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Abstract

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JEL Classification: F34, F42, F32, G15

Keywords: Us dollar, Financial channel of exchange rates, global financial conditions

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1 Introduction

What happens in financial markets does not always stay in financial markets. They also have real economy consequences through the influence of financial conditions on real variables. Among indicators of financial conditions, the US dollar exchange rate plays a particularly important role as a barometer of dollar credit conditions. Dollar credit grows faster when the dollar is weak and grows more slowly or declines when the dollar is strong. These attributes of the dollar are especially apparent during periods of financial stress, such as during the pandemic-induced financial stress of March 2020.[1]

Our focus is on the impact of financial conditions on international trade through the dollar exchange rate. Using finely disaggregated data on export shipments, we trace the impact of dollar strength on the shipments of exporters who have trade financing needs. For international trade, trade finance through dollar-denominated credit takes a central role.[2] Global banks play a pivotal role as intermediaries supplying trade finance (Niepmann and Schmidt-Eisenlohr, 2017b; Caballero, Candelaria, and Hale, 2018; Claessens and Van Horen, 2021).

In a seminal paper on trade finance, Amiti and Weinstein (2011) find that the health of banks providing finance emerges as an important determinant of the export performance of firms. Longer supply chains and greater delays in receiving payments mean that exports are highly sensitive to working capital needs. Indeed, exports turn out to be more sensitive to financial shocks than domestic sales due to the greater financing needs. In the same vein, Niepmann and Schmidt-Eisenlohr (2017a) find that shocks to individual banks can have sizable effects on aggregate trade as well as affecting trade patterns.

Our paper takes the theme of bank credit as a determinant of exports one step further by

[1] See, for instance, the following two Financial Times commentaries:
https://ftalphaville.ft.com/2019/10/16/1571257521000/The-risks-behind-foreign-banks–dollar-funding-/ and https://ftalphaville.ft.com/2020/03/26/1585218010000/What-makes-this-global-dollar-crunch-different-/

[2] According to data from SWIFT, the payment messaging service between banks, over 83% of cross-border payments associated with credit-related activity is denominated in US dollars (ICC (2018)), and one out of three banks surveyed in the same report cite the lack of availability of dollar credit as a limiting factor in satisfying customers' demand for trade financing.

weaving in the role of the US dollar as a credit supply factor. We find that a stronger dollar is associated with a decline in exports and show that the impact of the stronger dollar operates through bank lending conditions. In the context of our investigation, dollar appreciation is associated with diminished risk taking and subdued bank lending. Bruno and Shin (2015) dubbed this channel "the financial channel of exchange rates." We trace the impact of the financial channel on the operation of credit-intensive supply chains and ultimately on exports.

Our results are particularly notable in the context of international trade, as exchange rates also affect trade competitiveness, but typically in the opposite direction. A depreciation of the currency of the exporting firm would ordinarily improve trade competitiveness. However, our findings suggest that the impact on exports through tighter trade finance conditions goes in the opposite direction to the positive improvements from trade competitiveness during the horizon examined in our paper. Tellingly, we find that exports to the United States are subject to the same effects as exports to other destinations, even though a stronger dollar would entail an unambiguous improvement in trade competitiveness for the exporting firm.

Our findings provide a conceptual bridge between the literature linking trade and finance and the literature that examines the impact of dollar invoicing of trade (Gopinath and Stein, 2017; Gopinath et al, 2020). The connecting link comes from the fact that dollar invoicing implies that the trade financing requirements also translate into a need for dollar credit. In this way, a stronger dollar goes hand-in-hand with tighter trade financing conditions more broadly.

Figure 1 illustrates of our story. The top panel plots the ratio of world goods exports to world GDP over the past twenty years or so, a useful aggregate measure of the importance of supply chain activity in global goods trade.[3] We see a strong growth in exports before the financial crisis, a deep decline in exports during the crisis and an equally sharp rebound in its aftermath. Thereafter, global trade has been on a gentle declining trend relative to GDP. More

[3] This ratio serves as a useful proxy for the extent of supply chain activity because exports are measured in gross terms, while GDP is measured in value-added terms. That is, world exports measures the simple sum of goods that change hands along the supply chain, including exports of goods that have used imported intermediate goods as inputs. In contrast, GDP measures the value-added at each stage, and attempts to capture only the value of final goods. We would expect fluctuations in the ratio of world goods exports to world GDP around long-term trends to reflect the ebb and flow of supply chain activity.

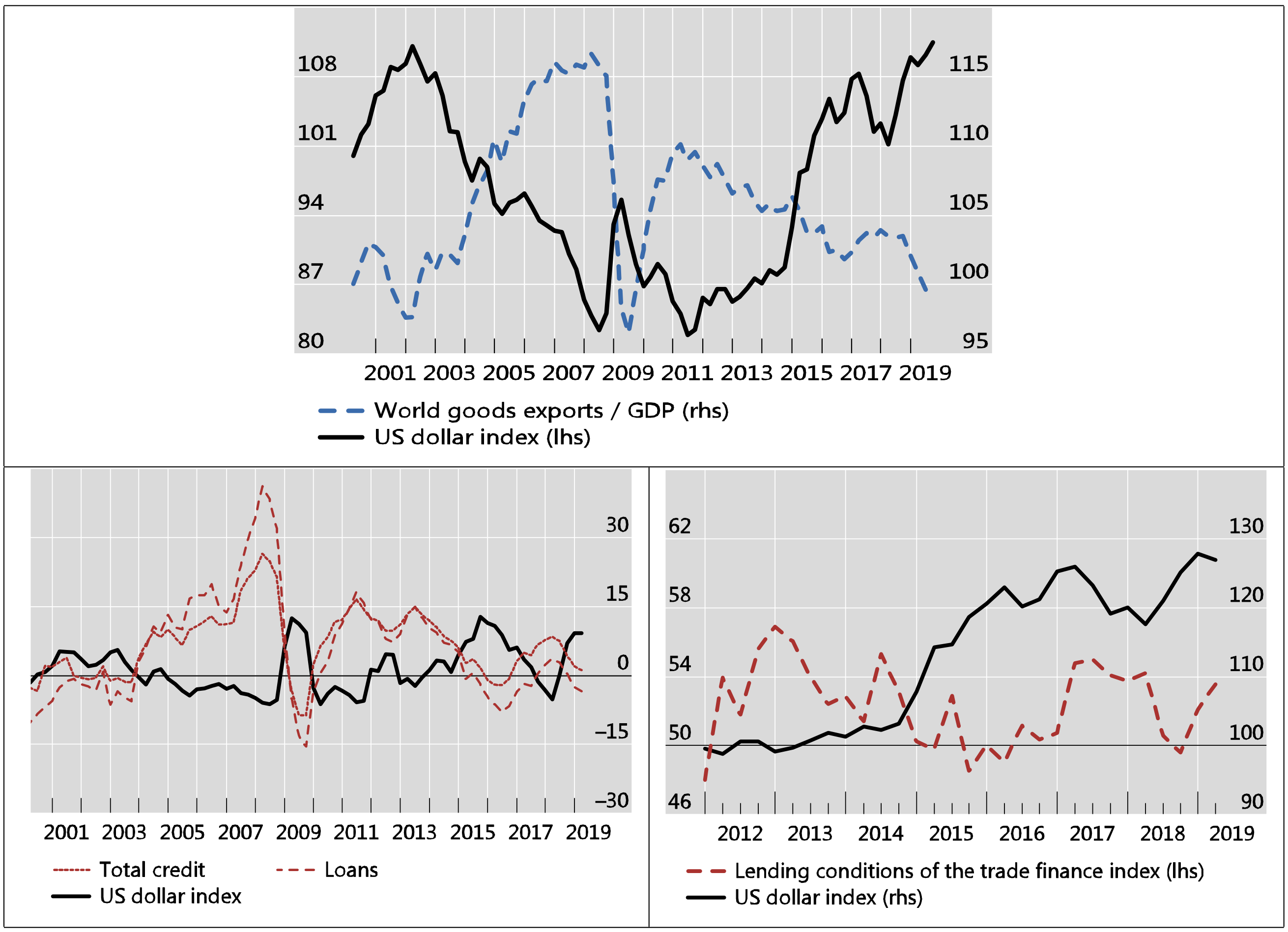


Figure 1: **Exports and US dollar credit.** The top panel shows the ratio of world merchandise exports to world output (right axis) and a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners, based only on trade in goods (left axis). Data are normalized as of Q1 2000. The bottom left-hand panel shows the annual growth of credit to non-banks denominated in US dollars and the annual growth of the Federal Reserve Board trade-weighted nominal dollar index, major EMEs. The bottom right-hand panel shows the annual percentage change of trade finance volumes reported by central banks to the BIS. Sources: BIS; Boissay, Patel and Shin (2020)

notably for our paper, we see that trade has been negatively correlated with the strength of the dollar.

The bottom left-hand panel of Figure 1 plots fluctuations of the broad dollar index and dollar-denominated credit. The panel shows the negative relationship between the four-quarter growth of dollar bank loans to emerging market borrowers and that in the broad dollar index. When the dollar is strong, lending in dollars slows. Historically, global trade finance volumes have also co-moved negatively with the dollar, as the bottom right-hand panel of Figure 1 shows. Taken together, Figure 1 provides motivation from aggregate variables for our main hypothesis - namely that tighter dollar credit conditions go hand-in-hand with more subdued export volumes.

The sample of exporting firms in our study is from Mexico. We chose Mexico for several reasons. First, Mexico is in the top 10 of exporters of manufactured goods (ranked 7th in WTO (2019)), with close links to the United States. Second, Mexico provides a setting that is data-rich for the empirical researcher, with detailed trade data that include the name the exporting firm, products, volumes, destinations and date of the shipment, available through a commercial data provider. Third, listed firms are required to disclose detailed information to the stock exchange, *Bolsa Mexicana*, on their capital structure, in particular loan amount and identity of the lender. Knowing the lender allows us to explore the financial channel at play. Overall, Mexico provides an ideal setting to observe firms' exposure to global financial conditions, while controlling for non-credit shocks.

We employ loan- and bank-level data to break down the source and characteristics of the financing obtained by the firm, as well as the characteristics of the banks that have lent to the firm. By tracking the firm-bank loan information, we can identify credit supply factors that may impinge on the firm's export business but which originate from the banking system. Previous studies have shown that an increase in dollar funding costs affects non-US banks' lending behavior (Correa, Sapriza, and Zlate, 2016; Ivashina, Scharftsein, and Stein, 2015), and that fluctuations in the dollar exchange rate are related to the price of dollar funding (Avdjiev et al, 2019) and to the risk-bearing capacity of global financial intermediaries (Bruno and Shin, 2015; Gabaix and Maggiori, 2015; IMF, 2019).

By exploiting the cross-sectional variation in banks' dollar funding structure, we can detect which banks reduce credit more when faced with a dollar appreciation. We indeed find that, following an appreciation of the US dollar, banks with high reliance on dollar short-term funding reduce supply of credit more *to the same firm* relative to banks with low dollar funding exposures. One immediate implication is that firms that borrowed from US dollar-funded banks will suffer a greater decline in credit following the dollar strengthening. Our hypothesis is that, ultimately, this will affect exports through the increased costs of working capital.

We test our hypothesis by using detailed export data with more than 4.6 million observations that include information on the product, exporting firm, destination country of exports, volume, values and date of each shipment for the period up to the first quarter of 2017. The bilateral trade information allows us to control for demand factors in the destination country. Specifically, we compare export growth by product-destination categories and combine it with the cross-section information of firms according to their reliance on banks with varying exposures to wholesale dollar funding. As dollar appreciation is associated with increasing funding costs and reduced lending, we test how firms' export growth changes with their reliance on dollar funded banks, whose credit supply affects the operation of credit-intensive global value chains and ultimately firm's export performance. By using firm-product-destination information, we control for non-credit shocks.

We find that firms that are more exposed to dollar-funded banks experience a greater slowdown in exports, even when controlling for non-credit explanatory factors. The exports of firms with higher working capital needs and intermediate goods are hit more by dollar appreciation. We conclude that changes in dollar credit conditions and associated impact on firms' financing costs are an important determinant of firm-level export performance.

Importantly, the financial channel behind our results is not just a crisis-related story, where a crisis-induced credit crunch suppresses trade volumes. During non-crisis periods, we find that changes in the supply of dollar-funded credit do not uniformly affect supply chain activity, specifically, have a mild impact on domestic sales and goods with less-intensive working capital needs. At the same time, trade credit becomes costlier and firms with higher financing needs change product pricing.

Our paper fits with the narrative emerging from an active literature on the US dollar as a global factor in economic and financial activity (e.g., Bruno and Shin, 2015; Rey, 2015; Gourinchas, 2019; Lilley, Maggiori, Neiman, and Schreger, 2021; Avdjiev, Bruno, Koch and Shin, 2019; Miranda-Agrippino and Rey, 2020; Cao and Dinger, 2021), a financial market indicator that tracks deviations from covered interest parity in FX markets through its impact on bank leverage (Avdjiev, Du, Koch and Shin, 2019), and a provider of world safe asset (Jiang, Krishnamurthy, Lustig, 2019). Our findings are also consistent with Rose (2021), who shows that currency wars and unconventional monetary policies do not stimulate exports.

Additional related literature

Our paper shares several points of contact with the literature on trade and finance. Our results shed further light on earlier findings on the impact of financial crisis stress on exporters. Paravisini, Rappoport, Schnabl, and Wolfenzon (2014) show that during the 2008 crisis, exporting firms in Peru were affected by the contraction in lending by banks that were more reliant on cross-border funding. Chor and Manova (2012) show that credit conditions are an important channel through which the financial crisis affected trade volumes. Amiti and Weinstein (2011) find that deteriorations in bank health explain the large drops in exports relative to output, and Amiti and Weinstein (2018) show that supply-side financial shocks have a large impact on firms investment. Ahn, Amiti and Weinstein (2011) also show that financial shocks show up in price changes. During the Great Financial Crisis, export prices rose relative to domestic manufacturing prices, and the prices of seaborne imports and exports rose relative to goods sent by land or air.

Niepmann and Schmidt-Eisenlohr (2017a) find that a shock to a country's letters-of-credit supply by US banks reduces US export growth to that country. Claessens and Van Horen (2021) also find that foreign banks can be important for trade because they can increase the availability of external finance for exporting firms. Effectively, financial frictions matter for trade and exports as well as macro-economic factors.

Working capital is sensitive to financial conditions. Kashyap, Lamont, and Stein (1994) show that inventories of firms that depend more on external financing fall more sharply in response to a contraction in credit supply. Love et al (2007) and Love and Zaidi (2010) document the contraction of trade credit in emerging markets following crisis episodes.

In trade, Manova and Yu (2016), Costello (2020), Shousha (2019) and Serena and Vashistha (2019) study the organization and operation of global supply chains and their sensitivity to financial conditions. Hardy and Saffie (2019) examine how FX debt affects inter-firm credit through trade receivables. Kalemli-Ozcan et al (2014) examine a model where upstream firms (supplier firms) have higher working capital needs compared to downstream firms (final product firms) because the production time and the presence of other firms in the chain entail a higher discount rate on costs and benefits of actions. Along these lines, Gofman (2013) uses information on suppliers and customers and finds that firms at higher vertical positions hold more net trade credit.

Eichengreen and Tong (2015) find that two revaluation episodes of the renminbi have a positive effect on sectors exporting final goods to China, but no effect on sectors providing intermediate goods. Ahmed, Appendino, and Ruta (2017) find that a currency depreciation only improves competitiveness of final goods exports, but GVC integration reduces the exchange rate elasticity of manufacturing exports by 22% on average. Furthermore, working capital needs of the exporter will differ in the case of long vs. short shipping times or between destination countries where products are more likely to sold on open accounts (Schmidt-Eisenlohr, 2013; Antras and Foley, 2015).

Our financial channel shares some similarities with studies that focus on banks' creditworthiness, although the mechanism is different. Ivashina, Scharfstein, and Stein (2015) and Correa, Sapriza and Zlate (2016) find that US money market funds reduced claims on European banks following the decline in banks' creditworthiness during the European sovereign debt crisis. Berthou et al (2018) find that the exports of French firms to the United States were adversely impacted during the European crisis. Cetorelli and Goldberg (2011) find that during the Great Financial Crisis, banking groups that depended more on short-term US dollar funding curtailed cross-border lending more. Our transmission channel works through fluctuations in bank lending that accompany exchange rate changes, and is a channel that operates also outside crises times. Specifically, banks that rely more on dollar wholesale funding suffer a sharper funding squeeze with appreciation of the US dollar, and consequently reduce credit supply (Bruno and Shin (2015)). This mechanism is in the spirit of Gabaix and Maggiori (2015) who approach exchange rate determination through intermediaries' risk-bearing capacity. Agarwal (2019) studies the shock from the 2015 Swiss franc appreciation and the impact on credit supply.

2 Banks and Exporters: data

Firm level trade data for Mexico are retrieved from Panjiva, a commercial database of S&P Global that compiles data from the Mexico Customs Department. Specifically, it contains the names of Mexican exporting companies along with the volumes (in kilograms) and values of the shipments at a high degree of disaggregated detail at the 8 digit HS code and their country of destination. The database also provides the date of the shipment. We have data since January 2011.

We create a list of firms headquartered in Mexico with financial data available from Capital IQ and manually match it with the list of exporters in Panjiva.[4] After an extensive process of data collection and cleaning, we successfully matched 368 non-financial firms with about 4.6 million export shipments over the period January 2011 to March 2017. We then aggregated export data at the quarterly frequency and construct the variable ΔX_{ipdt} as the log difference of the volume of exports between quarters t and $t-1$ within product-destination categories. Thus, X_{ipdt} is the sum of the volume of exports of product p to destination country d by firm i in quarter t. This gives us about 166,000 quarterly observations over the period from q1 2011 to q1 2017.

Next, we hand collect detailed information of the firms' debt structure from Capital IQ

[4]Firms were matched and verified by names. We then consolidated all the subsidiaries of the parent exporting firm by reference to the corporate tree. We downloaded subsidiary-level export data, and consolidated all the exports at the parent company level.

Table 1: **Firm descriptive statistics.** This table provides statistics on exports for the matched-sample of Mexican firms.

	2012		2016	
	mean	median	mean	median
No of lenders	4.7	3	3.7	2
Volume exports (Mil kg)	2554	73.8	2667.7	46.4
Value exports (Mil USD)	1274.5	42.2	672.7	27.2
No of destinations	21.3	12	19.4	12
No of products	176.2	55.5	162.4	50
No of products-destinations	480.2	103	456.8	86

(Capital structure details module) and from the firms' interim reports. Listed non-financial firms are required to submit quarterly reports to the *Bolsa Mexicana de Valores*, where they report detailed information about their capital structure. By using the public accounting data, we find firm-level capital structure details for a subset of 57 listed firms.[5] We are then able to match borrowing firms and lending banks at the individual loan level. Table 1 reports summary statistics on firm-level exports, destinations and products for this matched sample.

Table 2 gives us a snapshot of the amount of total credit to the 57 publicly-listed firms in our sample for which we could find capital structure details (column 1). We first notice that financial institutions provide between 99% and 91% of total credit to firms (column 2) and that total credit decreased over time (column 1).

We then delve deeper into the lending banks' capital structure, specifically their reliance on US dollar money market funding (MMF) for funding. In this way we can capture which banks, and ultimately which firms, are more exposed to the fluctuations in the short-term dollar funding and credit availability. A bank's exposure to US dollar funding through its liabilities is reported in the banks' regulatory filings to the US Securities and Exchange Commission (SEC), and it is obtained from Crane data. US and non-US global banks have access to wholesale dollar

[5] As a comparison, Capital IQ lists a total of 70 active public non-financial companies with available financial data as of 2013. Non-financial listed companies make up an important part of the Mexican economy: in 2013, the market capitalization of non-financial listed firms was 39% of GDP, and foreign sales were 48% of total exports.

funding from MMFs in the form of commercial paper and certificate of deposits.[6]

Among all the banks, we find 22 MMF-reliant global banks ("MMF banks") that lend to Mexican firms. Ideally, to capture the magnitude of banks' and firms' exposures to US dollar funding as a whole, we would need to include banks' total short-term dollar funding. Our variable on MMF funding therefore understates the size of total dollar funding. However, Table 9 (presented in the Appendix) shows substantial magnitudes for MMF funding for global banks.

The median bank relies on MMFs for about 10% of its total short term debt. For non-US banks, the ratio of MMF funding to short-term debt varies over a wide range, being as high as 69%, or as low as 0.1%. For US-headquarted banks in our sample, the maximum is 25%. Non-MMF banks are either local banks with headquarters in Mexico, or are the local subsidiaries of foreign banks who are reliant mostly on local deposits. We classify both categories as "local banks". Local banks provide the bulk of non-MMF credit (column 4).

Local banks can be domestically owned (e.g., Banobras, CI Banco, Banca Afirme) or are subsidiaries of foreign banks (e.g., Banamex, HSBC Mexico, Santander Mexico, BBVA Bancomer). Banco Santander, HSBC, and Credit Agricole are the top three global MMF banks in terms of aggregate credit to firms (131, 111, and 62.8 billion MXN pesos, respectively), while Bancomer, Banamex and Banobras are the top three local banks (293, 89.8, and 60.9 billion MXN pesos, respectively). Credit by global banks is predominantly in US dollars (ranging from 83% to 100%), with two notable exceptions (Santander and HSBC) that also lend in Mexican pesos. Specifically, the ratio of lending in pesos is about 75% for Santander and 35% in the case of HSBC.

In Table 2, column 3, we see that banks reliant on US money market funds (MMF banks) provided about 50% of total credit in 2012, but this ratio dropped to 33% in 2016. This decline in credit supply by global banks followed a worldwide trend.[7]

Subsidiaries of global banks are classified as local banks because their funding structure is

[6] See Aldasoro, Ehlers, and Eren (2018) for details.

[7] For the sample of 22 non-US global banks, the total gross loans data obtained from their balance sheets from CapitalIQ shows a decrease from 13,764 to 12,124 USD billions in aggregate. US global banks saw an increase in total gross loans from 3,149 to 3,460 USD billions.

Table 2: **Total credit descriptive statistics.** The first column of this table reports the total amount of credit (by banks and non-financial institutions) to the sample of Mexican firms used in the analysis and collected from Capital IQ Capital structure details (in billions of Mexican pesos). The second column presents the total amount of credit provided by financial institutions. The third column reports the amount of bank credit provided by banks with US money market funding. The fourth column reports the amount of bank credit provided by local Mexican banks.

Year	Total credit	From financial institutions	From MMF global banks	From local banks
	(1)	(2)	(3)	(4)
2012	500.7	495.6	248.9	169.8
2013	501.3	484.9	225.8	182.7
2014	477.3	435.5	175.4	210.5
2015	426.3	394.8	164.7	176.1
2016	460.5	442.4	144.6	248.2

typically deposits-based. However, we also run robustness tests that consider possible internal capital markets between global parent banks and their affiliates that may contribute to the propagation of shocks as shown in Cetorelli and Goldberg (2012).

US MMFs are a significant source of short-term dollar funding for non-US banks, although with a declining importance after the 2008 financial crisis. Before 2011, US-based branches were also suppliers of dollar funding. Following Correa et al (2016), we confirm from branch-level data from the FFIEC 002 reports that the dollar amount of such branch-level dollar funding for global banking groups is minimal as compared to US MMFs, and does not significantly change our estimation results.

Another issue concerns the US Money Market reform that was implemented on October 14, 2016. Anderson, Du and Schlusche (2021) find that most of the changes in the US MMF holdings occurred one year prior to the implementation deadline, reflecting the short-term maturities of MMF assets. Several tests will account for this concern.

2.1 Bank credit

To examine the impact of dollar financing cost for working capital, we appeal to the financial channel of exchange rates in Bruno and Shin (2015), which works through global banks that intermediate US dollar credit to local corporates. The global bank has a diversified loan portfolio

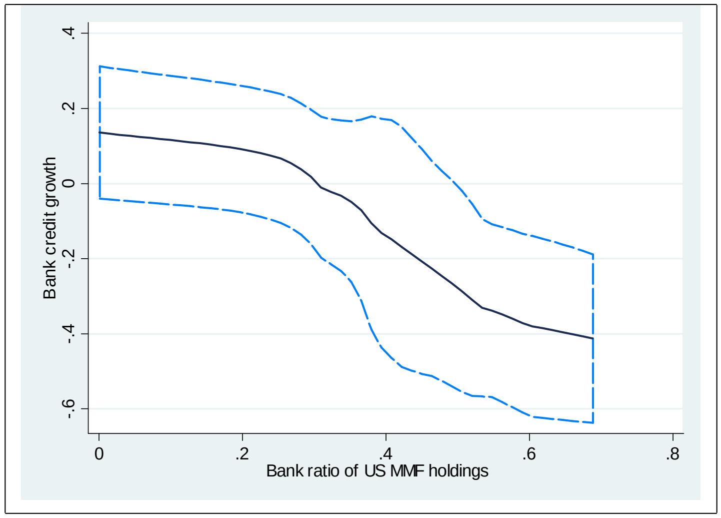


Figure 2: **Credit supply and bank dollar funding.** This figure shows the Kernel-weighted local polynomial smooth plot of the growth in bank credit to firms versus non-US banks' exposure to US dollar funding, with local mean smoothing and 90 percent confidence intervals and for the period from 2013 to 2016. Sources: Crane, Capital IQ, authors' computations.

to borrowers around the world. A broad-based depreciation of the dollar results in lower tail risk in the bank's credit portfolio and a relaxation of the bank's Value-at-Risk (VaR) constraint. The result is an expansion in the supply of dollar credit through increased bank leverage. In this way, a broad depreciation of the dollar is associated with greater risk-taking by banks.

Figure 2 shows the local polynomial smooth plot of the annual growth in bank credit over the period 2013-2016 as a function of the bank's exposure to MMF funding. The horizontal axis plots the ratio of holdings of US money market funds scaled by short term debt as of 2012 (MMF_b). The vertical axis captures the change in bank credit from bank b to firm i during the sample period, when the broad US dollar index strongly appreciated (30% increase in four years, from 2013 to 2016) after a prolonged period of weakness in the immediate preceding years. The cross-section evidence across banks in Figure 2 suggests that credit growth is strongly (negatively) correlated with bank reliance on MMF funding.

Digging deeper, we show that banks that are more exposed to wholesale US dollar funding reduce credit more compared to banks that are less dependent on wholesale US dollar funding:

as the US dollar appreciates, risk and dollar funding costs increase, and lending drops. We consider the period after the Taper Tantrum of May 22, 2013, which started a prolonged period of dollar appreciation. The focus is on the cross-sectional variation in dollar funding as the key element in our identification exercise.

We trace the fluctuations in the supply of credit provided by bank b to firm i from q1 2013 to q1 2016 from the hand-collected capital structure details in Capital IQ and company reports. We compute the variable ΔC_{ibt} as the annual percentage change in credit supply by bank b to firm i in year t. We use the following panel specification to capture the change in credit supply after the year 2013 as a function of the pre-2013 bank-level dependence on US dollar funding:

$$\Delta C_{ibt} = MMF_b + \psi_i + \tau_t + \varepsilon_{ibt} \tag{1}$$

where ΔC_{ibt} is the annual percentage change in credit from bank b to firm i from $t-1$ to t, MMF_b is the ratio of US MMFs liabilities of bank b to total short-term debt and as of end-2012, and $\psi_i + \tau_t$ are firm and time fixed effects, respectively. Firm fixed effects control for changes in credit demand by firm i, and year fixed effects control for changes in global and domestic financial conditions. Standard errors are clustered at the bank level. All regressions are produced in STATA using *reghdfe* as described in Correia (2017). The within-firm estimator compares the change in the amount of lending by banks with different exposure to dollar funding to the same firm, allowing us to disentangle credit supply from credit demand.

We then extend the specification by investigating the role of the dollar as a global credit supply factor:

$$\Delta C_{ibt} = MMF_b \cdot \Delta USDbroad_t + \psi_i + \tau_t + \lambda_b + \varepsilon_{ibt} \tag{2}$$

where $\Delta USDbroad_t$ is the percentage change of the US dollar broad index. This also allows us to further control for bank and firm specific effects by using bank fixed effects λ_b, firm fixed effects ψ_i, firm-level control variables or, in some specifications, firm-time fixed effects that control for all the time-varying firm heterogeneity. A range of robustness exercises tackles alternative channels of transmission that may affect credit supply decisions.

Table 3 shows the estimation results. We start by regressing the change in bank credit from bank b to firm i from 2013 to 2014 over MMF_b (Specification 1) and for the sample of MMF banks. Column 1 shows that the coefficient estimate of MMF_b is negative and statistically significant, meaning that global banks that are more reliant on US money market funds as a source of short term funding reduce their lending more to firms after the Taper Tantrum.

In column 2 we confirm the evidence also for a longer period, from 2013 to 2016, consistent with the hypothesis that banks with high reliance on US dollar funding reduce credit the most in the years when the US dollar appreciated by 30%. In terms of economic magnitude, the median bank with 10% of its short term debt funded by US money market funds reduces credit by about 20% over the sample period.

In column 3 we include banks with no MMF funding to the sample (whose MMF_b is therefore equal to zero), which allows to control for changes in bank credit by all banks, with similar results. In column 4, in addition to MMF banks we also consider the possibility that the dollar funding exposure of subsidiaries (e.g., Banamex) is linked to their parent bank (e.g., Citigroup), with unchanged results. This result suggests that regional subsidiaries of global banks are not as exposed to dollar funding as their parent bank, but they mostly operate as domestic-funded banks. Taken together, these results suggest that global banks that were more reliant on US dollar funding reduced credit supply more in the post Taper Tantrum period characterized by dollar appreciation and capital outflows.

In columns 5 to 7 we explore the role of the exchange rate. In column 5 we start by adding the percentage change in the broad dollar index $\Delta USDbroad$ interacted with MMF_b (Specification 2) for the sample of MMF banks and for the period 2013 to 2016. Consistent with the predictions in Bruno and Shin (2015), the interaction term $MMF \cdot \Delta USDbroad$ is negative and highly significant, meaning that more dollar funded banks reduce credit more when the US dollar appreciates. In terms of economic magnitude, a one percent appreciation of the US dollar impacts credit of banks in the upper tercile of MMF_b by 1% more than banks in the lower MMF_b tercile.

Table 3: **Bank credit and US dollar funding.** This table shows panel regressions where the dependent variable is the annual percentage change in bank credit from bank b to firm i over the period 2013 to 2014 (column 1) or the period 2013-2016 (columns 2 to 7). The variable MMF captures the holdings of US MMFs as reported in the banks' regulatory filings to the Securities Exchange Commission, scaled by short-term debt, as of 2012. USDbroad is the percentage change in the broad US dollar index. Standard errors are corrected by clustering at the bank level. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period	2013-14	2013-16	2013-16	2013-16	2013-16	2013-16	2013-16
Sample	Global banks	Global banks	All banks	Include subsid	Global banks	Global banks	All banks
MMF_b	-2.1255***	-2.1972***	-0.9218**	-0.7830**			
	[0.5803]	[0.6617]	[0.4065]	[0.3937]			
$MMF_b \cdot \Delta USDbroad$					-44.3683***	-69.6795***	-33.2933*
					[14.6711]	[19.6066]	[20.0370]
Constant	0.5229***	0.4397***	0.1085**	-0.1946**	0.6089***	0.8732***	0.2245***
	[0.1469]	[0.1388]	[0.0525]	[0.0907]	[0.1479]	[0.1984]	[0.0713]
Observations	108	294	889	889	291	260	857
R-squared	0.315	0.257	0.121	0.120	0.324	0.428	0.222
N banks	26	28	133	133	25	24	102
Firm FE		✓	✓	✓	✓		✓
Year FE	✓	✓	✓	✓	✓		✓
Firm-Year FE						✓	
Bank FE					✓	✓	✓

In column 6 we control for all observed and unobserved time-varying firm heterogeneity through firm-year fixed effects. The interaction term $MMF \cdot \Delta USDbroad$ continues remaining negative and significant, supporting the bank funding shock channel rather than firm balance sheet effects. Finally, in column 7 we augment the sample by including all non-MMF banks, with similar results. Taken together, the results in Table 3 show the existence of an association between credit supply and the shifts in financial conditions due to dollar appreciation.

Having established that dollar funded banks lend less when the dollar appreciates, in the Appendix we perform tests to account for alternative channels and unobserved factors, as our estimates could be biased if firms experience a contraction of credit for other reasons other than a shock to bank dollar funding generated by exchange rate fluctuations.

3 The financial channel and exports

In this section we investigate how firms' dependence on dollar credit affects (through their banks) the sensitivity of exports to dollar fluctuations. Our hypothesis is that firms more dependent on wholesale dollar-funded bank credit will suffer increasing working capital costs, with knock-out effects on exports, as the dollar strengthens.

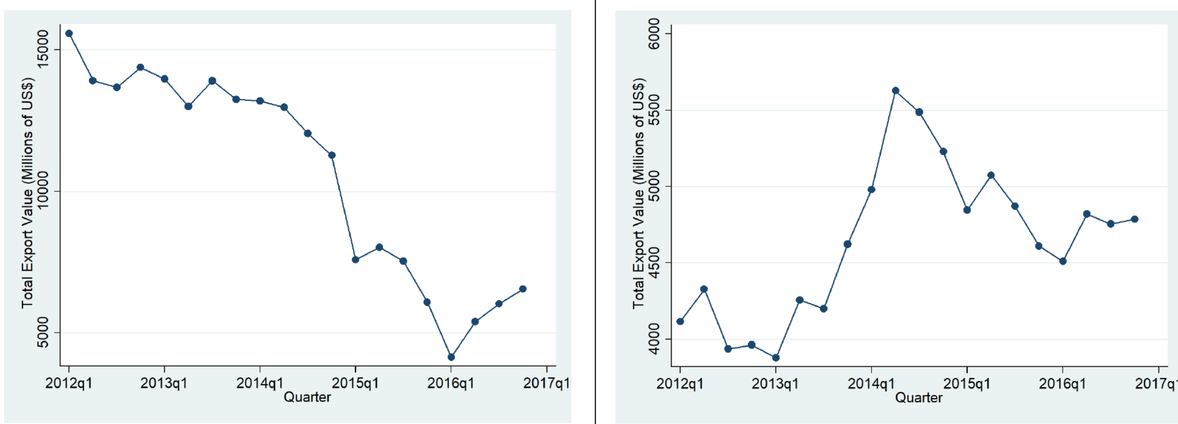
Figure 3 is a stark illustration of how reliance on dollar bank credit affects exports. It plots total value of exports for the subsample of firms with dollar bank credit (left-hand panel) and those without dollar bank credit (right-hand panel). Firms with dollar bank credit show a steady decline in the total exports during the period of strong dollar appreciation (from the second half of 2014 to early 2016). In contrast, for the sample of firms with no dollar bank credit, exports value increased over time. Motivated by Figure 3, we delve into a more detailed investigation of the relationship between dollar credit and export performance.

3.1 Empirical design

When identifying the impact of the financial channel on exports, we face the identification problem of disentangling demand and supply of credit. Our identification strategy is based on the following pillars.

First, we use disaggregated exports X_{ipdt} by firm i of product p to destination country d at time t, which allow us to control for product-destination demand factors. Hence, we compare variation of exports within product-destination categories.

Second, we use firms' initial exposure to dollar-funded banks as a proxy for the susceptibility to shocks to credit supply and exploit the cross-section difference across firms. For example, consider firms A and B that export the same product to the same country in the same period, but they borrow from two different banks, C and D, respectively. Bank C relies more on dollar wholesale funding than does bank D. Then the two exporting firms are subject to the same



Firms with dollar bank credit | No dollar bank credit

Figure 3: **Exports and Dollar Bank Credit.** This figure plots the variation in the total value of exports from 2012 to 2016 for the subsample of firms with (left-hand panel) and without dollar bank credit (right-hand panel). Sources: Panjiva, Capital IQ.

demand conditions in their export destinations, but they are exposed to different credit supply conditions. Dollar appreciation will affect bank C more than bank D, with a larger knock-on effect on firm A's exports. We make use of such cross-section differences across firms. In particular, we focus on the cross-sectional variation in funding sources as the key element in our identification exercise.

Third, we consider the period after the Taper Tantrum episode of May 22, 2013, which started a prolonged period of dollar appreciation and capital outflows from emerging markets after a period of sustained dollar weakness. The exchange rate is an endogenous variable, and its relationship with macro aggregates will reflect two-way causation. However, each firm taken individually will have limited impact on the exchange rate. Thus, from the point of view of individual firms, the exchange rate can be taken as exogenous, even though it affects firms differently depending on their characteristics.

We construct an index for each exporting firm of its exposure to fluctuations in dollar credit conditions based on the dependence of its *lending banks* to wholesale dollar funding. Specifically, we capture firm i's exposure to banks that rely on US dollar funding by constructing the variable:

$$FMMF_i = \sum_b \omega_{ib} MMF_b, \tag{3}$$

where ω_{ib} indicates the share of credit received by firm i from bank b as of q1 2013 (before the Taper Tantrum), and MMF_b is the end of 2012 outstanding amount of US MMFs holdings by bank b, normalized by the bank's short-term debt. "FMMF" stands for "firm's MMF exposure". The variable $FMMF_i$ is an indirect measure of firm i's exposure to dollar funding through its lending banks' reliance on US MMF funding, where the weight ω_{ib} captures the fraction of credit to firm i from bank b. Hence, $FMMF_i$ is a time invariant variable that captures the firm's exposure to banks more dependent on US dollar wholesale funding pre-Taper Tantrum. A higher $FMMF_i$ indicator indicates that firms are more exposed to banks with higher US money market funding. The variable $FMMF_i$ ranges from 0 (for those firms that do not receive credit from dollar funded banks) to a maximum value of 0.85. The mean exposure $FMMF_i$ to dollar funded banks is 0.07.

We estimate the effect on exports of firms that are exposed to dollar funding as:

$$\Delta X_{ipdt} = \beta \cdot \Delta USDbroad_{t-1} \cdot FMMF_i + \varphi_{tp} + \upsilon_{td} + \psi_i + \varepsilon_{ipdt} \tag{4}$$

where ΔX_{ipdt} is the quarterly log difference of the volume of exports, $\Delta USDbroad_{t-1}$ is the log difference of the US dollar broad index with one quarter lag, and $\varphi_{tp} + \upsilon_{td} + \psi_i$ are time-product, time-destination, and firm fixed effects, respectively.

This specification allows us to compare the growth in exports of the same product and to the same destination across firms that borrow from banks with different exposure to dollar funding shocks. By taking each firm's exposure to US dollar funded banks as of 2012 and looking at the impact on exports post 2012, we mitigate the endogeneity problem of regressing exports on the contemporaneous amount of bank credit taken by a firm. Hence, the coefficient estimate of $\Delta USDbroad_{t-1} \cdot FMMF_i$ captures the average sensitivity of the firm's credit to fluctuations in the dependence of the firm's *lenders* to US dollar funding.

The time-product and time-destination dummies absorb demand fluctuations of product p and destination d at quarter t. The estimation period is q3 2013 to q1 2017, and standard errors are corrected for clustering at the firm level. We present robustness tests to account for alternative reasons that may bias the evidence on exports other than credit supply, including horseracing the broad dollar exchange rate with other channels, like US monetary policy or global volatility. We also present a Bartik-style instrumental variable approach as an alternative estimation strategy.

3.2 Cross-section evidence across exporting firms

Column 1 of Table 4 shows a parsimonious specification in terms of fixed effects by using time-destination, product, and firm fixed effects, that allows to maximize the estimation sample. The coefficient of the interaction $\Delta USDbroad \cdot FMMF_i$ is negative and statistically significant, meaning that firms that are exposed to dollar-funded banks suffer a negative effect on exports growth. Column 2 further controls for product specific demand by using product-time fixed effects in a specification with destination and firm fixed effects. Because of the presence of singletons, the sample is reduced by about 14%, however the interaction $\Delta USDbroad \cdot FMMF_i$ remains negative and statistically significant.

In column 3 we fully control for destination and product specific demand at time t by using product-time and destination-time fixed effects concurrently with firm fixed effects. Results remain statistically significant at the 1 percent level. On average, following a one percent US broad dollar appreciation, firms in the upper $FMMF_i$ tercile suffer a reduction of export volumes by 1% more than firms in the lower $FMMF_i$ tercile on a quarterly basis.

Banks may specialize by lending to firms in specific markets, hence banks and firms may not be randomly matched. In our setting, since the USA accounts for three quarters of the Mexican export value, it is likely that some banks (especially in the USA) may select firms that are exposed to the US market. In column 4 we exclude the United States as the exports destination country, while continuing controlling for product, time and destination fixed effects, with qualitatively similar results.

Table 4: **Exports and US dollar funding.** This table shows panel regressions where the dependent variable is the quarterly change in firms' exports within products-destinations form the period q3 2013-q1 2017. Exports are measured in volume (columns 1 to 4), value (columns 5 and 6), and unit of cargo capacity (column 7). USDbroad is the quarterly change in the US dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Volume	Volume	Volume	Volume	Value	Value	TEU
$\Delta USDbroad{*}FMMF_i$	-4.6355***	-10.8226***	-8.7606***	-9.3910**	-12.9056**	-11.1315***	-10.2164***
	[1.7300]	[3.7800]	[2.7663]	[4.2843]	[5.0267]	[2.8496]	[3.4685]
Constant	0.0000	0.0056**	0.0043**	0.0082***	0.0269***	0.0286***	0.0046*
	[0.0012]	[0.0026]	[0.0019]	[0.0030]	[0.0035]	[0.0017]	[0.0023]
Time-destination FE	✓		✓	✓	✓		✓
Time-product FE		✓	✓	✓	✓	✓	✓
Product FE	✓						
Destination FE		✓					
Firm FE	✓	✓	✓	✓	✓	✓	✓
Sample	All	All	All	USA dest excluded	All	US dest only	All
Observations	58,901	50,363	50,174	37,781	50,174	15,395	49,405
R-squared	0.100	0.238	0.307	0.320	0.266	0.069	0.305

Our estimation approach compares volumes of exports within product-destination markets. Volumes do not suffer of potential confounding effects from changes in prices. In columns 5 and 6 we nevertheless use the percentage change in values rather than volumes. Goldberg and Tille (2009) and Gopinath et al (2020) find that exports are mostly invoiced in US dollars. Under the assumption of sticky prices, we should observe a similar effect to the case of volumes. Column 5 shows that the estimations are in line with the previous evidence: an appreciation of the US dollar negatively affects the export values of those firms that depend more on credit from dollar funded banks. Column 6 restricts the estimation sample to the exports to the United States as destination country. Goods exported to the US are likely to be invoiced in US dollar only. Results are confirmed. Finally, in column 7 we use the percentage change in TEU, a unit of cargo capacity based on the volume of a 20-foot-long container, with qualitatively similar results.

The preceding identification strategy is based on the firms' initial exposure to dollar-funded banks as a proxy for the susceptibility to credit supply shocks and for exploiting the cross-section difference across firms. In October 2016, the US money market reform was implemented. Although the reform was announced in 2014, most of the changes in the banks's MMF assets under management occurred within one year prior to the implementation deadline. In fact, Anderson, Du and Schlusche (2021) find that the MMF new rules became relevant after October 2015. Hence, the final period of our estimation could be potentially affected by the MMF reform. In Table 5, we re-estimate specifications 1 and 4, and exclude the "effective" period of the MMF reform. Columns 1 and 2 show that the results remain qualitatively unchanged.

An additional concern about our identification is related to endogeneity and the possibility that the association between exports and dollar funding may be spurious. We construct an instrument that resembles a Bartik-style shift-share estimator to take into account possible shocks at the MMF sector level that may not be correlated with exchange rate fluctuations:

$$B_{b,t} = MMF_b \cdot \Delta(MMF_{s,t} - MMF_{b,t}) \tag{5}$$

where $\Delta MMF_{s,t}$ ($\Delta MMF_{b,t}$) is the yearly change in the total wholesale dollar funding through the US money market funds sector s (bank b) in the form of repurchase agreements (repos), commercial paper, certificate of deposits and asset-backed commercial paper, and it is obtained from Crane data. The identification assumption underlying the instrument is that changes in the MMF sector are independent of funding demand shocks of individual bank b.

Table 5, column 3, shows the first stage estimation results from Specification 1 that looks at the growth in bank credit ΔC_{ibt} from bank b to firm i over the period 2013 to 2015 (pre-MMF reform) and uses the instrument $B_{b,t}$ in lieu of MMF_b. The coefficient estimate of $B_{b,t}$ is positive and statistically significant, meaning that a dollar funding shock has a significant effect on bank credit. The first stage F-statistics is 16.5, which suggests a fair quality of the instrument. These results are consistent with the evidence shown in Ivashina et al (2015) and Anderson et al (2021), who find that banks reduced their dollar loan origination in response to the negative funding shock from MMF during the European debt crisis.

In column 4 we take the fitted values $\widehat{C_{i,t}}$ from the first stage regression to construct a firm-level credit indicator with 2012 bank-level weights, and use it in specification 6 lieu of $\Delta\, USDbroad{*}FMMF_i$ for the pre-2016 MMF reform implementation period. The coefficient estimate of $\widehat{C_{i,t}}$ is positive and statistically significant, confirming the positive association between credit and exports.[8]

Taken together, these tests provide a mix of robustness checks related to identification issues. Specifically, we use firms' initial exposure (pre-Taper Tantrum) to dollar-funded banks as a proxy for the susceptibility to credit supply fluctuations and exploit the cross-sectional difference across firms. We control for unobserved heterogeneity in the cross-section by using firm-product-destination fixed effects. Our results are robust to excluding the US from the sample or excluding the US money market reform period. We consider a Bartik-style estimator to take into account

[8] The exclusion restriction assumes that the "shares" are quasi-randomly assigned. In their study Anderson Du and Schlusche (2021) find that money market fund shares are largely uncorrelated with the overall size of the banks. However, they find some evidence that some money market funds lend to more "sound" banks with better credit ratings, higher Tier-1 common equity ratios, and higher returns on assets. We follow their direction and address the concern that the correlation between fund share and the soundness of banks may bias our results by comparing the coefficient estimates without any bank-level controls to the coefficients with controls. In untabulated results, we find that the estimated coefficients of the first stage regressions are very similar, with and without control variables, and their difference is not statistically significant.

Table 5: **Exports and US dollar funding.** Columns 1 and 2 present regression results from specifications 1 and 4 after excluding the period related to the US MMF reform implementation. Columns 3 and 4 implement an instrumental variable estimation. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)
Dependent variable	Bank credit	Exports	Bank credit First stage	Exports Second stage
MMF_b	-2.7944***			
	[0.5933]			
$\Delta USDbroad{*}FMMF_i$		-6.8768**		
		[3.3695]		
$B_{b,t}$			35.1771***	
			[8.6468]	
$\widehat{C_{i,t}}$				1.3028**
				[0.5264]
Constant	0.5482***	0.0102***	0.5795***	-0.0465**
	[0.1409]	[0.0026]	[0.1523]	[0.0207]
Observations	213	34,136	210	33,893
R-squared	0.325	0.314	0.324	0.315

possible spurious correlations at the money market sector level before the US MMF reform. Ideally, we would like to use product-destination-fixed effects to better parsing out supply versus demand for credit. Because of singletons, introducing time-product-destination fixed effects reduces the sample by about 90%. Nevertheless, our results are confirmed also in this case (see Table 12 in the Appendix).

3.3 Exports and supply chains

The preceding sections have shown that firms that are financed by banks exposed to US dollar funding suffer a drop in credit supply following dollar appreciation, which negatively impacts their exports. We now examine the incremental impact of extended supply chains on the exports of firms. Building and sustaining supply chains are finance-intense activities, and so our hypothesis is that our results will hold with added force when firms have additional financing need due to extended supply chains.

To fix intuition, we illustrate the financing impact of lengthening of supply chains and possible tradeoffs with lower production costs using a simple example. Consider a good produced with two rounds of value-added. This case is depicted by the left-hand diagram in Figure 4. Each step in the production of the good takes one time period, and incurs a cost of $w > 0$. At date 1, the firm completes the first production step at cost w and sends the intermediate good to the second step. At date 2, the firm goes through the second step of production incurring cost w. Meanwhile, the firm begins the first-step of the production of the next unit at cost w.

The firm begins to receive revenue of p from date 3 onwards, when it sells the good at price p. Before then, the firm finances the costs incurred during the initial phase (dates 1 and 2) by borrowing at interest rate $r > 0$.

In steady state (from date 3 onwards), the firm's cashflow is

$$p - 2w - r\left(2w\left(1+r\right) + w\left(1+r\right)^2\right) \tag{6}$$

consisting of sales revenue p, per-period production cost $2w$ and the interest expense on the

Date t		Stages 1	Stages 2
	1	w	
	2	w	w
	3	w	w
	⋮	⋮	⋮

Date t		Stages 1	Stages 2	Stages 3
	1	c		
	2	c	0	
	3	c	0	w
	4	c	0	w
	⋮	⋮	⋮	⋮

Figure 4: **Costs of two-step production.** A good is produced with two rounds of value-added. The left-hand diagram depicts production with high costs. The right-hand diagram depicts the case of low production costs.

debt incurred during the initial phase of production.

Now, suppose that the firm has the possibility to lower the production cost of the first stage by moving to a different production location, but incurs a delay in cashflows and associated increase in working capital costs. The right-hand diagram of Figure 4 depicts production when the first stage of production happens at the cheaper location. The cost of the first step of production at the cheaper location (including the ensuing transport cost) is c, where $c < w$. At date 2, the intermediate good is transported, and the second step of production takes place at date 3. The firm receives revenue from the sale of the good from date 4 onwards.

In steady state (from date 4 onwards), the firm's cashflow is

$$p - (c + w) - r\left((c + w)(1 + r) + c(1 + r)^2 + c(1 + r)^3\right) \qquad (7)$$

consisting of sale revenue p, production cost $c + w$ and interest expense on the debt incurred during the initial phase of production. By moving the first step of production to the cheaper location, the firm lowers the first stage cost to c, but incurs a higher overall financing cost due to the financing need to build a longer production process.

The firm's steady-state cashflow is higher by lengthening the production process when (7) is larger than (6), or equivalently, when

$$1 - \frac{c}{w} > \frac{r(1 + r)^3}{1 + r(1 + r) + r(1 + r)^2 + r(1 + r)^3} \qquad (8)$$

The left-hand side of (8) is the cost reduction on the first step of production from w to c due to the move in production location for the first step. The right-hand side captures the effect of the additional financing costs stemming from the greater working capital needs due to the lengthening of the production chain.

The right hand side of (8) is increasing in the interest rate r. The firm does better to lengthen the production chain if financing cost is sufficiently small. However, higher r entails a higher hurdle for the cost reduction, and having a shorter supply chain dominates. Bruno, Kim and Shin (2018) examines a related model where this intuition can be generalized for a general n-stage production chain.

3.4 Evidence from intermediate goods

Building on the intuition above, we delve deeper in our empirical investigation to gauge whether the impact of financial conditions are felt more strongly for exporters with longer supply chains. We classify each product at the 8 digit HS code as capital, intermediate, or consumption goods as defined by the US International trade statistics.[9] We then split the sample between intermediate versus non-intermediate goods, (columns 1 and 2 of Table 6, respectively) in a panel analysis (Specification 4) that regresses the change in export volumes ΔX_{ipdt} over the interaction term $\Delta USDbroad{*}FMMF_i$. We use time-destination fixed effects, firm fixed effects, product fixed effects, but we cannot use product-time fixed effects or else the interaction term would drop due to singletons.

We find that the estimated coefficient of the interaction term $\Delta USDbroad{*}FMMF_i$ is negative and statistically significant only for the subsample of intermediate products (column 1). Since intermediate goods are typically associated with longer supply chains, we take this finding as further corroboration of our main financing channel of export fluctuations.

In Columns 3 and 4 we perform a further exercise by splitting the sample between dollar funded firms ($FMMF_i > 0$) versus non-dollar funded firms ($FMMF_i = 0$). This time, we construct a dummy variable that is equal to 1 if the product is classified as intermediate

[9] https://unstats.un.org/unsd/tradekb/Knowledgebase/50090/Intermediate-Goods-in-Trade-Statistics

good, and 0 otherwise (*Intermediate*), and interact it with $\Delta\,USDbroad.$ The interaction term $\Delta\,USDbroad{\cdot}Intermediate$ is negative and statistically significant only for the subsample of firms that are dollar-funded, consistent with the prediction that the exports of intermediate goods are more sensitive to a tightening in the dollar financial conditions (column 3). In contrast, intermediate goods produced by non-dollar funded firms are less subject to dollar financial conditions. Consequently, exchange rate fluctuations do not differentially affect the exports of intermediate and non-intermediate goods (column 4).

In Columns 5 and 6 we use working capital as an alternative proxy of intensity of production chains. Kalemli-Ozcan et al (2014) find that upstream firms have higher working capital compared to downstream firms because they are more remote from the direct consequences of their actions, meaning that the time to produce entail a higher discount rate on costs and benefits of actions. Gofman (2013) also finds that firms at higher vertical positions hold more trade credit. The interaction term $\Delta\,USDbroad{*}WorkingCapital$ is negative and statistically significant for the sample of all firms (column 5) and for the subsample of firms that receiving credit from dollar funded banks (column 6), and it is not significant for the subsample of firms with no dollar funded credit (result not reported). Taken together, these results confirm that firms with higher financing needs to sustain their production chains suffer from dollar appreciation associated with a reduction in credit supply.

We also check for the means of transportation of exported goods. Amiti and Weinstein (2011) and Schmidt-Eisenlohr (2013) show that working capital considerations loom larger for firms shipping goods by sea relative to those exporting by air due to the greater delays in cashflows. We find that when the dollar appreciates and credit supply declines, the shorter time needed for trade helps alleviating the increased financing costs, consistent with the fact that working capital considerations are larger for goods shipped by sea relative to those exported by air. Table 12 in the Appendix presents the analysis related to shipping times.

The preceding evidence focuses on export volumes. In Table 7 we investigate how firms deal with changes in the supply of dollar-funded credit. Prior work has shown that credit shocks during financial crises uniformly affect supply chain activity. Here, we study the trade-offs that

Table 6: **Exports and supply chains.** Columns 1 to 6 of this table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations. USDbroad is the quarterly change in the US dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Intermediate is a dummy variable that is equal to 1 if the product is classified as intermediate good, and 0 otherwise. Working capital is the ratio of working capital to total assets as of 2012. Standard errors are corrected for clustering of observations at the firm level, except in columns 3, 4, and 6, where they are corrected at the firm-time level, and are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Intermediate goods	Consumption goods	Dollar funded	Non-dollar funded	All	Dollar funded
$\Delta\, USDbroad$	-3.8072**	4.7559				
$*FMMF_i$	[1.6089]	[23.8856]				
$\Delta\, USDbroad$			-2.9328***	0.7154		
$*Intermediate$			[0.7578]	[1.7386]		
$\Delta\, USDbroad$					-7.2279*	-10.5567*
$*Working\ Capital$					[4.1634]	[6.3026]
Fixed effects						
Time-destination	✓	✓	✓	✓	✓	✓
Time-product					✓	✓
Product	✓	✓	✓	✓		
Destination						
Firm	✓	✓	✓	✓	✓	✓
Time						
Constant	0.0034**	-0.0049	0.0243***	0.0158	0.0066	0.0029
	[0.0014]	[0.0080]	[0.0078]	[0.0112]	[0.0050]	[0.0083]
Observations	35,395	18,146	43,706	9,710	49,600	40,387
R-squared	0.112	0.158	0.112	0.269	0.308	0.313

firms face in non-crisis times as a function of dollar-funded credit supply.

We start by looking at product pricing. Ahn, Amiti and Weinstein (2011) show that financial shocks may also affect price changes. We construct the export price as the ratio of the value to the volume of a product exported from Mexico and we replicate Specification 4 with prices in lieu of quantities. We also take Δ *USDbroad* with one and two-quarter lags to capture price adjustments over time. Column 1 in Table 7 considers all firms. We see that, in contrast to volumes, the interaction $\Delta USDBroad_{t-1} * FMMF_i$ is not statistically significant, meaning that firms on average do not adjust their prices a quarter after dollar appreciation even though the volume of their exports declines. Firms do not seem to adjust prices after two quarters either. However, when we split our sample of exported goods between intermediate (column 2) and consumption goods (column 3), we see that $\Delta USDBroad_{t-2} * FMMF_i$ is now positive and statistically significant for the subsample of intermediate goods. Taken together, firms with higher financing needs suffer a reduction in volumes following dollar appreciation and they subsequently increase the product price.

3.5 Evidence from domestic sales and accounts receivable

As a further check, we compare exports with domestic sales. Amiti and Weinstein (2011) find that the health of banks providing finance has a much larger effect on exports than on domestic sales because exporters need more working-capital financing than firms engaged in domestic transactions. In line with their finding that financial shocks affect exports and domestic sales differentially, we collect data on domestic sales from Capital IQ (Geographic segment module) and Thomson Reuters at the quarterly frequency. Such data are available for an unbalanced panel of firms. Our focus is again on the role of the US dollar for credit supply and the contrasting effect on domestic sales versus exports.

We compute the growth in quarterly domestic sales and regress it on $FMMF_i$ interacted with Δ *USDbroad,* with firm and year fixed effects. In column 4 of Table 7 $\Delta USDbroad*FMMF_i$ is not statistically significant, suggesting that the greater need for dollar funded working capital is export-specific, and not a general effect applicable to all sales. In untabulated results we also

Table 7: **Export prices, domestic sales and trade credit.** This table shows panel regressions where the dependent variable is the quarterly percentage change in firms' export prices within products-destinations (columns 1 to 3), the growth in quarterly domestic sales (column 4), or the quarterly percentage change of account receivables (columns 5 to 7). USDbroad is the quarterly percentange change in the US dollar broad index. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors are corrected for clustering of observations at the firm level and are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Price	Price	Price	Domestic sales	Account Receiv.	Account Receiv.	Account Receiv.
Sample	All	IG	CG		All	High Exports	Low Exports
$\Delta\, USDbroad_{t-1}$	-0.7451	0.6420	-0.7350	1.1118	-4.0178**	-5.5874***	4.0934
$*FMMF_i$	[1.2148]	[0.7690]	[6.1537]	[2.0743]	[1.6162]	[1.4832]	[6.4760]
$\Delta\, USDbroad_{t-2}$	1.3408	0.8947*	-1.0631				
$*FMMF_i$	[0.8768]	[0.4528]	[5.3647]				
Constant	-0.0061***	-0.0090***	-0.0041**	0.0185***	0.0181***	0.0270***	0.0189***
	[0.0008]	[0.0008]	[0.0018]	[0.0020]	[0.0012]	[0.0020]	[0.0040]
Firm FE	✓	✓	✓	✓	✓	✓	✓
Time-destination FE	✓	✓	✓				
Time-product FE	✓	✓	✓				
Time FE				✓	✓	✓	✓
Observations	50,174	29,893	15,873	477	729	262	257
R-squared	0.270	0.289	0.326	0.075	0.051	0.130	0.156

find that firms do not shift to selling more domestically. Overall, our findings reinforce earlier results by showing that exports are more sensitive to dollar funding shocks than are domestic sales. Our findings are consistent with those in Amiti and Weinstein (2011) who highlight the greater dependence of exporters on trade finance due to their higher working capital needs.

Finally, we look at trade credit and accounts receivable. In principle, a drop in credit supply may have an ambiguous effect on net receivables through differential impact on importers and domestic customers, or through possible inter-firm credit (Ahn, Amiti, and Weinstein, 2011; Hardy and Saffie, 2020). We explore this issue by regressing the quarterly percentage change of accounts receivable on $\Delta USDbroad{*}FMMF_i$. Column 5 of Table 7 shows that $\Delta USDbroad{*}FMMF_i$ is negative and statistically significant, and this result is driven by the subsample of firms with a higher percentage of exports (column 6). Overall, these results suggest that dollar funded exporters suffer a larger decline in trade credit following dollar appreciation, perhaps because extending trade credit becomes costlier in line with the generally higher working capital costs in the economy. The same evidence, however, does not apply to firms with low export intensity (column 7).

Taken together, the evidence in Table 7 is indicative of the broader consequences of credit supply fluctuations of US dollar movements that go beyond the volume of exports to supply chain credit more generally. However, not all firms are equally affected. The evidence is strongest for dollar-funded exporters.

3.6 Which exchange rate?

Our analysis has focused on the broad US dollar index as the relevant exchange rate at the center of the financial channel of exchange rates, as modeled in Bruno and Shin (2015). Here, dollar appreciation is associated with increased risk exposure of a globally diversified bank, which reacts by cutting back credit supply. Avdjiev et al. (2019) show that a dollar appreciation is associated with a widening of the CIP deviation, and argue that the broad dollar index serves as a good indicator of bank balance sheet costs. Cao and Dinger (2021) find that favorable global funding conditions, associated with local currency appreciation, encourage banks to increase lending, leverage and risk. When applied to our specific context, bank credit supply fluctuations captured by the interaction term $\Delta USDbroad{*}FMMF_i$ affect working capital costs and the operation of credit-intensive supply chains, with knock-on effects on exports.

How about the bilateral exchange rates? Gopinath et al (2020) have drawn attention to the prevalence of dollar invoicing: when exports are invoiced in dollars, if the destination country currency weakens against the US dollar, there is a decline in exports due to the loss of competitiveness of the exporter. Conversely, when the destination country currency strengthens against the dollar, exports increase through enhanced competitiveness. Although the "invoicing channel" also predicts a decline in exports following US dollar appreciation, the mechanism is different, and does not appeal to the cost of financing in dollars.

Column 1 of Table 8 reports the benchmark result (Specification 4) using $\Delta USDbroad.$ A key result is in column 2, which includes exports to the United States only. This subsample provides an important benchmark because the US dollar is the currency of the destination country (as well as being the invoicing currency), hence we can eliminate the invoicing channel from consideration. The estimated coefficient on $\Delta USDbroad{*}FMMF_i$ is negative and highly significant, suggesting that the broad dollar index is an indicator of bank balance sheet costs and confirming the importance of the financial channel for exports.

In column 3 we use the bilateral exchange rate of the export destination country vis-à-vis the US dollar ($\Delta USD\_\ destination$) in lieu of the US broad dollar index. The estimated coefficient of $\Delta USD\_\ destination{*}FMMF_i$ is negative and statistically significant, but the estimated coefficient is about five times smaller than $\Delta USD\_\ destination{*}FMMF_i$. Results hold when we add both $\Delta USDbroad{*}FMMF_i$ and $\Delta USD\_\ destination{*}FMMF_i$ together in the same regression (column 4).

Finally in column 5 we consider the Mexican pesos bilateral exchange rate vis a vis the US dollar, Euro or Canadian dollar. The interaction term $\Delta bilateral{*}FMMF_i$ is not statistically significant.

Taken together, these results are suggestive of a financial channel at work for dollar funded firms: a broad dollar appreciation increases tail risks in the global credit portfolio and reduces

Table 8: **Exchange rates.** This table shows panel regressions where the dependent variable is the quarterly change in firms' exports within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the US dollar broad index. USDdestination is the bilateral exchange rate of the export destination country vis-a-vis the US dollar. Bilateral is the Mexican pesos bilateral exchange rate. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
Δ *USDbroad*FMMF$_i$*	-8.7606***	-8.4788***		-8.1448***	
	[2.7663]	[2.8826]		[2.7775]	
Δ *USD_ destination*FMMF$_i$*			-1.7822*	-1.6395*	
			[0.9990]	[0.9579]	
Δ *bilateral*FMMF$_i$*					-1.7423
					[1.5011]
Constant	0.0043**	-0.0173***	-0.0019***	0.0037*	-0.0042**
	[0.0019]	[0.0017]	[0.0005]	[0.0020]	[0.0017]
Sample	All	USA	All	All	USA, Euro, Canada
Observations	50,174	15,395	49,885	49,885	23,090
R-squared	0.307	0.070	0.306	0.306	0.089

spare credit capacity through a value-at-risk (VaR) constraint. Consequently, firms that are mostly exposed to dollar funded credit will be the mostly affected by dollar fluctuations.

3.7 Additional robustness tests

Additional robustness tests and discussion of alternative channels are presented in the Appendix. In Table 13 we control for firm characteristics such as cash, size, profitability, or leverage, with unchanged results. We additionally look for potential firm-level effects that may bias the evidence on exports for reasons other than credit supply shocks. For instance, exchange rate fluctuations may impact certain types of firms (e.g., firms in distress or firms with a large share of foreign production) more than others, or banks that are exposed to these firms. We also look at commodity-oriented exporters and take into account bilateral trade costs that my impinge the exports flows between two countries.

We also look at the variable $FMMF_i$, which treats subsidiaries of global banks separately from their headquarters. Cetorelli and Goldberg (2011) and Correa et al. (2016) show that global banks (e.g. Citigroup) may affect local financial conditions through their subsidiaries (e.g., Banamex). To account for this possibility, we construct a modified version of $FMMF_i$ that considers headquarters of global banks and their subsidiaries as a unique entity. Results presented in Table 13 suggest that global banks are direct suppliers of dollar credit to firms, whilst firms' exposure to subsidiaries alleviates the impact from dollar fluctuations, consistent with the domestic funding structure of local subsidiaries.

Finally, in Table 14 we focus on alternative channels that may endogenously account for exchange rate shocks, e.g., US monetary policy, global economic conditions, volatility, and Mexican financial conditions. This analysis confirms the role of the broad US dollar index in funding and lending decisions by global banks, with repercussions on firm-level exports.

4 Concluding remarks

The philosopher René Descartes famously argued that the nature of the mind is distinct from that of the body, and that it is possible for one to exist without the other. Similarly, in the debates about trade globalization, there is a tendency to draw a sharp distinction between trade and finance, for instance by claiming that real openness is mostly a matter of removing trade barriers. In contrast, our findings suggest that merchandise trade is heavily dependent on bank finance so that the financial and real effects are two sides of the same coin.

The message of our paper is that, paradoxically, a strong dollar may actually serve to dampen trade volumes of emerging markets, rather than stimulate them. Our results complement the findings in Gopinath et al (2020) who show that dollar appreciation leads to a contraction in trade volume in the rest of the world under the assumption of sticky prices and dollar invoicing. Our work highlights an alternative mechanism in force, pointing to financial conditions that spill over to the real side of the economy.

Exchange rates are endogenous, and we cannot attribute a causal relationship between the dollar and exports in the aggregate. However, the micro-level analysis opens the door to a better identification of the risk-taking channel of exchange rates. Our results have made use of this opening. Horseracing tests and robustness analysis show that our results are robust to other possible confounding domestic or global variables. The sample period of our study (2013-2016) was one when exchange rates were front and center of the financial commentary, and serves as an ideal test period for the risk-taking channel. The dollar index appreciated by 30% in four years, even as monetary policy action was less dramatic (the Fed Funds rate started to rise gently from December 2015). Our results suggest that delving deeper into the macro impact of dollar appreciation will present further promising lines of inquiry.

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A Appendix

Table 9 reports summary statistics of the sample of global banks with access to US money market funding.

Tables 10 and 11 present robustness tests related to Section 2.1 "Bank credit." Here, we examine a number of alternative channels that may be linked to credit conditions, for instance changes in economic and financial conditions, or specific firm and industry characteristics.

In Table 10 we use the percentage change in oil prices and GDP growth in lieu of the broad dollar index to test if an energy price shock or domestic economic conditions are directly correlated with credit supply or account for bank selection issues. In fact, some banks may be exposed to energy or country shocks more than others. In column 1 of Table 10 we use the percentage change in oil prices (global price of WTI crude as reported by FED FRED) and in column 2 we use GDP growth in lieu of the broad dollar index. The interaction terms of MMF_b with such variables are statistically insignificant, meaning that these factors do not significantly interact with dollar funding as determinants of credit supply by global banks to Mexican firms.

In column 3 we use the percentage change of the bilateral exchange rate Mexican pesos to US dollar in lieu of the broad dollar index. Its statistically insignificance confirms that the broad dollar index is the relevant exchange rate because it captures the fluctuations in the global portfolio of global banks. Finally, in columns 4 and 5 we look at the VIX index and the term spread (obtained from the FED FRED) as possible indicators of global risk aversion. Also in these cases the interaction terms with MMF_b are statistically insignificant. Taken together, we interpret these results as suggestive evidence that the broad dollar index is the global factor affecting dollar-funded credit supply decisions by global banks because it directly affects the banks' portfolio returns at the VaR constraints.

In Table 11 we run an additional set of robustness tests. The financial channel of exchange rates described in Bruno and Shin (2015) works through global banks that intermediate US dollar credit and lend to local corporates. When the local currency depreciates, local borrowers' liabilities increase relative to assets. This increases the tail risk in the bank's credit portfolio and

Table 9: **Banks' reliance on US MMF funding.** This table reports summary statistics for the sample of non-US global banks (22) and US global banks (6) with US money market funding. The column US MMF holdings reports the aggregate outstanding volume of dollar funding (repos and non repos) obtained from Crane data as of the end of 2012. The column MMF/ST debt reports the ratio of US money market holding to short-term debt as of the end of 2012.

Bank Name	US MMF funding ($ billions) end 2012	MMF/ST debt end 2012
Non-US banks		
ING Bank	17.02	68.8%
Skandinaviska Enskilda	18.7	68.8%
Bank of Nova Scotia	52.53	57.4%
Toronto-Dominion Bank	36.97	56.9%
Credit Suisse	61.44	29.3%
Sumitomo Mitsui	54.15	28.8%
ABN Amro Bank	11.63	24.1%
Rabobank	28.47	21.9%
Credit Agricole	34.36	10.4%
Mitsubishi UFJ Financial Group	55.56	10.3%
Societe Generale	36.59	9.3%
Mizuho Financial Group	33.70	8.0%
Barclays Bank PLC	58.30	7.5%
BNP Paribas	51.38	7.4%
HSBC Holdings PLC	24.75	6.7%
Standard Chartered Bank	2.65	5.6%
Deutsche Bank AG	60.54	5.1%
UBS	13.07	3.0%
RBS	27.47	2.9%
Commerzbank AG	2.04	0.7%
Bank of China limited	0.55	0.5%
Banco Santander	0.12	0.1%
US banks		
Wells Fargo	17.21	24.9%
Bank of America	69.46	18.8%
The Bank of New York Mellon	3.45	13.7%
Citigroup	42.98	13.5%
JPMC	50.87	12.7%
Goldman Sachs	33.72	12.1%

Table 10: **Bank credit and US dollar funding - Robustness tests.** This table shows panel regressions where the dependent variable is the annual change in bank credit from bank b to firm i over the period 2013 to 2016. The variable MMF captures the holdings of US MMFs as reported in the banks' regulatory filings to the Securities Exchange Commission, scaled by short-term debt, as of 2012. Oil price is the percentage change in the WTI crude oil price, GDP is the growth in GDP for Mexico. USD-MX is the percentage change in the Mexico-US exchange rate, VIX is the percentage change in the CBOE Volatility Index, the Term Spread is the 10-Year minus 2-Year Treasury rate. The specifications include firm fixed effects, but no time or bank fixed effects. The sample of banks consists of global banks only. Standard errors are corrected by clustering at the bank level. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
MMF_b	-1.6095***	4.4139	-2.2103***	-1.8097***	-0.9230
	[0.5237]	[7.1407]	[0.6313]	[0.5636]	[2.2412]
Oil price	0.0016				
	[0.0083]				
MMF_b·Oil price	0.0277				
	[0.0277]				
GDP		-0.2516			
		[0.7559]			
$MMF_b \cdot GDP$		-2.2054			
		[2.5482]			
ΔUSD_MX			-0.0278		
			[0.0191]		
$MMF_b \cdot \Delta USD\_MX$			0.0029		
			[0.0728]		
VIX				0.0058	
				[0.0156]	
$MMF_b \cdot VIX$				-0.0754	
				[0.0474]	
Term spread					0.5679**
					[0.2343]
MMF_b·Term spread					-0.7477
					[1.0276]
Constant	0.4509**	1.1729	0.7782***	0.3891***	-0.4790
	[0.1692]	[2.2024]	[0.2001]	[0.1324]	[0.4802]
Observations	300	300	300	300	300
R-squared	0.254	0.254	0.263	0.252	0.266

reduce spare lending capacity for the bank at the Value-at-Risk constraints. The drop in credit supply should be more visible for the firms that are more exposed to a currency mismatch.

In columns 1 and 2 we split the sample of firms at the centile of the currency mismatch ratio, computed as the ratio bank credit denominated in Mexican pesos over total credit as of 2012, in a specification that includes firm and time fixed effects. Column 1 shows that the coefficient of the interaction term $MMF_b \cdot \Delta USDbroad$ is not statistically significant for the sample of firms with a high percentage (upper centile) of bank credit denominated in pesos. In contrast, in column 2 the interaction term is negative and statistically significant for the sample of firms in the lower centile, meaning that firms with a higher currency mismatch of their liabilities suffer of a higher drop in credit supply. Column 3 replicates column 2 specification and accounts for all the time-varying firm heterogeneity by including firm-time fixed effects, with qualitatively similar results in terms of both statistical significance and coefficient magnitude.

Column 4 confirms that our results survive when firms in the oil and energy sectors are excluded from the benchmarked specification. Finally, in columns 5 and 6 we investigate if non-global banks substitute global banks' credit when firms exposed to dollar funded banks suffer a drop in credit supply. To perform such a test, we construct the firm-level ratio of bank credit provided by global banks to total bank credit (*Global credit*) and use it in lieu of MMF_b in a specification that considers the credit provided either by non-global banks (column 5) or by the subsample of Mexican banks (column 6). In this way we test whether the credit supplied by non-global banks increases during dollar strengthening and replaces the drop in credit by global-banks. The interaction terms of $Global\ credit \cdot \Delta USDbroad$ for both samples are statistically insignificant, meaning that non-global banks do not substitute for the decline in credit supply by dollar funded banks. In untabulated regressions, we also verify that non-MMF banks do not step in for those firms that were highly exposed to dollar funded banks. This evidence suggests that credit provided by dollar funded banks is somehow special and cannot be easily replaced by other banking institutions.[10] It also suggests that finding alternative sources

[10]Hedging considerations may impinge our results and work against the financial channel as it would reduce the exposure to currency mismatches. Unfortunately, data on hedging are quite limited. Capital IQ reports data

of finance cannot be done very rapidly to prevent an interruption of their exports, as also shown in Amiti and Weinstein (2011).

Finally, in unreported regressions (available upon request) we explore if bank characteristics are a possible driver of credit supply. Specifically, we use the ratio of deposits to assets (Liquidity ratio) or the capital ratio in lieu of MMF_b and find that a higher liquidity or capital ratio are not associated with the credit supplied by global banks in conjunction with dollar exchange rate fluctuations.

Tables 12, 13, and 14 report robustness tests related to Section 3, "The Financial Channel and Exports."

In Table 12, column 1, we use time-product-destination fixed effects. Because of singletons, the sample drops by about 90%. Nevertheless, the interaction coefficient $\Delta USDbroad*FMMF_i$ remains negative and statistically significant. Column 2 explores an alternative way to preserve a larger sample, while at the same time using time-product-destination fixed effects. Instead of using 8 digits HS industry level as we do in column 1, we aggregate exports at the 6 digits HS industry level. Column 2 shows that the interaction coefficient $\Delta USDbroad*FMMF_i$ continues remaining negative and highly statistically significant. Taken together, these results confirm the robustness of our analysis to the inclusion of time-product-destination fixed effects.

In columns 3 and 4 we look at the transportation methods. We create a dummy *Air* equal to 1 when the firm-product-destination-level item is exported by air, 0 otherwise, and a dummy *Maritime* equal to 1 when the firm-product-destination-level item is exported by sea, 0 otherwise. Transportation by truck is the omitted variable. Column 3 shows that the coefficient of $\Delta USDbroad$ is negative and statistically significant, meaning that dollar appreciation hurts the exports of goods with longer transportation times (by truck). The coefficient of $\Delta USDbroad$ interacted with *Maritime* is not statistically significant, confirming that transportation by sea is not statistically different from transportation by road, and both ways of transportation are

on hedging activities for a sample of 16 firms. For such firms, hedging is very small: for the entire period of the analysis, the centile of the ratio of hedging to total debt is 0.43% and only four firms report a hedging ratio between 5% and 25%. Based on the available data, we are less concerned that hedging may significantly bias our results.

Table 11: **Bank credit and US dollar funding - Robustness tests.** This table shows panel regressions where the dependent variable is the annual change in bank credit from bank b to firm i over the period 2013 to 2016. The variable MMF captures the holdings of US MMFs as reported in the banks' regulatory filings to the Securities Exchange Commission, scaled by short-term debt, as of 2012. Global credit is the firm-level ratio of total bank credit provided by dollar-funded global banks over total bank credit, lagged by one period. The specifications include firm and time fixed effects, except column 3 that includes firm-time fixed effects. Standard errors are corrected by clustering at the bank level. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Low	High	High	Oil&Energy	All	All
Sample of firms	mismatch	mismatch	mismatch	excluded		
MMF_b	1.5372	1.9701	1.7955	0.6573		
	[1.6390]	[1.6272]	[1.6394]	[1.2252]		
$MMF_b \cdot \Delta USDbroad$	-22.7086	-42.5343*	-39.6246*	-40.2896***		
	[19.0068]	[21.5767]	[21.5695]	[10.6985]		
Global credit					0.3830	0.4788
					[0.5603]	[0.8133]
Global credit$\cdot \Delta USDbroad$					8.9960	15.1612
					[8.6433]	[12.3918]
Constant	-0.1655	-0.2507**	0.2137**	0.0257	-0.5650***	-0.5581**
	[0.1434]	[0.0959]	[0.0823]	[0.2388]	[0.1546]	[0.2177]
All banks	✓	✓	✓			
Global banks				✓		
Non-global banks					✓	
Mexican banks						✓
# banks	79	104	104	22	106	25
# firms	23	23	23	36	51	48
Observations	358	500	500	240	591	303
R-squared	0.099	0.138	0.201	0.326	0.151	0.248

associated with longer times. However, for the subsample of firms that receive credit from dollar funded banks, transportation by air seems to offset the increasing financing costs coming from dollar appreciation. In fact, the interaction term between $\Delta USDbroad$ and the dummy Air is positive and statistically significant, meaning that the shorter time needed for trade helps alleviating the increasing financing costs following from dollar appreciation. Column 4 confirms our evidence after including time-destination and time-product fixed effects.

In Table 13, column 1, we control for firm characteristics by adding to the main specification the ratio of cash to total assets (Cash), the logarithm of total assets (Size), profitability (ROA), and the ratio of liabilities to assets (Leverage) with unchanged results. In column 2, we use the 2012 Z-score index as computed in Capital IQ, as a proxy for distress in lieu of Leverage. The variable is not statistically significant, indicating that firm-level distress as broadly defined is not necessarily associated with lower exports or, alternatively, exports of firms in distress do not seem to be boosted by broad dollar appreciations. We additionally control for potential firm-level effects that may bias the evidence on exports for reasons other than credit supply shocks. For instance, exchange rate fluctuations may affect certain types of firms more than others or banks that are exposed to some firms. In column 3, we look at the ratio of domestic (Mexican) sales to total sales ($Export\%_i$) in lieu of $FMMF_i$, available for a subsample of firms in the geographical segment of Capital IQ as of 2012, and we horserace it against $\Delta USDbroad \cdot FMMF_i$. The interaction term $\Delta USDbroad * Export\%_i$ is not statistically significant, suggesting that more export-oriented firms are not necessarily affected by currency fluctuations, while also controlling for potential selection-bias concerns.

In column 4 we look at commodity goods and exclude the exports corresponding to commodity sectors (oil, metals, minerals, and agricultural products) with unchanged results. In column 5 we take into account the bilateral trade costs that my impinge the exports flows between two countries. We use the ESCAP-World Bank Trade Cost Database that includes all costs involved in trading goods internationally with another partner (i.e. bilaterally) relative to those involved in trading goods domestically. The variable *Trade Cost* captures trade costs in its wider sense, including not only international transport costs and tariffs but also other trade

Table 12: **Exports and US dollar funding-Robustness tests.** This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the US dollar broad index, lagged by one quarter. MMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable	Volume	Volume	Volume	Volume
Sample	All	All	Dollar Funded	Dollar Funded
$\Delta USDbroad \cdot FMMF_i$	-10.7434*	-14.2243**		
	[5.9144]	[6.4857]		
$\Delta USDbroad$			-1.7882*	
			[0.9815]	
$\Delta USDbroad \cdot Air$			3.7773***	10.1555***
			[0.8852]	[2.6366]
$\Delta USDbroad \cdot Maritime$			0.7835	4.3892
			[0.8946]	[4.0074]
Constant	0.0008	0.0069*	0.0119	-0.0680***
	[0.0036]	[0.0037]	[0.0109]	[0.0235]
Firm FE	✓	✓		
Time-Product-Destination	✓	✓		
Transportation FE			✓	✓
Time-destination FE				✓
Time-product FE				✓
HSCode	8 digit	6 digit		
Observations	6,644	33,750	21,280	17,167
R-squared	0.475	0.493	0.007	0.362

Table 13: **Exports and US dollar funding-Robustness tests.** This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the US dollar broad index, lagged by one quarter. MMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Cash is the ratio of cash to total assets, Size is the logarithm of total assets, ROA is return on assets, and Leverage is the ratio of liabilities to total assets. Distress the the Z-score index. Export is the ratio of Mexican sales to total sales. Trade costs is the bilateral trade costs. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta USDbroad \cdot FMMF_i$	-6.6003***	-7.1665***	-5.4440*	-10.7866*	-11.9176***	-0.0079
	[2.1003]	[2.4630]	[2.9871]	[5.6970]	[3.4513]	[0.0089]
Cash	0.3515	0.3793				
	[0.3179]	[0.4800]				
Size	-0.0175	-0.0932				
	[0.0947]	[0.1336]				
ROA	0.0160	0.0070				
	[0.0118]	[0.0129]				
Leverage	-0.0066*					
	[0.0034]					
Distress		0.0416				
		[0.0446]				
$\Delta USDbroad \cdot Export\%$			-0.0488			
			[5.2616]			
Trade costs					-0.0482	
					[0.1168]	
$\Delta USDbroad \cdot Trade\ costs$					-2.9846**	
					[1.2638]	
Constant	0.4850	0.8062	0.0097	0.0049*	0.4162	-0.0006
	[1.1194]	[1.4424]	[0.0465]	[0.0028]	[0.5571]	[0.0076]
Time-destination FE	✓	✓	✓	✓		
Time-product FE	✓	✓	✓	✓	✓	
Destination FE					✓	
Firm FE	✓	✓	✓	✓	✓	✓
Time FE						✓
Observations	45,960	35,077	36,669	41,428	44,851	45,010
R-squared	0.309	0.320	0.323	0.314	0.252	0.305

cost components, such as direct and indirect costs associated with differences in languages, currencies as well as cumbersome import or export procedures of manufacturing goods.[11] The estimated coefficient of $\Delta USDbroad \cdot Trade\ Cost$ is negative and statistically significant and the interaction term $\Delta USDbroad \cdot MMF_i$ continue remaining negative and statistically significant, meaning that transport and other trade costs amplify the increased financial costs following dollar appreciation.

Finally, in column 6 we construct a modified version of $FMMF_i$ that considers headquarters of global banks and their subsidiaries as a unique entity. Results show that $\Delta USDbroad * FMMF_i$ is not longer statistically significant. This result suggests that global banks are direct suppliers of dollar trade credit to firms. Taken together, this set of robustness tests confirms that our results are robust to controlling for firm characteristics, trade costs, and industry factors that may affect firms' export performance or account for potential shocks correlated with bank affiliation.

In Table 14 we focus on alternative channels that may account for exchange rate shocks. We start by looking at the change in the effective federal funds rate (ΔUS_rate), which we set equal to the Wu-Xia shadow rate[12] at the zero lower bound. Column 1 shows that $\Delta US\_rate \cdot MMF_i$ is negative and statistically significant, meaning that US monetary policy tightening is associated with tightening of global liquidity conditions that mostly affect dollar-funded firms, with an ultimate negative effect on exports. When we horserace $\Delta US\_rate \cdot MMF_i$ and $\Delta USDbroad \cdot MMF_i$, we observe that both coefficients are statistically insignificant (column 2). This is not surprising given that US monetary policy changes and US dollar exchange rate fluctuations are positively correlated and exchange rates are not exogenous. To partially alleviate this problem, in column 3 we use the component of $\Delta USDbroad$ that is orthogonal unrelated to ΔUS_rate. Here, both coefficients are negative and statistically significant as expected, yet the magnitude of $\Delta USDbroad \cdot MMF_i$ is significantly larger than $\Delta US\_rate \cdot MMF_i$, thus suggesting that the exchange rate channel plays an amplification effect that particularly affects dollar-funded firms.

We then account for global volatility by using the VIX index. $\Delta VIX \cdot FMMF_i$ is either not

[11] For more details, please refer to https://www.unescap.org/resources/escap-world-bank-trade-cost-database

[12] https://sites.google.com/view/jingcynthiawu/shadow-rates

statistically significant (column 4) or it becomes statistically significant when it is horseraced with $\Delta USDbroad{\cdot}MMF_i$ (column 5). An increase in volatility is associated with a worsening of global financial conditions that negatively affects the exports of dollar-funded firms. Regardless, the magnitude of the exchange rate impact is about ten times bigger. In column 6 we use the Baltic dry index (BDI), which is considered a proxy for shipping costs and, more general, global economic conditions. $\Delta USDbroad{\cdot}MMF_i$ remains negative and statistically significant, while $\Delta BDI{\cdot}FMMF_i$ is not. Finally, in column 7 we take into considerations the Mexican economic conditions by using the change in the share price index of Mexico ($\Delta StockMarket$, from the IFS). The resulting interaction term $\Delta StockMarket{\cdot}FMMF_i$ is positive and statistically significant, meaning that an improvement in the Mexican stock market conditions have a positive effect for the firms' financial conditions and, ultimately, their exports. We again observe that the magnitude of the impact deriving from the fluctuations in the dollar is significantly bigger in size. Take together, we interpret these results as evidence of the important role of the US broad dollar index in funding and lending decisions by global banks, with repercussions on firm-level exports.

Table 14: **Exports and US dollar funding-Robustness tests.** This table shows panel regressions with time-product, time-destinations, and firm fixed effects, and where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the US dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. USRate is the change in the effective federal funds rate, lagged by one quarter. VIX is the quarterly change in the CBOE Volatility Index, lagged by one quarter. BDI is the quarterly change in the Baltic Dry Index, lagged by one quarter. StockMarket is the quarterly change in the share price index of Mexico, lagged by one quarter. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta USDbroad \cdot FMMF_i$		-4.7823			-11.6381***	-11.7539***	-9.1065***
		[4.7428]			[3.1341]	[3.9253]	[2.7280]
$\Delta US\_rate \cdot FMMF_i$	-0.5680***	-0.4527	-0.6484***				
	[0.2023]	[0.2963]	[0.2112]				
$\Delta USDbroad\_orth \cdot FMMF_i$			-9.6737**				
			[4.1395]				
$\Delta VIX \cdot FMMF_i$				-0.8244	-1.2249**		
				[0.5325]	[0.5809]		
$\Delta BDI \cdot FMMF_i$						-0.4392	
						[0.2810]	
$\Delta StockMarket \cdot FMMF_i$							0.0745**
							[0.0311]
Constant	0.0016	0.0042**	0.0031**	-0.0023***	0.0055***	0.0073**	0.0013
	[0.0012]	[0.0019]	[0.0014]	[0.0004]	[0.0020]	[0.0032]	[0.0021]
Observations	50,174	50,174	50,174	50,174	50,174	50,174	50,174
R-squared	0.307	0.307	0.307	0.307	0.307	0.307	0.307