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Dollar and Exports*

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Abstract

The strength of the US dollar has attributes of a barometer of dollar credit conditions, whereby a stronger dollar is associated with tighter dollar credit conditions. Using finely disaggregated data on export shipments, we examine how dollar strength impacts exports through the lens of dollar financing availability. We find that exporters who are reliant on dollar-funded bank credit suffer a decline in exports due to increased funding costs. We argue that the US dollar is a global financial factor with real effects on the economy.

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1 Introduction

What happens in financial markets does not always stay in financial markets. Among various indicators of financial conditions, the US dollar exchange rate plays a particularly important role as a barometer of dollar credit conditions, with lending in dollars tending to grow faster when the dollar is weak while growing more slowly or declining when the dollar is strong. Because the US dollar is the dominant global funding currency, its exchange rate fluctuations pose global liquidity risks, as the 2020 economic shock has highlighted.[1]

Using finely disaggregated data on export shipments, we weigh up the impact of dollar strength on the shipments of exporters who have trade financing needs. For international trade, dollar-denominated credit takes a central role. 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.

Global banks play a pivotal role in the supply of trade finance (Niepmann and Schmidt-Eisenlohr, 2017b; Caballero, Candelaria, and Hale, 2018; Claessens and Van Horen, 2020). Amiti and Weinstein (2011) assess the importance of trade finance and find that the health of banks providing finance has a large effect on exports. Exports are more sensitive to financial shocks than domestic sales due to the higher working capital needs for exports arising from longer supply chains and greater delay in receiving payments. Since international trade is invoiced in dollars (on which more below), the trade financing needs translate into the need for dollar credit. Similarly, Niepmann and Schmidt-Eisenlohr (2017a) find that shocks to individual banks can have sizable effects in aggregate trade as well as affecting trade patterns.

In our context, since dollar-denominated credit is sensitive to the dollar exchange rate itself, fluctuations in the exchange rate impacts the operation of credit-intensive supply chains with a

[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-/

knock-on effect on exports. Our focus is on the financial channel of exchange rates, as modeled in Bruno and Shin (2015), where dollar appreciation is associated with increased risk and decreased bank lending activities, with negative effects on the real economy.

To the extent that a stronger dollar may be associated with weaker exports, the financial channel has a similar outward appearance to the important new work on the invoicing channel of trade due to Gopinath and Stein (2017) and Gopinath et al (2019). These papers show that when the US dollar is used as an invoicing currency for trade and the dollar strengthens, the volume of trade between two countries (neither of whom is the United States) may experience a decline because of the competitive implications of dollar invoicing. In both the invoicing and the financial channels, a stronger dollar is associated with weaker trade activity. However, the invoicing channel does not appeal to the cost of financing. In contrast, our story revolves around the role of the dollar for credit supply and hence on the financing of working capital.

On top of the financial channel and the invoicing channel, there is the third (and standard) trade competitiveness channel of the exchange rate, where a depreciation of the domestic currency against trading partners boosts competitiveness and exports. Our finely disaggregated data allows us to disentangle the three channels at work.

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 start our analysis by separating out the above three channels of the dollar exchange rate on export shipments. We use 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 from 2011 to the first quarter of 2017. The bilateral trade information allows us to control for demand factors in the destination country.

When we compare the invoicing and financial channels in the full sample, we find evidence that both are at play. However, for exporters who are reliant on dollar bank credit, the financial channel is dominant. Meanwhile, the trade competitiveness channel shows up weakly at best.

We can gain further insights into the financial channel by employing 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).

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 to 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 is not just a crisis-related story, where a crisis-induced credit crunch suppresses trade volumes, as in Amiti and Weinstein (2011). Instead, the claim is that it is a channel that operates all the time, where fluctuations in dollar financing costs feed into working capital costs and thereby affect the operation of supply chains.

Finally, we circle back and directly identify credit supply fluctuations linked to dollar appreciation by exploiting the cross-sectional variation in banks' dollar funding structure. Through this route, 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.

Our contribution is to identify the financial channel of the dollar exchange rate through which dollar fluctuations affect global financial conditions and bank credit supply also outside crisis times, with knock-on effects on exports and the real economy. In this respect, our paper fits with the narrative emerging from an active literature on the US dollar as a global factor in economic activity (e.g., Bruno and Shin, 2015; Rey, 2015; Gourinchas, 2019; Lilley, Maggiori, Neiman, and Schreger, 2019; Avdjiev, Bruno, Koch and Shin, 2019), 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 (2018), 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. 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. 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 (2020) 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 (2018), 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. In line with this, Gofman (2013) uses information on suppliers and customers for more than 2,735 US firms 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.

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 2007 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 Main hypothesis

2.1 Motivation

A useful summary measure of the importance of supply chain activity in global goods trade is the ratio of world goods exports to world GDP. 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, left-hand panel plots the ratio of world goods exports to world GDP over the past twenty years or so. We see the strong growth in exports before the financial crisis, the deep decline in exports during the crisis and the equally sharp rebound in its aftermath. Thereafter, global trade has been on a gentle declining trend relative to GDP.

More notably for our paper, we see that trade has been negatively correlated with the strength of the dollar, as given by the broad dollar index.

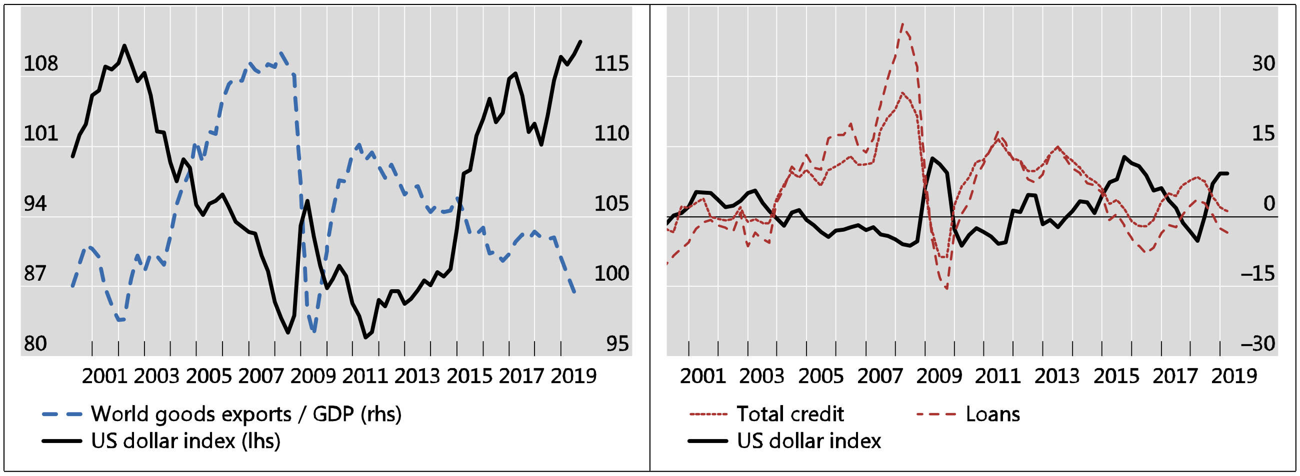

Figure 1: **Exports and US dollar credit.** The left panel shows the ratio of world merchandise exports to world output (right axis) and a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners, based only on trade in goods (left axis). Data are normalized as of Q1 2000. The right 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. Source: BIS

The right-hand panel of Figure 1 shows that the dollar exchange rate is also correlated with the growth of dollar-denominated credit. The panel shows the four-quarter growth rates of bank lending in dollars to emerging market borrowers, as well as the four-quarter growth rate of total credit activity. The negative correlation between dollar credit growth and the dollar exchange rate is notable. When the dollar is strong, lending in dollars slows.

The two panels of Figure 1 provide motivation from aggregate variables for our main hypothesis - namely that tighter dollar credit conditions go hand in hand with more subdued supply chain activity. The hypothesis is that these considerations are reflected in gross export volumes at the firm level.

A large portion of cross-border bank credit to emerging economies is in the form of short-term bank-intermediated trade finance. A key condition for the ability of many banks to provide trade finance is their access to US dollar funding.

Figure 2 plots lending conditions for trade finance as captured by the IIF emerging markets bank lending conditions index, together with the US broad dollar index. We observe the negative

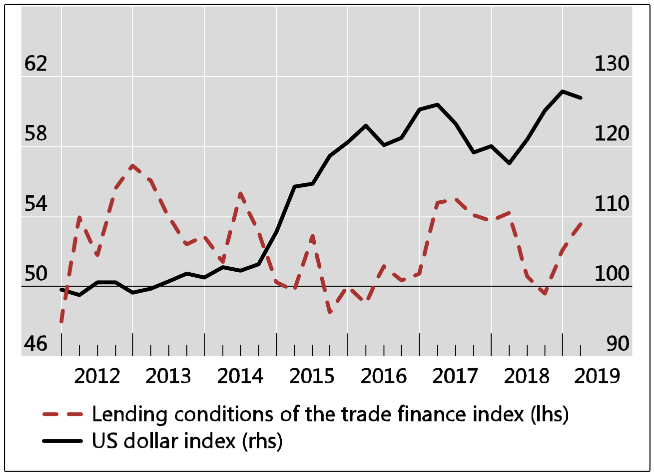

Figure 2: **Trade finance conditions and the US broad dollar index.** This figure shows the IIF Emerging Markets Bank Lending Conditions Index (left axis) related to the question "Over the past three months, how has your willingness to supply international trade finance changed" and the US broad dollar index (right axis). Sources: Institute of International Finance, Federal Reserve.

correlation between US dollar appreciation and deteriorating conditions for trade financing, especially after 2014.

2.2 Example

To fix intuition, we illustrate the tradeoffs arising from offshoring using a simple example. Consider a good produced with two rounds of value-added without offshoring. This case is depicted by the left-hand diagram in Figure 3. 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 $r > 0$.

		Stages	
		1	2
Date t	1	w	
	2	w	w
	3	w	w
	$\vdots$	$\vdots$	$\vdots$

		Stages		
		1	2	3
Date t	1	c		
	2	c	0	
	3	c	0	w
	4	c	0	w
	$\vdots$	$\vdots$	$\vdots$	$\vdots$

Figure 3: **Costs of two-step production with and without offshoring.** A good is produced with two rounds of value-added. The left-hand diagram depicts production without offshoring. The right-hand diagram depicts the case when there is offshoring of the first stage of production. Without offshoring, each production stage takes one period and incurs cost of w. By offshoring the first stage, the firm reduces the first-stage cost to c but lengthens the time to produce the final good to three periods due to the transport stage.

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

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

consisting of sales revenue p, per-period production cost $2w$ and the interest expense on the debt incurred during the initial phase of production.

Now, suppose that the firm can offshore the first stage of production abroad. The right-hand diagram of Figure 3 depicts production with offshoring.

By offshoring the first step of production, the firm saves on the cost of the first step of production, but has to lengthen the total production time to three periods to take account of the time taken to transport the intermediate good between the two steps of production. The cost of the first step of production with offshoring (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

$$p - (c+w) - r\left((c+w)(1+r) + c(1+r)^2 + c(1+r)^3\right) \tag{2}$$

consisting of sale revenue p, production cost $c + w$ and interest expense on the debt incurred during the initial phase of production. By offshoring the first step of production, 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 with offshoring when (2) is larger than (1), or equivalently, when

$$1 - \frac{c}{w} > \frac{r\left(1+r\right)^3}{1 + r\left(1+r\right) + r\left(1+r\right)^2 + r\left(1+r\right)^3} \tag{3}$$

The left-hand side of (3) is the cost reduction on the first step of production from w to c due to offshoring. The right-hand side captures the effect of the additional financing costs stemming from the greater working capital needs from offshoring.

The right hand side of (3) is increasing in the interest rate r. The firm can increase steady state profit through offshoring when the financing cost of offshoring is sufficiently small. However, higher r entails a higher hurdle for the cost reduction for offshoring to be superior to no offshoring. Bruno, Kim and Shin (2018) show that this intuition can be generalized in an analysis of working capital for a general n-stage production chain.

2.3 Empirical hypothesis

To the extent that financing costs matter for working capital, the supply of dollar credit plays a crucial role. 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 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 leverage. In this way, a broad depreciation of the dollar is associated with greater risk-taking by banks.

In this paper we explore the effect on real economic activity that derives from the financial channel. When the dollar appreciates, banks reduce leverage and credit supply. One immediate consequence is that firms that borrowed from US dollar funded banks will suffer a greater decline in credit following the dollar strengthening. Ultimately, this will affect real activity through increased cost of working capital and the curtailing of global value chains activity.

It is worth reiterating that our channel is not simply a crisis-related story. It is a channel that operates all the time through fluctuations in financing costs that enter the decisions of firms that can adjust the length of their supply chains. Firms involved in global value chains are like jugglers with many balls in the air at the same time. Building and sustaining GVCs require finance-intense activities, thereby acting as the "glue" that binds the components of global value chains. When the shadow price of credit rises with a stronger dollar, some GVCs will no longer be viable economically, with negative consequences for exports. Hence, tighter financial conditions make longer supply chains less attractive. Conversely, looser financial conditions are more conducive to longer supply chains. The hypothesis is that these decisions on supply chain length are reflected in real activity, including gross export volumes.

3 Exchange rates and exports: three channels

We are accustomed to drawing an automatic link between exchange rates and export performance through the trade competitiveness channel of exchange rates, as done in the Mundell-Fleming model. According to the competitiveness channel, exports rise when the domestic currency depreciates. The relevant exchange rate is the trade-weighted exchange rate.

The recent influential work by Gopinath et al (2019) has drawn attention to the prevalence of dollar invoicing ("Dominant Currency Paradigm" or DCP). When exports are invoiced in dollars, fluctuations of the dollar exchange rate against the currency of the destination country affects exports. 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. For the DCP, the relevant exchange rate is the bilateral dollar exchange rate against the destination country. The DCP does not appeal to the cost of financing in dollars.

Our focus is on the financial channel of exchange rates, as modeled in Bruno and Shin

(2015), where the broad US dollar index plays the central role in the mechanism. Here, dollar appreciation is associated with increased risk exposure of a globally diversified bank, which reacts by cutting back credit supply. When applied to our specific context, bank credit supply fluctuations affect working capital costs and the operation of supply chains, with knock-on effects on exports.

Given the detailed micro data at our disposal, we can discriminate between the three channels by comparing the impact on exports of three different measures of the strength of the dollar: the trade-weighted exchange rate (for the competitiveness channel), the bilateral dollar exchange rate with the export destination country (for the invoicing channel), and the broad dollar index (for the financial channel).

3.1 Firm-level export 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. Our sample covers data from 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.[2] 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

[2] 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.

in quarter t. This gives us about 166,000 quarterly observations over the period from q1 2011 to q1 2017.

3.2 Empirical design

Our finely disaggregated data allow us to examine the variation in exports within product-destination categories, and thereby discriminate the effect of the three measures of dollar strength. In particular, we estimate:

$$\Delta X_{ipdt} = \beta \cdot \Delta ER_{t-1} + \varphi_{ipd} + \varepsilon_{ipdt} \tag{4}$$

where ΔX_{ipdt} is the quarterly log difference of the volume of exports, ΔER_{t-1} is the log difference of the relevant exchange rate according to the three channels mentioned above, and φ_{ipd} are firm-product-destination fixed effects, respectively. Standard errors are corrected for clustering at the firm-time level. Regressions are produced in STATA using *reghdfe* as described in Correia (2017).[3]

3.3 Financial channel versus invoicing channel

Table 1 reports panel regression results on the change in export volumes ΔX_{ipdt} in response to changes in the broad dollar index ($\Delta\, USDbroad$) and to the bilateral dollar exchange rate against the destination currency ($\Delta\, USD\_destination$). Column 1 of Table 1 shows that the coefficient of $\Delta\, USDbroad$ is negative and statistically significant, consistently with the financial channel. When the US dollar appreciates by 1%, exports on average decline by 2%. So, as a rule of thumb, the elasticity of export decline to dollar appreciation is around 2.

A key result is in column 2, which includes exports to the United States only. This subsample provides an important benchmark, as it allows us to control for the invoicing channel. Since the

[3] Reghdfe is a STATA package that runs linear regressions with many levels of fixed effects and takes into account nesting of fixed effects within clusters, as well as sources of collinearity within fixed effects, by iterated elimination of singleton groups. For these reasons, in the presence of many levels of fixed effects it is preferred to the STATA functions areg or xtreg.

US dollar is the currency of the destination country (as well as being the invoicing currency), we can eliminate the invoicing channel from consideration. Nevertheless, the estimated coefficient on $\Delta USDbroad$ is negative and highly significant, suggesting that the financial channel is alive and well. This provides the first glimpse of 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 $\Delta USD\_destination$ is negative and statistically significant, meaning that a dollar appreciation against the destination country currency leads to a decline in exports, providing support for the DCP of Gopinath et al (2019). Thus, as well as the financial channel, we also find support for the dollar invoicing channel.

In column 4, we horserace the financial channel and the invoicing channel by including both the broad US dollar index and the bilateral dollar exchange rate against the destination country. We obtain significant coefficients on both, suggesting that both mechanisms are at work. However, the coefficient on $\Delta USDbroad$ is nearly twice that of $\Delta USD\_destination$ and with a higher t statistic, so that the broad dollar index retains a considerable punch even taking account of the invoicing channel. We obtain similar evidence after excluding the United States as the exports destination country (column 5), when we replace $\Delta USD\_destination$ with the component of $\Delta USD\_destination$ that is orthogonal unrelated to $\Delta USDbroad$ (column 6), and when we exclude the Euro-area as the region with the largest percentages of non-US dollar invoicing (not reported).

3.4 Financial channel versus trade competitiveness channel

In this section we compare the financial channel with the trade competitiveness channel for a selection of countries. We start by looking at the United States as the exports destination country. Because the bilateral Mexican pesos-US dollar is highly correlated with the US broad dollar (correlation of the percentage changes is nearly 0.8), we use the component of the bilateral pesos-dollar exchange rate that is orthogonal to $\Delta USDbroad$. Column 1 of Table 2 shows that the coefficient of the bilateral pesos-dollar exchange rate is statistically insignificant. This finding

Table 1: **Financial channel versus invoicing channel.** This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations. The estimation period ranges from q1 2011 to 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. Standard errors are clustered 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)
Destination sample	All	USA	All	All	USA excl.	USA excl.
Δ *USDbroad*	-2.0797***	-1.4940***		-1.7030***	-1.8663***	-2.2127**
	[0.3935]	[0.4712]		[0.3862]	[0.5962]	[0.5494]
Δ *USD_ destination*			-1.3491***	-0.9371***	-0.8983***	
			[0.2892]	[0.2801]	[0.2983]	
Δ *USD_ destination orth*						-1.3486**
						[0.5935]
Constant	0.0429***	0.0396***	0.0284***	0.0443***	0.0471***	0.043***
	[0.0100]	[0.0127]	[0.0092]	[0.0100]	[0.0129]	[0.0131]
Firm-product-destination FE	✓		✓	✓	✓	✓
Firm-product FE		✓				
Observations	196,543	74,826	195,697	195,697	120,871	117,146
R-squared	0.074	0.068	0.074	0.074	0.079	0.079

adds further support to the DCP.

In column 2, we see that $\Delta USDbroad$ is negative and statistically significant as previously shown in column 2 of Table 1. Taken together, there is little evidence for the trade competitiveness channel (whereby peso depreciation boosts exports to the United States). Instead, both the DCP and the financial channels feature strongly.

Similar results hold for the euro area countries. Column 3 shows that the bilateral peso-euro exchange rate is not statistically significant. Column 4 horseraces both the bilateral and the US broad dollar exchange rate, and shows that $\Delta USDbroad$ is again negative and statistically significant, meaning that the US broad dollar index is at play also in the case of exports to the euro area. Finally, column 5 looks at the case of Canada. The bilateral pesos-Canadian dollar exchange rate is statistically insignificant, while the US broad dollar is negative and significant.

Overall, these results provide strong confirmation that the broad US dollar exchange rate best captures the financial impact of the exchange rate on global banks with a diversified global portfolio of dollar loans, and it is the relevant exchange rate for the risk-taking channel in force. These results also allow us to reconcile our main findings with the DCP, as our evidence supports the combination of the DCP and financial channels over the trade competitiveness channel.

Table 2: **Financial channel versus trade channel.** This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within product-destination categories. The estimation period is from q1 2011 to q1 2017. USDbroad is the quarterly change in the US dollar broad index. Bilateral is the bilateral Mexican pesos-US dollar exchange rate that is orthogonal to USDbroad (columns 1 and 2), or the bilateral Mexican pesos-Euro exchange rate (columns 3, 4), or the bilateral Mexican pesos-Canadian dollar exchange rate (column 5). Standard errors are clustered 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)
Destination Sample	USA	USA	EU	EU	Canada
Bilateral	MX-USD orthog	MX-USD orthog	MX-Eur	MX-Eur	MX-CAD
$\Delta\, USDbroad$		-1.5372***		-4.0668***	-3.2823***
		[0.4729]		[1.0463]	[1.1270]
$\Delta\, Bilateral$	-0.4415	-0.5210	-0.2126	0.1047	-0.2121
	[0.4182]	[0.4179]	[0.6329]	[0.6296]	[0.5879]
Constant	0.0232**	0.0401***	0.0261	0.0666**	0.0528
	[0.0118]	[0.0127]	[0.0244]	[0.0261]	[0.0341]
Firm-product-destination FE			✓	✓	
Firm-product FE	✓	✓			✓
Observations	74,900	74,900	13,347	13,347	7,893
R-squared	0.067	0.067	0.079	0.083	0.064

4 Financial channel and exports

In this section we dig deeper into how firms' dependence on dollar credit affects the sensitivity of exports to dollar fluctuations. Figure 4 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 4, we delve into a more detailed investigation of the relationship between dollar credit and export performance.

4.1 A first look at the Post Taper-Tantrum evidence

The first two columns of Table 3 examine export growth around the threshold of the 2013 Taper Tantrum event, after which the dollar strengthened substantially. The dummy variable $PostTT$ is equal to 1 for the period after the Taper Tantrum (3rd quarter in 2013) and 0 during the preceding quarters. We use $PostTT$ in specification (4) in lieu of the exchange rate variable. The sample consists of all 368 firms for which we match data with Panjiva.

Column 1 of Table 3 shows that the estimated coefficient of $PostTT$ is -0.09 and statistically significant, highlighting the decline in exports after 2013. Column 2 restricts the sample to a two years window around the Taper Tantrum, and picks up the Taper Tantrum as the watershed.

The key findings are in columns 3 to 6, using the matched sample of firms for which we could obtain pre Taper-Tantrum capital structure and funding information (more information and statistics on this matched sample in the subsequent section). The sample period is from q3 2013 to q1 2017.

In column 3 we test specification (4) and use the broad dollar index as the reference exchange rate. The coefficient estimate of $\Delta USDbroad$ is negative and significant, confirming the evidence of a financial channel at play as we saw in Table 1.

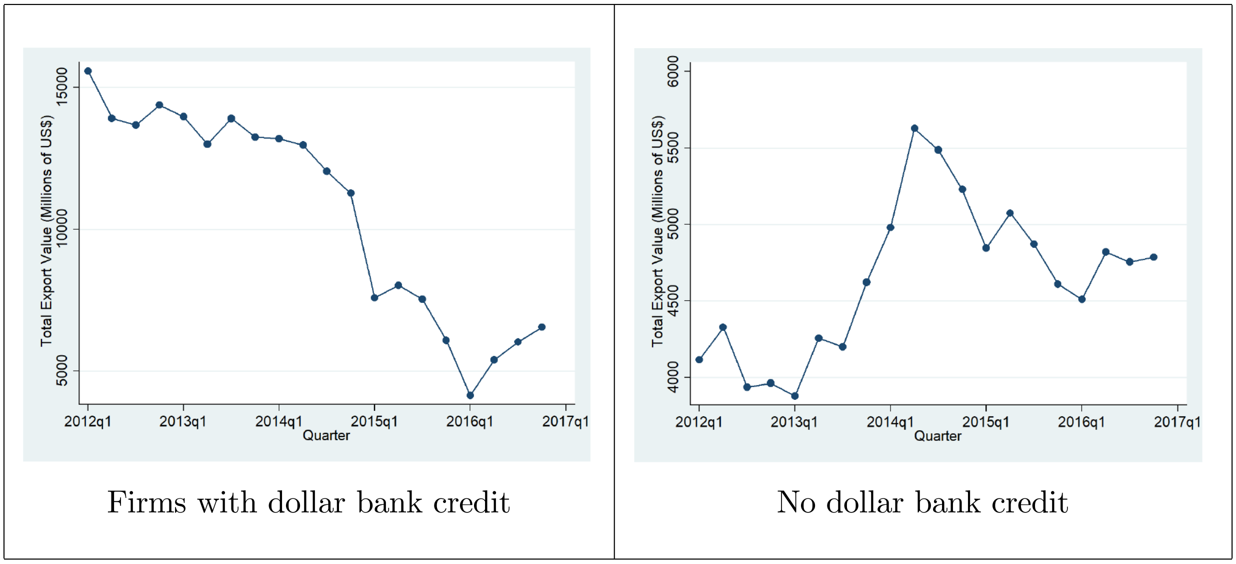

Figure 4: **Exports and Dollar Bank Credit.** This figure plots the variation in the total value of exports from 2012 to 2016 for the subsample of firms with (left-hand panel) and without dollar bank credit (right-hand panel). Sources: Panjiva, Capital IQ

Notably, we focus on the subsample of firms with credit from dollar-funded banks. When we use the bilateral destination dollar exchange rate as the reference exchange rates, the estimated coefficient of $\Delta USD\_destination$ is negative and statistically significant, supporting the DCP and the evidence in Table 1.

However, when we include the broad dollar index in the same specification, column 5 of Table 3 shows that, for the sample of firms with credit from dollar-funded banks, the coefficient on $\Delta USDbroad$ is negative and knocks out the statistical significance of $\Delta USD\_destination$, in contrast to Table 1. This result continues to hold when we replace $\Delta USD\_destination$ with the component of $\Delta USD\_destination$ that is orthogonal unrelated to $\Delta USDbroad$ (column 6).

The economic magnitude of the results is important, given that the elasticity of exports decline to broad dollar appreciation is around 2.5. In untabulated results, we verify that our results are not driven by outliers by excluding the 5% or the 10% percentile of the sample. The statistical significance of the broad dollar index is maintained at the 1% and the elasticity of exports to dollar appreciation gradually declines from 1.7 to around 1.1, respectively.

Table 3: **Growth in Exports after the Taper-Tantrum event.** This table shows panel regressions with firm-product-destination fixed effects where the dependent variable is the quarterly change in firms' export volumes within products-destinations. In column 1, PostTT is a dummy variable that is equal to 1 from Q3 2013 to Q1 2017 and 0 from Q1 2011 to Q2 2013. In column 2, PostTT is a dummy variable that is equal to 1 from Q3 2013 to Q2 2014 and 0 from Q3 2012 to Q2 2013. Columns 3 to 6 report results for the post Taper Tantrum period. 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. Standard errors are clustered 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)
Period	q1 2011-q1 2017	q3 2012-q2 2014		q3 2013-q1 2017		
PostTT	-0.0903***	-0.0803***				
	[0.0184]	[0.0270]				
$\Delta\, USDbroad$			-2.8122***		-2.4855***	-2.6390***
			[0.8005]		[0.9043]	[0.8648]
$\Delta\, USD\_\ destination$				-1.0243**	-0.5025	
				[0.4455]	[0.4436]	
$\Delta\, USD\_\ destination\ orth$						-0.5568
						[0.4365]
Constant	0.0784***	0.0823***	0.0403*	0.0041	0.0368	0.0305
	[0.0142]	[0.0167]	[0.0217]	[0.0198]	[0.0242]	[0.235]
Sample	All	All	Matched sample	Dollar funded	Dollar funded	Dollar funded
Observations	196,543	64,693	59,817	49,323	49,323	47,555
R-squared	0.074	0.113	0.074	0.076	0.077	0.076

Taken together, these results suggest that the impact of the financial channel appears to outweigh that of DCP for those firms that are exposed to dollar-funded bank credit, underlining the importance of the broad dollar index as a barometer of working capital costs of firms with dollar credit from banks.

Figure 5 plots the local polynomial smooth chart corresponding to the column 6 results. The vertical axis measures the quarterly growth in exports ΔX_{ipdt}, while the horizontal axis plots the quarterly change in the broad dollar index $\Delta\, USDbroad$ (left-hand panel) or the component of $\Delta\, USD\_\ destination$ that is orthogonal unrelated to $\Delta\, USDbroad$. It shows that export growth

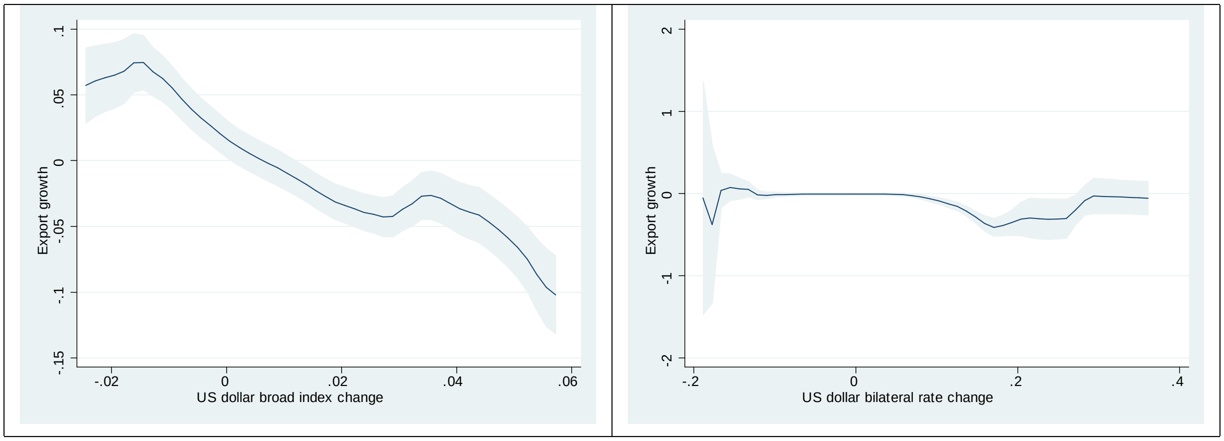

Figure 5: **Export growth of dollar funded firms.** This figure shows the Kernel-weighted local polynomial smooth plot of the growth in export volumes versus the change in the broad US dollar index (left-hand panel) and the component if the bilateral dollar exchange rate against the destination currency that is orthogonal unrelated to the broad US dollar index (right-hand panel), with local mean smoothing and 90 percent confidence intervals. The period runs from q3 2013 to q1 2017 and the sample of firms is restricted to those with credit from dollar funded banks.

is negatively related to the broad dollar index, while the association is weaker for the bilateral destination dollar exchange rate. Note that this evidence is consistent with the DCP for the average firm, but it is suggestive evidence of the large economic impact on dollar-funded firms through the financial channel.

4.2 Empirical design and capital structure data

We want to identify the impact of the financial channel on exports. Our assumption is that, because banks reduce lending when the dollar appreciates and risk increases, firms more dependent on dollar-funded credit will suffer increasing working capital costs, with knock-out effects on exports. Here, 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 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 match borrowing firms and lending banks at the individual loan level. In this way we can capture which banks, and ultimately which firms, are more exposed to the fluctuations in the US dollar in terms of short-term dollar funding and credit availability. Specifically, we hand collect detailed information of the firms' debt structure from Capital IQ (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.[4] Table 4 reports summary statistics on firm-level exports, destinations and products for this matched sample.

[4] As a comparison, Capital IQ lists a total of 70 active public non-financial companies with available financial data as of 2013.

Table 4: **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

A bank's exposure to US dollar funding through its liabilities to US money market funds 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 funding from MMFs in the form of repurchase agreements (repos), commercial paper, certificate of deposits and asset-backed commercial paper.[5]

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, especially to their European parents. This patterns sharply reverted after 2011. As in Correa et al (2016), we look at branch-level data from the FFIEC 002 reports. We indeed find that after 2011, US-based branches has become mostly borrowers, so US branches has diminished their supply of dollar funding. The dollar amount of such branch-level dollar funding is minimal as compared to US MMFs, and does not significantly change our estimation results.

Another issue may concern the US Money Market reform that was implemented on October 14, 2016. Anderson, Du and Schlusche (2019) find that most of the changes in the US MMF holdings occurred one year prior to the implementation deadline, reflecting the fact that MMFs cannot hold securities with remaining maturities longer than one year. Several tests will account for this concern.

[5] Please refer to Aldasoro, Ehlers, and Eren (2018) for details.

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:

$$FMMF_i = \sum_b \omega_{ib} MMF_b, \tag{5}$$

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 find 22 dollar-funded global banks that lend to Mexican firms. Ideally, to capture the magnitude of banks and firms exposures to US dollar funding we would need data on the banks' total short-term dollar funding and also distinguish between insured and uninsured dollar funding. Our ratio of MMFs therefore understates the size of total dollar funding. Yet, Table 11 (presented in the Appendix) shows substantial numbers for importance of MMF funding for global banks. For non-US banks, the ratio of MMF funding to short-term debt can be as high as 69%. For US banks it can be as high as 25%. The median bank relies on MMFs for about 10% of its total short term debt.

We estimate the effect on exports of firms that are exposed to dollar funding and due to exchange rate fluctuations as:

$$\Delta X_{ipdt} = \beta \cdot \Delta USDbroad_{t-1} \cdot FMMF_i + \varphi_{tp} + \upsilon_{td} + \psi_i + \varepsilon_{ipdt} \tag{6}$$

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 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. All regressions are produced in STATA using *reghdfe* as described in Correia (2017). 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.

4.3 Cross-section evidence across exporting firms

Column 1 of Table 5 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

Table 5: **Growth in exports, US dollar and exposure to 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

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.

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 (2019) 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.

4.4 Exports and supply chains

The preceding evidence shows that firms that are financed by banks exposed to US dollar funding suffer a drop in credit supply following the dollar appreciation, which negatively impacts their exports. We now test if exports of firms with higher working capital needs are affected more by the fluctuations in the dollar and credit availability. In the example illustrating the financing cost for working capital (Section 2.2), higher financing costs lead to a shorter production and to a decline in gross exports. Overall, tighter financing conditions curtail GVCs activities.

We classify each product at the 8 digit HS code as capital, intermediate, or consumption goods as defined by the US International trade statistics[6]. We then split the sample between intermediate versus non-intermediate goods, (columns 1 and 2 of Table 6, respectively) in a panel analysis (specification 6) 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,

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

product fixed effects, but we cannot use product-time fixed effects or else the interaction term would drop due to singletons. Results shows that the estimated coefficient of the interaction $\Delta\, USDbroad{*}FMMF_i$ is negative and statistically significant only for the subsample of intermediate products (column 1) and consistently with the hypothesis that intermediate goods have higher financing needs than final goods as in the example illustrated in Bruno, Kim, and Shin (2018), thus they will be more negatively affected by tighter financial conditions.

In Columns 3 and 4 we perform a symmetric 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 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 $\Delta\, USDbroad{*}Working\ Capital$ 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.

Amiti and Weinstein (2011) find that the health of banks providing finance has a much larger

Table 6: **Growth in exports, US dollar 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. Column 7 presents panel regressions where the dependent variable is the annual change in domestic sales. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample	Intermediate goods	Consumption goods	Dollar funded	Non-dollar funded	All	Dollar funded	Domestic sales
Δ *USDbroad*	-3.8072**	4.7559					3.8986
$*FMMF_i$	[1.6089]	[23.8856]					[2.5513]
Δ *USDbroad*			-2.9328***	0.7154			
$*$*Intermediate*			[0.7578]	[1.7386]			
Δ *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	0.0260***
	[0.0014]	[0.0080]	[0.0078]	[0.0112]	[0.0050]	[0.0083]	[0.0065]
Observations	35,395	18,146	43,706	9,710	49,600	40,387	158
R-squared	0.112	0.158	0.112	0.269	0.308	0.313	0.285

effect on exports than on domestic sales because exporters need more working-capital financing than firms engaged in domestic transactions. In line with their assumption that financial shocks affect exports and domestic sales differentially, we download domestic sales from Capital IQ (Geographic segment module). Such data are available on an annual frequency. We compute the growth in annual sales and regress it on $FMMF_i$ interacted with the annual percentage change of $\Delta USDbroad$, with firm and year fixed effects. Table 6, column 7, shows that the coefficient of $\Delta USDbroad{*}FMMF_i$ is positive but not statistically significant. This is consistent with the evidence in Amiti and Weinstein (2011) that exports are more sensitive to dollar funding shocks than domestic sales.

4.5 Additional robustness tests

In this section we discuss additional robustness tests and alternative channels. Analysis and tables are presented in the Appendix. In Table 12 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 12 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 13 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.

5 Bank credit supply and dollar appreciation

We circle back and we directly 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. Table 7 gives us a snapshot of the amount of bank credit to the 57 publicly-listed firms in our sample for which we could find capital structure details. In 2012, global banks provided about half of the total credit to our sample of firms, but significantly decreased their ratio of credit to 30% by the year 2016. This decline in credit supply by global banks followed a worldwide trend.[7]

Banco Santander, HSBC, and Credit Agricole are the top three global 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 Mexican banks that supply credit (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. Santander has the lowest reliance on US MMFs, only 0.1% of its short-term debt is financed through US money market funds (see Table 11 in the Appendix).

Subsidiaries of global banks should be considered as local banks because their funding structure is typically deposits-based. However, we also run robustness tests that consider possible internal capital markets between parent banks and their affiliates.

We want to identify credit supply fluctuations following dollar appreciation. Our assumption

[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 7: **Total credit descriptive statistics.** The first row 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 row presents the total amount of bank credit provided by global banks.

Year	Total credit (MXN billions)	From global banks (MXN billions)
2012	500.7	248.9
2013	501.3	225.8
2014	477.3	175.4
2015	426.3	164.7
2016	460.5	144.6

is that banks more exposed to wholesale US dollar funding reduce credit more compared to banks that are less dependent on 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 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 focus is on the cross-sectional variation in funding sources as the key element in our identification exercise.

Specifically, we use the following panel specification to capture the change in credit supply after the year 2013 as a function of the pre-event bank-level dependence on dollar funding:

$$\Delta C_{ibt} = MMF_b + \psi_i + \tau_t + \varepsilon_{ibt} \tag{7}$$

where ΔC_{ibt} is the annual 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. 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.

Figure 6 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

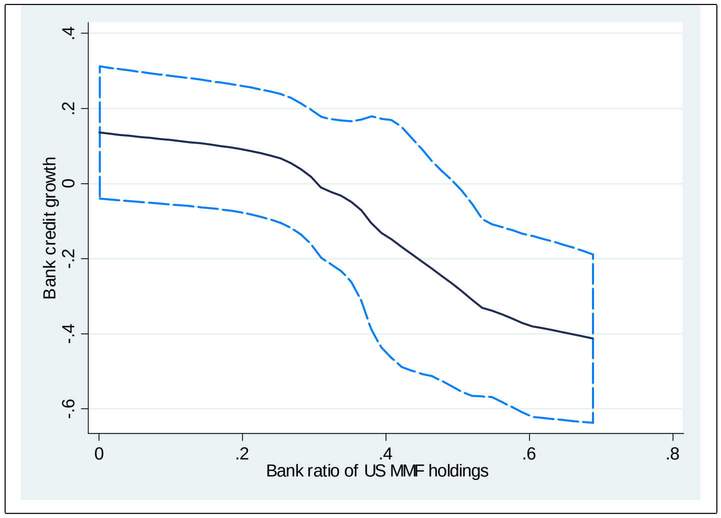

Figure 6: **Credit supply and bank dollar funding.** This figure shows the Kernel-weighted local polynomial smooth plot of the growth in bank credit to firms versus non-US banks' exposure to US dollar funding, with local mean smoothing and 90 percent confidence intervals and for the period from 2013 to 2016. Sources: Crane, Capital IQ, authors' computations.

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 each firm i in our sample. The cross-section evidence across banks suggests that credit growth during our sample period is strongly (negatively) correlated with reliance on MMF funding.

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

$$\Delta C_{ibt} = MMF_b \cdot \Delta USDbroad_t + \psi_i + \tau_t + \lambda_b + \varepsilon_{ibt} \tag{8}$$

where $\Delta USDbroad_t$ is the log difference 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.

5.1 Results

Table 8 shows estimation results from the change in credit supply after 2013 as a function of the bank dependence on dollar funding. We start by regressing the change in bank credit from bank b to firm i from 2013 to 2014 over MMF_b. 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 augment the sample to include the non dollar-funded banks and construct the dummy variable *Global* that is equal to 1 for the sample of dollar funded banks and 0 for the sample of non-dollar funded banks. The coefficient estimate of *Global* is not statistically significant, meaning that, on average, dollar and non-dollar funded banks behave similarly after the Taper Tantrum.

However, when we take into account the level of exposure to dollar funding we observe differences in credit supply within global banks. The interaction term $\mathrm{MMF}_b \cdot Global$ is negative and statistically significant (column 3), indicating that more dollar-funded banks reduce credit more than less or no dollar funded banks. Taken together, these results suggest that the drop in credit after 2013 is not due to a generalized decline in credit supply by global banks or in dollar credit demand. Instead, following the Taper Tantrum, banks that have previously funded loans by tapping the US money market fund reduce their lending to firms.

We then extend the sample period until the year 2016 and run a similar panel regression with time fixed effects. Column 4 reports results for the sample of non-US global banks. The coefficient estimate of MMF_b is negative and significant, 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%.

Interestingly, we observe similar findings when including US global banks (column 5), suggesting that US banks are also subject to similar incentives to adjust credit supply as are non-US banks. This is in line with the evidence found in Niepmann and Schmidt-Eisenlohr (2019) who

Table 8: **Bank credit and dollar funding.** 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 2014 (columns 1 to 3) or the period 2013-2016 (columns 4 to 6). 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. 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)
Period	2013-14	2013-14	2013-14	2013-16	2013-16	2013-16
Sample	Global banks	All banks	All banks	Global banks	Global banks	All banks
MMF_b	-2.1255***			-2.2291***	-2.1972***	-0.9218**
	[0.6192]			[0.5759]	[0.6684]	[0.4069]
$Global$		-0.0617	0.1429			
		[0.1600]	[0.1909]			
$MMF_b \cdot Global$			-1.3554**			
			[0.6105]			
Constant	0.5471***	0.2870***	0.2878***	-0.0109	0.1819	-0.2014**
	[0.1482]	[0.0894]	[0.0896]	[0.1259]	[0.1925]	[0.0887]
# banks	27	121	121	22	28	134
Observations	123	355	355	212	300	891
R-squared	0.410	0.136	0.144	0.292	0.265	0.123
US banks	✓	✓	✓		✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
Time FE				✓	✓	✓

find that and appreciation of the US dollar is associated with a reduction in the supply of commercial and industrial loans by US banks. In terms of economic magnitude, the median global bank with 10% of its short term debt funded by US money market funds reduces credit by about 20% over the sample period.

Finally, in column 6 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. Taken together, these results suggest that global banks that were more reliant on US dollar funding reduced credit supply to firms in the post Taper Tantrum period characterized by dollar appreciation and capital outflows. The decline in credit was also in force for US global banks, suggesting that also US banks are subject to similar balance sheet adjustments as non-US banks.

In Table 9 we explore the role of the exchange rate. In column 1 we start by adding the percentage change in the broad dollar index $\Delta USDbroad$ interacted with MMF_b (specification (8) without time fixed effects), for the sample of global 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. When we add bank and time fixed effects (column 2), we obtain stronger estimates that are statistically significant at the 1% level. 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.[8]

In column 3, we augment the sample by including all non-global banks in a specification with firm-level variables (log of assets, ROA, working capital to total assets, cash to total assets, and industry fixed effects, estimated coefficients not reported) that explicitly control for firm specific characteristics potentially correlated with credit supply. The coefficient estimate of

[8]Morais et al (2019) find that during the period from 2001 to 2015 a foreign policy rate shock affects the supply of credit to Mexican firms mainly via their respective foreign banks in Mexico. In untabulated results, we replicate column 2 specification after including subsidiaries of global banks (e.g., Banamex) into the sample and linking them to the dollar funding exposure of their headquarter bank (e.g., Citigroup). Results remain significant at the 1% and the coefficient estimate is slightly lower (-38 vs. -44), suggesting that regional subsidiaries of global banks do not amplify the effect coming from the exchange rate but mostly operate as domestic-funded banks.

Table 9: **Bank credit, dollar funding, and exchange rate.** 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. USDbroad is the percentage change in the broad US dollar index. Liquidity ratio is the ratio of deposits to total assets as of 2012. Capital ratio is the ratio of total capital to risk-adjusted assets as of 2012. 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)
Dep. variable	ΔC_{ibt}	ΔC_{ibt}	ΔC_{ibt}	ΔC_{ibt}	ΔC_{ibt}	ΔC_{ibt}
Sample	Global	Global	All	All	Global	Global
MMF_b	0.7100					
	[1.0266]					
$\Delta\, USDbroad$	7.4818					
	[5.0571]					
$MMF_b \cdot \Delta\, USDbroad$	-35.3801**	-44.3683***	-39.2631*	-37.2976*		
	[13.1948]	[15.5802]	[22.8845]	[21.9530]		
Liquidity ratio					-1.0677	
					[2.3022]	
Liquidity ratio$\cdot \Delta\, USDbroad$					7.6093	
					[29.8768]	
Capital ratio						-0.0423
						[0.0822]
Capital ratio$\cdot \Delta\, USDbroad$						0.3305
						[0.8167]
Constant	-0.1719	-1.0935***	0.4842	-0.0101	0.3421	0.3446
	[0.3906]	[0.3886]	[4.9303]	[0.1826]	[0.7779]	[0.9638]
# banks	28	28	129	134	27	25
Observations	300	300	799	891	296	242
R-squared	0.254	0.335	0.254	0.320	0.232	0.253
Firm FE	✓	✓	✓		✓	✓
Firm controls			✓			
Time FE		✓	✓		✓	✓
Bank FE		✓	✓	✓		
Firm-Time FE				✓		

$MMF \cdot \Delta USDbroad$ remains negative and statistically significant. Taken together, the results in Tables 8 and 9 show the effect on credit supply from the shifts in financial conditions due to dollar appreciation.

5.2 US Money Market reform and Bartik-style instrument

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 (2019) 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 10, we re-estimate specifications 6 and 8, and exclude the "effective" period of the MMF reform. Columns 1 and 2 show that the results remain qualitatively unchanged.

Furthermore, we construct a Bartik-style shift-share estimator as an alternative estimation specification to using MMF_b, and that takes into account possible shocks at the MMF sector level that may not be correlated with exchange rate fluctuations:

$$B_{b,t} = MMF_b \cdot \Delta MMF_{s,t} \tag{9}$$

where ΔMMF is the yearly change in the total wholesale dollar funding through the US money market funds sector s 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 10, column 3, shows the first stage estimation results of specification 7 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

Table 10: **Bank credit, dollar funding, and exports: Robustness tests.** This table shows panel regressions related to modified specification 6 (column 2 and 4) and specifications 7 (columns 1 and 3). The year before the implementation of the MMF reform is excluded and the sample is restricted to credit supplied by global banks. 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	Exports
			First stage	Second stage
MMF_b	-2.7944***			
	[0.6003]			
$\Delta\, USDbroad{*}FMMF_i$		-6.8768**		
		[3.3695]		
$B_{b,t}$			33.9514***	
			[6.1912]	
$\widehat{C_{i,t}}$				1.1336**
				[0.5315]
Constant	0.3313	0.0102***	0.0834	-0.0528**
	[0.2494]	[0.0026]	[0.2437]	[0.0259]
Observations	218	34,136	218	18,818
R-squared	0.333	0.314	0.313	0.3356

and statistically significant, meaning that an increase in money market funding translates in higher supply of credit. The first stage F-statistics is 18.14, which suggests a fair quality of the instrument. 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, suggesting that higher dollar funded credit is associated with a larger growth in exports.

5.3 Additional robustness tests and alternative channels

Our channel focuses on banks' dollar funding shocks due to exchange rate fluctuations. The within-firm estimator allows us to disentangle credit supply from changes in the demand of credit by comparing the change in the amount of lending by banks with a different exposure to dollar wholesale funding to the same firm. However, 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. In this section we perform tests to account for alternative channels and unobserved factors.

In the first identification test, we test if our estimates are biased due to a firm balance sheet channel at play, i.e., if the exchange rate affects the balance sheet of firms directly and not through bank lending. In column 4 of Table 9 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.

We next consider bank characteristics as a possible driver of credit supply. Columns 5 and 6 of Table 9 show results when the ratio of deposits to assets (Liquidity ratio) or the capital ratio are used in lieu of MMF_b. We see that both coefficients are statistically insignificant, meaning that a higher liquidity or capital ratio is not associated with the credit supplied by global banks in conjunction with dollar exchange rate fluctuations.

We also 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. Analysis and tables for these robustness exercises are presented in the Appendix.

In Table 14 presented in the Appendix, 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. The interaction terms of MMF_b with such variables are statistically insignificant, meaning that these factors are not statistically significant determinants of credit supply by global banks to Mexican firms.

We also use the percentage change of the bilateral exchange rate Mexican pesos to US dollar in lieu of the broad dollar index. Its statistical insignificance confirms that the broad dollar index is the relevant exchange rate because it captures the fluctuations in the diversified loan portfolio of global banks.

Finally, we look at the VIX index and the term spread as possible indicators of global risk aversion. Also in these cases the interaction terms with MMF_b are statistically insignificant. Taken together, we interpret our results as suggestive evidence that the broad dollar index is the global factor affecting credit supply decisions by global banks.

In Table 15 presented in the Appendix 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 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.

Consequently, we split the sample of firms between the lower and upper centile of the currency mismatch ratio, computed as the ratio bank credit denominated in Mexican pesos over total credit as of 2012. Results show that the coefficient of the interaction term $MMF \cdot \Delta USDbroad$ is not statistically significant for the sample of firms with a high percentage of bank credit denominated in pesos. In contrast, the interaction term is negative and statistically significant for the sample of firms with a low ratio of bank credit denominated in pesos, meaning that firms with a higher currency mismatch of their liabilities suffer of a higher drop in credit supply. This identification test also controls for time-varying firm heterogeneity through firm-time fixed effects. In this way, we are less concerned of biases due to firms with higher currency mismatch borrowing more from banks with more dollar wholesale funding.

Additional tests confirm that our results survive when firms in the oil and energy sectors are excluded from the benchmark specification, and also when we include year-industry fixed effects that account for time-varying industry shocks. We also investigate if non-global banks substitute global banks' credit when firms exposed to dollar funded banks suffer a drop in credit supply. We find that non-global banks do not substitute for the decline in credit supply by 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.[9]

6 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. Finance does not seem to have a role in it, but, in practice, merchandise trade is heavily dependent on bank finance.

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. (2019) who show that a 1% appreciation of the dollar leads to a 0.6% 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. Our explanation is centered on the financial conditions that eventually affect the real side of the economy. Firms involved in global value chains are like jugglers with many balls in the air at the same time. Building and sustaining GVCs require finance-intense activities, thereby acting as the "glue" that binds the components of global value chains. When the shadow price of credit rises with a stronger dollar, some GVCs will no longer be viable economically, with negative consequences for exports.

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 results. Each individual firm is small relative to the economy as a whole.

[9] 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 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.

Hence, from the point of view of an individual exporting firm, the shift in the exchange rate may be seen an exogenous shock. To the extent that the supply of dollar credit co-moves with the dollar index, our micro analysis provides a window on the international risk-taking channel of bank credit supply.

Horseracing tests and robustness analysis show that our results are robust to other possible confounding domestic or global conditions. While domestic and foreign monetary policy may still matter, during the restricted period of our study (2013-2016) much of the action is on the front of exchange rates. The US interest rate started increasing after December 2015, while the Mexican interbank rate ranged between 3% in 2013 and 2% in 2015. In contrast, the dollar index appreciated by 30% in four years.

Figure 1 at the outset showed that world trade grew rapidly until the 2007 financial crisis, but there has been a broad reversal since, indicating that GVC activity has been declining in the post-crisis period. World trade rebounded in the immediate aftermath of the crisis, but it never regained its pre-crisis level. Importantly, the slowdown in trade predates the retreat into protectionism and trade conflicts in the last couple of years. Thus, the relative decline in trade had been in place before discussions of trade disputes and protectionism started.

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A Appendix

Tables 11 reports summary statistics of the sample of global banks with access to US money market funding.

Tables 12 and 13 report robustness tests related to Section 4, "The Financial Channel and Exports". In table 12, 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 cost components, such as direct and indirect costs associated with differences in languages,

Table 11: **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 12: **Financial Channel and Exports-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***	3.8986
	[2.1003]	[2.4630]	[2.9871]	[5.6970]	[3.4513]	[2.5513]
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	0.0260***
	[1.1194]	[1.4424]	[0.0465]	[0.0028]	[0.5571]	[0.0065]
Time-destination FE	✓	✓	✓	✓		
Time-product FE	✓	✓	✓	✓	✓	
Destination FE					✓	
Firm FE	✓	✓	✓	✓	✓	✓
Time FE						✓
Observations	45,960	35,077	36,669	41,428	44,851	158
R-squared	0.309	0.320	0.323	0.314	0.252	0.285

currencies as well as cumbersome import or export procedures of manufacturing goods.[10] 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 13 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 ($\Delta\,US\_rate$), which we set equal to the Wu-Xia shadow rate[11] 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 $\Delta\,US\_rate$. 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 statistically significant (column 4) or it becomes statistically significant when it is horseraced

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

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

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.

Tables 14 and 15 present robustness tests related to the section "Bank credit supply and dollar appreciation". In column 1 of Table 14 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). 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.

Table 13: **Financial Channel and Exports-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

Table 14: **Bank credit supply and dollar appreciation - 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

In Table 15 we run an additional set of robustness tests. 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. This evidence suggests that credit provided by dollar funded banks is somehow special and cannot be easily replaced by other banking institutions.

Table 15: **Bank credit supply and dollar appreciation - 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

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