Banks' Foreign Currency Exposure and the Real Effects of Exchange Rate Shocks

Isha Agarwal*

University of British Columbia

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Abstract: In contrast to standard theory, recent empirical evidence shows that currency depreciations are not always expansionary. I posit a new channel of exchange rate transmission that works by affecting the lending capacity of banks, and show that this channel can offset or exacerbate the trade channel, explaining the heterogeneous response of economic activity to exchange rate shocks. To circumvent endogeneity concerns, I exploit a large and unanticipated currency appreciation shock from Switzerland in January 2015 when the Swiss National Bank surprised the markets by abandoning the lower bound on the chf/eur exchange rate. Using a novel hand-collected dataset on foreign currency exposure of Swiss banks and bank-firm relationships, I show that the currency appreciation shock enabled banks with net foreign currency liability exposure to increase their credit supply; non-financial firms that had a pre-shock relationship with positively affected banks were able to invest more, partially offsetting the negative impact of currency appreciation on exporters. At the firm level, I compare the bank-lending channel with the trade channel and the corporate balance-sheet channel and show how exchange rate shocks can have heterogeneous effects across sectors and types of firms depending on the relative strength of these channels. Extending my findings to historical currency devaluations over the 1950-2016 period, I provide suggestive evidence that foreign currency exposure of the banking sector can explain the differential response of economic activity to exchange rate shocks across countries and episodes.

JEL Codes: G15; G21; F30; F65.

Keywords: Bank lending; Exchange Rates; Open Economy; Currency Mismatch

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1 Introduction

Currency depreciation is often used as an important policy tool in emerging markets to stimulate real activity by affecting the competitiveness of exports. Even in advanced economies, the low-interest-rate environment after the global financial crisis has accorded exchange rates a central role in monetary policy. Many countries, including Japan, Taiwan, and South Korea, intervened in currency markets after the global financial crisis to weaken their currency in an attempt to boost output. What do we know about the effectiveness of such policies?

According to a broad range of open economy macro models, a weaker currency should have a positive impact on output by making exports more competitive (the trade channel). Empirical evidence suggests, however, that currency depreciations are not always expansionary. The Japanese yen depreciated by a staggering 50 percent during the 'Abenomics' episode but the impact on the real economy was modest (Rodnyansky, 2018). In contrast, for many emerging market economies, large currency depreciations often prove to be catastrophic, as illustrated by the currency crises in Latin America in the 1980s and in East Asia during the late 1990s. More recently, emerging market countries, such as China, India, and Brazil, have expressed concern over large depreciations and the falling Turkish lira has again sparked concern about a currency crisis with potentially adverse consequences for aggregate output.

I posit a new channel of exchange rate transmission that works by affecting the lending capacity of banks and show that this channel can either mitigate or exacerbate the trade channel, explaining the heterogeneous response of aggregate output to exchange rate shocks. I use a unique currency appreciation episode from Switzerland and a novel hand-collected dataset on banks' foreign currency exposure to provide the first causal evidence of the bank-lending channel of exchange rates. Using firm-level data on exports and loan-level data on bank-firm relationships, I dissect the trade channel, the corporate balance-sheet channel, and the bank-lending channel for the Swiss appreciation event. To the best of my knowledge, this is the first paper to investigate the relative importance of various balance sheet channels of exchange rates.

While there is a large body of research on the ineffectiveness of the trade channel and the corporate balance-sheet channel to explain the disconnect between exchange rates and real activity, the role of direct foreign currency exposure on banks' balance sheets in the

transmission of exchange rate shocks has not been explored.[1,2] Given the importance of cross-border linkages in credit markets, the direct foreign currency exposure of banks can be an important channel of exchange rate transmission.[3] While recent studies (Krogstrup and Tille, 2017) have examined the role of foreign currency mismatch of the banking sector as a driver of international capital flows, its role in affecting domestic credit supply has not been studied.

Exchange rate shocks can affect the lending capacity of banks if banks have foreign currency exposure on their balance sheets. A bank that has more foreign currency liabilities than foreign currency assets is likely to face a negative shock to its net worth and may contract lending in the event of home currency depreciation. This, in turn, can have a negative impact on investment of firms that have banking relationship with such banks. Hence, the increased competitiveness of exporters due to home currency depreciation (the trade channel) may be offset by a fall in investment of non-financial firms due to the negative credit supply shock induced by currency depreciation (the bank-lending channel). Similarly, the negative effects of home currency appreciation on exporters can be mitigated if some banks gain and increase lending. Thus, the bank-lending channel can act as a "financial mitigator" in the transmission of exchange rate shocks and can potentially explain the weak response of economic activity to currency depreciation.

It is difficult to estimate the causal impact of currency depreciations on the real economy using macroeconomic data. Episodes of currency depreciation often coincide with deteriorating economic conditions, as was the case during the Latin American Debt Crisis, making it hard to disentangle the cause from the effect. To circumvent endogeneity concerns, I use a natural experiment to study the bank-lending channel of exchange rates. On January 15, 2015, the Swiss National Bank (SNB) surprised the market by abandoning the floor on the exchange

[1]The literature has documented various features, such as, the emergence of global value chains and the presence of imported intermediate inputs (Rodnyansky (2018), Amiti *et al.* (2014)), the dominant currency paradigm (Gopinath *et al.* (2010), Casas *et al.* (2016)), local currency pricing (Devereux and Engel (2003)), and pricing-to-market (Fitzgerald and Haller (2013)), among others, to explain the muted response of economic activity to exchange rate shocks.

[2]Prior studies have argued that the presence of foreign currency debt on the balance sheet of non-financial firms can have a negative impact on thier investment and can offset the positive effect of currency depreciation on exports. But there is mixed evidence in the literature regarding the effectiveness of the firm balance-sheet channel. For instance, Aguiar (2005) shows that, after the Mexican peso crisis of 1994, exporters had higher sales and profits relative to non-exporters but their relatively high exposure to foreign currency debt had a negative impact on investment. On the contrary, for a sample of Latin American firms, Bleakley and Cowan (2008) fail to find any significant difference between investment of firms which are highly exposed to foreign currency debt and those which are not, in the aftermath of the Latin American currency crisis.

[3]Existing studies on the effects of currency depreciations on the banking sector are mostly in the context of currency crises and banking crises (for instance, the East Asian crises in the late 1990s) and show how banks' foreign currency borrowing during (and leading up to) a currency crisis can lead to self-fulfilling bank runs, in the spirit of Diamond and Dybvig (1983). In contrast, this paper highlights how banks' net foreign foreign currency exposure can, in some cases, *help* the economy by enhancing banks' ability to supply more credit.

rate between the Swiss franc and the euro that had been in place since September 2011.[4] The announcement led to an approximately 20 percent appreciation in the value of the Swiss franc, which is large in currency markets with daily average fluctuations that are typically no greater than 1 percent. Moreover, the value of the Swiss franc remained elevated for approximately two years after the announcement. The persistence of this shock could plausibly have economically significant effects on the banking sector in Switzerland, which borrows heavily in foreign currency — as of December 2014, foreign currency liabilities accounted for 48 percent of the total liabilities of the banking sector. Besides, the Swiss economy relies heavily on exports, with a share of exports to GDP greater than 50 percent. Given the country's heavy reliance on exports and the significant exposure of the banking sector to foreign currency borrowing, this episode provides a useful laboratory to test the importance of both the exports channel and the bank-lending channel of exchange rates.

The empirical strategy relies on the differential exposure of banks to foreign currencies in the pre-shock period. I construct a novel dataset on Swiss banks' foreign currency exposure by hand-collecting data from their annual reports. This measure is constructed for the largest 100 banks (by assets) in Switzerland as the difference between their foreign currency-denominated assets and liabilities, normalized by total assets in 2014. I hypothesize that the appreciation of the Swiss franc should have a positive impact on the net worth of banks with more foreign currency liabilities than foreign assets as a stronger domestic currency reduces the value of banks' foreign liabilities. This increase in net worth should then allow these banks to lend differentially more.

Using a difference-in-differences research design, I show that banks with more foreign currency liabilities than foreign assets experience higher loan growth in the post-shock period as compared with banks with higher foreign asset exposure. In particular, a one-standard-deviation increase in the foreign currency exposure measure is associated with approximately 3.3 percentage-point higher loan growth after the shock. This is economically significant given that the average loan growth in the sample is 7 percent. This result is qualitatively robust to using hedged measures of currency exposure, controlling for other events that could have coincided with the currency shock, and controlling for other observable factors that can be correlated with banks' foreign currency exposure.

This identification strategy hinges on the assumption that the differential response of bank lending after the shock is driven by differences in banks' exposure to foreign currency and not

[4]The following statement from the annual report of Bank Linth shows that the SNB's decision was not expected by the market: "*Like all market participants, we were surprised by the decision of the Swiss National Bank on 15 January, 2015.*" I argue in greater detail about the exogeneity of the event in section 5.1.

by changes in credit demand correlated with exposure. Using data on bank-firm relationships, I show that there seems to be no endogenous sorting between banks' foreign currency exposure and their pre-existing relationships with exporting firms.

I show that the appreciation shock allows banks to increase lending by positively affecting their net worth. This result complements the findings reported in the literature on the risk-taking channel of domestic currency appreciation (Bruno and Shin (2014) , Kearns *et al.* (2016)) which suggests that currency appreciation increases credit supply by relaxing banks' value-at-risk constraints as their existing clients with foreign currency debt become better credit risks. I also show that currency appreciation affects banks' net worth by affecting their non-interest income as valuation changes due to exchange rate fluctuations are captured in non-interest income. This result complements the literature on the bank-lending channel of monetary policy in closed economies (Kashyap and Stein (2000), Kashyap and Stein (1995), Gambacorta and Mistrulli (2004), Gomez *et al.* (2016)) where monetary policy affects bank lending through its effect on net-interest income.

Having established that the appreciation shock affected credit supply of banks, I examine the real effects of the appreciation shock using firm-level data and data on bank-firm relationships. Real effects at the firm level will be driven by a combination of three channels: (i) *the exports channel*, which should have a negative impact on investment, sales growth, profitability, and employment of exporting firms as a stronger domestic currency makes exports less competitive; (ii) *the non-financial firm balance sheet channel*, which should imply a positive impact on investment of firms with foreign currency debt as a stronger domestic currency reduces their debt burden and allows them to borrow more; (iii) *the bank-lending channel*, which should have a positive impact on investment of firms borrowing from positively affected banks.

To isolate the exports channel, I compare the differential real effects of currency appreciation on exporters versus non-exporters. I find that exporting firms experienced 8 percent slower growth of sales and 5 percent slower growth of employment as compared with non-exporting firms. Their profitability ratios, such as return on equity and assets, were approximately 6 percentage points lower on average relative to those of non-exporting firms. Investment of exporters fell by approximately 2 percentage points relative to that of non-exporting firms.

To quantify the effects of the firm balance-sheet channel, I compare the differential real effects across firms that had foreign currency debt on their balance sheet in 2014 and those that had no foreign currency debt in 2014. I find that the firm balance-sheet channel did not have a significant impact on firms' investment, employment, or sales growth. This finding is

in line with results reported in the previous literature on the firm balance-sheet channel of exchange rates in the context of Latin American debt crises. Those studies have shown that firms typically match their income stream with the currency composition of their debt, leading to an endogenous sorting between exporters and firms with foreign currency debt (Bleakley and Cowan, 2008). In fact, this does seem to be the case for firms in my sample as well. Close to 80 percent of the firms that had foreign currency debt on their balance sheets were exporters. Hence, even though these firms could, in principle, borrow more, they were also hit by a negative shock due to lower demand for their products abroad, leading to no change in investment.

Finally, to quantify the effects of the bank-lending channel, I match non-financial firms with banks and compute an average measure of bank lending exposure for each firm, based on the average lending share of each bank for that firm in the syndicated loan market prior to the shock. In this way, I categorize firms into those that had banking relationships with positively affected banks and those that had banking relationships with negatively affected banks. My results suggest that the bank-lending channel did play a significant role in affecting investment of firms. In terms of economic magnitude, investment of firms that had lending relationships with positively affected banks was 1 percentage point higher in the post-shock period as compared with firms that had banking relationships with negatively affected banks. This is economically significant as this implies that the bank-lending channel did offset the exports channel by almost 50 percent. Moreover, the impact of the bank-lending channel was more persistent as compared with that of the exports channel. While investment of exporters reverted back to its pre-shock level in 2016, investment of firms with banking relationship with positively affected banks continued to be higher in 2016.

As a final extension to help assess external validity, I construct a new historical dataset on foreign currency exposure of banking sectors for a sample of 44 emerging and advanced economies over the 1950-2016 period and explore the importance of the bank-lending channel in the transmission of exchange rate shocks more generally. To this end, I interact the foreign currency exposure of the banking sector with the currency shock and examine the response of one-year-ahead GDP growth to currency shocks. I find that in response to a 20 percent depreciation of domestic currency, one-year-ahead GDP growth falls by 1.6 percentage points more in countries with banking sectors that were net borrowers in foreign currency. The bank-lending channel matters more for emerging markets. A 20 percent depreciation of domestic currency in emerging markets is associated with an approximately 2 percentage point fall in one-year-ahead GDP growth if the banking sector has net foreign currency liability exposure.

Although these country-panel results show correlations, unlike those in the earlier analysis, these results provide suggestive evidence of another reason why currency depreciations are often catastrophic in emerging markets, where banks typically have more foreign currency liabilities than assets on their balance sheets. These findings have implications for monetary policy in small open economies as currency depreciations may not stimulate growth if the banking sector has large foreign currency exposure that is not perfectly hedged.

The rest of the paper is organized as follows. Section 2 provides background on the Swiss currency appreciation episode and the Swiss banking sector. Section 3 presents data and summary statistics. Section 4 discusses the empirical strategy and results and section 5 concludes.

2 Background

2.1 The Currency Appreciation Episode - January 2015

Switzerland is a small open economy with heavy reliance on exports – the share of exports in GDP has been greater than 50 percent since 2000. Europe is the most important destination for Swiss exports. In 2016, exports to Europe accounted for 54 percent of Switzerland's total exports. Hence, the chf/eur exchange rate is an important policy variable for the Swiss National Bank (SNB) as changes in this exchange rate can potentially have a significant impact on the real economy by affecting exports. In the early 2000s, the exchange rate between the Swiss franc and the euro fluctuated between CHF 1.45 and 1.7 to the euro. Since 2008, however, as the global economic turmoil gathered pace, demand for the Swiss franc as a safe haven currency increased and, by August 2011, the Swiss franc had appreciated by around 30 percent as compared with its value in 2000. To prevent further appreciation of the Swiss franc, the SNB introduced a floor of CHF 1.20 per euro in September 2011. According to a press statement released in September 2011, the SNB announced that it was willing to purchase foreign exchange in unlimited quantities to defend the floor of CHF 1.20 to the euro.

On January 15, 2015, the SNB surprised the markets by discontinuing the minimum exchange rate of CHF 1.20 per euro. The announcement was all the more surprising because the Vice Chairman of the SNB had said in an interview on January 12, 2015 that "the cap on the swiss-euro exchange rate must remain a cornerstone of our monetary policy." The January 15 announcement led immediately to an approximately 20 percent increase in the value of the Swiss franc (figure 2). This was a huge shock by historical standards and led to an immediate collapse in the broad stock market index. Even after one year from the announcement, the Swiss Franc maintained its high value at 1.09 CHF per euro.

There is some narrative evidence indicating that the SNB's decision to discontinue the

minimum exchange rate was completely unanticipated. For instance, the following statement from the annual report of Bank Linth shows that the SNB's decision took the market by surprise: "*Like all market participants, we were surprised by the decision of the Swiss National Bank on 15 January, 2015*". Moreover, the one-month-forward exchange rate between the Swiss franc and the euro did not change in December 2014, which should have been the case if the announcement was anticipated (figure 3).

2.2 The Swiss Banking Sector

The banking sector in Switzerland is divided into six broad categories of banks – big banks, foreign banks, cantonal banks, regional and savings banks, Raiffeisen banks, and stock-exchange banks. UBS and Credit Suisse are the two banks in the 'big banks' category, with a combined market share of 48 percent of banking system assets in 2014.[5] Cantonal banks are government-owned banks, one in each canton of Switzerland.[6] Cantonal banks had a share of 17 percent of banking system assets in 2014. Foreign banks in Switzerland exist mostly as legal entities (controlled by their parent bank), with an asset share of 10 percent. Branches of foreign banks, which are not separate legal entities, had an asset share of 2 percent in 2014. Most of the foreign banks in Switzerland are European banks. Regional and savings banks are small banks and focus on retail lending. They are geographically concentrated, with limited foreign exposure. The regional and savings banks had an asset share of 3.5 percent in 2014. Raiffeisen banks are structured as co-operatives, and have a regional presence, with an asset share of 6 percent. Stock exchange banks are involved primarily in providing asset management services to domestic and foreign clients, and have an asset share of 7 percent. 'Other' banks had an asset share of 6 percent in 2014.

The banking sector in Switzerland has a large exposure to international currencies. As of December 2014 (one month before the central bank announced its decision to abandon the Swiss Euro peg), foreign currency assets accounted for 47 percent of the total assets of the banking system while foreign currency liabilities accounted for 48 percent of the total liabilities. Overall, the foreign currency exposure on the liability side exceeded the foreign currency exposure on the asset side by one percentage point. This is not trivial given that the size of the banking sector (measured as total assets) in Switzerland was approximately five times the GDP in 2014 . A breakdown by bank groups reveals significant heterogeneity in net foreign currency exposure, defined as the difference between the liability and asset share of

[5]The share of assets in total assets of the banking system in 2014 is calculated using the list of reporting banks and their balance sheet size, downloaded from the SNB's website.

[6]There are 26 cantons in Switzerland and 24 cantonal banks. The cantonal bank in the canton of Appenzel Ausserrhoden was sold to UBS, and the one in the canton of Solothurn was privatized in 1995.

foreign currency denominated liabilities and assets, respectively. Big banks (UBS and Credit Suisse) had a net negative foreign currency exposure as of December 2014 – their asset exposure exceeded their liability exposure by 4 percentage points.[7] While cantonal banks, regional banks, and Raiffeisen banks had a net positive foreign exposure – their liability exposure exceeded their asset exposure.

3 Data and Summary Statistics

A principal contribution of this paper is the construction of a new dataset on foreign currency exposure (including off-balance sheet exposures) of banks and to link major bank- and firm-level datasets for Switzerland to observe the real effects of currency appreciation via changes in credit supply.

For the bank-level analysis, I use annual data on balance sheet, income statement, and cash flow variables for banks in Switzerland from the Bankscope Database, accessed through the Wharton Research Data Services. This database is compiled by Bureau van Dijik (BvD) and provides information on bank balance sheet variables for banks in many countries around the world. It sources micro-data on banks in different countries from their financial statements and presents the final data in a consistent and harmonized format across countries.[8] This database, however, does not have information on foreign currency exposure of banks. Hence, I hand-collect data on foreign currency denominated assets and liabilities from the annual reports of the biggest 100 banks, which account for approximately 80 percent of the banking system by assets in 2014.[9]

I use two sets of dependent variables for the bank-level analysis. I hypothesize changes in exchange rates influence bank credit by affecting banks' profitability and equity. The first set of dependent variables includes lending outcomes such as annual loan growth, and loan growth broken down by types of customers – mortgage loans, inter-bank loans, and consumer loans.[10] The second set of dependent variables includes profitability and net worth variables such as pre-tax profits, net income, net interest income, net non-interest income, trading income, and bank equity.[11] In line with the literature on the bank-lending channel of monetary policy

[7] The gross asset exposure of the big banks to foreign currencies is huge – it was 71 percent in 2014. The high level of gross exposure makes these banks particularly vulnerable to foreign exchange shocks.

[8] BvD no longer publishes the Bankscope Database. It has replaced Bankscope database with ORBIS Bankfocus database. For my analysis, I have combined Bankscope database with ORBIS Bankfocus database.

[9] According to the Swiss National Bank's website, there are 268 reporting banks in Switzerland in 2014, including branches of foreign banks and excluding private bankers who do not actively seek deposits from the public.

[10] Bankscope does not have a good coverage of lending broken down by types (mortgage vs industrial). Hence, I hand-collect data on mortgage loans, inter-bank loans, customer loans.

[11] Data on trading income is hand-collected.

(Kashyap and Stein (1995), Kashyap and Stein (2000)), bank-level controls include size (log of total assets), liquidity, bank equity (normalized by assets), and loans to deposits ratio. I use annual data on these variables for the time period 2011-2016.[12]

Sample selection is based on availability of data on foreign currency exposure. All variables are winsorized at 5 and 95 percent to remove outliers. Panel A of table 1 reports summary statistics for the main variables used in the bank-level analysis. The average values of control variables in my sample are similar in magnitude to those reported in the literature. Average equity-to-assets ratio is 8.9 percent in my sample, compared to 8.7 percent in Gomez *et al.* (2016) and 9.5 percent in Campello (2002). Liquidity ratio is 31.5 percent in my sample, compared to 27 percent in Gomez *et al.* (2016)'s sample and 32 percent in Campello (2002).

Data on accounting variables and operating performance of firms in Switzerland is from the Worldscope database. This database provides information on financial and income statements of publicly listed firms in Switzerland. To study the trade channel of currency appreciation, I define firms as exporters and non-exporters. To do that, I merge Worlsdcope database with Amadeus database, which contains information on export turnovers of publicly listed as well as private firms in Switzerland. I characterize a firm as an exporter if it has positive values of export turnover to total turnover ratio in the pre-shock period (before 2015). Using this measure, 76 percent of the firms in my sample are exporters. This seems reasonable since I am using data on publicly listed firms which tend to be very large and there is a positive correlation between propensity to export and firm size.

To study the bank-lending channel of currency appreciation, I compute a measure of bank dependence of non-financial firms. I merge Capital IQ data with Worlsdsope data using 'ticker' symbol as the identifier. Capital IQ database has detailed information on capital structure of publicly listed firms. For each firm, I compute the average ratio of bank debt to total capital between 2011 and 2014. A firm is classified as bank dependent if its ratio of bank debt to total capital is in the top quartile of the bank debt to capital distribution. I also gather evidence on bank-firm relationships using Dealscan database. This database contains deal/loan level information on financial transactions between non-financial firms and financial intermediaries. I match firms in Worldscope database with those in Dealscan database and create a measure of their banking relationship with banks with different values of foreign currency exposure to study the impact of their banking relationships on credit supply/financial constraints in the post-shock period. I supplement this dataset with hand-collected data on bank-firm linkages from the financial statements of non-financial firms.

[12] See Appendix for definitions of variables used in the analysis.

For the firm-level analysis, I use annual data on assets, market capitalization, employment, pre-tax income, leverage, investment, Tobin's Q, cash-to-assets, sales, and profitability measures like return on assets and equity for the period 2011-2016.[13] The sample contains only non-financial firms – firms with SIC codes in the range 6000 - 6999 are dropped. Following Almeida and Campello (2007), I exclude firms for which annual asset growth is higher than 100 percent. This practice is standard in the empirical corporate finance literature. Annual asset growth rates higher than 100 percent can be indicative of mergers or reorganizations. Hence, this rule ensures such firms are excluded from the sample. I also drop firms with negative values for sales. I use a balanced sample of firms for my analysis to make sure that my results are not driven by the entry and exit margin. All variables are winsorized at 5 and 95 percent to exclude outliers.

This selection procedure implies I have 138 unique firm IDs and more than 600 firm-year observations. Around 65 percent of the firms are in manufacturing sector and 15 percent belong to the services sector. Panel B of Table 1 presents summary statistics for key firm-level variables for the pre-shock period (2011-2014).

Daily data on bilateral exchange rate between the Swiss franc and the euro and central bank policy rates is from the Global Financial Database (GFD).[14] Data on one-month forward exchange rate between the Swiss franc and the euro is from Datastream. Data on nominal exchange rate for each country in the sample is from the Bank for International Settlements database. Aggregate data on foreign currency assets and liabilities of banking sector in different countries are from the International Financial Statistics database (IFS) of the IMF. Annual data on real GDP for advanced and emerging markets is from the Maddison Project database, version 18. The Appendix provides more details on the construction of historical dataset for each variable used in the cross-country analysis. Panel C of table 1 shows summary statistics for the main macroeconomic variables used it the cross-country analysis.

4 Empirical Analysis

This section discusses the identification strategy and presents results.

4.1 Identification Strategy

It is difficult to estimate the causal impact of exchange rates on real economy using macroeconomic data. Changes in exchange rates are often driven by cyclical factors – low GDP growth

[13] See table A1 for detailed definitions of all variabels used in the analysis and also their sources.
[14] See table A3 for definitions of policy rates for each country in the sample.

may lead to a depreciation of exchange rates. This leads to a problem of reverse causality and can produce biased estimates. Using lagged values of exchange rates may partially address the issue but can not completely eliminate it as the exchange rate changes may be driven by anticipation of future economic activity. Another issue with using macroeconomic data is the simultaneity bias. A positive productivity shock may simultaneously lead to an appreciation in real exchange rate and an increase in current and future output. Hence, a time series analysis using macroeconomic data may result in the false conclusion that that real exchange rate appreciations lead to higher economic growth.

To circumvent these endogeneity issues, I use micro-data on bank balance sheets and estimate the causal impact of currency appreciation using a difference-in-differences estimation strategy with continuous treatment. In particular, I exploit the differential exposure of banks' balance sheets to foreign currency denominated assets and liabilities. A bank which has a higher share of foreign currency assets (in total assets) relative to foreign currency liabilities in the pre-shock period should be negatively affected by the appreciation of the Swiss franc as the value of its assets goes down and the value of its liabilities goes up. Similarly, a bank that borrows heavily in foreign currency but does not have a proportional foreign currency exposure on the asset side of the balance sheet should be positively affected by home currency appreciation since the appreciation reduces the debt burden of the bank.

Using micro-data ensures that reverse causality is not an issue — credit supply of one bank can not affect the SNB's decision to abandon the peg. Since the identification strategy relies on the cross-sectional variation in *currency exposure* of banks, it also mitigates the concerns that other macroeconomic events that coincide with the appreciation event would confound the casual mechanism.

A potential concern with the identification strategy is that distribution of exposure across banks is not random. In other words, certain bank characteristics, such as liquidity or size, are correlated with foreign currency exposure. Hence, the differential lending response of banks after the shock could be driven by differences in bank characteristics, and not in their currency exposure. To account for this possibility, I interact bank characteristics with the dummy for the appreciation event so that it soaks up any variation in the outcome variable due to bank characteristics that could be correlated with currency exposure.

Another concern with the identification strategy could be that the differences in lending behavior of banks is driven by endogenous matching of banks and firms — banks which higher loan growth could be lending to firms that were relatively unaffected by the appreciation shock and hence, their relatively higher loan growth is an artifact of higher demand. To alleviate

this concern, and also to shed light on the real effects of the appreciation shock, I match non-financial firms with banks using loan-level data from Dealscan and provide evidence on this kind of sorting in section 4.5.

4.2 Currency Exposure and Lending Outcomes

I construct the foreign currency exposure for each bank in the sample as the difference between foreign currency denominated liabilities and assets (as a share of total liabilities and assets respectively) in December 2014:[15]

$$exposure \equiv \left[\frac{liabilities_{foriegn}}{liabilities_{tot}} - \frac{assets_{foreign}}{assets_{tot}} \right]_{2014}$$

This measure will be positive if the share of foreign currency liabilities exceeds the share of foreign currency assets. A bank with a positive value of this measure should be positively affected by the appreciation of the Swiss franc as the fall in the value of foreign assets is less than the fall in the value of foreign liabilities, leading to a positive impact on the banks' net worth. The average foreign exposure of the banking sector using this measure is 2.7 with standard deviation of 12.6. This implies that on an average, the share of foreign currency liabilities exceeds that of foreign currency assets by 2.7 percentage points. For comparison, I use aggregate data on foreign assets and liabilities of bank groups from SNB's website and compute an average measure of currency exposure across bank groups. The average foreign exposure of the banking sector using SNB data is 2.8 percentage points, which roughly matches the average foreign exposure in the sample constructed using hand-collected data from banks' annual reports.

To explore the impact of foreign currency exposure on bank lending in the aftermath of home currency appreciation, I estimate the following model commonly used in the literature on bank-lending channel of monetary policy:

$$\begin{aligned} loan\ growth_{b,t} &= \alpha + \beta post_t + \gamma exposure_b + \delta(post_t \times exposure_b) \\ &+ \sum_{x \in controls} \eta_x (post_t \times x_{b,t-1}) + \sum_{x \in controls} \mu_x x_{b,t-1} + \epsilon_{b,t} \end{aligned} \tag{1}$$

where, $loan\ growth_{b,t}$ is the annual growth rate of gross loans of bank b in time t, $post_t$ is a dummy variable that takes a value 1 for years 2015 and 2016, $exposure_b$ is the foreign currency

[15] This measure is constructed using information on foreign liabilities and assets based on domicile. Few banks report assets and liabilities broken down by currency and positions in the derivatives market. For banks that do report information on hedging, I compute net positions in foreign currencies after incorporating off-balance sheet exposure arising from positions in forex derivative markets. I show that my results robust to using the hedged measures of exposure and exposure on the basis of foreign currency in section 4.4.2. I use the measure based on domicile in the baseline analysis to ensure a large sample size.

exposure of bank b as defined above, $exposure_b \times post_t$ is an interaction term between the post-shock period (i.e., for years 2015 and 2016) and the exposure variable. This variable estimates the differential impact of the currency shock on banks with different levels of foreign currency exposure and is our main variable of interest. The set of control variables includes lagged value of total assets (size), ratio of equity to assets, bank liquidity, and loans to deposits ratio, in line with the literature on the bank-lending channel of monetary policy. To allow for the possibility that the exposure variable can be correlated with certain bank characteristics, the model contains interactions between bank characteristics and the event dummy. This would ensure that any variation in the outcome variable in the post-shock period that is driven by the bank characteristics is absorbed by these interaction terms. Since the treatment variable varies at the bank level, standard errors are clustered at the bank level to allow for intra-bank auto-correlation of residuals within banks. This equation is estimated for the time period 2011 to 2016.

The main variable of interest is δ as it reflects the differential lending response of banks with different levels of currency exposure. Table 2 reports the results for equation 1. From column (1), we see that the coefficient on the interaction between *exposure* and *post* is positive and significant. This implies that banks with a more positive net foreign currency exposure experience a higher loan growth in the post-shock period as compared to banks with smaller values of net exposure. Column (2) and (3) add bank- and country-level controls that are known to have an effect on bank lending. We see that the coefficient on the interaction term remains positive and significant. As is established in the banking literature, bank size (assets) is negatively correlated with loan growth while liquidity is positively related to loan growth. GDP growth has a positive and significant impact on loan growth. While the sign on the coefficient for interest rates is in the right direction (negatively related to loan growth), it is not statistically significant.

In column (4), I add the interaction terms between bank characteristics and the dummy for the currency shock. We see that while the magnitude on the interaction term between currency exposure and the event dummy goes down, it remains positive and statistically significant. In particular, size plays an important role. The coefficient on the interaction between *size* and *post* is negative and significant. This implies that big banks were negatively affected by the currency shock and reduced lending more than smaller bank in the post-shock period. The interaction term between exposure and currency shock remains positive even if I exclude big banks from the sample (column 5).

Finally, in column (6), I test whether gross exposures also matter for bank lending. I

decompose net currency exposure into exposure from only the liability side and that from the asset side. We see that the interaction term between foreign currency liabilities and post is positive and statistically significant while the interaction term between foreign currency assets and post is negative and statistically significant. This confirms the mechanism driving the results. As home currency appreciates, the value of foreign liabilities goes down and this should have a positive impact on the bank's net worth and consequently its ability to lend. Hence, we should expect banks with high foreign liability exposure to gain from domestic currency appreciation. Similarly, banks with a high share of foreign currency assets should lose as home currency appreciates as their value in domestic currency falls. It is also encouraging to note that the cumulative magnitudes on the interaction terms for gross exposures roughly correspond to the magnitude on the interaction term between net exposure and post in column (4). A one standard deviation increase in the net exposure measure leads to approximately a 3.3 percentage point increase in loan growth after the shock. This is economically significant given the average loan growth in the sample is 7 percent.

A possible concern with the identification strategy could be that there are pre-existing trends that are driving the difference in lending growth of positively versus negatively exposed banks after the shock. To address this concern, I check for parallel trends. The parallel trends assumption requires that in the absence of treatment, the difference between treated and control group should be constant over time. I test this assumption formally using the following specification:

$$\begin{aligned} \log(loans)_{bt} &= \alpha_b + \textstyle\sum_t \beta_t T_t + \sum_t \gamma_t (Treated_b \times T_t) + \\ &\textstyle\sum_t \sum_{x \in controls} \mu_{xt} (x_{b,t-1} \times T_t) + \sum_{x \in controls} \eta_x x_{b,t-1} + \epsilon_{b,t} \\ &\forall t \in \{2011, 2012, 2013, 2015, 2016\} \end{aligned} \tag{2}$$

where, α_b captures bank fixed effects, T_t is a dummy variable for each time period (year) in the sample (2014 is the omitted year), $Treated$ is a dummy variable that takes a value 0 if the bank is net long in foreign currency and 1 otherwise, $(Treated_b \times T_t)$ is an interaction term between time dummies and the dummy variable for exposure to foreign currency, $x_{b,t-1}$ is a set of lagged bank-level controls and $x_{b,t-1} \times T_t$ are the interaction terms between bank-level controls and time dummies. Standard errors are clustered at the bank-level to allow for auto-correlation of residuals across time.

The main coefficients of interest are γ_t, which show the difference in loan growth of treated and control groups in each period in the sample. Figure 4 shows the 95 percent confidence

interval plots for the estimated coefficients γ_t from equation 2. It is evident from the figure that there are no statistically significant differences in loan growth of banks with positive and negative foreign currency exposure in the years prior to the currency appreciation episode in 2015, which is consistent with the parallel trends assumption for the difference-in-differences methodology. In 2015, however, the banks with a positive foreign currency exposure (foreign currency liability share higher than foreign currency asset share) experience a higher loan growth as compared to banks with a negative foreign currency exposure and the difference is statistically significant.

4.2.1 Types of Lending

It may be important to understand how the currency shock affected lending in different markets. For instance, adjusting inter-bank lending vs industrial lending can have different macroeconomic implications. While it is not possible to distinguish between consumer loans and industrial loans, banks do report their loans broken down as inter-bank loans, mortgage loans, and costumer loans. Customer loans can be short-term consumer loans as well as industrial loans. Mortgage lending has the biggest share in bank lending, with an average share of roughly 72 percent. Customer lending and inter-bank lending have average shares of 22 percent and 18 percent in total lending. Bankscope does not have good coverage of different types of lending, hence I hand-collect data on inter-bank, customer, and mortgage loans for 2014 and 2015. To explore the effect on different types of lending, I estimate the following equation:

$$\Delta Y_b = \alpha + \beta exposure + \theta \mathbf{BANK}_b + \epsilon_b \tag{3}$$

where, the dependent variable can be loan growth of mortgage loans, inter-bank loans, and customer loans of bank b in 2015. $\mathbf{BANK}_b$ is a vector of lagged bank-level controls as discussed in the baseline specification. This equation is estimated for a cross-section of banks in 2015. Results are reported in table 3.

Columns (1), (2), and (3) show results for mortgage lending, inter-bank lending and customer lending, respectively. We see that *exposure* is significant and positive for mortgage loans and customer loans. In terms of economic magnitude, a one standard deviation increase in exposure variable leads to 5.6 percentage point increase in growth rate of mortgage loans and 3.3 percentage point increase in the growth rate of customer loans. The coefficient on exposure is insignificant for inter-bank loans.

Another interesting dimension is to examine the effect on secured vs unsecured loans. When banks suffer losses, do they respond by changing the risk profile of their portfolio? To

answer this question, I hand-collect data on loans secured by collateral and those without any collateral and investigate how the loan growth of secured vs unsecured loans reacts to the currency shock. Results are reported in table 3. The dependent variable is annual loan growth of unsecured loans in column (4) and of secured loans in column (5). We see that the foreign currency exposure does not matter for unsecured loans but it is positive and significant for secured loans. One way to interpret this result is that banks which have net long exposure in foreign currency reduce their collateralized lending when they are hit by the currency shock while they keep their unsecured lending unchanged. This implies that the share of unsecured loans increases in the lending portfolio of banks with a net long foreign currency exposure and has implications for risk shifting as an unintended consequence of currency appreciation.

4.3 Channels

In this section, I investigate what are the channels through which the Swiss franc appreciation episode affects bank lending. Financial intermediaries try to hedge foreign exchange risk on their balance sheets by buying foreign exchange forward contracts, swaps or other forex derivatives. However, a financial intermediary that actively hedges its portfolio may be unable to fully insulate its balance sheet from sudden movements in exchange rates as their Value-at-Risk models typically calculate expected losses based on historical events. The following statement from the annual report of UBS reflects the inability of banks to fully protect their balance sheets from unfavorable movements in market prices: "*As seen during the financial crisis of 2007-09, we are not always able to prevent serious losses arising from extreme or sudden market events that are not anticipated by our risk measures and systems. Value-at-risk, a statistical measure for market risk, is derived from historical market data, and thus by definition could not have anticipated the losses suffered in the stressed conditions of the financial crisis."*

Given that the January 2015 appreciation shock was largely unprecedented, it is likely that it affected banks' profits. Banks report losses arising from derivatives and foreign currency translation as net trading income. If banks were not perfectly hedged against the appreciation shock, we should expect the trading income of banks with a net liability foreign currency exposure to go up relative to banks with a net asset foreign currency exposure.

To test this formally, I investigate the response of profits and net income of banks around the shock. More importantly, I want to explore the response of the non-interest component of net income, which includes trading income. To do this, I estimate equation 1, with $\Delta Profit$, $\Delta NetIncome$, and $\Delta Non-interest\ Income$ and $\Delta Interest\ Income$ and $\Delta TradingIncome$

as dependent variables.[16] Results are reported in table 4. In column (1), the dependent variable is one-year difference in net income, in column (2) , the dependent variable is one-year difference in net interest income, in column (3), the dependent variable is one-year difference in net non-interest income and in column (4), the dependent variable is one-year difference in trading income. All outcome variables are scaled by bank assets in 2014. All columns include bank-level controls.

From table 4, we find that banks with more foreign currency liabilities see a higher increase in net income in 2015 (column 1). It is useful to examine whether this increase in net income is driven by an increase in interest income or non-interest income. In contrast to the conventional monetary policy transmission channel that works by affecting net interest income of banks, we see that the bank lending channel of currency appreciation works by affecting non-interest income. From column (2) and (3), we see that the exposure variable is insignificant for interest income but is positive and statistically significant for non interest income. Further, trading income is positively affected for banks with a net foreign currency liability exposure (column 4). Since trading income is part of non-interest income, it explains why the coefficient on exposure is statistically significant and positive for non-interest income.

4.4 Robustness and Additional Evidence

In this section, I conduct a battery of robustness checks to address a number of concerns with the identification strategy and also supplement the main analysis with a narrative measure of exposure.

4.4.1 Narrative Evidence

To provide additional support to the importance of foreign currency mismatch as a mechanism for transmission of currency shocks, I conduct an in-depth study of the annual reports of Swiss banks to gather narrative evidence on their foreign currency exposure and on the likely impact of the exchange rate shock on their balance sheet. I create a qualitative measure of exposure which takes a value 0 if the bank was negatively affected by the currency shock *and mentions so in its annual report.* For instance, the following statement from the annual report of Banque Privee BCP (Suisse) reflects a negative impact of the shock:

"*... the decision of the Swiss National Bank to discontinue the minimum exchange rate of CHF 1.20 per euro impacted negatively the results of the bank, given that costs are expressed in CHF while the asset and revenue base are split between EUR and USD.*"

[16] I am using a cross-section analysis for this section because I use hand-collected data on trading income (for which I collect data for 2014 and 2015).

The qualitative measure takes a value 0 for this bank. While Aargauische Cantonalbank has the following statement on the impact of the currency shock in its 2015 annual report:
"*A massive increase is reflected in the result from trading activities. The previous year's figure of CHF 32.2 million was increased by 52.4% to CHF 49.1 million. The additional income was accrued primarily in foreign exchange and foreign currency trading due to the decisions of the SNB in January 2015.*"
The qualitative measure of exposure takes a value 1 for this bank.

Using this measure, I investigate the response of bank lending to the change in exchange rate for a cross-section of banks by estimating the following model:

$$\Delta Y_b = \alpha + \beta QualitativeMeasure + \theta \mathbf{BANK}_b + \epsilon_b \tag{4}$$

where, ΔY_b could be loan growth, change in profit or change in income of bank b between 2014 and 2015, $QualitativeMeasure$ is an indicator variable which takes a value 0 if the bank mentioned in its 2015 annual report that it was negatively affected by the shock and 1 otherwise, and $\mathbf{BANK}_b$ is a vector of bank-level control variables including total assets (size), capital, liquidity, and loans to deposits in 2014. The main variable of interest is β, which provides an estimate of the differential impact of the currency shock on positively affected vs negatively affected banks. Equation 4 is estimated for a cross section of 53 banks in 2015.[17]

Table 5 reports the estimates from equation 4. Column (1) shows the estimate of β without including bank-level controls. We see that banks which reported as being positively affected by the shock experienced a 4.4 percentage point higher growth rate of loans as compared to banks which reported as being negatively affected by the shock. After controlling for bank-level variables like size, capital to assets ratio, liquidity, loans to deposits ratio (in 2014), we see that the coefficient on β is slightly lower in magnitude but remains statistically significant and positive (column (4)).

Next, I investigate what explains the relatively higher loan growth of banks which reported being positively affected by the currency shock. In particular, I test whether the banks which had a relatively higher loan growth rate in 2015 also experienced relatively higher growth in profit or income, which allowed them to expand credit. Table 5 presents the results. In column (2) and (3), the dependent variable is one-year difference in profit and income, respectively, normalized by total assets in 2014. Column (2) and (3) do not control for bank-level characteristics while column (5) and (6) include bank-level controls. From column (2) and (3),

[17] I studied more than 100 annual reports to create this measure. Not all banks attribute changes in their balance sheets in 2015 to the currency shock. Sample selection (53 banks) for this analysis is based entirely on the existence of statements in banks' annual reports on the effect of the shock.

we see that banks which were positively affected by the currency shock did see an increase in their profits and net income. The coefficient for the Qualitative measure is positive and significant. Even after controlling for bank-level characteristics, the coefficient on qualitative measure remains positive and significant for profits and net income (column 5 and 6). These results suggest that the appreciation of the Swiss franc affected the loan growth of banks with differential exposure to foreign currency by affecting their profits.

4.4.2 Alternate Measures of Exposure

In this section, I construct different measures of exposure to test whether my results are dependent on the definition of exposure variable. The first measure of foreign currency mismatch is constructed using only on-balance sheet exposures and is based on currency of denomination rather than domicile. The second measure is constructed by incorporating positions in the derivatives market, i.e., by incorporating off-balance sheet exposure.

The measure of foreign currency mismatch on the basis of currency is constructed as follows:

$$\left[\frac{\sum_c liabilities_{foriegn^c}}{liabilities_{tot}} - \frac{\sum_c assets_{foreign^c}}{assets_{tot}}\right]_{2014}$$

where, foreign liabilities and foreign assets are liabilities and assets denominated in foreign currency. The average exposure was 3.4 percentage points in 2014 with a high standard deviation of 14.8 percentage points. Figure 5 shows the distribution of this measure for 69 banks for which data is available. We can see that there is enough variation in this measure, with values ranging from -36.1 to 58.6.

Using this measure, I estimate equation 1 in a one-year window around the appreciation event. Results are reported in column (1) of table 6. The coefficient on the interaction term in column (1) is positive and significant. One standard deviation increase in the exposure measure leads to 4.4 percentage point increase in loan growth in the post-shock period.

The second measure of exposure is based on difference between liabilities and assets in different currencies as opposed to domicile. Even though the appreciation of the Swiss franc against all its trading partners was broad based (figure 2 panel (b)), the appreciation was strongest against the Euro. To capture the relative importance of Euro for certain banks, I construct a weighted measure of exposure as follows:

$$exposure \equiv \sum_c \frac{liabilities_c}{foreign\ liabilities} [liabilities_c - assets_c]_{2014}$$

where, c refers to currency c. This measure first computes the total difference between liabilities and assets of currency c (including off-balance sheet positions because of participation in

derivatives markets). Then, it computes an average mismatch over all currencies using the share of each currency in total foreign liabilities as weights. The advantage of using this measure is that it captures the true extent of foreign currency exposure because it takes into account hedging activity by banks. Also, using pre-determined weights ensures that the measure captures the relative importance of different currencies for different banks.

I construct this measure for 54 banks which report information on off-balance sheet exposures. The average (hedged) exposure was CHF 8 million in 2014 with a standard deviation of CHF 37 million. The bottom panel of figure 5 plots this measure. We see that most banks have a net asset foreign currency exposure.

Column (2) of table 6 shows estimates from equation 1 using this measure of exposure. We see that the coefficient on the interaction term is positive and significant. One standard deviation increase in this measure leads to a 4.1 percentage point increase in loan growth of banks in the post-shock period.

The above two measures are based on direct exposure of banks to currency fluctuations. However, there are indirect channels through which currency appreciation can affect the banks. For instance, banks which specialize in trade finance could be negatively affected because of negative impact on exporters. One way to capture such indirect effects is to look at the response of bank stock returns to the currency shock.

I compute one-month difference in bank stock returns around the currency appreciation event. Using it as an indirect measure of exposure, I estimate equation 1. Results are reported in column (3) of table 6. One standard deviation increase in this measure leads to 16 basis points increase in loan growth in the post-shock period. This suggests that the indirect effects of currency appreciation on banks are limited in terms of economic significance.

4.4.3 Robustness: Other

A standard robustness check in the difference-in-difference methodology is to change the window around the event and make sure that the effect of treatment dissipates as the window around the event expands. To test this, I estimate equation 1 for the sample period 2014-2016. If the identification strategy is really picking up the effect of currency exposure, we should expect a larger coefficient on the interaction term for this time period as compared to the baseline specification.

Table 7 reports the results. Column (1) reproduces estimates from equation 1 for comparison. In column (2), the sample period is 2014-2016. The coefficient on the interaction terms is higher as compared to the baseline specification. This implies that the treatment effect is

stronger around the main event.

It can be argued that loan growth is generally persistent and the persistence should be controlled for by including lagged value of loan growth in controls. In column (3), I control for lagged value of loan growth and find that the coefficient on the interaction term becomes slightly smaller in magnitude but remains statistically significant and positive. Another robustness test is to exclude lagged value of loans to deposits variable from the set of controls. We see that the coefficient on the interaction terms barely changes because of this change (column 4).

A potential concern with the identification strategy is that there could be other macroeconomic events that coincided with the currency shock and could have negatively affected the loan growth of banks with a net asset exposure to foreign currency. If this is the case, it would confound the identification strategy. One major macroeconomic event that did coincide with the removal of the floor between the Swiss franc and euro, and merits discussion, is the reduction in interest rates on sight deposits that commercial banks hold with the SNB. In a press release on January 15, 2015, the SNB announced that in order to make investments in Swiss franc less attractive and to mitigate the effects of the discontinuation of the minimum exchange rate between the Swiss franc and the euro, the interest rates for balances held on slight deposit accounts would be lowered to -0.75% from January 22.[18] This interest rate applies to sight deposits above a certain threshold, where the threshold is 20 times the minimum reserve requirement.

Such a high threshold implies that few banks were affected by the change in interest rates. For banks that have deposits above the exemption level, the reduction in interest rate should affect their balance sheet by affecting their net interest revenue. This will confound the identification of the currency shock only if banks which have a net asset foreign currency exposure are also the ones that have deposits above the exemption limit and are negatively affected by the interest rate decline.

To test this formally, I check whether the net interest revenue of banks with differential foreign currency exposure responds differently to the currency shock. If the decline in interest rates is driving the result, we should expect a significant difference in net interest revenue for banks with differential currency exposure around the event.

[18]Sight deposits are balances that commercial banks hold with the SNB. These balances are used to satisfy statutory minimum reserve requirements. Commercial banks typically maintain sight balances higher than the minimum reserve requirement since these are the most liquid assets for banks, and are readily available for payment transactions. Current minimum reserve requirement stipulates that banks hold a minimum of 2.5 percent of their short-term liabilities (upto 90 days) plus 20 percent of liabilities towards customers in the form of savings and investments.

Column (4) in table 6 reports the results. The dependent variable is one-year difference in net interest revenue. We see that the interaction term is not significant. This suggest that the decline in interest rates is not driving the main results from the baseline specification.

4.5 Real Effects

This section investigates the real effects of the currency shock using micro-data on non-financial firms and tries to disentangle the trade channel from the bank-lending channel. Since Switzerland is an export oriented economy, a 20 percent appreciation of domestic currency should have a large negative impact on exporting firms. In particular, we should expect to see a negative impact on sales and profitability ratios of exporting firms. To test whether this was the case, I look at the response of sales growth, employment growth, and profitability ratios for exporters and non-exporters to the nominal exchange rate appreciation. I estimate the following model to tease out the causal effect of nominal exchange rate appreciation on various outcome variables for exporters:

$$\begin{aligned} Y_{it} = \quad & \alpha_i + \beta \mathbf{T}_t + \textstyle\sum_{\mathbf{t}} \gamma_t (\mathbf{T}_t \times Exporter_i) + \sum_{\mathbf{t}} \delta_t (\mathbf{T}_t \times \mathbf{FIRM}_{it-1}) + \\ & \theta \mathbf{FIRM}_{it-1} + \epsilon_{it} \qquad\qquad \forall t \in \{2011, 2012, 2013, 2015, 2016\} \backslash 2014 \end{aligned} \tag{5}$$

where, Y_{it} could be sales growth, employment growth, or one-year change in return on equity for firm i at time t. α_i are firm fixed effects, $\mathbf{T}_t$ are time dummies for each year in the sample, excluding 2014, which is used as the reference year. $Exporter_i$ is a dummy variable which takes a value 1 for exporting firms and 0 otherwise. $(\mathbf{T}_t \times Exporter_i)$ is the interaction between year dummies and the *Exporter* variable. **FIRM** is a vector of firm-level control variables, including firm size, market capitalization and cash-to-assets ratio. Standard errors are clustered at the firm-level to allow for intra-firm serial correlation over time.

The above specification tests for the parallel trends assumption as well. In the absence of the event, the outcome variables for exporting and non-exporting firms should not deviate from their pre-existing trends. If this is not true, the results would be biased and we will not be able to get clean estimates of the causal impact. For further robustness, I have also included interactions of all control variables with time dummies to allow for differential correlation between the outcome variable and control variables across years.

The main variables of interest are γ_t which capture the difference in outcome variables of exporters and non-exporters over time. If exporters were negatively affected in 2015, we should expect to see a negative value for γ_t in 2015 (and not before 2015). Figure 6 shows the estimated γ_t for sales growth, employment growth, and one-year change in return on equity

for the sample of listed firms in Worldscope. The red dashed line indicates the beginning of the exchange rate shock. The black dots represent point estimates from equation 5 and the blue bars show 90 percent confidence intervals around the point estimates.

Consistent with the parallel trends assumption, we find that there is no significant difference in the outcome variables of exporters and non-exporters in the pre-shock period, but the difference becomes negative and significant in 2015, i.e., after the currency shock. We see that in 2015, sales growth, employment growth of exporters is lower than that of non-exporters. Exporters also experience lower profits – the one-year change in return on equity is lower for exporters as compared to non-exporters.

These results suggest that the trade channel did, in fact, play an important role in the transmission of the exchange rate shock to the real economy. This is not surprising, given the high reliance of Swiss economy on exports. The next question to ask is: do lower profits and sales imply that exporters also invest less as compared to non-exporters in the aftermath of the currency shock? Figure 7 suggests that they do. The top panel of this figure shows the evolution of investment for exporters and non-exporters. Exporters and non-exporters have similar trends in the pre-shock period, but in 2015, exporters see a slowdown in investment while non-exporters continue to increase their capital expenditure.

The bottom panel of figure 7 plots coefficients γ_t from equation 5 with investment as the outcome variable. Firm control variables for investment include Tobin's Q, lagged value of cash to assets ratio, and the ratio of short-term debt to assets, as is standard in the corporate finance literature. From the figure, we see that there is no significant difference between investment of exporters and non-exporters in the pre-shock period, but it becomes negative and significant in 2015. This suggests that appreciation of Swiss franc in 2015 not only had a negative impact on firms' profits and sales growth but also had a detrimental impact on investment of exporting firms.

However, non-exporting firms continued to increase their investment. Since financial constraints also play an important role in shaping firms' investment decisions, I investigate the bank-lending channel played any role in firms' investment decisions. I match non-financial firms in Worldscope with those in the Dealscan database and compute the average exposure of each firm to multiple banks, depending upon their lending share in the syndicate. The bank lending channel would imply that firms that had banking relationship with positively affected banks should see an increase in investment as those banks increase credit supply.

To test the hypothesis that the positive credit supply shock due to positive foreign currency exposure of banks leads to higher investment of non-financial firms, I estimate the following

equation:

$$Y_{it} = \alpha_i + \beta \mathbf{T}_t + \sum_{\mathbf{t}} \gamma_t (\mathbf{T}_t \times BankExposure_i) + \sum_{\mathbf{t}} \delta_t (\mathbf{T}_t \times \mathbf{FIRM}_{it-1}) + \theta \mathbf{FIRM}_{it-1} + \epsilon_{it}$$
$$\forall t \in \{2011, 2012, 2013, 2015, 2016\} \backslash 2014$$

where, Y_{it} is either investment of firm i at time t, α_i are firm fixed effects, $\mathbf{T}_t$ are time dummies for each year in the sample, excluding 2014, which is used as the reference year. $BankExposure$ is a dummy variable which takes a value 1 for firms that had banking relationships with banks that were positively affected by the appreciation shock, $(\mathbf{T}_t \times BankExposure_i)$ is the interaction between year dummies and the $BankExposure$ variable. **FIRM** is a vector of firm-level control variables, including firm size, investment opportunities, and cash-to-assets ratio. Standard errors are clustered at the firm-level to allow for intra-firm serial correlation over time.

Equation 6 is estimated for the time period 2011-2016 for the sample of listed firms from the Worldscope database. A potential concern with the identification strategy is that there is endogenous sorting between banks and firms – exporters were borrowing from banks which were negatively affected by the appreciation shock and hence the results we see could driven by demand changes. To alleviate this concern I provide direct evidence on sorting. The average bank exposure of exporting firms was -1.78 while that of non-exporters was -1.96. This difference is not statistically significant, which provides evidence against sorting.

Figure 8 plots the γ_t coefficient from the above equation. The blue dots are point estimates and the vertical lines represent 95 percent confidence intervals. We can see that after the appreciation shock, firms that had banking relationships with positively affected banks do see an increase in their investment. This suggest that the bank lending channel did partially offset the negative impact of currency appreciation on non-financial firms.

4.6 Cross-country Evidence

The results from the previous section suggest that the bank-lending channel explains the muted response of real outcomes to the large currency appreciation shock in Switzerland. In this section, I explore the importance of the bank lending channel of exchange rates for a cross-section of advanced and emerging markets by estimating the following model:

$$\Delta Y_{i,t+1} = \alpha_i + \beta Currency\ Depreciation_{i,t} + \gamma Exposure_{i,t} + \delta Currency\ Depreciation_{i,t} \times Exposure_{i,t} + \Theta \mathbf{X}_{i,t} + \epsilon_{i,t} \quad (6)$$

where, $\Delta Y_{i,t+1}$ is one-year ahead growth rate of real GDP, α_i are country fixed effects, *Currency Depreciation* is a dummy variable for domestic currency depreciation episodes, $Exposure_{i,t}$ is a dummy variable that takes a value 1 if the banking sector of country i has more foreign currency liabilities relative to foreign currency assets in period t. The main variable of interest is the interaction between currency depreciation episodes and banking sector exposure: $Currency\ Depreciation \times Exposure_{i,t}$. The interaction term captures the effect of the bank lending channel. $\mathbf{X}_{i,t}$ are country-level control variables, including inflation rate, policy rate of the central bank, contemporaneous and lagged value of GDP growth. Equation 6 is estimated for a sample of 44 emerging and advanced countries using annual data over the period 1950-2016.[19]

A positive β implies that nominal currency depreciation is associated with higher one-year ahead GDP growth, while a negative value for β indicates that nominal currency depreciation is associated with lower subsequent growth in real GDP. δ captures the bank-lending channel of exchange rate fluctuations. I hypothesize that countries with foreign liability exposure of the banking sector should be negatively affected by home currency depreciation as compared to those with a foreign asset exposure of the banking sector. In other words, δ should be negative for the bank lending channel to offset the trade channel.

Results from equation 6 are reported in table 8. The table shows the response of one-year ahead GDP growth to currency depreciation episodes involving higher then 20 percent depreciation of domestic currency. Column (1) includes only country fixed effects , column (2) adds macroeconomic controls – inflation rate, central bank policy rate, contemporaneous and lagged value of GDP growth, column (3) adds time fixed effects , column (4) and (5) show results for the sub-sample of advanced economies and emerging markets respectively. We see that that overall one-year ahead GDP growth rate is not affected by currency depreciation episodes. However, the interaction term between currency depreciation episodes and exposure of banking sector is negative. From column (3), we see that following currency depreciation episodes, the one-year ahead GDP growth in countries with net foreign liability exposure of the banking sector is approximately 1.6 percentage points lower than in countries with a net foreign asset exposure of the banking sector. This channel matters more for emerging markets and does not matter for advanced economies. This can perhaps be explained by the fact that banks in advanced economies are better equipped to hedge their foreign currency exposure as compared to banks in emerging markets as financial markets in advanced economies are

[19]See Appendix for the list of countries and country group classification in the sample. The Appendix also provided additional details on different data sources used to construct variables for the cross-country analysis.

relatively more developed. Also, equity markets are more developed in advanced economies. Hence, even if exchange rate shocks affect credit supply, availability of other sources of finance implies that the real impact will be limited.

Figure 9 plots δ from equation 6 for different levels of currency depreciation episodes. We see that the coefficient on the interaction term becomes more negative as the level of currency depreciation increases. This is reasonable since for a given level of currency exposure of the banking sector, a larger depreciation of domestic currency should imply a larger change in banks' net worth and, hence, a larger impact on real activity.

5 Conclusion

This paper uses the Swiss franc appreciation episode of January 15, 2015 as an exogenous exchange rate shock to study the bank lending channel of exchange rates. Using a novel hand-collected dataset on foreign currency mismatch of Swiss banks, I find that banks which had more foreign currency liabilities relative to foreign currency assets before the appreciation shock gain from appreciation of domestic currency and increase lending in the post-shock period. This positive credit supply shock leads to higher investment by bank-dependent firms, while exporters see a decline in their investment as a result of weak demand for exported goods. Hence, the bank-lending channel of exchange rates mitigates the traditional trade channel of exchange rates and can explain why large changes in exchange rates often have muted impact on economic activity. To test the importance of the bank-lending channel more generally, I use cross-country data on foreign exposure of banking sector for a sample of advanced and emerging markets. I find that following currency depreciation episodes, one -year ahead GDP growth is lower in countries with a net foreign currency liability exposure of the banking sector relative to countries with a net foreign asset exposure of the banking sector.

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Table 1: **Summary Statistics**

This table reports summary statistics for the main variables used in the analysis. Panel A is for bank-level variables for the time period 2011-2016. Panel B is for firm-level analysis from the Worldscope database over the time period 2014-2015. Panel C reports summary statistics for macroeconomic variables for the time period 1994-2016 using quarterly data. Panel C1 is for the sample of advanced economies and panel C2 is for emerging markets.

A. Bank-level variables	mean	sd	p25	p50	p75	count
exposure	2.706	12.380	-1.900	0.700	4.800	590
loan growth	6.750	13.142	1.790	4.446	7.849	564
$\Delta Profit$	-0.017	0.304	-0.035	0.000	0.043	570
$\Delta NetIncome$	-0.010	0.292	-0.023	0.000	0.035	570
$\Delta IntIncome$	0.017	0.117	-0.033	0.000	0.059	573
ΔNII	0.024	0.300	-0.042	0.000	0.044	573
size	14.910	1.584	13.493	14.618	16.537	581
equity to assets	8.927	3.527	6.774	8.005	9.520	580
liquidity	32.658	26.526	12.614	19.087	52.743	580
loans to deposits	89.024	39.195	52.738	107.415	118.861	579
B. Firm-level variables						
exporter	0.768	0.422	1.000	1.000	1.000	690
Employment growth	0.061	0.577	-0.017	0.023	0.078	495
Sales growth	0.017	0.119	-0.034	0.019	0.074	475
Return on assets	5.112	7.650	2.463	5.374	9.352	681
Return on equity	8.995	14.741	3.837	10.268	17.515	678
Pre-tax Income (CHF Million)	213.565	471.335	4.501	35.097	151.555	688
Firm Size	20.376	1.894	19.193	20.283	21.647	689
Market capitalization (log)	20.353	1.846	19.044	20.251	21.561	674
Investment	0.002	0.035	-0.013	0.003	0.019	532
Leverage	24.628	20.155	4.987	22.034	40.483	689
Tobin's Q	1.201	0.847	0.579	0.934	1.553	674
Cash-to-assets	0.147	0.115	0.060	0.114	0.203	665
C. Macro variables						
$\Delta NEER$	-0.361	5.155	-1.519	0.096	1.522	4004
$\Delta RGDP$	3.217	3.932	1.312	3.098	5.136	3791
Policy Rate	12.720	210.783	2.500	4.500	7.750	3234

Table 2: **Baseline Results: Effect on Lending**

This table reports estimates from equation 1, estimated for the time period 2011-2016. The dependent variable is annual growth rate of gross loans. *post* is a dummy variable that takes a value 1 for years 2015 and 2016. *exposure* measures foreign currency exposure of each bank, defined as the difference between the share of foreign currency liabilities and assets in total liabilities and assets respectively. Column (1) does not contain bank- and country-level controls, column (2) adds bank-level controls, column (3) adds country-level controls, and column (4) add interactions of bank characteristics with the *post* dummy, column (5) reports results after excluding big international banks, and column (6) reports results for foreign currency liability and foreign currency asset exposure separately. Standard errors are clustered at the bank level and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var: loan growth	(1)	(2)	(3)	(4)	(5)	(6)
post	-2.568**	-0.716	-4.048	23.746	32.064	-3.639
	(1.263)	(1.624)	(19.196)	(26.010)	(26.943)	(32.128)
post × *exposure*	0.380**	0.399**	0.409**	0.263*	0.279*	
	(0.172)	(0.172)	(0.166)	(0.148)	(0.148)	
size		-18.932***	-24.395***	-23.678***	-22.633***	-27.973***
		(5.918)	(6.658)	(6.986)	(7.155)	(8.311)
capital to assets		-1.167	-1.252	-1.041	-0.989	-0.987
		(0.829)	(0.847)	(0.812)	(0.810)	(1.691)
liquidity		0.431***	0.372**	0.477***	0.494***	0.422***
		(0.163)	(0.163)	(0.145)	(0.149)	(0.128)
loans to deposits		-0.143*	-0.194**	-0.176*	-0.178*	-0.286**
		(0.080)	(0.092)	(0.099)	(0.100)	(0.143)
post × *size*				-2.827***	-2.893***	-3.527***
				(0.646)	(0.650)	(1.133)
post × *capital*				0.602	0.667	-0.188
				(0.447)	(0.490)	(0.661)
post × *liquidity*				0.214	0.176	0.263*
				(0.160)	(0.193)	(0.150)
post × *loans to deposits*				0.053	0.035	0.364***
				(0.121)	(0.131)	(0.116)
gdp growth			10.511**	10.530**	10.647**	0.464
			(4.950)	(4.959)	(5.034)	(5.881)
policy rate			-9.769	-7.110	0.117	-18.780
			(25.721)	(24.972)	(25.198)	(39.066)
post × *foreign liab*						0.665***
						(0.250)
post × *foreign assets*						-0.429**
						(0.203)
Observations	564	564	564	564	552	564
R-squared	0.472	0.546	0.555	0.585	0.538	0.750
No. of banks	100	100	100	100	98	100
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	Yes	Yes	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes	Yes
Bank Controls X Post	No	No	No	Yes	Yes	Yes
Sample	All	All	All	All	Exclude Big Banks	All

Table 3: **Types of Lending**

This table reports estimates from equation 3, estimated for 2015. The dependent variable is annual growth of mortgage loans, inter-bank loans, customer loans, unsecured loans, and secured loans in column (1), (2), (3), (4), and (5) respectively. The main variable of interest is exposure computed as the difference in share of foreign liabilities and assets. All columns include bank-level controls: size, equity to assets, liquidity, and loans to deposits (in 2014). Robust standard errors are are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1) Mortgage Loans	(2) Inter-bank Loans	(3) Customer Loans	(4) Unsecured Loans	(5) Secured Loans
Net Exposure	0.0654*	-0.0470	0.1738**	0.0456	0.0442*
	(0.033)	(0.179)	(0.074)	(0.089)	(0.023)
size	1.3069	4.5682	-1.4545	0.6776	-1.6890
	(1.048)	(5.522)	(3.561)	(4.177)	(1.242)
capital to assets	-0.7733	-1.9753	2.5784	4.1187*	-0.0544
	(0.609)	(2.244)	(2.084)	(2.295)	(0.741)
liquidity	-0.2334	0.2119	0.1669	-0.8893	-0.2307
	(0.236)	(0.679)	(0.452)	(0.535)	(0.198)
loans to deposits	-0.2782**	-0.3305	-0.1514	-0.5566*	-0.2329*
	(0.132)	(0.418)	(0.292)	(0.296)	(0.121)
Observations	75	91	91	91	91
R-squared	0.404	0.178	0.239	0.146	0.206

Table 4: **Channels of Transmission**

This table reports the estimates from equation 1. In column (1), the dependent variable is one-year change in net income, in column (2), the dependent variable is one-year difference in net interest income, in column (3), the dependent variable is one-year difference in non interest income, In column (4), the dependent variable is one-year difference in trading income. Column (4) reports results only for the cross-section of banks in 2015 since data on trading income is hand-collected. Outcome variables in all columns are scaled by lagged size. All columns include bank-level control variables. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1) $\Delta NetIncome$	(2) $\Delta IntInc$	(3) $\Delta NonintInc$	(4) $\Delta TradingIncome$
Post	-0.0658	0.0040	-0.1390*	
	(0.066)	(0.029)	(0.075)	
Exposure				0.0056***
				(0.001)
Post × *Exposure*	0.1141*	0.0249	0.1299*	
	(0.058)	(0.028)	(0.067)	
size	-0.3044	-0.0448	-0.3865	-0.0147
	(0.246)	(0.047)	(0.245)	(0.013)
capital to assets	-0.0129	-0.0078	-0.0081	-0.0043
	(0.020)	(0.007)	(0.018)	(0.006)
liquidity	-0.0024	-0.0005	0.0047	-0.0003
	(0.005)	(0.001)	(0.003)	(0.002)
loans to deposits	-0.0045	-0.0012	-0.0040	-0.0005
	(0.004)	(0.001)	(0.003)	(0.001)
Observations	564	564	564	55
R-squared	0.026	0.026	0.088	0.111
Bank Fixed Effects	Yes	Yes	Yes	No

Table 5: **Robustness: Narrative Analysis**

This table reports the estimates from equation 4, estimated for the cross-section of 53 banks in 2015. In column (1) and (4), the dependent variable is loan growth, defined as yearly change in outstanding loans. Qualitative Measure is a dummy variable that takes a value 1 for banks which reported as being positively affected by the currency shock and 0 for banks which were negatively affected by the shock. In column (2) and (5), the dependent variable is one-year change in profits (normalized by assets in 2014), in column (3) and (6), the dependent variable is one-year difference in net income (normalized by assets in 2014). Columns (1), (2), and (3) do not control for bank-level variables while column (4), (5), and (6) include bank-level controls. Size is defined as the log of bank assets in 2014, capital to assets is the ratio of total capital to assets in 2014, and liquidity is the ratio of liquid assets to total assets in 2014, and loans to deposits is the ratio of loans to deposits in 2014. Standard errors clustered at the bank level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1) loan growth	(2) $\Delta Profit$	(3) $\Delta Income$	(4) loan growth	(5) $\Delta Profit$	(6) $\Delta Income$
Qualitative Measure	4.4046*	0.2103**	0.1641**	3.7200*	0.1826**	0.1438**
	(2.505)	(0.090)	(0.077)	(2.142)	(0.081)	(0.068)
size				-1.5316**		
				(0.609)		
capital to assets				-0.0954	-0.0030	-0.0017
				(0.501)	(0.015)	(0.014)
liquidity				0.2077**	-0.0026	-0.0022
				(0.082)	(0.004)	(0.003)
loans to deposits				0.1584***	-0.0006	-0.0006
				(0.056)	(0.002)	(0.002)
Observations	53	53	53	53	53	53
R-squared	0.081	0.160	0.135	0.323	0.191	0.161
Bank Controls	No	No	No	Yes	Yes	Yes

Table 6: **Robustness: Alternate Measures of Exposure**

This table reports the estimates from equation 1, estimated for the time period 2014-2016, for different measures of exposure. The dependent variable is annual loan growth in all columns. In column (1), the measure of foreign currency exposure is calculated as the difference between foreign currency liabilities and assets, where foreign assets and liabilities are characterized on the basis of foreign currency rather than domicile. In column (2), the measure of exposure is computed after taking off-balance sheet exposures for each foreign currency into account. In column (3), the measure of exposure is the one-month difference in stock returns of banks around the appreciation event. All columns include bank-level control variables and bank-fixed effects. Standard errors are clustered at the bank level and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1) loan growth	(2) loan growth	(3) loan growth
Post	-5.2309**	-3.3656	-7.7388**
	(2.409)	(3.611)	(3.389)
Post × *Exposure*	0.2980*		
	(0.157)		
Post × *Exposure*		0.1114**	
		(0.048)	
Post × *Exposure*			0.0112*
			(0.006)
size	-6.5666	-12.6720	-17.7960
	(16.598)	(17.982)	(23.013)
capital to assets	3.7465	0.8484	-0.7130
	(2.402)	(1.219)	(2.973)
liquidity	0.5260**	0.5008*	0.9625*
	(0.202)	(0.270)	(0.528)
loans to deposits	-0.4406*	-0.2793	0.0653
	(0.255)	(0.243)	(0.169)
Observations	196	152	62
R-squared	0.176	0.130	0.164
Bank FE	Yes	Yes	Yes
Exposure Measure	Currency	Hedged	Stock Returns

Table 7: **Robustness: Other**

This table reports the results for robustness tests discussed in section 4.4.3 Column (1) reproduces the results from baseline specification (column (4) from table 2) for comparison. Column (2) estimates equation 1 for a smaller window around the currency shock – 2014 - 2016. Column (3) adds lagged loan growth as a control variable, column (4) drops loans to deposits from the set of controls, column (5) has one-year change in net interest revenue as the dependent variable. All columns include bank-level controls and bank fixed effects. Standard errors clustered at the bank level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1) loan growth	(2) loan growth	(3) loan growth	(4) loan growth	(5) Δ Net Interest Revenue
post	23.746	56.952**	-133.715	32.727*	73.577*
	(26.010)	(26.374)	(91.816)	(18.804)	(38.608)
post × *exposure*	0.263*	0.367**	0.263*	0.264*	0.025
	(0.148)	(0.166)	(0.156)	(0.157)	(0.262)
size	-23.678***	-57.394***	-23.858***	-22.307***	61.839**
	(6.986)	(12.197)	(8.202)	(6.721)	(30.189)
capital to assets	-1.041	1.543	-0.601	-1.178	0.665
	(0.812)	(1.017)	(0.720)	(0.828)	(1.537)
liquidity	0.477***	0.493***	0.494***	0.566***	0.129
	(0.145)	(0.181)	(0.149)	(0.133)	(0.311)
loans to deposits	-0.176*	-0.456**	-0.307**		-0.282
	(0.099)	(0.185)	(0.122)		(0.309)
post × *size*	-2.827***	-2.568***	-2.601***	-2.831***	-4.912*
	(0.646)	(0.772)	(0.638)	(0.651)	(2.527)
post × *capital*l	0.602	0.099	0.303	0.707	-0.173
	(0.447)	(0.592)	(0.443)	(0.470)	(0.972)
post × *liquidity*	0.214	0.262*	0.127	0.148***	-0.010
	(0.160)	(0.158)	(0.119)	(0.054)	(0.325)
post × *loans to deposits*	0.053	0.144	0.011		0.192
	(0.121)	(0.109)	(0.089)		(0.298)
lagged dep. var.,			0.160**		
			(0.074)		
Observations	564	291	564	564	564
R-squared	0.585	0.754	0.613	0.579	0.970
No. of banks	100	100	97	100	100
Bank FE	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes
Specification	Original	Smaller Window	Lagged Dep. Var	Controls	Interest Rate Exposure

Table 8: **Currency depreciation and subsequent GDP growth**

This table reports the estimates for equation 6. The dependent variable is one-year ahead growth of real GDP. $\mathbb{1}_{\Delta ER>=20\%}$ is a dummy variable that takes a value 1 if a country experiences a 20 percent or higher depreciation of home currency, *exposure* is a dummy variable that takes a value 1 if the banking sector has more foreign currency liabilities than foreign currency assets. Column (1) includes only country fixed effects , column (2) adds macroeconomic controls – inflation rate, central bank policy rate, contemporaneous and lagged value of GDP growth, column (3) adds time fixed effects , column (4) and (5) show results for the sub-sample of advanced economies and emerging markets respectively. Standard errors clustered at the country level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}_{\Delta ER>=20\%}$	-0.643	-0.205	-0.730	0.300	-0.743
	(0.673)	(0.601)	(0.495)	(0.605)	(0.693)
$\mathbb{1}_{\Delta ER>=20\%} \times exposure$	-1.443*	-1.831**	-1.574**	-0.534	-1.899**
	(0.808)	(0.705)	(0.650)	(0.612)	(0.838)
exposure	-0.147	0.054	0.124	0.302	-0.052
	(0.316)	(0.360)	(0.285)	(0.395)	(0.439)
Observations	2,178	1,869	1,869	1,023	843
R-squared	0.170	0.173	0.411	0.516	0.411
Controls	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes	Yes
Sample	All	All	All	Advanced Economies	Emerging Markets

Figures

Figure 1: **Channels of Transmission**

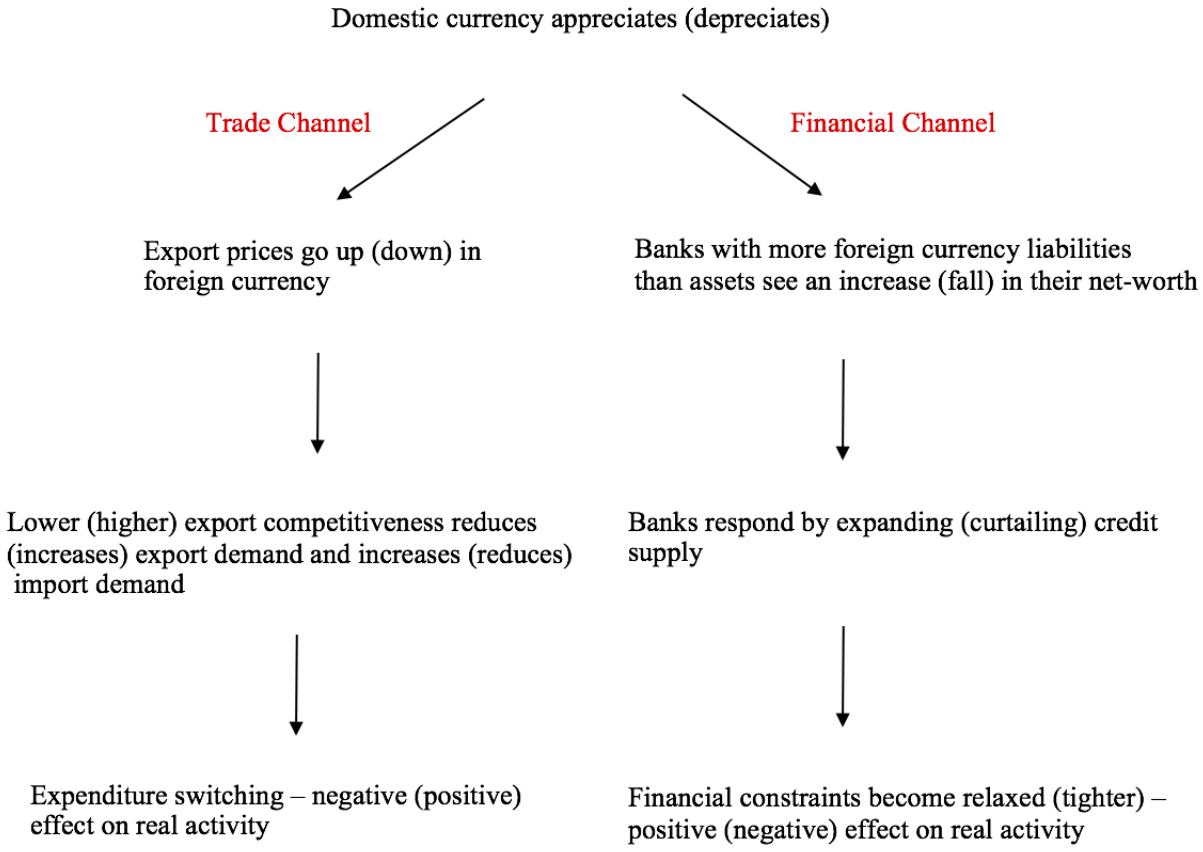
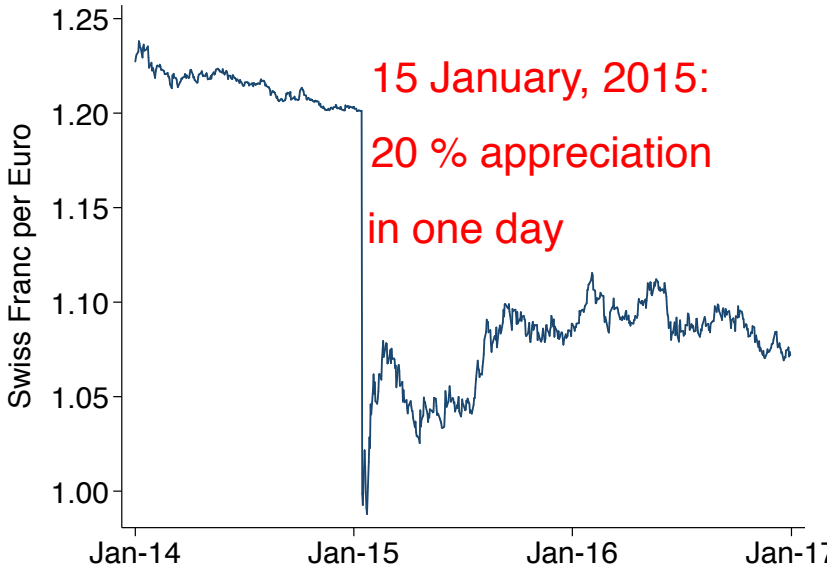
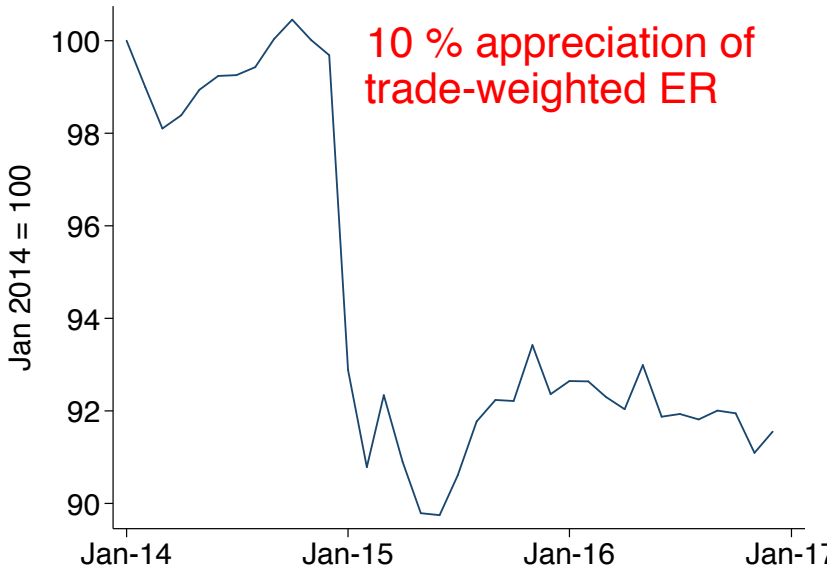


Figure 2: **The Jan 2015 Siwss Franc Appreciation Episode**

Panel (a) of this figure shows the daily exchange rate between the Swiss Franc and the Euro for the 2014-2015 period. The floor of 1.20 Swiss Franc per Euro was removed on January 15, 2015. Panel (b) of this figure shows the monthly trade weighted real and nominal exchange rate of Swiss franc for the period 2014-2015. Note: a fall in effective exchange rate is appreciation of home currency.



(a) Bilateral Exchange Rate



(b) Effective Exchange Rate

Figure 3: Sport and Forward Exchange Rate: CHF/EUR

This figure shows the daily spot and on-month forward exchange rates between the Swiss franc and the euro. Note: a fall in exchange rate is appreciation.

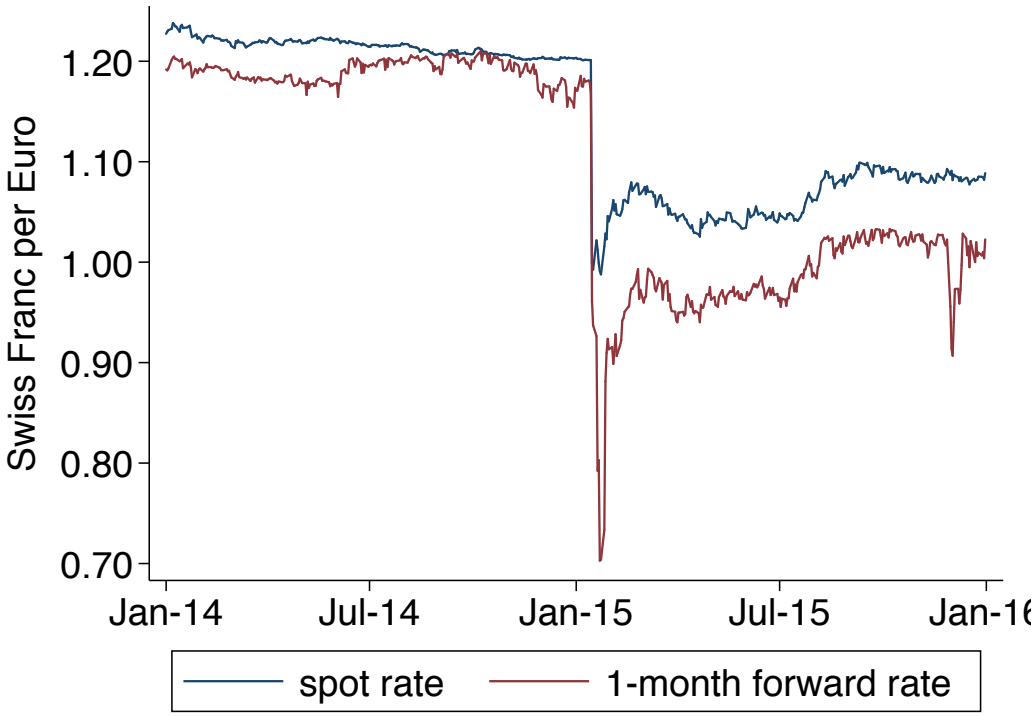


Figure 4: **Parallel Trends**

This figure plots the γ_t coefficients from equation 2. The blue diamonds represent the point estimates and the vertical lines around them reflect 95 percent confidence bands. The dashed green line marks the beginning of the Swiss franc appreciation episode.

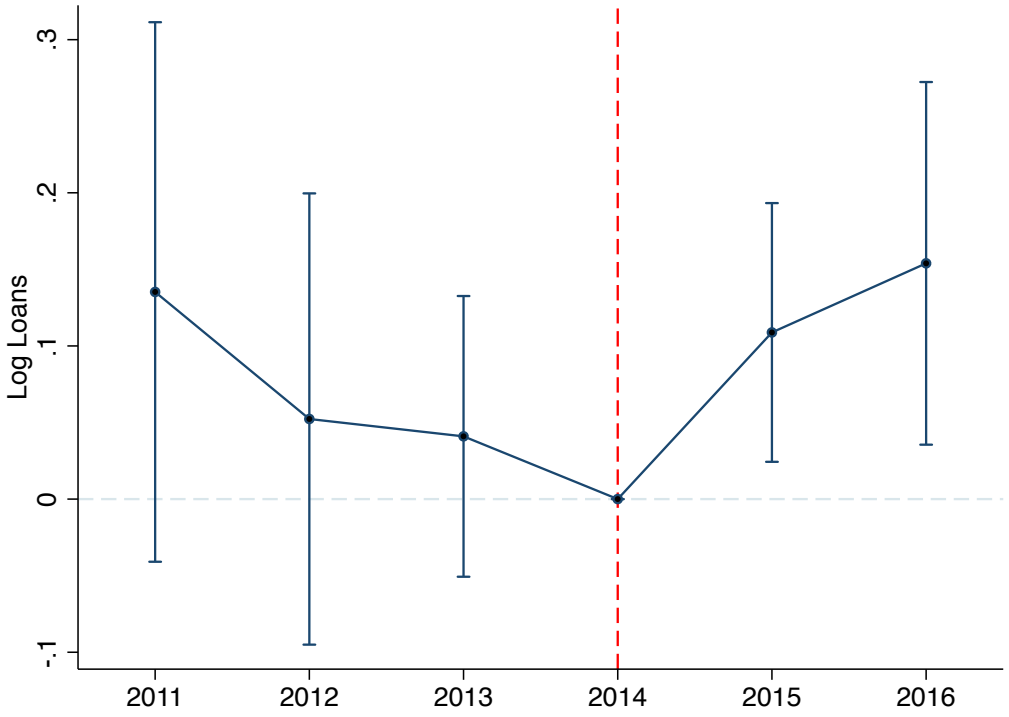


Figure 5: **Alternate measures of exposure**

This figure plots the distribution of alternative foreign currency measures. The top panel plots the exposure measure based on foreign vs domestic currency while the bottom panel plots the exposure measure after taking into account off-balance sheet positions.

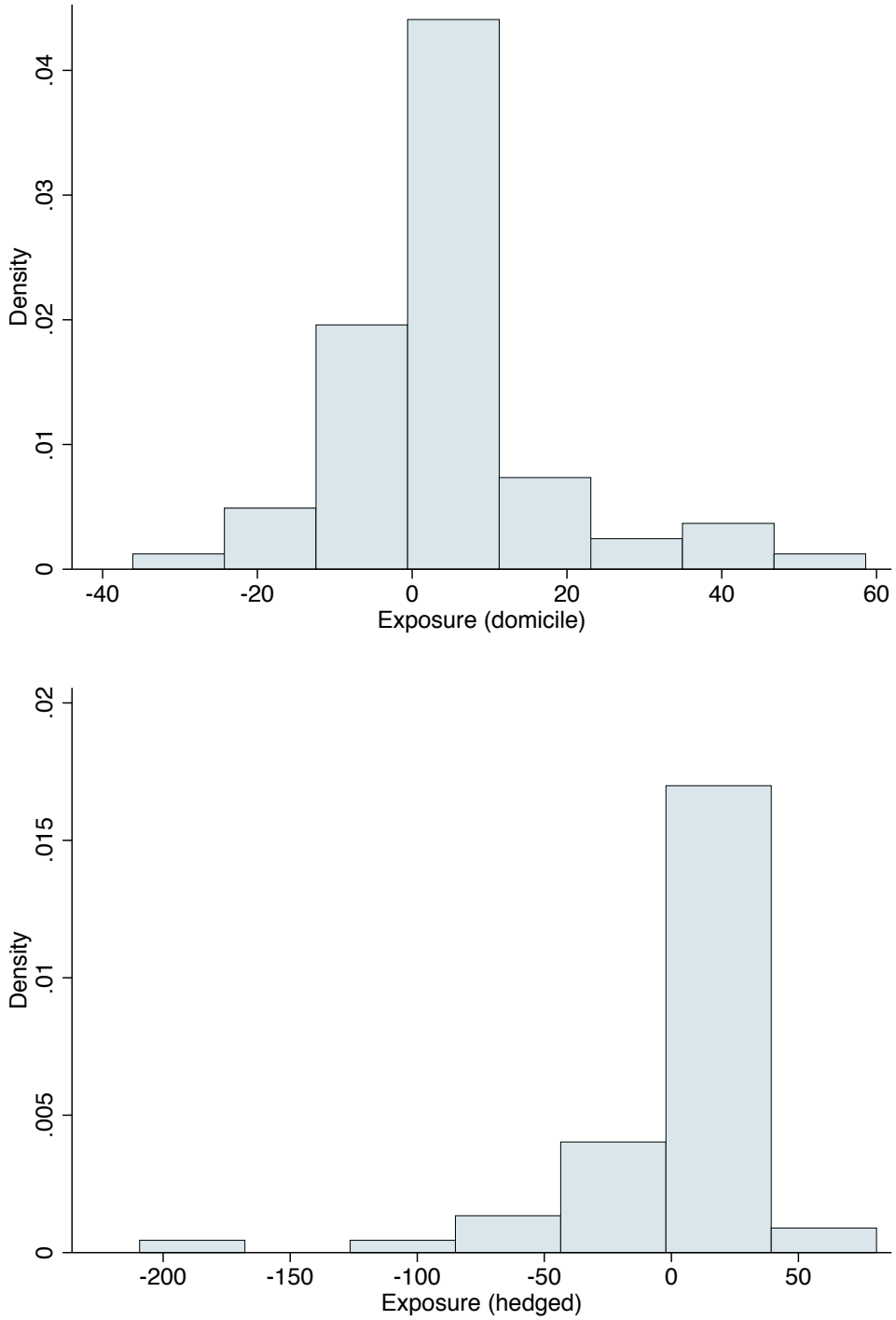


Figure 6: **Real Effects: Sales Growth, Employment Growth, and Return on Equity**

This figure plots the coefficients γ_t from equation 5 for sales growth, employment growth, and difference in return on equity. The red dashed lines indicate the beginning of the currency appreciation event. The blue vertical bars around point estimates represent 90 percent confidence intervals.

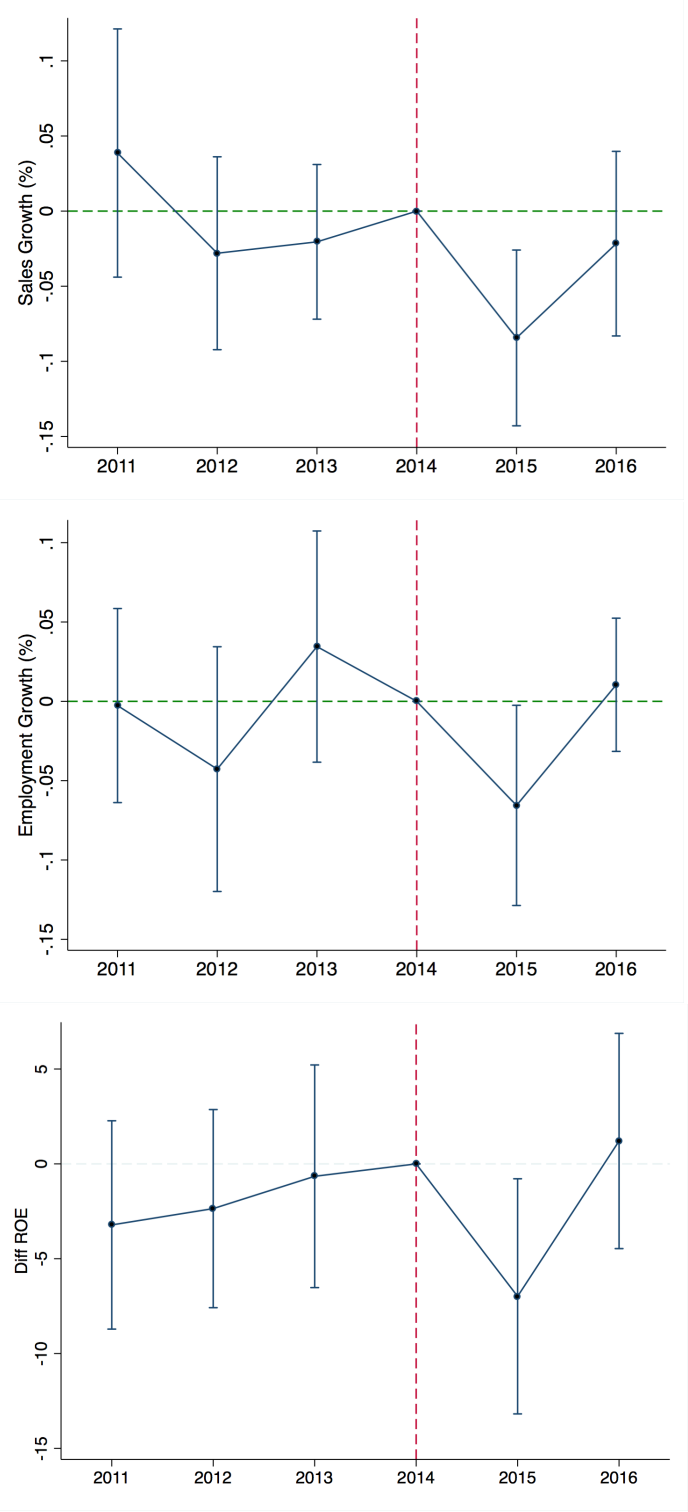


Figure 7: **Real Effects: Investment**

The top panel of this figure shows evolution of investment rates for exporters and non-exporters. The bottom panel shows the coefficients γ_t from equation 5 for investment. The red dashed lines indicate the beginning of the currency appreciation event. The blue vertical bars around point estimates represent 90 percent confidence intervals.

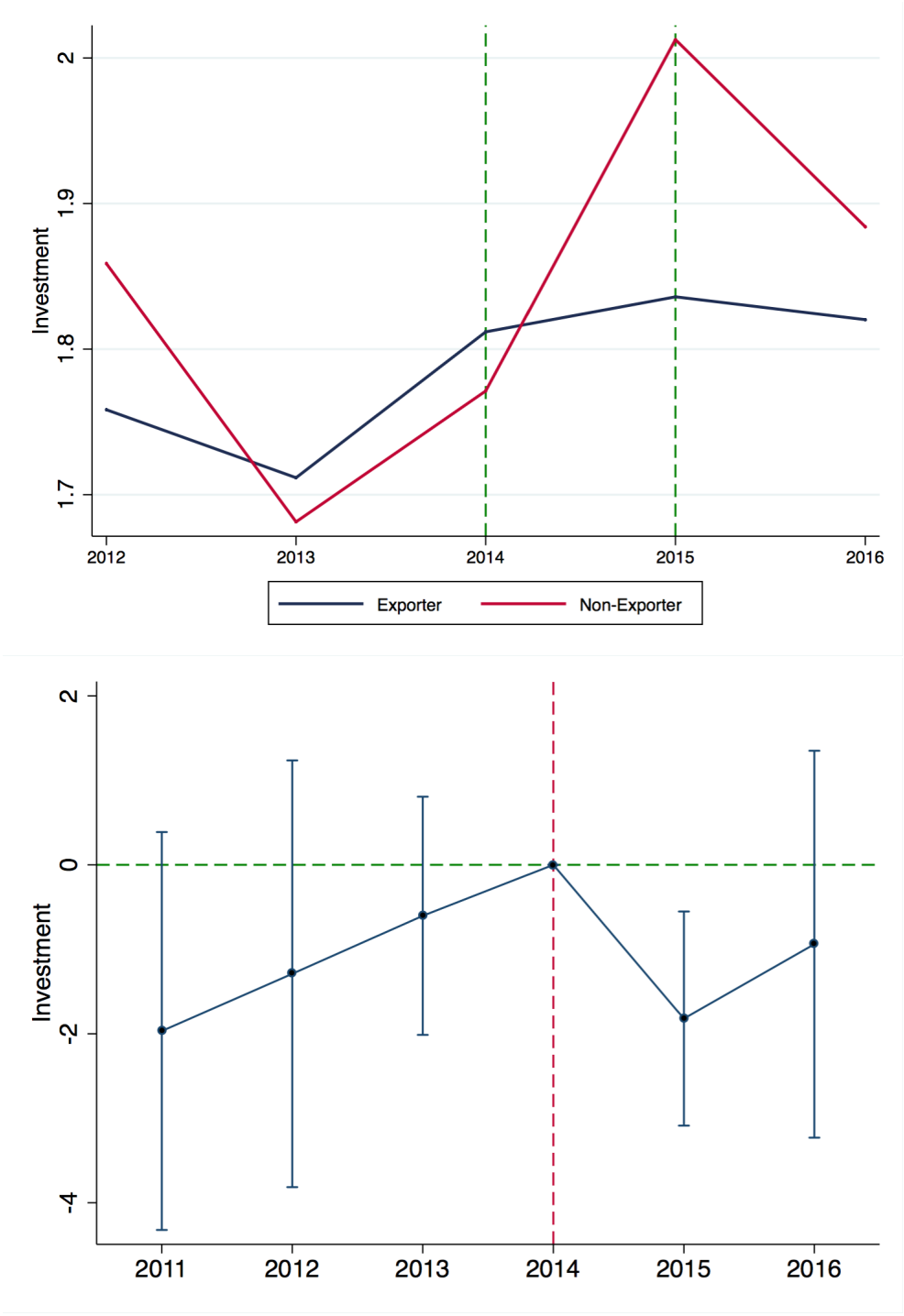
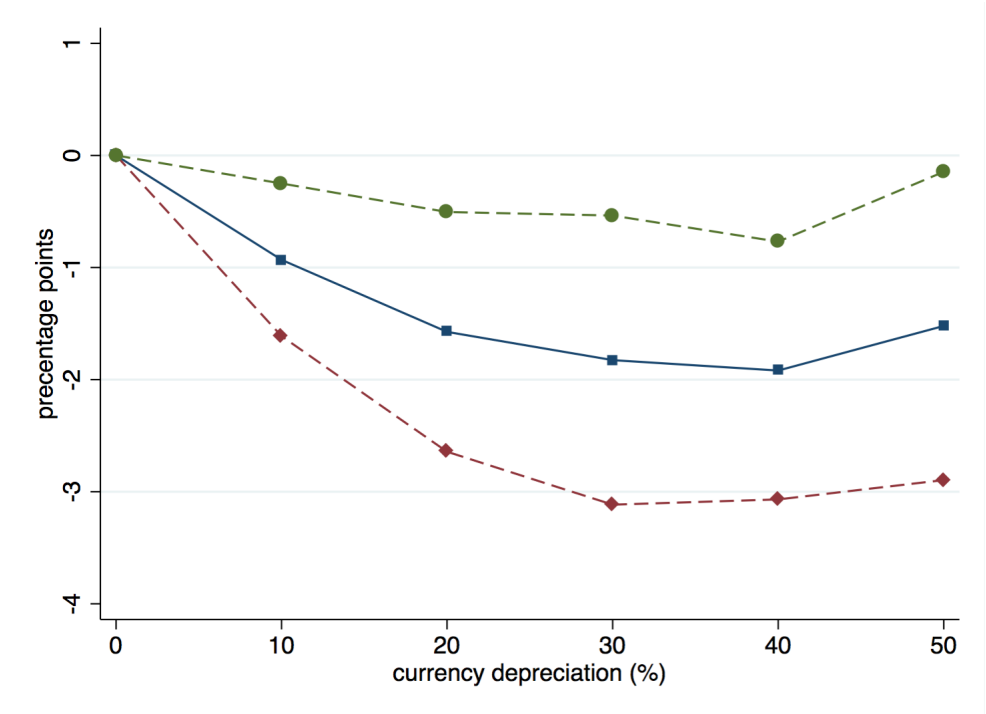


Figure 8: **Credit Supply and Investment**

Figure 9: **One-year ahead GDP growth and currency depreciation episodes**

This figure plots the coefficient on the interaction between currency depreciation episodes and banking sector exposure from equation 6 for different levels of currency depreciation. The solid line represents actual estimates and the dashed lines are 90 percent confidence intervals.



A Appendix

A-I Sample and historical data construction for cross-country analysis

In this section, I provide additional details on historical data construction for the cross-country analysis.

Sample: The sample for cross-country analysis has 44 emerging and advanced economies. I use the IMF's classification to define country groups in the sample:

Advanced Economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

Emerging Markets: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Peru, Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey.

Data Construction:

- *Real GDP:* Data on real GDP is from the Maddison Project Database, version 2018. I use real GDP in 2011US$. The most recent version of this database facilitates cross-country comparison of GDP growth by taking into account differences in living standards across countries using multiple benchmark comparisons of prices and income.[20]
- *Net foreign currency liability of the banking sector:* I compute net foreign liabilities of the banking sector as the difference between foreign liabilities and foreign assets of the banking sector using the 'Banking Institutions' survey of the IMF that is based on non-standardized report forms by country. These data are converted from local currency to USD using nominal exchange rate data from the BIS. For countries that do not have survey data on these indicators, I use data on net foreign assets from the 'Other depository corporations' survey of the IFS database. According to the IMF's Monetary and Financial Statistics Manual and Compilation Guide, this survey covers all deposit taking institutions (primarily banks), excluding central banks. Data on net foreign liabilities of the banking sector starts in 1950 for most advanced economies and some emerging markets. See table A2 for further details on data construction for each country.
- *Exchange Rate:* Exchange rate data for each country in the sample is from the BIS. Exchange rate is defined as local currency per USD.
- *CPI Inflation:* Data on CPI Inflation is from the Global Financial Database.
- *Short-term Interest Rate:* Data on short-term interest rates is from the Global Financial Database and CEIC database. See table A3 for further details on the short rate used for each country.

[20] The earlier version of the database was based on a single cross-country comparison of relative income levels for the year 1990, projected forwards and backwards. See Bolt *et al.* (2018) for more details on historical GDP data.

Table A1: **Variable Definitions**

This table describes the variables used in empirical analysis and lists the data sources.

Variable	Definition	Source
Loan Growth	Yearly growth rate of outstanding gross loans	Bankscope
$\Delta Profit$	One year difference in profits before tax, normalized by lagged assets	Bankscope
$\Delta NetIncome$	One year difference in net income, normalized by lagged assets	Bankscope
Size	Log of total assets	Bankscope
Capital to assets	Ratio of total capital to total assets	Bankscope
Liquidity	Ratio of liquid assets to deposits and short-term funding	Bankscope
Loans to Deposits	Ratio of gross loans to total deposits	Bankscope
Assets	Total assets of the firm	Worldscope
Sales	Total Sales of the firm	Worldscope
Employment	Includes both full time and part-time workers of the firm	Worldscope
Market Capitalization	Annual close price $\times$ number of shares outstanding	Worldscope
Investment	Change in capital expenditure (scaled by lagged property, plant, and equipment)	Worldscope
Return on Equity	Profitability Ratio - Net Income divided by lagged common equity	Worldscope
Leverage	Total Debt as a percentage of total capital	
Tobin's Q	Price to book ratio	Worldscope
Cash-to-assets	Cash and equivalents divided by total assets	Worldscope
Bank Debt to Capital	Ratio of total bank debt to total capital	Capital IQ
$\Delta RGDP$	Year-over-year percent growth in quarterly real GDP (%)	IMF IFS Database
$\Delta NEER$	Quarterly growth of Nominal Effective Exchange Rate (%)	Bank for International Settlements
Policy Rate	Central Bank Policy Interest Rate (%)	Global Financial Database

Table A2: **Net foreign liabilities of the banking sector**

This table provides details on the construction of net foreign liabilities of the banking sector for each country in the sample.

Country	Time	IMF Survey
Argentina	1963-2016	Banking Institutions Survey
Australia	1950-2015	Banking Institutions Survey
Australia	2016-2016	Other Depository Corporations Survey
Austria	1953-1996	Banking Institutions Survey
Austria	2001-2016	Other Depository Corporations Survey
Belgium	1950-1997	Banking Institutions Survey
Belgium	2001-2016	Other Depository Corporations Survey
Brazil	1950-2008	Banking Institutions Survey
Brazil	2009-2016	Other Depository Corporations Survey
Canada	1950-2008	Banking Institutions Survey
Chile	1957-2008	Banking Institutions Survey
Chile	2009-2016	Other Depository Corporations Survey
China	1985-2016	Banking Institutions Survey
Colombia	1950-2008	Banking Institutions Survey
Colombia	2009-2016	Other Depository Corporations Survey
Czech Republic	1993-2008	Banking Institutions Survey
Czech Republic	2009-2016	Other Depository Corporations Survey
Denmark	1950-2008	Banking Institutions Survey
Denmark	2012-2016	Other Depository Corporations Survey
Finland	1950-1998	Banking Institutions Survey
Finland	2001-2016	Other Depository Corporations Survey
France	1969-1997	Banking Institutions Survey
France	2009-2016	Other Depository Corporations Survey
Germany	1951-1998	Banking Institutions Survey
Germany	2001-2016	Other Depository Corporations Survey
Greece	1953-2000	Banking Institutions Survey
Greece	2001-2016	Other Depository Corporations Survey
Hong Kong	1991-2016	Banking Institutions Survey
Hungary	1982-2008	Banking Institutions Survey
Hungary	2009-2016	Other Depository Corporations Survey
India	1950-2016	Banking Institutions Survey
Indonesia	1980-2008	Banking Institutions Survey
Indonesia	2009-2016	Other Depository Corporations Survey
Ireland	1964-1998	Banking Institutions Survey
Ireland	2001-2016	Other Depository Corporations Survey
Israel	1958-2011	Banking Institutions Survey
Israel	2012-2016	Other Depository Corporations Survey

Country	Time	IMF Survey
Italy	1963-1998	Banking Institutions Survey
Italy	2001-2016	Other Depository Corporations Survey
Japan	1953-2008	Banking Institutions Survey
Japan	2009-2016	Other Depository Corporations Survey
South Korea	1958-2012	Banking Institutions Survey
South Korea	2013-2016	Other Depository Corporations Survey
Luxembourg	1950-1997	Banking Institutions Survey
Luxembourg	2001-2016	Other Depository Corporations Survey
Malaysia	1950-2008	Banking Institutions Survey
Malaysia	2009-2016	Other Depository Corporations Survey
Netherlands	1950-1997	Banking Institutions Survey
Netherlands	2001-2016	Other Depository Corporations Survey
New Zealand	1950-2010	Banking Institutions Survey
Norway	1950-2006	Banking Institutions Survey
Norway	2007-2016	Other Depository Corporations Survey
Peru	1959-2016	Banking Institutions Survey
Philippines	1950-2007	Banking Institutions Survey
Philippines	2008-2016	Other Depository Corporations Survey
Poland	1979-2008	Banking Institutions Survey
Poland	2009-2016	Other Depository Corporations Survey
Portugal	1953-1998	Banking Institutions Survey
Portugal	2001-2016	Other Depository Corporations Survey
Russia	2000-2016	Other Depository Corporations Survey
Saudi Arabia	1960-2016	Banking Institutions Survey
Singapore	1963-2016	Banking Institutions Survey
South Africa	1965-2008	Banking Institutions Survey
South Africa	2009-2016	Other Depository Corporations Survey
Spain	1961-1998	Banking Institutions Survey
Spain	2001-2016	Other Depository Corporations Survey
Sweden	1950-2008	Banking Institutions Survey
Sweden	2009-2016	Other Depository Corporations Survey
Switzerland	1950-2016	Banking Institutions Survey
Thailand	1950-2008	Banking Institutions Survey
Thailand	2009-2016	Other Depository Corporations Survey
Turkey	1970-2008	Banking Institutions Survey
Turkey	2009-2016	Other Depository Corporations Survey
United Kingdom	1952-2016	Banking Institutions Survey
United States	1951-2016	Banking Institutions Survey

Table A3: **Short-term Interest Rates**

This table lists the short-term interest rate measures for each country in the sample.

Country	Time	Measure
Argentina	1950-2009	Argentina Reserve Bank Discount Rate
Argentina	2009-2016	30-day Repo Rate
Australia	1950-2016	Australia Reserve Bank Overnight Cash Rate
Austria	1950-1998	Austria Central Bank Discount Rate
Austria	1999-2016	ECB Refinancing Rate
Belgium	1950-1998	Belgium Central Bank Discount Rate
Belgium	1999-2016	ECB Refinancing Rate
Brazil	1950-2004	Brazil Central Bank Discount Rate
Brazil	2005-2016	Special Clearance and Escrow System (SELIC) Overnight Rate
Canada	1950-2016	Bank of Canada Discount Rate
Chile	1950-2016	Chile Central Bank Minimum Interest Rate
China	1990-2016	China Central Bank Discount Rate
Colombia	1950-2016	Colombia Bank of the Republic Intervention Rate
Czech Republic	1950-2016	Czech Republic Central Bank Deposit Facility
Denmark	1950-2016	Denmark National Bank Discount Rate
Finland	1950-1998	Finland Central Bank Discount Rate
Finland	1999-2016	ECB Refinancing Rate
France	1950-1998	Bank of France Discount Rate
France	1999-2016	ECB Refinancing Rate
Germany	1950-1998	Germany Berlin Bundesbank Discount Rate
Germany	1999-2016	ECB Refinancing Rate
Greece	1950-1998	Bank of Greece Discount Rate
Greece	1999-2016	ECB Refinancing Rate
Hong Kong	1992-2016	Bank of Hong Kong Best Lending Rate
Hungary	1994-2016	Hungary National Bank Deposit Rate
India	1950-2016	India Reserve Bank Discount Rate
Indonesia	1950-2011	1-month SBI Certificates Discount Rate
Indonesia	2012-2016	Prime Lending Rate
Ireland	1979-1998	Bank of Ireland Repo Rate
Ireland	1999-2016	ECB Refinancing Rate
Israel	1982-2016	Bank of Israel Discount Rate
Italy	1950-1998	Bank of Italy Discount Rate
Italy	1999-2016	ECB Refinancing Rate
Japan	1950-2016	Bank of Japan Discount Rate
South Korea	1950-2016	Bank of Korea Discount Rate
Luxembourg	1990-1998	Luxembourg Inter-bank Offer Rate
Luxembourg	1999-2016	ECB Refinancing Rate

Country	Time	Measure
Malaysia	1959-2016	Malaysia Bank Negara Discount Rate
Netherlands	1975-1998	Netherlands Bank Repo Rate
Netherlands	1999-2016	ECB Refinancing Rate
New Zealand	1950-2016	New Zealand Reserve Bank Official Cash Rate
Norway	1984-2016	Bank of Norway Overnight Lending Rate
Peru	1950-2016	Central Bank of Peru Discount Rate
Philippines	1950-2016	Philippines Central Bank Discount Rate
Poland	1950-2016	Poland Central Bank Refinancing Rate
Portugal	1950-1998	Bank of Portugal Discount Rate
Portugal	1999-2016	ECB Refinancing Rate
Russia	1950-2016	Russia Central Bank Refinancing Rate
Saudi Arabia	1991-2016	Saudi Arabia Repo Rate
Singapore	1973-2016	Singapore 3-month SIBOR
South Africa	1969-2016	South Africa 3-month JABIR
Spain	1950-1998	Bank of Spain Discount Rate
Spain	1999-2016	ECB Refinancing Rate
Sweden	1974-2016	Sweden Riksbank Repo Rate
Switzerland	1950-2016	Switzerland National Bank Discount Rate
Thailand	1950-2016	Bank of Thailand Lending Facility Rate
Turkey	1950-2016	Turkey Central Bank Discount Rate
United Kingdom	1950-2016	Bank of England Base Lending Rate
United States	1951-2016	Federal Funds Rate