with holding bonds of longer maturity than are local investors. A longer duration in dollar terms than in local currency terms implies that local currency bond yields fall when the currency appreciates against the dollar, and that yields rise when the currency depreciates. In short, there is a negative correlation between the value of the currency and local currency bond yields.

1. At the same time, currency risk shifted from EME sovereigns to corporates. EME corporates have substantially increased their issuance of foreign currency debt in international bond markets over the past decade, satisfying foreign investor demand for high-yielding but liquid investment opportunities (Calomiris et al. (2019)). As a consequence, the foreign currency debt of EME corporates and hence their exposure to exchange rate risk have risen significantly.

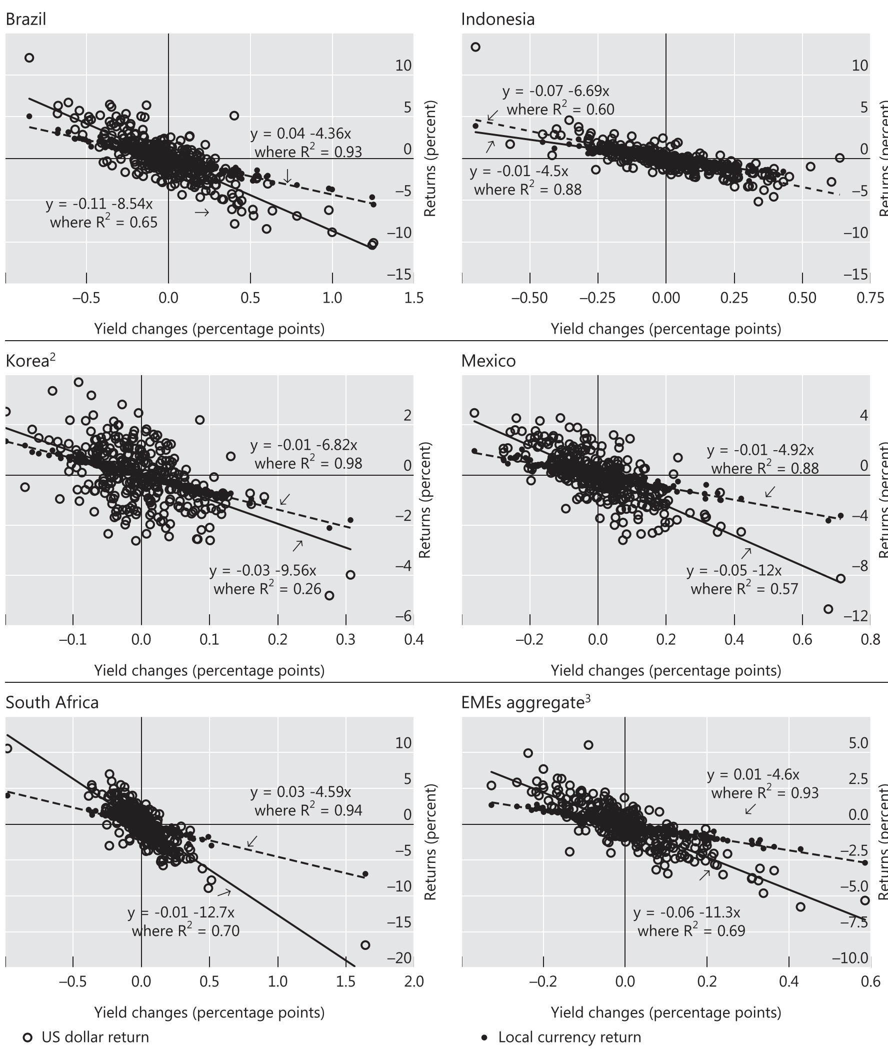

Fig 1. EME local currency sovereign bond performance, January 2013 to January 2019.
SOURCE: JPMorgan Chase.

NOTE: Return on bonds denominated in local currency is the weekly change in the JPMorgan GBI-EM principal return index in local currency and in the U.S. dollar. For Korea, the JPMorgan JADE index is used. The EME aggregate is the average of Brazil, Indonesia, Korea, Mexico, and South Africa.

This negative association between currency appreciation and local currency sovereign yields is also evident in a cross section of 20 EMEs.[2] The left-hand panel

2. The 20 EMEs are Brazil, Chile, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Thailand, and Turkey.

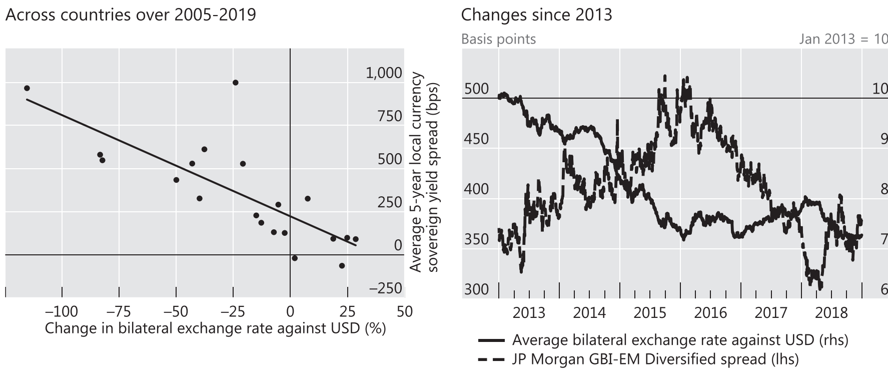

Fig 2. Changes in the bilateral exchange rate against the U.S. dollar and local currency sovereign spreads in EMEs.

NOTE: A decrease in the exchange rate is a depreciation of the domestic currency against the U.S. dollar. In the right-hand panel, the average bilateral exchange rate against the U.S. dollar is calculated by using the country weights in the JPMorgan GBI-EM Diversified index. Sources: Bloomberg; Datastream; JPMorgan Chase; national data; and Authors calculations.

of Figure 2 shows the relationship between the cumulative appreciation of an EME local currency against the U.S. dollar (horizontal axis) and the average spread of the 5-year EME local currency sovereign bond yield over the 5-year U.S. Treasury yield (vertical axis) since 2005. The scatterplot shows that there is a clear negative relationship. Countries with stronger currencies had on average lower yield spreads.

The relationship also holds over time. It has played out forcefully since 2013, a period characterized by a large depreciation of many EME currencies against the U.S. dollar, including the "taper tantrum" period. (Figure 2, right-hand panel). Between 2013 and 2018, EME currencies depreciated on average by about 30%. At the same time, the EME local currency sovereign bond spread, measured by the spread of the JP Morgan GBI-EM Diversified index yield over the 10-year U.S. Treasury yield, rose by more than 100 basis points. The spread subsequently narrowed as the dollar depreciated, but widened again when the dollar appreciated in 2018.

A negative association between currency appreciation and local currency bond yields is not obvious from the perspective of standard exchange rate models, which instead mostly suggest a positive link. An increase in local currency yields makes local currency bonds more attractive, which would give rise to more capital inflows and currency appreciation. Similarly, in Dornbusch's (1976) exchange rate overshooting model, the exchange rate appreciates in the short run so that investors can expect future currency depreciation to justify a rise in local currency interest rates. In this paper, we suggest that credit risk and its link with the exchange rate are the driver of the negative association between exchange rate appreciation and EME local currency bond yields that is visible from Figures 1 and 2.

Our paper assesses the link between exchange rates and EME bond premia more systematically using exchange rate shocks. Our central finding is that an appreciation of an EME currency against the U.S. dollar is associated with a significant compression in sovereign yield spreads, both for local currency bonds and for foreign currency bonds. Delving deeper, we find that these fluctuations in yield spreads are mainly due to shifts in the credit risk premium. We examine the local currency credit risk spread measure due to Du and Schreger (2016a), defined as the spread of the yield on EME local currency government bonds achievable by a dollar-based investor over the yield on the equivalent U.S. Treasury security, where the definition takes account of hedging of currency risk through currency swaps.

We find strong evidence that currency appreciation against the U.S. dollar is associated with a compression of the Du–Schreger spread and that the local currency sovereign spread is driven primarily by shifts in this risk premium. This result points to the importance of risk taking and portfolio adjustments in generating our results.

Crucially, the relevant exchange rate for our finding is the exchange rate relative to the U.S. dollar rather than the trade-weighted effective exchange rate. We find no evidence that an appreciation of the effective exchange rate that is orthogonal to the dollar exchange rate has a similar impact in compressing sovereign yields. Indeed, we actually find the opposite result for the trade-weighted exchange rate: an appreciation in trade-weighted terms is associated with more stringent financial conditions. We attribute this finding to the standard trade-channel effects whereby an appreciation of the effective exchange rate has a negative effect on net exports and hence on growth, which in turn may drive up credit risk.

Our paper is intended primarily as an empirical investigation documenting the impact of the exchange rate on sovereign bond markets. In order to build intuition, we develop a simple portfolio-choice model for global bond investors who hold EME local currency bonds without hedging for currency risk and measure their returns in dollar terms. The optimal portfolio choice of the global investors under standard mean-variance preferences gives rise to larger portfolio flows into EME local currency bond markets when EME currencies appreciate against the dollar. The portfolio inflows drive up the prices and reduce the yields of EME bonds.

In this way, currency movements amplify the gains and losses of dollar-based investors and generate a positive link between the exchange rate and local currency yields. Thus, “original sin” has been lurking in the background, but in a different way from how Eichengreen and Hausmann had laid out originally. The currency mismatch on the borrower’s balance sheet has migrated to the investor’s (i.e., lender’s) balance sheet.

Our results add to the rich literature on international asset pricing (see Lewis (2011) for an overview). Our findings on the link between the dollar exchange rate and financial conditions have a point of contact with the literature that builds on the role of financial intermediaries for market dynamics. Gabaix and Maggiori (2015) and Bruno and Shin (2015a, 2015b) analyze the determination of exchange rates through balance sheet costs borne by intermediaries.

Our paper also builds on the accumulating empirical literature on the link between exchange rates and financial market outcomes. 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 U.S. dollar across advanced economies (AEs) and EMEs. They interpret this 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. Avdjiev et al. (2019b) and Engel and Wu (2018) explore the link between the exchange rate and the deviation from covered interest parity (CIP). Avdjiev et al. (2019b) emphasize the dollar exchange rate, while Engel and Wu (2018) show that other major currencies also exhibit similar properties.

We also assess the macroeconomic impact of currency appreciation. From traditional arguments in the spirit of the Mundell–Fleming model (Mundell (1963), Fleming (1962)), currency appreciation is contractionary. An appreciation is associated with a decline in net exports and a contraction in output, other things being equal. In this vein, Krugman (2014) argues that a "sudden stop" is expansionary under floating exchange rates.

However, through fluctuations in financial conditions, there may be broader effects of exchange rate changes on the real economy going in the opposite direction. 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.[3] Indeed, currency appreciation often goes hand in hand with rapid credit growth and economic booms (Kaminsky and Reinhart (1999), Borio and Lowe (2002), Reinhart and Reinhart (2009)). More formally, Blanchard et al. (2015) show that currency appreciation may be expansionary in a multi-asset extension of the Mundell–Fleming model, and present evidence to that effect. Bussière, Lopez, and Tille (2015) analyze the impact of currency appreciations on growth for a large sample of AEs and EMEs and find that the impact on growth of currency appreciation associated with a capital surge is significantly positive in the case of EMEs. Avdjiev et al. (2019a) show in a panel investigation using both macroeconomic and firm-level data that investment in EMEs tends to move in the opposite direction to the strength of the dollar.

Our empirical results reconcile the two arguments. We find that an appreciation of EME currencies against the U.S. dollar that is unrelated to the effective exchange rate significantly boosts EME output, while an isolated appreciation of the effective exchange rate has contractionary effects. This finding is consistent with evidence presented by Kearns and Patel (2016) suggesting that an appreciation of the trade-weighted exchange rate dampens growth in EMEs, while an appreciation against funding currencies boosts it.

3. Aghion, 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 outline of our paper is as follows. In Section 1, we sharpen intuition by presenting a model underlying the main predictions of the empirical analysis. In Section 2, we conduct a more systematic empirical investigation of the role of exchange rate shocks for future EME sovereign spreads by running daily predictive regressions. In Section 3, we explore the wider macroeconomic impact of exchange rate shocks, assessing their effects on domestic credit to the private nonfinancial sector and output. Section 4 concludes and presents potential policy implications.

1. MODEL

In this section, we hone intuition for the empirical investigation by outlining a simple model of a local currency bond market with the participation of global investors who evaluate their returns in dollar terms.

Our model is a one-period portfolio choice problem. Portfolios are chosen at date 0 and returns are realized at date 1. There is a single bond denominated in local currency, which we call the "peso." The price of the bond at date 0 in peso terms is P_0. The date 0 value of the peso in dollar terms is denoted by Θ_0, so that the price of the peso bond in dollar terms is $P_0\Theta_0$. Similarly, the dollar value of the peso bond at date 1 is $P_1\Theta_1$. In log terms, the dollar value of peso bonds is denoted by $p_t + \theta_t$ where $t \in \{0, 1\}$.

The law of motion for the peso exchange rate is given by

$$\theta_1 = \theta_0 + \tau_1 + \eta, \tag{1}$$

where η, is a zero mean random variable with variance σ_η^2, and τ_1 is the trend appreciation of the peso against the dollar that is also assumed to follow a random walk:

$$\tau_1 = \tau_0 + \upsilon, \tag{2}$$

where υ, is a zero mean random variable with variance σ_υ^2, independent of η.

Denote by $\tilde{R}$ the return on the peso bond in dollar terms:

$$\tilde{R} \equiv \frac{P_1\Theta_1}{P_0\Theta_0} - 1 \tag{3}$$

and denote the log return as $\tilde{r} \equiv \ln(1 + \tilde{R})$. A continuum of global investors evaluate returns in dollar terms, and are assumed to maximize the following quadratic objective function by choosing b:

$$E_0(\tilde{r})b - \frac{\beta}{2}\mathrm{Var}_0(\tilde{r})b^2,$$

where $\beta > 0$ is a preference parameter, and the subscript 0 on $E_0(\cdot)$ and $\mathrm{Var}_0(\cdot)$ indicates that the expectations are taken with respect to the information set at date 0. The notional bond holding b then satisfies:

$$b = \frac{E_0(\theta_1 + p_1) - (\theta_0 + p_0)}{\beta \mathrm{Var}_0(\theta_1 + p_1)}. \tag{4}$$

The choice of b by global investors at date 0 is then implemented between dates 0 and 1, so that p_1 reflects the portfolio flows between dates 0 and 1.[4]

The peso price of the bond at date 1 can then be described as follows:

$$p_1 = p_0 + \alpha b + \varepsilon, \tag{5}$$

where ε is a zero mean random variable with variance σ_ε^2, independent of η and υ.[5] We assume that the preference parameter β is sufficiently large that $\beta > \alpha/(\sigma_\eta^2 + \sigma_\upsilon^2 + \sigma_\varepsilon^2)$.

Substituting (1) and (5) into (4), we have $b = (\tau_0 + \alpha b)/\beta(\sigma_\eta^2 + \sigma_\upsilon^2 + \sigma_\varepsilon^2)$, giving us a solution for the portfolio flows b into peso bonds:

$$b = \frac{\tau_0}{\beta\left(\sigma_\eta^2 + \sigma_\upsilon^2 + \sigma_\varepsilon^2\right) - \alpha}. \tag{6}$$

Given our assumption that $\beta > \alpha/(\sigma_\eta^2 + \sigma_\upsilon^2 + \sigma_\varepsilon^2)$, portfolio flow b has the same sign as the exchange rate trend τ_0, so that an appreciating peso goes hand-in-hand with capital inflows, while a depreciating peso entails capital outflows. Trend appreciation or depreciation shocks that move τ_0 hence also shift portfolio flows b.

Finally, substituting (6) into (5) and taking expectations, we have

$$E_0(p_1) - p_0 = \frac{\tau_0 \alpha}{\beta\left(\sigma_\eta^2 + \sigma_\upsilon^2 + \sigma_\varepsilon^2\right) - \alpha} \tag{7}$$

so that the expected percentage appreciation of the peso bond in peso terms is an increasing function of the trend τ_0 in the peso exchange rate. Faster peso appreciation goes hand-in-hand with a sharper increase in the return on the peso bond in local currency terms. By implication, it will also lower local currency bond yields.

We summarize our findings by means of the following proposition:

4. The timing of bond portfolio flows between date 0 and date 1 is meant to capture "slow moving capital." Decisions on portfolio allocation are made at date 0, but the actual flows into the bond market occur after p_0 and θ_0 are determined, between date 0 and date 1. Therefore, bond flows respond with a lag to new price information, while bond prices respond instantaneously to bond flows. We believe that this is a realistic assumption reflecting the lag between portfolio decision and execution of the flows.

5. If an EME central bank intervenes in the local currency government bond market as a buyer-of-last-resort, this could create a floor for bond prices or, more generally, make them a function of the size of the central bank's bond purchases. EME central banks have conducted such interventions in bond markets only very recently in the wake of the Covid-19 pandemic. For this reason, we see the modeling and analysis of such interventions beyond the scope of our paper. For discussions and early analyses of the effectiveness of these measures, see Arslan, Drehmann, and Hofmann (2020) and Hofmann, Shim, and Shin (2020).

PROPOSITION 1. *Peso appreciation is associated with portfolio inflows into peso bonds, positive returns on peso bonds and lower yields in local currency terms. Conversely, peso depreciation is associated with portfolio outflows, negative returns on peso bonds and higher yields in local currency terms.*

Note the importance of the role of the dollar exchange rate—or more generally, the exchange rate with respect to the investor's numeraire currency. It is useful to contrast the effects of the dollar exchange rate and of the trade-weighted exchange rate of the EME borrower. A conjecture might be that a depreciation in terms of the *trade-weighted exchange rate* will have the opposite effect on the bond yield as compared to the dollar exchange rate. This is because a depreciation of the trade-weighted exchange rate would be expansionary through the net exports channel. Other things being equal, the strength of the real economy might even *reduce* the probability of default.

We thus pose the following conjecture, which we will proceed to investigate empirically:

CONJECTURE 1. An appreciation of the bilateral exchange rate against the dollar will reduce bond yields, but an appreciation of the trade-weighted exchange rate will increase bond yields.

Of course, this conjecture is meaningful only if the EME borrower has trading partners other than the United States. Our empirical investigation will explore this conjecture by including orthogonal components of the trade-weighted exchange rate that factors out the bilateral exchange rate with respect to the dollar.

2. EXCHANGE RATE SHOCKS AND BOND SPREADS

We assess the association between exchange rates and EME bond spreads based on predictive regressions using daily data for 14 EMEs over the period from January 2005 to December 2017. The analysis is based on sovereign yields and local currency/U.S. dollar cross-currency swap rates at the 5-year maturity. The Appendix tables give the list of countries and data sources.

We consider three bond spread measures in our empirical investigation: the local currency bond spread, the Du–Schreger measure of the local currency risk premium, and the foreign currency bond spread.

The *local currency spread* ($s_{i,t}^{LC}$) is defined as the spread between the local currency government bond yield ($y_{i,t}^{LC}$) and the U.S. Treasury yield:

$$s_{i,t}^{LC} = y_{i,t}^{LC} - y_t^{\$}. \tag{8}$$

The *local currency credit risk premium* ($s_{i,t}^{DS}$), following Du and Schreger (2016a), is the spread between the local currency government bond yield and the synthetic local currency yield available to a dollar-based investor. This synthetic yield is given by the sum of the U.S. Treasury yield and the cross-currency swap rate ($y_{i,t}^{CCS}$), achievable by a dollar-based investor who has access to the local currency bond as well as the cross-currency swap contract of the same maturity:

$$s_{i,t}^{DS} = y_{i,t}^{LC} - y_t^{\$} - y_{i,t}^{CCS}. \tag{9}$$

The underlying assumption here is that a dollar investor can lock in the local currency spread by eliminating the currency risk through a swap contract that converts, at the outset, the cash flow from the local currency bonds into the U.S. dollar. As shown by Du and Schreger, the level and the dynamics of local currency credit risk spreads are quite different from those of foreign currency risk spreads, potentially reflecting several risk factors for the dollar-based investor, such as (i) covariance between currency and credit risk (quanto adjustment), (ii) selective default and capital control risk, and (iii) financial market frictions, including specific frictions in local currency bond markets and the failure of covered interest parity (CIP). If exchange rates affect local currency bond market conditions through a risk-taking channel, we would expect to see in particular a significant link between exchange rate changes and shifts in the Du–Schreger local currency credit risk premium.

Financial frictions may dampen the effects of the exchange rate risk-taking channel on the local currency credit risk premium. In particular, during times of financial stress, the local currency credit risk premium may be artificially compressed due to illiquidity in FX swaps markets, market segmentation between onshore and offshore markets as a result of capital controls, and financial repression more generally whereby domestic investors are forced in some way to hold local currency bonds. For these reasons, it is useful to assess the exchange rate risk-taking channel also for foreign currency bond spreads as a robustness check as these frictions are not present in the foreign currency bond markets. The *foreign currency spread* ($s_{i,t}^{FC}$) is defined as the spread between the dollar-denominated foreign currency government bond yield ($y_{i,t}^{FC}$) and the U.S. Treasury yield ($y_t^{\$}$):

$$s_{i,t}^{FC} = y_{i,t}^{FC} - y_t^{\$}. \tag{10}$$

In order to mitigate the endogeneity problems that arise from the joint determination of yield changes and exchange rate changes, we employ a database of exchange rate shocks that arise from monetary policy news from major AEs. We consider shocks to the nominal bilateral exchange rate against the U.S. dollar (*BER*) and to the nominal trade-weighted (effective) exchange rate (*NEER*), both measured such that an increase is an appreciation of the domestic currency.

Specifically, we construct a shock measure that is equal to the log change in the respective exchange rate on days of monetary policy news from the European Central Bank (ECB), taking into account differences in time zones, and zero on the other days. We do not consider news related to monetary policy announcements of the Federal Reserve as these could shift not only the exchange rate but also the bond

TABLE 1

Descriptive Statistics for Bond Spreads and Exchange Rate Shocks (in Percent)

	Mean	Std. Dev	Observations	Countries
Foreign currency spread	2.62	1.37	40,504	13
Local currency spread	4.19	3.25	43,515	14
Local currency risk premium	1.02	1.06	38,191	14
Shock to bilateral USD exchange rate				
All observations (absolute values)	0.04	0.24	46,242	14
Non-zero observations (absolute values)	0.55	0.68	3,472	14
Shock to trade-weighted exchange rate				
All observations (absolute values)	0.04	0.20	46,242	14
Non-zero observations (absolute values)	0.47	0.58	3,472	14

premium that is measured relative to the U.S. Treasury yield.[6] Our database of monetary policy news comes from the updated version of the monetary policy news database developed by Ferrari, Kearns, and Schrimpf (2017).

The monetary policy news dates comprise both scheduled monetary policy events such as the release of information on the outcomes of policy meetings (e.g., policy announcements and publication of minutes) and nonscheduled events (e.g., key speeches and press releases) that reveal news about unconventional policies such as asset purchases or forward guidance. In total, there were 248 days of monetary policy news from the ECB over the sample period which covers in total 3,300 working days.

Denote by N the set of dates with ECB news. The exchange rate shocks $\triangle BER^S_{i,t}$ and $\triangle NEER^S_{i,t}$ are then calculated as follows:

$$\triangle BER^S_{i,t} = \begin{cases} \triangle BER_{i,t} & \text{if } t \in N \\ 0 & \text{otherwise} \end{cases} \tag{11}$$

$$\triangle NEER^S_{i,t} = \begin{cases} \triangle NEER_{i,t} & \text{if } t \in N \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

where $\triangle BER_{i,t}$ and $\triangle NEER_{i,t}$ are, respectively, the daily log changes in the *BER* and the *NEER*.[7]

Table 1 reports summary statistics for the bond spreads and the exchange rate shocks used in the empirical analysis. Local currency spreads are considerably larger

6. The results are, however, robust to including exchange rate shocks linked to U.S. monetary policy news. See the working paper version of this paper (Hofmann, Shim, and Shin (2019)).

7. We also performed the analysis using actual log changes of exchange rates, rather than the exchange rate shocks from monetary policy news. In general, the effects were qualitatively similar but quantitatively much smaller when we used actual exchange rate changes, suggesting that our approach of using the exchange rate shocks from our monetary policy news database enables a better identification of the impact of the risk-taking channel. The results of this exercise are available upon request.

than foreign currency spreads (4.19% versus 2.62%). The Du–Schreger local currency risk premium accounts on average for a little less than a quarter of the local currency bond spread (1.02% on average). The average size of exchange rate shocks on days of monetary policy news is about half a percent. The mean and the standard deviation of the *BER* and the *NEER* shocks are similar, reflecting their close (but not perfect) correlation. The correlation of the two shock series over the sample period is 0.7.

In the analysis, we control for common factors that could drive both exchange rates and bond premia. We consider three main factors. The first is bond market conditions in major AEs, captured by the change in the 5-year sovereign benchmark bond yields in the United States and in the euro area.[8] Although we measure EME local currency yields already as a spread over the 5-year U.S. Treasury yield, we capture in this way additional dynamic effects of changes in AE yields. Importantly, including the change in the United States and euro area yields controls for additional effects of conventional and, since 2008, unconventional monetary policy measures that could otherwise be absorbed by the exchange rate shock (which is linked to ECB monetary policy announcements). The second factor is global investor risk appetite, which is measured through the VIX index. High risk appetite is commonly associated with portfolio flows to EMEs, appreciating the exchange rate and pushing down bond spreads. The third factor is changes in domestic monetary conditions in EMEs. For instance, a tightening in domestic short-term interest rates may impact the currency as well as bond spreads. Other candidate common factors, such as the change in global commodity or oil prices, were not included in the final regressions as they did not enter the regressions in a significant way and also did not affect the estimated impact of exchange rate shocks. There might of course be other observable or unobservable common factors driving both exchange rates and bond premia, so that we have to remain cautious in giving our results a clear causal interpretation.

The empirical methodology used for the analysis is panel local linear projection (*LLP*) regressions. The *LLP* method due to Jordà (2005) has become a standard tool in empirical analyses to derive dynamic impulse responses. Compared to vector autoregressions (VARs), it is regarded as being more robust to misspecification because it does not impose implicit dynamic restrictions on the shape of the impulse responses.[9]

We run *LLP* regressions over horizons up to 50 working days. We regress the change in EME sovereign bond spreads (denoted by s) over the next h days on their own lags as well as on the lagged exchange rate shocks and a set of lagged control variables (Z).

8. The 5-year euro area sovereign bond yield is the average yield of all euro area 5-year sovereign bonds whose issuers have a triple A rating. The data series is provided by the ECB.

9. See, for example, Bernardini and Peersman (2018) for a discussion of the pros and cons of the *LLP* approach compared to the VAR approach.

Specifically, we run the following regressions:

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta s_{i,t-1} + \beta_h \Delta BER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (13)$$

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta s_{i,t-1} + \beta_h \Delta NEER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (14)$$

for $h = 0, \ldots, 50$. The vector of control variables Z includes the changes in the United States and the euro area 5-year sovereign benchmark yields, the percent change in the VIX index, capturing changes in global investor risk appetite, and the change in the domestic short-term interest rate as the primary gauge of changes in domestic monetary conditions in EMEs. The regressions include country fixed effects α_i and a lagged dependent variable.[10] L is the lag operator and we include five lags of the daily change in the respective bond spread in order to mitigate serial correlation of the error term. The series of coefficient estimates $\widehat{\beta}_0, \ldots, \widehat{\beta}_{50}$ from equations (13) and (14) provide the impulse responses to a 1% shock to the *BER* and to the *NEER*, respectively.

Figure 3 reports impulse responses from the *LLP* regressions with 90% confidence bands (based on heteroskedasticity and autocorrelation robust standard errors). The results show that an appreciation shock to the *BER* and to the *NEER* is, respectively, followed by significant decreases in EME bond spreads.

A 1% appreciation shock to the *BER* (left-hand panels) is followed by a significant and persistent decline of the local currency bond spread and the local currency credit risk premium by around 10 basis points. The negative impact of the exchange rate appreciation on the local currency bond spread is thus largely driven by the drop in the local currency credit risk premium. This result lends strong support to a risk-taking channel of the exchange rate driving local currency bond spreads through their credit risk premium. The impact of the appreciation shock on the foreign currency spread is somewhat larger and more persistent, at around −15 basis points. The somewhat larger effect of exchange rate shocks on the foreign currency spread compared to the local currency credit risk premium likely reflects the above mentioned financial frictions dampening the exchange rate risk-taking channel in the case of the latter.

The effects of an appreciation shock to the *NEER* are qualitatively similar, but quantitatively smaller and statistically less significant (right-hand panels). This finding reflects the close correlation between the two exchange rate shock measures.

10. The inclusion of a lagged dependent variable in fixed-effects panel estimations can give rise to biases in panels with small time dimensions (Nickell (1981)). However, with about 3,300 daily observations, the time dimension of our panel is quite large so that the Nickell bias should not be of concern to us. This assumption is validated by the fact that the results are virtually identical when we re-run the regressions with the lagged dependent variable excluded.

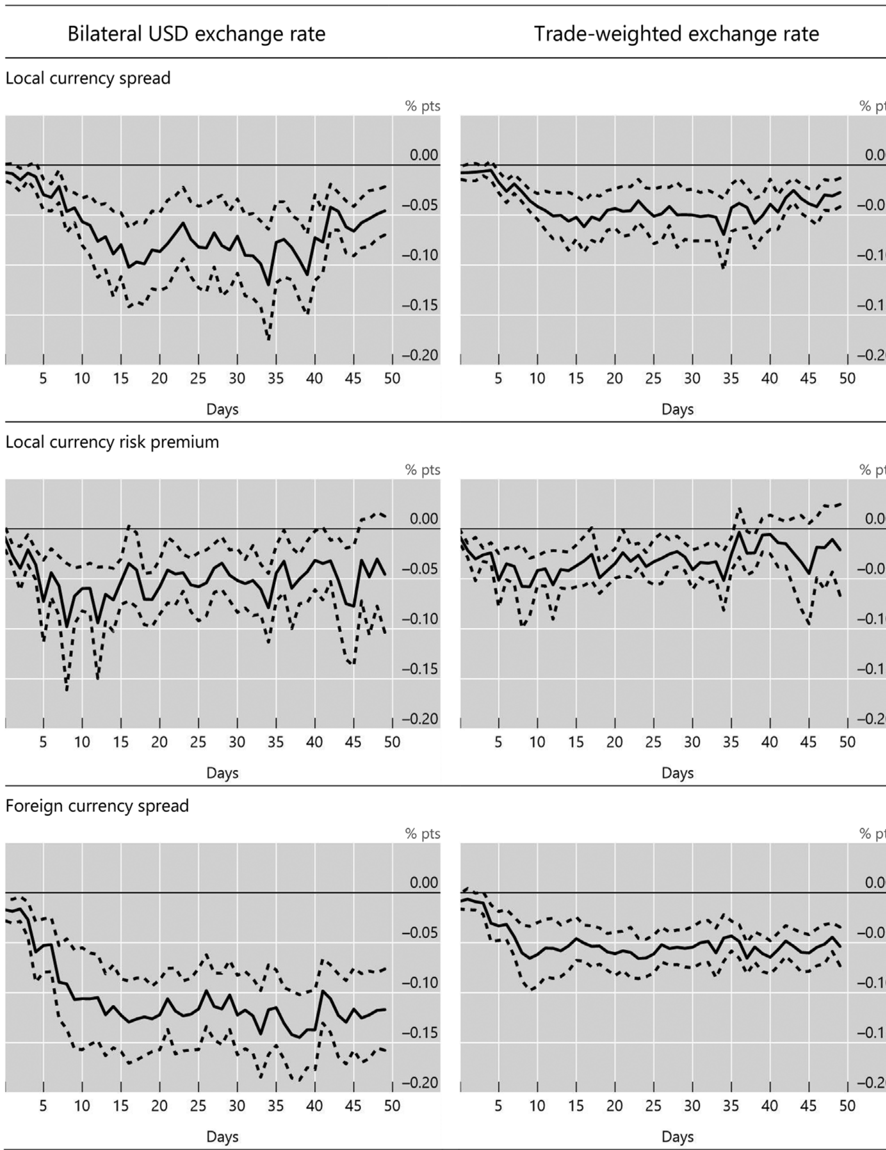

Fig 3. Impact of exchange rate appreciation on EME bond spreads.

NOTE: The figure shows the impact of a 1% appreciation shock to the exchange rate (log exchange rate changes on days of euro area monetary policy news). The 90% confidence bands are based on heteroskedasticity and autocorrelation robust standard errors.

In order to shed further light on the role of the two exchange rates for bond spreads in EMEs, we run a set of "horse-race" regressions that include both exchange rates, but in a way that mitigates the multicollinearity arising from the close correlation between the *BER* and the *NEER*.

Specifically, we run the following two regressions:

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta s_{i,t-1} + \beta_h \Delta BER^{S\perp}_{i,t-1} + \delta_h \Delta NEER^{S}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}, \tag{15}$$

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta s_{i,t-1} + \beta_h \Delta BER^{S}_{i,t-1} + \delta_h \Delta NEER^{S\perp}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}. \tag{16}$$

That is, we run the same panel *LLP* regressions as before, but now including, respectively, orthogonalized components of both exchange rate shocks. Equation (15) includes $\triangle NEER^S$ together with $\Delta BER^{S\perp}$, which is the component of $\triangle BER^S$ that is unrelated (orthogonal) to $\triangle NEER^S$ obtained as the residual of country-level regressions of $\triangle BER^S$ on $\triangle NEER^S$. Equation (16) includes $\triangle BER^S$ together with $\Delta NEER^{S\perp}$, which is the component of $\triangle NEER^S$ that is unrelated (orthogonal) to $\triangle BER^S$ obtained as the residual of country-level regressions of $\triangle NEER^S$ on $\triangle BER^S$. This approach serves the purpose of filtering out the correlation between the two variables in order to isolate specific changes in the two exchange rate shock measures and thereby to identify their ultimate effect on bond spreads.

For the sake of brevity, we report in Figure 4 only the estimated impulse responses to the orthogonalized exchange rate shock component. That is, the left-hand panels show the impulse responses to $\Delta BER^{S\perp}_{i,t-1}$ from equation (15), while the right-hand panels those to $\Delta NEER^{S\perp}_{i,t-1}$ from equation (16).

The results of this exercise show that it is the appreciation of the *BER* that exerts a negative effect on EME bond spreads, while an appreciation of the *NEER* exerts an insignificant or even a positive effect, consistent with our conjecture in the previous section. After an isolated 1% appreciation shock to the *BER*, the local currency spread and the embedded risk premium again drop persistently by around 10 basis points, respectively, while the foreign currency spread also drops by around 15 basis points as before (left-hand panels). Also here, the negative impact of the appreciation against the U.S. dollar on the local currency spread is largely driven by the drop in the local currency credit risk premium, supporting the notion of an exchange rate risk-taking channel driving local currency bond spreads.

In contrast, an isolated appreciation of the *NEER*, after controlling for changes in the *BER*, has either an insignificant or a significantly *positive* effect on the three spreads (right-hand panels). In other words, the trade-weighted exchange rate has an impact that goes in the opposite direction to the bilateral exchange rate against the dollar. This result is consistent with trade channel-type effects where an

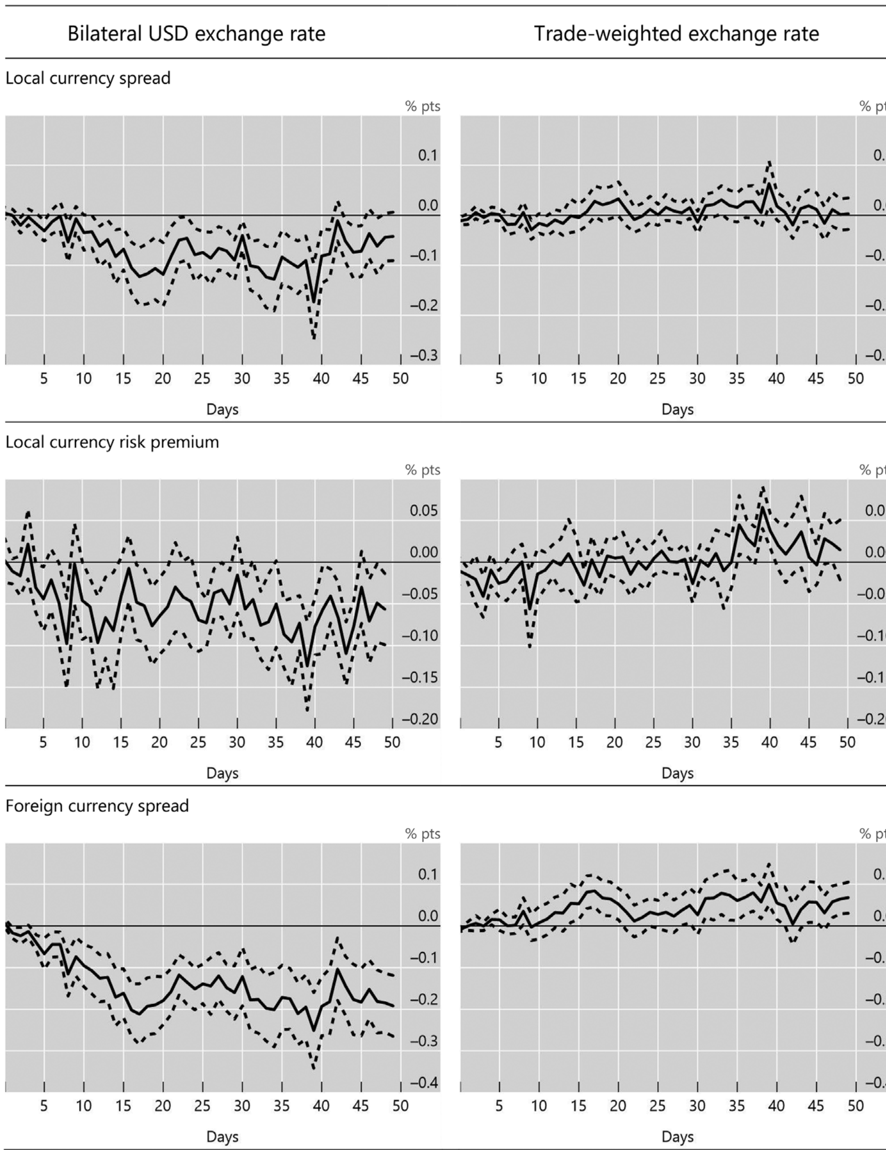

Fig 4. Impact of exchange rate appreciation on EME bond spreads based on orthogonalized exchange rate shocks.

NOTE: The figure shows the impact of a 1% appreciation shock (log exchange rate changes on days of euro area monetary policy news) to the bilateral exchange rate against the U.S. dollar and to the nominal effective exchange rate. Each shock is, respectively, orthogonal to the other exchange rate shock (the residuals of a linear regression on the other exchange rate shock). The 90% confidence bands are based on heteroskedasticity and autocorrelation robust standard errors.

appreciation of the effective exchange rate has a negative effect on macroeconomic activity through decline in exports or the fiscal position. Conceivably, these effects may in turn adversely affect perceptions of sovereign credit risk and hence increase bond spreads.

3. MACROECONOMIC EFFECTS OF EXCHANGE RATE SHOCKS

As a complement to our empirical exercise on asset pricing, we examine the broader macroeconomic repercussions of the exchange rate shocks explored in the previous section.

Specifically, we follow the dynamic impact of shocks to the *BER* and to the *NEER* on domestic credit to the private nonfinancial sector and on economic activity measured by industrial production. The frequency of the data is monthly and the country coverage is the same 14 EMEs as for the asset pricing exercise conducted in the previous section (see Appendix Table 1).[11]

We first assess the impact of the shocks to the *BER* and to the *NEER* separately by running the following panel *LLP* regressions over horizons up to 36 months ($h = 0, \ldots, 36$):

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta x_{i,t-1} + \beta_h \Delta BER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}, \quad (17)$$

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta x_{i,t-1} + \beta_h \Delta NEER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}, \quad (18)$$

where x is, respectively, log domestic credit to the private nonfinancial sector or log industrial production. Monthly measures of ΔBER^S and $\Delta NEER^S$ are obtained by summing over the daily shocks in a given month. The set of control variables Z includes the changes in the U.S. and the euro area 5-year benchmark sovereign yields, the percentage change in the VIX index as a measure of global financial conditions, and measures of domestic macro-financial dynamics in EMEs, specifically the change in the domestic 3-month interest rate, the growth of domestic industrial production, domestic CPI inflation, and domestic credit growth. The regressions include again country fixed effects α_i. We also include three lags of monthly credit and industrial production growth, respectively, in order to mitigate serial correlation of the error term.

The impulse-response functions from the *LLP* regressions are reported in Figure 5. The results are broadly consistent with the idea that financial conditions fluctuate with shifts in the bilateral dollar exchange rate, where an appreciation of the domestic currency against the dollar is associated with subsequent boosts to credit and output. Particularly notable is the finding (top left-hand panel) that an appreciation shock

11. Again, we conducted the analysis also based on actual exchange rate changes rather than exchange rate shocks from monetary policy news. The impulse responses were qualitatively similar, but the quantitative effects were again much smaller. The results of this exercise are also available upon request.

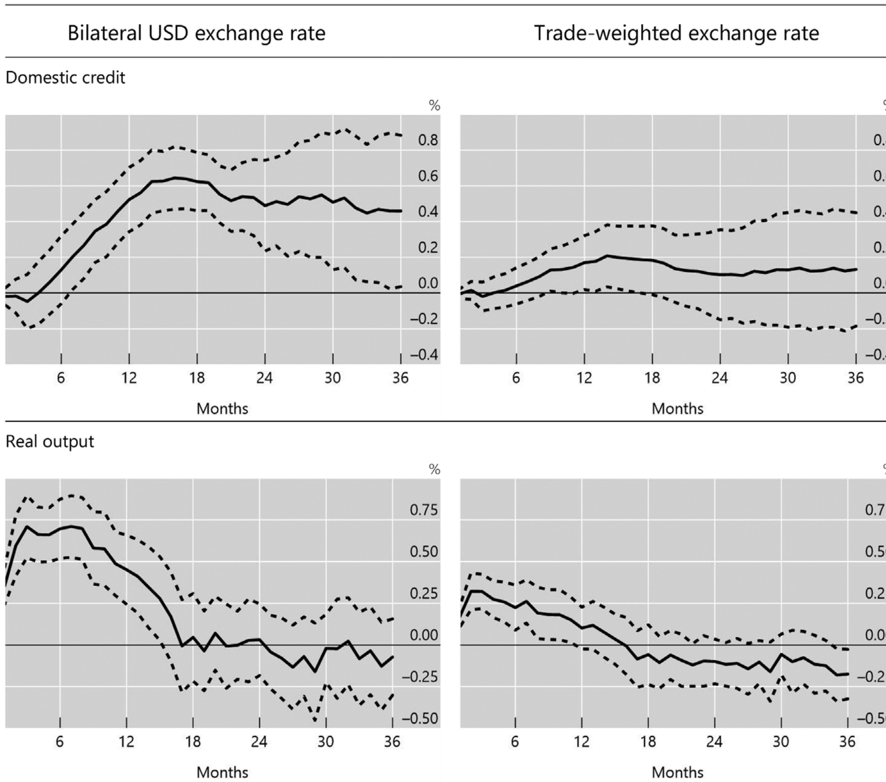

Fig 5. Impact of exchange rate appreciation on EME macroeconomic conditions.

NOTES: The figure shows the impact of a 1% appreciation shock to the bilateral exchange rate against the U.S. dollar and to the nominal effective exchange rate (log exchange rate changes on days of euro area monetary policy news). The 90% confidence bands are based on heteroskedasticity and autocorrelation robust standard errors.

against the U.S. dollar of 1% raises credit in a persistent way by up to 0.6%. Also real output increases significantly after an appreciation shock. Output rises by up to 0.7% during the first eight months after the shock, before the effect fades out. The effects of an appreciation shock to the *NEER* are again similar, but quantitatively smaller.

In order to isolate the specific role of the two exchange rates, we run again "horse-race" regressions that include both exchange rates:

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta x_{i,t-1} + \beta_h \Delta BER^{S\perp}_{i,t-1} + \delta_h \Delta NEER^{S}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}, \tag{19}$$

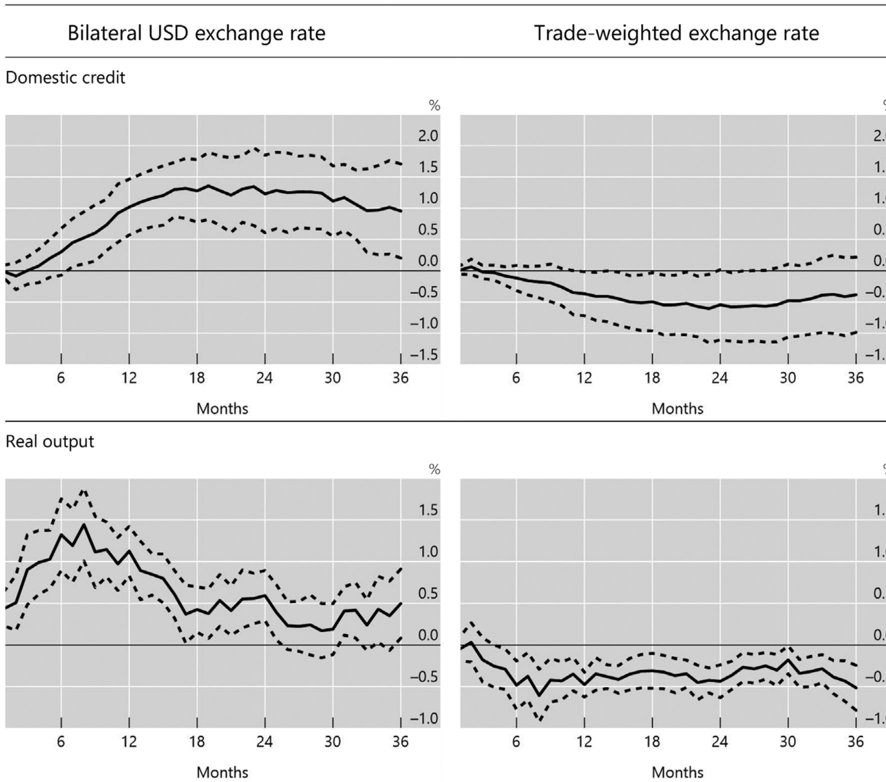

Fig 6. Impact of exchange rate appreciation on EME macroeconomic conditions based on orthogonalized exchange rate shocks.

NOTE: The figure shows the impact of a 1% appreciation shock to the bilateral exchange rate against the U.S. dollar and to the nominal effective exchange rate (log exchange rate changes on days of euro area monetary policy news). Each shock is, respectively, orthogonal to the other exchange rate shock (the residuals of a linear regression on the other exchange rate shock). The 90% confidence bands are based on heteroskedasticity and autocorrelation robust standard errors.

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h(L)\Delta x_{i,t-1} + \beta_h \Delta BER^{S}_{i,t-1} + \delta_h \Delta NEER^{S\perp}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h}. \tag{20}$$

As before, $\Delta BER^{S\perp}$ refers to the component of the shock in the *BER* that is unrelated (or orthogonal) to the shock in the *NEER*, and $\Delta NEER^{S\perp}$ to the component of the shock in the *NEER* that is unrelated (or orthogonal) to the shock in the *BER*.

The results reported in Figure 6 reinforce the asset pricing results reported in the previous section. An appreciation shock to the *BER* that is orthogonal to the *NEER* shock has significant expansionary effects on credit and output (left-hand panels). In contrast, an appreciation shock to the *NEER* that is orthogonal to the *BER* shock tends to have a dampening macroeconomic impact (right-hand panels).

4. CONCLUSIONS

We have explored the risk-taking channel of currency appreciation that 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.

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 financial conditions. Specifically, the results of the empirical analysis support the hypothesis that an appreciation of an EME's bilateral exchange rate against the U.S. dollar loosens financial conditions in the EME through a risk-taking channel, that is, by lowering credit risk spreads.

Our results further suggest that it is the bilateral U.S. dollar exchange rate that works through these financial channels, and not the nominal effective exchange rate (*NEER*). An appreciation in terms of the latter is instead often followed by higher bond and risk spreads. These findings suggests that the *NEER* appears 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. Indeed, our analysis also shows that an appreciation shock to the bilateral U.S. dollar exchange rate has expansionary macroeconomic effects on EMEs, while the effect of an appreciation shock to the effective exchange rate is contractionary.

A key implication of our paper is that an EME currency appreciation against the U.S. dollar is associated with lower EME local currency bond spreads as a consequence of lower local currency credit risk premia. These effects reverse when the EME currency depreciates. Together with the evidence that lower sovereign risk pushes up the exchange rate as reported in earlier studies (see, e.g., Della Corte et al. (2015)), this implies that self-reinforcing feedback loops between exchange rate appreciation (depreciation) and financial easing (tightening) can develop.

To the extent that global investors hold a large share of EME local currency bonds, EME borrowers are no longer directly subject to currency mismatch. However, exchange rate fluctuations affect EME borrowers indirectly: currency movements alter the risk-taking capacity of global investors in EME bonds, which in turn influences domestic financial conditions in EMEs. This mechanism is at the heart of "original sin redux" coined by Carstens and Shin (2019).

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 globalization worsens the trade-offs monetary policy faces in navigating among multiple domestic objectives, which makes additional tools of macroeconomic and financial policy more valuable.

That said, our findings also show that the development of local currency bond markets in EMEs makes these economies more resilient to exchange rate swings. Our results suggest that exchange rate shocks have a quantitatively larger effect on foreign currency bond spreads compared to local currency bond spreads. A larger share of local currency borrowing therefore makes a country's overall funding costs less sensitive to exchange rate shocks. At the same time, our findings show that currency depreciation and rising credit risk go hand-in-hand. If a country were to borrow in foreign rather than local currency, this effect would be compounded by an increase in real debt burdens as the value of foreign currency debt would increase as the exchange rate depreciates.

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 reduce the excessive volatility of exchange rates, which is the source of the problem; (ii) prudential measures aiming to slow down the speed of bond inflows during periods of EME local currency appreciation; and (iii) developing a domestic long-term institutional investor base that sets their investment objectives in local currency and thus is not subject to a mismatch between the currency of asset denomination and the currency of performance measurement or liability denomination.

APPENDIX A

TABLE A1

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, the Philippines, Thailand
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

TABLE A2

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, the Philippines
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

TABLE A3

Description of Variables used in Regression Analyses

Variable	Description	Unit	Sources
Local currency bond yield	5-year local currency sovereign bond yield	Per cent	Bloomberg, Datastream, Global Financial Data, national data
Foreign currency bond yield	EMBI country-level yield	Per cent	Datastream, JP Morgan Chase
Cross-currency swap rate	Local currency/U.S. dollar 5-year cross-currency swap rate	Per cent	Bloomberg
VIX	CBOE volatility index	Percentage points	Bloomberg
CPI	CPI inflation (seasonally adjusted)	2000 M1 = 100	National data
Domestic credit	Credit to the private nonfinancial sector	National currency	IMF International Financial Statistics
Industrial production	Industrial production (seasonally. adjusted)	2000 M1 = 100	National data
Short-term rate	3-month money market rate	Percent	Bloomberg, Datastream, IMF International Financial Statistics, national data
BER	Nominal exchange rate against the U.S. dollar	U.S. dollars per unit of local currency	National data
NEER	Nominal effective exchange rate, broad index	2000 Q1 = 100	National data

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