Dollar Funding, Bank Currency Mismatch, and the Transmission of Exchange Rate Policy*

Mai Li†

Columbia University

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Abstract

This paper studies a novel transmission channel for exchange rate policy in emerging markets that acts through financial institutions. According to this "credit-supply channel," banks in emerging markets fund themselves in U.S. dollars, lend in the local currency, and bear foreign exchange risk if hedging is imperfect. This currency mismatch exposes banks to exchange rate fluctuations and makes economies vulnerable to adverse global financial conditions. To ascertain the significance of this transmission mechanism, I focus on the large and unanticipated currency depreciation episode following the U.S. Fed's decision to taper the size of its security purchases and exploit the heterogeneity in banks' pre-determined exposure to currency risk. Using loan level data in Taiwan during 2012-15, I provide evidence that the effect of depreciation on credit supply is contractionary. Banks with higher net USD liabilities cut lending more and were less likely to renew loans to firms with which they had pre-existing relationships. In turn, firms with greater dependence on exposed banks hardly switched to alternative funding sources and disproportionately decreased investment and employment as compared to other firms that relied less on these banks. I find that the credit-supply effects of depreciation on investment and employment are both economically and statistically significant.

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†Department of Economics, Columbia University, New York, NY 10027, ml3689@columbia.edu

1 Introduction

The combination of exceptionally low interest rates and unprecedented quantitative easing pursued by the major central banks in the aftermath of the financial crisis of 2008 was accompanied by trillions of dollars of "hot money" flowing into emerging markets. Growing evidence of the dominance of global "push" factors in driving this phase of credit growth in emerging markets has generated a heated discussion about the connection between cross-border bank flows and global financial cycles.[1] Bruno and Shin (2014) find evidence of monetary policy spillovers on cross-border bank capital flows and the US dollar exchange rate through the banking sector. Bruno and Shin (2015) provide evidence that episodes of U.S. dollar appreciation are associated with bank deleveraging and an overall tightening of global financial conditions. Rey (2016) emphasizes that the credit channel or the risk-taking channel broadly defined could be a potent channel for the international transmission of monetary policy. The reliance of local banking sectors on international dollar funding has been regarded as a crucial transmission mechanism for shocks that move the strength of the U.S. dollar, thereby creating a source of vulnerability for emerging markets.[2]

In this paper, I propose and empirically evaluate a novel channel of transmission of exchange-rate shocks that works through the financial sector in emerging market economies. The starting point of this mechanism, which I name the credit-supply channel, is the observation that banks in emerging markets are subject to a fundamental risk management problem arising from a currency mismatch. While financial intermediaries fund themselves in the international wholesale dollar funding market, the majority of domestic households and producers, especially those whose revenues stemming from domestic markets, borrow in local currency. As a result, depreciation of the domestic currency inflates the real value of unhedged debts denominated in foreign currency. This reduces banks' net worth and adversely affects their solvency and liquidity condition. Thus, through the credit-supply channel, a bank with a large exposure to currency risk strongly responds to an exchange

[1] Calvo et al. (1996) distinguishes the global "push" factors for capital flows from the country-specific "pull" factors, and emphasized the importance of external push factors in explaining capital flows to emerging economies. Forbes and Warnock (2012) argue that global factors are significantly associated with extreme capital flow episodes, and contagion through banking could be associated with stop and retrenchment episodes. Avdjiev et al. (2019) document a triangular relationship formed by the broad strength of the US dollar, cross-border bank lending in dollars and deviations from covered interest parity.

[2] Tille and Krogstrup (2018) find that the sign and size of the responses of foreign currency funding flows to global risk factors depends on the pre-existing currency exposure of banks, i.e. whether banks are initially net long or net short in foreign currency.

rate depreciation by tightening its credit supply, which in turn has negative consequences for its borrower's propensity to invest and hire.

To ascertain the significance of the credit-supply channel, I focus on the depreciation episode in Taiwan following the U.S. Fed's decision to taper the size of security purchases (the so-called Taper Tantrum).[3] Between 2014 and 2015, Taiwan's spot exchange rate depreciated by 10 percent against U.S. dollar. Similar sized losses in domestic currency value were observed in other emerging markets. I use syndicated loan origination data for Taiwan from Thomson Reuters DealScan and exploit cross-sectional variation in pre-determined dollar exposure across banks. Specifically, I construct bank net USD exposure one year prior to the depreciation episode as a proxy for the treatment intensity of the depreciation shock, which is defined as the difference between bank gross USD liabilities and gross USD assets as a fraction of bank equity. Banks with relatively higher values of net USD exposure are considered to be the treated banks and are expected to be more affected by the depreciation shock than the rest in the control group. The detailed data sourced from the banking bureau in Taiwan permits direct observation of banks' usage of derivatives, based on which I find that FX hedging by the banks are largely imperfect.

The firm-bank matched structure of the loan origination data and its combination with bank and firm information enable me to isolate the component of credit supply from the credit demand, and to evaluate the effect of exchange rate depreciation on each component separately. I disentangle my proposed bank credit channel from the two main alternative channels considered in related literature—namely, the exporter trade channel[4] and the firm credit constraint channel.[5] These

[3]Eichengreen and Gupta (2015) document that the "tapering talk" had a large and unexpected negative impact on the exchange rates and financial markets in emerging markets and find that emerging market economies with larger inflows of capital in prior years experienced more pressure on their exchange rate, foreign reserves, and equity prices. Cerutti et al. (2018) find a higher bilateral US dollar share on the eve of the 2013 taper tantrum was associated with a lower growth rate of cross-border bank lending to emerging markets during the taper tantrum. Avdjiev and Takáts (2014) find cross-border bank lending to emerging markets slowed sharply during the taper tantrum.

[4]For a survey on the literature on how exchange rate affects trade and current account, see Forbes (2004) and Engel (2010). Gourinchas (1999) finds traded-sector industries are very responsive to real exchange rate movements, and estimates that a 1% appreciation of the real exchange rate destroys 0.95% of tradable jobs over the next two years. Verhoogen (2008) finds that following the 1994 peso crisis, initially more productive plants increased the export share of sales more than others. Ekholm et al. (2012) study firms' response to the appreciation of the Norwegian krone in the early 2000s with respect to employment, productivity, and offshoring. Berman et al. (2012) find that different French firms react differently to currency depreciation, with high productivity firms raising their markups and low productivity firms raising export volumes; either way, exporters benefit from depreciation.

[5]A large literature has investigated the borrower credit constraint channel of exchange rate depreciation. For the recent theoretical work, see Du and Schreger (2016) and Salomao and Varela (2018) among many others. For the empirical work, the evidence of the impact of depreciation on corporate borrowing constraint is mixed and inconclusive, and see Aguiar (2005), Bleakley and Cowan (2008), Kim et al. (2015) and Kalemli-Ozcan (2019) among many others for more discussion on this channel.

granular data allows me to draw causal inference on a variety of underlying transmission mechanisms of exchange rate shocks, and to circumvent a wide range of endogeneity concerns that would arise if I were to use aggregate data.

The identification of the credit-supply channel rests on the following assumptions. First, the parallel trend assumption requires that banks in the control group (i.e., those with relatively low exposure to exchange rate risk) form a valid counterpart for those in the treated group (i.e. banks with a higher exposure to exchange rate risk). In other words, the parallel trend assumption means that the credit supply of treated banks with more currency mismatch would have been identical to that of control banks if exchange rate shock had not occurred. I perform a variety of checks that suggest that the parallel trend assumption is satisfied in my data set. These include testing balancing on bank observable characters, testing pre-trends before the depreciation episode, and performing a placebo test on the previous round of depreciation. Second, the measure of net USD exposure is supposed to be the representation of bank currency risk rather than other confounding bank features. I add the conventionally accepted bank health indicators as explanatory variables in addition to bank net USD exposure, which includes the tier 1 capital ratio, the leverage ratio, and the liquidity ratio. The robustness of the estimate of net USD exposure to the inclusion of the additional control variables suggests that bank currency mismatch is another dimension of bank health beyond the common indicators. Third, I provide evidence to show that the shock caused by the U.S. Fed's "tapering talk" was plausibly unexpected from the perspective of Taiwan. I find no evidence that alternative aggregate shock could be the confounding factor to explain the empirical results.[6] Fourth, the depreciation shock should be orthogonal to other time-varying factors in the foreign exchange market. It is hard to believe such a condition holds, because central banks in emerging markets may intervene in the foreign exchange market or impose capital control. However, the identification strategy works as long as either FX intervention or capital control policy are of the second-order effects compared with the influence caused by the shifting condition in the global financial market.[7]

[6] In 2014-15, VIX was staying at the lowest level since the financial crisis. The policy rate in the United States remained constant throughout the sample period, binding at the zero lower bound. The policy rate in Taiwan did not change until 2015Q4. To the best of my knowledge, there is no major change in bank regulation law in Taiwan during the sample period.

[7] According to the central bank in Taiwan, there is no major change in the capital control policy or FX regulation law. Gonzalez et al. (2019) find that the Brazilian large intervention in the local FX market halves the negative effects caused by the taper tantrum.

Using a difference-in-differences (DID) methodology, I start by evaluating the impact of a depreciation shock on the intensive margin[8] of credit supply using loan-level panel data. I saturate the model specification with firm×bank fixed effects to absorb time-invariant unobserved factors that can determine the matching between bank and firm in the loan market. In addition, the further adoption of firm×time fixed effects is intended to soak up all time-varying firm heterogeneity. My most stringent specification essentially analyzes the size of loan granted to the same firm by different banks in the same period of time—that is, the supply of credit (Khwaja and Mian (2008); Jiménez et al. (2012); Amiti and Weinstein (2018); Jiménez et al. (2019)). I find evidence that a one-standard deviation increase in the measure of currency mismatch is associated with approximate a 6-percentage-point reduction in credit supply when confronted with a 10-percent loss in the value of domestic currency. The result is robust to controlling for other widely used bank health indicators.

In the second stage of my empirical study, I proceed to explore the extensive margin of credit supply using panel data that depicts the relationship between a firm and all its potential lenders at the annual frequency. I quantify the change in the likelihood of rolling over bank loans in response to the depreciation shock. Moreover, I distinguish between lender's role in the syndicated loan market as lead bank[9] or participant when studying bank-firm relationship. As the previous literature suggests, bank–borrower relationships are shown to be sticky in the U.S. syndicated loan market (Chodorow-Reich (2013)). I verify this argument in my Taiwanese data set. Using an autoregressive model specification, first, I confirm stickiness by showing that a bank is more likely to act as lead bank for a borrower as compared to a new lender if the bank has been the lead bank for the same borrower in the previous loans. Next, I examine how the renewal propensity alters upon the depreciation shock, and moreover, how this change would depend on the bank's pre-existing level of currency risk exposure. The baseline specification for the extensive margin suggests a reduction in the renewal propensity by 16 percent for the treated banks upon the depreciation shock, as relative to the control banks. The robustness check supports the validity of the identification strategy by confirming the finding of a parallel trend of renewal propensity

[8]For expositional convenience, I divide my analysis on the bank lending channel into two parts, an "intensive margin" referring to a reduction in the amount of lending to firms borrowing at the time of exchange rate depreciation shock, and an "extensive margin" referring to the denial of the credit to existing borrowers.

[9]In line with Ivashina et al. (2015), I consider a lead bank to be one that is designated as a "lead arranger" or "lead agent" in the DealScan database.

before the depreciation episode. Furthermore, I show that the result could hardly be explained by alternative bank health characteristics.

Having established the contractionary effect of depreciation on bank credit supply, I move on to examine the real economic consequences using firm-level panel data. As a typical firm borrows from both groups of banks, I use the share of the pre-existing loans to compute the firm's dependence on the highly mismatched banks, and thereby, as the reduced-form impact of the credit supply shock on the borrowing firm. Among firms in close geographic proximity and in the same industry, a one-standard-deviation increase in the dependence on the highly mismatched banks is associated with an 12-percent drop in debt growth, a 3-percent reduction in investment, and a 2-percent decrease in employment.[10] This result implies that the depreciation shock of 10 percent has a sizable contractionary effect on real activities.

To understand the extent to which the bank lending channel can account for the overall effect of exchange rate transmission, I isolate it from the exporter trade channel and the borrower credit constraint channel by adding the corresponding measures. I use the share of firm's export sales revenue as the proxy for the export intensity using detailed segment data. For the borrower credit constraint channel, I construct the firm's foreign currency indebtedness by resorting to the share of its outstanding debt in foreign currency. The joint analysis of all three channels finds strong evidence that depreciation is expansionary through the export trade channel, but no evidence in favor of the borrower credit constraint channel. The bank lending channel is estimated to be contractionary and statistically significant.

In sum, my empirical evidence suggests that a depreciation shock can cause a significant contraction in credit supply when financial intermediaries are exposed to currency risk in the first place. The contractionary shock in credit supply spills over to the non-financial sector, resulting in a lower propensity to invest and hire. The findings contribute to a better understanding of how exchange rate policy and global financial shocks get transmitted to a small open economy. The results provide a policy-related argument for macro-prudential regulation of bank's access to international financial markets in order to achieve a trade-off between the benefit of cheap external dollar funding and the cost of currency risk accumulated in the financial sector of emerging markets.

[10]The estimates are robust when controlling for time-varying factors that can be attributed to firm characteristics, such as firm size, riskiness or bond market access. Moreover, the results remain consistently similar when taking into account some indirect measures of other bank health dimensions.

The rest of the paper is organized as follows. Section 2 reviews the related literature and provides background on the Taper Tantrum and the exchange rate depreciation episode I study. Section 3 presents data construction. Section 4 discusses the empirical strategy. Section 5, 6 and 7 present loan-level evidence, firm-level evidence, and a placebo test, respectively. Section 8 discusses external validity using bank-level evidence of the credit supply channel for a wide range of emerging market economies. The conclusion is in section 9.

2 Literature and Context

2.1 Related Literature

This paper connects various strands of literature in macroeconomics and finance. First, my paper contributes to the international finance literature on currency mismatch and the causal impact of exchange rate shock. One strand of prior research that investigates the pass-through of exchange rate policy via the exporter trade channel is featured by local currency pricing (Devereux and Engel (2003); Engel (2006)), pricing-to-market (Fitzgerald and Haller (2013)), and dominant currency paradigm (Gopinath et al. (2010); Casas et al. (2016); Gopinath et al. (2019)), to rationalize the muted response of economic activities to exchange rate shock. The other previous studies argue that exchange rate depreciation can be contractionary by tightening credit constraint of non-financial corporations if they borrow in foreign currency but have less foreign currency incomes for debt repayment (Aguiar (2005); Bleakley and Cowan (2008); Kim et al. (2015); Du and Schreger (2016); Kalemli-Ozcan et al. (2016); Salomao and Varela (2018)).[11] In addition, Verner and Gyongyosi (2018) analyzes the effect of household foreign currency exposure in a small open economy. In contrast, my empirical evidence focuses on the pivotal role played by domestic financial intermediaries in the transmission of exchange rate shock.

Second, my paper is related to a growing field of literature on bank lending channel of financial

[11] The strand of literature that is related to corporate foreign currency balance-sheet effect at firm level presents mixed evidence. Calvo et al. (2008) finds that country-level foreign currency indebtedness increase the probability and severity of sudden stop crisis. Aguiar (2005) finds that firms with heavy exposure to short-term foreign currency debt before the devaluation experienced relatively low levels of post-devaluation investment. On the contrary, Bleakley and Cowan (2008) shows that firms holding more dollar debt do not invest less than their peso-indebted counterparts following a depreciation, and that these firms match the currency denomination of their liabilities with the exchange rate sensitivity of their profits. Kalemli-Ozcan et al. (2016) finds that domestic exporters holding unhedged foreign currency debt decrease investment if currency crises are accompanied by banking crises, but not so under pure currency crises.

shock and in particular the recent work that exploits loan-level data (Chodorow-Reich (2013); Ivashina et al. (2015); Jiménez et al. (2019)) springing from the seminal work by Khwaja and Mian (2008). The adoption of granular data allows me to disentangle the role of firm and bank balance-sheet effects as well as other country-level shocks and policy responses. My empirical evidence complements the literature on the band lending channel of monetary policy in closed economies (Kashyap and Stein (1995); Kashyap and Stein (2000); Gambacorta and Mistrulli (2004); Gomez et al. (2019)).

Third, there is a large literature on the nexus between the bank lending channel in emerging markets and global financial conditions (Cetorelli and Goldberg (2011); Schnabl (2012); De Haas and Van Horen (2013); Bruno and Shin (2015); Giovanni et al. (2017); Kalemli-Ozcan (2019); Bräuning and Ivashina (2019)). In the recent paper by Buch et al. (2019), the authors document that bank foreign currency funding and hedging considerations can be key sources of heterogeneity that determines the international transmission of the global financial cycle. In the model of Bruno and Shin (2014), local banks are assumed to be fully hedged and exchange rate depreciation is contractionary by tightening banks' value-at-risk constraints as their clients with foreign currency debt become more risky. My empirical evidence corroborates the finding that banks in emerging markets are susceptible to the fluctuation in global financial conditions and argues that bank currency risk is the culprit of the vulnerability. My findings support macro-prudential regulation of the use of dollar funding to prevent the undue accumulation of systemic risk in the domestic financial sector.

2.2 Table Tantrum and Currency Depreciation Episode

In mid 2013, the U.S. Federal Reserve began to talk of the possibility of tapering its security purchases after a prolonged period of unconventional monetary policy. The U.S. Fed's action to reduce the scale of the quantitative easing program resulted in a sharp negative impact on the economic and financial conditions of emerging markets.[12] In the following years, the emerging markets have witnessed a large scale of exchange rate depreciation and capital flow reversal, which stands in stark contrast to the first few years following the financial crisis.[13] Among the emerging markets

[12] See Chari et al. (2017), Eichengreen and Gupta (2015), Aizenman et al. (2014), Mishra et al. (2014) for discussion about the impact of the tapering talk on emerging markets.

[13] See Appendix Figure A1 for exchange rate depreciation and external debt growth in a group of emerging markets.

surveyed in the paper, Taiwan shared a similar experience. As shown in Figure 1, the exchange rate of Taiwan dollar (TWD) against USD depreciated by 10 percent during 2014-15.[14] The outstanding amount of Taiwan external debt reversed, trending downward after undergoing a surge since 2012. I focus on this specific emerging market, Taiwan, for most parts of my empirical analysis and consider the four-year episode between 2012 and 2015 as my sample period to empirically investigate the exchange rate policy transmission.

To the best of my knowledge, no policy change has been made in terms of either foreign exchange regulation or banking regulation during the sample period in Taiwan. I found no evidence that the external shock that moved the exchange rate had greatly impacted local fundamental conditions such as the creditworthiness of the local administration. In 2014-15, VIX was staying at the lowest level since the financial crisis. The policy rate in the United States remained constant throughout the sample period, and the policy rate in Taiwan did not change until the fourth quarter of 2015.

2.3 Foreign Exchange Market in Taiwan

It is common for the banking authority in emerging markets to regulate financial intermediary to prevent them from overly bearing currency risk. In Taiwan, banks authorized to engage in foreign exchange business[15] are allowed to determine their overbought and oversold positions, subject to the regulation that limits their overall net FX position in foreign currency to 50% of their total capital. Additionally, the capital requirement for the net FX position is set to be 8% in Taiwan. In Appendix Table A5, I survey foreign exchange regulation law for a group of emerging market and advanced economies using the IMF AREAER database. I present the distribution of FX limiting ratios for the surveyed emerging market economies in Appendix Figure A4. Many emerging markets impose quantitative limits on bank net FX positions as a share of capital or equity in a similar way as Taiwan.[16] In contrast, most of the advanced economies do not explicitly set up a quantitative

[14]According to the central bank in Taiwan, a flexible exchange rate system has been formally implemented. Since then, the TWD exchange rate has been determined by the market.

[15]According to the central bank in Taiwan, bank authorized to engage in foreign exchange business shall comply with the following conditions: (1) maintain capital to risk-weighted assets ratio at 8% or above; (2) maintain a sound financial position for the last three years; (3) deploy sufficient experienced personnel for conducting foreign exchange business; and (4) participate in joint processing of foreign exchange business with other authorized banks for an accumulated amount up to USD 400 million or up to 7000 transactions.

[16]For example, in Brazil, a limit of 30% of a financial institution's capital base applies to its exposure in gold and assets and liabilities denominated in foreign currency. In South Korea, a foreign exchange bank's overall net open position, sum of overall net short positions, or sum of overall net long positions in each currency is limited to 50% of its total equity capital at the end of the previous month. In Turkey, the absolute value of the weekly arithmetic

restriction on banks' net FX positions.

The foreign exchange derivative market in Taiwan is developing and is featured by a lack of innovation, products, and liquidity according to the Triennial Survey by BIS. One prominent feature of Taiwan's derivative market, which is also shared by some other emerging market economies, is the prevalence of non-deliverable contracts.[17] Given the fact that non-deliverable contracts can only be settled down in domestic currency, such feature reflects the presence of restrictions on currency convertibility and the existence of capital control, which can prevent domestic banks from hedging current risk efficiently at low costs. I highlight the frictions in the Taiwan derivative market using covered interest parity deviation implied by interbank offered rates as shown in Appendix Figure A3.[18] Moreover, I provide detailed information on Taiwan bank's usage of derivative in Section 4.2.

3 Data

3.1 Data Description

A principal innovation of this paper relative to the previous empirical work on currency mismatch is to link data sets of loan origination with bank exposure to currency risk and firm-level outcomes so I can observe the real effects of exchange rate depreciation on borrowers of different banks.

The loan market data comes from the Thomson Reuters Dealscan database, which provides comprehensive coverage of the syndicated loan market. Dealscan collects historical information on the identities of borrowers and lenders present at origination, pricing, contract detail, terms, as well as loan conditions. The sample I use begins from all loans granted by local banks[19] in Taiwan to local business excluding financial, insurance or real estate corporations (non-FIRE). I exclude syndicated loans whose the primary purpose is stated as "merger and acquisition" or "leverage buyout." The loan sample period spans the years from 2012 to 2015. The role that syndicated loan market plays in the gross bank lending can differ greatly across economies. By referring the

mean of daily ratios between net foreign exchange positions and own funds must be no greater than 20%.

[17] See McCauley and Shu (2016) for discussion about non-deliverable FX market in emerging markets.

[18] Du et al. (2018) argues that the deviation reflects the financial market imperfections.

[19] I do not include in my analysis branches of foreign banks or subsidiaries of foreign banks in order to ensure better comparability of sample banks. It is possible for foreign ownership to be one of the determinants of bank lending outcomes. For example, Giannetti and Laeven (2012) finds that the home bias of lenders' loan origination increases by approximately 20% if the bank's home country experiences a banking crisis. De Haas and Van Horen (2013) finds that banks reduce credit less to markets that are geographically close. The market share of foreign banks in Taiwan syndicated loan market is small.

total amount of sample syndicated loans to the official statistics released by the monetary authority in Taiwan, the loan sample manages to cover slightly more than 50% of the gross lending to the non-financial private sector during the sample period.

To obtain lender financial information, the syndicated loan sample is merged at the lender's ultimate-parent level with data from BankFocus and Taiwan Economic Journal. BankFocus provides information on standard balance sheet variables for banks in many economies around the globe at annual frequency. It sources micro-data on banks from financial statements and presents the finalized data in a consistent and harmonized format across countries and regions. The key information on foreign currency exposure of banks is provided by BankFocus and is mostly available since 2012. Taiwan Economic Journal provides detailed information on the use of FX derivatives by domestic banks and their U.S. dollar cash inflow and outflow term structures sourced from the banking bureau in Taiwan. I merge the banks with data from Thomson Reuters Eikon to obtain stock price information for a subsample of banks with equity publicly traded on the Taiwan stock exchange. To keep the sample reasonably well balanced, I eliminate loans for which the lead lenders made only a small number of loans during the sample period. All the restrictions reduce the sample to syndicated loans granted by 29 banks, which represents approximately 75% of the total assets in the local banking sector. All the major lenders in sample turn out to be commercial banks. No domestic subsidiaries of foreign banks or branches of foreign banks are included in the sample. I use a set of bank balance sheet databases to construct the measure of bank exposure to currency risk as well as controls for bank observable characteristics such as size, tier 1 capital ratio, leverage ratio, liquidity ratio, and exposure to real estate sector .

I augment the data with firm-level information obtained from Bureau van Dijk's Orbis database[20], Capital IQ and Worldscope. Orbis contains annual balance sheets and income statements for public and private companies. Capital IQ provides details on the whole debt structure for a subsample of borrowers, including detailed information on total outstanding debt by currency denomination. Furthermore, Worldscope provides a full picture of firm annual sales revenue composition by destination market for the subsample of borrowers. All the borrowers from the syndicates loan markets are consolidated at the ultimate-parent level. I use this information to construct firm-level out-

[20] I follow Kalemli-Ozcan et al. (2015) for the detailed instructions on the data gathering process from Orbis in terms of downloading methodology and cleaning procedure.

come variables of interest (total debt, sales, employment and investment) and control variables for firm characteristics (size, primary industry, geographic location, etc.). The borrowers active in the syndicated loan market turns out to be the major component of the real economy in Taiwan. As shown in Appendix Figure A2, I calculate the total value added and sales revenue of the sample firms and compare their dynamics with the that of the gross domestic product. The dynamics are able to match the key features such as the sharp recovery from the financial crisis and a production slowdown since year 2014.

Neither Orbis, Capital IQ or Worldscope shares a common identifier with the Dealscan data for borrowers in the syndicated loan market. I first perform a "fuzzy merge" using geographic and industry identifiers along with a bigram string comparator score of the firm name as reported in Dealscan and Orbis. Orbis contains the identifiers such as entity invoice number or stock and security number (ISIN, etc.), which, in turn, can be used to easily link the sample to Capital IQ and Worldscope. The final merged sample contains approximately 400 firms in the panel.

I use market data (such as exchange rates, forward prices, GDP and external debt) obtained from Bloomberg and Datastream.

4 Identification strategy

4.1 Measurement of bank currency risk

I construct bank currency risk exposure for each bank in sample as the difference between gross US dollar liabilities and US dollar assets,[21] and then scaled by the bank total equity as observed by the end of year 2013:

$$\text{Net USD Exposure}_{\,b,13} = \frac{\text{Gross USD Liability} - \text{Gross USD Asset}}{\text{Bank Total Equity}}$$

A positive value of net USD exposure implies that bank equity will be negatively impacted by the depreciation of domestic currency against the U.S. dollar. Provided that bank funding capacity is constrained by the net worth, the loss of bank equity value incurred by exchange rate depreciation

[21]U.S. Dollar is the dominant foreign currency in the Taiwan banking system in terms of the positions of asset and liability. The positions of asset and liability denominated in other foreign currencies are not available for some sample banks.

shall lead to a reduction in bank lending.

Previous literature may conventionally treat gross USD liabilities (as a share of total bank liabilities) as the proxy for currency mismatch, while Figure 2 suggests that such proxy can be problematic in my case.[22] The scatter plot shows how gross USD liabilities displayed on the horizontal axis is associated with net USD exposure on the vertical axis. Each circle is one sample bank, the size of which represents the total amount of loan granted by the lender respectively. The scatter plot concludes that the relation between two variables turns out to be weak, and the consideration for both foreign currency asset and liability is a more accurate method to quantify currency mismatch in bank balance sheets.

Table 1 presents the descriptive statistics for banks included in the sample. Net USD exposure distributes around 0 and is bounded between 50% and -50% with a standard deviation of 23%. Besides the continuous variable used in the baseline empirical analysis, I also consider a dummy variable for banks with net USD exposure greater than 25%. Five banks with net USD exposure above the threshold are categorized to be in the treated group and the rest in the control group. The treated banks are responsible for one fourth of the loan volume in the sample. The treated bank are highlighted in red and the control bank in blue, as shown in Figure 2.

4.2 Bank usage of derivatives

Measure of bank currency risk constructed in the previous part of this section does not consider banks using derivatives for hedging. Using data from the banking bureau in Taiwan, I show that banks in my sample are actually far from perfectly hedged. The descriptive statistics on bank usage of derivatives management are in Table 2. Interest rate and foreign exchange hedging is quite concentrated, with many banks not hedging at all. The gross hedging data shows that banks, at the third quantile, hedge interest rate risk to a limited extent and do not hedge foreign exchange risk. Furthermore, conditional on hedging, the notional amount of FX derivative held for hedging purpose (as a share of bank total equity) is smaller than bank Net USD Exposure by one order of magnitude. Therefore, the level of risk management with derivatives is relatively limited. It essentially makes no difference in the classification of treated and control group of

[22] As shown in Figure 2, banks that borrow extensively in USD are generally larger in size and presumably healthier. Thereby, it is possible that banks with more gross USD liabilities are more likely to be associated with exporters who prefer loans denominated in USD. Hence, gross USD liabilities alone cannot reflect currency mismatch.

banks after taking into account their usage of derivatives for FX hedging. Although understanding the determinants of a bank's hedging decision is beyond the scope of this paper, some substantial barriers to risk management could be derivatives market friction and financial expenses associated with hedging (Rampini et al. (2019)).

4.3 Bank balance on observable

In order to check how the measure of bank currency mismatch is correlated with other bank's observables, I run a series of univariate regressions to regress bank net USD exposure against a wide set of bank's characteristics:

$$\text{Net USD Exposure}_{b,2013} = \alpha + \beta X_{b,2013} + \varepsilon_b \tag{1}$$

I examine a wide range of observables such as bank size, return on equity and asset, tier 1 capital ratio, leverage ratio, liquidity ratio and so on. I report the estimates of univariate regressions in Table 3 . The results suggest that the measure of bank currency mismatch is positively correlated with bank size but the correlation is not significant at 90% confidence level. The rest of the observables under scrutiny exhibit less correlation with bank currency risk exposure.

5 Effect of Depreciation on Bank Credit Supply

Using data described in the previous part, the section estimates whether exchange rate depreciation plausibly triggered by talk of U.S. Fed's tapering, led banks with a higher currency mismatch to cut lending. I focus on the extent of bank lending cut at the intensive margin and the extensive margin. The intensive margin measures the change in the amount of loans a borrower received from the same bank for two consecutive times, and the extensive margin refers to a lender's likelihood to renew bank loans for past clients.

Ideally, to estimate the effect of depreciation on bank lending, one would randomly assign currency risk exposure and compare the outcomes of banks affected by depreciation to those that are not. Banks that are randomly assigned with greater currency risk will be hit by larger shocks in net worth that can adversely affect their solvency and liquidity condition. Hence, depreciation shock does not affect all banks in the same way. Nevertheless, banks do not randomly choose their foreign currency assets and liabilities, and the choice of net USD exposure is endogenously determined. One critical assumption is that the cohort of banks with less currency risk should form a valid counterfactual for the highly mismatched banks. I provide more discussion and evidence in support of this assumption in the following sections.

To this end, I articulate the methodology to identify the effect of depreciation on bank lending and the model specification for the empirical analysis. Potential threats to the validity of identification strategy are discussed and a set of robustness checks follow to address the respective concerns. The findings presented in the section support the key argument that exchange rate depreciation is transmitted as a sizable contractionary credit supply shock via domestic financial intermediaries.

5.1 Intensive Margin Results

I use the difference-in-differences (DID) framework to compare lending at the intensive margin before and after the depreciation episode by exploiting the variation in the cross-section of banks' exposure to currency risk. I examine the time-series evolution of bank credit supply following the baseline specification

$$log(L_{b,f,t}) = \beta \text{Net USD Expo.}_b \times \Delta\xi + \alpha_{b,f} + \alpha_{f,t} + \varepsilon_{b,f,t} \tag{2}$$

The dependent variable $log(L_{b,f,t})$ is log amount of all syndicated loan that bank b grants to firm f in year t. By taking the logarithm, the sample automatically restricts itself to the firms that are observed with positive borrowing during the sample period. The continuous variable Net USD Expo.$_b$ represents bank's exposure to currency risk measured by the end of 2013 and before the occurrence of depreciation. The interaction between Net USD Expo.$_b$ and yearly depreciation rate can be easily interpreted as the shock to bank net worth caused by revaluation of bank foreign assets and liabilities. The coefficient of interest, β, is the estimate for the elasticity of credit supply to bank net worth change as a result of depreciation, and it is expected to be negative. I normalize net USD exposure so that its standard deviation is one.

Table 4 show the results of model specification. Column (1) shows the regression of loan credit against lender's net USD exposure over a sample period between 2012 and 2015. Here I introduce bank fixed effects (to absorb any time invariant bank characteristics), firm fixed effects (to absorb any time-invariant borrower characteristics) and time fixed effects (to absorb aggregate shock that evenly affect the annual credit supply). The estimate is negative but insignificant.

It is plausible that a firm has a different relationship intensity with different banks. Highly mismatched banks might be related with borrowers that have weak fundamentals and are inclined to reduce credit demand upon the depreciation. In the following steps, I control for the endogenous matching between borrowers and lenders in the syndicated loan market. In Column (2), I add controls to proxy for bank-firm relations. These controls are composed of the length of the relationship between a bank and a firm as well as the fraction of loans that a firm received from the a bank over the past borrowing experience. In Column (3), I saturate the model with bank×firm fixed effects to address any potential threat coming from non-exogenous matching between banks and firm. The adoption of bank×firm fixed effects can to pick up both observable time-invariant determinants of relationship lending as well as other non-observable time-invariant factors. From Column (2), we see that the coefficient on bank net worth shock due to depreciation is negative and strongly significant. Using bank×firm fixed effects reduces the number of observations by 40% due to the removal of borrowers associated with single bank in the sample, however, the estimate barely changes and becomes even more significant with a t-statistic of 3.30.

In the preferred specification shown in Column (4), I replace time fixed effects with firm×time fixed effects to absorb any variation stemming from firm-level factors in line with the seminal work by Khwaja and Mian (2008). The coefficient is estimated from the firms with multi-relations, and exploits the within-firm variation in the size of credit across banks with different levels of currency mismatch. The estimation could be accounted for as the effect of exchange rate fluctuation on credit supply due to the fact that credit demand has been soaked up by firm×time fixed effects.

An alternative way that banks becomes sensitive to depreciation can be attributed to the fact that they are lending to non-tradable sectors without any U.S. dollar income, such as real estate. Depreciation raises the likelihood of loan default by borrowers in the specific sectors, and in turn adversely impacts the lenders. In Column (5), I address this hypothesis by including the bank's main sector×time fixed effects to control for sector-specific factor. The inclusion of this term only makes a slight change in the result.

The coefficient estimate of β for the model specification is negative and statistically significant suggesting that depreciation can generate a negative impact on bank lending to firms. In terms of economic significance, the coefficient estimate by the most stringent specification (Column 5) implies that a one-standard deviation increase in bank net USD exposure is associated with a 6 percent decrease in credit supply at the intensive margin when confronted with a depreciation of 10 percent.

In Table 5, I show the results of alternative specification using the dummy variable High Net USD Exposure that categorizes sample banks into treated and control group. The dummy variable Post_t takes one if year is either 2014 or 2015, and zero otherwise. The coefficient estimates of Column (2)-(5) are negative and statistically significant. The adoption of the categorical variable for currency mismatch facilitates the economic interpretation of the results. As suggested by the last column, the treated banks reduce the credit supply by around 10.9 percent on average relative to the control group upon the depreciation shock that occurred in 2014 and afterwards.

Besides the method of dividing sample banks into only two groups (i.e., treated and control), I implement a more precise classification approach using binscatter plot as shown in Figure 5. All sample banks are sorted into five bins by net USD exposure, among which five banks regarded as the treated constitute the bin located on the right. I estimate the change of credit supply upon the shock for each bin separately. The point estimate with the 90% confidence interval is displayed for each bin. The finding by binscatter plot is consistent with the observation from Table 5, in the sense that banks in the fifth bin decrease credit supply by more than 10 percent relative to the counterparts with the least net USD liabilities.[23]

5.2 Validity and Robustness

The identification strategy rests on the assumption that banks in the control group should be a valid counterfactual for those in the treated group. For banks in the two groups with different levels of currency mismatch to be comparable, it is required that the credit supply of banks with higher currency risk exposure would have been the same as that of the rest of the banks if no depreciation had ever occurred. In other words, the parallel trends assumption should holds. I provide two pieces of evidence in support of the underlying assumption (1) I check balance on bank observables, (2) I show the pre-trends by estimating the dynamic difference-in-differences specification.

[23] In fact, banks in the first bin have more USD assets than USD liabilities

First, I check the balance on bank observables to show that no significant differences in the bank characteristics are observed by the end of year 2013. The check is conducted by running univariate linear regression of bank net USD exposure against a wide range of bank observables. The result are presented in Table 3 to find no evidence of bank currency risk exposure correlating with any of bank characteristics under scrutiny.

Second, I modify the specification into a dynamic difference-in-differences version. The specification allows me to observe how quickly banks react to the depreciation shock and how persistent the effect of the shock could be. One may also infer causality via the timing and examine the extent of the pre-existing parallel trend. The specification for dynamic DID takes the following form

$$log(L_{b,f,t}) = \sum_{t=2012}^{2015} \beta_t (\text{Net USD Expo.}_b \times \mathbf{1}_{year=t}) + \alpha_{b,f} + \alpha_{f,t} + \varepsilon_{b,f,t} \tag{3}$$

Figure 4 plots the sequence of coefficient β_t estimates for each year from the equation above. The red dots are point estimates and the vertical lines represent 90 percent confidence intervals. The figure indicates that there was no significant difference in lending by treated and control banks prior to the depreciation shock. This serves as the second piece of evidence of no pre-trend. Another finding revealed by the dynamic is that the impact of the depreciation shock, though large in its magnitude, decays by half in year 2015.

Third, one potential threat to identification is that the measure of bank currency mismatch picks up the other dimensions of bank health or confounding factors that have less to do with bank's behavior in the foreign exchange market. I address the concern by showing that the results in the baseline specification are robust when controlling for interaction with other bank characteristics. I consider the commonly used indicators that have been regarded as relevant to bank health by the previous literature. Table 6 shows the results. Column (2)-(4) each separately considers the additional control for bank tier 1 capital ratio, leverage ratio, and liquidity ratio, and Column (5) includes all three interaction terms together. The coefficient of net USD exposure remains generally stable and statistically significant after controlling for other bank health indicators. This provides corroborating evidence that bank currency mismatch is another crucial health dimension beyond the ones that have been widely considered.

Fourth, another possible concern is that the result is driven by a shifting in the borrower's preference for loan currency denomination. Even though the credit demand has been accounted for by firm×time fixed effects, the elasticity of credit demand to depreciation can differ by loan currency denomination. It is likely that firms reduce their demand for USD loans after depreciation shock in response to the preference change. It is also plausible that banks with higher net USD exposure happen to be better at conducting USD loan business than their counterparts. I address the concern by restricting to the subsample composed of syndicated loans denominated in the domestic currency, and then repeating the estimation procedure. The results of this robustness check can be found in Table 7. The coefficient estimates are smaller in scale but remain statistically significant.

Fifth, I show in Appendix Table A1 that my findings are robust to the collapsed specification of difference-in-differences which compare the average lending before and after the depreciation shock. I present the results that use the continuous measure of bank currency mismatch and the binary version. While the effects are quantitatively similar, the baseline model specification is preferred as it allows the absorption of any observable and unobservable time-invariant bank-firm characteristics.

The last robustness check regards standard error clustering. I report the estimates using two-way clustered standard errors at the bank and firm level, which allow me to address the threat that firm shock can be serially correlated and also that bank shock can be correlated across firms. Appendix Table A2 shows that the findings for bank credit supply at intensive margin are robust to alternative ways of clustering either at the bank-time and firm level or at only firm level.

5.3 Extensive Margin Results

In this section, I investigate whether exchange rate depreciation affects bank lending at the extensive margin. I focus on the propensity of banks to continue lending to past clients. More specifically, I investigate whether the propensity to renew bank loans reduces after the depreciation shock, and moreover, whether the reduction in the renewal propensity is disproportionately large for highly mismatched banks.

I start by estimating the average propensity for a lender to act as lead bank. In a typical syndicated loan deal, the lead bank comes to a preliminary agreement with the borrower on the terms of the loan, and recruits other participant lenders to provide some of the financing. The lead bank is responsible for monitoring the loan package and generally provides more funds in proportion than participant bank does. The outcome variable $\text{Lead}_{f,b,t}$ is an indicator that is set to be 1 if a potential bank b acts as the lead lender for borrower f in year t. The independent variable $\text{Lead}_{f,b,t-1}$ is set to be 1 if the bank acts as the lead lender for the borrower in the previous syndicated loan package before year $t-1$. The indicators for a bank acting as a participant can be constructed in a similar way. The baseline model specification follows Chodorow-Reich (2013) and takes the form shown below:

$$\text{Lead}_{f,b,t} = \rho\text{Lead}_{f,b,t-1} + \alpha_{b,t} + \alpha_{f,t} + Z_{b,f} + \varepsilon_{b,f,t} \tag{4}$$

The specification also serves as a direct test on the stickiness of the bank-firm relationship implicitly assumed by the bank lending channel literature.

Table 8 summarizes the results. In Column (1), the estimated value ρ is 0.375. In words, after controlling for the bank's average market share (bank fixed effects), a bank that served as the prior lead lender for a borrower has a 37.5-percentage-point greater likelihood of serving as the new lead lender when compared with other banks that were not previously a lead lender. Although Column (1) controls for the overall bank market share, it fails to account for the possibility that some banks concentrate in lending to particular types of firms. If so, the repeating borrowing propensity reflects bank specialization rather than actual stickiness in relationship lending. Column (2) tackles the issue by adding a set of fixed effects that effectively control for a lender's market share separately by borrower industry, geographic location, incorporation status and riskiness. The firm×time fixed effects can control for the time-varying market concentration of a borrower in the syndicated loan market. The inclusion of these fixed effects increases the explanatory power to the regression but does not make a large difference to the coefficient estimate of interest. These results provide the evidence in support of the stickiness in bank-firm relationship.

To validate that the renewal propensity is affected by the depreciation shock, I modify the baseline specification by allowing for the triple interaction with the indicator for acting as previous lead bank. The modified version takes the following form:

$$\begin{aligned}\text{Lead}_{f,b,t} = {} & \rho_0\text{Lead}_{f,b,t-1} + \rho_1\text{Lead}_{f,b,t-1} \times \text{Post}_t + \rho_2\text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \\ & + \rho_3\text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \times \text{Post}_t + \alpha_{b,t} + \alpha_{f,t} + Z_{b,f} + \varepsilon_{b,f,t}\end{aligned} \tag{5}$$

The binary variable High Net USD Exposure is set to be 1 for banks that as belong to the treated group in line with the previous section. The dummy variable Post_t is 1 for the period 2014-15. The coefficient of interest, ρ_3, can be interpreted as the additional change in propensity by the treated banks relative to the control banks after the depreciation shock. The estimation by the triple DID specification is essentially equivalent to the alternative two-step approach—that is, (1) divide the extensive margin panel data by the bank-treated or control categorization, and estimate the propensity change after the depreciation for each subpanel, and (2) calculate the relative change of propensity between two groups. Column (3) presents the results for this model specification. The value of the coefficient ρ_3 is -0.159 and is significant. In other words, the treated banks reduce the likelihood of continuing to serve as lead lender for past clients by 15.9 percentage points relative to the control banks when they are hit by depreciation shock.

I estimate the dynamic version of the triple DID specification by allowing the coefficient estimate for each year. The modified version is given by the following equation:

$$\begin{aligned}\text{Lead}_{f,b,t} = & \sum_{t=2012}^{2015} \rho_{1,t}(\text{Lead}_{f,b,t-1} \times \mathbf{1}_{year=t}) + \rho_2 \text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \\ & + \sum_{t=2012}^{2015} \rho_{3,t}(\text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \times \mathbf{1}_{year=t}) + \alpha_{b,t} + \alpha_{f,t} + Z_{f,b} + \varepsilon_{f,b,t}\end{aligned} \tag{6}$$

According to the equation, the dynamic of lead bank propensity is defined as $\rho_{1,t} + \rho_2 + \rho_{3,t}$ for the treated group, and $\rho_{1,t}$ for the control group. The dynamics sequences are illustrated in the left panel of Figure 6. Additionally, the dynamic of the triple DID coefficient ρ_3 is displayed in the right panel of Figure 6. The pre-trend assumption holds as indicated by the figure.

As a robustness check, I add the explanatory variables of bank characteristics to address a potential concern that net USD exposure might pick up any confounding effect of other bank health dimensions, rather than bank currency risk exposure. The results of this robustness check are summarized in Table 9. The inclusion of either tier 1 capital ratio, leverage or liquidity ratio does not incur a significant difference in the baseline estimate.

I also estimate the renewal propensity of acting as participant in the syndicated loan market. The regression results are presented in Column (4)-(6) of Table 8 and the dynamics of the coefficient estimates are illustrated by Figure 7. I did not find any significant impact of depreciation shock on the renewal propensity of banks acting as a participant for past clients.

In sum, I find strong evidence on the credit supply channel at the extensive margin. Banks with higher net USD exposure reduce the likelihood of lending as the lead to past clients by roughly 16 percentage points.

6 Firm-level Evidence

In this section, I explore whether the shock that is transmitted through the credit supply channel translates to firm-level credit and real outcomes. This is a valid question even though evidence has been found in the loan-level analysis, because firms might switch to non-exposed banks or another source of financing. I construct firm-level panel data containing balance sheet information of the non-FIRE local borrowers that are active in the syndicated loan market between 2009-13. In line with bank lending channel literature,[24] the identification strategy exploited by the firm-level analysis rests on the heterogeneity of the firm's dependence on banks that differ in their currency risk exposures. For each firm f, the indirect measure of its lenders' currency risk exposure is defined as the loans granted by all highly mismatched banks as a share of total loans that the firm received during the five-year episode, which is formally written as

$$\overline{\text{Net USD Exposure}}_f = \frac{\sum_{b \in B_f} L_{b,f}^{09-13} \times \text{High Net USD Exps.}_{b,13}}{\sum_{b \in B_f} L_{b,f}^{09-13}} \tag{7}$$

The measure, by construction, is non-negative and bounded between zero and one. Figure 3 shows the histogram of this firm-level proxy for lenders' currency mismatch. The value of the median firm (red line) is around 0.28—, that is, the firm borrows from one treated bank for every four banks with which it is associated. I normalize the continuous variable $\overline{\text{Net USD Exposure}}_f$ by the standard deviation (0.15) for the firm-level regressions.

A valid concern about the identification assumption is that the endogenous matching between bank and firm may confound the causal inference on the real effects of credit supply with demand.[25] In the firm-level analysis, the sorting in the credit markets can no longer be addressed by using

[24] See Huber (2018), Chodorow-Reich (2013), Ivashina et al. (2015), Acharya et al. (2018)

[25] See Chang et al. (2019) for the discussion on bank-firm sorting.

bank×firm fixed effects as in the loan-level regression. I look into this potential treat by conducting two checks before drawing an inference on the firm-level outcomes. First, I check the balance on firm observables. Second, I test whether firms are systematically matched to banks with similar level of health.

6.1 Firm Statistics and Balance on Firm Observable

I present descriptive statistics and explore whether the identification assumption is plausible. I divide the firm sample equally into two groups. I label the firms with $\overline{\text{Net USD Exposure}}_f$ above the sample median as the treated, and those below as the control. Panel A of Table 10 shows summary statistics of a wide range of firm control variables that are observed before the depreciation episode. The last two columns in Panel A present the results of t-test. I find significant differences in the size of borrower and the all-in-drawn loan spread—that is, firms that rely more on banks with higher currency mismatch tend to be larger in size and less risky. No systemic difference is found for the rest of the characteristics under scrutiny, including the commonly used measures of firm balance sheet strength, foreign currency indebtedness and the share of export sales revenue.

Panel B of Table 10 checks the balance on firm dependent variables. The first three rows show no significant difference in debt growth, investment or employment growth between firms in the treated and the control group before the depreciation episode. The fourth and fifth row show the average change in the tangible fixed asset (investment) in a borrower's industry and location respectively, and the last two rows show the average change in employment in a borrower's industry and location respectively. Borrowers with more pre-existing reliance on highly mismatched banks belong to the industries that experienced an average change in the tangible fixed asset of 6.0 percent, compared to an average change of 5.4 percent in the industries of borrowers with less reliance on these banks. The key message conveyed by the tests is that borrowers identified as either the treated or the control by their pre-existing dependence on the highly-mismatch banks are not belonging to the sectors or geographic areas that doing significantly poorly in terms of investment or employment after the depreciation shock. In other words, bank specialization by industry or geography cannot explain the borrower outcomes even in a bivariate ordinary least squares context.

6.2 Test of Sorting on Firm Unobservable

The identification assumption requires orthogonality between bank health and unobserved firm characteristics that can affect loan demand and real outcomes. While the empirical exercises can control for a rich set of observed firm characteristics, it is plausible that firm unobservables may drive the sorting pattern between borrower and lender, which consequently nullifies the identification assumption and confounds the credit supply shock with credit demand. One thing that allows me to at least look into the extent of the sorting is to test the correlation between a firm's first and second lender's characteristics, as proposed by the recent paper Chang, Gomez and Hong (2019). The null hypothesis of the test is that after controlling for a set of firm observables Z_f, a firm should not be systemically matched to banks with a particular level of health δ. Otherwise, the existence of any firm unobservable that serves as the sorting device should lead to the consequence that a firm borrows from a group of lenders sharing bank health similarities. This sorting test is undertaken by estimating the following regression:

$$\delta_{f,firstbank} = \alpha + \beta\delta_{f,secondbank} + Z_f + \varepsilon_f \tag{8}$$

where $\delta_{f,firstbank}$ is the health proxy of the first lender of firm f during 2009-13, and $\delta_{f,secondbank}$ the health of its second lender. The rejection of the null hypothesis to favor the sorting between firm and bank implies that $\beta > 0$.

Panel A of Table 11 reports the results obtained using bank lending growth as the dependent variable. In Column (1), the regression is run without any borrower characteristic. In Column (2), I add borrower all-in-drawn loan spread. In Column (3), I saturate the model with additional borrower controls including the size of firm and firm's industry fixed effects. Along with all the specifications, the coefficient estimate β is insignificant and slightly negative. The rest of the panels check other bank health proxies ranging from bank size, tier 1 capital ratio, leverage ratio, and liquidity ratio. Overall, the results find no evidence in support of a strong assortative matching between bank and firm in the sample. In sum, it is less likely a concern that firm unobserved characteristic is correlated with the measure of bank health to confounds the causal inference on the real effects of credit supply with demand.

6.3 Effect on Firm Real Outcomes

This section presents evidence of the real effects of depreciation shock that spills over to the real side of the economy through financial intermediaries. I use the panel data containing balance sheet information during 2012-15 of the non-FIRE local firms that borrowed at least once during 2009-13. I estimate the following equation:

$$y_{f,t} = \theta \overline{\text{Net USD Exposure}}_f \times \text{Post}_t + \alpha_f + \overline{B}_{f,t} + Z_{f,t} + \varepsilon_{f,t} \tag{9}$$

where $\overline{\text{Net USD Exposure}}_f$ is the firm f's dependence on the highly mismatched banks, α_f the firm fixed effects, $\overline{B}_{f,t}$ the firm-level bank health controls, and $Z_{f,t}$ the firm characteristic controls. The dummy variable Post_t is set to be one if year is between 2014-2015, and zero otherwise. θ is the coefficient of interest that captures how much more a firm with dependence on highly mismatched banks changes real outcomes relative to its counterpart after the depreciation shock.

The estimate results are presented in Table 12. I start by analyzing the impact on firm debt growth to see if a firm could mitigate the adverse credit supply shock by switching to non-exposed lenders or substituting other sources of funding. Panel A in the table suggests that this was not the case. The dependent variable is computed as the change in the firm's outstanding debt from the previous period. In Column (1), I include no control variable and the coefficient estimate is negative and significant. In Column (2), I introduce firm fixed effects to control for time-invariant firm characteristics and time fixed effects to control for any aggregate shock that affects borrowers equally. In Column (3), the sector×time fixed effects are added to control for sector-specific shock (e.g. demand shock on tradable goods) and city×time fixed effects are able to control for location-specific shock (e.g. labor supply shock in local region). The coefficient estimate remains stable and significant.

In Column (4), I control for a group of indirect measures of other bank health dimensions, including bank tier 1 capital ratio, leverage ratio, and liquidity ratio. For example, I compute the share of the loans granted by banks whose leverage ratios are above the sample median—that is,

$$\overline{\text{Leverage}}_f = \frac{\sum_{b \in B_f} L_{b,f}^{09-13} \times \text{High Leverage}_{b,13}}{\sum_{b \in B_f} L_{b,f}^{09-13}}$$

which is analogous to the definition of $\overline{\text{Net USD Exposure}}$. For each bank health dimension, I categorize firms into two bins by the corresponding indirect measure, and then add the bin-time fixed effects to the regression, which are denoted by the vector $\overline{B}_{f,t}$. The inclusion of these controls barely changes the coefficient estimate of bank currency risk exposure. This is consistent with the finding in the loan-level analysis that bank currency risk exposure is less likely to pick up the channel through other bank health dimensions. In Column (5), I control for firm characteristics using a series of firm-control-bin×time fixed effects, which are denoted by $Z_{f,t}$. These firm control variables include firm size, all-in-drawn loan spread, interest coverage, leverage, profit margin, and bond market access. The coefficient estimate of θ is negative and statistically significant for all specifications in Panel A, suggesting that firms relying on the banks with higher currency risk exposure could hardly "hedge" credit supply shock by resorting to non-exposed banks or alternative source of funding. In terms of economic interpretation, my most stringent specifications (Column 5, Panel A) implies that a one-standard deviation increase in a firm's dependence on the highly exposed banks is associated with a 12-percent reduction in debt growth.

In Panel B, C, and D of Table 12, I repeat the same procedure for investment, employment growth, and sales revenue growth, respectively. I measure investment as an annual log change in firm tangible fixed assets from the previous period. Employment growth is defined as the annual log change in the number of employees from the previous period. Sales revenue growth is defined as the annual log change in sales revenue from the previous period. For each outcome variable, I saturate the model specification progressively with the fixed effects and the control variables in the same way as Panel A. The coefficient estimates are consistently negative and significant along with the variety of specifications in all three panels. My most stringent specifications (Column 5) imply that a one-standard-deviation increase in a firm's dependence on the highly exposed banks, which is measured by $\overline{\text{Net USD Exposure}}_f$, is associated with a 3-percent reduction in investment, a 2-percent reduction in employment growth, and a 3-percent reduction in sales revenue growth.

6.4 Dynamics and Robustness

I conducted a battery of additional checks on the effect of depreciation on firm-level outcomes. First, I estimate the dynamic DID equation as shown in the following equation:

$$y_{f,t} = \sum_{t=2012}^{2015} \theta_t \big(\overline{\text{Net USD Exposure}}_f \times \mathbf{1}_{year=t} \big) + \alpha_f + \overline{B}_{f,t} + Z_{f,t} + \varepsilon_{f,t} \tag{10}$$

Figure 8 plots the coefficient sequences θ_t estimated from the equation above for debt growth, investment, employment and sales revenue growth, respectively. The red dots are point estimates and the surrounding vertical dash lines represent 90 percent confidence intervals. Two additional points can be made by the figures. Firstly, there is no significant pre-trend before the depreciation shock. Second, the impact on firm-level credit reaches the maximum in year 2014 and leads to the major impacts on investment and employment, which are observed in year 2015.

Moreover, I show that the results are robust to an alternative definition of firm-level measure of bank currency risk exposure. Recall that the baseline measure $\overline{\text{Net USD Exposure}}_f$ takes into account all the loans that are granted five years before the depreciation shock when computing the weight on each lender. This definition might overstate the dependence on some lenders if the relationships with past clients were terminated before the shock. As a robustness check, I define firm's dependence on the highly mismatched bank as the share of loans from these banks in its last loan package before the depreciation episode:

$$\overline{\text{Net USD Exps.}}_f^{\text{last loan}} = \frac{\sum_{b \in B_f} L_{b,f}^{\text{last loan}} \times \text{High Net USD Exps.}_{b,13}}{\sum_{b \in B_f} L_{b,f}^{\text{last loan}}} \tag{11}$$

In line with the definition, a bank that showed up between 2009-13, but not in the last loan package of firm f, will be weighted by zero. I repeat the estimation procedure after substituting this new measure of the firm's bank currency risk exposure. Appendix Table A3 presents the results of this robustness check. The coefficients estimated by the preferred specification (Column 5) are negative and statistically significant for debt growth, investment and employment growth.

6.5 Additional Channels

To what extent does the bank lending channel contribute to the overall effect of exchange rate policy transmission? In this section, I undertake a joint analysis of the transmission via the bank lending channel, the exporter trade channel, and the borrower credit constraint channel. The joint analysis allows me to draw comparisons across the impacts of different channels exerted to the real outcomes.

I construct the firm-level measures to quantify the last two channels. I quantify the effect of the trade channel by resorting to the detailed segment data from Worldscope. Suppose exporters are able to set prices of tradable goods in the domestic currency, the depreciation against the U.S. dollar will increase their competitiveness in the international market as long as the local-currency prices are sticky at least in the short run.[26] In light of this logic, the trade channel predicts a firm with a larger export revenue share to benefit from exchange rate depreciation. One potential exception in practice is that the bilateral trade transactions between Taiwan and Mainland China might be settled in RMB rather than in U.S. dollars. For each firm, I define $\text{Trade}^{\text{RoW}}_{f,09-13}$ as the sales to the rest of the world (RoW, excluding Mainland China) as a fraction of total sales revenue during 2009-13 in the spirit of Amiti et al. (2014), that is,

$$\text{Trade}^{\text{RoW}}_{f,09-13} = \frac{\sum_{t=09}^{13} \text{Sales}^{\text{RoW}}_t}{\sum_{t=09}^{13} \sum_m \text{Sales}^m_t}$$

where m denotes market in which firm f has positive sales revenue. Similarly, the trade exposure to Mainland China is given by

$$\text{Trade}^{\text{China}}_{f,09-13} = \frac{\sum_{t=09}^{13} \text{Sales}^{\text{China}}_t}{\sum_{t=09}^{13} \sum_m \text{Sales}^m_t}$$

The total export share is written as follows

$$\text{Trade}^{\text{Export}}_{f,09-13} = \frac{\sum_{t=09}^{13} (\text{Sales}^{\text{China}}_t + \text{Sales}^{\text{RoW}}_t)}{\sum_{t=09}^{13} \sum_m \text{Sales}^m_t}$$

To quantify the effect of the borrower credit constraint channel, I calculate firm foreign currency

[26] See Fitzgerald and Haller (2013) , Gopinath et al. (2010), Casas et al. (2016) for discussion of local currency pricing (LCP) and producer currency pricing (PCP).

(FC) indebtedness defined as the amount of USD syndicated loans as a fraction of total loans during 2009-13. I also consider the dummy variable which takes one if a firm borrows in USD syndicates loan during 2009-13.[27]

I add the proxies for two additional channels to the baseline specification and estimate the modified equation:

$$y_{f,t} = \theta \overline{\text{Net USD Exps.}}_f \times \text{Post}_t + \gamma \text{Trade}_f \times \text{Post}_t + \phi \text{FC}_f \times \text{Post}_t + \alpha_f + \overline{B}_{f,t} + Z_{f,t} + \varepsilon_{f,t} \quad (12)$$

Table 13 presents the results of the joint analysis. For each dependent variable, Column (1)-(3) exploit different specifications of the trade channel proxy to take into consideration different currencies in the invoicing of export to Mainland China and the rest of the world. The first finding is that the inclusion of the trade and the credit constraint channel makes little difference to the coefficient estimates of the bank lending channel, which remain negative and statistically significant along all the specifications. Second, I find strong evidence in support of the exporter trade channel. A one-standard-deviation increase in the share of export sales revenue (Column 3) is associated with an increases in debt growth by 10.8 percent, an increases in investment by 2.8 percent, and an increases in sales revenue growth by 3.0 percent, respectively. Third, I find no evidence for the borrower credit constraint channel as the coefficient on firm foreign currency indebtedness is insignificant.[28] Robustness checks using an alternative definition of borrower foreign currency indebtedness and using alternative model specifications also find the borrower credit constraint channel to be negligible in the overall effect of depreciation on firm-level outcomes. The results of these checks are presented in Appendix Table A4.

7 Placebo Test

An important threat to identification is that banks with higher currency risk exposure observed at the end of year 2013 are inherently more cyclical to business cycle fluctuation. In this section, I use

[27] Besides the syndicated loan, I take into account other types of bank loans and corporate bonds that are denominated in foreign currency sourced from Capital IQ. The results are similar.

[28] This finding is in line with Bleakley and Cowan (2008) which shows firms can match their income stream with the currency composition of their debt to achieve a natural hedge. Another potential explanation could be motivated by the observation that most of the syndicated loan covenants are the cash-flow-based constraints rather than contingent on tangible fixed asset as documented by Lian and Ma (2018) and Drechsel (2018). Therefore, the firm's borrowing capacity will not necessarily tighten after the exchange rate depreciation.

the previous round of sharp depreciation in Taiwan during 2005Q2-2009Q1 as a placebo sample. The results of the placebo test support the argument that banks with higher net USD exposure in 2013 are not generally the shock propagator.

To begin, I would like to compare bank currency risk exposure in 2008 with that in 2013. Unfortunately, the information on bank gross USD assets and liabilities have only been available since 2012, which prevents any direct observation of net USD exposure before the financial crisis. As an alternative, I provide two pieces of indirect evidence to justify the argument that the scheme of bank currency risk exposure in 2008 is different from that in 2013. One potential reason bank currency risk pattern shifted is the low-interest-rate environment created by the unconventional policies as implemented by major central banks since the financial crisis. The persistent differentials between the policy rates in emerging markets and the U.S. dollar funding rate in the aftermath of financial crisis has made carry trade a profitable business from the perspective of banks in emerging markets.

7.1 Bank USD Beta

I follow the extensive literature on foreign exchange rate exposure by defining USD Beta as the relationship between excess return of bank stock prices and the change in the exchange rate (Adler and Dumas (1984); Dominguez and Tesar (2006)). Formally, I measure USD Beta for the subsample of publicly traded banks from the following two factor regression specification:

$$R_{b,t} = \alpha_b + \beta_b^M R_{M,t} + \beta_b^{USD} \Delta\xi_t + \varepsilon_{b,t} \tag{13}$$

where $R_{b,t}$ is the weekly return on bank b at time t, $R_{M,t}$ is the weekly return on the market portfolio[29] at time t, and $\Delta\xi_t$ is the weekly depreciation rate at time t. Under this definition, the coefficient β_b^{USD} reflects the change in returns that can be explained by movements in the exchange rate after conditioning on the market return. Hereby, the two-factor model specification distinguishes the direct effect of exchange rate changes and the effects of macroeconomic shocks that simultaneously affect bank equity price and exchange rate. For each publicly listed bank, I estimate USD Beta β_b^{USD} using the two-factor model for two three-year episodes, one is 2006Q2-2009Q1 and

[29] According to Bloomberg, Taiwan Capitalization Weighted Stock Index (TAIEX) is capitalization-weighted index of all listed common shares traded on the Taiwan Stock Exchange.

the other 2012Q1-2014Q4, respectively.

Figure 9 shows the relationship between bank net USD exposure in 2013 and its USD Beta for each episode. First, the scatterplot in the left panel illustrates a negative and significant correlation between bank net USD exposure in 2013 and bank USD beta estimated from the second episode, which suggests that bank equity value is adversely affected by currency risk exposure. Second, the scatterplot on the right panel shows no evidence of correlation between net USD exposure in 2013 and USD Beta estimated from the first episode. In sum, bank net USD exposure in 2013 is consistent with the sensitivity of the contemporaneous equity price to the exchange rate fluctuation, but not for the one during the financial crisis.

7.2 Bank USD Cash Flow

Additionally, I turn to the information on bank net USD cash flow and argue that the scheme of bank net USD exposure had changed drastically since the outbreak of the financial crisis. This information is from the banking bureau and is available for all sample banks since 2006m6. Each quarter, banks report the upcoming USD/TWD inflows and outflows on the remaining days to maturity ranging from 1 month to over 1 year. Bank net USD cash flow (NCF^{USD}) is defined as the difference between total USD outflows and total USD inflows, and is normalized by bank equity. Bank net TWD cash flow (NCF^{TWD}) is defined in a similar way. I compute NCF^{USD} and NCF^{TWD} of all sample banks every six months from 2006m6 to 2013m12. I use NCF^{USD} to draw inferences about bank currency mismatches in their USD position. The intuition is that if a bank is a debtor in USD position, its NCF^{USD} is plausibly negative.

To provide a sense of persistence of bank net cash flows, I regress NCF in 2013m12 on each of the lags that date back to 2006m6, that is,

$$\begin{aligned}\text{NCF}^{\text{USD}}_{b,2013m12} &= \beta_{0,t} + \beta_{1,t}\text{NCF}^{\text{USD}}_{b,t} + e_{b,t} \\ \text{NCF}^{\text{TWD}}_{b,2013m12} &= \gamma_{0,t} + \gamma_{1,t}\text{NCF}^{\text{TWD}}_{b,t} + \epsilon_{b,t}\end{aligned} \tag{14}$$

for t = 2006m6, 2006m12, ..., 2013m6. The coefficient $\beta_{1,t}$ captures the correlation between bank NCF^{USD} in 2013m12 and that in time t, or equivalently, the persistent of NCF^{USD} between period t and 2013m12.

Figure 10 visualizes the persistence of net cash flows. As shown in the right panel, NCF^{TWD} is highly persistent. The NCF^{TWD} observed in 2013m12 is significantly correlated with all the lagged values. In contrast, NCF^{USD} is far less persistent according to the left panel. The value of NCF^{USD} in 2013m12 cannot be strongly predicted by any of its lags before 2009m12. Interestingly, the correlation of NCF^{USD} became strong and significant after the financial crisis.

To sum up, the evidence provided by bank net USD cash flow and by bank equity return as noted in the previous section both suggest that bank currency risk exposure has changed dramatically since the financial crisis. Therefore, it is unlikely that bank net USD exposure in 2008 would strongly predict the exposure in 2013 even though bank foreign currency assets and liabilities cannot be directly observed before the financial crisis due to data limitation,

7.3 Placebo Test Results

The effect of bank currency risk exposure on loan supply and firm-level outcomes during the placebo period can serve as a specification check on the validity of the bank health measure. Table 14 reports the results of a placebo test using the previous round of depreciation during the 2007-08 financial crisis.

Panel A and B of Table 14 present the results of loan-level placebo regressions by the same estimation procedure performed in Table 4 and Table 5 respectively. The placebo period for the loan-level regressions is a four-year episode ranging from 2005Q2 to 2009Q1. The loan-level regressions in the placebo test use the same sample as that of Table 4, and assign the same net USD exposure to each bank. Thus, the only two differences in specification are the period covered by the dependent variable and the definition of Post, which is set to be one if the time is between 2008Q2-2009Q1 and zero otherwise. Recall the evidence in the previous parts of this section that the scheme of bank currency risk exposure in 2008 has no predictive power for the exposure in 2013. A finding of a negative relationship between bank currency risk exposure and loan supply during the financial crisis would raise the concern that the lenders classified as the treated banks in 2013 are generally more susceptible to business cycle fluctuation, regardless of their currency risk exposure. However, both panels find no significant effect of currency risk exposure on bank credit supply after the depreciation in this placebo period.

Panel C and D of Table 14 present the results of the firm-level placebo regressions estimated by the same procedure in Table 12. The placebo period for firm-level regression is during 2005-2008. The firm-level regressions in the placebo test use the same sample as that in Table 12, and assign the same dependence on the highly mismatched banks to each borrower. The dependent variables are debt growth and investment in the placebo period. The definition of Post is slightly changed, and is set to be one for year 2008 and zero otherwise.[30] The estimate in four of five columns of panels C and D are statistically insignificant, ruling out the thread to my identification strategy that bank with higher net USD exposure in 2013 might be the shock propagator in general.

8 External Validity and Evidence from Emerging Markets

In this section, I assess the external validity of the credit supply channel of exchange rate transmission using bank panel data for a group of emerging markets as evidence.[31] The model specification is given by the following specification:

$$\begin{aligned} y_{b,m,t} = & \beta_1 \text{Net USD Expo.}_b + \beta_2 \Delta\xi_{m,t} + \beta_3 \text{Net USD Expo.}_b \times \Delta\xi_{m,t} \\ & + \gamma Z_b \times \Delta\xi_{m,t} + \alpha_b + \alpha_{m,t} + \varepsilon_{b,m,t} \end{aligned} \tag{15}$$

where Net USD Exposure$_b$ is the continuous variable that represents the currency mismatch of bank b in year 2013, $\Delta\xi_{m,t}$ is exchange rate depreciation in emerging market m in year t, and the interaction term is supposed to capture the equity loss (gain if negative) associated with currency risk exposure. The dependent variables investigated in this section are bank loan growth rate and net revenue growth rate.[32]

Table 15 presents the results. Panel A studies bank loan growth rate. I progressively saturate the model with time fixed effects, bank fixed effects and emerging market×time fixed effects. The inclusion of EM×time fixed effects reduces the scale of coefficient estimate β_3 by half as compared with that in Column (2). The downward bias in Column (2) is likely to be driven by the fact that credit demand shock in emerging market tends to be negatively correlated with the choice of

[30] Fiscal year of a company in Taiwan conventionally ends in December.

[31] The panel is at bank-year level with the time frame of 2012-2017. Banks considered in this section have non-missing Net USD Exposure in 2013, and are located in the emerging market economies whose domestic currencies are not pegged to the U.S. dollar. I also exclude the emerging market economies with less than five banks in the sample. The results are not sensitive to the last requirement. The sample selection delivers 753 banks from 54 emerging markets in total. Data source for this panel is BankFocus.

[32] One caveat is that BankFocus does not provide information on banks using derivatives for currency risk hedging.

exchange rate depreciation by its monetary authority. Column (3) suggests that a one-standard deviation increase in Net USD Exposure is associated with approximately 0.5-percent drop in loan growth rate when confronted with a depreciation shock of 10 percentage points. Column (4)-(7) control for other bank characteristics that are presumably pertinent to bank lending outcomes, including leverage ratio, liquidity ratio, the reliance on wholesale funding market, and non-performing loan ratio (NPL). The coefficient estimates in all the specifications are negative and significant.

Panel B in Table 15 explores the effect on bank net revenue growth. I replicate the estimation procedure in the previous panel. Column (3) suggests that a one-standard-deviation increase in Net USD Exposure is associated with a 1-percent reduction in bank net revenue growth rate given the same depreciation shock of 10 percentage points. Column (4)-(7) show that the coefficient estimate of bank currency risk exposure is robust to the inclusion of other bank characteristics.

It is worth noting that bank net USD exposure could not explain either dependent variables of banks in advanced economies, which also experienced noticeable scale depreciation after the tapering talk. One potential explanation could be that the derivative markets in advanced economies feature less frictions, and hereby allow for more intensive use of derivatives for currency risk hedging. Meanwhile hedging in emerging markets is costly due to the lack of innovation, products, and liquidity. In sum, I find consistent evidence that bank currency risk exposure is economically and statistically important in explaining bank operation and lending outcomes for a wide-range of emerging markets.

9 Conclusion

In this paper, I provide new evidence that bank currency mismatch acts as a strong contractionary channel during times of exchange rate depreciation. I trace the effect of an unexpected and external shock following the "tapering talk" by the U.S. Fed, that led to a large-scale depreciation in a typical small open economy Taiwan. Instead of focusing on an increasing demand for export goods or the inflated value of firm's foreign currency debt following the depreciation, I focus on the bank currency mismatch and the subsequent impact on bank credit supply upon depreciation. Exploiting the cross-sectional variation in bank currency risk exposure, I find that the depreciation led banks with higher currency risk to cut their credit supply by a disproportionately large amount, and also to reduce by a significant margin the likelihood they would renew past loans. Relying on the heterogeneity in firms' dependence on banks with different currency risks, I show that the credit supply shock triggered by the depreciation spilled over to the real sector, and generated economically and statistically significant impacts on firm's propensity to invest and hire—a one-standard-deviation increase in firm's dependence on highly mismatched banks is associated with a 3% decrease in investment and a 2% reduction in employment. Thus, the findings of this paper suggest that the bank lending channel plays a crucial role in the transmission of exchange rate fluctuation to the real economy.

References

Acharya, V. V., T. Eisert, C. Eufinger, and C. Hirsch (2018). Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans. *The Review of Financial Studies 31*(8), 2855–2896.

Adler, M. and B. Dumas (1984). Exposure to currency risk: definition and measurement. *Financial management*, 41–50.

Aguiar, M. (2005). Investment, devaluation, and foreign currency exposure: The case of Mexico. *Journal of Development Economics 78*(1), 95–113.

Aizenman, J., M. Binici, and M. M. Hutchison (2014). The transmission of Federal Reserve tapering news to emerging financial markets. National Bureau of Economic Research, No. w19980.

Amiti, M., O. Itskhoki, and J. Konings (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review 104*(7), 1942–78.

Amiti, M. and D. E. Weinstein (2018). How much do idiosyncratic bank shocks affect investment? evidence from matched bank-firm loan data. *Journal of Political Economy 126*(2), 525–587.

Avdjiev, S., W. Du, C. Koch, and H. S. Shin (2019). The dollar, bank leverage, and deviations from covered interest parity. *American Economic Review: Insights 1*(2), 193–208.

Avdjiev, S. and E. Takáts (2014). Cross-border bank lending during the taper tantrum: the role of emerging market fundamentals. *BIS Quarterly Review September*.

Berman, N., P. Martin, and T. Mayer (2012). How do different exporters react to exchange rate changes? *The Quarterly Journal of Economics 127*(1), 437–492.

Bleakley, H. and K. Cowan (2008). Corporate dollar debt and depreciations: much ado about nothing? *The Review of Economics and Statistics 90*(4), 612–626.

Bräuning, F. and V. Ivashina (2019). US monetary policy and emerging market credit cycles. *Journal of Monetary Economics*.

Bruno, V. and H. S. Shin (2014). Cross-border banking and global liquidity. *The Review of Economic Studies 82*(2), 535–564.

Bruno, V. and H. S. Shin (2015). Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics 71*, 119–132.

Buch, C. M., M. Bussiere, L. Goldberg, and R. Hills (2019). The international transmission of monetary policy. *Journal of International Money and Finance 91*, 29–48.

Calvo, G. A., A. Izquierdo, and L.-F. Mejía (2008). Systemic sudden stops: the relevance of balance-sheet effects and financial integration. National Bureau of Economic Research, No. w14026.

Calvo, G. A., L. Leiderman, and C. M. Reinhart (1996). Inflows of capital to developing countries in the 1990s. *Journal of Economic Perspectives 10*(2), 123–139.

Casas, C., F. J. Díez, G. Gopinath, and P.-O. Gourinchas (2016). Dominant currency paradigm. National Bureau of Economic Research, No. w22943.

Cerutti, E., C. Koch, and S.-K. Pradhan (2018). The growing footprint of EME banks in the international banking system. *BIS Quarterly Review December*.

Cetorelli, N. and L. S. Goldberg (2011). Global banks and international shock transmission: Evidence from the crisis. *IMF Economic Review 59*(1), 41–76.

Chang, B., M. Gomez, and H. Hong (2019). Sorting out the real effects of credit supply. *Manuscript*.

Chari, A., K. D. Stedman, and C. Lundblad (2017). Taper tantrums: QE, its aftermath and emerging market capital flows. National Bureau of Economic Research, No. w23474.

Chodorow-Reich, G. (2013). The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis. *The Quarterly Journal of Economics 129*(1), 1–59.

De Haas, R. and N. Van Horen (2013). Running for the exit? International bank lending during a financial crisis. *The Review of Financial Studies 26*(1), 244–285.

Devereux, M. B. and C. Engel (2003). Monetary policy in the open economy revisited: Price setting and exchange-rate flexibility. *The Review of Economic Studies 70*(4), 765–783.

Dominguez, K. M. and L. L. Tesar (2006). Exchange rate exposure. *Journal of international Economics 68*(1), 188–218.

Drechsel, T. (2018). Earnings-based borrowing constraints and macroeconomic fluctuations. *Working Paper*.

Du, W. and J. Schreger (2016). Sovereign risk, currency risk, and corporate balance sheets. *Harvard Business School BGIE Unit Working Paper* (17-024).

Du, W., A. Tepper, and A. Verdelhan (2018). Deviations from covered interest rate parity. *The Journal of Finance 73*(3), 915–957.

Eichengreen, B. and P. Gupta (2015). Tapering talk: The impact of expectations of reduced federal reserve security purchases on emerging markets. *Emerging Markets Review 25*(1), 1–15.

Ekholm, K., A. Moxnes, and K. H. Ulltveit-Moe (2012). Manufacturing restructuring and the role of real exchange rate shocks. *Journal of International Economics 86*(1), 101–117.

Engel, C. (2006). Equivalence results for optimal pass-through, optimal indexing to exchange rates, and optimal choice of currency for export pricing. *Journal of the European Economic Association 4*(6), 1249–1260.

Engel, C. (2010). Exchange rate policies: A Federal Reserve Bank of Dallas staff paper. DIANE Publishing, 2010.

Fitzgerald, D. and S. Haller (2013). Pricing-to-market: evidence from plant-level prices. *Review of Economic Studies 81*(2), 761–786.

Forbes, K. J. (2004). The Asian flu and Russian virus: the international transmission of crises in firm-level data. *Journal of International Economics 63*(1), 59–92.

Forbes, K. J. and F. E. Warnock (2012). Capital flow waves: Surges, stops, flight, and retrenchment.

Journal of International Economics 88(2), 235–251.

Gambacorta, L. and P. E. Mistrulli (2004). Does bank capital affect lending behavior? *Journal of Financial Intermediation 13*(4), 436–457.

Giannetti, M. and L. Laeven (2012). The flight home effect: Evidence from the syndicated loan market during financial crises. *Journal of Financial Economics 104*(1), 23–43.

Giovanni, J. d., S. Kalemli-Ozcan, M. F. Ulu, and Y. S. Baskaya (2017). International spillovers and local credit cycles. National Bureau of Economic Research, No. w23149.

Gomez, M., A. Landier, D. A. Sraer, and D. Thesmar (2019). Banks' exposure to interest rate risk and the transmission of monetary policy. *Available at SSRN 2220360*.

Gonzalez, R. B., D. Khametshin, J.-L. Peydró, and A. Polo (2019). Hedger of last resort: evidence from Brazilian FX interventions, local credit, and global financial cycles. *CEPR Discussion Paper No. DP12817*.

Gopinath, G., E. Boz, C. Casas, F. Diez, P.-O. Gourinchas, and M. Plagborg-Møller (2019). Dominant currency paradigm. *NBER Working Paper 22943*.

Gopinath, G., O. Itskhoki, and R. Rigobon (2010). Currency choice and exchange rate pass-through. *American Economic Review 100*(1), 304–36.

Gourinchas, P.-O. (1999). Exchange rates do matter: French job reallocation and exchange rate turbulence, 1984–1992. *European Economic Review 43*(7), 1279–1316.

Huber, K. (2018). Disentangling the effects of a banking crisis: evidence from German firms and counties. *American Economic Review 108*(3), 868–98.

Ivashina, V., D. S. Scharfstein, and J. C. Stein (2015). Dollar funding and the lending behavior of global banks. *The Quarterly Journal of Economics 130*(3), 1241–1281.

Jiménez, G., A. Mian, J.-L. Peydró, and J. Saurina (2019). The real effects of the bank lending channel. *Journal of Monetary Economics*. June 2019.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2012). Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review 102*(5), 2301–26.

Kalemli-Ozcan, S. (2019). US monetary policy and international risk spillovers. National Bureau of Economic Research, No. w26297.

Kalemli-Ozcan, S., H. Kamil, and C. Villegas-Sanchez (2016). What hinders investment in the aftermath of financial crises: Insolvent firms or illiquid banks? *Review of Economics and Statistics 98*(4), 756–769.

Kalemli-Ozcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas (2015). How to construct nationally representative firm level data from the ORBIS global database. National Bureau of Economic Research, No. w21558.

Kashyap, A. K. and J. C. Stein (1995). The impact of monetary policy on bank balance sheets.

Carnegie-Rochester Conference Series on Public Policy 42, 151–195.

Kashyap, A. K. and J. C. Stein (2000). What do a million observations on banks say about the transmission of monetary policy? *American Economic Review 90*(3), 407–428.

Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review 98*(4), 1413–42.

Kim, Y. J., L. L. Tesar, and J. Zhang (2015). The impact of foreign liabilities on small firms: Firm-level evidence from the Korean crisis. *Journal of International Economics 97*(2), 209–230.

Lian, C. and Y. Ma (2018). Anatomy of corporate borrowing constraints. *Working paper*.

McCauley, R. N. and C. Shu (2016). Non-deliverable forwards: impact of currency internationalisation and derivatives reform. *BIS Quarterly Review December*.

Mishra, P., K. Moriyama, P. M. N'Diaye, and L. Nguyen (2014). Impact of fed tapering announcements on emerging markets. International Monetary Fund, 2014 June.

Rampini, A. A., S. Viswanathan, and G. Vuillemey (2019). Risk management in financial institutions. *Journal of Finance*. forthcoming.

Rey, H. (2016). International channels of transmission of monetary policy and the mundellian trilemma. *IMF Economic Review 64*(1), 6–35.

Salomao, J. and L. Varela (2018). Exchange rate exposure and firm dynamics. *Working Paper*.

Schnabl, P. (2012). The international transmission of bank liquidity shocks: Evidence from an emerging market. *The Journal of Finance 67*(3), 897–932.

Tille, C. and S. Krogstrup (2018). Foreign currency bank funding and global factors. International Monetary Fund, May 2018.

Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the mexican manufacturing sector. *The Quarterly Journal of Economics 123*(2), 489–530.

Verner, E. and G. Gyongyosi (2018). Household debt revaluation and the real economy: Evidence from a foreign currency debt crisis. *Working Paper*.

Table 1: Summary Statistics: Banks Balance Sheet

	Min	Median	Mean	Max	S.D.
Net USD Exposure (% Equity)	-0.484	-0.012	0.019	0.457	0.230
Size: ln(Asset)	14.877	16.878	16.691	18.447	1.087
Return on assets	0.170	0.650	0.707	2.030	0.415
Return on equity	2.950	10.030	9.997	19.210	4.044
Tier 1 capital ratio	6.120	9.010	9.456	13.670	1.940
Leverage ratio	88.640	93.490	93.059	95.680	1.974
Liquidity ratio	6.360	21.935	20.820	68.700	12.934
Loan loss reserve (% Gross loans)	0.880	1.240	1.300	2.080	0.250
Impaired loans (% Gross loans)	0.550	1.960	2.062	4.660	0.916
Gross loans (% Asset)	29.350	62.090	60.973	74.510	9.112
Wholesale funding (% Total funding)	1.320	10.285	14.930	100.000	19.732
Gross USD Asset (% Equity)	0.004	1.640	1.994	5.424	1.300
Gross USD Debt (% Equity)	0.000	1.738	2.013	5.147	1.288
Real estate exposure	0.000	0.054	0.098	0.580	0.117

This table reports the summary statistics of the main variables that will be used in the equation 1. Net USD Exposure is defined as the difference between bank gross USD liabilities and gross USD assets, and thus scaled by bank total equity. It represents the treatment effect of depreciation on bank. All bank balance sheet variables have been measured as of December 2013.

Table 2: Bank Risk Management and Derivative Usage

	p1	p10	p25	p50	p75	p90	p95	p99
Gross FX hedg.	0.000	0.000	0.000	0.000	0.000	0.000	0.078	0.324
Gross IR hedg.	0.000	0.000	0.000	0.000	0.035	0.210	0.482	1.332
Gross FX trad.	0.000	0.000	0.099	1.394	6.259	17.296	25.703	39.186
Gross IR trad.	0.000	0.000	0.062	0.553	3.733	9.725	16.013	32.722

This table provides descriptive statistics on the use of derivative for the purpose of hedging and trading. Data is at bank's ultimate parent level. Gross FX (IR) hedging is defined as total gross notional amount of foreign exchange rate (interest rate) derivatives held for purposes other than trading over bank total equity. Gross FX (IR) trading is total gross notional amount of foreign exchange rate (interest rate) derivatives held for trading over bank total equity. Winsorization is at the 99th percentile. Time frame: 2006Q1 - 2018Q4

Table 3: Currency Risk Exposure and Balance on Bank Observable

Right-hand-size variable	Estimate	S.E.	p-value
Size: ln(Asset)	0.055	0.039	0.166
Return on assets	-0.112	0.102	0.282
Return on equity	-0.013	0.010	0.237
Tier 1 capital ratio	-0.017	0.022	0.437
Leverage ratio	0.016	0.022	0.455
Liquidity ratio	-0.002	0.003	0.628
Loan loss reserve (% Gross loans)	0.096	0.179	0.597
Impaired loans (% Gross loans)	0.025	0.049	0.614
Gross loans (% Asset)	0.001	0.005	0.839
Wholesale funding (% Total funding)	0.000	0.002	0.991
Gross USD Asset (% Equity)	-0.025	0.033	0.463
Gross USD Debt (% Equity)	0.007	0.034	0.843
Real estate exposure	-0.376	0.377	0.327

This table presents coefficients from a series of univariate regressions that regress the treatment variable Net USD Exposure against a set of bank observable characteristics (see equation 1):

$$\text{Net USD Exposure}_{b,2013} = \alpha + \beta X_{b,2013} + \varepsilon_b$$

Size is log of total assets of a bank. Tier 1 capital ratio is the ratio of a bank's core tier 1 capital—that is, its equity capital and disclosed reserves—to its total risk-weighted assets. Leverage ratio is the the ratio of a bank's total liabilities to its total assets. Liquidity ratio is the ratio of a bank's liquid asset to its deposit and short-turn funding. Standard errors and p-values are displayed in the second and the third column respectively. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Effect of Depreciation on Credit Supply at the Intensive Margin

	Loan Supply				
	(1)	(2)	(3)	(4)	(5)
Net USD Exps. $\times$ $\Delta\xi$	-0.144	-0.611**	-0.599***	-0.580**	-0.584**
	(-0.59)	(-2.41)	(-3.30)	(-2.29)	(-2.22)
R^2	0.787	0.814	0.910	0.957	0.957
N	3702	2290	1376	1356	1356
Time FE	Y	Y	Y		
Bank FE	Y	Y			
Firm FE	Y	Y			
Relation Controls		Y			
Firm-Bank FE			Y	Y	Y
Firm-Time FE				Y	Y
Main Sector-Time FE					Y

This table presents the regression results regarding the effect of depreciation on the size of loan origination by estimating the equation 2:

$$log(L_{b,f,t}) = \beta \text{Net USD Exposure}_b \times \Delta\xi + \alpha_{b,f} + \alpha_{f,t} + \varepsilon_{b,f,t}$$

The dependent variable is the log amount of all syndicated loan granted by bank b to firm f in year t. Net USD Exposure is the continuous variable that measures bank currency mismatch prior to the depreciation. $\Delta\xi$ is the annual depreciation rate. This first column shows the estimate by the model specification with time fixed effects, bank fixed effects and firm fixed effects. Additional terms are progressively added. The second column adds bank-firm relationship controls. The third column adds bank$\times$firm fixed effects while bank-firm relationship controls are dropped due to the collinearity with bank$\times$firm fixed effects. The fourth column adds firmtime fixed effects while time fixed effects are dropped due to the collinearity with the former. The fifth column adds main sector$\times$time fixed effects to control for the sector-specific factor that a bank is exposed to. The bank-firm relationship controls are (1) the first year when the relationship is established in the syndicated loan market, (2) the last year when the firm is observed to borrow from the bank before the depreciation episode and (3) the percentage of credit that a firm receives from a bank before the depreciation episode. Standard errors are the two-way clustered at bank and firm level. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Credit Supply at the Intensive Margin, Categorical Specification

	Loan Supply				
	(1)	(2)	(3)	(4)	(5)
High Net USD Exps. × Post	-0.0753	-0.148***	-0.0900*	-0.108**	-0.109**
	(-1.45)	(-2.81)	(-1.88)	(-2.15)	(-2.15)
R^2	0.787	0.815	0.910	0.957	0.957
N	3702	2290	1376	1356	1356
Time FE	Y	Y	Y		
Bank FE	Y	Y			
Firm FE	Y	Y			
Relation Controls		Y			
Firm-Bank FE			Y	Y	Y
Firm-Time FE				Y	Y
Main Sector-Time FE					Y

This table presents the regression results regarding the effect of depreciation on the size of loan origination by estimating the equation:

$$log(L_{b,f,t}) = \beta \text{High Net USD Exposure}_b \times \text{Post}_t + \alpha_{b,f} + \alpha_{f,t} + \varepsilon_{b,f,t}$$

The dependent variable is the log amount of all syndicated loan granted by bank b to firm f in year t. High Net USD Exposure is the dummy variable that is set to be one for treated banks, and zero for control banks. Post is set to be one if year is either 2014 or 2015. This first column shows the estimate with only time fixed effects, bank fixed effects and time fixed effects. The second column adds bank-firm relationship controls. The third column adds bank×firm fixed effects while bank-firm relationship controls are dropped due to the collinearity with the former. The fourth column adds firm×time fixed effects while time fixed effects are dropped due to the collinearity with the former. The fifth column adds main sector×time fixed effects to control for the sector-specific factor that a bank is exposed to. The bank-firm relationship controls are (1) the first year when the relationship is established in the syndicated loan market, (2) the last year when the firm is observed to borrow from the bank before the depreciation episode and (3) the percentage of credit that a firm receives from a bank before the depreciation episode. Standard errors are the two-way clustered at bank and firm level. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Credit Supply at the Intensive Margin, Other Bank Control Variable

	Loan Supply				
	(1) Baseline	(2) Tier 1	(3) Leverage	(4) Liquidity	(5) All
Net USD Exps. × $\Delta\xi$	-0.584**	-0.581**	-0.553**	-0.666**	-0.565**
	(-2.22)	(-2.23)	(-2.18)	(-2.65)	(-2.38)
Control × $\Delta\xi$		0.0785	0.334	-0.894*	
		(0.23)	(0.78)	(-1.82)	
R^2	0.957	0.957	0.957	0.957	0.957
N	1356	1356	1356	1356	1356
Firm-Bank FE	Y	Y	Y	Y	Y
Firm-Time FE	Y	Y	Y	Y	Y
Main Sector-Time FE	Y	Y	Y	Y	Y

This table presents the regression results that are related to the intensive margin analysis and allow for the interaction terms of depreciation rate with conventional bank health indicators. Control is the bank characteristic indicated in the column heading, including tier 1 capital ratio, leverage ratio, and liquidity ratio. In the fifth column, all three interaction terms are added all together. Standard errors are the two-way clustered at bank and firm level. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Credit Supply at the Intensive Margin, Local Currency Loan

	Loan Supply (TWD Loan)				
	(1)	(2)	(3)	(4)	(5)
Net USD Exps. × $\Delta\xi$	-0.0464	-0.379*	-0.334***	-0.453**	-0.468**
	(-0.21)	(-1.83)	(-2.88)	(-2.08)	(-2.09)
R^2	0.801	0.833	0.914	0.961	0.961
N	3446	2133	1269	1255	1255
Time FE	Y	Y	Y		
Bank FE	Y	Y			
Firm FE	Y	Y			
Relation Controls		Y			
Firm-Bank FE			Y	Y	Y
Firm-Time FE				Y	Y
Main Sector-Time FE					Y

This table presents the regression results that are related to the intensive margin analysis. The sample is restricted to the syndicated loans denominated in the domestic currency (TWD) only. Standard errors are the two-way clustered at bank and firm level. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: Effect of Depreciation on Credit Supply at the Extensive Margin

	Bank chosen as lead			Bank chosen as participant		
	(1)	(2)	(3)	(4)	(5)	(6)
Previous lead	0.375***	0.337***	0.290***	0.108***	0.103***	0.102***
	(15.36)	(13.61)	(8.56)	(6.16)	(5.87)	(5.79)
Previous participant	0.0626***	0.0527***	0.0524***	0.295***	0.261***	0.253***
	(4.49)	(4.19)	(4.19)	(10.11)	(8.71)	(6.54)
Pre. lead × High Net USD Exp. × Post			-0.159***			
			(-2.72)			
Pre. ptcp. × High Net USD Exp. × Post						-0.0172
						(-0.27)
R^2	0.286	0.432	0.433	0.165	0.321	0.321
N	9884	9884	9884	9884	9884	9884
Bank FE	Y			Y		
Time-Bank FE		Y	Y		Y	Y
Time-Firm FE		Y	Y		Y	Y
2-digit NACE × Bank FE		Y	Y		Y	Y
City × Bank FE		Y	Y		Y	Y
Public/private × Bank FE		Y	Y		Y	Y
All in drawn quartile × Bank FE		Y	Y		Y	Y
Pre. lead/ptcp. × Post			Y			Y
Pre. lead/ptcp. × High Net USD Exps.			Y			Y

This table presents the coefficients from the regression related to loan-level extensive margin. Model specification for Column (3) is described in equation 5:

$$\text{Lead}_{f,b,t} = \rho_0 \text{Lead}_{f,b,t-1} + \rho_1 \text{Lead}_{f,b,t-1} \times \text{Post}_t + \rho_2 \text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b$$
$$+ \rho_3 \text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \times \text{Post}_t + \alpha_{b,t} + \alpha_{f,t} + Z_{b,f} + \varepsilon_{b,f,t}$$

The dependent variable is an indicator for whether bank b serves in the role in the table header for firm f in time t. For each loan in which a borrower has accessed the syndicated loan market, the data set contains one observation for each potential lender and each year. The independent variable Previous Lead and Previous Participant equal 1 if bank b served as the lead or as a participant on the firm f's previous loan up to year $t-1$, respectively. High Net USD Exposure is the dummy variable that is set to be one for treated banks, and zero for control banks. Post is set to be one if year is either 2014 or 2015. Level of standard error clustering is firm. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Credit Supply at the Extensive Margin, Other Bank Control Variable

	Bank chosen as lead			
	Baseline	Tier 1	Leverage	Liquidity
	(1)	(2)	(3)	(4)
Previous lead	0.290***	0.293***	0.290***	0.287***
	(8.56)	(7.59)	(7.15)	(8.23)
Previous participant	0.0524***	0.0528***	0.0527***	0.0524***
	(4.19)	(4.22)	(4.22)	(4.18)
Pre. lead × High Net USD Exp. × Post	-0.159***	-0.160***	-0.182***	-0.158***
	(-2.72)	(-2.75)	(-2.96)	(-2.74)
Pre. lead × Control × Post		-0.0181	-0.0617	0.00939
		(-0.32)	(-1.09)	(0.16)
R^2	0.433	0.433	0.433	0.433
N	9884	9884	9884	9884
Time-Bank FE	Y	Y	Y	Y
Time-Firm FE	Y	Y	Y	Y
2-digit NACE × Bank FE	Y	Y	Y	Y
City × Bank FE	Y	Y	Y	Y
Public/private × Bank FE	Y	Y	Y	Y
All in drawn quartile × Bank FE	Y	Y	Y	Y
Previous lead × Post	Y	Y	Y	Y
Previous lead × High Net USD Exps.	Y	Y	Y	Y
Previous lead × Control		Y	Y	Y

This table presents the regression results that are related to the extensive margin analysis and allow for the interaction terms of time dummy with conventional bank health indicators. Control is the bank characteristic indicated in the column heading, including tier 1 capital ratio, leverage ratio, and liquidity ratio. Level of standard error clustering is firm. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 10: Summary Statistics and Balance on Firm Observable

	Treated Group		Control Group		T Test	
	Mean	Std. Dev.	Mean	Std. Dev.	diff.	p-value
Panel A: Firm Characteristics						
Size ln(Asset)	20.191	1.568	19.769	1.472	0.422**	(0.010)
All-in-Drawn Spread	91.401	34.970	106.793	41.528	-15.393***	(0.000)
Leverage Ratio	0.581	0.230	0.549	0.160	0.032	(0.127)
Current Ratio	1.688	1.067	1.596	0.726	0.092	(0.349)
Liquidity Ratio	1.247	1.026	1.141	0.607	0.106	(0.243)
Interest Coverage	17.586	84.827	9.948	50.625	7.638	(0.316)
Tangibility (% Asset)	38.285	20.422	35.088	20.467	3.197	(0.145)
Borrow USD Loan	0.309	0.463	0.339	0.475	-0.031	(0.544)
USD Loan (% Total Loan)	0.145	0.288	0.174	0.311	-0.029	(0.366)
Loan with Flow-type Covenant (% Total Loan)	0.798	0.357	0.732	0.399	0.066	(0.105)
Sales to Mainland China (% Total Revenue)	0.365	0.446	0.356	0.430	0.009	(0.854)
Sales to RoW (% Total Revenue)	0.385	0.445	0.424	0.459	-0.039	(0.450)
Panel B: Dependent Variables						
Debt Growth	-0.040	0.811	-0.061	0.723	0.021	(0.802)
Investment	0.014	0.217	-0.021	0.232	0.035	(0.150)
Employment	-0.008	0.153	-0.026	0.157	0.018	(0.297)
Mean tangible fixed asset change in						
Borrower's Sector, 13-15	0.060	0.125	0.054	0.101	0.006	(0.631)
Borrower's City, 13-15	-0.059	0.349	-0.032	0.348	-0.027	(0.495)
Mean employment change in						
Borrower's Sector, 13-15	0.026	0.069	0.022	0.062	0.004	(0.581)
Borrower's City, 13-15	-0.019	0.223	-0.003	0.276	-0.016	(0.562)
Observations	175		174		349	

This table reports the summary statistics of firm characteristics and the dependent variables that will be used in the equation 9. Firm is labeled as the treated (control) if its dependence on the highly mismatched banks are above (below) the sample median. Size is log of firm total assets. All-in-drawn spread is the median of loan spread over benchmark rate (e.g. LIBOR or TIBOR) of syndicated loans made to firm f during 2009-13. The variable Borrow USD Loan is an indicator that is set to be one if firm f has borrowed in U.S. dollar during 2009-13, and zero otherwise. The variable USD Loan is the share of loan denominated in USD during 2009-2013. Sales to Mainland China and Sales to the Rest-of-the-World (RoW) are the shares of sales revenue from the two corresponding regions during 2009-13, respectively. The variable Investment is the annual log change of tangible fixed assets. The variable Employment is the annual log change of number of employees.

Table 11: Test of Bank-Firm Sorting on Firm Observable

	Second Bank Observable		
	(1)	(2)	(3)
Panel A: Lending Growth			
First Bank Observable	-0.0325	-0.0296	-0.0304
	(-1.02)	(-0.90)	(-0.86)
Borrower Loan Spread		-0.0179*	-0.0106
		(-1.80)	(-0.96)
Panel B: Bank Size			
First Bank Observable	-0.0114	-0.0390	-0.0464
	(-0.24)	(-0.81)	(-0.82)
Borrower Loan Spread		-0.305***	-0.283***
		(-5.13)	(-4.45)
Panel C: Tier 1 Capital Ratio			
First Bank Observable	-0.0243	-0.0178	-0.00925
	(-0.68)	(-0.48)	(-0.22)
Borrower Loan Spread		0.0360	0.0459
		(0.80)	(0.93)
Panel D: Leverage Ratio			
First Bank Observable	-0.0103	-0.00854	0.00141
	(-0.27)	(-0.21)	(0.03)
Borrower Loan Spread		0.0171	0.0170
		(0.42)	(0.38)
Panel E: Liquidity Ratio			
First Bank Observable	-0.0656*	-0.0561	-0.0609
	(-1.73)	(-1.42)	(-1.36)
Borrower Loan Spread		0.0366	0.00241
		(0.83)	(0.05)
N	871	817	817
Additional Firm Controls	N	N	Y

This table presents the regression results that test the sorting on firm unobservable by equation 8:

$$\delta_{f,firstbank} = \alpha + \beta\delta_{f,secondbank} + Z_f + \varepsilon_f$$

where f denotes a borrower, δ is bank lending growth from 2013-15 (Panel A), bank size (Panel B), tier 1 capital ratio (Panel C), leverage ratio (Panel D) and liquidity ratio (Panel E), respectively. Column (2) includes the median of all-in-drawn loan spread of loans received by firm. Column (3) includes firm's industry fixed effects and firm size measured by the log of total asset. Firm f's first bank and second bank are determined by share of loans received by the firm during 2009-13. t-statistics are in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 12: Credit Supply Effect on Firm-level Outcomes

Panel A	Debt Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$	-0.0355***	-0.106***	-0.113***	-0.107**	-0.118***
	(-2.71)	(-2.76)	(-2.60)	(-2.53)	(-2.76)
R^2	0.00395	0.189	0.264	0.271	0.283
N	1363	1363	1310	1310	1310
Panel B	Investment				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$	-0.0139***	-0.0189**	-0.0260***	-0.0278***	-0.0312***
	(-3.60)	(-2.05)	(-2.79)	(-2.73)	(-2.77)
R^2	0.00968	0.435	0.498	0.502	0.515
N	1366	1366	1313	1313	1313
Panel C	Employment Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$	0.000549	-0.0132*	-0.0196**	-0.0184**	-0.0190**
	(0.17)	(-1.78)	(-2.27)	(-2.07)	(-2.12)
R^2	0.0000209	0.391	0.456	0.461	0.478
N	1290	1290	1235	1235	1235
Panel D	Sales Revenue Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$	-0.0155***	-0.0226**	-0.0284**	-0.0277**	-0.0263**
	(-3.66)	(-2.14)	(-2.36)	(-2.19)	(-1.98)
R^2	0.00818	0.335	0.415	0.425	0.435
N	1363	1363	1310	1310	1310
Time FE		Y			
Firm FE		Y	Y	Y	Y
City-Time FE			Y	Y	Y
Sector-Time FE			Y	Y	Y
$\overline{\text{Bank Controls}}$ × Time				Y	Y
Firm Controls × Time					Y

This table presents the coefficients from regression related to the credit-supply effect of depreciation on firm-level outcomes estimated by equation 9:

$$y_{f,t} = \theta\overline{NetUSDExps}_f \times \text{Post}_t + \alpha_f + \overline{B}_{f,t} + Z_{f,t} + \varepsilon_{f,t}$$

The dependent variable Debt Growth is annual log change of total debt, Investment is annual log change of tangible fixed asset, Employment growth is annual log change of number of employees, and Sales Revenue Growth is annual log change of total sales revenue. $\overline{NetUSDExps}_f$ is firm's dependence on the highly mismatched banks defined by equation 7. Post is set to be one if year is either 2014 or 2015. City is firm geographic location. Sector is firm primary 2-digit NACE number. $\overline{\text{Bank Control}}$ are indirect measures of bank tier 1 capital ratio, leverage ratio, and liquidity ratio. Firm controls include borrower interest coverage bin, leverage bin, profit margin bin, bond market access bin, size bin and loan spread bin fixed effects. Bank and firm controls are all interacted with year and are all observed before the depreciation episode. Level of standard error clustering is firm. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13: Effect of Depreciation via Trade Channel and Borrower Credit Constraint Channel

Panel A	Debt Growth			Investment		
	(1)	(2)	(3)	(1)	(2)	(3)
Post × $\overline{NetUSDExps}$	-0.100**	-0.100**	-0.101**	-0.0273**	-0.0273**	-0.0275**
	(-2.25)	(-2.27)	(-2.28)	(-2.20)	(-2.20)	(-2.15)
Post × Firm FC (% USD Loan)	-0.00348	-0.00749	0.00338	-0.0349	-0.0359	-0.0329
	(-0.03)	(-0.06)	(0.03)	(-1.13)	(-1.17)	(-1.07)
Post × $\text{Trade}^{\text{RoW}}$	0.104**	0.147**		0.0283***	0.0389**	
	(2.49)	(2.48)		(2.92)	(2.43)	
Post × $\text{Trade}^{\text{China}}$		0.0613			0.0151	
		(0.96)			(0.94)	
Post × $\text{Trade}^{\text{Export}}$			0.108*			0.0280*
			(1.94)			(1.86)
R^2	0.298	0.299	0.296	0.533	0.534	0.531
N	1174	1174	1174	1175	1175	1175
Firm FE	Y	Y	Y	Y	Y	Y
City-Time FE	Y	Y	Y	Y	Y	Y
Sector-Time FE	Y	Y	Y	Y	Y	Y
$\overline{\text{Bank Controls}}$ × Time	Y	Y	Y	Y	Y	Y
Firm Controls × Time	Y	Y	Y	Y	Y	Y

Panel B	Employment Growth			Sales Revenue Growth		
	(1)	(2)	(3)	(1)	(2)	(3)
Post × $\overline{NetUSDExps}$	-0.0207**	-0.0207**	-0.0208**	-0.0318**	-0.0318**	-0.0317**
	(-2.20)	(-2.20)	(-2.22)	(-2.04)	(-2.06)	(-2.06)
Post × Firm FC (% USD Loan)	-0.000690	-0.000874	-0.000617	-0.0154	-0.0176	-0.0184
	(-0.03)	(-0.04)	(-0.02)	(-0.32)	(-0.36)	(-0.37)
Post × $\text{Trade}^{\text{RoW}}$	0.00288	0.00471		0.00516	0.0284*	
	(0.35)	(0.41)		(0.46)	(1.80)	
Post × $\text{Trade}^{\text{China}}$		0.00261			0.0331*	
		(0.22)			(1.96)	
Post × $\text{Trade}^{\text{Export}}$			0.00373			0.0299**
			(0.36)			(2.03)
R^2	0.491	0.491	0.491	0.401	0.402	0.401
N	1170	1170	1170	1178	1178	1178
Firm FE	Y	Y	Y	Y	Y	Y
City-Time FE	Y	Y	Y	Y	Y	Y
Sector-Time FE	Y	Y	Y	Y	Y	Y
$\overline{\text{Bank Controls}}$ × Time	Y	Y	Y	Y	Y	Y
Firm Controls × Time	Y	Y	Y	Y	Y	Y

This table presents the joint analysis of depreciation transmission via the bank lending channel, the trade channel and the borrower credit constraint channel estimated by equation 12. The trade channel is proxied by firm f's average export sales revenue during 2009-13, where $\text{Trade}^{\text{RoW}}$ is the share to the rest of the world (excluding Mainland China), $\text{Trade}^{\text{China}}$ is the share to Mainland China, and $\text{Trade}^{\text{Export}}$ is the total export share. The borrower credit constraint channel is proxied by Firm FC, that is defined as the amount of USD denominated loans as a share of total loans firm f received during 2009-13. Level of standard error clustering is firm. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 14: Effect of Depreciation on Loan Supply and Real Outcomes in Placebo Period

Panel A	Loan Supply: 2005Q2-2009Q1				
	(1)	(2)	(3)	(4)	(5)
Net USD Exps. $\times$ $\Delta\xi$	0.286**	0.119	0.321	0.585	0.660
	(2.28)	(1.45)	(1.00)	(1.62)	(1.67)
R^2	0.741	0.828	0.831	0.902	0.902
N	4199	4199	1454	1398	1398
Panel B	Loan Supply: 2005Q2-2009Q1				
	(1)	(2)	(3)	(4)	(5)
High Net USD Exps. $\times$ Post	-0.00893	-0.0453	-0.0362	0.0621	0.0626
	(-0.11)	(-0.79)	(-0.25)	(0.46)	(0.44)
R^2	0.741	0.828	0.831	0.901	0.902
N	4199	4199	1454	1398	1398
Time FE	Y	Y	Y		
Bank FE	Y	Y			
Firm FE	Y	Y			
Relation Cntrls.		Y			
Firm-Bank FE			Y	Y	Y
Firm-Time FE				Y	Y
Main Sector-Time FE					Y
Panel C	Debt Growth: 2005-2008				
	(1)	(2)	(3)	(4)	(5)
$\overline{NetUSDExps}$ $\times$ Post	-0.0536***	-0.0589	-0.0311	-0.00603	-0.0346
	(-3.03)	(-1.34)	(-0.61)	(-0.11)	(-0.65)
R^2	0.00772	0.201	0.276	0.283	0.308
N	1060	1060	1013	1013	1013
Panel D	Investment: 2005-2008				
	(1)	(2)	(3)	(4)	(5)
$\overline{NetUSDExps}$ $\times$ Post	-0.0142***	0.00116	0.000319	-0.00373	-0.00835
	(-2.73)	(0.10)	(0.02)	(-0.26)	(-0.57)
R^2	0.00661	0.452	0.518	0.525	0.535
N	1060	1060	1013	1013	1013
Time FE		Y			
Firm FE		Y	Y	Y	Y
City-Time FE			Y	Y	Y
Sector-Time FE			Y	Y	Y
$\overline{\text{Bank Controls}}$ $\times$ Time				Y	Y
Firm Controls $\times$ Time					Y

This table presents the results of the placebo test. In Panel A and B, the dependent variable is the log of loan origination granted by bank b to firm f in placebo period t. All right-hand-size variables exactly equal those used to produce Table 4 and Table 5 respectively, except for the variable Post, which is set to be one for period 2008Q2-2009Q1 and zero otherwise. In Panel C and D, the dependent variables are debt growth and investment of firm f in placebo period t. All right-hand-size variables except for Post exactly equal those used to produce Table 12. t-statistics are in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 15: External Validity Assessment and Evidence from Banks in Emerging Markets

Panel A	Loan Growth						
				Bank Control Variable			
				Leverage	Liquidity	Wholesale	NPL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Net USD Expo.$_b$	0.00264						
	(0.38)						
Depreciation $\Delta\xi_{m,t}$	-0.812***	-0.706***					
	(-14.97)	(-18.08)					
Net USD Expo.$_b$ $\times$ $\Delta\xi_{m,t}$	-0.0754***	-0.0856**	-0.0448**	-0.0470***	-0.0286*	-0.0462**	-0.0384***
	(-3.66)	(-2.37)	(-2.58)	(-2.74)	(-1.81)	(-2.47)	(-3.14)
Control$_b$ $\times$ $\Delta\xi_{m,t}$				-0.0497***	0.115***	0.0523**	0.0327**
				(-2.76)	(6.52)	(2.63)	(2.01)
R^2	0.196	0.514	0.567	0.568	0.574	0.570	0.605
N	6264	6264	6264	6264	6170	6002	5580
Time FE	Y	Y					
Bank FE		Y	Y	Y	Y	Y	Y
Emerging Market-Time FE			Y	Y	Y	Y	Y

This table presents the results to assess the external validity of the credit supply channel using a panel data of banks from a group of emerging markets. Banks whose Net USD Exposure is missing in 2013 are excluded. Emerging market whose domestic currency is pegged to the U.S. dollar and emerging market with less than five banks are excluded. The model specification is given by equation 15 below:

$$y_{b,m,t} = \beta_1 \text{Net USD Expo.}_b + \beta_2 \Delta\xi_{m,t} + \beta_3 \text{Net USD Expo.}_b \times \Delta\xi_{m,t} + \gamma Z_b \times \Delta\xi_{m,t} + \alpha_b + \alpha_{m,t} + \varepsilon_{b,m,t}$$

Dependent variable is loan growth of bank b from region m in period t. Net USD Exposure is the difference between gross USD liabilities and gross USD assets, and normalized by bank equity. Net USD Exposure and bank controls are the values observed in 2013 and all normalized by standard deviation. Column (1) controls for time fixed effects. Column (2) adds bank fixed effects, which fully soak up the cross-sectional variation in Net USD Exposure. Column (3) replaces time fixed effects by emerging market$\times$time fixed effects, which absorb the cross-market variation in exchange rate fluctuation. Column (4)-(7) additionally control for bank leverage, liquidity ratio, wholesale funding liabilities as a share of total bank liabilities, and non-performing loans (NPL) as a fraction of total loans, respectively. The panel includes 54 emerging markets: Albania, Argentina, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Croatia, Cyprus, Czech Republic, Dominican Republic, Egypt, Estonia, Georgia, Ghana, Guatemala, Hungary, Israel, Kazakhstan, Kenya, Kosovo, Kuwait, Kyrgystan, Latvia, Lithuania, Malawi, Malta, Mauritius, Mexico, Moldova, Montenegro, Namibia, Nigeria, Pakistan, Peru, Poland, Romania, Russia, Rwanda, Serbia, Slovakia, Slovenia, South Africa, Syria, Taiwan (Province of China), Tajikistan, Tanzania, Turkey, Uganda, Ukraine, Uruguay, Uzbekistan, Vietnam and Zambia. Standard errors are the two-way clustered at bank and region. t-statistics are in parenthesis. Data source: BankFocus. Time frame: 2012-2017. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

External Validity Assessment and Evidence from Banks in Emerging Markets (continued)

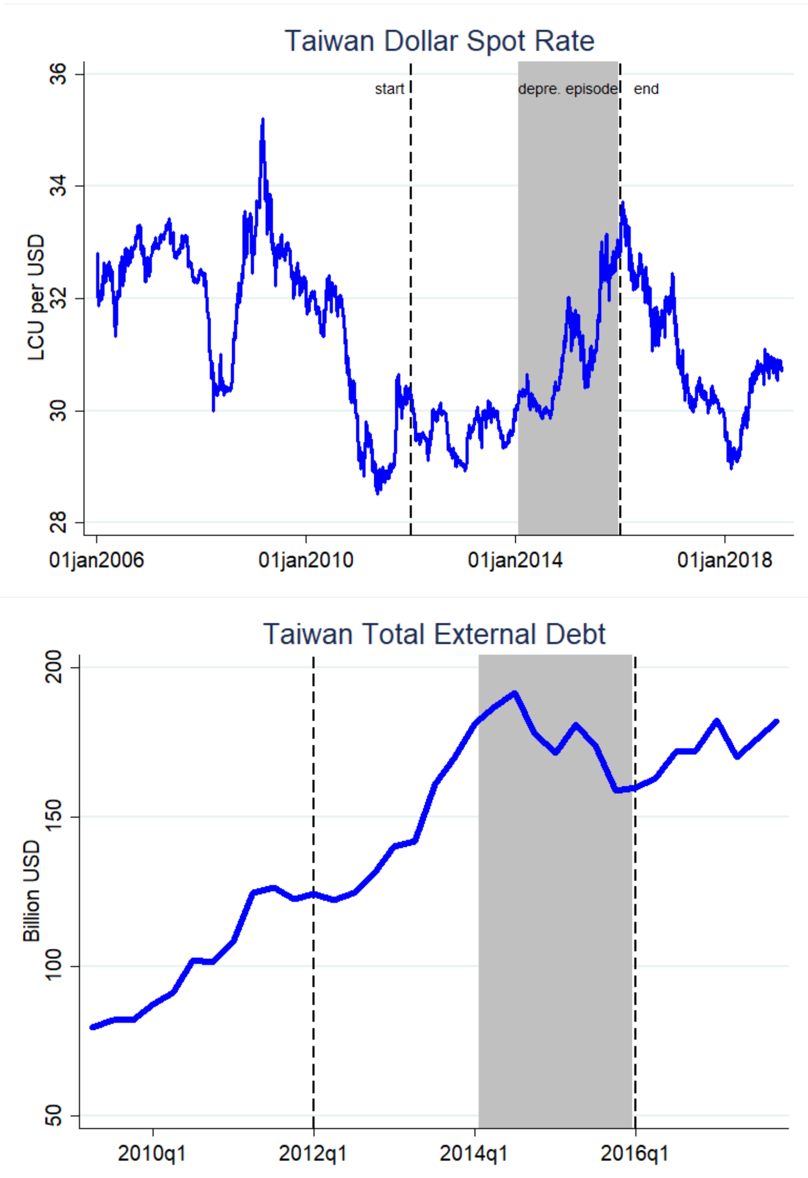
Panel B	Net Revenue Growth						
				Bank Control Variable			
				Leverage	Liquidity	Wholesale	NPL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Net USD Expo.$_b$	0.0115						
	(1.60)						
Depreciation $\Delta\xi_{m,t}$	-0.872***	-0.954***					
	(-9.58)	(-12.15)					
Net USD Expo.$_b$ $\times$ $\Delta\xi_{m,t}$	-0.197***	-0.206***	-0.115***	-0.119***	-0.0923***	-0.103***	-0.0755**
	(-4.11)	(-2.80)	(-3.38)	(-3.50)	(-2.96)	(-2.90)	(-2.58)
Control$_b$ $\times$ $\Delta\xi_{m,t}$				-0.0851***	0.162***	0.116***	-0.0123
				(-3.48)	(8.19)	(3.30)	(-0.46)
R^2	0.147	0.323	0.411	0.412	0.418	0.412	0.442
N	5868	5823	5822	5822	5735	5569	5202
Time FE	Y	Y					
Bank FE		Y	Y	Y	Y	Y	Y
Emerging Market-Time FE			Y	Y	Y	Y	Y

This table presents the results to assess the external validity of the credit supply channel using a panel data of banks from a group of emerging markets. Banks whose Net USD Exposure is missing in 2013 are excluded. Emerging market whose domestic currency is pegged to the U.S. dollar and emerging market with less than five banks are excluded. The model specification is given by equation 15 below:

$$y_{b,m,t} = \beta_1 \text{Net USD Expo.}_b + \beta_2 \Delta\xi_{m,t} + \beta_3 \text{Net USD Expo.}_b \times \Delta\xi_{m,t} + \gamma Z_b \times \Delta\xi_{m,t} + \alpha_b + \alpha_{m,t} + \varepsilon_{b,m,t}$$

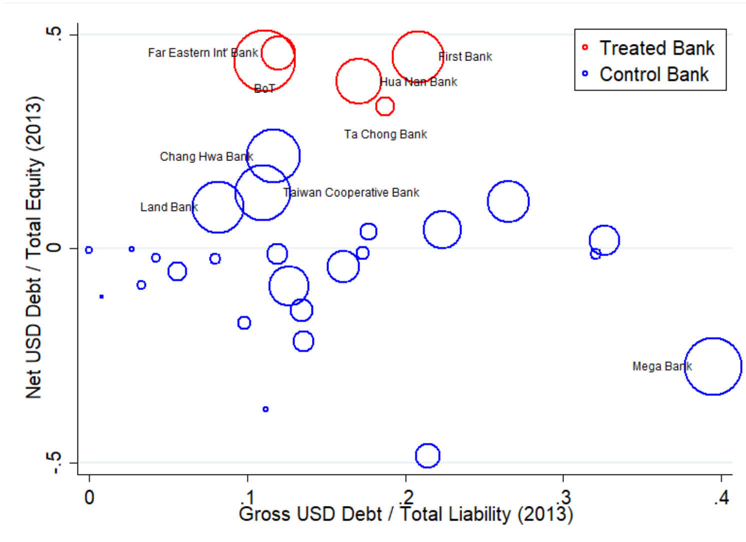
Dependent variable is net revenue growth of bank b from region m in period t. Net USD Exposure is the difference between gross USD liabilities and gross USD assets, and normalized by bank equity. Net USD Exposure and bank controls are the values observed in 2013 and all normalized by standard deviation. Column (1) controls for time fixed effects. Column (2) adds bank fixed effects, which fully soak up the cross-sectional variation in Net USD Exposure. Column (3) replaces time fixed effects by emerging market×time fixed effects, which absorb the cross-market variation in exchange rate fluctuation. Column (4)-(7) additionally control for bank leverage, liquidity ratio, wholesale funding liabilities as a share of total bank liabilities, and non-performing loans (NPL) as a fraction of total loans, respectively. The panel includes 54 emerging markets: Albania, Argentina, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Croatia, Cyprus, Czech Republic, Dominican Republic, Egypt, Estonia, Georgia, Ghana, Guatemala, Hungary, Israel, Kazakhstan, Kenya, Kosovo, Kuwait, Kyrgystan, Latvia, Lithuania, Malawi, Malta, Mauritius, Mexico, Moldova, Montenegro, Namibia, Nigeria, Pakistan, Peru, Poland, Romania, Russia, Rwanda, Serbia, Slovakia, Slovenia, South Africa, Syria, Taiwan (Province of China), Tajikistan, Tanzania, Turkey, Uganda, Ukraine, Uruguay, Uzbekistan, Vietnam and Zambia. Standard errors are the two-way clustered at bank and region. t-statistics are in parenthesis. Data source: BankFocus. Time frame: 2012-2017. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 1: Taiwan Exchange Rate and External Debt



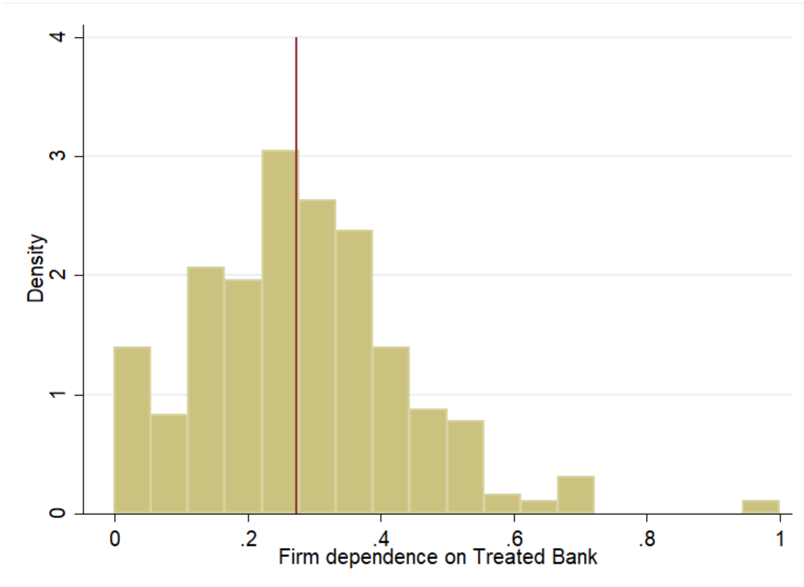
Notes: Figures are daily spot rate and quarterly total external debt from Thomson Reuters. An increase in the spot rate indicates depreciation of Taiwan dollar against the U.S. dollar. External debt is the level of outstanding amount of the total external debt claimed by the rest of the world. Gray shaded area ranging from 2014Q1 to 2015Q4 is considered to be the depreciation episode for Taiwan. Two vertical dashed lines indicate the beginning- and the ending-period of the loan sample in the baseline.

Figure 2: Bank Net USD Exposure and Gross USD Liabilities



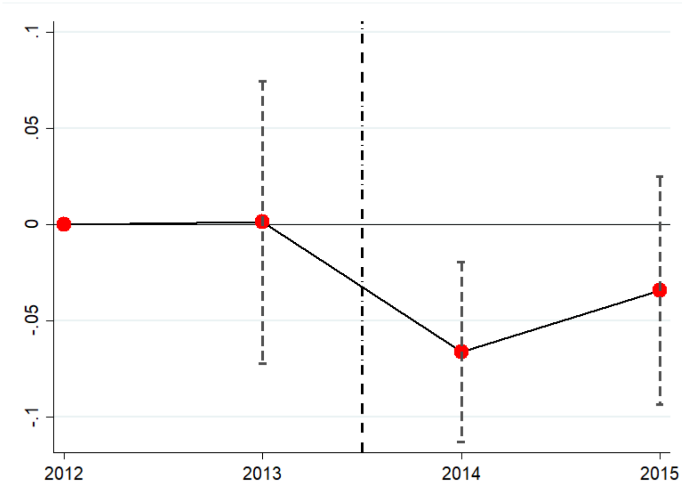
Notes: Each circle represents one Taiwan bank. Circle size indicates the relative size of bank lending in the sample. On the vertical axis, Net USD Debt/Equity is gross USD debt minus gross USD asset, and then divided by bank equity. The horizontal axis is bank gross USD liabilities as a fraction of total liabilities. A bank is labeled as the treated bank if its net USD exposure is above 0.25. Five banks in the treated group account for roughly one quarter of the sample loans in terms of the volume.

Figure 3: Histogram of Firm's Dependence on Treated Banks



Notes: This figure presents the histogram of firm's dependence on treated banks, $\overline{\text{Net USD Exposure}}_{f,2013}$, defined as the share of loan amount that firm f received from the highly mismatched banks during 2009-13. The vertical line indicates the median.

Figure 4: Loan Supply Dynamics and Coefficient Estimates

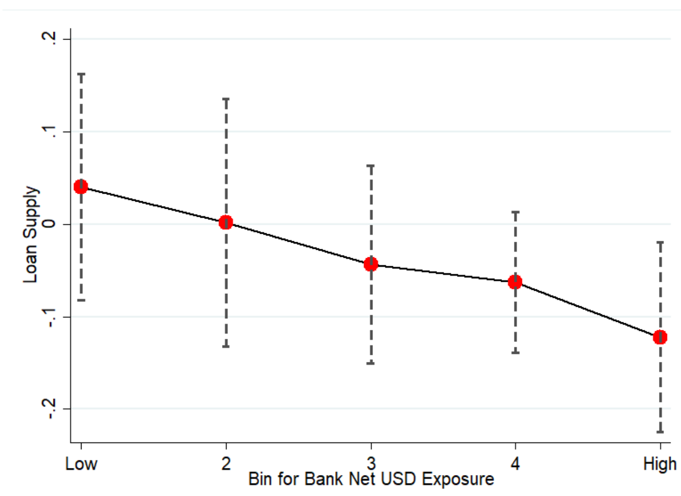


Notes: This figure presents coefficient estimates of β_t for each year t from equation 3:

$$log(L_{b,f,t}) = \sum_{t=2012}^{2015} \beta_t(\text{Net USD Expo.}_b \times \mathbf{1}_{year=t}) + \alpha_{b,f} + \alpha_{f,t} + \varepsilon_{b,f,t}$$

The dependent variable is the log amount of all syndicated loan granted by bank b to firm f in year t. Net USD Exposure is the difference between bank gross USD liabilities and gross USD assets over bank total equity as observed by the end of 2013. Vertical bands represent 90% confidence interval of each point estimate. Vertical dotted dash line separates the period when exchange rate depreciates again USD. Standard errors are two-way clustered at bank and firm level.

Figure 5: Binscatter Plot of Loan Supply and Bank Currency Risk

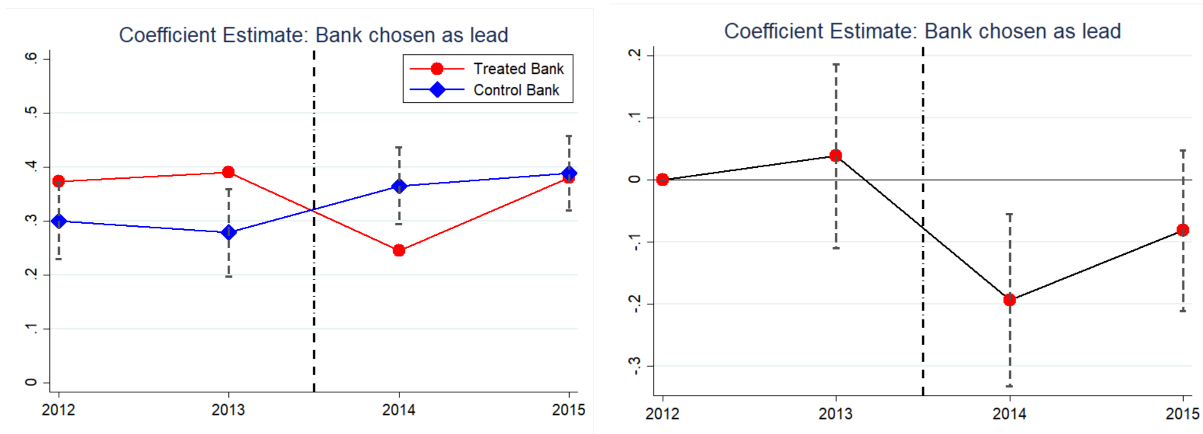


Notes: This figure presents the binscatter plot of loan supply and bank net USD exposure. Sample banks are sorted and grouped into five bins. Treated banks constitute the fifth bin. The coefficient of each bin is estimated separately from the equation:

$$log(L_{f,b,t}) = \beta^i \text{Post}_t + \alpha_{f,b} + \varepsilon_{f,b,t}$$

Vertical bands represent 90% confidence interval of each point estimate. Level of standard error clustering is firm.

Figure 6: Bank Propensity to Act as Lead Leander and Coefficient Estimates

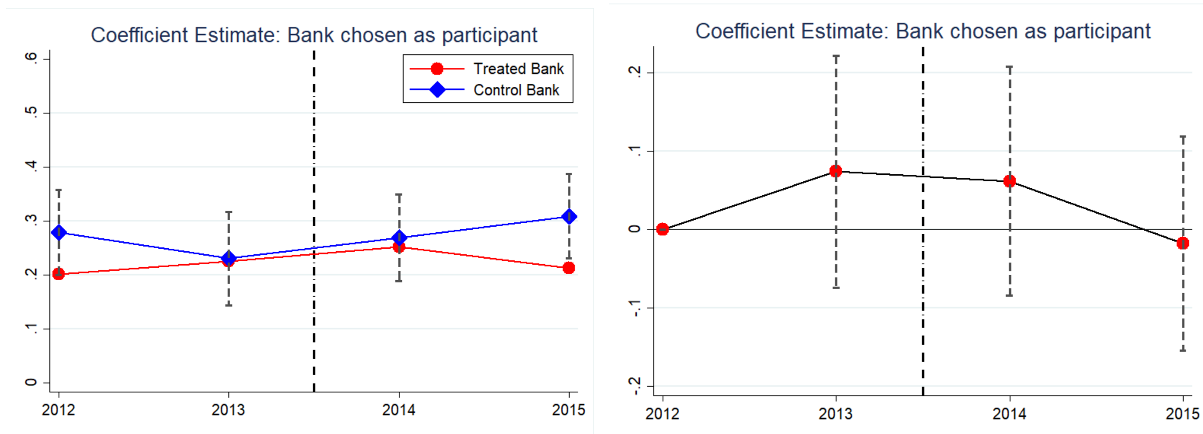


Notes: These figures present coefficient estimates of ρ for each year t from equation 6

$$\begin{aligned}\text{Lead}_{f,b,t} = & \sum_{t=2012}^{2015} \rho_{1,t}(\text{Lead}_{f,b,t-1} \times \mathbf{1}_{year=t}) + \rho_2 \text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \\ & + \sum_{t=2012}^{2015} \rho_{3,t}(\text{Lead}_{f,b,t-1} \times \text{High Net USD Exps}_b \times \mathbf{1}_{year=t}) + \alpha_{b,t} + \alpha_{f,t} + Z_{f,b} + \varepsilon_{f,b,t}\end{aligned}$$

The dependent variable is an indicator for whether bank b serves as the lead for firm f in time t. For each loan in which a borrower has accessed the syndicated loan market, the data set contains one observation for each potential lender and each year. The independent variable $\text{Lead}_{f,b,t-1}$ equal 1 if bank b served as the lead on the firm f's previous loan up to year $t-1$. High Net USD Exposure is the dummy variable that is set to be one for treated banks, and zero for control banks. Panel (a) plot the estimated propensity to act as lead lender for treated and control banks. For treated bank, the propensity is given by $\rho_{1,t} + \rho_2 + \rho_{3,t}$. For control bank, the propensity is given by $\rho_{1,t}$. Panel (b) plots the coefficient estimates of $\rho_{3,t}$. Vertical bands represent 90% confidence interval of each point estimate. Vertical dotted dash line separates the period when exchange rate depreciates again USD. Level of standard error clustering is firm.

Figure 7: Bank Propensity to Act as Participant and Coefficient Estimates

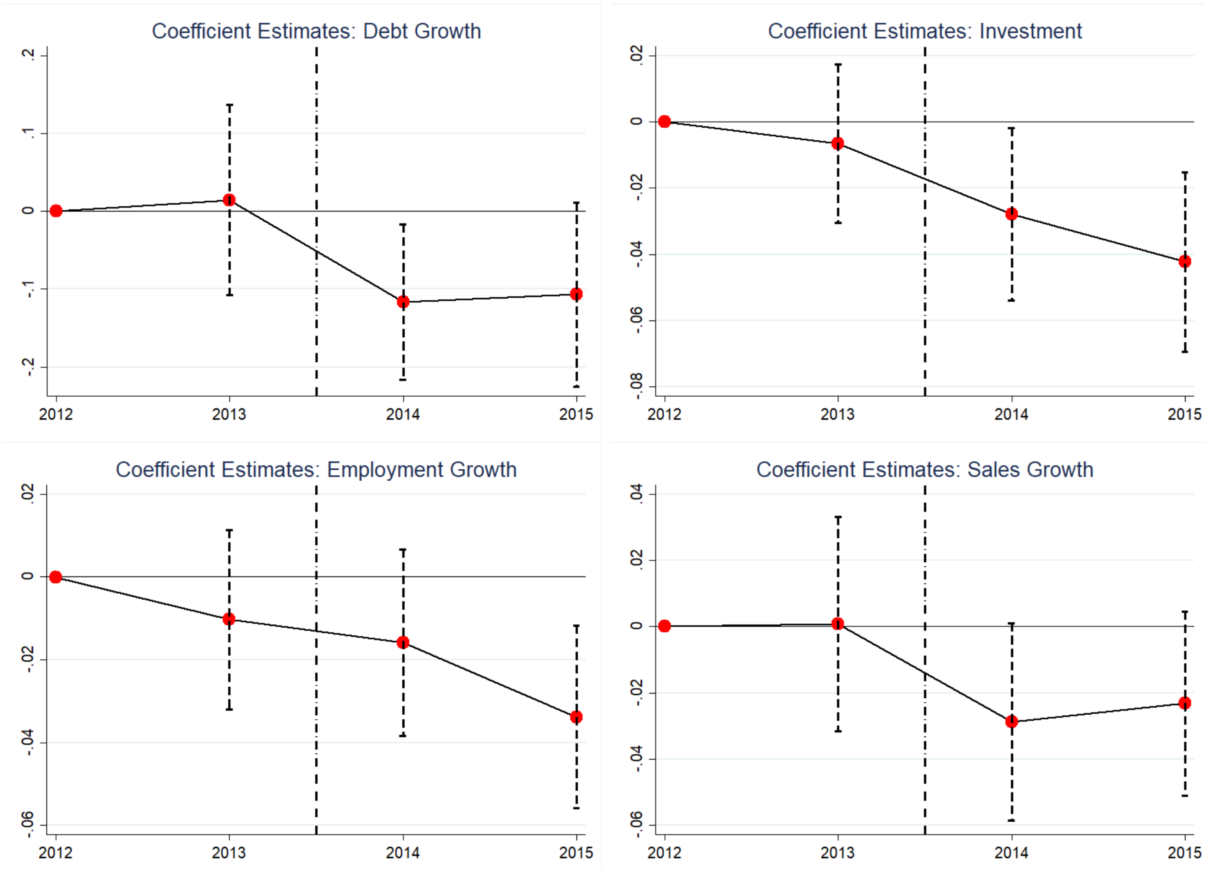


Notes: These figures present coefficient estimates of ρ for each year t from equation

$$\begin{aligned}\text{Participant}_{f,b,t} = &\sum_{t=2012}^{2015} \rho_{1,t}(\text{Participant}_{f,b,t-1} \times \mathbf{1}_{year=t}) + \rho_2 \text{Participant}_{f,b,t-1} \times \text{High Net USD Exps}_b \\ &+ \sum_{t=2012}^{2015} \rho_{3,t}(\text{Participant}_{f,b,t-1} \times \text{High Net USD Exps}_b \times \mathbf{1}_{year=t}) + \alpha_{b,t} + \alpha_{f,t} + Z_{f,b} + \varepsilon_{f,b,t}\end{aligned}$$

The dependent variable is an indicator for whether bank b serves as a participant for firm f in time t. For each loan in which a borrower has accessed the syndicated loan market, the data set contains one observation for each potential lender and each year. The independent variable $\text{Participant}_{f,b,t-1}$ equal 1 if bank b served as a participant on the firm f's previous loan up to year $t-1$. High Net USD Exposure is the dummy variable that is set to be one for treated banks, and zero for control banks. Panel (a) plot the estimated propensity to act as participant for treated and control banks. For treated bank, the propensity is given by $\rho_{1,t} + \rho_2 + \rho_{3,t}$. For control bank, the propensity is given by $\rho_{1,t}$. Panel (b) plots the coefficient estimates of $\rho_{3,t}$. Vertical bands represent 90% confidence interval of each point estimate. Vertical dotted dash line separates the period when exchange rate depreciates again USD. Level of standard error clustering is firm.

Figure 8: Firm-level Outcome Dynamic and Coefficient Estimate

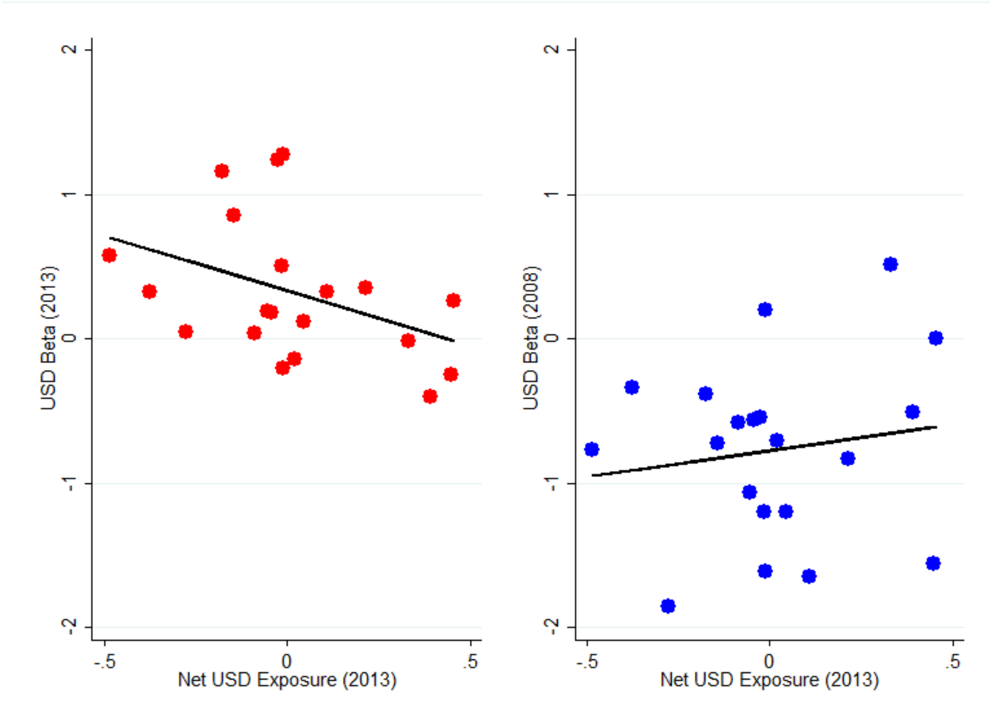


Notes: Figures present coefficients estimates θ_t for each year t from equation 10:

$$y_{f,t} = \sum_{t=2012}^{2015} \theta_t \left(\overline{\text{Net USD Exposure}}_f \times \mathbf{1}_{year=t} \right) + \alpha_f + \overline{B}_{f,t} + Z_{f,t} + \varepsilon_{f,t}$$

The dependent variable is debt growth (Panel A), investment (Panel B), employment growth (Panel C) and sales revenue growth (Panel D), respectively. $\overline{\text{Net USD Exposure}}_f$ is firm's dependence on the highly mismatched banks defined by equation 7. Vertical bands represent 90% confidence interval of each point estimate. Vertical dotted dash line separates the period when exchange rate depreciates again USD. Level of standard error clustering is firm.

Figure 9: Bank USD Beta and Net USD Exposure

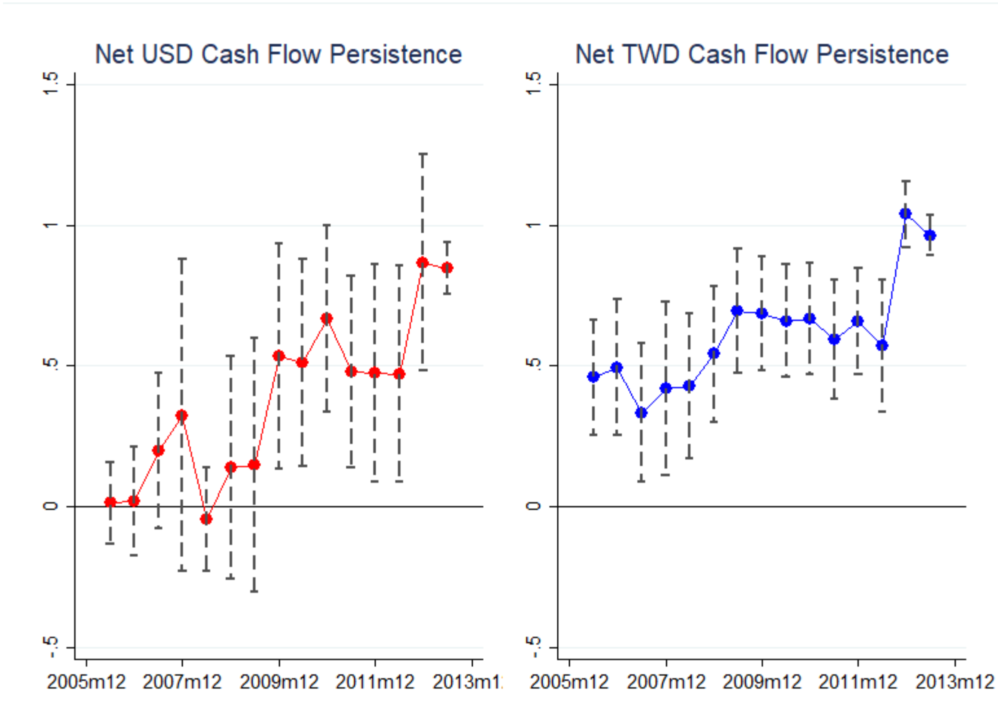


Notes: These scatterplots display the correlation between bank net USD exposure observed in 2013 and USD Beta β_b^{USD} estimated for two three-year episodes respectively, one is 2006Q2-2009Q1 shown in the left panel and the other is 2012Q1-2014Q in the right panel. Bank USD Beta β_b^{USD} is estimated by equation 13:

$$R_{b,t} = \alpha_b + \beta_b^M R_{M,t} + \beta_b^{USD} \Delta\xi_t + \varepsilon_{b,t}$$

where $R_{b,t}$ is the weekly return on bank b at time t, $R_{M,t}$ is the weekly return on the market portfolio and $\Delta\xi_t$ is the weekly depreciation rate.

Figure 10: Persistence of Bank USD and TWD Cash Flow



Notes: These figures display the persistence of bank net USD cash flow and net TWD cash flow. The persistence of bank cash flows is estimated by the equation 14:

$$\text{NCF}^{\text{USD}}_{b,2013m12} = \beta_{0,t} + \beta_{1,t}\text{NCF}^{\text{USD}}_{b,t} + e_{b,t}$$
$$\text{NCF}^{\text{TWD}}_{b,2013m12} = \gamma_{0,t} + \gamma_{1,t}\text{NCF}^{\text{TWD}}_{b,t} + \epsilon_{b,t}$$

where NCF^{USD} is defined as the difference between USD outflows and USD inflows, and normalized by bank equity. The panel on the left shows the coefficient estimates of $\beta_{1,t}$ for period t ranging from 2006m6 to 2013m6, and the panel on the right shows the coefficient estimates of $\gamma_{1,t}$ for period t ranging from 2006m6 to 2013m6. Vertical bands represent 90% confidence interval of each point estimate.

Appendix Tables and Figures

Table A1: Credit Supply at the Intensive Margin, Collapsed Specification

	Loan Supply Change		
	(1)	(2)	(3)
Net USD Exps.	-0.0509**	-0.0581***	-0.0590**
	(-2.55)	(-3.07)	(-2.55)
R^2	0.479	0.488	0.547
N	520	520	520
	(1)	(2)	(3)
High Net USD Exps.	-0.145***	-0.161***	-0.161***
	(-3.16)	(-4.44)	(-4.72)
R^2	0.483	0.492	0.551
N	520	520	520
Firm FE	Y	Y	Y
Bank Controls		Y	Y
Relation Controls			Y

This table presents coefficients from regression related to loan-level intensive margin described as

$$\Delta log(L_{f,b,t}) = \beta \text{Net USD Exps.}_b + \alpha_f + \tau B_b + \delta Q_{b,f} + \varepsilon_{f,b}$$

The dependent variable $\Delta log(L_{f,b,t})$ is change in the log of average credit in the period before (2012-13) and after (2014-2015) the depreciation. Standard errors are at bank level. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A2: Credit Supply at the Intensive Margin: robustness to standard error clustering

	Loan Supply					
S.E. Clustering	Bank and Firm		Firm		Bank-Time and Firm	
	(1)	(2)	(3)	(4)	(5)	(6)
Net USD Exps. × $\Delta\xi$	-0.611**	-0.580**	-0.611**	-0.580**	-0.611**	-0.580**
	(0.254)	(0.253)	(0.264)	(0.255)	(0.234)	(0.267)
R^2	0.814	0.957	0.814	0.957	0.814	0.957
N	2290	1356	2290	1356	2290	1356
Time FE	Y		Y		Y	
Bank FE	Y		Y		Y	
Firm FE	Y		Y		Y	
Relation Controls	Y		Y		Y	
Firm-Bank FE		Y		Y		Y
Firm-Time FE		Y		Y		Y

This table presents coefficients from regression related to loan-level intensive margin, as described in equation 2. Clustered standard errors are in parenthesis. Level of standard error clustering is bank and firm, firm, and bank-time and firm, respectively. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A3: Robustness Check on Alternative Specification

Panel A	Debt Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$ (last loan)	-0.0347**	-0.0957**	-0.0999**	-0.0893**	-0.100**
	(-2.54)	(-2.56)	(-2.30)	(-2.15)	(-2.42)
R^2	0.00346	0.188	0.262	0.276	0.286
N	1363	1363	1310	1310	1310
Panel B	Investment				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$ (last loan)	-0.0132***	-0.0147*	-0.0213**	-0.0192*	-0.0218**
	(-3.34)	(-1.66)	(-2.36)	(-1.95)	(-1.99)
R^2	0.00804	0.434	0.496	0.501	0.514
N	1366	1366	1313	1313	1313
Panel C	Employment Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$ (last loan)	0.00204	-0.00795	-0.0146*	-0.0144	-0.0152*
	(0.64)	(-1.09)	(-1.67)	(-1.63)	(-1.69)
R^2	0.000263	0.390	0.454	0.465	0.482
N	1290	1290	1235	1235	1235
Panel D	Sales Revenue Growth				
	(1)	(2)	(3)	(4)	(5)
Post × $\overline{NetUSDExps}$ (last loan)	-0.0142***	-0.0158	-0.0211*	-0.0213*	-0.0191
	(-3.13)	(-1.50)	(-1.72)	(-1.76)	(-1.49)
R^2	0.00623	0.334	0.413	0.417	0.426
N	1363	1363	1310	1310	1310
Time FE		Y			
Firm FE		Y	Y	Y	Y
City-Time FE			Y	Y	Y
Sector-Time FE			Y	Y	Y
$\overline{\text{Bank Controls}}$ × Time				Y	Y
Firm Controls × Time					Y

This table presents the results of the robustness check on the alternative specification of firm's bank currency risk exposure. The dependent variable Debt Growth is annual log change of total debt, Investment is annual log change of tangible fixed asset, Employment growth is annual log change of number of employees, and Sales Revenue Growth is annual log change of total sales revenue. $\overline{NetUSDExps}_f$ (last loan) is firm's dependence on the highly mismatched banks defined by equation 11. Post is set to be one if year is either 2014 or 2015. City is firm geographic location. Sector is firm primary 2-digit NACE number. $\overline{\text{Bank Control}}$ are indirect measures of bank tier 1 capital ratio, leverage ratio, and liquidity ratio. Firm controls include borrower interest coverage bin, leverage bin, profit margin bin, bond market access bin, size bin and loan spread bin fixed effects. Bank and firm controls are all interacted with year and are all observed before the depreciation episode. Level of standard error clustering is firm. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A4: Alternative Specification for Borrower Credit Constraint Channel

Panel A	Debt Growth		Investment	
	(1)	(2)	(1)	(2)
Post × $\overline{NetUSDExps}$	-0.118***		-0.0314***	
	(-2.75)		(-2.78)	
Post × Firm FC (% USD Loan)	0.00831	0.0153	-0.0215	-0.0194
	(0.06)	(0.11)	(-0.69)	(-0.60)
R^2	0.283	0.277	0.516	0.510
N	1310	1310	1313	1313
Panel B	Debt Growth		Investment	
	(1)	(2)	(1)	(2)
Post × $\overline{NetUSDExps}$	-0.118***		-0.0312***	
	(-2.75)		(-2.77)	
Post × Firm FC (USD Dummy)	-0.0609	-0.0617	-0.00840	-0.00850
	(-0.75)	(-0.74)	(-0.46)	(-0.46)
R^2	0.283	0.278	0.516	0.509
N	1310	1310	1313	1313
Firm FE	Y	Y	Y	Y
City-Time FE	Y	Y	Y	Y
Sector-Time FE	Y	Y	Y	Y
$\overline{\text{Bank Controls}}$ × Time	Y	Y	Y	Y
Firm Controls × Time	Y	Y	Y	Y

This table presents the results of using alternative definition and model specification to find no evidence in support of the borrower credit constraint channel. Panel A uses the amount of USD denominated loans as a fraction of total loans received by firm f during 2009-13. Panel B uses the dummy variable that is set to be one if firm f borrows in USD denominated loan during 2009-13, and zero otherwise. Level of standard error clustering is firm. t-statistics are in parenthesis. Time frame: 2012-2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A5: Bank Currency Risk Management in Emerging and Advanced Economies

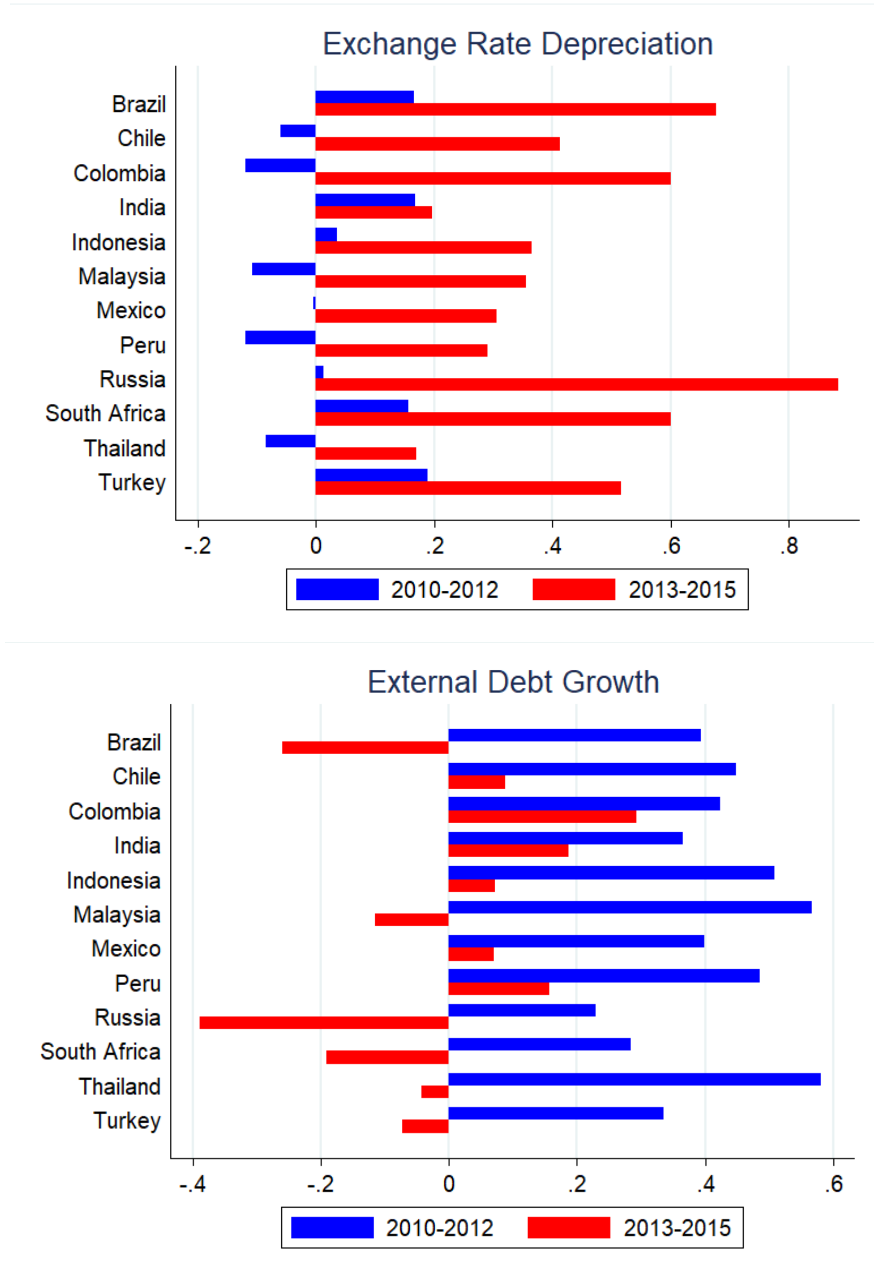
This table surveys regulation on bank currency risk exposure for a wide range of emerging and advanced economies using the information from the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) compiled by IMF. Column (3) indicates whether bank authority in an economy imposes limit on bank open foreign exchange position. Column (6) details the regulation requirement. Most emerging markets set the limits in terms of a measure of overall capital. The limiting ratio ranges from 10% to 50% in the survey.

Country	Year	Limit	Base	Ratio	Open foreign exchange position limits	EM
Argentina	2014	Yes	Regulatory Capital	30	Effective February 4, 2014, the limit on the overall net positive position in foreign currency is the lesser of 30% of the bank's regulatory capital or its own liquid assets;	Y
Brazil	2014	Yes	Capital	30	A limit of 30% of a financial institution's capital base applies to its exposure in gold and assets and liabilities denominated in foreign currency.	Y
Chile	2014	Yes			Banks are required to observe a limit on interest rates and currency risk exposure, in accordance with the recommendations of the BCBS.	Y
Colombia	2014	Yes	Capital	20	The arithmetic mean of EMIs' own position over three business days may not exceed the equivalent in foreign currency of 20% of their capital and reserves.	Y
Croatia	2014	Yes	Regulatory Capital	30	The limit on open positions in foreign exchange is 30% of a bank's regulatory capital.	Y
Hungary	2014	No				Y
Indonesia	2014	Yes	Capital	20	Banks must maintain a maximum overall (on- and off-balance-sheet) NOP of 20% of capital at the end of the working day.	Y
Korea	2014	Yes	Equity	50	A foreign exchange bank's overall net open position, sum of overall net short positions, or sum of overall net long positions in each currency is limited to 50% of its total equity capital at the end of the previous month.	Y
Malaysia	2014	No				Y

Country	Year	Limit	Base	Ratio	Open foreign exchange position limits	EM
Mexico	2014	Yes	Core Capital	15	At the end of each day, open foreign exchange positions may not exceed 15% of the bank's core capital.	Y
Pakistan	2014	Yes	Capital	20	The aggregate foreign exchange exposure limit for each bank is 20% of its audited paid-up capital (free of losses).	Y
Peru	2014	Yes	Equity	10	The limit on the net position in derivatives in foreign currency is 20% of net worth or S/. 300 million, whichever is higher. A prudential limit of 50% of net worth applies to the long foreign exchange position of financial institutions, and a limit of 10% of net worth applies to the short foreign exchange position.	Y
Philippines	2014	Yes	Capital	20	Banks' allowable open foreign exchange position (either over-bought or oversold) is the lower of 20% of their unimpaired capital.	Y
Russia	2014	Yes	Capital	20	The limits on open foreign exchange positions of credit institutions are 20% of the internal funds (capital) for all foreign currencies and precious metals and 10% of the internal funds (capital) for any individual foreign currency and precious metal.	Y
South Africa	2014	Yes	Capital	10	The effective net open foreign currency position of a reporting bank may not exceed 10% of the net qualifying capital and reserve funds of the reporting bank.	Y
Thailand	2014	Yes	Capital	15	The regulation on net foreign exchange exposure limits allows commercial banks to maintain a position for each currency relative to its capital fund up to 15% or US$5 million, whichever is greater, and to maintain an aggregate position relative to its capital fund up to 20% or US$10 million, whichever is greater.	Y
Turkey	2014	Yes	Equity	20	The absolute value of the weekly arithmetic mean of daily ratios between net foreign exchange positions and own funds must be no greater than 20%.	Y
Ukraine	2014	Yes	Capital	10	Banks' total long open foreign exchange position limits may not exceed 5% and total short open foreign exchange position limit may not exceed 10% of regulatory capital.	Y

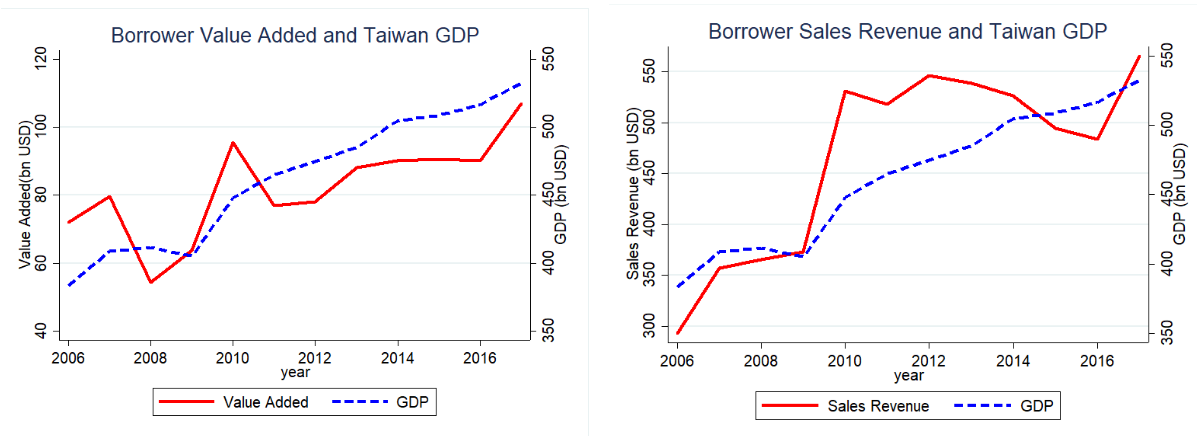
Country	Year	Limit	Base	Ratio	Open foreign exchange position limits	EM
Australia	2014	No				N
Austria	2014	Yes			Credit institutions must fulfill at all times the minimum capital requirement to cover foreign exchange risk.	N
Belgium	2014	No				N
Canada	2014	No				N
Finland	2014	Yes			Prudential regulations that are harmonized with EU directives apply.	N
Germany	2014	No				N
Greece	2014	No				N
Ireland	2014	No				N
Japan	2014	No				N
Netherland	2014	No				N
Normay	2014	Yes	Equity	15	Net positions of up to 15% of institutions' equity and subordinated loan capital may be taken out in individual currencies.	N
Spain	2014	No				N
Sweden	2014	No				N
Switzerland	2014	No				N
United Kingdom	2014	Yes			Effective June 1, 2013, net spot liabilities in foreign currencies (i.e., the net amount of foreign currency resources funding sterling assets) form part of a bank's liabilities subject to a 0.18% non-interest-bearing deposit requirement with the BOE.	N
United States	2014	No			The foreign currency positions of banks, whether overall or with respect to individual currencies, are not subject to quantitative limits, but banks are subject to prudential oversight. In addition, large foreign exchange market participants are required to report their holdings of five major foreign currencies and U.S. dollars weekly, monthly, or quarterly.	N

Figure A1: Emerging Market Exchange Rate Depreciation and External Debt Growth



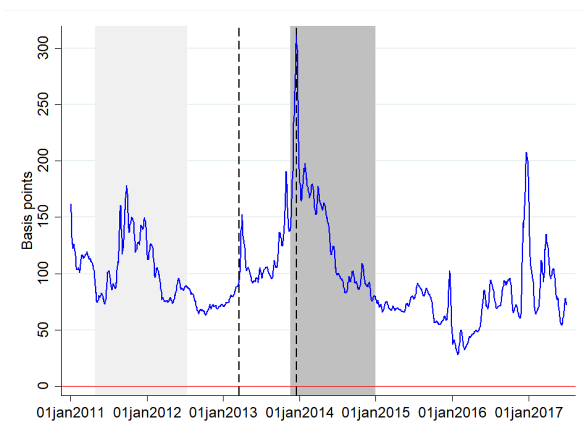
Note: Top panel shows the log change in exchange rate of emerging markets during the two episodes. Bottom panel shows the growth rate of external debt of emerging markets during the two episodes. Data source: Datastream and IMF.

Figure A2: Borrower Sample Representativeness

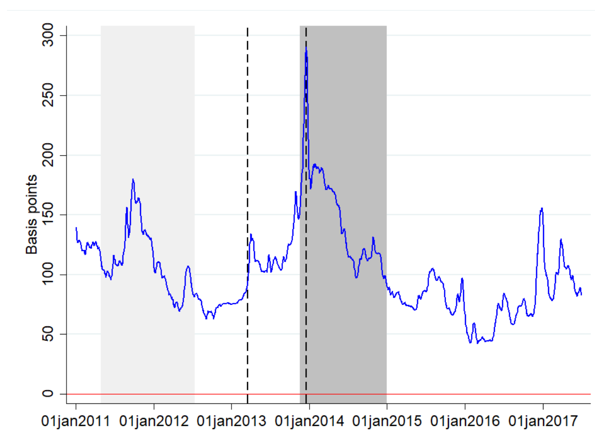


Notes: Figures show the total value added and the total sales revenue of sample syndicated loan borrowers, and compare them with Taiwan gross domestic product to visualize the sample representativeness of domestic real sector. GDP from Thomson Reuters. Value added and sales revenue from Orbis. Firms are the borrowers that are active in the Taiwan syndicated loan market in the sample period.

Figure A3: Short-term Libor-based deviations from covered interest rate parity for Taiwan Dollar



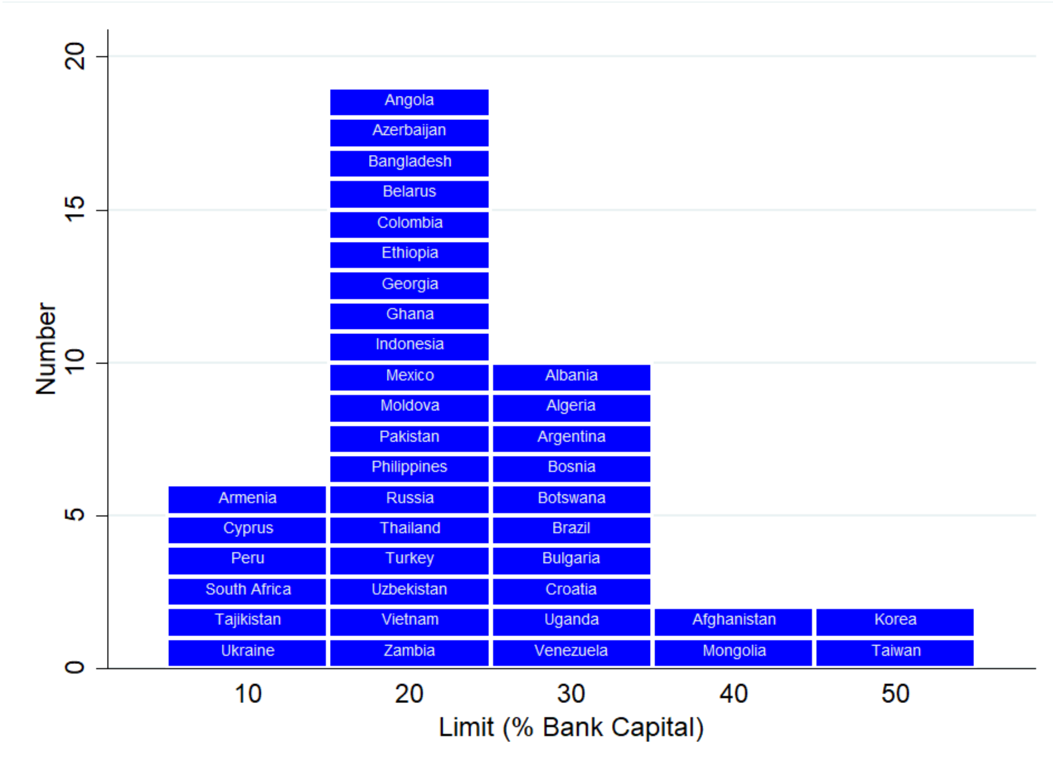
A: one-month tenor



B: three-month tenor

Notes: These figures plots the 10-day moving average of the one-month and three-month Libor-implied cross-currency basis for Taiwan. Covered interest rate parity implies that the basis should be zero. The Libor basis is equal to $y^{\$,Libor}_{t,t+n} - (y^{Libor}_{t,t+n} - \rho_{t,t+n})$, where $n =$ one month or three month, $y^{\$,Libor}_{t,t+n}$ and $y^{Libor}_{t,t+n}$ denote the U.S. and Taiwan corresponding interbank offered rate, and $\rho_{t,t+n}$ denotes the forward premium obtained from the forward $f_{t,t+n}$ and spot s_t exchange rate. The first vertical dash line (19Mar2013) is the day when FOMC meeting revealed concern on scaling down bond purchase. The second vertical dash line (18Dec2013) is the day when the U.S. Fed began to taper the size of bond purchase by USD 10 billion per month. The light gray region indicates the money market fund run during the European sovereign debt crisis investigated by Ivashina et al. (2015). The dark gray region indicates the depreciation following the tapering talk by the U.S. Fed. Data source: Bloomberg.

Figure A4: Regulation on Bank Net Foreign Exchange Position in Emerging Markets



Note: This figure presents the limiting ratio of bank net foreign exchange position as is required by domestic regulators for a list of emerging market economies. Data is presented in a harmonized way. Source is IMF's 2013 AREAER Report.