Exchange rates and the transmission of global liquidity

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Abstract

Exchange rate fluctuations influence economies not only through a net exports channel, but also through a financial amplification channel. While the trade-weighted effective exchange rate is key for the net exports channel, financial amplification rests on risk-taking and leverage associated with shifts in the bilateral exchange rate against international funding currencies. We examine the impact of fluctuations in the US dollar, the euro and the yen on cross-border bank lending. While the US dollar remains the preeminent global funding currency, the yen also exhibits many similar characteristics. Meanwhile, the euro has recently also emerged as an international funding currency.

Keywords: international risk taking channel, cross-border bank lending, international currencies.

JEL classification: F30, F31, F32.

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Contents

1. Introduction

Exchange rate fluctuations influence the economy through both real and financial channels. The real effects, which operate through the net exports channel, are well-known and are standard in open economy macro models.

The financial channel operates when borrowing in international funding currencies takes place outside the jurisdiction of the currency, so that exchange rate fluctuations set in train valuation changes, balance sheet adjustments and risk-taking, both in financial and real assets with impact on the real economy. The financial channel is less standard compared to the net exports channel, but has become more important with the greater integration of the global financial system in recent years.

Crucially, the financial channel of exchange rate fluctuations often operates in the opposite direction relative to the net exports channel. Specifically, under the net exports channel, it is when the domestic currency depreciates that real economic activity picks up. By contrast, the financial channel operates through the liabilities side of the balance sheet of domestic borrowers, so that it is when the domestic currency appreciates that balance sheets strengthen and economic activity picks up.

Our empirical findings suggest that the financial channel of exchange rate fluctuations is key to understanding the ebb and flow of global liquidity. "Global liquidity" is a catch-all term for the ease of financing in global financial markets, encompassing both credit and market liquidity conditions, and is often associated with the transmission of monetary conditions through global financial markets.[2] There is mounting evidence that monetary policy shocks in financial centres can be transmitted further afield and have a significant impact on global financial conditions. Miranda-Agrippino and Rey (2012) and Rey (2015) make the case for the existence of a global financial cycle that synchronises capital flows, asset prices and credit growth, and which is associated with the stance of monetary policy in the Unites States. Furthermore, the main types of capital flows are also highly correlated with each other and negatively correlated with the VIX (Forbes and Warnock, 2012).

One of the most important channels through which monetary policy in advanced economies impacts global financial conditions is through cross-border bank lending. Bruno and Shin (2015b) have documented the international risk-taking channel of monetary policy, which operates though the preeminent role that the US dollar plays in international banking. In particular, Bruno and Shin (2015a) show that episodes of appreciation of the US dollar are associated with deleveraging of global banks and an overall tightening of global financial conditions.

The key empirical regularity at the heart of the financial channel of exchange rates is the association between the depreciation of an international funding currency and the greater borrowing in that currency by non-residents. In the specific case of the US dollar, when it depreciates against the currency of a given country, the residents of that country tend to borrow more in US dollars.

This empirical regularity may have several drivers, both on the demand side and on the supply side of dollar credit. In terms of the *demand* for dollar credit, a borrower who has dollar-denominated liabilities and domestic currency assets would see a strengthening of its balance sheet as a result of a dollar depreciation. Furthermore, an exporting firm with dollar receivables or an asset manager with dollar denominated assets -- but with domestic currency obligations -- would hedge currency risk more aggressively when the dollar is expected to depreciate further. Incurring dollar liabilities, or an equivalent off-balance sheet transaction would be the way to hedge currency risk in such instances.

The link between dollar depreciation and greater borrowing in dollars by non-residents may also operate through the *supply* of dollar credit, and has been dubbed the *risk-taking channel* by Bruno and

[2] For further discussion, see Fender and McGuire (2010), CGFS (2011), Domanski et al (2011) and Caruana (2016).

Shin (2015b). When there is the potential for valuation mismatches on borrowers' balance sheets arising from exchange rate changes, a weaker dollar flatters the balance sheets of dollar borrowers, whose liabilities fall relative to assets. From the standpoint of creditors, the stronger credit position of the borrowers reduces tail risk in the credit portfolio and creates spare capacity for additional credit extension even with a fixed exposure limit through a value-at-risk (VaR) constraint or economic capital (EC) constraint.

In theory, there are two exchange rate concepts that could be relevant for the financial channel of exchange rate fluctuations. First, fluctuations in the *bilateral* exchange rate of the US dollar against the currency of a given country could impact the net worth of local borrowers with currency mismatches on their balance sheets. This could, in turn, affect the *demand* for dollar credit. Second, movements in the *broad US dollar index* could affect the credit risk in a diversified portfolio of US dollar-denominated loans and the Value-at-Risk (VaR) of global banks' loan portfolios. As a consequence, it could impact the *supply* of credit by global banks (Bruno and Shin, 2015a and 2015b).

The risk-taking channel of currency fluctuations has both a price dimension and a quantity dimension. The price dimension has been addressed by Hofmann, Shim and Shin (2016), who examine how currency appreciation is associated with greater risk-taking by both borrowers and lenders. Tellingly, the relevant exchange rate for the risk-taking channel is that with the international funding currency – almost invariably the US dollar, but also increasingly the euro – rather than the trade-weighted effective exchange rate. This is because the risk-taking channel has to do with leverage and risk-taking, in contrast to the net exports channel, which revolves around trade and the effective exchange rate. The wedge between the two provides a window for a reconciliation of the risk-taking channel with the net exports channel, and permits an empirical investigation that disentangles the two channels.

Our focus in this paper is on the quantity dimension of the risk-taking channel. More concretely, we conduct a targeted empirical investigation of the impact of fluctuations in the three major global funding currencies, the US dollar, the euro and the Japanese yen, on cross-border bank lending denominated in those currencies. We examine the question using a wide range of econometric techniques – global time series regressions, borrowing country-specific time series regressions, panel regressions, and structural panel vector autoregressions (SPVARs). The results obtained in all of the above empirical settings conclusively point to a robust negative relationship between the value of a given funding currency and cross-border bank flows denominated in that currency. We interpret these findings as evidence for the existence of a risk-taking channel of currency fluctuations.

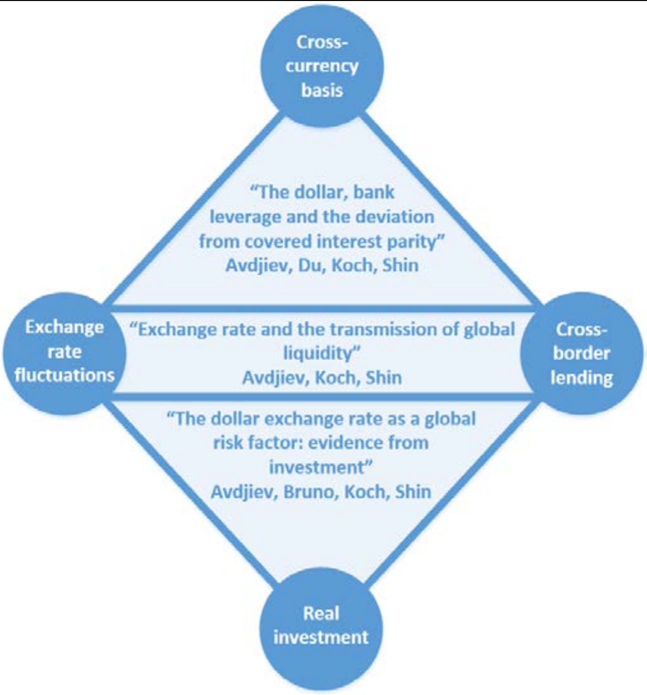
We further find that the strength of the risk-taking channel varies both, across individual currencies and over time. More specifically, our results indicate that the US dollar has been the preeminent global funding currency. The Japanese yen also exhibits many key characteristics of a global funding currency over some periods, albeit not as much as the US dollar. The euro, which before the Global Financial Crisis did not exhibit any of the properties that characterise international funding currencies, has started to emerge as a major international funding currency during the post-crisis period, especially for lending to emerging Europe and non-euro area European advanced economies.

In addition to the papers mentioned above, our paper is also related to several other strands of literature.

First, our paper is most closely related to the empirical work that explores the financial and macroeconomic implications of the financial channel of exchange rate fluctuations. Avdjiev, Du, Koch and Shin (2016) document the triangular relationship formed by (i) the strength of the US dollar, (ii) cross-border bank lending in dollars and (iii) deviations from covered interest parity (CIP). Meanwhile, Avdjiev, Bruno, Koch and Shin (2017) find evidence of another "triangular" relationship among (i) the strength of the US dollar, (ii) cross-border bank lending, and (iii) real investment. The combined results (from the above two papers and our paper) represent evidence of the existence of a diamond-like relationship between four key macroeconomic and financial variables: (i) the strength of the US dollar,

(ii) cross-border bank lending in dollars, (iii) deviations from covered interest parity (CIP) and (iv) real investment (Graph 1). In that context, the main contribution of our paper is that it provides robust empirical evidence for the existence of the main axis in the above "diamond" – the axis that links exchange rate fluctuations in a given currency and cross-border bank lending denominated in that currency.

The international finance/macro "diamond" Graph 1



Source: BIS.

Second, our work is connected to the literature that examines the financial channels through which exchange rate movements affect macroeconomic and financial outcomes across countries. Bebczuk et al. (2010) and Kohn et al. (2015) have demonstrated that local currency devaluations can be contractionary. Bruno and Shin (2015a) have found that a US dollar appreciation can cause a reduction in cross-border bank lending through its impact on the balance sheets of global banks. Kim, Tesar and Zhang (2015) have demonstrated that, in the case of Korea, the balance-sheet effect is important for small, non-exporting firms that entered the global financial crisis with short-term foreign-currency denominated debt. Eichengreen and Tong (2015) examine the impact of a renminbi revaluation on non-Chinese firms' stock returns through the trade channel. Du and Schreger (2016) have found that a higher reliance on external foreign currency corporate financing is associated with a higher default risk on sovereign debt. Using loan-level data from U.S. banks' regulatory filings, Niepmann and Schmidt-Eisenlohr (2017) have demonstrated that exchange rate changes can affect the ability of currency-mismatched firms to repay their debt. Further, Claessens, Tong and Zuccardi (2015) find that the euro crisis had a larger impact on firms with greater ex ante financial dependence and, in particular, on firms residing in creditor countries that are more financially exposed to peripheral euro countries through bank claims. In addition, Druck, Magud, and Mariscal (2017) document a negative relation between the strength of the U.S. dollar and emerging markets' growth: when the dollar is strong, emerging markets' real GDP growth decreases, and vice versa. In a recent paper, Goldberg and Krogstrup (2017) propose a new measure of capital flow pressures, which captures pressures that materialize in actual international capital flows as well as pressures that result in exchange rate adjustments.

Last but not least, our paper is also related to the literature on international shock transmission by banks. This literature dates back to two seminal papers by Peek and Rosengren (1997 and 2000). Our work is most closely linked to the strand within this literature that focuses on emerging market borrowers (eg McGuire and Tarashev 2008, Takáts 2010, Cetorelli and Goldberg 2011, Schnabl 2012, Beck 2014, Cerutti et al 2016, Avdjiev et al 2017 and Avdjiev and Hale 2017).

The rest of this paper is organised as follow. We conduct a preliminary examination of the empirical evidence in Section 2. In Section 3, we present our empirical methodology. In Section 4, we describe the data used in our empirical analysis. In Section 5, we present the main results from our empirical analysis of the global funding properties of the US dollar, the Japanese yen, and the euro. Finally, Section 6 concludes and presents some policy implications.

2. A preliminary look at the empirical evidence

We start by examining the evolution of cross-border bank lending flows denominated in the three main global funding currencies – the US dollar, the Japanese yen and the euro.

Graph 2 provides a preliminary glimpse of the risk-taking channel of currency fluctuations at work. It plots the cumulative flows of cross-border bank lending denominated in US dollar (left-hand panel), Japanese yen (centre panel) and euro (right-hand panel) to borrowers *outside* the respective currency area using quarterly data from the *BIS locational banking statistics*[3]. The dark shaded areas in each panel indicate quarters when the respective currency depreciated in trade-weighted effective terms.

We see that those dark shaded bars in the left-hand panel of Graph 2 tend to be associated with steeper growth in cross-border lending in US dollars, suggesting a *negative* relationship between the strength of the US dollar and cross-border lending denominated in dollars. The above pattern holds for both interbank lending (red line) and lending to non-banks (blue line), but is much more pronounced for the former category, suggesting that bank-to-bank flows are most sensitive to exchange rates. This is in line with the predictions of the "double-decker" model of international banking proposed by Bruno and Shin (2015b).

Cross-border bank lending in Japanese yen exhibits a similar pattern (Graph 2, centre panel). Namely, periods of JPY weakness tend to be associated with increases in lending denominated in yen to borrowers outside of Japan. Just as in the case of the US dollar, the most sensitive component appears to be interbank lending.

The euro has some distinctive features that set it apart from both the dollar and the yen (Graph 2, right-hand panel). Cross-border bank lending in euros to borrowers residing outside of the euro area grew steadily during the pre-crisis period. This growth appeared to be uncorrelated with the strength of the euro, which actually appreciated during most of that period. Nevertheless, a negative relationship has emerged in the post-crisis period, with euro-denominated lending growing more rapidly during periods of euro depreciation.

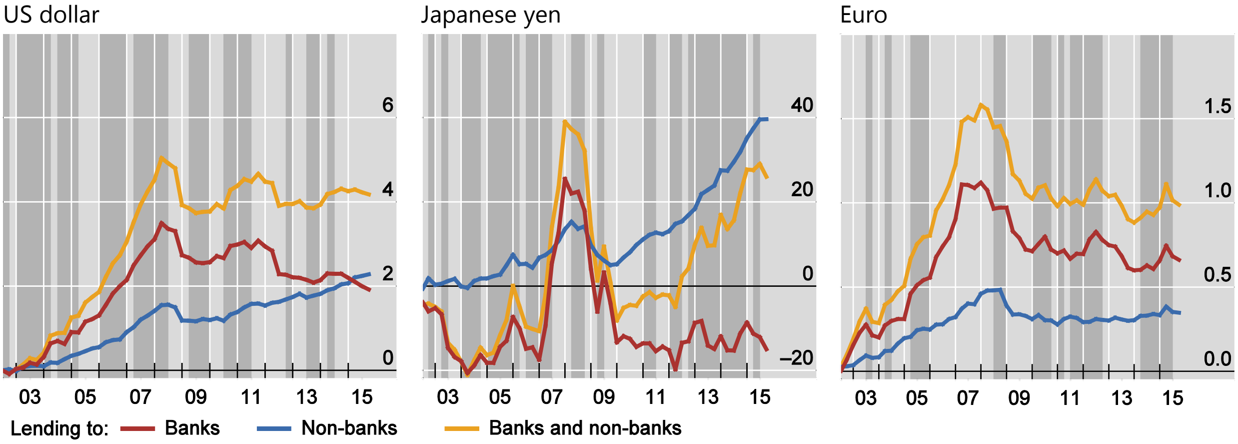
The initial observations based on the plots in Graph 2 are also confirmed by preliminary empirical analysis. More concretely, we run regressions of (the quarterly growth rate of) cross-border bank lending to non-residents in a given global funding currency on (the quarterly change in) the exchange-rate value of the respective currency, measured by the nominal effective exchange rate (NEER). We find that there is a statistically significant negative relationship between the strength of a global funding

[3] The BIS locational banking statistics are structured according to the location of banking offices and capture the activity of all internationally active banking offices in the reporting country regardless of the nationality of the parent bank. Banks record their positions on an unconsolidated basis, including those vis-à-vis their own offices in other countries.

currency (dollar, yen, or euro) and cross-border bank capital flows denominated in the respective currency. Over the entire time window (2002-2015) that we examine, the above empirical relationship holds for the US dollar (Graph 3, left-hand panel) and the Japanese yen (Graph 3, centre panel), but not for the euro. Nevertheless, the post-crisis period (2010-2015) has seen the emergence of a statistically significant negative relationship for the euro, as well (Graph 3, right-hand panel). This could be interpreted as early evidence for the emergence of the euro as a major global funding currency.

Cumulative flows of cross-border bank lending to non-residents

In trillions of the respective currency — Graph 2

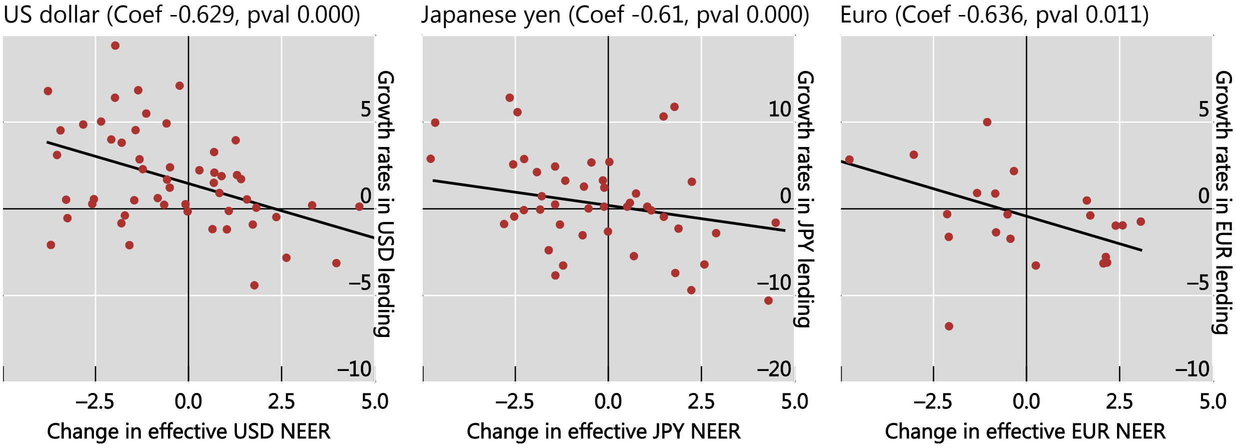


The three panels show the cumulative lending flows to all borrowers worldwide located outside of the respective currency area (eg, in the left-hand panel, US dollar denominated cross-border lending to all borrowers located outside of the United States on a non-consolidated basis). Lending flows comprise loan issuance and holdings of debt securities. The shaded areas indicate a quarterly depreciation of the nominal effective exchange rate for the respective currency denomination.

Sources: BIS Locational Banking Statistics; BIS effective exchange rate indices.

Cross-border bank lending to non-residents vs NEER

Graph 3



The left-hand and the centre panel cover the Q1/2002-Q3/2015 period; the right-hand panel covers the Q1/2010-Q3/2015 period. In all three panels, lending refers to loans and holdings of debt securities by BIS reporting banks, while all borrowers reside outside of the respective currency areas. The black line is a fitted regression line whose respective coefficient estimates and p-values are provided in the title of each panel. Positive changes in the foreign exchange rate indicate an appreciation of the respective currency. For presentational purposes, outliers with FX rate changes exceeding 5% in absolute value have been dropped from the panels, but not from the regressions.

Sources: BIS Locational Banking Statistics; BIS effective exchange rate indices; BIS calculations.

Our preliminary regression analysis suggests that, as a rule of thumb, a 1% depreciation of the US dollar is associated with an approximately 0.63 percentage point contemporaneous increase in the quarterly growth rate of US dollar-denominated cross-border lending to borrowers outside the United States. The magnitude of the estimated impact for the Japanese yen (-0. 61) is similar to the one for the US dollar. Finally, the estimated impact for the euro (-0.64) during the 2010-2015 period is also in the same range of magnitude.

3. Empirical methodology

Based on four different econometric techniques, we examine the risk-taking channel of currency fluctuations. We start with time-series regressions, first for different currency denominations based on global aggregates, and then for individual borrower countries. In the next step, we exploit the cross-sectional richness of the data (along the borrower country dimension) in a panel framework. Finally, we explore the dynamic properties of the relationship by estimating structural panel vector autoregressions (SPVARs).

Throughout our empirical analysis, we apply a twofold approach with respect to the foreign exchange rate of a global currency. On the one hand, we draw on the bilateral exchange rate $\left(\Delta BER_{i,t}^{c}\right)$ of that global funding currency vis-à-vis a particular borrower country. On the other hand, we resort to the broad BIS nominal effective exchange rate index ($\Delta NEER_{t}^{c}$) taking a host of borrower countries into account.

3.1 Time series regressions

In our first formal empirical exercise, we regress the quarterly growth rate of cross-border lending (Δxbl_{t}^{c}) denominated in a specific global currency c on the quarterly percentage changes in the exchange rate. Equation (1) describes our regression setup for global aggregates of lending in currency c and the nominal effective exchange rate index for that currency ($\Delta NEER_{t}^{c}$).

$$\Delta xbl_{t}^{c} = \alpha^{c} + \beta^{c}\,\Delta NEER_{t}^{c} + \varepsilon_{t}^{c} \qquad (1)$$

Apart from lending to all sectors, we run separate regressions for lending to banks and non-banks. As a positive change in the NEER of a given currency indicates an appreciation of that currency, we expect β^{c} to be negative.

In the next step, we conduct country-level analyses with equation (2a) showing our specification for the bilateral exchange rate, and equation (2b) referring to the exchange rate index:

$$\Delta xbl_{i,t}^{c} = \alpha_{i,a}^{c} + \beta_{i,a}^{c}\Delta BER_{i,t}^{c} + \vartheta_{i,t}^{c} \qquad (2a)$$

$$\Delta xbl_{i,t}^{c} = \alpha_{i,b}^{c} + \beta_{i,b}^{c}\Delta NEER_{t}^{c} + \epsilon_{i,t}^{c} \qquad (2b)$$

In this case, $\Delta xbl_{i,t}^{c}$ stands for the quarterly growth rate of cross-border lending to borrower country i denominated in a currency c during period t. We separately estimate equations (2a) and (2b) for lending to all sectors as well as to banks and non-banks each country. Since the risk-taking channel implies that a depreciation of the global funding currency is associated with more cross-border lending in this funding currency, we again expect the estimates of $\beta_{i,a}^{c}$ and $\beta_{i,b}^{c}$ to be negative.

3.2 Panel regressions

In the next part of our empirical investigation, we pool our data across all borrower countries. We now run separate regressions for the bilateral exchange rate (equation 3a) and the broad NEER dollar index (equation 3b) to distinguish between the bilateral and the more general impact of global currency depreciations.

$$\Delta xbl_{i,t}^{c} = \alpha_a^c + \beta_a^c \Delta BER_{i,t}^c + \pi_{i,t}^c \quad (3a)$$

$$\Delta xbl_{i,t}^{c} = \alpha_b^c + \beta_b^c \Delta NEER_{t}^c + \sigma_{i,t}^c \quad (3b)$$

As both concepts of describing the strength of a global currency denomination are related, we want to isolate those fluctuations in the bilateral exchange rate that are orthogonal to the index fluctuations. For this reason, we retrieve the residuals that ensue from a regression of the bilateral on the index measure. Equation (3c) exhibits this approach which allows us to differentiate between borrower country-specific and global factors driving cross-border lending through the exchange rate mechanism.

$$\Delta xbl_{i,t}^{c} = \gamma_0^c = +\gamma_1^c \Delta BER_{i,t}^{c,orth} + \gamma_2^c \Delta NEER_t^c + f_i + \mu_{i,t}^c \quad (3c)$$

We let country fixed effects, f_i, absorb any time-invariant heterogeneity among borrowing countries. As in the previous empirical specifications, we expect the currency-specific coefficient estimates γ_s^c to be negative since an appreciation of the local currency against a given funding currency should trigger an increase in cross-border bank lending in the respective global currency via the risk-taking channel.

In addition to the full sample specifications, we estimate equations (3a) to (3c) for a number of different subsamples. This allows us to investigate how the strength of the risk-taking channel of currency fluctuations varies across geographical regions and levels of economic development.

3.3 Structural panel VARs (SPVARs)

In order to take dynamic interdependencies and the multidimensional structure of our data into account, we consider the following structural panel VAR for each currency denomination:[4]

$$By_{i,t} = f_i + A(L)y_{i,t-1} + u_{i,t} \quad (4)$$

Where $y_{i,t}$ is an m-dimensional vector of our stacked endogenous variables, f_i is a diagonal matrix of country-specific intercepts, $A(L) = \left(\sum_{j=0}^{p} A_j L^j\right)$ is a polynomial of lagged coefficients A_j, L^j the lag operator, B is a matrix of contemporaneous coefficients, and $u_{i,t}$ is a vector of stacked structural innovations with a diagonal covariance matrix described by $u_t \sim N(0, \mathrm{I}_m)$ and $E[\boldsymbol{u_t}\ \boldsymbol{u'_s}] = \boldsymbol{0_m}$ for all $s \neq t$.

In our baseline specification, we use $y_{i,t} = [\Delta ir_t\ , \Delta xbl_{i,t}, \ln VIX_t\ , \Delta BER_{i,t}]$ for the bilateral rate or $y_{i,t} = [\Delta ir_t\ , \Delta xbl_{i,t}, \ln VIX_t\ , \Delta NEER_t]$ for the broad index to capture the vector of m endogenous variables.

Since f_i is correlated with regressors due to the lags of the dependent variables in dynamic panels, OLS-based estimation would lead to biased coefficient estimates (see Nickell, 1981). To avoid this concern, we rewrite the structural panel VAR in (4) as an m-dimensional system of equations in first differences with $\boldsymbol{e_t}$ as an m x 1 vector of reduced from residuals based on $\boldsymbol{e_t} \sim N(0, \Sigma_e)$ and $E[\boldsymbol{e_t}\ \boldsymbol{e'_s}] = 0_m$ for all $s \neq t$.

$$\begin{aligned} \Delta y_{1,i,t} &= \textstyle\sum_{j=1}^{p} \gamma_{11}^{j}\, \Delta y_{1,i,t-j} + \cdots + \sum_{j=1}^{p} \gamma_{1m}^{j}\, \Delta y_{m,i,t-j} + e_{1,i,t} \\ &\vdots \\ \Delta y_{m,i,t} &= \textstyle\sum_{j=1}^{p} \gamma_{m1}^{j}\, \Delta y_{1,i,t-j} + \cdots + \sum_{j=1}^{p} \gamma_{mm}^{j}\, \Delta y_{m,i,t-j} + e_{m,i,t} \end{aligned} \quad (5)$$

[4] For the sake of tractability, we drop the superscript that denotes the currency denomination in this subsection.

We resort to Arellano-Bond's GMM/IV technique to estimate the system in (5) using four lags of our endogenous variables as instruments (Arellano and Bond, 1991). This procedure gives us an estimate of the variance-covariance matrix $\sum_e = E[e_{i,t}e'_{i,t}]$.

The equivalent moving average representation of the structural panel VAR model (4) can be re-stated as follows

$$\boldsymbol{B}y_{i,t} = \Phi(L)u_{i,t} \tag{6}$$

with $\Phi(L) = \sum_{j=0}^{\infty} \Phi_j L^j = \sum_{j=1}^{\infty} A_1^j L^j$ describing the structural-form responses of horizon j to unit-variance structural innovations with $\Phi_0 = A_1^0 \equiv \mathrm{I}_m$.

As $B^{-1}u_{i,t} = e_{i,t}$, we can rewrite $\sum_e = E[\boldsymbol{B}^{-1}u_{i,t}u'_{i,t}\boldsymbol{B}^{-1\prime}]$ with $u_{i,t}$ denoting the structural innovations which are assumed to be uncorrelated $(u_{i,t}u'_{i,t} = \mathrm{I}_m)$ leading to $\sum_e = E[B^{-1} \quad B^{-1\prime}]$. We can hence retrieve the $\boldsymbol{B}$ matrix by decomposing the estimate of our variance-covariance matrix $\sum_e$ into two lower triangular matrices. To identify the model, we orthogonalize the contemporaneous responses. In particular, we impose the ordering restriction on our baseline specification, so that shocks in the fx-equation do not have a contemporaneous effect on changes in lending, whereas shocks to lending are allowed to contemporaneously affect in the FX rate.

We follow Lütkepohl (2007) to obtain impulse responses at horizon h from the vector moving average representation of the structural panel VAR. The marginal responses Φ_h are recovered recursively:

$$\Phi_h = \sum_{k=1}^{h} \Phi_{h-k} A_h \tag{7}$$

Then multiplying all Φ_h by our estimate of B^{-1} and using an m-dimensional impulse response vector $s \equiv [1, \dots, 0]'$ to construct the matrix P of structural responses at horizon h:

$$P = \begin{bmatrix} B^{-1}\Phi_0 s \\ \vdots \\ B^{-1}\Phi_h s \end{bmatrix}_{hxm} \tag{8}$$

Collecting the first column into a vector, we have the impulse response of the first endogenous variable to a shock in the first endogenous variable. After recovering the point estimates of all the impulse response functions, we calculate standard errors nonparametrically through a simulation algorithm with 1000 replications at a horizon of 10 quarters.

Again, we estimate the SPVAR for a number of different subsamples in order to explore how the strength of the risk-taking channel differs across geographical regions and levels of economic development.

4. Data

The main dataset that we use in all of our empirical exercises is the BIS Locational banking statistics (LBS). They capture outstanding claims and liabilities of banks located in BIS reporting countries, including intragroup positions between offices of the same banking group (BIS, 2015). The locational statistics are compiled following principles that are consistent with balance of payments. Exchange rate and break adjusted changes in amounts outstanding are calculated, as an approximation for flows. Most importantly for our empirical investigation, the LBS provide information about the currency composition of banks' balance sheets. Furthermore, they also contain country and sector breakdowns of reporting banks' counterparties.

The summary statistics presented in Table 1 reveal that there are considerable differences across the three major currencies we examine in this paper. The average quarterly growth rate of cross-border lending denominated in US dollars (2.2%) was much higher than those of lending in yen (1.1%) and euro (1.5%). In the meantime, lending in yen was much more volatile than lending in US dollars and euros.

For all three major currencies we examine, the volatility of lending to banks is higher than that of lending to non-banks. Furthermore, the average growth rate of interbank lending was higher than that of lending to non-banks.

Descriptive statistics

Table 1

	mean	median	sd	min	max	N
Panel A: USD (Q1 2002–Q3 2015, 106 borrower countries)						
Δxbl (all)	2.22	1.38	10.99	-17.70	26.98	5,775
Δxbl (banks)	3.38	1.36	19.80	-32.35	53.57	5,771
Δxbl (non-banks)	2.38	1.25	11.95	-19.53	31.06	5,775
ΔBER	0.39	0.00	5.54	-26.46	117.08	5,830
ΔNEER	-0.09	-0.50	2.60	-3.77	10.80	5,830
ln Vix	2.94	2.86	0.35	2.40	4.07	5,830
Δir(SSR)	-0.03	0.00	0.60	-2.17	1.13	5,830
Panel B: JPY (Q1 2002–Q3 2015, 114 borrower countries)						
Δxbl (all)	1.06	-0.67	21.32	-38.58	56.05	6,074
Δxbl (banks)	1.40	-1.87	38.12	-69.35	97.87	5,762
Δxbl (non-banks)	1.25	-0.44	23.15	-42.99	62.77	5,921
ΔBER	0.51	0.00	6.89	-22.42	116.66	6,270
ΔNEER	-0.11	-0.46	4.47	-12.40	21.15	6,270
ln Vix	2.94	2.86	0.35	2.40	4.07	6,270
Δir(SSR)	-0.03	-0.14	0.53	-0.84	1.90	6,270
Panel C: EUR (Q1 2010–Q3 2015, 93 borrower countries)						
Δxbl (all)	1.54	0.17	11.52	-18.40	31.99	2,106
Δxbl (banks)	3.17	-0.32	25.16	-41.09	71.53	2,096
Δxbl (non-banks)	1.81	0.39	12.75	-21.53	36.46	2,105
ΔBER	-0.18	0.00	4.92	-16.96	78.23	2,109
ΔNEER	-0.53	-0.51	2.49	-5.65	3.07	2,109
ln Vix	2.88	2.82	0.25	2.54	3.42	2,109
Δir(SSR)	-0.18	-0.17	0.44	-0.91	0.67	2,109

With observations at the quarterly borrower country level, this table provides summary statistics for the panel regression and the structural panel VAR analysis. Panel A refers to our analysis of the USD, Panel B to the JPY and Panel C to the EUR. All variables except for the ln Vix (the natural logarithm of the VIX) are expressed in percent. Growth rates of cross-border lending are adjusted for breaks-in-series and exchange rate effects in case of JPY- and EUR-denominated lending. We also winsorize them at the 5% level in each tail. The set of counterparty countries excludes the country of the currency denomination itself, and all countries whose exchange rate is pegged to the respective currency denomination. For the complete list of borrower countries, see Appendix A. For variable definitions and sources, see Appendix B.

Since the policy rates associated with the three currencies we examine were stuck at the zero lower bound for very large parts of the benchmark window that we examine, we use shadow rates as a measure of the monetary policy stance of the respective central banks. More concretely, we use changes in the shadow policy rates described in Krippner (2015). Krippner's shadow rate estimates are based on a two-factor model which is shown to be more stable over time than the alternative, three-factor model.

There are some concerns that the estimated level of the shadow rate may not be a perfect measure of monetary stance as it is sensitive to the assumption underlying the specification. However, changes in shadow rates are shown to be consistent and an effective proxy for monetary policy changes.[5]

In addition to bilateral exchange rates, we use the broad BIS nominal effective exchange rate (NEER) index for the US dollar, yen and euro. These indices cover 61 economies and are calculated as geometric trade weighted averages of bilateral exchange rates.

5. Results

In this section, we present three main sets of results – one for each of the three currencies we examine: the US dollar, the yen and the euro. In turn, for each of the three currencies, we report the results from two sets of empirical exercises –panel regressions and structural panel vector autoregressions (SPVARs). In addition, we present results from borrowing country-specific time series regressions for US dollar-denominated cross-border lending and global rolling-window time series regressions for euro-denominated lending.

5.1 The US dollar as the premier global funding currency

We start by presenting the results from our empirical examination of the impact of fluctuations in the value of the US dollar on cross-border bank lending flows to non-US residents.

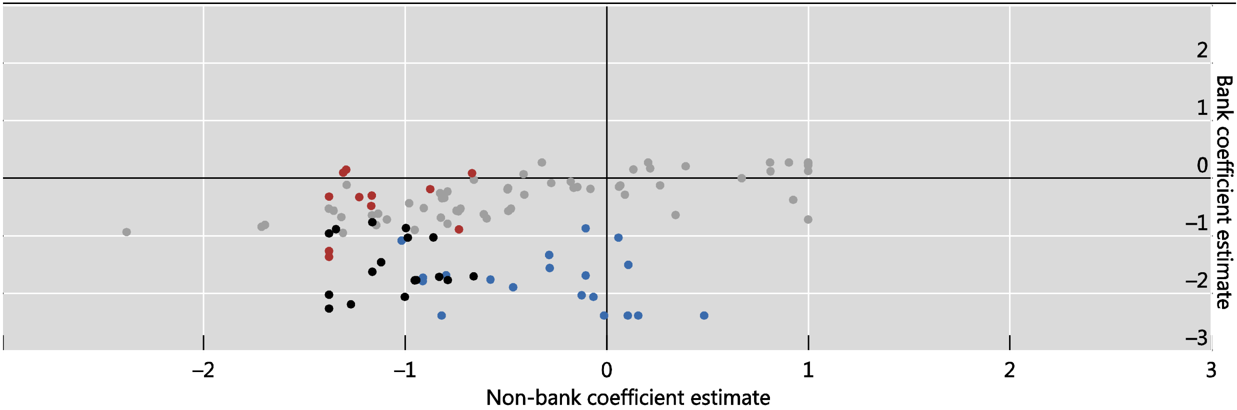
In our preliminary empirical investigation in Section 2, we regressed the growth rate of cross-border bank lending in US dollars to non-residents on the change in the value of the US dollar (measured by the US dollar NEER). In line with the predictions of the theoretical model of Bruno and Shin (2015b), the estimates from that regression implied that a US dollar depreciation has a negative and statistically significant impact on cross-border bank lending denominated in US dollars.

Next, we examine to what extent the above global relationship between the strength of the US dollar and dollar-denominated cross-border bank lending holds at the borrowing country level. We do that by running country-specific regressions, using the specification presented in Equation (2). More specifically, we regress the quarterly growth rate of cross-border bank lending in US dollars to the residents of a given country on the *bilateral* exchange rate between the currency of that country and the US dollar.

The results from the country-specific regressions reveal that the negative relationship between the strength of the US dollar and cross-border dollar-denominated bank lending is present not only at the global level, but also at the individual (borrowing) country level (Graph 4). The majority of the borrowing country-specific coefficients are situated in the lower left-hand quadrant of Graph 4, indicating a negative relationship for lending to both bank and non-bank borrowers. Furthermore, for most countries, the relationship is negative and statistically significant for lending to either banks (blue dots), non-banks (red dots) or both sectors (black dots).

[5] There is an argument that the level of monetary policy is a more important determinant of bank lending than its change, given that bank lending is a relatively slow-moving variable. The main focus of the analysis is on changes in monetary policy as it is unclear how identification challenges can be overcome when we focus on the level of monetary policy which co-moves with many other slower moving unobservables.

Estimated coefficients from country-specific regressions, US dollar — Graph 4



This graph plots three sets of coefficient estimates based on individual country-level regressions of the quarterly percentage growth rates of US dollar-denominated lending to a particular country on the percentage changes in the broad US dollar index. Period covered: Q1/2002-Q3/2015. Red (blue) dots indicate that the coefficient estimate of lending to non-banks (banks) is negative and statistically significant at the 10% level, while black dots indicate that both individual coefficient estimates (for lending to banks and lending to non-banks) are negative and statistically significant at the 10% level. Lending refers to loans and debt securities by BIS reporting banks.

Sources: BIS Locational Banking Statistics; BIS calculations.

In the next step of our empirical analysis, we examine the relationship between the value of the US dollar and cross-border bank lending in US dollars in a panel regression setting. More concretely, we use the specification presented in Equation (3) and include borrowing-country fixed effects in order to control for heterogeneity on the demand side of cross-border credit.

The results for the full sample of borrowing countries are presented in the top panel of Table 2. An appreciation of the bilateral exchange rate of the US dollar against the currency of a given country is associated with a statically significant decline in cross-border bank lending to that country (Column 1). Similarly, a broad increase in the value of the US dollar (as captured by an increase in the broad USD NEER index) also leads to statically significant decline in cross-border bank lending (Column 2). Furthermore, when the NEER and (the orthogonal component of) the BER are simultaneously included in the panel regression, both of them have a negative and statically significant impact on cross-border bank lending (Column 3). The remaining columns in the top panel of Table 2 reveal that the above negative relationship holds not only for lending to all sectors but also for lending to both banks and non-banks.

The above results represent strong evidence of the existence of the financial channel of exchange rate fluctuations. Furthermore, the fact that both the broad US dollar index and the bilateral exchange rate have statically significant negative impacts on cross-border bank lending suggests that the above channel has important drivers both on the supply and the demand side.

The negative relationship between the value of the US dollar and dollar-denominated cross-border bank lending holds not only across borrowing sectors, but also across borrowing country groups. Specifically, the estimated coefficients for both advanced economies (AEs) and emerging market economies (EMEs) are negative and statistically significant (Table 2, second and third panel, respectively). Moreover, we obtain highly significant results even for lending to offshore financial centres (OFCs), which typically does not conform to patterns that are present for other types of lending.

US dollar panel regressions

Cross-border lending to selected borrowing country groups, by borrower sector — Table 2

	All sectors			Banks			Non-banks		
All countries									
ΔBER	-0.224***			-0.280***			-0.148***		
	(0.067)			(0.092)			(0.053)		
ΔNEER		-0.496***	-0.498***		-0.664***	-0.673***		-0.295***	-0.304***
		(0.049)	(0.052)		(0.088)	(0.094)		(0.055)	(0.059)
ΔBER^{orth}			-0.148**			-0.175*			-0.106*
			(0.069)			(0.091)			(0.058)
Obs	5,775	5,775	5,260	5,771	5,771	5,256	5,775	5,775	5,260
R-squared	0.042	0.045	0.049	0.028	0.031	0.034	0.031	0.032	0.033
Advanced economies									
ΔBER	-0.341***			-0.410***			-0.186***		
	(0.041)			(0.071)			(0.058)		
ΔNEER		-0.513***	-0.513***		-0.622***	-0.622***		-0.339***	-0.339***
		(0.096)	(0.096)		(0.168)	(0.168)		(0.102)	(0.102)
ΔBER^{orth}			-0.248***			-0.289**			-0.125
			(0.071)			(0.109)			(0.082)
Obs	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
R-squared	0.032	0.028	0.033	0.032	0.030	0.033	0.012	0.013	0.014
Emerging market economies									
ΔBER	-0.169**			-0.223**			-0.117*		
	(0.077)			(0.109)			(0.063)		
ΔNEER		-0.435***	-0.430***		-0.703***	-0.693***		-0.196***	-0.211***
		(0.062)	(0.067)		(0.120)	(0.128)		(0.070)	(0.075)
ΔBER^{orth}			-0.120			-0.138			-0.094
			(0.075)			(0.098)			(0.066)
Obs	3,335	3,335	3,060	3,334	3,334	3,059	3,335	3,335	3,060
R-squared	0.038	0.042	0.046	0.020	0.025	0.028	0.036	0.034	0.037
Offshore centres									
ΔBER	-0.543***			-0.391***			-0.458**		
	(0.087)			(0.119)			(0.172)		
ΔNEER		-0.651***	-0.755***		-0.492**	-0.605*		-0.558***	-0.646***
		(0.126)	(0.108)		(0.225)	(0.304)		(0.136)	(0.171)
ΔBER^{orth}			-0.458***			-0.438**			-0.349*
			(0.128)			(0.169)			(0.155)
Obs	680	680	440	677	677	437	680	680	440
R-squared	0.103	0.113	0.142	0.073	0.076	0.085	0.064	0.070	0.063

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 106 borrower countries that are not pegged to the USD. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Our results also provide evidence that the credit supply component of the financial channel of exchange rates is more powerful than the respective credit demand component. The magnitudes of the estimated coefficients on the NEER index tend to be consistently larger than those for the bilateral exchange rates. For example, the results from the full-sample regressions imply that the impact of a one percentage point increase in the broad US dollar index on cross-border bank lending (50 basis points) is more than twice as large as the respective impact of a one percentage point rise in the bilateral exchange rate value of the US dollar against the currency of the borrowing country (22 basis points). Furthermore, the results from the full-sample specifications which simultaneously include the NEER and (the orthogonal component of) the BER, suggest that the impact of the former (50 basis points) is more than three times larger than the impact of the latter (15 basis points). This pattern persists across both borrowing country groups (AEs, EMEs, OFCs) and borrowing sectors (banks and non-banks).

Dollar-denominated cross-border interbank lending appears to be more responsive to exchange rate movements than lending to non-banks. In most cases, the estimated coefficients in the regressions for bank borrowers tend to be larger than the respective coefficients for non-bank borrowers. This pattern most likely reflects the greater procyclicality of bank balance sheets, and is consistent with the "double-decker" model of international banking proposed by Bruno and Shin (2015b). In this model, the global banking system is characterised by a core-periphery structure, in which large global banks in the core of the system provide cross-border funding to periphery banks, which in turn lend to local non-bank borrowers.

The negative and statistically significant relationship between the value of the US dollar and dollar-denominated cross-border bank lending also holds for all major EME regions (Table 3). For emerging Asia and emerging Europe, both the broad US dollar index and the bilateral exchange rate are negative and strongly statistically significant. Just as in the aggregate results, the estimated coefficients on the broad US dollar index tend to be larger in magnitude than their counterparts for the bilateral exchange rate. In the case of Arica and the Middle East (AME), the broad US dollar index is statistically significant, but the bilateral rate is not. Thus, it appears that, for the above three EME regions, the credit supply component of the financial channel of exchange rates is more active than the respective credit demand component.

In contrast to the other EME regions, Latin America appears to be more affected by the credit demand component than by the credit supply component of the financial channel of exchange rates. The estimated coefficients on the bilateral exchange rate and on its orthogonal component are statistically significant, while those on the broad dollar index are insignificant. The borrowing sector breakdowns reveal that this pattern is driven by lending to non-banks rather than by interbank lending (Table C1 in Appendix C). This is in line with the intuition that the former should be more directly affected by a deterioration in the creditworthiness of currency-mismatched borrowers triggered by a depreciation of the local currency against the US dollar.

In order to take full advantage of the cross-sectional richness of the dataset, we estimate structural panel VARs (SPVAR) using borrowing country level data. As discussed in the Section 3, we examine the structural panel VAR specification presented in Equation (5), following the variable ordering used in Bruno and Shin (2015a). Most importantly, in all structural panel VAR specifications that we explore, the cross-border lending variable is ordered ahead of the FX variable. This rules out any contemporaneous effects of the FX rate on cross-border lending, thus tilting the odds against us finding the results predicted by the theoretical model of Bruno and Shin (2015b). Once again, we examine both potentially relevant exchange rate measures – the bilateral exchange rate of the US dollar against the local currency of the borrowing country and the broad US dollar index.

US dollar panel regressions

Cross-border lending to all sectors, by borrowing emerging market region — Table 3

	Emerging Asia			Emerging Europe		
ΔBER	-0.501***			-0.338***		
	(0.129)			(0.070)		
ΔNEER		-0.542***	-0.542***		-0.558**	-0.556**
		(0.108)	(0.108)		(0.195)	(0.195)
ΔBER^{orth}			-0.402**			-0.316***
			(0.147)			(0.057)
Obs	935	935	935	585	585	585
R-squared	0.039	0.039	0.049	0.041	0.024	0.041

	Latin America			Africa and Middle East		
ΔBER	-0.123**			-0.059		
	(0.049)			(0.097)		
ΔNEER		-0.171	-0.171		-0.437***	-0.419***
		(0.118)	(0.118)		(0.096)	(0.122)
ΔBER^{orth}			-0.120**			-0.017
			(0.054)			(0.081)
Obs	660	660	660	1,155	1,155	880
R-squared	0.038	0.031	0.040	0.038	0.049	0.050

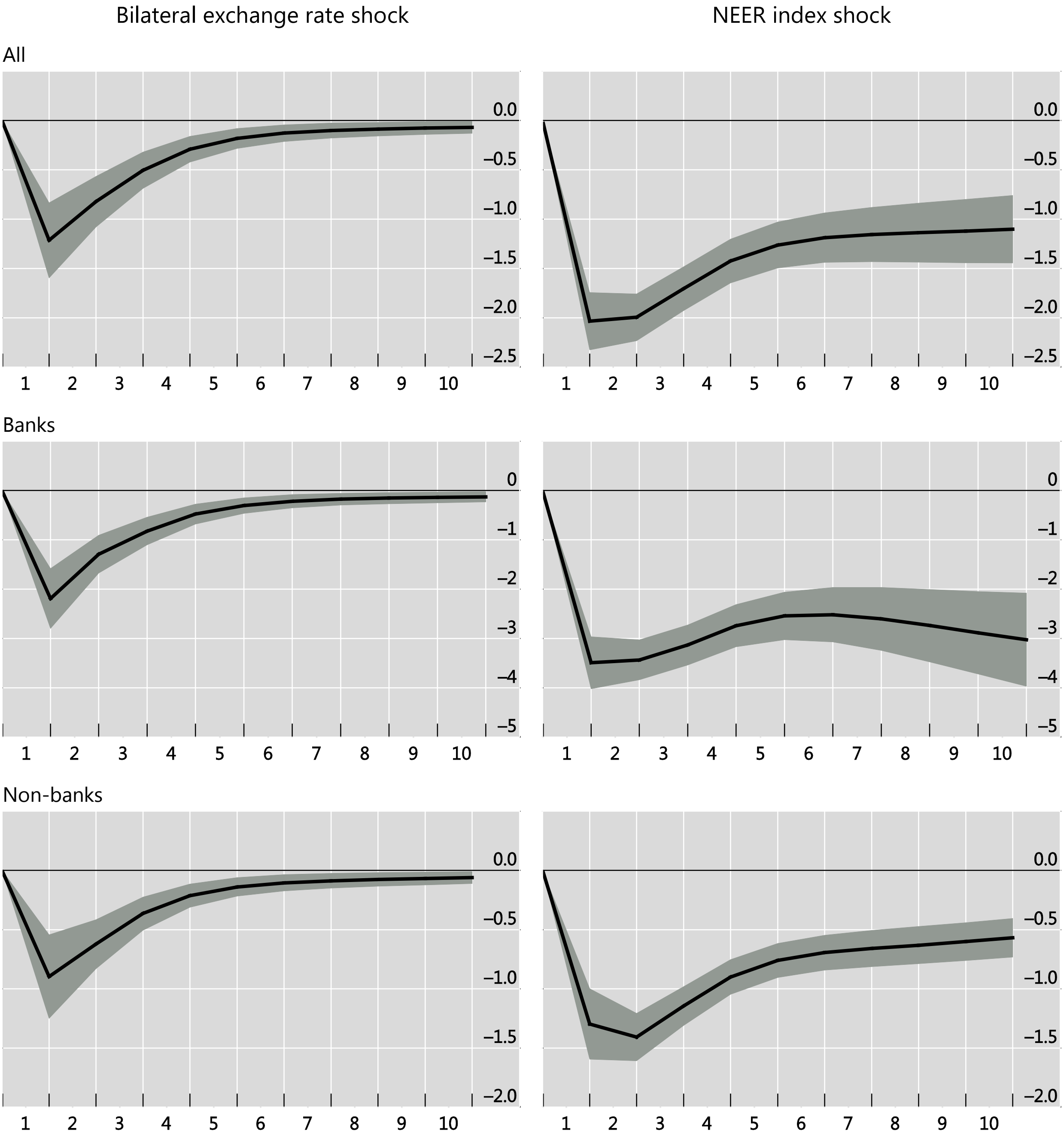
This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 106 borrower countries that are not pegged to the USD. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

The impulse responses from our benchmark specification indicate that the FX rate has a negative and strongly statistically significant impact on cross-border bank lending (Graph 5). This is the case for lending to borrowers from all sectors (top row), as well as for lending to bank (middle row) and non-bank borrowers (bottom row). The estimated negative impact is quite persistent, remaining statistically significant for six to eight quarters after the occurrence of the shock in the case of the bilateral exchange rate and over ten quarters in the case of the broad dollar index.

In line with the results from the panel regressions, the SPVAR impulse response functions also suggest that the credit supply component of the financial channel of exchange rates is more potent than the respective credit demand component. The contractions in cross-border lending triggered by an increase in the broad dollar index are both deeper and more persistent than those caused by an appreciation of the US dollar bilateral exchange rate. This is true not only for lending to borrowers from all sectors (top row), but also for lending to banks (middle row) and to non-bank borrowers (bottom row). Consistent with the results from the panel regressions and with the predictions of the Bruno and Shin (2015b) model, a US dollar appreciation has a larger impact on interbank lending (middle row) than on lending to non-bank borrowers (bottom row).

Impulse response functions, US dollar shock on USD cross-border bank lending

All borrowing countries, by borrowing sector | Graph 5



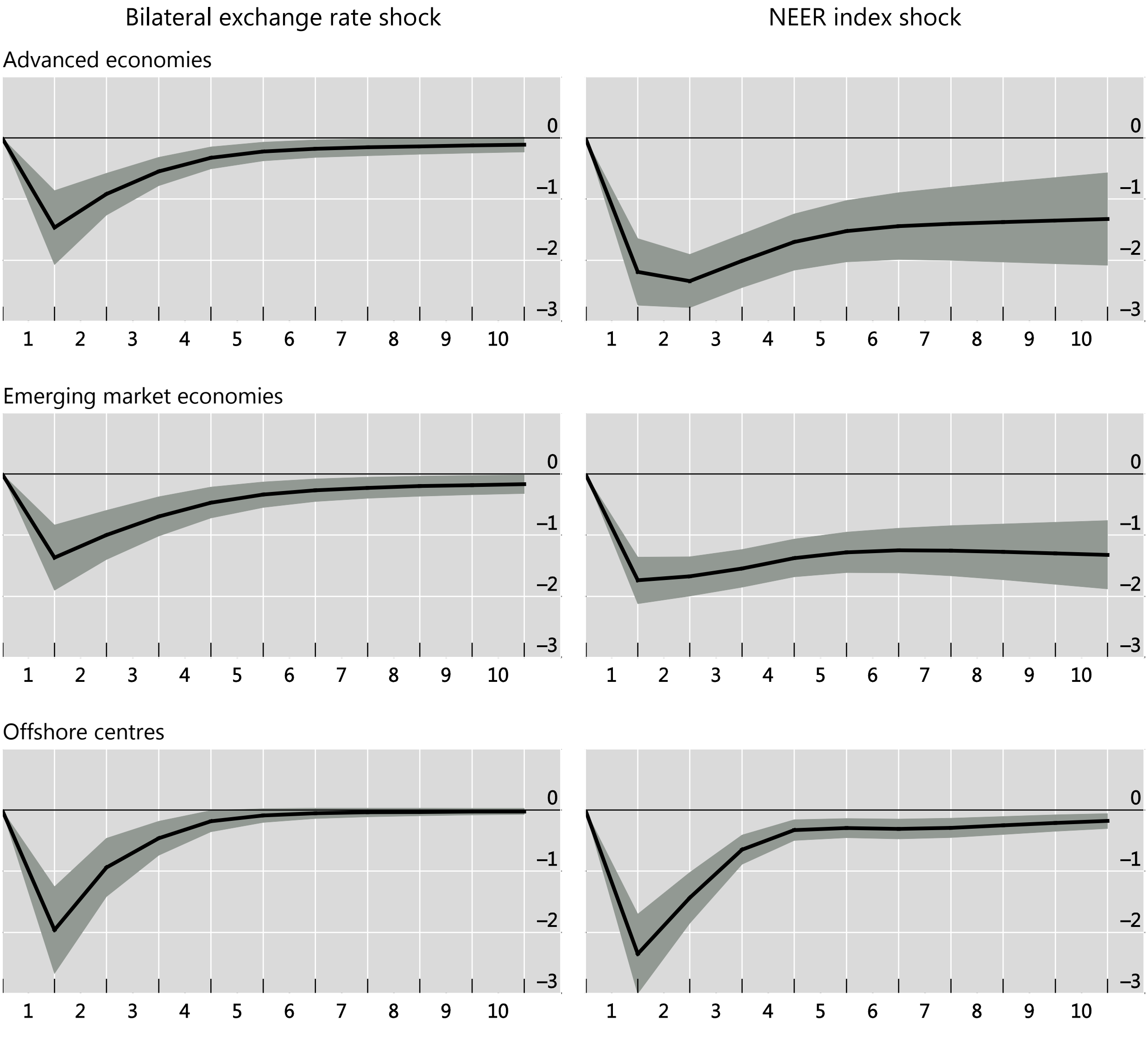
Responses in cross-border lending to a 1 standard deviation shock to the bilateral exchange rate (left-hand column) or nominal effective exchange rate index (NEER, right-hand column). Estimated orthogonalized Impulse Response Functions are based on a Cholesky decomposition with 4 endogenous variables ordered as $y_{i,t} = \left[\Delta ir^c_t, \Delta xbl^c_{i,t}, \ln VIX_{i,t}, \Delta fx^c_{i,t}\right]'$. Confidence bands reflect 95 percent confidence intervals using a Gaussian approximation based on 1000 Monte Carlos draws from the estimated structural panel VAR. Period covered: Q1/2002-Q3/2015.

Source: BIS calculations.

The above patterns hold across all main borrowing country groups that we examine (Graph 6). A US dollar appreciation shock triggers statistically significant and persistent contractions in dollar-denominated cross-border bank lending to borrowers in AEs (top row), EMEs (middle row) and OFCs (bottom row). Furthermore, the credit supply component appears to be more important than the credit demand component for all borrowing country groups – the impact of a shock to the broad US dollar index is larger and longer-lasting than that of a shock to the bilateral US dollar exchange rate in all three cases.

Impulse response functions, US dollar shock on USD cross-border bank lending

All borrowing sectors, by borrowing country group | Graph 6

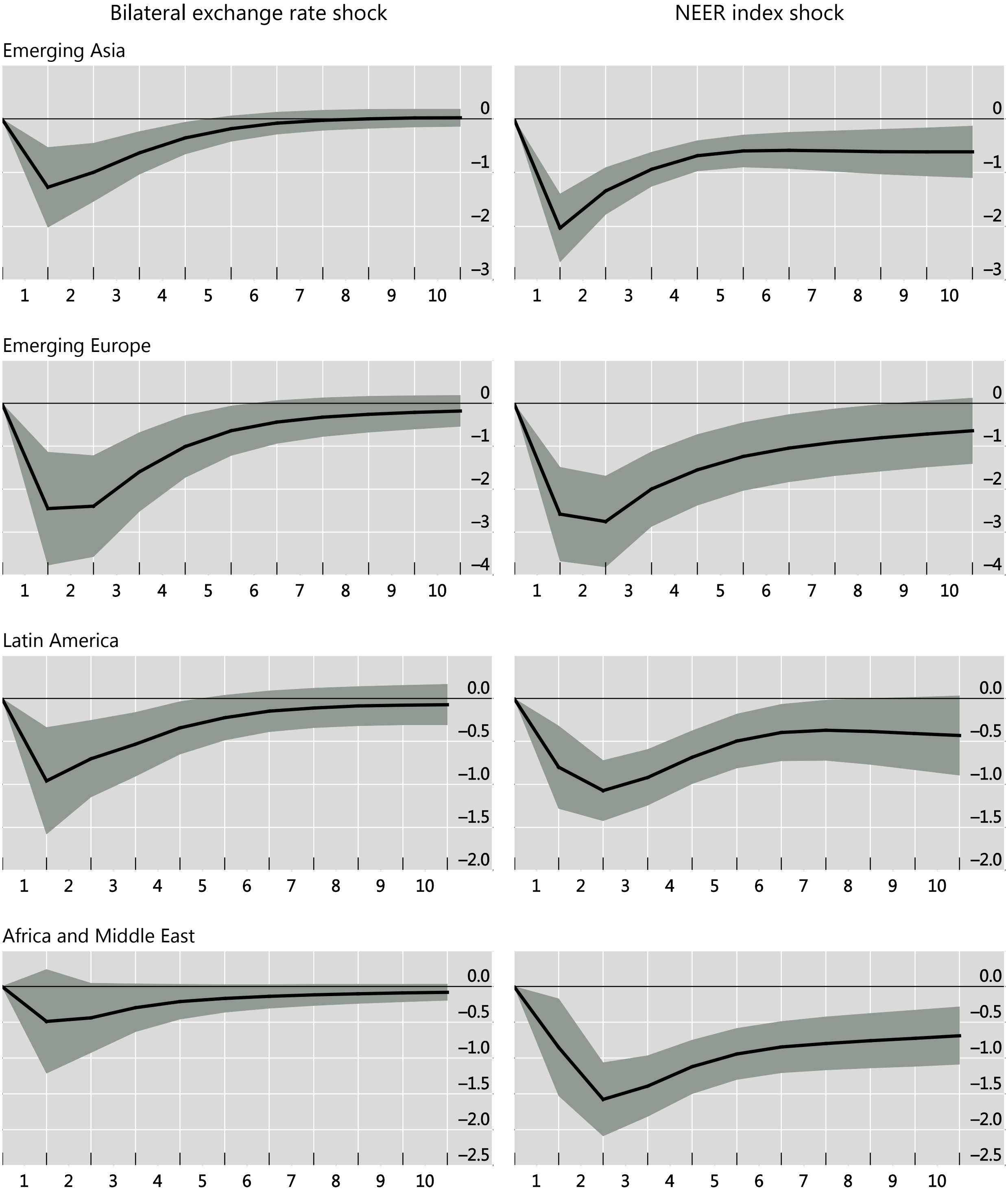


Responses in cross-border lending to a 1 standard deviation shock to the bilateral exchange rate (left-hand column) or nominal effective exchange rate index (NEER, right-hand column). Estimated orthogonalized Impulse Response Functions are based on a Cholesky decomposition with 4 endogenous variables ordered as $y_{i,t} = \left[\Delta ir^{c}_{t}, \Delta xbl^{c}_{i,t}, \ln VIX_{i,t}, \Delta fx^{c}_{i,t}\right]'$. Confidence bands reflect 95 percent confidence intervals using a Gaussian approximation based on 1000 Monte Carlos draws from the estimated structural panel VAR. Period covered: Q1/2002-Q3/2015.

Source: BIS calculations.

Impulse response functions, US dollar shock on USD cross-border bank lending

All borrowing sectors, by borrowing EME region Graph 7



Responses in cross-border lending to a 1 standard deviation shock to the bilateral exchange rate (left-hand column) or nominal effective exchange rate index (NEER, right-hand column). Estimated orthogonalized Impulse Response Functions are based on a Cholesky decomposition with 4 endogenous variables ordered as $y_{i,t} = \left[\Delta ir^c_t, \Delta xbl^c_{i,t}, \ln VIX_{i,t}, \Delta fx^c_{i,t}\right]'$. Confidence bands reflect 95 percent confidence intervals using a Gaussian approximation based on 1000 Monte Carlos draws from the estimated structural panel VAR. Period covered: Q1/2002-Q3/2015.

Source: BIS calculations.

Graph 7 reveals that virtually all aspects of our main results are present in all four major EME regions.

Is the US dollar unique? Is it the only global funding currency with such empirical attributes? Or, are there other currencies that share similar characterises when it comes to the risk taking channel of currency appreciation? In order to examine the above questions, we next replicate the empirical analysis that we conducted on the US dollar for the Japanese yen and the euro.

5.2 The yen as an international funding currency

Our empirical investigation reveals that the Japanese yen exhibits a number of characteristics of a global funding currency, albeit not as many as the US dollar.

The panel regressions for the Japanese yen reveal a strong negative relationship between cross-border lending denominated in yen and the value of the yen (Table 4). This is true not only at the global level, but also for all major borrowing country groups - AEs, EME and OFCs.

Japanese yen panel regressions

Cross-border lending to all sectors, by borrowing country group — Table 4

	All countries			**Advanced economies**		
ΔBER	-0.222***			-0.405***		
	(0.062)			(0.071)		
ΔNEER		-0.411***	-0.411***		-0.578***	-0.577***
		(0.062)	(0.062)		(0.091)	(0.091)
ΔBER^{orth}			-0.066			-0.176
			(0.079)			(0.150)
Obs	6,074	6,074	6,074	1,640	1,640	1,640
R-squared	0.023	0.026	0.026	0.025	0.027	0.028

	Emerging market economies			**Offshore centres**		
ΔBER	-0.148**			-0.339**		
	(0.074)			(0.118)		
ΔNEER		-0.307***	-0.307***		-0.431***	-0.431***
		(0.091)	(0.091)		(0.140)	(0.140)
ΔBER^{orth}			-0.049			-0.050
			(0.088)			(0.273)
Obs	3,479	3,479	3,479	845	845	845
R-squared	0.018	0.020	0.020	0.057	0.061	0.061

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 114 borrower countries that are not pegged to the JPY. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Furthermore, the estimated coefficients for two out of the four major EME regions (emerging Asia and Latin America) are also negative and highly significant (Table 5). Once again, the estimated contractionary impact of a rise in the yen index on cross-border bank lending tends to be greater than the respective impact of an appreciation of the bilateral exchange rate of the yen versus the currency of the borrowing country. Meanwhile, the estimated impact of fluctuation in the exchange rate value of the yen on cross-border lending to emerging Europe and Arica and the Middle East is insignificant.

Japanese yen panel regressions

Cross-border lending to all sectors, by borrowing emerging market region — Table 5

	Emerging Asia			Emerging Europe		
ΔBER	-0.530***			-0.066		
	(0.119)			(0.114)		
$\Delta NEER$		-0.622***	-0.623***		0.090	0.093
		(0.143)	(0.142)		(0.246)	(0.247)
ΔBER^{orth}			-0.247			-0.146
			(0.281)			(0.160)
Obs	961	961	961	547	547	547
R-squared	0.033	0.034	0.035	0.023	0.022	0.024

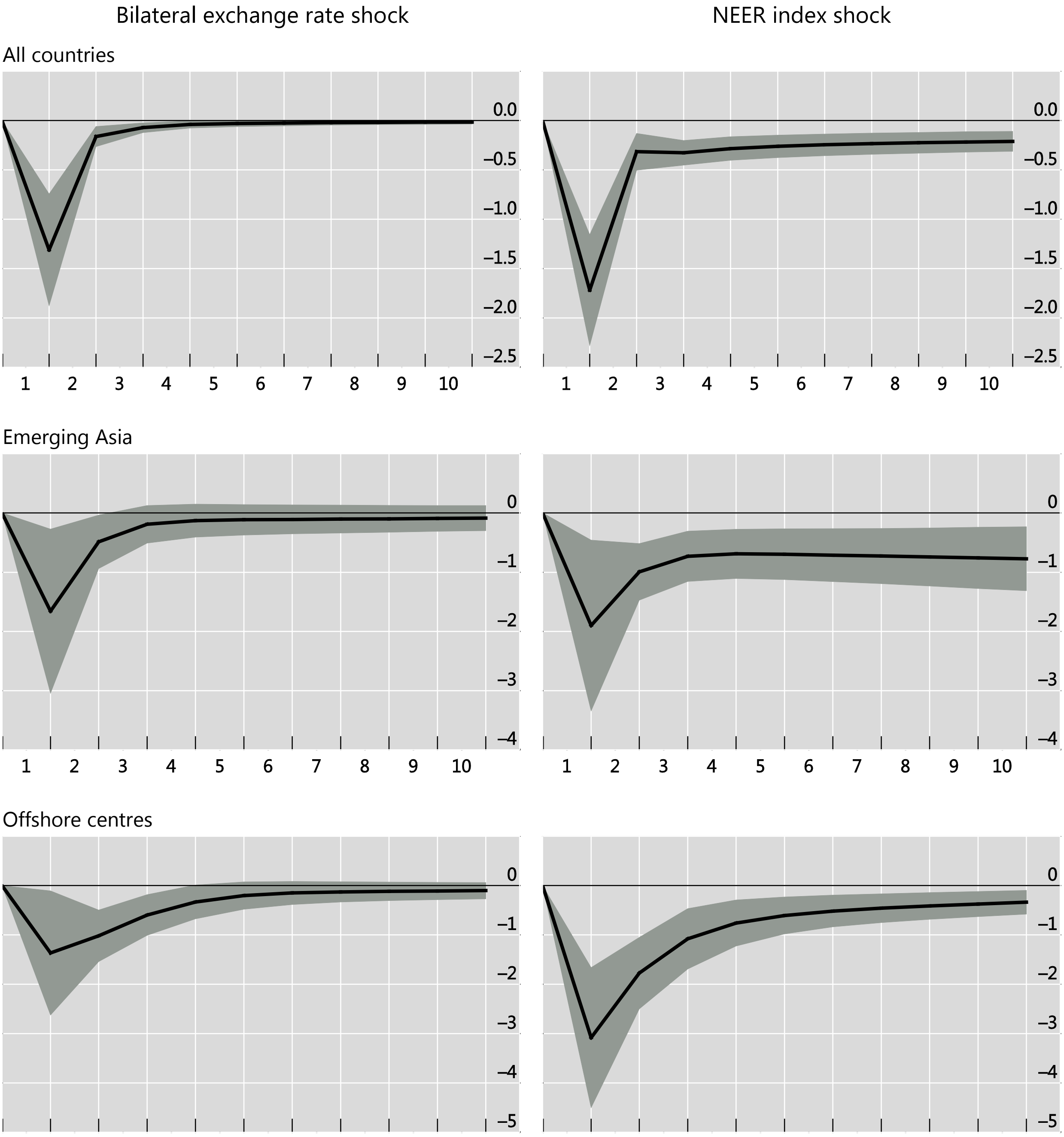
	Latin America			Africa and Middle East		
ΔBER	-0.222**			-0.007		
	(0.081)			(0.123)		
$\Delta NEER$		-0.425**	-0.425**		-0.150	-0.149
		(0.159)	(0.159)		(0.175)	(0.176)
ΔBER^{orth}			-0.155*			0.089
			(0.073)			(0.094)
Obs	849	849	849	1,122	1,122	1,122
R-squared	0.018	0.019	0.021	0.013	0.014	0.015

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on $\Delta NEER$. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 114 borrower countries that are not pegged to the JPY. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

The impulse responses from our benchmark SPVAR specification reveal that the impact of the yen FX rate on cross-border bank lending is negative, but not as strong as that for the US dollar (Graph 8). The estimated impacts for the full sample of borrowing countries are negative and statistically significant for both the bilateral yen exchange rate (top left-hand panel) and the broad yen NEER index (top right-hand panel). Nevertheless, the estimated impacts are somewhat smaller and considerably less persistent than their US counterparts.

Impulse response functions, yen shock on JPY cross-border bank lending

All borrowing sectors, by borrowing country group | Graph 8



Responses in cross-border lending to a 1 standard deviation shock to the bilateral exchange rate (left-hand column) or nominal effective exchange rate index (NEER, right-hand column). Estimated orthogonalized Impulse Response Functions are based on a Cholesky decomposition with 4 endogenous variables ordered as $y_{i,t} = \left[\Delta ir_t^c, \Delta xbl_{i,t}^c, \ln VIX_{i,t}, \Delta fx_{i,t}^c\right]'$. Confidence bands reflect 95 percent confidence intervals using a Gaussian approximation based on 1000 Monte Carlos draws from the estimated structural panel VAR. Period covered: Q1/2002-Q3/2015.

Source: BIS calculations.

The role of the yen as an international funding currency is most evident in the case of bank lending to borrowers in emerging Asia (middle row) and in OFCs (bottom row). This is not surprising given the relatively high share of yen-denominated lending to borrower in those two country groups. Meanwhile, the estimated impacts of yen exchange rate fluctuations on yen-denominated cross-border bank lending to several of the other main borrowing country groups are not statistically significant.

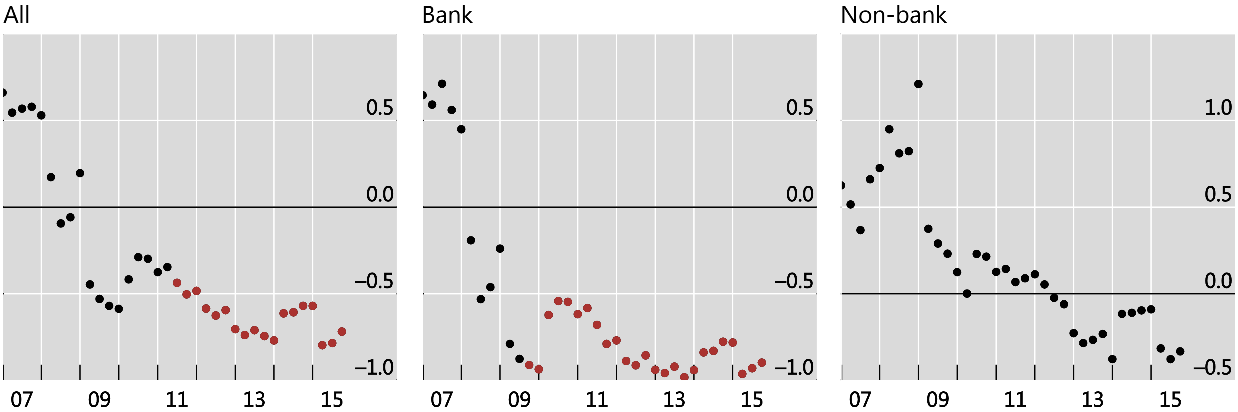
Taken together, the above results suggest that although the yen exhibits many of the properties of an international funding currency, it has more of a regional flavour relative to the US dollar, which is unique in its role as the preeminent global funding currency.

5.3 The post-crisis emergence of the euro as an international funding currency

Historically, the euro has not been used as a global funding currency as much as the US dollar. Nevertheless, we find evidence that this has started to change recently.

The relationship between the strength of the euro and cross-border lending to non-euro area borrowers denominated in euros has progressively become more and more negative over time (Graph 9, left-hand panel). In fact, the relationship was positive at the beginning of our time window, which saw periods of euro strength coupled with a rapid expansion of euro-denominated cross-border lending. Nevertheless, the relationship has slowly, but steadily, moved into negative territory over the past couple of decade. And, in the post crisis period (2010-2015), it has become statistically significant. This pattern has been mainly driven by interbank lending (Graph 9, centre panel) rather than by lending to non-banks (Graph 9, right-hand panel).

20 quarter rolling window regressions, euro — Graph 9



This graph presents estimated coefficients from 20 quarter rolling window regressions of quarterly growth rates of euro-denominated cross-border bank lending on quarterly changes in the broad EUR NEER index. Coefficients are positioned on the last period of the rolling window. Red dots indicate a negative coefficient estimate that is statistically significant at the 10% level.

Sources: BIS Locational Banking Statistics; BIS effective exchange rate indices; BIS calculations.

Informed by the above rolling window results, we go on to examine the role of the euro as an international funding currency during the post-crisis period, utilising the panel regression and the SPVAR methodologies used in the empirical investigations for the US dollar and the yen.[6]

The panel regressions results for the euro are presented in Table 6. They reveal that the relationship between the strength of the euro and cross-border lending to non-euro area borrowers denominated in euros is not statistically significant at the global level (top left-hand panel), Nevertheless, the estimated impacts are negative and statistically significant for a couple of important non-euro area

[6] The euro panel regression and SPVARs largely yield insignificant results for the full sample (Q1 2002-Q4 2015). Those are not reported here, but are available upon request.

European borrowing country groups. In particular, an increase in the broad euro NEER index is associated with a statistically significant increase in lending to advanced European countries outside the euro area (top right-hand panel). Moreover, a depreciation in the bilateral exchange rate value of the euro versus the respective local currency is also associated with a statistically significant increase in lending to borrowers in emerging Europe (bottom right-hand panel).

Euro panel regressions

Cross-border lending to all sectors, by borrowing country group — Table 6

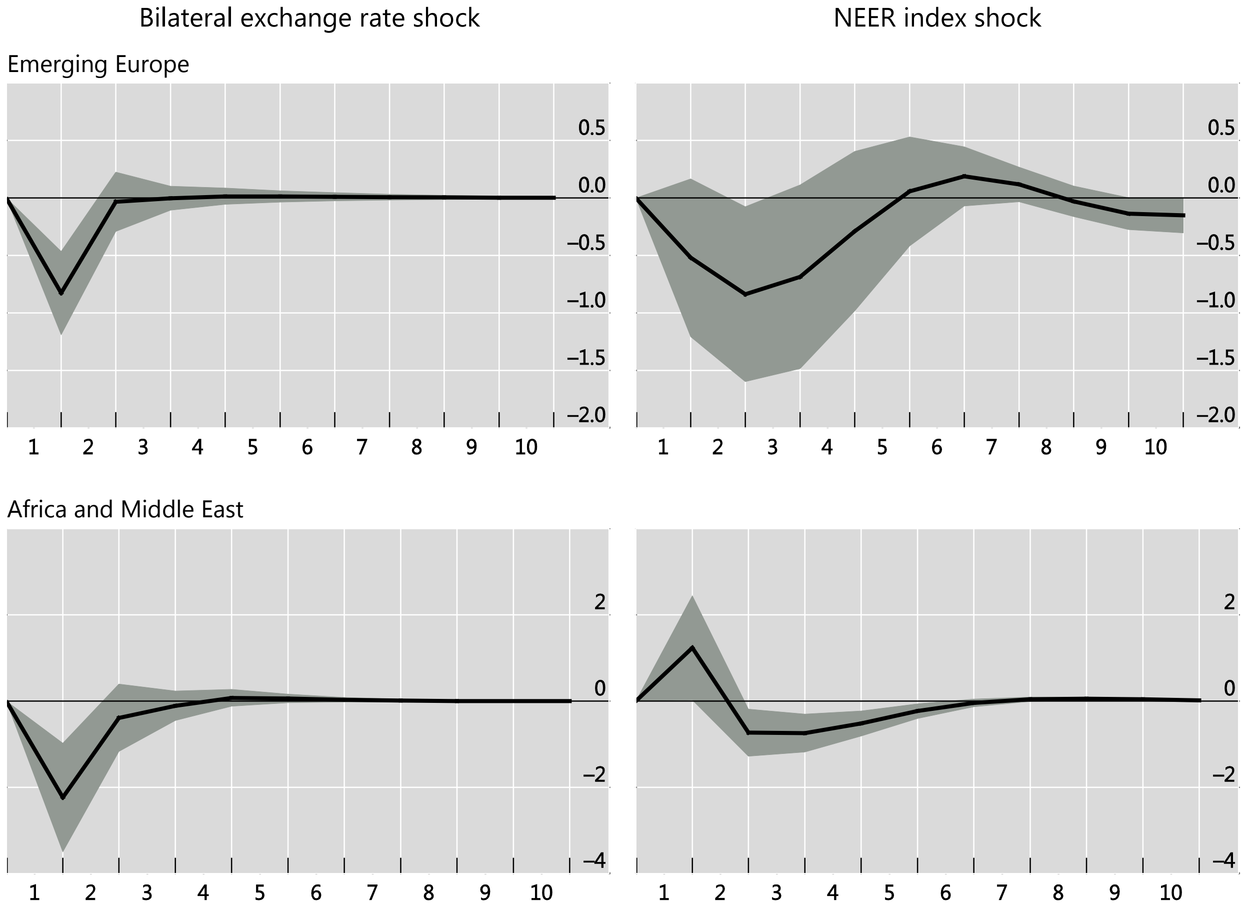
	All countries			**Non-euro area Europe**		
ΔBER	0.041			-0.669**		
	(0.042)			(0.194)		
ΔNEER		0.116	0.120		-1.014**	-1.014**
		(0.091)	(0.092)		(0.273)	(0.274)
ΔBER^{orth}			0.002			0.006
			(0.060)			(0.129)
Obs	2,106	2,106	2,083	85	85	85
R-squared	0.068	0.069	0.067	0.134	0.234	0.234
	Non-Europe advanced			**Emerging Europe**		
ΔBER	0.041			-0.092		
	(0.196)			(0.052)		
ΔNEER		-0.060	-0.060		0.317	0.317
		(0.286)	(0.287)		(0.184)	(0.185)
ΔBER^{orth}			0.186			-0.116**
			(0.282)			(0.050)
Obs	115	115	115	230	230	230
R-squared	0.016	0.016	0.019	0.129	0.139	0.155

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 93 borrower countries that are not pegged to the EUR. The sample ranges from Q1 2010 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

The impulse responses from our benchmark SPVAR specifications reveal that the impact of the euro FX rate on cross-border bank lending is negative, but much weaker than its US dollar and Japanese yen counterparts (Graph 10). The estimated coefficients for the full sample of borrowers and for most borrowing country groups are not statistically significant. Nevertheless, the estimated impacts are negative and statistically significant in the case of two EME borrowing regions, emerging Europe and Africa and the Middle East, for which the share of euro-denominated cross-border lending is relatively high. In both cases, the impact of the bilateral euro exchange rate appears to be much more significant than the impact of the broad euro NEER index.

Impulse response functions, euro shock on EUR cross-border bank lending

All borrowing sectors, by borrowing country group | Graph 10



Responses in cross-border lending to a 1 standard deviation shock to the bilateral exchange rate (left-hand column) or nominal effective exchange rate index (NEER, right-hand column). Estimated orthogonalized Impulse Response Functions are based on a Cholesky decomposition with 4 endogenous variables ordered as $y_{i,t} = \left[\Delta ir^{c}_{t}, \Delta xbl^{c}_{i,t}, \ln VIX_{i,t}, \Delta fx^{c}_{i,t}\right]'$. Confidence bands reflect 95 percent confidence intervals using a Gaussian approximation based on 1000 Monte Carlos draws from the estimated structural panel VAR. Period covered: Q1/2010-Q3/2015.

Source: BIS calculations.

Overall, the above results suggest that, during the post-crisis period, the euro has emerged as an international funding currency, at least at the regional (European) level.

6. Conclusion

The organising theme of our paper has been the financial amplification role of the exchange rate through the risk-taking channel of currency appreciation. The focus has been on the quantity dimension, as manifested in cross-border bank lending flows. Specifically, we have examined the impact of fluctuations in the three major global funding currencies (the US dollar, the euro and the Japanese yen) on cross-border bank lending to borrowers located outside the respective currency area.

Our main results corroborate the existence of the risk-taking channel of currency appreciation in the spirit of Rey (2015) and Bruno and Shin (2015b). Specifically, we find that exchange rate fluctuations of the main international funding currencies are closely tied to fluctuations in cross-border bank lending denominated in those currencies.

In this respect, the US dollar stands out as the preeminent international funding currency. The Japanese yen also exhibits many key characteristics of an international funding currency, although the quantitative impact is smaller than the US dollar. Last but not least, our paper also provides new evidence that the euro has recently started to emerge as a major international funding currency, particularly for lending to emerging Europe and European advanced economies outside the euro area.

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Appendix A: List of borrowing countries used in empirical analyses

AO	Angola	GT	Guatemala	NO	Norway
AR	Argentina	HK	Hong Kong SAR	NZ	New Zealand
AT	Austria	HN	Honduras	OM	Oman
AU	Australia	HR	Croatia	PA	Panama
AZ	Azerbaijan	HU	Hungary	PE	Peru
BB	Barbados	ID	Indonesia	PH	Philippines
BD	Bangladesh	IE	Ireland	PK	Pakistan
BE	Belgium	IL	Israel	PL	Poland
BG	Bulgaria	IM	Isle of Man	PT	Portugal
BH	Bahrain	IN	India	QA	Qatar
BM	Bermuda	IR	Iran	RO	Romania
BR	Brazil	IS	Iceland	RS	Serbia
BS	Bahamas	IT	Italy	RU	Russia
BY	Belarus	JE	Jersey	SA	Saudi Arabia
BZ	Belize	JO	Jordan	SC	Seychelles
CA	Canada	JP	Japan	SE	Sweden
CH	Switzerland	KE	Kenya	SG	Singapore
CL	Chile	KH	Cambodia	SI	Slovenia
CN	China	KR	Korea	SK	Slovakia
CO	Colombia	KW	Kuwait	SV	El Salvador
CR	Costa Rica	KY	Cayman Islands	TH	Thailand
CW	Curacao	KZ	Kazakhstan	TN	Tunisia
CY	Cyprus	LB	Lebanon	TR	Turkey
CZ	Czech Republic	LI	Liechtenstein	TT	Trinidad and Tobago
DE	Germany	LK	Sri Lanka	TW	Chinese Taipei
DK	Denmark	LR	Liberia	UA	Ukraine
DO	Dominican Republic	LT	Lithuania	US	United States
DZ	Algeria	LU	Luxembourg	UY	Uruguay
EC	Ecuador	LV	Latvia	UZ	Uzbekistan
EE	Estonia	MA	Morocco	VE	Venezuela
EG	Egypt	MH	Marshall Islands	VN	Vietnam
ES	Spain	MO	Macao SAR	WI	West Indies
FI	Finland	MT	Malta	WS	Samoa
FR	France	MU	Mauritius	ZA	South Africa
GB	United Kingdom	MX	Mexico	ZM	Zambia
GE	Georgia	MY	Malaysia		
GG	Guernsey	MZ	Mozambique		
GH	Ghana	NC	New Caledonia		
GI	Gibraltar	NG	Nigeria		

Country groups

Advanced

Austria, Belgium, Switzerland, Cyprus, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Liechtenstein, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Norway, Portugal, Sweden, Slovenia, Slovakia, Australia, Canada, Japan, New Zealand and United States.

Advanced Economies in Europe

Austria, Belgium, Switzerland, Cyprus, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Liechtenstein, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Norway, Portugal, Sweden, Slovenia and Slovakia.

Euro area

Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Portugal, Slovenia and Slovakia.

EMEs

Aggregate of economies listed under *Emerging Europe, Latin America, Emerging Asia* and *Africa and Middle East*.

Emerging Europe

Bulgaria, Belarus, Czech Republic, Croatia, Hungary, Poland, Romania, Serbia, Russia, Turkey and Ukraine.

Latin America

Argentina, Brazil, Belize, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Peru, El Salvador, Trinidad and Tobago, Uruguay and Venezuela.

Emerging Asia

Azerbaijan, Bangladesh, China, Georgia, Indonesia, India, Cambodia, Korea, Kazakhstan, Sri Lanka, Marshall Islands, Malaysia, New Caledonia, Philippines, Pakistan, Thailand, Chinese Taipei, Uzbekistan and Vietnam.

Africa and Middle East

Algeria, Angola, Egypt, Ghana, Iran, Israel, Jordan, Kenya, Kuwait, Liberia, Morocco, Mozambique, Nigeria, Oman, Qatar, Saudi Arabia, Seychelles, South Africa, Tunisia, United Arab Emirates and Zambia.

Offshore Centres

Cayman Islands, Hong Kong SAR, Singapore, Jersey, Bahamas, Bermuda, Guernsey, Panama, Macao SAR, Isle of Man, Bahrain, Barbados, Curacao, Lebanon, Samoa and West Indies.

Appendix B: Definition of Variables

Variable Name	Description	Data Source
$\Delta xbl_{i,s,t}^{c}$	Cross-border lending (loans and debt securities) denominated in currency *c* (USD, JPY, EUR), to sector s (all sectors, banks, non-banks) resident in country *i*; quarterly percentage changes[1]	BIS Locational Banking Statistics
$\Delta NEER_t^c$	Broad nominal effective exchange rate (EER) index for currency *c*, quarterly changes	BIS effective exchange rate (EER) indices
$\Delta BER_{i,t}^c$	Bilateral exchange rate of country *i* against currency *c* (USD, JPY, EUR), average quarterly percent changes	National Sources
$\Delta ir(SSR)_t^c$	Policy rate, quarterly changes USD: Federal Funds Rate, Shadow Short Rates (L. Krippner), JPY and EUR: Shadow Short Rates (L. Krippner)	Reserve Bank of New Zealand
$\ln VIX_{i,t}$	natural log of CBOE volatility index, VIX	Federal Reserve Bank of St. Louis

[1] Dependent variables are winsorized at the 5th and 95th percentiles.

Appendix C: Detailed panel regression results

US dollar panel regressions

Cross-border lending to borrowing emerging market regions, by borrower sector — Table C1

	All sectors			Banks			Non-banks		
Emerging Asia									
ΔBER	-0.501***			-0.756***			-0.177		
	(0.129)			(0.169)			(0.127)		
ΔNEER		-0.542***	-0.542***		-0.702***	-0.702***		-0.162	-0.162
		(0.108)	(0.108)		(0.168)	(0.168)		(0.157)	(0.157)
ΔBER^{orth}			-0.402**			-0.702***			-0.183
			(0.147)			(0.192)			(0.137)
Obs	935	935	935	935	935	935	935	935	935
R-squared	0.039	0.039	0.049	0.028	0.024	0.035	0.024	0.024	0.025
Emerging Europe									
ΔBER	-0.338***			-0.437***			-0.247***		
	(0.070)			(0.137)			(0.077)		
ΔNEER		-0.558**	-0.556**		-1.004**	-1.003**		-0.420**	-0.419**
		(0.195)	(0.195)		(0.344)	(0.343)		(0.167)	(0.167)
ΔBER^{orth}			-0.316***			-0.315**			-0.225**
			(0.057)			(0.120)			(0.085)
Obs	585	585	585	585	585	585	585	585	585
R-squared	0.041	0.024	0.041	0.023	0.021	0.026	0.036	0.026	0.036
Latin America									
ΔBER	-0.123**			-0.110			-0.121**		
	(0.049)			(0.122)			(0.040)		
ΔNEER		-0.171	-0.171		-0.298	-0.298		-0.094	-0.094
		(0.118)	(0.118)		(0.269)	(0.269)		(0.094)	(0.094)
ΔBER^{orth}			-0.120**			-0.064			-0.143**
			(0.054)			(0.116)			(0.046)
Obs	660	660	660	660	660	660	660	660	660
R-squared	0.038	0.031	0.040	0.011	0.012	0.012	0.036	0.027	0.039
Africa and Middle East									
ΔBER	-0.059			-0.098			-0.040		
	(0.097)			(0.140)			(0.088)		
ΔNEER		-0.437***	-0.419***		-0.782***	-0.772**		-0.167	-0.209
		(0.096)	(0.122)		(0.216)	(0.268)		(0.124)	(0.153)
ΔBER^{orth}			-0.017			-0.043			-0.011
			(0.081)			(0.118)			(0.078)
Obs	1,155	1,155	880	1,154	1,154	879	1,155	1,155	880
R-squared	0.038	0.049	0.050	0.024	0.033	0.039	0.031	0.032	0.033

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 106 borrower countries that are not pegged to the USD. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Japanese yen panel regressions

Cross-border lending to selected borrowing country groups, by borrower sector | Table C2

	All sectors			Banks			Non-banks		
All countries									
ΔBER	-0.222***			-0.216**			-0.156***		
	(0.062)			(0.099)			(0.039)		
ΔNEER		-0.411***	-0.411***		-0.601***	-0.602***		-0.280***	-0.280***
		(0.062)	(0.062)		(0.108)	(0.108)		(0.065)	(0.065)
ΔBER^{orth}			-0.066			0.091			-0.062
			(0.079)			(0.113)			(0.049)
Obs	6,074	6,074	6,074	5,762	5,762	5,762	5,921	5,921	5,921
R-squared	0.023	0.026	0.026	0.025	0.028	0.028	0.028	0.028	0.029
Advanced economies									
ΔBER	-0.405***			-0.479***			-0.157*		
	(0.071)			(0.111)			(0.082)		
ΔNEER		-0.578***	-0.577***		-0.678***	-0.677***		-0.349***	-0.350***
		(0.091)	(0.091)		(0.127)	(0.127)		(0.097)	(0.097)
ΔBER^{orth}			-0.176			-0.223			0.177
			(0.150)			(0.264)			(0.159)
Obs	1,640	1,640	1,640	1,607	1,607	1,607	1,609	1,609	1,609
R-squared	0.025	0.027	0.028	0.023	0.024	0.025	0.021	0.025	0.026
Emerging market economies									
ΔBER	-0.148**			-0.075			-0.151***		
	(0.074)			(0.116)			(0.044)		
ΔNEER		-0.307***	-0.307***		-0.445**	-0.446**		-0.248***	-0.248***
		(0.091)	(0.091)		(0.172)	(0.172)		(0.093)	(0.093)
ΔBER^{orth}			-0.049			0.123			-0.107**
			(0.088)			(0.121)			(0.046)
Obs	3,479	3,479	3,479	3,215	3,215	3,215	3,361	3,361	3,361
R-squared	0.018	0.020	0.020	0.026	0.027	0.028	0.027	0.027	0.027
Offshore centres									
ΔBER	-0.339**			-0.756***			-0.089		
	(0.118)			(0.134)			(0.164)		
ΔNEER		-0.431***	-0.431***		-0.953***	-0.954***		-0.202	-0.202
		(0.140)	(0.140)		(0.178)	(0.179)		(0.176)	(0.176)
ΔBER^{orth}			-0.050			0.229			0.167
			(0.273)			(0.470)			(0.366)
Obs	845	845	845	830	830	830	841	841	841
R-squared	0.057	0.061	0.061	0.036	0.041	0.041	0.021	0.022	0.022

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 114 borrower countries that are not pegged to the JPY. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Japanese yen panel regressions

Cross-border lending to borrowing emerging market regions, by borrower sector — Table C3

	All sectors			Banks			Non-banks		
Emerging Asia									
ΔBER	-0.530***			-0.852***			-0.139		
	(0.119)			(0.175)			(0.126)		
ΔNEER		-0.622***	-0.623***		-1.049***	-1.052***		-0.127	-0.127
		(0.143)	(0.142)		(0.218)	(0.218)		(0.118)	(0.119)
ΔBER^{orth}			-0.247			-0.248			-0.238
			(0.281)			(0.378)			(0.249)
Obs	961	961	961	918	918	918	905	905	905
R-squared	0.033	0.034	0.035	0.039	0.042	0.043	0.050	0.050	0.051
Emerging Europe									
ΔBER	-0.066			-0.095			0.032		
	(0.114)			(0.200)			(0.130)		
ΔNEER		0.090	0.093		-0.074	-0.062		-0.069	-0.065
		(0.246)	(0.247)		(0.323)	(0.313)		(0.257)	(0.256)
ΔBER^{orth}			-0.146			-0.181			0.248
			(0.160)			(0.269)			(0.207)
Obs	547	547	547	485	485	485	525	525	525
R-squared	0.023	0.022	0.024	0.030	0.030	0.031	0.030	0.030	0.033
Latin America									
ΔBER	-0.222**			0.095			-0.317***		
	(0.081)			(0.163)			(0.060)		
ΔNEER		-0.425**	-0.425**		-0.319	-0.322		-0.625***	-0.627***
		(0.159)	(0.159)		(0.369)	(0.370)		(0.158)	(0.158)
ΔBER^{orth}			-0.155*			0.228			-0.247***
			(0.073)			(0.184)			(0.049)
Obs	849	849	849	770	770	770	830	830	830
R-squared	0.018	0.019	0.021	0.023	0.023	0.024	0.025	0.026	0.031
Africa and Middle East									
ΔBER	-0.007			0.053			-0.110		
	(0.123)			(0.204)			(0.068)		
ΔNEER		-0.150	-0.149		-0.184	-0.184		-0.154	-0.154
		(0.175)	(0.176)		(0.366)	(0.367)		(0.196)	(0.197)
ΔBER^{orth}			0.089			0.185			-0.086*
			(0.094)			(0.178)			(0.041)
Obs	1,122	1,122	1,122	1,042	1,042	1,042	1,101	1,101	1,101
R-squared	0.013	0.014	0.015	0.028	0.028	0.029	0.014	0.013	0.014

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 114 borrower countries that are not pegged to the JPY. The sample ranges from Q1 2002 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Euro panel regressions

Cross-border lending to selected borrowing country groups, by borrower sector — Table C4

	All sectors			Banks			Non-banks		
All countries									
ΔBER	0.041			-0.012			0.061		
	(0.042)			(0.094)			(0.049)		
ΔNEER		0.116	0.120		-0.154	-0.155		0.264**	0.270**
		(0.091)	(0.092)		(0.189)	(0.191)		(0.115)	(0.116)
ΔBER^{orth}			0.002			0.129			-0.078
			(0.060)			(0.119)			(0.064)
Obs	2,106	2,106	2,083	2,096	2,096	2,073	2,105	2,105	2,082
R-squared	0.068	0.069	0.067	0.041	0.041	0.041	0.061	0.063	0.062
Advanced economies									
ΔBER	-0.035			0.070			-0.348*		
	(0.162)			(0.191)			(0.167)		
ΔNEER		-0.412*	-0.427*		-0.267	-0.282		-0.401**	-0.418**
		(0.213)	(0.235)		(0.288)	(0.318)		(0.166)	(0.184)
ΔBER^{orth}			0.204			0.368*			-0.446
			(0.179)			(0.170)			(0.309)
Obs	246	246	223	246	246	223	246	246	223
R-squared	0.072	0.091	0.078	0.110	0.115	0.114	0.074	0.070	0.072
Emerging market economies									
ΔBER	0.046			0.004			0.093*		
	(0.046)			(0.107)			(0.051)		
ΔNEER		0.176	0.176		-0.118	-0.118		0.329**	0.329**
		(0.116)	(0.116)		(0.261)	(0.261)		(0.137)	(0.137)
ΔBER^{orth}			0.008			0.123			-0.011
			(0.062)			(0.126)			(0.062)
Obs	1,449	1,449	1,449	1,440	1,440	1,440	1,449	1,449	1,449
R-squared	0.055	0.056	0.056	0.037	0.037	0.037	0.057	0.060	0.060
Offshore centres									
ΔBER	0.038			-0.220			0.053		
	(0.152)			(0.200)			(0.271)		
ΔNEER		0.249	0.249		-0.202	-0.202		0.469	0.467
		(0.153)	(0.153)		(0.260)	(0.260)		(0.349)	(0.350)
ΔBER^{orth}			-0.469			-0.176			-1.083**
			(0.522)			(0.784)			(0.459)
Obs	365	365	365	364	364	364	364	364	364
R-squared	0.101	0.103	0.108	0.035	0.034	0.035	0.062	0.068	0.083

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 93 borrower countries that are not pegged to the EUR. The sample ranges from Q1 2010 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Euro panel regressions

Cross-border lending to borrowing emerging market regions, by borrower sector — Table C5

	All sectors			Banks			Non-banks		
Emerging Asia									
ΔBER	0.155			0.279			0.208**		
	(0.100)			(0.226)			(0.094)		
ΔNEER		0.213	0.213		-0.017	-0.017		0.458*	0.458*
		(0.204)	(0.204)		(0.408)	(0.409)		(0.248)	(0.248)
ΔBER^{orth}			0.048			0.818*			-0.161
			(0.151)			(0.414)			(0.198)
Obs	414	414	414	407	407	407	414	414	414
R-squared	0.062	0.061	0.061	0.038	0.036	0.042	0.070	0.073	0.074
Emerging Europe									
ΔBER	-0.092			-0.165			-0.092**		
	(0.052)			(0.097)			(0.032)		
ΔNEER		0.317	0.317		0.323	0.323		0.451	0.451
		(0.184)	(0.185)		(0.361)	(0.362)		(0.342)	(0.343)
ΔBER^{orth}			-0.116**			-0.163			-0.153**
			(0.050)			(0.094)			(0.055)
Obs	230	230	230	230	230	230	230	230	230
R-squared	0.129	0.139	0.155	0.099	0.096	0.102	0.041	0.061	0.081
Latin America									
ΔBER	0.176**			0.227			0.117		
	(0.076)			(0.171)			(0.075)		
ΔNEER		0.387	0.387		0.041	0.041		0.139	0.139
		(0.290)	(0.290)		(0.748)	(0.749)		(0.281)	(0.281)
ΔBER^{orth}			0.171*			0.358*			0.151
			(0.083)			(0.189)			(0.116)
Obs	368	368	368	367	367	367	368	368	368
R-squared	0.035	0.033	0.037	0.035	0.033	0.036	0.035	0.033	0.036
Africa and Middle East									
ΔBER	-0.141			-0.478			0.152		
	(0.110)			(0.282)			(0.150)		
ΔNEER		-0.112	-0.112		-0.578	-0.578		0.302	0.302
		(0.204)	(0.204)		(0.424)	(0.424)		(0.263)	(0.263)
ΔBER^{orth}			-0.170			-0.362			0.011
			(0.166)			(0.449)			(0.174)
Obs	437	437	437	436	436	436	437	437	437
R-squared	0.042	0.040	0.041	0.028	0.026	0.027	0.043	0.044	0.044

This table presents the estimates from regressions of changes in cross-border lending on changes in exchange rates. ΔBER^{orth} stands for the residuals obtained from a regression of ΔBER on ΔNEER. All panel regressions use quarterly borrower-country level data from the BIS LBS and include borrower country fixed effects. The reported results are based on a sample of 93 borrower countries that are not pegged to the EUR. The sample ranges from Q1 2010 to Q3 2015. For a list of borrower countries and country groups, see Appendix A. For variable definitions, see Appendix B. Standard errors are clustered at the borrower country level and reported in parentheses. * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.