Bond risk premia and the exchange rate*

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Abstract

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 US dollar exchange rate, not the trade-weighted exchange rate. Our findings highlight endogenous comovement 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.

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1 Introduction

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 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 borrowers now routinely borrow in their local currency, with foreign participation reaching as high as 40 per cent in some local currency sovereign bond markets.

As a result of the shift in the currency composition of the bond market, global investors increasingly hold a large share of EME bonds that are denominated in local currency. Since these investors measure their returns in terms of US dollars or other major currencies, exchange rate movements amplify their gains and losses, thereby magnifying the risks they face in meeting obligations at home in the investor’s home currency.

In this sense, original sin may not have disappeared altogether, but rather may have migrated elsewhere within the financial system. The currency mismatch is no longer borne by the EME borrower but may have migrated to the holders of the EME bonds. 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 for a number countries how yield changes relate to returns in local currency terms (in blue) and in dollar terms (in red). The vertical axis in each panel measures the percentage return, and the horizontal axis the yield change, in percentage points.

On 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

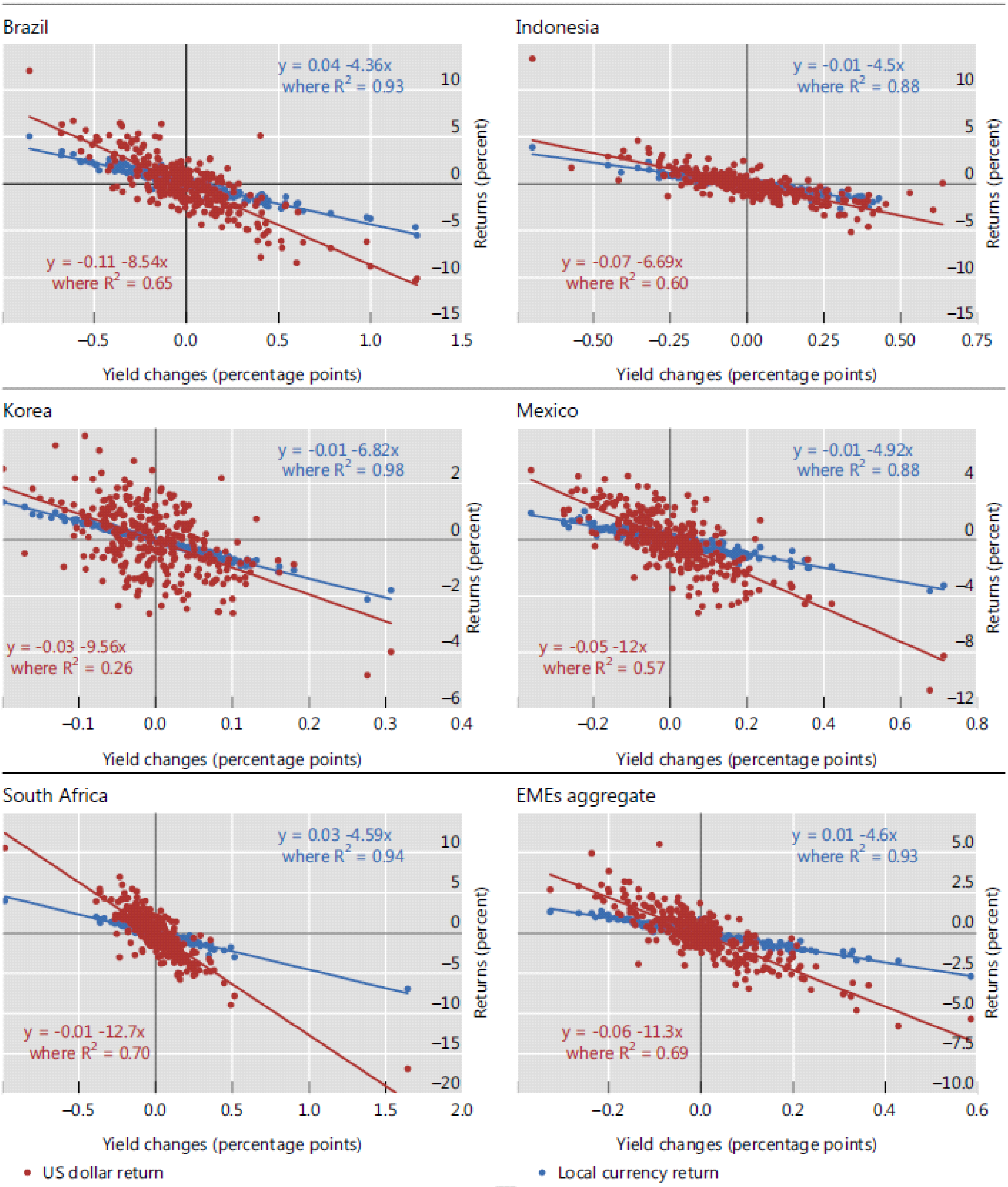

Figure 1. **EME local currency sovereign bond performance, Jan 2013–Jan 2019.** Total return on bonds denominated in local currency is the weekly change in the JPMorgan GBI-EM principal return index in local currency and in the US dollar. For Korea, the JPMorgan JADE index is used. The EME aggregate is the average of Brazil, Indonesia, Korea, Mexico and South Africa. Source: JPMorgan Chase.

the gains from a decline in yields to dollar-based investors. Conversely, on 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 this way, dollar returns are more sensitive to yield changes (red line is steeper) as currency movements magnify the gains and losses from yield changes.[1] In short, when local currency bond yields fall, the currency tends to appreciate against the dollar. Currency appreciation and looser financial conditions therefore go hand in hand.

In Figure 1, the slope of the regression line has the interpretation of the *duration* of the bond index, in that it shows the ratio of percentage returns to yield changes. The duration in dollar terms is higher than the duration in local currency terms, so that the endogenous relationship between exchange rates and yields implies that global investors are in effect subject to risks associated with holding bonds of longer maturity than local investors.

A negative association between currency appreciation and local currency sovereign spreads is also evident in a cross section of 20 EMEs[2] over the past 13 years. The left-hand panel of Figure 2 shows the relationship between the cumulative appreciation of an EME local currency against the US dollar (x-axis) and the average spread of the 5-year EME local currency sovereign bond yield over the 5-year US Treasury yield (y-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 characterised by a large depreciation of many EME currencies against the US 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 US 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.

Our paper assesses the connection between exchange rates and sovereign yield spreads

[1]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).

[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.

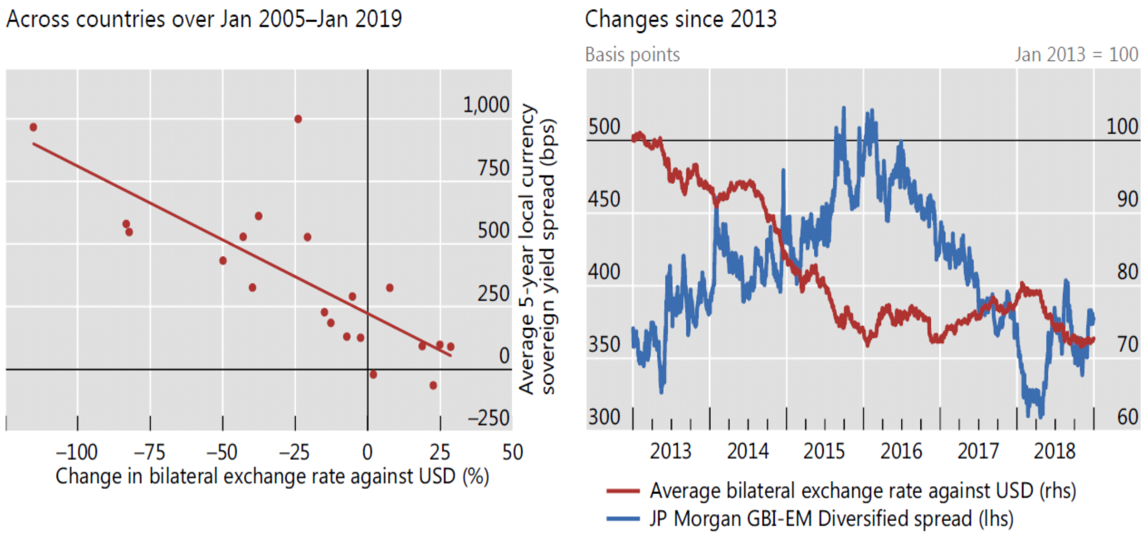

Figure 2. **Changes in the bilateral exchange rate against the US dollar and local currency sovereign spreads in EMEs.** A decrease in the exchange rate is a depreciation of the domestic currency against the US dollar. In the right-hand panel, the average bilateral exchange rate against the US dollar is calculated by using the country weights in the JPMorgan GBI-EM Diversified index. Sources: Bloomberg; Datastream; JPMorgan Chase; national data.

in EMEs more formally, using exchange rate shocks.

Our central finding is that an appreciation of an EME currency against the US dollar is associated with a 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 US Treasury security, where the definition takes account of hedging of currency risk through currency swaps.

We find strong evidence that currency appreciation against the US 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 US 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 model of global bond investors who hold EME local currency bonds without hedging for currency risk. Global bond investors measure their returns in dollar terms, and they are subject to risk constraints, also expressed in dollar terms.

On the asset side of the balance sheet, these investors hold a portfolio of EME local currency bonds. To the extent that the investors' assets are in EME currencies but their obligations are in dollars, there is something akin to a currency mismatch on the balance sheets of the global bond investors. For them, their risk constraints may become binding in those states of the world when EME bonds fall in value, and this may lead them to sell and exit their investments, resulting in currency depreciation as they exit. If the combined effect of currency depreciation and bond price declines is large enough, this may set off second-round effects that induce further selling.

In this way, currency movements amplify the gains and losses of dollar-based investors and may generate a correlation between local currency yields and exchange rates. In this sense, "original sin" may have been lurking in the background, but in a different way from the way that Eichengreen and Hausmann had laid out originally. The currency mismatch on the borrower's balance sheet may have 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) analyse 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 US 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. (2016) and Engel and Wu (2018) explore the link between the exchange rate and the deviation from covered interest parity (CIP). Avdjiev et al. (2016) emphasise 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) and 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) and 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) analyse 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. (2018) 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 both arguments. We find that an appreciation of EME currencies against the US dollar that is unrelated to the effective exchange rate

[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.

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.

The outline of our paper is as follows. In section 2, we sharpen intuition by presenting a model underlying the main predictions of the empirical analysis. In section 3, 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 4, we explore the wider macroeconomic impact of exchange rate shocks, assessing their effects on domestic credit to the private non-financial sector and output. Section 5 concludes and provides potential policy implications.

2 Model

In this section, we hone intuition for the empirical investigation by outlining a model of a local currency bond market with participation of both local investors who evaluate their returns in domestic currency terms and global bond 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 realised at date 1. There are n bonds denominated in local currency, which we call the "peso".

Consider first a local investor. The notional holdings of this investor, the expected returns and the covariance matrix of returns at date 0 are denoted, respectively, by

$$b = \begin{bmatrix} b_1 \\ \vdots \\ b_n \end{bmatrix}, \qquad r = \begin{bmatrix} r_1 \\ \vdots \\ r_n \end{bmatrix} \qquad \text{and} \qquad \Sigma = \begin{bmatrix} \sigma_1^2 & \cdots & \sigma_{1n} \\ & \ddots & \\ \sigma_{n1} & & \sigma_n^2 \end{bmatrix}. \tag{1}$$

The local investor is risk-neutral and maximises expected return, but is subject to a risk constraint at date 0 which requires the standard deviation of portfolio returns to be no higher than e pesos, where e is the peso value risk capital for the local investor:

$$\sqrt{b'\Sigma b} \leq e. \tag{2}$$

After we transform the constraint by squaring both sides, the Lagrangian is

$$\begin{aligned}\mathcal{L} &= b'r - \lambda\left(b'\Sigma b - e^2\right) \\ &= b'r - \lambda b'\Sigma b + \lambda e^2,\end{aligned}$$

where λ is the Lagrange multiplier. The first-order condition with respect to b is

$$\begin{bmatrix} r_1 \\ \vdots \\ r_n \end{bmatrix} = 2\lambda \begin{bmatrix} & \Sigma & \end{bmatrix} \begin{bmatrix} b_1 \\ \vdots \\ b_n \end{bmatrix}.$$

Solving for the optimal portfolio, we obtain

$$b = \frac{1}{2\lambda}\Sigma^{-1}r. \tag{3}$$

We can solve fully by using (3) to write the variance of the portfolio return as:

$$\begin{aligned}b'\Sigma b &= \frac{1}{4\lambda^2}r'\Sigma^{-1}\Sigma\Sigma^{-1}r \\ &= \frac{1}{4\lambda^2}r'\Sigma^{-1}r.\end{aligned}$$

Since the investor's risk constraint binds, $b'\Sigma b = e^2$. Therefore

$$\frac{1}{4\lambda^2}r'\Sigma^{-1}r = e^2.$$

Solving for λ, we get

$$\lambda = \frac{1}{2e}\sqrt{r'\Sigma^{-1}r}.$$

Substituting into the first-order condition (3) allows us to solve for the optimal portfolio.

$$b = e\frac{1}{\sqrt{r'\Sigma^{-1}r}}\Sigma^{-1}r. \tag{4}$$

The expression $\sqrt{r'\Sigma^{-1}r}$ is the n-dimensional analogue of the Sharpe ratio – the expected return normalised by the standard deviation of returns. We refer to $\sqrt{r'\Sigma^{-1}r}$ as the *generalised Sharpe ratio.* To gain further intuition, we premultiply (4) by r' and re-arrange to obtain

$$\frac{r'b}{e} = \sqrt{r'\Sigma^{-1}r}. \tag{5}$$

Therefore, the generalised Sharpe ratio has an interpretation as the expected return on economic capital.

We now turn to the global investor. The global investor evaluates his returns in dollar terms and is also subject to a risk constraint. The peso exchange rate at date 0 is normalised to 1 while the peso at date 1 in dollar terms is denoted by θ. A higher value of θ corresponds to a stronger peso. Let $q = \theta r$ denote the return vector in dollar terms. Denote by $\hat{b}$ the global investor's bond portfolio and denote by $\hat{\Sigma}$ the covariance matrix of returns in dollar terms. We assume that the risk constraint for the global investor is given by

$$\frac{\hat{b}'\hat{\Sigma}\hat{b}}{\theta} \leq \hat{e}^2, \tag{6}$$

where $\hat{e}$ is the economic capital of the global investor in dollars. At date 0, the exchange rate is 1, so that $\hat{e}$ is also the peso value of economic capital.

The constraint (6) incorporates the "risk-taking channel" of exchange rates developed in Bruno and Shin (2015a, 2015b), in which the risk-taking capacity of financial institutions increases as the dollar depreciates. In (6), a dollar depreciation results in higher θ, and a relaxation of the risk constraint.

The derivation of the global investor's optimal portfolio then follows the same steps as for the local investor. The optimal portfolio of the global investor is

$$\hat{b} = \hat{e}\sqrt{\theta}\frac{1}{\sqrt{q'\hat{\Sigma}^{-1}q}}\hat{\Sigma}^{-1}q. \tag{7}$$

The expected return on economic capital for the global investor is

$$\frac{q'\hat{b}}{\hat{e}} = \sqrt{\theta}\sqrt{q'\hat{\Sigma}^{-1}q}, \tag{8}$$

which is increasing in θ, reflecting the greater risk-taking as the dollar weakens against the peso.

The market clearing condition is $b + \hat{b} = z$, where z is the vector of outstanding stocks of bonds, which are fixed.

We conduct a comparative statics exercise on the expected returns on peso bonds to a perfectly anticipated change in the value of the peso. First, note that the generalised Sharpe ratio in dollar terms is invariant to θ, and is identical to the generalised Sharpe ratio in peso terms, since

$$\sqrt{q'\hat{\Sigma}^{-1}q} = \sqrt{\frac{\theta r'\Sigma^{-1}r\theta}{\theta^2}} = \sqrt{r'\Sigma^{-1}r}. \tag{9}$$

Therefore, from the market clearing condition, we obtain

$$\begin{aligned} z = b + \hat{b} &= e\frac{1}{\sqrt{r'\Sigma^{-1}r}}\Sigma^{-1}r + \hat{e}\sqrt{\theta}\frac{1}{\sqrt{q'\hat{\Sigma}^{-1}q}}\hat{\Sigma}^{-1}q \\ &= e\frac{1}{\sqrt{r'\Sigma^{-1}r}}\Sigma^{-1}r + \hat{e}\sqrt{\theta}\frac{\theta}{\theta^2}\frac{1}{\sqrt{r'\Sigma^{-1}r}}\Sigma^{-1}r \\ &= \left(e + \frac{\hat{e}}{\sqrt{\theta}}\right)\frac{1}{\sqrt{r'\Sigma^{-1}r}}\Sigma^{-1}r. \end{aligned}$$

After premultiplying both sides by r', we get

$$\begin{aligned} r'z &= \left(e + \frac{\hat{e}}{\sqrt{\theta}}\right)\frac{r'\Sigma^{-1}r}{\sqrt{r'\Sigma^{-1}r}} \\ &= \left(e + \frac{\hat{e}}{\sqrt{\theta}}\right)\sqrt{r'\Sigma^{-1}r} \\ &= \left(e + \frac{\hat{e}}{\sqrt{\theta}}\right)G, \end{aligned}$$

where G is the generalised Sharpe ratio, which is invariant to θ.

The left-hand side is the expected return in peso terms of the outstanding stock of peso denominated bonds. The right-hand side is decreasing in θ. Therefore, we have our key result that the peso returns are negatively related to the dollar value of the peso. As the peso appreciates against the dollar, peso bonds yield less.

Proposition 1 *Peso bond yields fall as the peso appreciates.*

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. The dollar exchange rate matters because of the currency denomination of the liabilities side of the global investor's balance sheet. The correlation between the local currency yield r and the dollar arises endogenously from portfolio choice of global investors.

It is useful to contrast the effect of the dollar strength with 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 the orthogonal component of the trade-weighted exchange rate that factors out the bilateral exchange rate with respect to the dollar.

3 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 appendix tables give the list of countries and data sources.

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

The *foreign currency spread* ($s_{i,t}^{FC}$) is defined as the spread between the dollar-denominated 5-year foreign currency government bond yield ($y_{i,t}^{FC}$) and the 5-year US Treasury yield ($y_t^{\$}$):

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

The *local currency spread* ($s_{i,t}^{LC}$) is defined as the spread between the 5-year local currency government bond yield ($y_{i,t}^{LC}$) and the 5-year US Treasury yield:

$$s_{i,t}^{LC} = y_{i,t}^{LC} - y_t^{\$} \tag{11}$$

Finally, the *local currency credit risk premium* ($s_{i,t}^{DS}$), following Du and Schreger (2016a), is the spread between the 5-year local currency government bond yield and the synthetic local currency 5-year yield available to a dollar-based investor. This synthetic yield is given by the sum of the 5-year US Treasury yield and the 5-year 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:

$$s_{i,t}^{DS} = y_{i,t}^{LC} - y_t^{\$} - y_{i,t}^{CCS} \tag{12}$$

The underlying idea of the Du-Schreger risk premium 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 US dollar. As shown by Du and Schreger (2016a), 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 risk premium.

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 central banks. We consider shocks to the bilateral exchange rate against the US dollar (*BER*) and to the nominal trade-weighted (effective) exchange rate (*NEER*), both measured such that an increase denotes 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 US Federal Reserve (Fed) and the European Central Bank (ECB), and zero on the other days. Our database of monetary shocks 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 non-scheduled 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 455 days of monetary policy news from the Fed and the ECB over the sample period (which covers in total 3,300 working days).

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

$$\triangle BER^S_{i,t} = \begin{cases} \triangle BER_{i,t} \text{ if } t \in N \\ 0 \text{ otherwise} \end{cases} \tag{13}$$

	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)	0.07	0.29	45,940	14
Non-zero observations (absolute values)	0.50	0.62	6,271	14
Shock to trade-weighted exchange rate				
All observations (absolute values)	0.06	0.24	45,940	14
Non-zero observations (absolute values)	0.44	0.52	6,271	14

Table 1. **Descriptive statistics for bond spreads and exchange rate shocks.** In per cent.

$$\triangle NEER^{S}_{i,t} = \begin{cases} \triangle NEER_{i,t} \text{ if } t \in N \\ 0 \text{ otherwise} \end{cases} \tag{14}$$

where $\triangle BER_{i,t}$ and $\triangle NEER_{i,t}$ are, respectively, the daily log changes in the *BER* and the *NEER*. In Appendix Figures 1 and 2, we report for completeness the empirical results from using actual log changes of exchange rates, rather than the exchange rate shocks from monetary policy news. In general, the effects are qualitatively similar but quantitatively much smaller when we use 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.

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 than foreign currency spreads (4.19% vs 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 percentage point. 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 two main candidate factors. The first is global investor risk appetite, which is proxied 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 second is changes in domestic monetary conditions. For instance, a tightening in domestic short-term interest rates may impact the currency as well as bond spreads. In addition, domestic and global macroeconomic conditions may affect both variables, a consideration relevant for the analysis of the macroeconomic implications in the next section. 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.[4]

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 lag as well as on the lagged (log) change in the exchange rate and a set of lagged control variables (Z).

Specifically, we run the following regressions:

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h \Delta s_{i,t-1} + \beta_h \Delta BER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \tag{15}$$

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h \Delta s_{i,t-1} + \beta_h \Delta NEER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \tag{16}$$

for $h = 1, ..., 50$. The vector of control variables Z includes the per cent 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. The regressions include country fixed effects α_i and a lagged dependent variable.[5] The series of coefficient estimates $\widehat{\beta}_1, ..., \widehat{\beta}_{50}$ from equations (15) and (16) provide the impulse responses to a 1 percent 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

[4] See e.g. Bernardini and Peersman (2018) for a discussion of the pros and cons of the LLP approach compared to the VAR approach.

[5] The inclusion of a lagged dependent variable in fixed-effects panel estimations can gives 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.

results show that an appreciation shock to the *BER* and to the *NEER* is respectively followed by significant decreases in all three EME bond spreads.

Specifically, a 1 percent appreciation shock to the *BER* (left-hand panels) is followed by a significant decline of the foreign currency spread, the local currency spread and the local currency risk premium by up to 10, 9 and 7 basis points, respectively, over the 50-day horizon. The negative impact of the exchange rate appreciation on the local currency 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 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.

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:

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h \Delta s_{i,t-1} + \beta_h \Delta BER^{S\perp}_{i,t-1} + \delta_h \Delta NEER^{S}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (17)$$

$$s_{i,t+h} - s_{i,t-1} = \alpha_{h,i} + \rho_h \Delta s_{i,t-1} + \beta_h \Delta BER^{S}_{i,t-1} + \delta_h \Delta NEER^{S\perp}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (18)$$

That is, we run the same panel *LLP* regressions as before, but now including respectively orthogonalised components of both exchange rate shocks. Equation (17) 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 (18) 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 orthogonalised exchange rate shock component. That is, the left-hand panels show

Figure 3. **Impact of exchange rate appreciation on EME bond spreads.** The figure shows the impact of a 1% appreciation shock to the exchange rate (log exchange rate changes on days of US and euro area monetary policy news) over the 50-day horizon. Control variables are the log change in the VIX index and the change in the domestic 3-month money market rates. The 90% confidence bands are based on cross-section and period cluster robust standard errors.

the impulse responses to $\Delta BER^{S\perp}_{i,t-1}$ from equation (17), while the right-hand panels those to $\Delta NEER^{S\perp}_{i,t-1}$ from equation (18).

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 percent appreciation shock to the *BER*, the foreign currency spread drops by 20 basis points (at its maximum) over the 50-day horizon, while the local currency spread and the embedded risk premium drop by up to 10 basis points, respectively, over the same horizon (left-hand panels). Also here, the negative impact of the appreciation against the US dollar on the local currency spread is entirely driven by the drop in the local currency credit risk premium, supporting the notion of a powerful exchange rate risk-taking channel driving local currency bond spreads.

By 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 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.

4 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 non-financial sector and on economic activity measured by industrial production. The frequency of the data is monthly and the country coverage is the same 14 emerging economies as for the asset pricing exercise conducted in the previous section (see Appendix Table 1). In Appendix Figures 3 and 4, we report again for comparison purposes the analogous impulse-response functions based on actual exchange rate changes rather than exchange rate shocks from monetary policy news. The impulse-responses are qualitatively similar, but the quantitative effects are again much smaller.

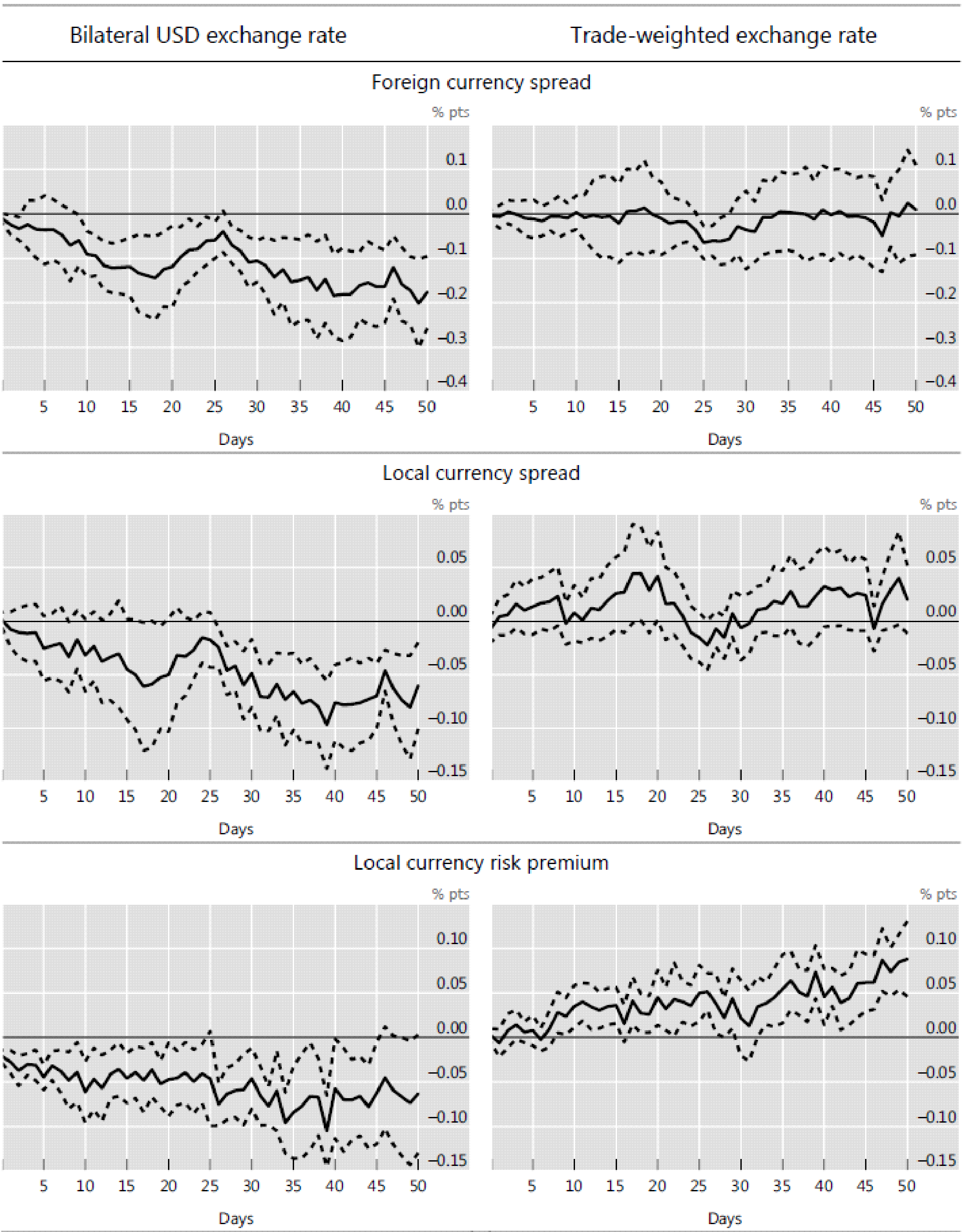

Figure 4. **Impact of exchange rate appreciation on EME bond spreads based on orthogonalised exchange rate shocks.** The figure shows the impact of a 1% appreciation shock (log exchange rate changes on days of US and euro area monetary policy news) to the bilateral exchange rate against the US dollar 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) over the 50-day horizon. Control variables are the log change in the VIX index and the change in the domestic 3-month money market rates. The 90% confidence bands are based on cross-section and period cluster robust standard errors.

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 ($h = 1, ..., 36$):

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h \Delta x_{i,t-1} + \beta_h \Delta BER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (19)$$

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h \Delta x_{i,t-1} + \beta_h \Delta NEER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (20)$$

where x is, respectively, log domestic credit to the private non-financial 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 percentage change in the VIX index, the change in the domestic 3-month interest rate, the growth of US and domestic industrial production and US and domestic CPI inflation.

The impulse-response functions from the local linear projections 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 against the US dollar of 1 per cent raises credit in a persistent way, reaching around 0.75 per cent after 36 months. Also real output increases significantly after an appreciation shock. Output rises by up to 0.4% during the first twelve 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:

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h \Delta x_{i,t-1} + \beta_h \Delta BER^{S\perp}_{i,t-1} + \delta_h \Delta NEER^S_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (21)$$

$$x_{i,t+h} - x_{i,t-1} = \alpha_{h,i} + \rho_h \Delta x_{i,t-1} + \beta_h \Delta BER^S_{i,t-1} + \delta_h \Delta NEER^{S\perp}_{i,t-1} + \Gamma_h Z_{i,t-1} + \eta_{i,t+h} \quad (22)$$

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

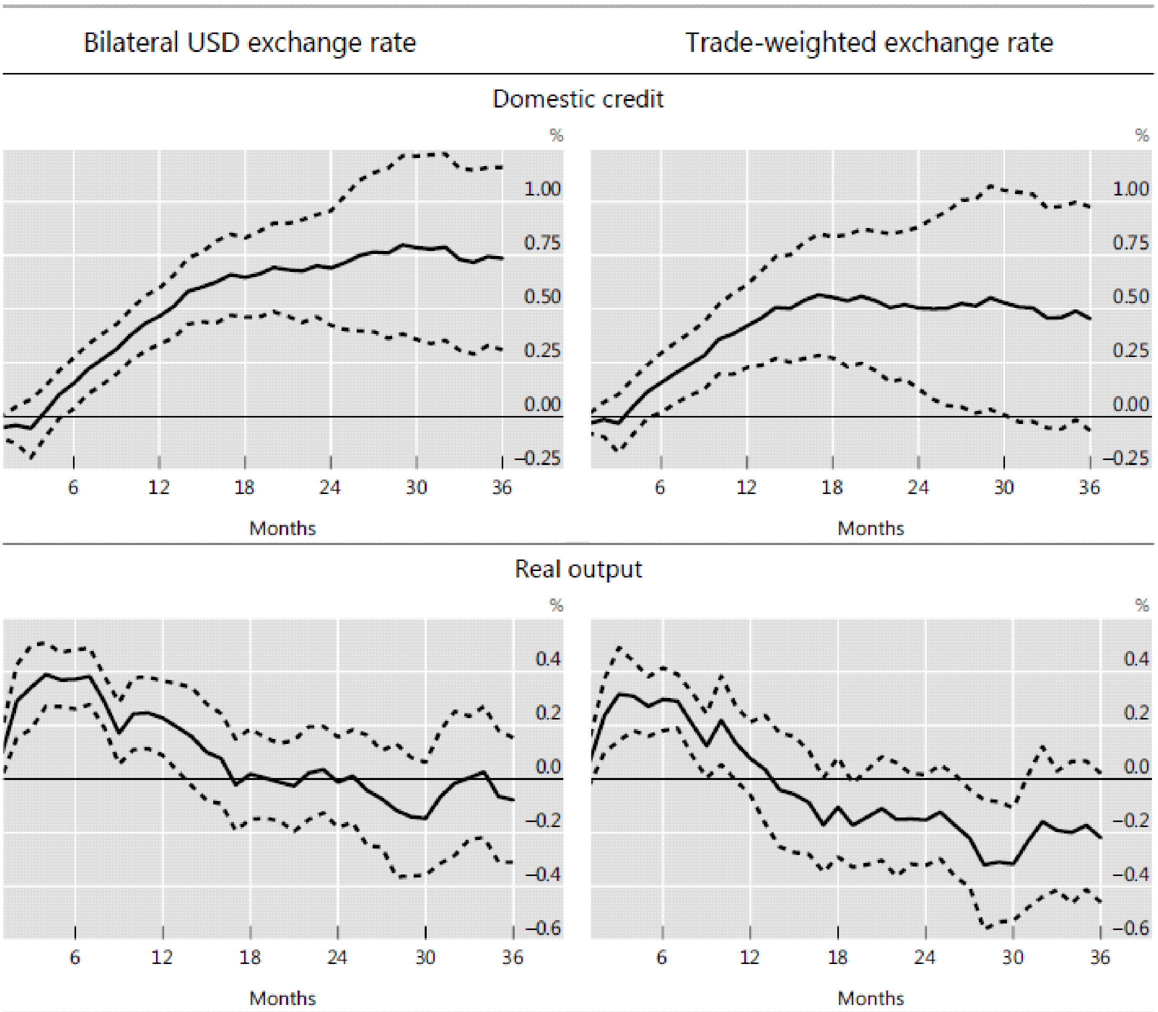

Figure 5. **Impact of exchange rate appreciation on EME macroeconomic conditions.** The figure shows the impact of a 1% appreciation shock to the bilateral exchange rate against the US dollar and to the nominal effective exchange rate (log exchange rate changes on days of US and euro area monetary policy news) over the 36-month horizon. Control variables are the percent change in the VIX index, the change in the domestic 3-month money market rates, the growth of US and domestic industrial production and US and domestic CPI inflation. The 90% confidence bands are based on cross-section and period cluster robust standard errors.

Figure 6. **Impact of exchange rate appreciation on EME macroeconomic conditions based on orthogonalised exchange rate shocks.** The figure shows the impact of a 1% appreciation shock to the bilateral exchange rate against the US dollar and to the nominal effective exchange rate (log exchange rate changes on days of US and euro area monetary policy news) over the 36-month horizon. Each shock is respectively orthogonal to the other exchange rate shock (the residuals of a linear regression on the other exchange rate shock). Control variables are the percent change in the VIX index, the change in the domestic 3-month money market rates, the growth of US and domestic industrial production and US and domestic CPI inflation. The 90% confidence bands are based on cross-section and period cluster robust standard errors.

contrast, an appreciation shock to the *NEER* that is orthogonal to the *BER* shock tends to have a dampening macroeconomic impact (right-hand panels).

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.

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 US dollar loosens financial conditions in the EME through a risk-taking channel, i.e. by lowering credit risk spreads. Our results further suggest that it is the US 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 US 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 US dollar is associated with lower EME local currency bond spreads as a consequence of lower local currency credit risk spreads. 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 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.

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.

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Appendix

Appendix Table 1: 14 EMEs for which the Du-Schreger spread is available

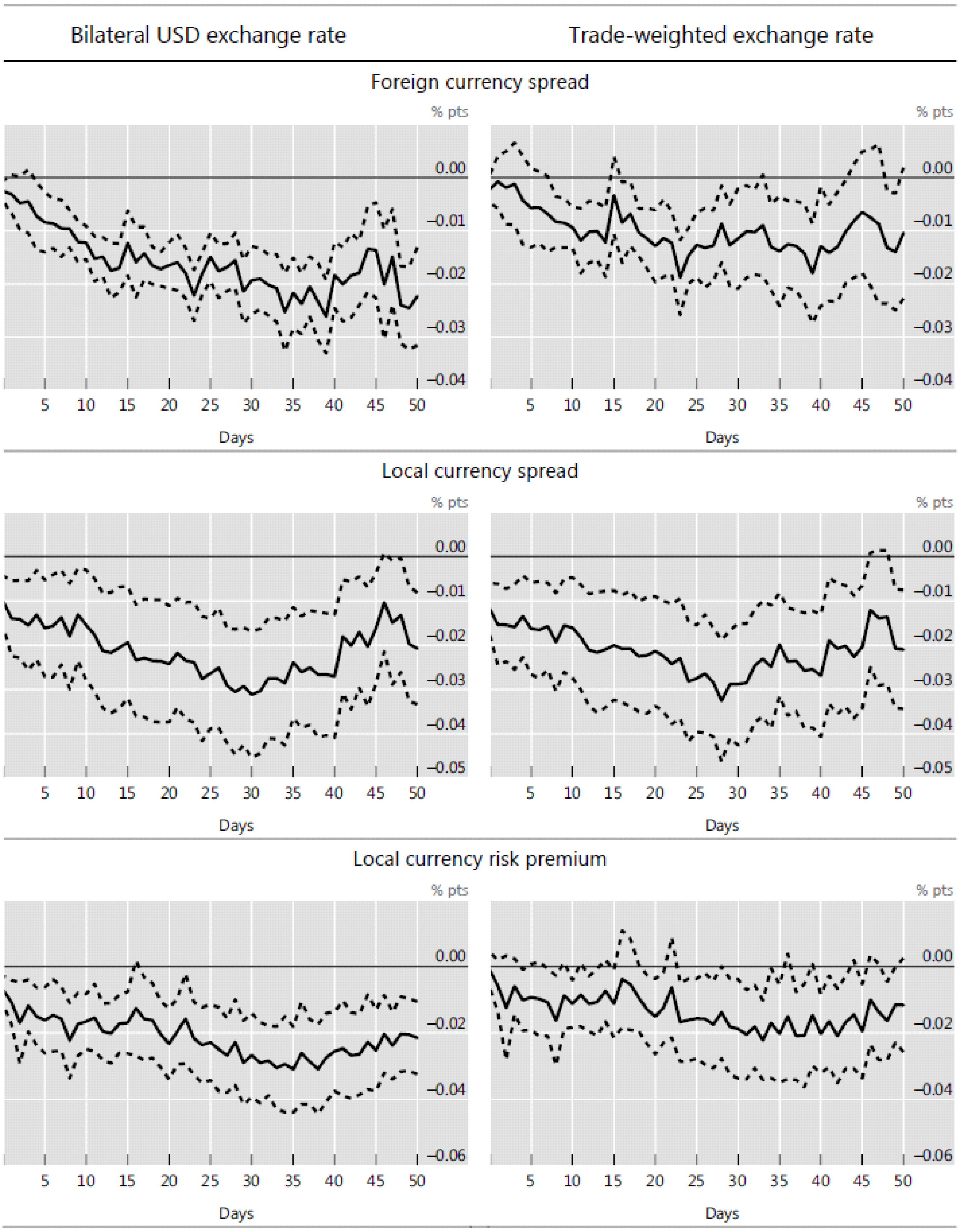
Africa and the Middle East (3)	Israel, Turkey, South Africa
Emerging Asia (5)	Indonesia, Korea, Malaysia, the Philippines, Thailand
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

Appendix Table 2: 13 EMEs for which foreign currency bond yield is available

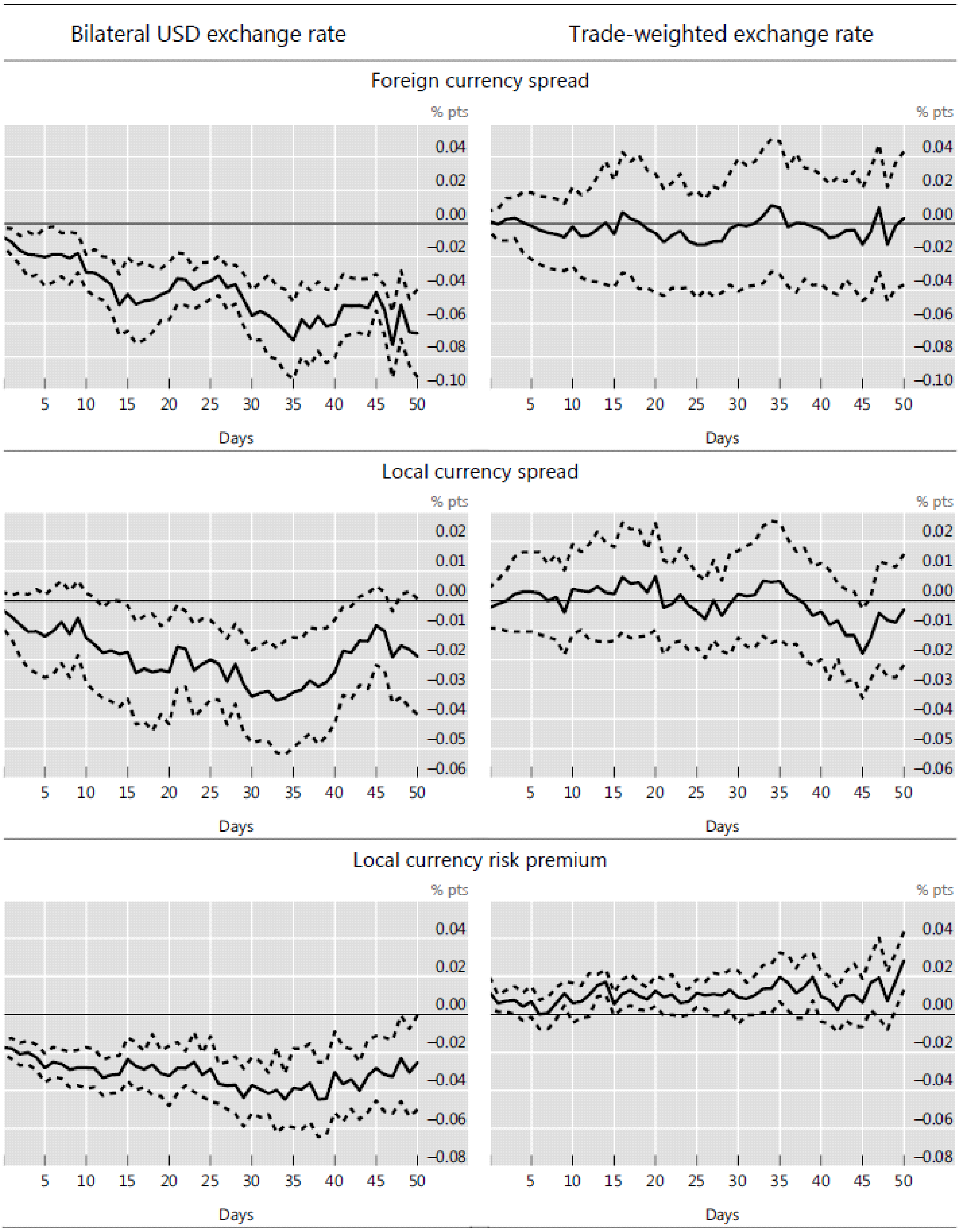
Africa and the Middle East (3)	Israel, Turkey, South Africa
Emerging Asia (4)	Indonesia, Korea, Malaysia, the Philippines
Emerging Europe (2)	Hungary, Poland
Latin America and the Caribbean (4)	Brazil, Colombia, Mexico, Peru

Appendix Table 3: Description of variables used in regression analyses

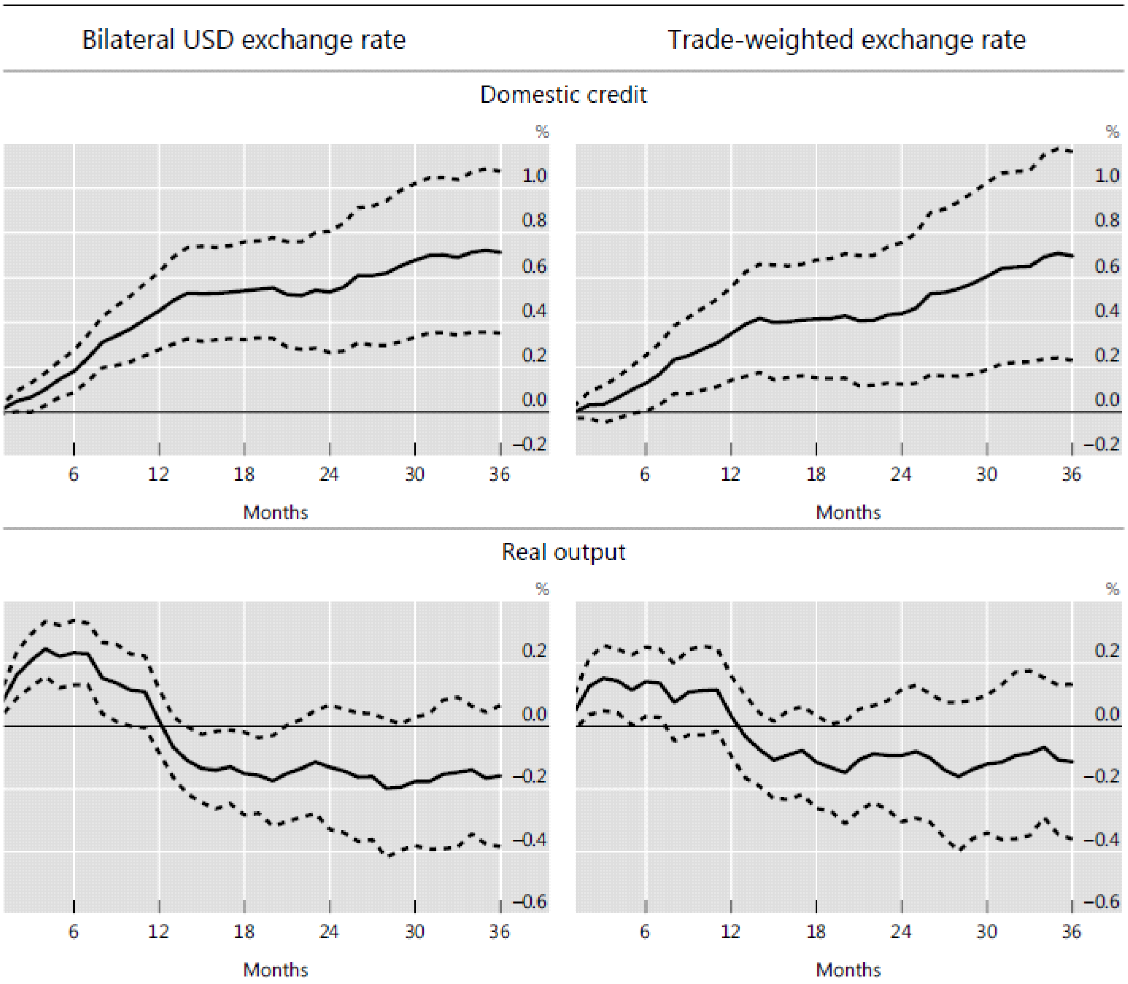
Variable	Description	Unit	Sources
Local currency bond spread	5-year local currency sovereign bond yields over 5-year US Treasury yield	Percentage points	Bloomberg, Datastream, Global Financial Data, national data
Foreign currency bond spread	EMBI country-level yield over 5-year US Treasury yield	Percentage 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 (2016a): "Local currency sovereign risk"
VIX	CBOE volatility index	Percentage points	Bloomberg
CPI	CPI inflation (seasonally adjusted)	2000 M1 = 100	National data
Domestic credit	Credit to the private non-financial sector	National currency	IMF International
			Financial Statistics
IP	Industrial production (seas. adjusted)	2000 M1 = 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



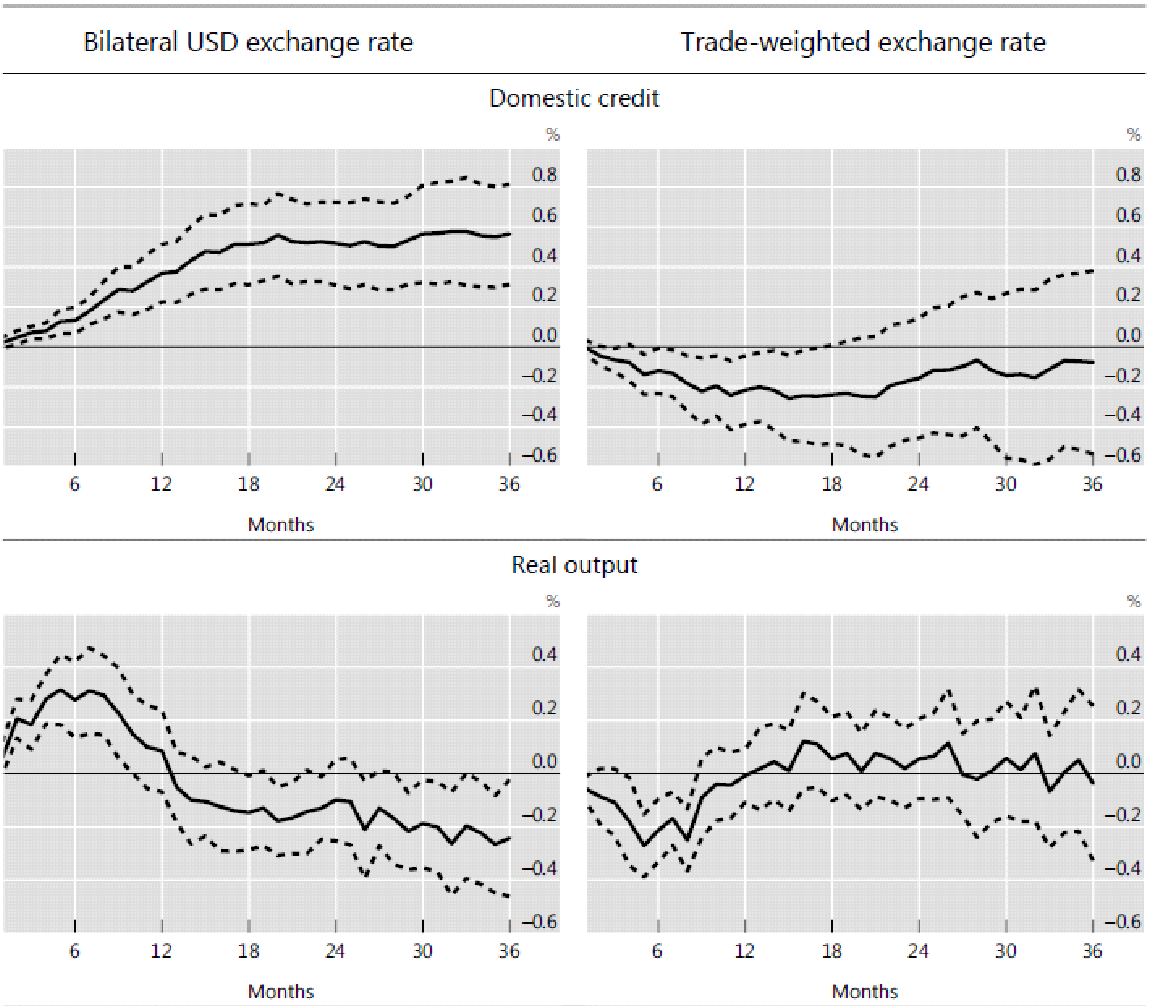
Appendix Figure 1: Bond spread impact of actual exchange rate appreciation.



Appendix Figure 2: Bond spread impact of orthogonal exchange rate appreciations.



Appendix Figure 3: Macroeconomic impact of actual exchange rate appreciation.



Appendix Figure 4: Macroeconomic impact of orthogonal exchange rate appreciations.