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The Real Effects of Exchange Rate Depreciation: The Role of Bank Loan Supply

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JEL Classification: E44, E52, G21, O40

Keywords: Exchange Rates, bank lending, Interbank Markets, Real effects, Regional business cycles, Germany

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The Real Effects of Exchange Rate Depreciation: The Role of Bank Loan Supply*

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1 Introduction

With the onset of the gradual reversal of the quantitative easing policy in the United States, known as the Federal Reserve's tapering, the euro depreciated sharply against the US dollar. Specifically, between 2014:Q2 and 2015:Q1, the euro lost slightly more than 20% in value relative to the dollar. Similar sharp exchange rate movements have happened in other countries, not always related to fundamentals in the country and often unexpected, with Brazil in 2008 and India in 1997 as two prominent examples. How do such exchange rate movements affect macroeconomic outcomes? What is the role of the banking system in the transmission of exchange rate shocks to the real economy?

In this paper, we use both bank-firm loan data based on the German credit registry and German regional bank and output data to study these questions. Exploiting the euro depreciation of 2014, which can be seen as exogenous to bank lending in Germany as it was driven to a large extent by the tapering of the Fed's QE policies,[1] and running a difference-in-differences analysis around this event, we show that large banks with higher USD net assets and thus higher net worth after the USD appreciation increase their loan supply to export-intensive firms and small local banks without significant foreign-currency asset exposure but with a high share of exporting firms in their loan portfolios. We further find that in regions where the local banking sector benefits more from higher interbank borrowing, GDP growth is significantly higher—an effect that seems to be driven by an increase in investment of more affected firms. In economic terms, we establish that more affected regions grow by at least 1.3 percentage points more than less affected ones, cumulatively, in the two years after the depreciation relative to the two pre-depreciation years. Taken together, our results imply that an exchange rate depreciation, by increasing interbank market liquidity, can have sizeable economic effects, even when local banks have low foreign-currency asset exposure and are therefore not affected directly by the exchange rate shock.

Our paper straddles two literatures: on the one hand, standard open economy macro models imply that an exchange rate depreciation raises output growth via higher net exports, but ignores the role of banks as important transmitters of shocks. Empirical evidence has shown, however, that

[1] The Bundesbank (2017) shows that tighter monetary policy in the US even had a slightly larger impact on the EUR/USD exchange rate in 2014 than expansionary monetary policy in the euro area.

the exposure of firms and financial institutions to foreign currency assets and liabilities can also play an important role in the effect of exchange rate movements on the real economy (Bruno and Shin, 2015, Bruno and Shin, 2020). While an extensive literature has documented the importance of financing constraints for firms', industries' and countries' exports (Beck, 2002; Manova, 2013), these findings have not been linked to changes in the exchange rate that exporters face.[2] On the other hand, changes in banks' net worth can result in changes in their lending behavior (Adrian and Shin, 2010). We conjecture that exchange rate shocks should affect bank loan supply when banks have foreign-currency exposure on their balance sheets that is not perfectly hedged. If this is the case, and there is plenty of evidence supporting this assumption,[3] a bank with higher volumes of foreign-currency assets than liabilities experiences an increase in net worth because of the USD appreciation and is, therefore, likely to expand credit supply.[4] This, in turn, should have a positive impact on macroeconomic outcomes.

In order to identify the linkages between the EUR/USD depreciation, bank lending and the real economy, we construct two unique data sets. The first combines data at the bank-firm level from the German credit registry with firm balance sheet characteristics from Amadeus and bank balance sheet data from the Bundesbank. The second matches comprehensive region-level data from INKAR with balance sheet characteristics of local savings banks. Here, we make use of a unique feature of the German banking sector because the lending activity of savings banks is geographically restricted to a particular administrative district, which is typically the same as the definition of administrative regions in the INKAR database, allowing us to relate regional economic dynamics to the exposure of local banks to the exchange rate depreciation.

Germany is an interesting laboratory for studying the impact of exchange rate movements on the real economy via the banking sector, not only because of this unique feature of the German banking system and the granularity of the available data, but also because the exchange rate shock was exogenous and largely unanticipated from the perspective of German banks and firms. This

[2] With the exception of Agarwal (2019), which we will discuss below.

[3] For instance, Gabaix and Maggiori (2015) gauge that large financial intermediaries actively seek risk in currency markets. Similarly, the results of Abbassi and Bräuning (2021) imply that banks do not fully hedge their on-balance sheet currency exposure.

[4] In Online Appendix Section B, we show that after the EUR/USD depreciation, banks with higher net foreign-currency assets do indeed have a higher net worth.

is the case because the euro depreciation (dollar appreciation) of 2014 was induced, at least to large extents, by the Federal Reserve's gradual reversal of its quantitative easing policies (we provide details on the exchange rate shock and its drivers in Section 2.1). In addition, the German banking sector had accumulated significant amounts of net foreign-currency assets. This fact combined with the pronounced cross-bank variation in foreign-currency asset holdings allows us to identify the exchange rate effects across banks. At the same time, Germany is an export-intensive economy with one of the largest net exports to GDP ratios in the world. Therefore, the shift in the composition of credit towards export-intensive firms is likely to have significant aggregate effects.

In terms of identification, we estimate difference-in-differences regressions around the depreciation episode of 2014:Q2-2015:Q1, during which the euro depreciated significantly by more than 20%. This depreciation was also very persistent with the EUR/USD exchange rate staying at its post-shock level for several quarters. Our identification strategy relies on the differential, pre-shock exposure of German banks to net USD assets (scaled by total assets), with banks having higher foreign-currency assets being more exposed. When studying the cross-firm differences in credit allocation, identification also hinges on the heterogeneity of firms' pre-depreciation balance sheet characteristics. Following the standard approach in the credit registry literature, we further restrict our sample to firms with multiple bank relationships and include firm fixed effects to thus control for loan demand and isolate supply effects (Khwaja and Mian, 2008). Some specifications also include bank fixed effects to control for heterogeneity at the bank level, such as bank size (see, e.g., Jiménez et al., 2014). We also distinguish between bank lending to firms and to other banks to isolate the effect of the exchange rate depreciation on the interbank market. In order to identify the real effects of the depreciation, we complement these regressions with (i) firm-level estimations of credit growth, investment and employment, and (ii) region-level estimations of GDP growth, as discussed in greater detail below.

Our analysis provides three main results. First, we show that the euro depreciation encourages larger banks with significant net foreign-currency asset exposure to expand their credit supply. This effect is statistically significant and economically meaningful: depending on the bank size definition, we find a large bank that has a one percentage point higher net foreign-currency asset share than the median large bank to have a 4.5-5.5 percentage point higher credit growth from the pre- to the post-depreciation episode. Second, we establish that this increase can be explained by growth in loan supply to export-intensive firms, not to riskier firms, and, even more important, by an increase in interbank market activity. In particular, large banks with significant net foreign-currency assets raise their interbank lending to small banks without significant foreign-currency asset exposure, but with a higher share of exporting firms in their credit portfolio, which in turn also allows small banks to expand their credit supply. This is evidence that the exchange rate depreciation, by increasing the liquidity of distinct tiers of the domestic banking sector, can have sizeable economic effects, even when local banks have low foreign-currency asset exposure and are therefore not affected directly by the exchange rate shock. Finally, we show that exporting firms borrowing from smaller banks that have higher interbank market dependence increase their investment following the exchange rate depreciation, and that regions with local banks benefiting from this increase in interbank borrowing experience significantly higher GDP growth than less exposed regions. In economic terms, we show that more exposed regions grow by 1.3-1.4 percentage points more than less exposed regions, cumulatively, in the two years after the depreciation relative to the two pre-depreciation years. Therefore, exchange rate movements, by shifting the composition of bank loan supply and increasing interbank liquidity, can have sizeable aggregate implications.

Related Literature. Our paper relates to the literature along multiple dimensions. First and foremost, we contribute to the literature on the impact of exchange rate changes on the real economy. While there is abundant evidence showing that exchange rate depreciations can reduce firm investment and real economic growth when firms have foreign-currency debt (e.g., Aguiar, 2005; Kearns and Patel, 2016; Du and Schreger, 2016; Kalemli-Ozcan et al., 2021), only one study, at least to the best of our knowledge, looks at how the growth effects of exchange rate movements are affected by banks' foreign-currency exposure. Specifically, Agarwal (2019) shows that exchange rate depreciations (appreciations) can lead to an increase (decrease) in domestic credit and higher (lower) aggregate growth when the domestic banking sector has high net foreign-currency asset exposure. Our paper employs more granular loan-level data that do not only cover listed firms, as is the case in Agarwal (2019), and provides evidence for specific mechanisms through which exchange rate changes can affect loan supply, i.e., through direct lending and interbank lending, and links these mechanisms to real economic effects.

Second, our paper speaks to the literature relating macroeconomic developments, especially changes in the stance of monetary policy, to interbank markets. Fiordelisi et al. (2014) examine the impact of conventional and unconventional monetary policy on interbank credit markets and identify a more important role for the former. Abbassi et al. (2014) show that the European Central Bank's non-conventional long-term refinancing operations increased the supply of wholesale funding liquidity, consistent with Allen et al. (2014) and Freixas et al. (2011), who argue that monetary policy can have a *direct* impact on interbank market conditions. We show that similar effects can also be generated *indirectly* when changes in the stance of monetary policy affect the exchange rate and large domestic banks have significant foreign-currency exposure.

Finally, we contribute to the literature investigating potential implications of the taper tantrum on the financial sector. Several studies show that the taper tantrum reduced cross-border capital flows, especially to emerging market economies, thereby reducing credit growth in these countries (e.g., Avdjiev and Takáts, 2014; Avdjiev and Takáts, 2019). Bruno and Shin (2019) gauge that Mexican firms more reliant on banks with greater dollar funding experience a drop in credit and exports with the taper tantrum (through its impact on the dollar). In contrast, we establish that the taper tantrum can have a positive impact on credit dynamics by appreciating the USD and thus increasing the value of USD assets in countries where the domestic banking sector has significant foreign-currency exposure.

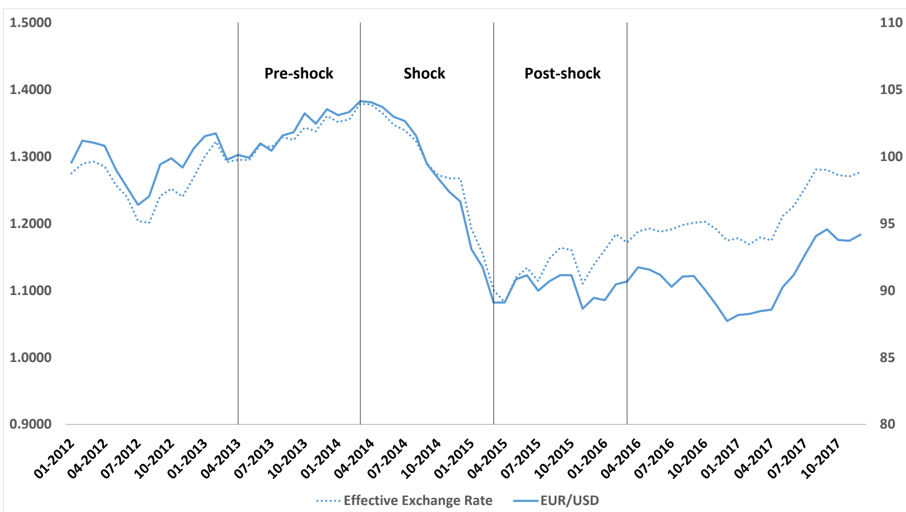
The remainder of the paper is structured as follows. In Section 2, we describe our data and the background of the EUR/USD depreciation episode that we are studying. Section 3 describes the empirical strategy. The results for the linear relation between banks' net foreign-currency exposure and loan supply are presented in Section 4. Section 5 investigates the cross-firm differences in loan supply. In Section 6, we study the real effects of the exchange rate depreciation using both firm-level data on investment and employment and German region-level data. Section 7 concludes. All technical details and additional results can be found in an Online Appendix at the end of the paper.

2 Data and Institutional Background

2.1 The 2014/15 Exchange Rate Depreciation

Following ECB president Mario Draghi's "whatever it takes" speech in July 2012, the euro appreciated gradually relative to other currencies, as can be seen from Figure 1. However, from April 2014, a very sharp and persistent depreciation of the euro took place. Specifically, within a relatively short time period, between 2014:Q2 and 2015:Q1, the euro lost slightly more than 20% in value relative to the US dollar. The decline relative to other currencies, as proxied by the trade weighted nominal effective exchange rate, was slightly less pronounced and less persistent.

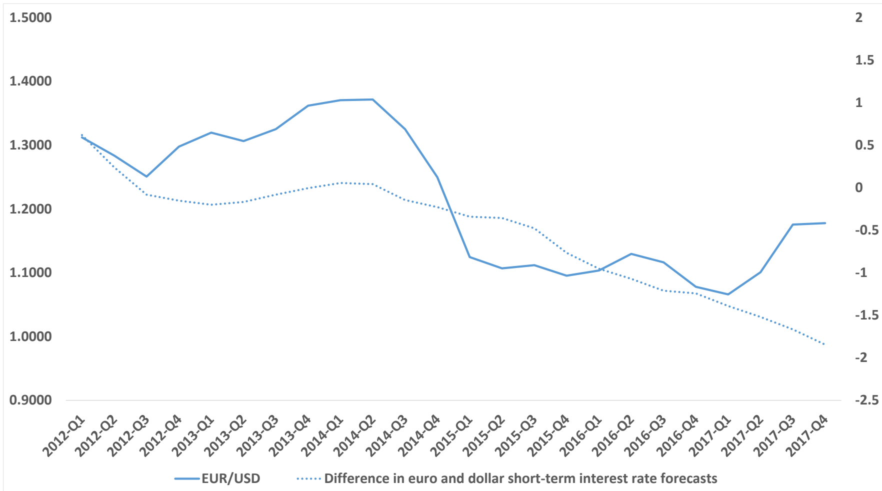
Figure 1 THE EUR/USD EXCHANGE RATE OVER TIME



NOTE. This figure shows the monthly dynamics of the EUR/USD exchange rate and of the trade weighted nominal effective exchange rate (1999:Q1=100) around the depreciation episode of 2014:Q2-2015:Q1. Data Sources: Federal Reserve Bank of St. Louis and ECB.

We argue that this depreciation was largely unexpected for financial market participants. This is the case because, during the euro depreciation episode we study, the difference in short-term interest rate forecasts between the euro area and the US were relatively stable (Figure 2). According to the Uncovered Interest Rate Parity stable forecasts of interest rate differentials imply a stable exchange rate, which was obviously not the case in 2014/15.

Figure 2 THE EUR/USD AND DIFFERENCES IN SHORT-TERM INTEREST RATE FORECASTS



NOTE. This figure shows the quarterly dynamics of the EUR/USD exchange rate and of the difference between short-term interest rate forecasts in the euro area and the US. Data Sources: Federal Reserve Bank of St. Louis and OECD.

What drove the sharp decline in the value of the euro? While it is impossible to attribute this exchange rate movement to just one single factor, many currency dealers interpret the decline in the euro as a rise in the dollar, driven at least to a large extent by the gradual reversal of the quantitative easing policy in the United States, known as the Federal Reserve's tapering.[5] Yet, as shown by the Bundesbank (2017), a more expansionary monetary policy in the euro area also had a non-negligible impact on the EUR/USD exchange rate around the year 2014, with an estimated impact of the ECB's monetary policy being slightly smaller, however, than that of the Fed's policies. Overall, it therefore seems that the divergent monetary policy strategies in the US and the euro area, with the ECB continuing its purchases of financial assets, significantly weakened the euro relative to the dollar by raising the interest rate differentials between both regions.

We note that both policies are exogenous to lending at the bank-firm level. While German bank lending behavior is highly unlikely to affect the stance of monetary policy in the US for obvious reasons, it is also implausible to have driven the ECB's decision to expand its lax monetary

[5]See, for instance: https://www.theguardian.com/business/2015/mar/11/euro-12-year-low-gainst-the-dollar. In fact, in its FOMC meeting in December 2013, the Fed announced plans to begin tapering its purchases in January 2014. Purchases were halted altogether on 29 October 2014 after accumulating 4.5 trillion USD in assets.

policies. This is because the ECB calibrates its monetary policy for the euro area as a whole and, especially during the episode considered in this paper, it was directed by the weak macroeconomic fundamentals in Southern Europe.[6]

Germany is an interesting laboratory for studying the impact of this exchange rate movement on the real economy via the banking sector because the German banking sector had accumulated significant amounts of net foreign-currency assets, as we show in the summary statistics below. This fact combined with the pronounced cross-bank variation in foreign-currency asset holdings allows us to identify the exchange rate effects across banks.[7] At the same time, Germany is an export-intensive economy with one of the largest net exports to GDP ratios in the world. Therefore, exchange rate changes are likely to have significant real effects.

2.2 Data

For the analysis carried out in this paper, we use two unique data sets, one at the bank-firm level and one at the region level, which we describe in turn. More details about the construction and sources of the variables can be found in the Data Appendix. The construction of the bank-firm level data set is also outlined in greater detail in Bednarek et al. (2021).

2.2.1 Bank-Firm-Level Data

The bank-firm-level data set is at quarterly frequency. The main source of this data set is the Deutsche Bundesbank's credit registry, which includes traditional loans, bonds, off-balance sheet positions and exposures from derivatives positions. Financial institutions in Germany have to report any credit exposures to the Deutsche Bundesbank that exceed a threshold of 1 million euro.[8] Overall, the total volume of loans in the German credit registry corresponds to about two thirds

[6]See Ilzetzki et al. (2020) for evidence that the ECB did no longer focus on the German economic situation after 2012.

[7]Note that, since 2018, financial institutions in Germany have had to report liquidity coverage ratios separately for each "significant" currency according to Article 415(2) of the Capital Requirements Regulation (CRR), where significance is defined as having liabilities in a foreign currency that are larger than 5% of total liabilities. This regulation, in turn, could bias German banks' holding of foreign liabilities towards values of slightly smaller than 5%. Yet, such a regulation, or any other regulation (or cap) on foreign-currency lending or borrowing, was not in place prior to 2018 during our sample period, so this concern in our analysis is unwarranted.

[8]This threshold stood at 1.5 million euro before 2014.

of total bank loans in Germany, including a sizable number of loans to small and medium-sized enterprises (Bednarek et al., 2021).

We match the credit registry data with bank balance sheet information. Specifically, we augment the data with the bank-level share of net USD assets over total assets, bank size (log of total assets), returns on equity and assets, the capital-to-risk weighted asset ratios and non-performing loans over total loans. We also match firm-level accounting variables to our data set, sourced from Bureau van Dijk's Amadeus database. This match is complicated by the fact that the German credit registry and the Amadeus database do not share a common identifier. To overcome this challenge, we first match by the unique commercial registry number, which is available for a sub-set of firms. Where this identifier is unavailable, we rely on Stata's reclink command, which probabilistically matches records.[9] Here, we match firms either by their name and zip code or by their name and city with a minimum matching reliability of 0.99. Finally, we also hand-match some of the hitherto unmatched firms.[10] After this matching process, we calculate firms' export intensity as the share of export turnover over total turnover. One issue here is that export turnover data are only reported by a minority of firms in Amadeus. In order to obtain a larger and more representative sample, we hence average export intensities by one-letter industry code and apply the same export intensity to all firms in the same industry. This procedure has the additional advantage of allowing us to include in our regressions firms from the German credit registry that have not been matched with Amadeus. We also perform a robustness check, where we average export intensities by a Bundesbank industry classification similar to the two-digit NAICS code whenever it contains at least 50 matched firms (otherwise, we use the broader one-letter average) and our results are unaffected. Other firm covariates used in the baseline analysis of this paper include the Altman Z-Score (Altman, 1968), leverage, size (log of total assets), labor productivity (defined as total sales over the number of employees), capital intensity (defined as total fixed assets over employees), and the share of tangible assets over total assets. Finally, in order to identify the real effects of the exchange rate depreciation, we use Amadeus data to calculate firm-level investment and employment growth as firm outcome variables.

[9] See Blasnik (2010).

[10] We match 4,143 firms by the commercial registry number, 23,010 firms by Stata's reclink command and 1,038 firms by hand.

From our matched sample, we exclude borrowing firms in the utility or public sector. We finally end up with a sample of more than 300,000 bank-firm relationships. Specifically, we have data for about 1,500 banks and slightly less than 240,000 firms, so that, on average, each firm has relationships with 1.4 banks. Note that the regressions include a smaller number of observations due to missing data for some of the regressors and because we restrict the sample to firms borrowing from more than one bank, as explained in detail below. For this reason, on average, each firm in the regression sample has credit relationships with 3.6 banks.

2.2.2 Region-Level Data

Our region-level data mostly come from the INKAR database. It comprises data on 401 administrative regions in Germany and covers the period 2000-2017 at annual frequency. The main outcome variable for the region-level analysis is the change in the log of nominal GDP per capita from the pre- to the post-depreciation episode. INKAR only provides data on nominal per capita GDP. As region-level CPI indexes are not available, we do not deflate this variable. Note, however, that inflation in Germany was low and stable during the period we consider. Hence, using nominal rather than real GDP is unlikely to bias our estimation results.

In order to relate real economic activity at the region level to changes in regional bank lending behavior, we make use of a unique feature of the German banking sector, which comprises three pillars–private commercial banks, savings banks and cooperative banks. Private commercial banks are not geographically constrained in their business activities and data on the cross-regional variation of their operations are also unavailable. We hence do not consider them for the regional analysis in this paper. In contrast, what makes the German banking sector unique is that both savings and cooperative banks are confined geographically and their business model is focused on lending within their respective administrative district only. While this institutional feature implies that savings and cooperative banks have no economically meaningful foreign-currency exposure (see Table 1 that reports mostly zeros for banks' net USD asset exposure) and they are, therefore, not affected *directly* by the exchange rate depreciation, our results below show that large banks with significant foreign-currency asset exposure raise their interbank lending to small and regional banks. Thus, savings and cooperative banks are affected *indirectly* by the depreciation via an increase in interbank funding and the geographical constraints on their lending activity then allow us to relate regional economic dynamics to the (indirect) exposure of local banks to the EUR/USD depreciation.

Whereas savings banks' area of activity typically matches the 401 administrative regions in Germany,[11] the area of activity of cooperative banks is smaller than an administrative region. In addition, Dinger et al. (2020) argue that the regional market shares of savings banks are larger than those of cooperative banks, with savings banks being the largest bank in a lot of districts. This, in turn, suggests that exchange rate shocks, by affecting the balance sheet of savings banks, can have a sizeable impact on the local real economy.[12] For these reasons, in our regional analysis, we focus on savings banks rather than cooperative banks. Another reason for excluding cooperative banks in that analysis is that their number has been decreasing significantly from about 7,000 in the 1970s to about 1,000 today (see Dinger et al., 2020), with several mergers taking place across administrative reasons, which would be likely to introduce noise in our regional regressions.[13]

We use the match between savings banks and the 401 administrative regions of Dinger et al. (2020), which is based on a list of savings banks and the administrative regions in which they operate, as provided by the German Savings Banks and Giro Association, and allows us to aggregate the savings bank balance sheet variables described in Section 2.2.1 at the region level.[14]

Lastly, note that our omission of both cooperative and private credit banks from the regional analysis implies that our estimates are likely to be downward-biased and that the "true" effect of

[11]Deviations from this principle can occur for two reasons, as discussed in Dinger et al. (2020). First, there are a few cases where multiple individual municipalities within an administrative region each operate a savings bank, so that more than one savings bank can operate in a particular region. Second, mergers among savings banks can imply that one savings bank is active in more than one administrative region.

[12]See also Hakenes et al. (2015), who argue that regional banks are more effective than large private banks in promoting local economic growth.

[13]In unreported regressions, however, we also include cooperative banks in our regional specifications and the results are qualitatively unchanged.

[14]In some cases, the territorial boundaries of administrative regions have changed over time. For instance, the district Osterode was merged with an enlarged district Goettingen in 2016. Whereas Dinger et al. (2020) use an older territorial status of administrative regions, which, for instance, still includes the old (smaller) district Goettingen that had another district identifier than the new (enlarged) one, we use the 2019 territorial status of districts, which implies that we had to adjust their matching to be consistent with the 2019 status. Note as well that the list of Dinger et al. (2020) matches one bank to one district. However, there are a few cases where one savings bank operates in multiple administrative districts. For instance, after the merger between the savings bank Cologne and the savings bank Bonn to the new savings bank Cologne and Bonn, the latter operates in both districts. Therefore, whenever any of the 401 administrative districts considered in our paper were not matched to a savings bank in the list of Dinger et al. (2020), we verified whether this could be because one savings bank operates in multiple districts and matched such cases by hand, thus allowing one bank to be present in multiple districts.

the depreciation on GDP growth, working through the mechanisms highlighted in this paper, can be expected to be even larger.

2.3 Summary Statistics

Table 1 presents the summary statistics. We provide the exact variable definitions and data sources in the Data Appendix, Table A.1.

The main dependent variable in our analysis, credit growth from the pre-depreciation episode (2013:Q2-2014:Q1) to the post-depreciation episode (2015:Q2-2016:Q1), has a median value of -7.12%. Considering the three-year period used to calculate this variable, this corresponds to an annualized decrease in credit volumes of approximately -2.5% – a value that is in line with the literature using German credit registry data (e.g., Bednarek et al., 2021; Behn et al., 2016a). Note that this negative value also implies that, in this paper, we examine whether the depreciation of the euro reduces this negative credit growth rate and, potentially, makes it turn positive for certain banks and firms.

Table 1 also shows that for many banks net USD assets as a share of total assets are relatively low, as can be seen from the 75th percentile of 0%. However, several banks also have significant foreign-currency asset exposure, with a 99th percentile of the distribution equal to 13.3% and six banks even having ratios larger than 25%. As we show in Section 4, these banks drive our results. On average, the fraction of net USD assets in total net foreign-currency assets is equal to 65%, making the dollar by far the most important foreign currency for German banks. Banks in our sample further have median values of liquidity equal to 14.6%, of non-performing loans equal to 2.7% and an average return on equity of 14.8%.

From the firm-level covariates, it is striking that firms have a median share of turnover generated abroad that is equal to 37.3%, strengthening our argument that Germany is an export-intensive economy, where exchange rate depreciations can be expected to have particularly strong real economic effects. Firms' median leverage, defined as total liabilities divided by total assets, comes to 70.3% and firms' average Z-Score stands at 6.2, indicating that German firms, on average, are relatively safe. Note here as well that the correlation between these firm characteristics and banks' net USD assets in our matched bank-firm sample is very low (coefficients not reported in Table

Table 1 SUMMARY STATISTICS

Variable	Level	Obs.	Median	25th	75th
$\Delta LOANS_{f,b}$	*bank-firm*	344,777	-7.12	-33.51	6.02
Net USD Assets	*bank*	1,544	0.00	0.00	0.00
Net Foreign-currency Assets	*bank*	1,544	0.01	0.00	0.01
Gross USD Assets	*bank*	1,544	0.06	0.01	0.21
Gross USD Liabilities	*bank*	1,544	0.06	0.00	0.19
Size	*bank*	1,544	20.20	19.26	21.23
Liquidity	*bank*	1,544	14.59	10.70	20.46
ROE	*bank*	1,479	14.75	10.21	19.68
NPL	*bank*	1,477	2.65	1.62	4.09
Loans	*bank*	1,542	60.47	50.62	68.62
Capital	*bank*	1,486	18.61	15.81	22.53
$Exportshare_b$	*bank*	525	36.30	20.19	40.04
Interbank Deposits	*bank*	1544	12.54	7.99	18.29
Exports	*firm*	1,349	37.26	17.45	58.31
Size	*firm*	42,118	1.59	0.34	2.89
Tangible Assets	*firm*	39,132	23.35	4.76	60.84
Labor Prod.	*firm*	18,734	0.23	0.12	0.50
Capital Intensity	*firm*	33,176	0.04	0.01	0.21
Leverage	*firm*	40,828	70.33	44.74	89.77
Z-Score	*firm*	18,080	6.16	4.47	8.34
$\Delta EMPL$	*firm*	15,936	0.00	0.00	11.78
ΔK	*firm*	13,684	-0.05	-5.71	8.79
ΔGDP	*region*	401	11.88	9.51	14.51
$Exportshare_r$	*region*	395	26.16	0.15	40.04
Share Agricultural Land	*region*	401	45.05	34.00	58.05
Share of People Above 65	*region*	401	20.60	19.30	22.20
GDP p.c.	*region*	401	28.85	23.85	35.15

NOTE. The table reports summary statistics for our main variables. The variable definitions and data sources are in Table A.1. Note that the bank- and firm-level statistics are reported for all banks and firms in the German credit registry. The corresponding descriptive statistics for the final regression sample are available from the authors upon request.

1), with correlation coefficients of, for instance, 2.4% (for export turnover shares) and 0.1% (for firms' Z-Scores).[15] This evidence is corroborated in Table C.1 of the Appendix, where we regress bank-level net USD assets on the weighted average of several firm characteristics in a bank's loan portfolio, with weights corresponding to the bank-firm exposure in the German credit registry. This table shows that most firm characteristics are unrelated to banks' foreign-currency exposure. Two exceptions here are labor productivity and capital intensity, which enter our regressions, however, in only one specification. Therefore, selection between firms and banks is unlikely to drive our results. Regarding our two main firm outcome variables, it becomes apparent that they hardly change, on average, during our sample period. However, there are several firms that raise both their employment and investment significantly, as can be seen from the 75th percentile of the

[15] These coefficients are similar when we confine the matched sample to large banks with significant foreign-currency asset exposure.

respective distribution.

Finally, concerning the region-level variables, Table 1 shows that average nominal GDP growth from 2012-13 to 2016-17 was 11.9% (or about 3% per year), average GDP per capita in 2012-13 is 28,850 euro, the median share of land covered by agriculture is 45.1% and regions have a median share of people aged 65 or above of 20.6%.

3 Identification Strategy and Testable Hypotheses

We identify the impact of the 2014/15 exchange rate depreciation on bank lending in two steps. First, we explore the direct effect of the depreciation on bank loan supply to borrowers, with a sensitivity that depends on banks' net foreign-currency assets. The hypothesis is that the depreciation should especially increase the net worth of banks with higher USD assets, thus boosting their lending capacity.[16] Therefore, identification relies on the differential, ex-ante exposure of German banks to the depreciation, with banks having a higher share of foreign-currency assets being more exposed. Second, we study the cross-firm differences in credit allocation. Identification here also hinges on the heterogeneity of firms' pre-depreciation balance sheet characteristics, as discussed in Section 3.3.

After identifying the impact of the depreciation on bank lending behavior in Sections 4 and 5, we also study its real economic effects using our comprehensive firm-level and region-level data set. We present the econometric approach for this part of the analysis in Section 6.

3.1 Linear Model: Within-Firm Regressions

In the first step of our empirical analysis, we investigate the linear effect of bank-level net USD assets on bank lending, specified in a regression of the following form:

$$\Delta LOANS_{f,b,post-pre} = \alpha_f + \theta * NetUSDAssets_{b,pre} + \gamma X_{b,pre} + \varepsilon_{fb}, \tag{1}$$

[16]See the Online Appendix Section B, where we show that after the EUR/USD depreciation, banks with higher volumes of net foreign-currency assets do indeed have a higher net worth.

where the dependent variable is the log change in the credit exposure of bank b to firm f from the pre-shock period average (the four quarters before the depreciation, i.e., 2013:Q2-2014:Q1) to the post-shock period average (the four quarters afterwards, i.e., 2015:Q2-2016:Q1). This calculation, consistent with a recent study by Bottero et al. (2020), minimizes problems that arise due to the standard errors' serial correlation (Bertrand et al., 2004) and averages out potential seasonality effects (Duchin et al., 2010). The main regressor is the bank-level, pre-shock share of net USD assets over total assets. The regressions also include the following bank controls, subsumed in the vector X: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted capital and return on equity. As we exploit within-firm variation by including firm-fixed effects α_f, we restrict the sample to firms borrowing from at least two banks. Thus, we examine whether a firm which borrows from several banks experiences differential credit growth from banks with different amounts of USD assets on their balance sheets. Because of this, firm-specific demand shocks are absorbed by the firm fixed effects and we are able to identify credit supply side effects (Khwaja and Mian, 2008).

All regressions in the paper that are based on German credit registry data are weighted by the volume of bank-firm credit exposures in order to prevent an oversampling of small bank-firm pairs that are unlikely to affect aggregate economic dynamics. After estimating this regression for the full sample of lenders and borrowers, we also partition the sample into borrowers in the real and financial sector, and we furthermore distinguish between large and small lenders. To this end, we use two distinct size definitions. First, we differentiate between systemically important and non-systemically important banks.[17] Second, we define all banks in the top 2% of the total asset distribution as large, and the lowest 98% as small lenders, a threshold consistent with Kashyap and Stein (2000). In unreported specifications, we also define banks in the top 1% of the total asset distribution as large and the results are robust. Finally, the standard errors are either clustered at the bank level or, when the number of clusters is smaller than 40 as in the the regressions of the

[17] Since 2014, according to the Deutsche Bundesbank, the following 15 banks have been classified as systemically important in Germany: Commerzbank, Deutsche Bank, DZ Bank, UniCredit Bank, Landesbank Baden-Wuerttemberg, Bayerische Landesbank, Landesbank Hessen-Thueringen, Norddeutsche Landesbank, ING DiBa, DekaBank Deutsche Girozentrale, Landwirtschaftliche Rentenbank, NRW.Bank, Hamburg Commercial Bank, Volkswagen Bank and TARGOBANK.

sub-sample of large banks, we employ heteroskedasticity-robust standard errors.[18]

3.2 Linear Model: Cross-Firm Regressions

While the within-firm regressions allow us to gauge the intensive margin of the euro depreciation, the necessary inclusion of firm fixed effects does not allow us to gauge whether firms actually experience an overall change in credit or not. We therefore estimate a regression of the following form:

$$\Delta LOANS_{f,post-pre} = \widehat{\alpha_f} + \theta * \overline{NetUSDAssets}_{f,pre} + \gamma * \bar{X}_{f,pre} + \varepsilon_f, \tag{2}$$

where the dependent variable is the log change in total credit between the pre- and post-depreciation episode from all banks lending to firm f. $\overline{NetUSDAssets}$ is a firm's exposure to the depreciation, which we calculate as the weighted average of banks' net USD asset shares across all banks that a firm maintains credit relationships with. The applied weights are the pre-depreciation bank-firm credit exposures. Bank controls, subsumed in the matrix X, are the same as in Regression 1, but are in these specifications also averaged at the firm level based on the share of bank-firm credit exposure before the depreciation.

Finally, given that we are not able to include firm fixed effects in Regression 2, we control for credit demand by following the methodology proposed by Abowd et al. (1999), and recently employed by di Patti and Sette (2016), Cingano et al. (2016) and Beck et al. (2021). That is, we include in the regression the firm-level fixed effects estimated from Regression 1, $\widehat{\alpha_f}$.

3.3 Interaction Model

In order to examine the effect of the exchange rate depreciation on the composition of bank loan supply across firms, in a second step, we expand Regression 1 by including the interaction between bank-level net foreign-currency assets and different firm-level balance sheet characteristics. Identification, therefore, not only hinges on German banks' differential pre-depreciation USD exposure, but also on the differential, pre-depreciation characteristics of firms. This part of the

[18] See Angrist and Pischke (2008), who recommend that clusters should number at least 40.

analysis is specified as follows:

$$\Delta LOANS_{f,b,post-pre} = \alpha_f + \alpha_b + \beta * (FIRMVAR_{f,pre} * NetUSDAssets_{b,pre}) + \varepsilon_{fb}, \quad (3)$$

where the vector FIRMVAR contains different firm-level, pre-depreciation balance sheet characteristics discussed below. In addition to firm fixed effects, these regressions also include bank fixed effects, α_b, to control for (unobservable) heterogeneity across banks. Note that the sets of fixed effects absorb the main coefficients of the firm-level characteristics and bank-level net foreign-currency assets, which therefore cannot be added separately. The same is true for the bank-level controls of Regression 1.

Regression 3 allows us to test different hypotheses on what characteristics determine firms' access to the increased credit supply following the depreciation. On the one hand, one important strand of the literature argues that export-intensive firms experience disproportionate improvements in their cash flows following a depreciation (e.g., Dao et al., 2021), which increases their credit worthiness. As a consequence, banks should expand the credit supply to such firms in particular. To verify this hypothesis, we employ the share of firm-level export sales relative to total sales in the pre-shock period, averaged by industry because data on export sales are missing for the majority of firms.[19] We also present specifications in which we replace the share of export sales with other firm variables that are shown to correlate tightly with the export intensity of firms.[20] These variables comprise firm size, capital intensity, labor productivity and asset tangibility.[21]

A competing hypothesis builds on Martynova et al. (2020) whose model predicts that higher profitability of banks' core business loosens capital constraints, thus enabling banks to borrow more and to engage more in risky side activities. This theoretical mechanism is consistent with empirical evidence found by Calem and Rob (1999) and Perotti et al. (2011), among others.[22]

[19] We use the median to calculate average export intensities by industry in order to reduce the impact of outliers that are present in the firm-level data. Note, however, that using the mean yields similar coefficient estimates, but slightly lower statistical significance.

[20] See Wagner (2011) for a survey on this topic.

[21] For the latter, Manova et al. (2015) show that it is correlated with lower credit constraints and therefore higher exports.

[22] Note that the recent empirical evidence contradicts traditional corporate finance models that predict instead that more profitable firms take less risk (e.g., Keeley, 1990). For instance, around the global financial crisis, as highlighted in Martynova et al. (2020), profitable financial institutions took disproportionately high risks.

In order to examine the empirical validity of this competing hypothesis in our setting, we enrich the vector FIRMVAR (see Regression 3) by firms' Z-Score, in line with Altman (1968), and firms' leverage (debt over total assets). We use the Altman Z-Score as one of our firm risk measures because it can be interpreted as firms' distance to default and because it includes various dimensions of firm risk, such as working capital, profitability and capitalization.[23] In addition, leverage is an appropriate firm risk proxy because levered firms are more likely to default (Carling et al., 2007) both because of their higher risk-taking incentives and their worse loss-absorbing capacity. For this reason, leverage has thus been used extensively in the empirical literature (e.g., Paligorova and Santos, 2017; te Kaat, 2021).

Note that we estimate Regression 3 for the full sample of firms, as well as for financial firms (banks) only, since the results from estimating Regression 1 suggest that an important role is played by interbank market lending. In order to investigate the bank-to-bank lending market, we aggregate the previously introduced firm balance sheet characteristics at the bank level. Specifically, we compute weighted bank-level averages of the firm characteristics, with weights equal to the pre-depreciation bank-firm credit exposure. Using these averages, we examine whether lenders with a higher share of net USD assets increase their interbank lending disproportionately to borrowing banks whose credit portfolio is made up of a higher share of firms with particular balance sheet characteristics.

Finally, after studying the effects on the composition of bank loan supply across firms using a within-firm identification strategy, we also investigate whether the within-firm evidence feeds into an overall change in credit volumes. The attendant cross-firm specifications are similar to those presented in Section 3.2. We will provide their specifics further below in Section 5.4.

4 Depreciation, Net Foreign-Currency Assets and Loan Supply

This section reports the results for estimations of the linear relationship between banks' net USD asset exposure and their lending activity, presenting first the within-firm results, then the cross-firm ones and finally discussing different robustness tests.

[23] In particular, we calculate the Z-Score as 3.25+6.56*working capital/total assets+3.26*retained earnings/total assets+6.72*EBIT/total assets+1.05*equity/total liabilities, in line with Altman et al. (2017).

4.1 Main Results: Within-Firm Variation

The results in Table 2 show that banks with higher net USD assets increase lending to their borrowers, but only the largest banks and only, on average, to other banks. Specifically, the results in column (1) show that banks with higher net USD assets increase their lending relatively more than banks with lower net foreign-currency assets after the EUR/USD depreciation. The coefficient estimate, however, has a statistical significance slightly below the 10% level.

The results in columns (2)-(5) show the importance of differentiating between banks of different sizes. Specifically, we distinguish between small and large banks, using two distinct size definitions. First, we distinguish between systemically important banks (SIBs) and non-systemically important banks, with the former being significantly larger than the latter.[24] Second, we define all banks in the top 2% of the total asset distribution as large, and all other banks as small. The coefficient estimates suggest that net foreign-currency assets do not play an important role in the sensitivity of small banks' lending behavior to the exchange rate shock. In contrast, the previous results become both economically and statistically more significant for large lenders, which is evidence that only large banks with higher net USD assets raise their lending in response to the exchange rate depreciation. In economic terms and given the overall decline in credit volumes in Germany throughout our sample period by about 7%, within the sub-group of systemically important banks, a bank that has an one-percentage point higher net USD asset share than the median bank has a 5.65 percentage point lower credit growth contraction from the pre- to the post-depreciation episode. For banks with a 1.24 percentage point higher net USD asset share than the median SIB, the overall credit growth rate, on average, turns positive.[25] This significance also shows that banks do not perfectly hedge their foreign-currency exposure and thus gain from the exogenous exchange rate movement. This evidence is consistent with Gabaix and Maggiori (2015) and Abbassi and Bräuning (2021), who gauge that banks do not perfectly hedge their foreign-currency exposure, but instead actively seek risk in currency markets.

The results in columns (6)-(9), finally, show that the lending effect of higher capital stemming

[24] While total assets of SIBs in our sample average 276,179 million euro, those of non-SIBs average only 2,268 million euro.

[25] To get this number, we divide 7 by 5.65.

from the euro depreciation is limited to borrowers from the financial sector.[26] Specifically, when we drop from our sample borrowers that belong to the financial sector, the coefficient on net USD assets turns negative (but statistically insignificant), suggesting that the positive coefficient of column (1) is driven by an increase in interbank market activity. This result is corroborated in column (7), where we focus on borrowers in the financial sector only and where net foreign-currency assets again have a positive impact on lending that is statistically significant at the 10% level. In columns (8)-(9), we also investigate lending to financial vs non-financial borrowers for systemically important banks only. The coefficient estimates show that, relative to the specification for all banks in column (7), SIBs allocate disproportionately more credit to financial borrowers (column (9)). The attendant point estimate is statistically significant at the 5% level. In contrast, SIBs rather reduce their lending to non-financial borrowers (column (8)). In unreported specifications, we also find that net foreign-currency asset differences are not significantly associated with the lending of small (non-SIB) lenders to financial or non-financial borrowers in a statistically significant manner. Therefore, our results are mainly driven by large banks and their lending to financial sector borrowers.

Our finding that only large but not small banks with higher net foreign-currency assets react in their lending behavior to the exchange rate depreciation raises the question why. One possibility are different sensitivities of large and small banks to exchange rate depreciation. Another possibility is that this is because only the largest banks have economically significant net USD asset exposure, suggesting that there might be important non-linearities in the effect of net foreign-currency assets on bank lending around the depreciation episode. If this hypothesis is indeed true, we should find that the significant coefficient on large banks' net foreign-currency assets in column (2) of Table 2 disappears once we drop banks with high net foreign-currency asset exposure. In the regressions of Table C.2 in the Appendix, we therefore drop, from the sub-set of systemically important banks, subsequently (i) the bank with the highest share of net USD assets in total assets, (ii) the five largest net USD asset-banks and (iii) the ten largest net USD asset-banks. While, once we drop only one bank, the coefficient estimate gets smaller in size, but remains statistically

[26] The results get even stronger when we restrict the sample to banks only, and hence do not include other non-bank financial borrowers.

significant, once we drop the five banks with the highest USD shares, the corresponding estimate turns statistically insignificant and, once we drop the ten largest USD-banks, the coefficient estimate even turns negative, but is estimated very imprecisely. Taken together, this suggests that large banks do not per se have a higher sensitivity to the exchange rate depreciation, but that their more substantial shares of net foreign-currency assets, on average, can explain their differential response to the depreciation.

Across the specifications of columns (1)-(9), it is mainly three bank-level controls that turn out to be statistically significant: banks' loan-to-asset ratio, liquidity ratio and profitability. Specifically, more liquid banks and banks with higher loan-to-asset ratios tend to increase lending less, which is consistent with other studies employing German credit registry data (e.g., Behn et al., 2016a; Behn et al., 2016b; Bednarek et al., 2021) and can be interpreted as a convergence effect in bank lending. We also find that higher profitability reduces the lending growth by large banks, and increases lending growth by small banks. For large banks, we also find a negative relation between non-performing loans and lending growth, especially when it comes to lending to financial borrowers.

Taken together, these results imply that only large banks with higher net USD assets raise their lending in response to the depreciation and that only an increase in interbank lending, not in lending to non-financial borrowers, can explain this effect. After exploiting the cross-firm (instead of the within-firm) variation of the data in Section 4.2 and presenting several robustness checks in Section 4.3, Section 5 focuses on the potential drivers of the increase in interbank lending activity by establishing that large banks serve as a central intermediary that reallocates liquidity towards small banks with a higher portfolio share of export-intensive firms that experience higher demand on account of the exchange rate depreciation and are thus in need of external funds. In most of these specifications, we only use the systemically important bank definition to distinguish between small and large banks, mainly because it makes our analysis less prone to criticism regarding the exact cutoff used to define whether a bank is large or small. The results, however, are similar if we distinguish between the largest 2% of banks by total assets and the smallest 98%. These results are not reported for reasons of space, but they are readily available upon request.

Table 2 Exchange Rate Depreciations and Bank Lending: Main Results

	Full Sample	SIBs	Non-SIBs	Top 2% Bank	No Top 2% Bank	Non-Fin. Borrowers	Fin. Borrowers	Non-Fin. Borrowers, SIBs	Fin. Borrowers, SIBs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
Net USD Assets$_{b,pre}$	1.109	5.651**	-0.462	4.690*	-0.250	-0.485	1.947*	-2.497*	10.915**
	(0.73)	(2.74)	(0.74)	(2.57)	(0.48)	(0.99)	(1.02)	(1.39)	(2.99)
Size$_{b,pre}$	-2.727	-56.422**	-1.688	-2.776	2.504	1.059	-3.692	7.865	-116.221***
	(2.81)	(26.04)	(3.22)	(9.77)	(2.97)	(5.70)	(3.12)	(24.35)	(31.40)
Loans$_{b,pre}$	-0.615***	-0.193	-0.193	-1.017**	-0.128	-0.042	-0.741***	0.110	-3.402***
	(0.23)	(0.46)	(0.19)	(0.48)	(0.21)	(0.23)	(0.27)	(0.42)	(0.45)
Liquidity$_{b,pre}$	-0.642*	1.522	-0.324	-1.581**	-0.511	0.026	-0.955**	-0.550	4.461**
	(0.33)	(1.33)	(0.40)	(0.62)	(0.42)	(0.27)	(0.47)	(1.40)	(1.57)
Capital$_{b,pre}$	-0.001	1.040	0.018	0.166	0.106	-0.032	0.051	0.981	1.120
	(0.11)	(0.67)	(0.09)	(0.15)	(0.12)	(0.09)	(0.27)	(0.76)	(0.87)
NPL$_{b,pre}$	-0.820	-7.113*	-1.585	-5.819*	0.511	0.434	-1.170	3.676	-14.836***
	(1.37)	(3.59)	(1.91)	(2.90	(0.77)	(1.23)	(1.71)	(2.47)	(4.26)
ROE$_{b,pre}$	0.518	-2.074**	1.024***	0.038	0.707***	0.431	0.537	1.073	-4.486***
	(0.40)	(0.92)	(0.29)	(0.60)	(0.25)	(0.29)	(0.46)	(1.02)	(1.04)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	131,742	25,090	79,888	51,498	52,743	78,331	53,411	17,192	7,898
R^2	0.392	0.527	0.334	0.457	0.278	0.516	0.357	0.619	0.498

The regressions are based on quarterly bank-firm-relationship level data. The dependent variable is the log-difference in loan volume of bank b to firm f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable is the bank-level share of net USD assets over total assets. Columns (1)-(5) use all borrowers in the sample, columns (6) and (8) only borrowers in the non-financial sector and columns (7) and (9) only borrowers in the financial sector. While Column (1) uses all lender banks, columns (2), (8) and (9) focuses on systemically important banks, column (3) on non-systemically important banks, column (4) on the 2% of largest banks according to total assets and column (5) on banks in the lowest 98% of the total asset distribution. The regressions include firm fixed effects, as well as the following bank controls: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted capital, return on equity. The regressions are weighted by the volume of bank-firm credit exposures and the standard errors are shown in parentheses, using bank clustered errors (columns 1, 3, 5, 6 and 7) or heteroskedasticity-robust errors (columns 2, 4, 8 and 9). *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

4.2 Main Results: Cross-Firm Variation

While so far we have exploited within-firm variation in lending growth by banks, these within-firm specifications do not allow us to assess the overall impact of the depreciation on firms' credit access, as they only capture the intensive margin of lending and, therefore, do not take into account credit flows from new lending relationships or from those that were terminated between the pre- and post-depreciation period. We therefore turn to cross-sectional estimations as in regression 2.

The results in Table 3 show that our within-firm results also feed into higher overall credit supply for more exposed firms. In particular, firms whose lenders have higher USD exposure experience a stronger increase in overall credit supply than less exposed firms (column (1)). In columns (2) and (3), we limit the sample to firms that have their main credit relationship with a systemically-important bank. The coefficient estimates for lending to all firms, as well as to financial ones only, remain positive, as expected. Yet, the statistical significance lies below the 10% level, probably due to the small sample size in these specifications. We hence define, in columns (4) and (5), the largest 2% of banks according to total assets large. As becomes apparent, the attendant coefficients remain positive, but now turn statistically significant at the 1% level. In unreported regressions, we further find that the same estimates for small banks are even negative. Thus, those banks that drive our within-firm results (large banks) are also those that drive the cross-firm ones. Importantly, for firms mainly borrowing from systemically-important banks or the largest 2% of banks, the point estimates are larger when we restrict the sample to firms in the financial sector (see columns (3) and (5)). This is further evidence that the increase in bank lending following the depreciation is mainly driven by an increase in interbank market lending of large banks.

4.3 Robustness Checks

In this sub-section, we report the results of several robustness checks in which we adjust the main regression for systemically-important banks, corresponding to column (2) of Table 2, in several aspects. First, while previous regressions report the coefficient estimates for net USD assets, we now calculate a similar variable using not only banks' assets and liabilities denominated in USD,

Table 3 Results for the Cross-Firm Analysis

	All Firms and Banks	All Firms/SIBs	Financials/SIBs	All Firms/Top 2% Bank	Financials/Top 2% Bank
	(1)	(2)	(3)	(4)	(5)
	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT
$\overline{NetUSDAssets}_{f,pre}$	0.868**	0.794	1.916	2.653***	3.610***
	(0.39)	(1.00)	(1.94)	(0.80)	(1.20)
Bank Controls	Yes	Yes	Yes	Yes	Yes
Credit Demand	Yes	Yes	Yes	Yes	Yes
Obs	36,430	8,963	2,629	12,335	4,282
R^2	0.440	0.391	0.436	0.416	0.412

The regressions are based on quarterly bank-firm-relationship level data. The dependent variable is the log change in total credit between the pre- and post-depreciation episode from all banks lending to a particular firm f. The key independent variable is a firm's exposure to the depreciation, computed as the weighted average of banks' net USD asset shares across all banks that a firm has credit relationships with. The weights are the pre-depreciation bank-firm credit exposures. Bank controls include those of Regression 1, but are here also averaged at the firm level based on the share of bank-firm credit exposure prior to the depreciation. The attendant coefficients are not shown in order to conserve space. We also control for credit demand by adding the vector of firm-level fixed effects estimated from Regression 1. In columns (2) and (3), we restrict the sample to firms that have their main credit relationship with a systemically-important bank and we distinguish between all borrowers and financial borrowers only. In columns (4) and (5), we restrict the sample to firms that mainly borrow from the largest 2% of banks according to total assets, distinguishing again between all and financial borrowers. The standard errors are clustered at the main bank level and are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

but also in Swiss franc, British pound and Japanese yen. In particular, the main regressor in column (1) of Table 4 is the bank-level, pre-depreciation share of net assets denominated in one of these four currencies.[27] As becomes apparent, our main estimate remains positive and statistically significant at the 5% level once we apply this broader definition of net foreign-currency assets.

Second, we disaggregate net USD assets into gross USD assets (column (2)) and liabilities (column (3)). As becomes apparent and consistent with our main result, the euro depreciation induces banks with higher gross foreign-currency assets to raise their credit supply. The gross foreign-currency liability estimate, however, is also positive and statistically significant at the 10% level, which is counter-intuitive because a weaker home currency increases the value of foreign-currency liabilities. Given the substantial correlation between gross foreign-currency assets and liabilities, which is equal to 89% in our sample, one potential reason for this result might be that gross foreign-currency liabilities serve as a proxy for foreign-currency assets. In fact, when we include both variables in a single regression (not reported), the gross foreign-currency asset coefficient remains positive and the foreign-currency liability coefficient turns negative. However, the estimates are very imprecisely estimated, presumably because of the high correlation between

[27] Note that Bundesbank only provides banks' net foreign-currency assets for these four currencies, which prevents us from including other currencies for this robustness check.

Table 4 Exchange Rate Depreciations and Bank Lending: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
Net Foreign-currency Assets$_{b,pre}$	5.850**					
	(2.59)					
Gross USD Assets$_{b,pre}$		3.829**				
		(1.58)				
Gross USD Liabilities$_{b,pre}$			4.369*			
			(2.27)			
Net USD Assets$_{b,pre}$				6.847**	4.996**	-6.622
				(2.74)	(2.26)	(7.91)
Interest Rate Exposure$_{b,pre}$				-5.700**		
				(2.55)		
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	25,090	25,090	25,090	25,090	25,495	5,626
R^2	0.527	0.528	0.527	0.528	0.563	0.394

These robustness exercises are based on quarterly bank-firm-relationship level data. In column (1), we calculate net foreign-currency assets as the sum of net assets in USD, Swiss franc, Japanese yen and British pounds. In columns (2)-(3), we dis-aggregate net USD assets into gross USD assets and liabilities. In column (4), we add banks' interest rate exposure as an additional covariate, defined as the change in present value (in % of own funds) of banking book positions exposed to interest rate risk due to an abrupt increase in interest rates by 200 basis points across all maturities. In column (5), the dependent variable is the log-difference in loan volume of bank b to firm f from the 8-quarter, pre-depreciation period (2012:Q2-2014:Q1) to the 8-quarter, post-depreciation period (2015:Q2-2017:Q1). In column (6), we run a placebo analysis around the year 2002, assuming that the placebo event happened during 2002:Q2-2003:Q1. In this specification, we calculate the dependent variable as the log change in credit volumes from the 2001:Q2-2002:Q1 average to the 2003:Q2-2004:Q1 average. All of the regressions include firm fixed effects, as well as the following bank controls that are not reported to conserve space: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted assets, return on equity. The regressions are weighted by the volume of bank-firm credit exposures and the heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

both variables.

Third, we include an additional bank-level control on the right-hand side of the regression—banks' interest rate exposure defined as the change in the present value (in % of own funds) of banking book positions exposed to interest rate risk due to an abrupt increase in interest rates by 200 basis points across all maturities. Adding this control might be important because our sample period saw not only the depreciation of the EUR/USD exchange rate but also a dramatic fall in interest rates in the euro area. To the extent that banks' interest rate exposure correlates with their net USD assets, this would bias our results. As column (4) shows, this concern, however, is unwarranted. Specifically, even after controlling for banks' interest rate exposure, we find that banks with higher net foreign-currency assets raise their loan supply after the depreciation. If anything, adding this control increases the size of the estimated net foreign-currency asset coefficient.

Fourth, we adjust the calculation of the dependent variable. Specifically, instead of calculating it as the log change in the credit exposure of bank b to firm f from the four-quarter pre-depreciation average to the four-quarter post-depreciation average, we now use eight-quarter pre and post averages. As can be seen from column (5), our main estimate only decreases slightly relative to the baseline estimate of Table 2 and remains statistically significant at the 5% level.

Finally, we run a placebo analysis, calculating the credit growth rates around the year 2002, when the EUR/USD exchange rate remained relatively constant and, if anything, appreciated slightly from an average of 0.90 in 2001 to 0.95 in 2002. Specifically, we assume that the placebo event happened between 2002:Q2-2003:Q1, following our baseline analysis where the actual depreciation also started in the second quarter and continued for another three quarters (making four quarters altogether). We then calculate the dependent variable as the log change in credit volumes from the 2001:Q2-2002:Q1 average to the 2003:Q2-2004:Q1 average. As shown in column (6), in the absence of a significant exchange rate depreciation, banks with higher net USD assets do not increase their lending disproportionately compared to banks with lower net USD assets, confirming the parallel trend assumption underlying our difference-in-differences analysis. Note that we also observe insignificant effects for alternative placebo episodes (results not reported to conserve space). Specifically, we also run this placebo analysis for all other quarters between 2001 and 2014 and the coefficient estimate corresponding to banks' net USD assets is never positive and statistically significant at the 5% level or higher. This result confirms our main results because there was not a single episode between 2001 and 2014 where the EUR/USD exchange rate depreciated both *significantly* and *persistently*.

In sum, Section 4.3 shows the robustness of our baseline results. Most importantly, we establish that the parallel trend assumption is likely to be satisfied in our analysis. That is, the credit growth rates of banks with high and low net foreign-currency asset exposure do not differ in the absence of a significant and persistent depreciation of the EUR/USD exchange rate.

5 The Composition of Bank Loan Supply

So far, we have explored the average effect of the depreciation on lending by banks with different levels of net USD asset exposure. We now explore borrower heterogeneity, first exploring differences across firms (Section 5.1), then focusing on interbank market lending (Section 5.2) and finally on the pass-through of greater interbank market liquidity to bank loan supply (Section 5.3). Section 5.4 explores borrower heterogeneity in cross-firm regressions.

5.1 The Allocation of Credit Across Firms

The previous results show that large banks with a high net foreign-currency asset position increase lending after the euro depreciation. In this sub-section, we explore to which firms large banks raise their lending disproportionately more, thus contributing to the bank-level increase in loan supply. As discussed in Section 3.3 and summarized in Regression 3, from a theoretical perspective, there are two competing hypotheses. The first suggests that export-intensive firms should obtain a disproportionately large share of the additional credit because the depreciation boosts their cash flows and increases their creditworthiness. As export-intensive firms are known to be more productive on average, an increase in lending to these firms would imply significant positive real effects. The other hypothesis suggests that banks should shift their credit allocation towards riskier firms, as the depreciation raises banks' net worth and risk-taking capacity.

The results in column (1) of Table 5 show that large banks reallocate credit towards more export-intensive firms, as approximated by the industry average of export turnover over total

Table 5 Exchange Rate Depreciations and the Composition of Large Banks' Lending

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
Net USD Assets$_{b,pre}$ × EXPORTS$_{f,pre}$	0.092*					0.114*		
	(0.06)					(0.06)		
Net USD Assets$_{b,pre}$ × SIZE$_{f,pre}$		6.374**						
		(2.78)						
Net USD Assets$_{b,pre}$ × Tangible Assets$_{f,pre}$			0.114**					
			(0.05)					
Net USD Assets$_{b,pre}$ × Labor Prod.$_{f,pre}$				10.756*				
				(6.00)				
Net USD Assets$_{b,pre}$ × Capital Intensity$_{f,pre}$					2.841**			
					(1.22)			
Net USD Assets$_{b,pre}$ × Z-Score$_{f,pre}$							-0.759	
							(1.92)	
Net USD Assets$_{b,pre}$ × Leverage$_{f,pre}$								0.141
								(0.16)
Net USD Assets$_{b,pre}$ × Residual SIZE$_{f,pre}$						0.255		
						(2.48)		
Net USD Assets$_{b,pre}$ × Residual Tangible Assets$_{f,pre}$						0.036		
						(0.07)		
Net USD Assets$_{b,pre}$ × Residual Labor Prod.$_{f,pre}$						-0.317		
						(7.55)		
Net USD Assets$_{b,pre}$ × Residual Capital Intensity$_{f,pre}$						3.689*		
						(2.18)		
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	25,090	25,090	25,090	25,090	25,090	25,090	25,090	25,090
R^2	0.531	0.531	0.531	0.531	0.531	0.531	0.530	0.530

The regressions are based on quarterly bank-firm-relationship level data for systemically important lender banks only. The dependent variable is the log-difference in loan volume of bank b to firm f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable is the bank-level share of net USD assets over total assets, interacted with the following industry medians of firm characteristics: export turnover over total turnover, log of total assets, tangible over total assets, labor productivity defined as sales per employee, fixed assets over the number of employees as a measure of capital intensity, Altman's Z-Score and leverage. In column (6), we also add several residual components of some of these firm characteristics, stemming from regressions of these variables on export turnover over total turnover. The regressions include firm and bank fixed effects. The regressions are weighted by the volume of bank-firm credit exposures and the heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

turnover. The effect is statistically significant and economically meaningful. In particular, the credit growth differential around the depreciation episode of a firm at the 75th percentile of export intensity and one at the 25th percentile is equal to 2.8 percentage points for each percentage point higher net USD asset share of large banks.[28] As we detail in Section 2.2.1, the previous regression averages export intensities by one-letter industry code as the coverage of export data in Amadeus is very limited. For robustness, Table C.3 of the Appendix therefore shows that we obtain similar results when we average by a finer Bundesbank industry classification similar to the two-digit NAICS code when an industry contains at least 50 matched firms, and by one-letter industry code as before otherwise.

As export turnover is only reported by a minority of firms in our sample, we next approximate export intensity with other firm characteristics that are shown to correlate closely with export turnover, as surveyed in Wagner (2011), and are available for a larger number of firms. These proxies include size (log of total assets), labor productivity, defined as sales over the number of employees, capital intensity, defined as total fixed assets relative to the number of employees, and the share of tangible over total assets. For consistency with our previous export intensity regressions, in our baseline specification of Table 5, we also average these variables by one-letter industry code. However, Table C.3 of the Appendix provides robustness to using the actual firm-level value without averaging. The results are largely unaffected.

Columns (2)-(5) indicate that the coefficient estimate on the interaction between bank-level net foreign-currency assets and the respective firm-level characteristic is positive and statistically significant, showing a very robust relation between the exchange rate depreciation and a shift in large banks' credit allocation towards firms that are likely to have higher export intensities.[29]

Column (6) shows that it is export intensity, rather than other firm characteristics possibly correlated with firm-level exports, that explain the increase in borrowing from large banks with higher net USD assets. Specifically, we run a horse race of the previous double interactions with

[28] We obtain this effect by multiplying the coefficient estimate (0.092) by the interquartile range of the firm-level export variable (52.28-22.05).

[29] Note that the bank fixed effects absorb the linear (main) effect of bank-level net USD assets. We therefore also run specifications without bank fixed effects (the attendant results are not reported). In these specifications, the main effect of net USD assets turns out to be statistically insignificant in most specifications, whereas the interaction coefficient between net USD assets and the previous firm characteristics remains positive and statistically significant.

each other. The idea is to see whether export intensities dominate all other firm characteristics. In order to circumvent multicollinearity issues due to the substantial correlation between export turnover and the other firm-level variables, we replace the firm characteristics of columns (2)-(5) by residuals from a regression of these characteristics on firm-level export intensity. As column (6) indicates, the interaction between bank-level net USD assets and firm-level export intensity remains positive and statistically significant at the 10% level. The coefficient estimate is even higher than in column (1). All other interactions, apart from the one between bank-level net USD assets and firms' capital intensity, turn statistically insignificant. Thus, our empirical results confirm the first hypothesis of Section 3.3: the euro depreciation disproportionately increased banks' credit supply to firms with higher ex-ante export intensity.

The results in columns (7) and (8) do not provide evidence in favor of the second hypothesis of an increased bank loan supply to riskier firms in response to the EUR/USD depreciation. Here, we interact banks' net foreign-currency assets with the industry averages of important firm risk measures, the Altman Z-Score and leverage ratio, respectively. As is apparent from columns (7) and (8), both firm risk interaction coefficients are statistically insignificant.[30]

Overall, this section shows that the overall rise in lending of large banks can mainly be explained by a credit expansion towards export-intensive firms, which are more productive on average, so that the 2014 EUR/USD depreciation, at least through the channel identified in this paper, is likely to have a positive impact on German output growth. In contrast, we do not find evidence for increased bank risk-taking. The findings of a credit expansion towards export-intensive firms is also consistent with our findings in sub-section 4.1 of an amplified effect of the depreciation on lending to the financial sector. The financial sector has a high export intensity both because of its *direct* turnover generated abroad (Mano and Castillo, 2015; OECD, 2018; Black et al., 2021) and because of its *indirect* export exposure from its lending to export-intensive firms. As data on the *direct* export turnover is not available for most banks in our sample, the next sub-sections take a closer look at how the exchange rate shock affects interbank market lending focusing on heterogeneity in banks' *indirect* export exposure.

[30] As Table C.3 of the Appendix shows, this result is unaffected by using firm-level Z-Scores and leverage without averaging them by industry.

5.2 Interbank Market Lending

Section 5.1 identifies a shift in credit towards export-intensive firms. At the same time, Section 4.1 shows that the exchange rate depreciation leads to a particularly strong increase in interbank lending activity of banks with higher net foreign-currency assets. As the next step of our bank-firm level analysis, we ask whether the increase in interbank lending of large banks can be explained by an increase in the interbank credit supply to small banks that have a higher portfolio share of export-intensive firms. The idea is that large banks will reallocate funds towards small banks if small banks do not have significant net foreign-currency asset exposure but a large share of exporting firms that experience higher demand on account of the exchange rate depreciation and are thus in need of external funds.

To identify this mechanism, following the strategy introduced in Section 3.3, we restrict the sample to large lending banks, as well as borrowers in the financial sector, and regress the credit growth rate for each lender-borrower pair on the interaction between lender-level net USD assets and the borrower-level weighted average share of export sales over total sales of all firms in the borrowing bank's credit portfolio, where the weights are equal to the respective lender-borrower credit exposure in the pre-depreciation period.

As is apparent from column (1) of Table 6, large banks with higher net foreign-currency assets do indeed increase their interbank lending to banks with a higher portfolio share of firms with significant export turnover. This effect is both statistically and economically significant: the credit growth differential around the depreciation episode of a borrowing bank at the 75th percentile of export shares and one at the 25th percentile is equal to 6.9 percentage points for each percentage point higher net USD asset share of large banks.[31] As can be seen from columns (2) and (3), this effect is driven by small borrowing banks, not by larger ones. We thus show that the largest lender banks, following the appreciation of their foreign-currency assets, serve as a central intermediary that reallocates liquidity towards small borrowing banks that have a higher portfolio share of export-intensive firms, suggesting that the impact of the EUR/USD depreciation on bank lending behavior is not restricted to banks that themselves have significant foreign-currency asset expo-

[31] To see this, multiply the coefficient estimate (0.268) by the interquartile range of the firm-level export variable (47.38-21.57).

Table 6 Exchange Rate Depreciations and Large Banks' Interbank Lending

	All borrowers	Small borrowers	Large borrowers
	(1)	(2)	(3)
	ΔLOANS	ΔLOANS	ΔLOANS
Net USD Assets$_{b,pre}$ $\times$ Exportshare$_{f,pre}$	0.268*	0.359*	0.046
	(0.16)	(0.20)	(0.17)
Lender FE	Yes	Yes	Yes
Borrower FE	Yes	Yes	Yes
Obs	1,837	1,643	161
R^2	0.439	0.455	0.548

The regressions are based on quarterly bank-firm-relationship level data for systemically important lenders only. The dependent variable is the log-difference in loan volume of lender bank b to borrower bank f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable is the lender-level share of net USD assets over total assets, interacted with the borrower-level average share of export sales over total sales of all firms in a borrowing bank's credit portfolio, weighted by the respective credit exposures. While column (1) uses the full sample of borrowers, column (2) only includes non-systemically important borrowing banks and column (3) only includes systemically important borrowing banks. The regressions include lender and borrower fixed effects. The regressions are weighted by the volume of lender-borrower credit exposures and the heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

sure, but that exchange rate changes can instead affect distinct tiers of the banking system through an increase in interbank market activity.

5.3 Do Small Banks Pass on the Additional Liquidity to (Exporting) Firms?

The regressions in the previous sub-section indicate that the 2014/15 euro depreciation induces large banks with higher net foreign-currency assets to increase their interbank lending to small banks that have a higher share of exporting firms in their credit portfolios. In this sub-section, we examine whether this, in turn, allows small banks to raise their credit supply. To do so, we restrict the sample to small banks and model their lending to all firms around the depreciation as a function of the share of exporting firms in their credit portfolio, as in Section 5.2 weighted by the respective credit exposures. As can be seen from column (1) of Table 7, small banks with a higher share of exporting firms, which, as Section 5.2 shows, obtain a disproportionately large share of the increase in interbank liquidity, do indeed raise their credit supply. The attendant coefficient estimate is positive and statistically significant at the 10% level.

This significance, however, does not necessarily have to be driven by the improved access to interbank market liquidity of banks with higher shares of export-intensive firms in their portfolios. Rather, it could also be driven by alternative channels. For instance, it could be that such banks have excess liquidity anyway and the exchange rate depreciation induces them to shift some of that liquidity towards exporting firms that experience higher demand for their goods due to the depreciation and which, therefore, see improvements in their income statements. To show that the improved access to interbank markets can indeed explain the result of column (1), we next split the sample into banks with high vs low interbank dependence, using the 67th percentile of the in-sample distribution of interbank deposits to total assets as the threshold.[32] To the extent that the higher interbank liquidity drives the previous result, we should obtain a significant coefficient for the high-dependence sub-sample and an insignificant coefficient for the low-dependence sub-sample.

Table 7 Exchange Rate Depreciations and Small Banks' Lending

	Full Sample of Small Banks	Low Interbank Dependence	High Interbank Dependence		
	(1)	(2)	(3)	(4)	(5)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
$\text{Exportshare}_{b,pre}$	0.452*	0.084	1.187***	-0.225	-0.043
	(0.26)	(0.18)	(0.39)	(0.63)	(0.050)
$\text{Exportshare}_{b,pre} \times \text{EXPORTS}_{f,pre}$				0.031*	
				(0.02)	
$\text{Exportshare}_{b,pre} \times \text{I(EXPORTS)}_{f,pre}$					1.435*
					(0.75)
Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Obs	41,212	18,166	13,613	13,613	13,613
R^2	0.356	0.406	0.381	0.382	0.382

The regressions are based on quarterly bank-firm-relationship level data for small (i.e., non-systemically important) lender banks only. The dependent variable is the log-difference in loan volume of lender bank b to firm f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The main independent variable is the bank-level average share of export sales over total sales of all firms in a bank's credit portfolio, weighted by the respective credit exposures. While column (1) uses the full sample, columns (2) and (3) split the sample into banks with high vs low interbank dependence, using the 67th percentile of the in-sample distribution of interbank deposits to total assets as the threshold. Columns (4) and (5) include the double interaction between bank-level export shares and firm-level export intensities (in column (4) continuously and in column (5) as a dummy equal to one if the variable is larger than the median) for the sub-sample of small banks with high interbank dependence. The regressions include firm fixed effects, as well as the following bank controls that are not reported to conserve space: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted capital, return on equity. The regressions are weighted by the volume of bank-firm credit exposures and the standard errors are clustered at the bank level and shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

In fact, as columns (2) and (3) indicate, only for the sub-sample of small banks with high

[32] Here and in all other specifications where we split the sample, the results are similar, but less precisely estimated, if we use the median of the distribution as threshold.

interbank dependence do we obtain a positive and statistically significant coefficient, which even increases in size and statistical significance relative to the full sample estimate of column (1). In contrast, for less interbank dependent banks, the estimate is smaller and not statistically different from zero. As a next step, we interact banks' portfolio export shares with firm-level export intensity, as in Section 5.1, in order to determine whether small banks use the additional interbank liquidity to raise their lending to export-intensive firms to a relatively greater extent. As becomes apparent from column (4), this is indeed the case with a coefficient estimate on the double interaction term that is positive and weakly statistically significant.[33] This result is similar when we replace the continuous export shares by a dummy equal to one if the export intensity is larger than the in-sample median (column (5)).

In summary, Section 5.3 shows that the additional interbank liquidity that small banks with a higher portfolio share of exporting firms obtain from large banks with higher net foreign-currency asset exposure ultimately feeds into an increase in the credit supply of small banks, especially so to export-intensive firms. This result implies that an exchange rate depreciation, by increasing the liquidity of distinct tiers of the domestic banking sector, can have sizeable economic effects, even when local banks have low foreign-currency asset exposure and are therefore not directly affected by the exchange rate shock.

5.4 Further Cross-Firm Evidence

In this sub-section, we examine to what extent the previous within-firm results of Section 5 feed into an overall credit change across firms. Whereas the cross-firm specifications of Section 4.2 have confirmed the *linear* within-firm specifications in that the depreciation increased credit growth of (financial) firms borrowing from large banks with higher net USD assets, this sub-section reports cross-firm regression results taking into account borrower heterogeneity.

Column (1) of Table 8 shows that, in the cross section, exporting firms do not obtain a disproportionately larger share of credit than other firms, even when they borrow to a greater extent from large banks with higher net USD assets. This result shows that the main within-firm result of Table

[33] In unreported regressions, we saturate this regression with bank fixed effects. The results are similar, but estimated with slightly less precision.

5 does not feed into an overall credit change of export-intensive firms—these firms, on balance, do not have greater credit growth when they borrow from banks with higher foreign-currency exposure.

In the next set of cross-firm regressions, we thus continue examining whether firms borrowing from banks that increased their interbank borrowing most substantially during the depreciation period perceive higher overall credit growth. To this end, the main regressor in this specification is the weighted average of banks' change in interbank borrowing during 2014:Q2-2015:Q1 scaled by lagged total assets across all banks lending to a firm. While the linear effect in column (2) is positive, as expected, but not statistically significant, once we take firms' heterogeneous export exposure into account by interacting the weighted interbank borrowing change with firms' export intensity, we see that exporting firms perceive a rise in credit volumes. This result holds independent of whether we use a continuous export turnover dependence variable (column (3)) or a dummy equal to one for export turnover shares larger than the median (column (4)), and it is robust to restricting the sample to firms that have their main credit relationship with a small bank (column (5)). This is evidence that the within-firm results of Section 5.3 also hold in the cross section—export-dependent firms, on the whole, have greater credit access after the depreciation when they borrow from banks benefiting more from the depreciation-induced increase in interbank market liquidity.

Taken together, Table 8 shows that export-intensive firms only benefit disproportionately more from the depreciation than other firms when they have credit relationships with interbank dependent banks. In contrast, having a relationship with a bank that *directly* benefits from the depreciation via an appreciation of its net foreign-currency assets does not feed into higher overall credit growth. This is further evidence that the bulk of the euro depreciation-bank loan supply nexus identified in this paper works through the interbank market.

6 Real Effects of Exchange Rate Depreciations

So far, we have documented the effect of the EUR/USD depreciation on the financial sector, with the positive effect for export-oriented borrowers working mainly indirectly (if they borrow from

Table 8 Additional Cross-Firm Evidence

	SIBs	Full Sample	Full Sample	Full Sample	Small Banks
	(1)	(2)	(3)	(4)	(5)
	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT	ΔTOTAL CREDIT
$\overline{NetUSDAssets}_{f,pre}$	2.226**				
	(0.94)				
$\overline{NetUSDAssets}_{f,pre} \times$ EXPORTS$_{f,pre}$	-0.050				
	(0.04)				
$\overline{\Delta Interbankborrowing}_{f,pre}$		0.104	-1.451**	-0.580	-0.592
		(0.35)	(0.73)	(0.46)	(0.51)
$\overline{\Delta Interbankborrowing}_{f,pre} \times$ EXPORTS$_{f,pre}$			0.044**		
			(0.02)		
$\overline{\Delta Interbankborrowing}_{f,pre} \times$ I(EXPORTS)$_{f,pre}$				1.103**	1.466***
				(0.53)	(0.57)
Bank Controls	Yes	Yes	Yes	Yes	Yes
Credit Demand	Yes	Yes	Yes	Yes	Yes
Obs	4,412	38,260	38,260	38,260	24,966
R^2	0.391	0.444	0.445	0.445	0.428

The regressions are based on quarterly bank-firm-relationship level data. The dependent variable is the log change in total credit between the pre- and post-depreciation episode from all banks lending to a particular firm f. The main independent variable in column (1) is a firm's exposure to the depreciation, computed as the weighted average of banks' net USD asset shares across all banks that a firm maintains credit relationships with. The applied weights are the pre-depreciation bank-firm credit exposures. We also interact this variable with the industry average of export turnover over total turnover. Similarly, columns (2)-(5) use the weighted average change in interbank borrowing between 2014:Q2-2015:Q1. We also interact this regressor with the industry median of export shares (continuously and transformed to a dummy equal to one if this share is larger than the in-sample median). Bank controls are those of Regression 1, but are here also averaged at the firm level based on the pre-depreciation bank-firm credit exposures. The attendant coefficients are not shown in order to conserve space. We also control for credit demand by adding the vector of firm-level fixed effects estimated from Regression 1. In column (1), we restrict the sample to firms that have their main credit relationship with a systemically-important bank, and in column (5) to firms that have their main relationship with a non-systemically important one. The standard errors are clustered at the main bank level and are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

smaller banks dependent on the interbank market). This section explores the effect of this higher lending on real sector outcomes. We first present evidence based on firm-level data on investment and employment and then regional growth regressions.

6.1 Real Effects at the Firm Level

We first explore whether the exchange rate depreciation-induced increase in lending to exporting firms had a significant effect on investment and employment by these firms. In particular, following the previous evidence that exporting firms experience a disproportionately stronger increase in lending from small, non-systemically important banks after the exchange rate depreciation, we restrict the sample to firms whose main credit relationship is with a non-systemically important bank and test whether the employment and investment response of firms with a higher export share is stronger than that of non-exporting firms. As in Section 5.1, we define export shares as the industry average of export turnover over total turnover to maximize the number of observations. We run regressions of the following type:

$$\Delta Y_{f,post-pre} = \nu * Exportshare_{f,pre} + \eta * X_{f,pre} + \varepsilon_f, \tag{4}$$

where ΔY is the firm-level log difference in the number of employees (as our proxy for employment) and total fixed assets (as our proxy for the capital stock) from the pre-event year 2012 to the post-event year 2014.[34] X includes the following two firm-level covariates, measured in 2012: size (log of total assets) and the Altman Z-Score, which encompasses capital and profitability, both of which therefore do not have to be added as separate controls. Note that the number of observations in these firm-level regressions is quite small and our firm sample only covers a very small sub-set of all firms in Germany. We therefore interpret the following results, at most, as being indicative of the real effects of exchange rate depreciations.

Table 9 indicates that, for the full sample of firms, firms with a higher export turnover raise

[34] Our firm-level data end in 2014 and we, therefore, cannot be consistent with the regional analysis, in which we compare the years 2016-2017 with 2012-2013. Yet, as the bulk of the depreciation took place in the course of 2014, and most firms report their balance sheet numbers at the end of the respective year, comparing 2014 with 2012 allows us, to a large extent, to compare the post-depreciation period with the pre-depreciation one.

their investment, but not their employment. Yet, this significance for investment could be driven by the fact that these firms benefit from the depreciation via higher exports (the classical trade channel), and not necessarily because they have credit relationships with banks more affected by our channel. Hence, we split the sample into firms where the relationship banks have a ratio of interbank deposits to total assets that is smaller (columns (3) and (4)) and larger (columns (5) and (6)) than the 67th percentile of the distribution, where the interbank ratio is weighted by the credit exposures if a firm borrows from multiple banks. These specifications show that firms that are most likely to be affected by the channel proposed in our paper, and as opposed to less affected firms, raise their investment in a highly statistically significant manner (column (6)). In contrast, the employment dynamics seem to be statistically insignificant for all firms throughout.

Table 9 The Exchange Rate Depreciation and Firms' Real Outcomes

	All Firms		Low interbank dependence		High interbank dependence	
	(1)	(2)	(3)	(4)	(5)	(6)
	ΔEMPL	ΔK	ΔEMPL	ΔK	ΔEMPL	ΔK
$\text{EXPORTS}_{f,pre}$	0.033	0.175^{***}	0.067	0.175	-0.017	0.185^{***}
	(0.13)	(0.04)	(0.16)	(0.11)	(0.11)	(0.02)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1,050	1,151	620	678	430	473
R^2	0.030	0.059	0.056	0.038	0.042	0.094

The regressions are based on annual firm-level data and include all firms in our sample that have their main credit relationship with a non-systemically important bank. The dependent variables are the differences in the log of the number of employees and fixed assets from the pre-depreciation period (2012) to the post-depreciation period (2014). The key independent variable is the industry average of firms' pre-depreciation export turnover relative to the total turnover. While columns (1) and (2) use the full sample of firms, columns (3)-(4) split the sample into firms where the relationship banks have a ratio of interbank deposits to total assets that is smaller than the 67th percentile of the in-sample distribution, where the interbank ratio is weighted by the credit exposures if a firm borrows from multiple banks. Columns (5)-(6) focus on the sample of firms with above-median interbank ratios. Additional firm-level controls include size (log of total assets), leverage, liquid over total assets, returns on assets, tangible over total assets and interest coverage ratios. The regressions are weighted by firms' total credit registry exposure and the heteroskedasticity-robust standard errors, clustered at the one-letter industry level, are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

In summary, these firm-level regressions show that exporting firms borrowing from smaller banks with higher interbank dependence increased investment, but not employment, after the exchange rate depreciation, providing suggestive evidence that the increase in lending to these firms had real effects. Next, we will gauge whether these results also hold on a more aggregate level and translate into higher economic growth.

6.2 Real Effects at the Regional Level

In the final step of our empirical analysis, we study the real effects of the 2014/15 euro depreciation, working through the mechanism highlighted in Sections 4 and 5. As discussed in Section 2.2.2, we exploit a unique feature of the German banking system, which is that savings banks are only allowed to operate within a specific geographical area that typically matches one of the 401 administrative regions in Germany. This feature allows us to relate output growth in these 401 regions to how exposed the local banking sector is to the mechanism identified in this paper. Focusing on savings banks and following the evidence of Section 5.2 that large banks with higher net foreign-currency assets increase their interbank lending to small banks with a higher share of exporting firms in their credit portfolios, we examine whether administrative regions where the local savings bank has a higher share of exporting firms in their portfolio have disproportionately higher GDP growth rates after the 2014 exchange rate shock. Note that such banks/regions are not affected directly by the depreciation because they typically have low shares of net foreign-currency assets; they are, however, affected indirectly via an increase in interbank market liquidity. The region-level regressions are specified as follows:

$$\Delta Y_{r,post-pre} = \nu * Exportshare_{r,pre} + \eta * X_{r,pre} + \varepsilon_r, \tag{5}$$

where ΔY is the region-level log difference in nominal GDP per capita from the two-year, pre-shock average (2012-2013) to the two-year, post-shock average (2016-2017).[35]

The main regressor is the region-level average of savings banks' share of export turnover over total turnover (as described in Section 3.3), computed as the average share of export sales over total sales of all firms in a bank's credit portfolio, weighted by the respective credit exposure, where the regional average is weighted by banks' total assets if more than one savings bank operates in a specific administrative region. Consistent with previous steps of the analysis, we expect

[35] 2014 and 2015 are excluded because the EUR/USD exchange rate depreciated from 2014:Q2-2015:Q1. The results, however, are robust to including 2015 in the post-shock average. Note as well that we get similar, albeit economically and statistically slightly weaker effects, if we compare GDP *one* year after the depreciation to the value *one* year before the depreciation.

ν to be positive, indicating that the previous results ultimately spill over to an improvement in macroeconomic outcomes. Additional region-level controls, subsumed in the vector X, include the pre-depreciation average of GDP per capita (in logs), the share of people aged at least 65, as a proxy for the demography in a region, and the share of agricultural land, an alternative proxy for economic development. The latter two are fixed at their pre-sample 2008 value. In unreported specifications, we also add fixed effects for the 16 German federal states. Their inclusion does not change the results materially, but leads to a slight reduction in the number of observations, as we are not able to include states with only one region, i.e., the city states Berlin and Hamburg.

Column (1) of Table 10 shows that, for the full sample of regions, there is no positive relation between output growth and the share of exporting firms in local banks' credit portfolios around the 2014/15 depreciation episode. However, this non-significance can be driven by the fact that some of the savings banks with a lot of exporting firms in their portfolios have a low interbank dependence, i.e., they do not benefit from the increase in interbank lending of large banks after the depreciation. We thus split the sample into regions where the local bank has a share of interbank deposits over total assets that is below and above, respectively, the 67th percentile of the in-sample distribution. As can be seen from columns (2) and (3), while the impact of a higher share of exporting firms is even negative for regions with a low interbank dependence after the depreciation, the impact in regions where the local bank has a high share of interbank deposits is positive and statistically significant at the 10% level. Column (4) gauges that this result is economically and statistically even more significant when we include additional region-level variables, i.e., the share of land covered by agricultural land and the share of people aged at least 65, all set to their pre-sample values in 2008. In economic terms, the estimates of 0.032 (column 3) and 0.036 (column 4) imply that interbank dependent regions at the 75th percentile of the export share distribution grow by 1.3-1.4 percentage points more than regions at the 25th percentile, cumulatively, in the two years after the depreciation relative to the two pre-depreciation years, compared to the sample median of 11.8% and average GDP growth in Germany of 15.1%.

In unreported specifications, instead of splitting the sample, we obtain very similar results when we interact the share of exporting firms with the region-level interbank dependence of local banks, in which case the interaction coefficient is positive and statistically significant at the 1%

level.

Table 10 The Exchange Rate Depreciation and Regional GDP Growth

	All regions	Low interbank dependence	High interbank dependence		
	(1)	(2)	(3)	(4)	(5)
	ΔGDP	ΔGDP	ΔGDP	ΔGDP	ΔGDP
$\text{Exportshare}_{r,pre}$	-0.012	-0.025	0.032^{*}	0.036^{**}	0.001
	(0.012)	(0.014)	(0.019)	(0.018)	(0.017)
$\text{GDP p.c.}_{r,pre}$	-0.032	-0.025	-0.080^{*}	-0.068	0.014
	(0.033)	(0.036)	(0.047)	(0.051)	(0.046)
$\text{Share Agricultural Land}_{r,2008}$				0.030	
				(0.028)	
$\text{Share of People Above 65}_{r,2008}$				-0.574^{***}	-
				(0.208)	
Obs	395	264	131	130	131
R^2	0.014	0.024	0.046	0.121	0.001

The regressions are based on annual region-level data. The dependent variable is the difference in the log of nominal GDP per capita from the pre-depreciation period (2012-2013) to the post-depreciation period (2016-2017). The key independent variable is the region-level, pre-depreciation average of savings banks' share of export turnover over total turnover as in Section 5.2, where the average is weighted by banks' total assets. Additional region-level controls include the pre-depreciation average of GDP per capita, the share of people aged 65 or above, and the share of land covered by agricultural land. While column (1) includes all regions, column (2) restricts the sample to regions with a below-67th percentile average of savings banks' share of interbank deposits over total assets, weighted as before. Columns (3)-(5) restrict the sample to regions above the 67th percentile of interbank dependence. Column (5) runs a placebo regression using 2000-2001 as the pre-shock and 2003-2004 as the post-shock period. The heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Finally, in column (5), we run a placebo analysis, calculating the growth in GDP around the year 2002, where the EUR/USD exchange rate remained relatively constant (if anything, the euro appreciated). Specifically, we calculate the dependent variable as the log change in nominal GDP per capita from the 2000/01 average to the 2003/04 average. As becomes apparent, in the absence of a significant exchange rate depreciation, regions with local banks that have both high interbank dependence and a high share of exporting firms do not grow disproportionately more.

In summary, Section 6 establishes that the mechanism identified in this paper spills over to significantly higher firm-level investment and output growth in more exposed regions. That is, the result that the exchange rate depreciation induces large banks with higher net foreign-currency assets to raise their interbank lending to small banks with a higher share of exporting firms ultimately has significant macroeconomic effects. Economically, our estimates imply that regions more exposed to this loop grow by at least 1.3 percentage points more than less exposed regions, cumulatively, in the two years after the depreciation relative to the two pre-depreciation years.

7 Conclusions

In this paper, we use matched bank-firm-level data based on the German credit registry and exploit the exogenous and unanticipated EUR/USD depreciation of 2014/15 to show, in a difference-in-differences setting, that exchange rate depreciations lead to an increase in bank loan supply of large banks with higher net foreign-currency assets. We further gauge that this increase is driven by a rise in interbank lending. Specifically, large banks, following an appreciation of their foreign-currency assets, serve as a central intermediary that reallocates liquidity towards small banks that have a higher portfolio share of export-intensive firms experiencing stronger demand due to the exchange rate depreciation and are thus in need of external funds. Employing comprehensive region-level data, we further establish that regions that are more exposed to this mechanism experience significantly higher GDP growth—an effect that is likely to be driven by an increase in investment by more affected firms. In economic terms, we show that more exposed regions grow by at least 1.3 percentage points more than less exposed ones, cumulatively, in the two years after the depreciation relative to the two pre-depreciation years. Therefore, the documented shift in bank loan supply also has important aggregate implications.

Our paper contributes to the literature on banking and real sector effects of exchange rate changes. For future research, it would be interesting to study potential asymmetric responses of bank lending and real outcomes to exchange rate depreciations and appreciations in a uniform empirical setting. It would further be interesting to examine whether exchange rate movements, induced by changes in the *domestic* monetary policy stance, have a different impact than those induced by *foreign* monetary policy or economic fundamentals. We leave these interesting questions for future research.

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A Data Details

Table A.1 DEFINITIONS AND SOURCES OF THE MAIN VARIABLES

Variable	Definition	Unit	Source
$\Delta LOANS_{f,b}$	Log-difference in the post-depreciation to pre-depreciation credit volume average of bank b to firm f	%	Credit Registry
Net USD Assets	Bank b's net USD assets over total assets	%	Bundesbank
Net Foreign-currency Assets	Bank b's net USD, yen, pounds and franc assets over total assets	%	Bundesbank
Gross USD Assets	Bank b's gross USD assets over total assets	%	Bundesbank
Gross USD Liabilities	Bank b's gross USD liabilities over total assets	%	Bundesbank
Size	Bank b's logarithm of total assets	ln(Euro)	Bundesbank
Liquidity	Bank b's liquid assets over total assets	%	Bundesbank
ROE	Bank b's return on equity	%	Bundesbank
NPL	Bank b's non-performing over total loans	%	Bundesbank
Loans	Bank b's loans over total assets	%	Bundesbank
Capital	Bank b's regulatory capital-to-asset ratio	%	Bundesbank
$Exportshare_b$	Average export over total sales of all firms in a bank's credit portfolio, weighted by credit exposures	%	Bundesbank, Amadeus
Interbank Deposits	Bank b's interbank deposits over total assets	%	Bundesbank
EXPORTS	Industry median of firms' export over total sales	%	Amadeus
SIZE	Industry median of the log of firms' assets	ln(Euro)	Amadeus
Tangible Assets	Industry median of firms' tangible over total assets	%	Amadeus
Labor Prod.	Industry median of firms' sales over employees	%	Amadeus
Capital Intensity	Industry median of firms' fixed assets over employees	%	Amadeus
Leverage	Industry median of firms' total liabilities over total assets	%	Amadeus
Z-Score	Industry median of firms' Altman's Z-Score	-	Amadeus, own calculation
$\Delta EMPL$	Firms' growth in the number of employees	%	Amadeus
ΔK	Firms' growth in total fixed assets	%	Amadeus
ΔGDP	Region r's log-difference in the post- (2016-2017) to pre-depreciation (2012-2013) average in nominal GDP per capita	%	Own calculation, BBSR Bonn (INKAR)[a]
$Exportshare_r$	Region r's asset-weighted average of savings banks' share of export over total sales in their credit portfolio	%	Amadeus, Credit Registry
GDP p.c.	Region r's average GDP per capita in 2012-2013	-	BBSR Bonn (INKAR)
Share Agricultural Land	Region r's agricultural land relative to the total area in 2008	%	IOER Monitor
Share of People Above 65	Region r's share of people aged 65 or more in total population in 2008	%	BBSR Bonn (INKAR)

[a] All data from BBSR Bonn are subject to Data licence Germany – BBSR Bonn – Version 2.0

B The Depreciation and Banks' Net Worth

The underlying channel through which an exchange rate depreciation has a significant effect on bank loan supply is as follows: if a bank's foreign-currency exposure is not perfectly hedged, a bank with higher foreign-currency assets than liabilities will experience an increase in its net worth, which raises its lending capacity. In this section, we test this channel empirically. Specifically, we examine whether the EUR/USD depreciation increases the capital positions of banks with higher net USD assets to a disproportionately greater extent. To this end, we replace the dependent variable in Regression 1 with the change in the logarithm of banks' liable capital around the depreciation.[36] The right-hand side of the regression is left unchanged.[37]

Table B.1 The Effect of the Depreciation on Banks' Net Worth

	Full Sample	SIBs	Non-SIBs
	(1)	(2)	(3)
	ΔEQUITY	ΔEQUITY	ΔEQUITY
Net USD Assets$_{b,pre}$	0.451	4.571***	-0.036
	(0.32)	(0.25)	(0.19)
Bank Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Obs	128,745	25,090	77,021
R^2	0.634	0.820	0.488

The regressions are based on quarterly bank-firm-relationship level data. The dependent variable is the log-difference in liable capital of bank b from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable is the bank-level share of net USD assets over total assets. Column (1) includes all banks in the sample, column (2) only systemically important ones, and column (3) only non-systemically important ones. The regressions include firm fixed effects, as well as the following bank controls that are not reported to conserve space: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted capital, return on equity. The regressions are weighted by the volume of bank-firm credit exposures. Columns 1 and 3 employ bank clustered standard errors; column 2 uses heteroskedasticity-robust standard errors, all of which are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

As Table B.1 shows, the depreciation does indeed raise the net worth of banks with higher net foreign-currency assets to a disproportionately greater extent; however, the statistical significance of the attendant coefficient estimate for all banks in column (1) is slightly below the 10% level.

[36] The results are similar if we use banks' total capital.

[37] We run this analysis at the bank-firm level, not at the bank level, in order to be consistent with our main regressions in the paper. In addition, if we ran that analysis at the bank level, we would have just 15 observations for the regression that is restricted to systemically important banks. This is why the attendant coefficients in this bank-level regression are estimated very imprecisely (results not reported).

Once we restrict the sample to systemically important banks only, the effect turns statistically significant at the 1% level. This means that for those banks that drive our main results, higher pre-depreciation net foreign-currency assets are associated with increased equity positions after the depreciation. This is evidence consistent with the underlying theoretical mechanism that the significant effects of the depreciation on more exposed banks' lending can be explained by an increase in their net worth.

C Additional Tables

Table C.1 Selection Between Banks and Firms?

	(1) Net USD Assets	(2) Net USD Assets
$\overline{EXPORTS}_{f,pre}$	0.017	
	(0.01)	
$\overline{SIZE}_{f,pre}$	0.089	0.085
	(0.31)	(0.24)
$\overline{TangibleAssets}_{f,pre}$	-0.002	0.003
	(0.03)	(0.02)
$\overline{LaborProd.}_{f,pre}$	-0.033**	-0.029***
	(0.01)	(0.01)
$\overline{CapitalIntensity}_{f,pre}$	0.161**	0.127***
	(0.07)	(0.04)
$\overline{Z-Score}_{f,pre}$	0.223	0.187
	(0.15)	(0.13)
$\overline{Leverage}_{f,pre}$	0.063	0.068
	(0.07)	(0.04)
Obs	345	643
R^2	0.178	0.086

The regression is based on quarterly bank data. The dependent variable is the bank-level share of net USD assets over total assets. The key independent variables are the firm characteristics of Section 5.1, averaged for each bank. Specifically, we average them at the bank level based on the share of bank-firm credit exposure prior to the depreciation. The heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table C.2 The Effect on Large Banks with Lower USD Assets

	All SIBs	Drop Largest USD-Bank	Drop 5 Largest USD-Banks	Drop 10 Largest USD-Banks
	(1)	(2)	(3)	(4)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
Net USD Assets$_{b,pre}$	5.651**	5.383**	4.899	-3.257
	(2.74)	(2.66)	(3.70)	(284.49)
Bank Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Obs	25,090	23,552	8,786	516
R^2	0.527	0.536	0.584	0.453

The regressions are based on quarterly bank-firm-relationship level data. The dependent variable is the log-difference in loan volume of bank b to firm f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable is the bank-level share of net USD assets over total assets. The regressions include systemically important lender banks only. While column (1) includes all of these lender banks, column (2) drops one bank with the highest share of net USD assets, column (3) drops the five largest net USD asset banks and column (4) the ten largest ones. The regressions include firm fixed effects, as well as the following bank controls that are not reported to conserve space: log of total assets, loan-to-asset ratio, liquid over total assets, non-performing over total loans, regulatory capital over risk-weighted capital, return on equity. The regressions are weighted by the volume of bank-firm credit exposures and the heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table C.3 Exchange Rate Depreciations and the Composition of Large Banks' Lending: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS	ΔLOANS
Net USD Assets$_{b,pre}$ × EXPORTS$_{f,pre}$	0.086*						
	(0.05)						
Net USD Assets$_{b,pre}$ × SIZE$_{f,pre}$		0.000					
		(0.55)					
Net USD Assets$_{b,pre}$ × Tangible Assets$_{f,pre}$			0.085*				
			(0.05)				
Net USD Assets$_{b,pre}$ × Labor Prod.$_{f,pre}$				0.141*			
				(0.08)			
Net USD Assets$_{b,pre}$ × Capital Intensity$_{f,pre}$					0.158**		
					(0.08)		
Net USD Assets$_{b,pre}$ × Z-Score$_{f,pre}$						-0.000	
						(0.00)	
Net USD Assets$_{b,pre}$ × Leverage$_{f,pre}$							0.028
							(0.07)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	25,090	7,460	9,313	6,713	8,380	6,874	9,394
R^2	0.531	0.722	0.613	0.559	0.570	0.576	0.612

The regressions are based on quarterly bank-firm-relationship level data for systemically important lender banks only. The dependent variable is the log-difference in loan volume of bank b to firm f from the pre-depreciation period (2013:Q2-2014:Q1) to the post-depreciation period (2015:Q2-2016:Q1). The key independent variable in column (1) is the bank-level share of net USD assets over total assets, interacted with the industry average of firms' export turnover over total turnover, using a finer industry classification similar to the 2-digit NAICS code (when the number of firms in one of these finer industries lies below 50, we use the broader industry average as in the main part of the paper to reduce the impact of outliers). In the other columns, we interact bank-level net USD assets with the following firm-level characteristics (not averaged by industry, but censored at the 1% and 99% levels): log of total assets, tangible over total assets, labor productivity defined as sales per employee, fixed assets over the number of employees as a measure of capital intensity, Altman's Z-Score and leverage. The regressions include firm and bank fixed effects. The regressions are weighted by the volume of bank-firm credit exposures and the heteroskedasticity-robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.