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by Valentina Bruno, Hyun Song Shin

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Dollar exchange rate as a credit supply factor: evidence from firm-level exports*

Valentina Bruno
American University

Hyun Song Shin
Bank for International Settlements

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Abstract

The dollar exchange rate affects real outcomes not only through competitiveness, but also through fluctuations in credit supply. Using detailed export data at the firm-level, we find that the dollar exchange rate affects exports and, conditional on the firms' and banks' financing structure, operates in the opposite direction to the competitiveness channel. Other things equal, firms that are more reliant on banks with higher dollar funding suffer a larger negative effect on exports following an appreciation of the dollar. The effect is particularly pronounced for firms with long production chains. We identify a financial channel of the dollar exchange rate operating through bank credit supply to the exporting firm.

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1 Introduction

We are accustomed to drawing an automatic link between exchange rates and export performance through the textbook trade competitiveness channel. However, exchange rates impact the real economy through both the competitiveness and financial channels. These two channels can operate in opposite directions. On the one hand, trade competitiveness improves when the domestic currency depreciates. On the other hand, a stronger dollar can set in motion lender balance sheet effects that tighten credit supply and undermine the operation of credit-intensive global value chains (GVCs).

The objective of our paper is to weigh up the relative impact of the two opposing channels of exchange rate movements on firm-level export performance. Firms carry inventories and accounts receivable on their balance sheet when operating in a supply chain. Inventories and receivables are assets of the firm, and like any asset, they must be financed somehow. Longer supply chains entail greater working capital needs, and building and sustaining supply chains are finance-intensive activities.

For international trade, dollar-denominated credit takes a central role. According to SWIFT data that tracks cross-border payment activity, over 83% of 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 funding as a limiting factor in satisfying customers' demand for trade financing. To the extent that dollar-denominated credit is sensitive to the dollar exchange rate itself (to be discussed below), fluctuations in the exchange rate may impact the operation of credit-intensive supply chains with a knock-on effect on exports.

We conduct a detailed micro empirical analysis to shed light on the impact of exchange rate fluctuations on firm-level export activity. The hypothesis is that the dollar exchange rate affects exports differentially across firms according to their exposure profile to the banking sector. Specifically, dollar wholesale-funded banks show greater sensitivity in their lending decisions to fluctuations in the dollar exchange rate. Consequently, dollar exchange rate fluctuations would impact firms differently due to the differential exposure *of their banks* to dollar funding. When dollar credit conditions tighten, firms that rely more on wholesale-funded banks would suffer a greater contraction in trade financing. This would undermine their working capital access, and ultimately their export performance.

As an example, take two 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. This is our key hypothesis.

It is worth stressing that our channel is not just a crisis-related story, where a crisis-induced credit crunch suppresses trade volumes. Instead, the claim is that ours is a channel that operates all the time, where fluctuations in dollar financing costs feeds into working capital costs and the operation of supply chains.

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 conduct analysis at the loan-level by matching the lending bank with the borrowing firm. Mexico provides an ideal setting to observe bank credit supply, bank characteristics, and control for non-credit shocks.

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 2017. The bilateral trade information allows us to control for demand factors in the destination country. In addition, we employ loan- and bank-level data to break down the source and characteristics of the financing obtained by the firm, as well as the characteristics of the banks that have lent to the firm. The purpose of tracking the firm-bank loan information is to identify credit supply factors that may impinge on the firm's export business but which originate from the banking system.

Our empirical strategy rests on two pillars. First, we identify credit supply fluctuations linked to dollar appreciation by exploiting the cross-sectional variation in banks' funding structure, especially by keeping track of banks' reliance on dollar wholesale funding through their liabilities to US money market funds. Through this route, we can detect which banks reduce credit more when faced with a dollar appreciation.

Second, we compare export growth by product-destination categories and combine it with the cross-section information across firms according to their reliance on banks with varying exposures to dollar funding. By using firm-product-destination information, we control for non-credit shocks. Our sample covers the period after 2012, covering the years when the broad dollar index saw strong appreciation (30% increase in four years, from 2013 to 2016) including the Taper Tantrum episode of 2013. This appreciation of the dollar came after a prolonged period of weakness in the preceding years.

We document the following findings. First, following an appreciation of the US dollar, banks with high reliance on dollar wholesale funding reduce supply of credit more *to the same firm* relative to banks with low wholesale dollar funding exposures. Second, firms that are more exposed to wholesale dollar-funded banks (and hence suffer a decline in credit supply), experience a slowdown in exports, even when controlling for non-credit explanatory factors. Third, the exports of firms that are more exposed to wholesale dollar-funded banks and have higher working capital needs and longer production chains are hit more by the dollar appreciation. Interestingly, it is the broad dollar index that is the relevant exchange rate for the financial channel. The bilateral exchange rate between the Mexican peso and the US dollar or other currencies has little effect, or conforms to the conventional trade competitiveness channel where a peso depreciation is positive for exports. We present these findings in support of our hypothesis that the main channel of influence is through supply of dollar credit, with knock-on effects on firms' working capital cost and supply chain activity.

Taken together, our results show evidence of a trade suppressing effect of dollar appreciation working through a global bank credit channel. Our findings are consistent with the conventional trade competitiveness channel, as we still observe the positive effect on exports deriving from the trade competitiveness channel, but only in those firms that borrow from banks that are less exposed to dollar wholesale funding, or are not exposed at all.

Our paper shares several points of contact with the literature. First, to the extent that a stronger dollar may be associated with weaker export activity, our explanation 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, 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. Both in the invoicing story and in our story, a stronger dollar is associated with weaker trade activity. However, the invoicing story does not appeal to supply chains or 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. In order to distinguish our story from the invoicing channel, our empirical strategy focuses on the impact of the financial channel on supply chains.

More broadly, 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. Niepmann and Schmidt-Eisenlohr (2017) 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 (2017) 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.

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 broad dollar index 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)), and as 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)).

Other related literature

Working capital is sensitive to financial conditions. Kashyap, Lamont, and Stein (1994) showed 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 economic 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,

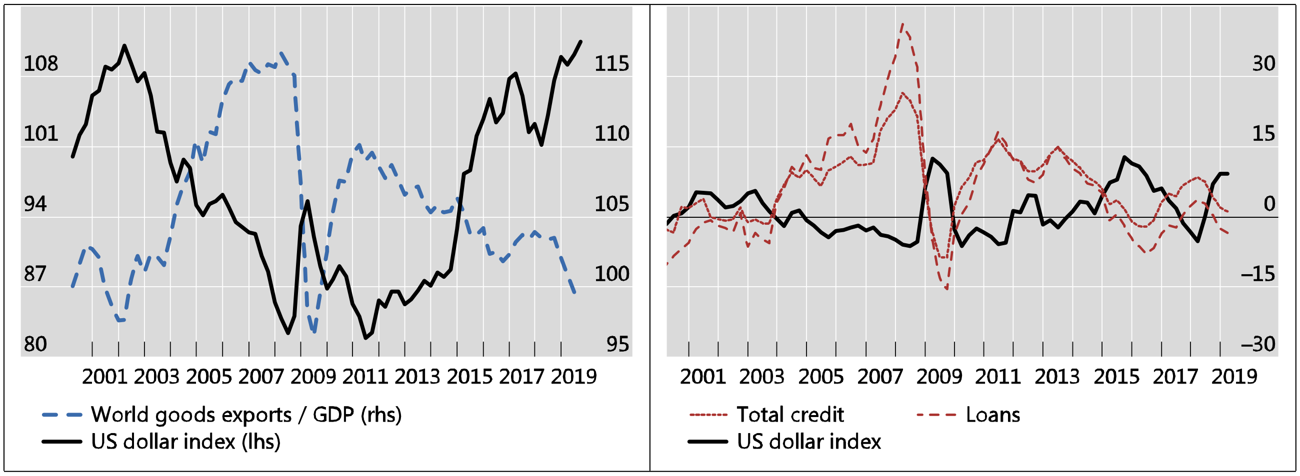

Figure 1: **Exports and US dollar credit.** The left panel shows the ratio of world merchandise exports to world output (right axis) and a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners, based only on trade in goods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

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.

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

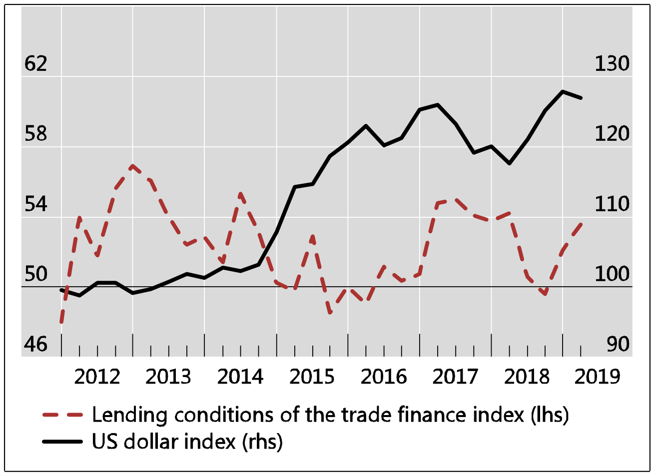

Figure 2: **Trade finance conditions and the US broad dollar index.** This figure shows the IIF Emerging Markets Bank Lending Conditions Index (left axis) related to the question "Over the past three months, how has your willingness to supply international trade finance changed" and the US broad dollar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

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

2.2 Example

To fix intuition, we illustrate the financing cost for working capital of a supply chain using a simple algebraic example, based on Bruno, Kim and Shin (2018).

Consider a good produced by a multi-plant firm. The good is produced with n rounds of value-added. Each stage takes one time period, and incurs a wage cost of $w > 0$. Wages cannot be deferred, and the firm finances the wage bill during in the initial phase by borrowing at interest rate $r > 0$. At date 1, plant 1 incurs wage cost w and sends to plant 2, who incurs wage cost w at date 2, and so on. Meanwhile, plant 1 begins the production of the next unit. The first positive cash flow to the firm arrives at date $n + 1$ when the firm sells the good. Thereafter, the firm receives a constant positive cashflow from the sale of the good, but incurs negative cashflows from two sources. First, there is the wage cost w per plant every period. Second, there is the interest charge on the debt that has accumulated up to that period. Suppose that the interest rate is r, which is assumed constant over time.

		plants					debt attributable to wage costs at date t
		n	$n-1$	$\cdots$	2	1	
	1					w	$w(1+r)^n$
	2				w	w	$2w(1+r)^{n-1}$
date	$\vdots$			$\cdots$	w	w	$\vdots$
t	k		w	$\cdots$	w	w	$kw(1+r)^{n-k+1}$
	$\vdots$				$\vdots$	$\vdots$	$\vdots$
	n	w	w	$\cdots$	w	w	$nw(1+r)$
	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$	

Figure 3: **Initial credit need in setting up supply chain of length n.** The good is produced with n rounds of value-added. Each stage takes one time period, and incurs a wage cost of w. Wages cannot be deferred, and the firm finances the wage by borrowing at interest rate r. At date 1, plant 1 incurs wage cost w and sends to plant 2, who incurs wage cost w at date 2, and so on. Meanwhile, plant 1 begins the production of the next unit. The firm's first positive cash flow comes in date n + 1.

Viewed from the end of date n, the accumulated debt can be attributed to the past wage costs as in the right hand column of the table in Figure 3. Total debt incurred by the end of date n is the sum of the entries in the right hand column of Figure 3, and is given by

$$\begin{aligned} & w(1+r)^n + 2w(1+r)^{n-1} + 3w(1+r)^{n-2} + \cdots + kw(1+r)^{n-k+1} + \cdots + nw(1+r) \\ = \; & w \sum_{j=1}^{n} j(1+r)^{n-j+1} \equiv Z(n) \end{aligned}$$

where we define $Z(n)$ as the total debt incurred by the firm before seeing the first positive cashflow. Then

$$\begin{aligned} Z(n) &= w \sum_{j=1}^{n} j(1+r)^{n-j+1} \\ &= \frac{w(1+r)^2}{r^2} \left((1+r)^n - 1 - n \frac{r}{1+r} \right) \end{aligned} \tag{1}$$

Hence, the steady state interest expense for the firm once the sale of the good starts is

$$rZ(n) = \frac{w(1+r)^2}{r}\left((1+r)^n - 1 - n\frac{r}{1+r}\right) \tag{2}$$

Assume that the good with n stages of production has the market price θn, where $\theta > 0$ is a constant.[1] We further take the limiting case where the discount rate of the firm tends to zero, so that the optimal choice of n for price-taking firms is to maximize steady state profit:

$$\begin{aligned} \Pi(n) &= \theta n - wn - rZ(n) \\ &= \theta n - wn - \frac{w(1+r)^2}{r}\left((1+r)^n - 1 - n\frac{r}{1+r}\right) \end{aligned} \tag{3}$$

where wn is steady state per-period wage cost and $rZ(n)$ is the interest expense. The first-order condition for optimal chain length n is

$$\theta - w - \frac{(1+r)^2}{r}w\left((\ln(1+r))(1+r)^n - \frac{r}{1+r}\right) = 0$$

Rearranging and using the approximation $\ln(1+r) \simeq r$ we have

$$\frac{\theta - w}{w(1+r)^2} + \frac{1}{1+r} = (1+r)^n$$

Or

$$\ln\left(\frac{\theta - w}{w(1+r)^2} + \frac{1}{1+r}\right) = n\ln(1+r) \simeq nr$$

Therefore we can solve for n as

$$n \simeq \frac{1}{r}\ln\left(\frac{\theta - w}{w(1+r)^2} + \frac{1}{1+r}\right) \tag{4}$$

Equation (4) gives the solution for the optimal length of the supply chain. We see that n is increasing in θ and decreasing in r. So, higher financing cost will lead to a shorter production chain, while higher productivity will lead to a longer production chain.

[1] For instance, consumers' preferences can be given by the linear utility function $U(x_1, x_2, \cdots) = \theta\sum_{n=1}^{\infty} x_n n$, where x_n is the units of consumption of the n stage good.

The solution for optimal n comes from the feature that the financing cost of the supply chain is convex in the chain length n, as seen in the expression for steady state profit (3). An immediate implication is that easier financing conditions benefit the financing needs of long GVCs, whilst tighter financing conditions curtail GVCs activities.

Our algebraic example sheds light on how the ratio of gross exports to value-added behaves as a function of the financing cost. Suppose that the firm in Figure 3 is a multinational firm with each stage of production located in separate jurisdictions. Then, the transfer of intermediate goods is captured in gross exports. Sale of the stage k intermediate good is marked to market at price θk. Then, gross exports, including of the intermediate goods at all stages, is given by $\theta \sum_{i=1}^{n} i = \theta n (n+1)/2$. Hence

$$\frac{\text{Gross exports}}{\text{Final good sale}} = \frac{\theta n (n+1)}{2\theta n} = \frac{n+1}{2} \tag{5}$$

From (4), this ratio is decreasing in the financing cost r, consistent with the left hand panel of Figure 1. In our empirical exercise we focus on the role of the US dollar as a barometer of financial conditions.

2.3 Empirical hypothesis

To the extent that financing costs matter for supply chain length, 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 whose balance sheets may embed currency mismatch. 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. 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 Data and empirical strategy

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. The database contains export shipments from Mexico for all modes of transport (maritime, air, truck or rail). Specifically, it contains the names of Mexican exporting companies along with the volumes (in kilograms) and values of the shipments 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 June 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 quarter t and four quarters before $t-4$ (due to export seasonality) within product-destination countries. Thus, X_{ipdt} is the sum of the volume of exports of product

[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.

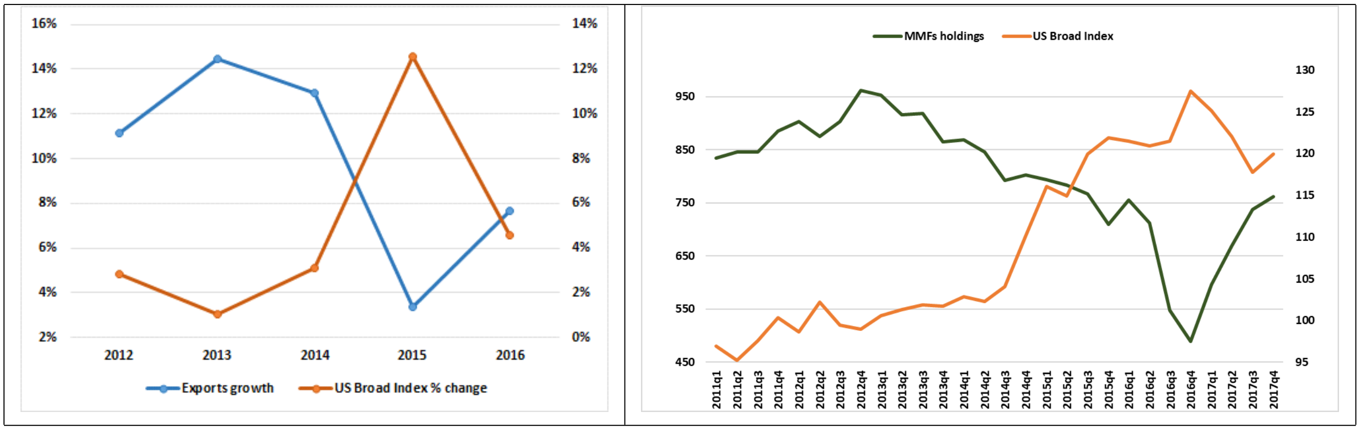

Figure 4: **Exports, Bank credit, and the US dollar.** The left panel shows median values of the annual percentage growth in firms' exports and the annual percentage change in the US dollar broad index over the period 2012-2016. The right panel shows the aggregated outstanding amounts of MMFs by non-US global banks (left axis, in millions of US dollar). Sources: Panjiva, Crane, Federal Reserve, authors' calculations.

p to destination country d by firm i in quarter t, for about 166,000 quarterly-observations over the period from q1 2011 to q2 2017.

The left-hand panel of Figure 4 presents the median of annual percentage changes in export volumes for the entire sample of firms for which we have export data (left axis). We see that the growth of export volumes had a slight decline in the year after the Taper Tantrum and then sharply declined in the two subsequent years. When we plot the annual percentage change in the US dollar broad index in the same panel, we observe a symmetric pattern, where dollar appreciation is associated with a decline in export growth (right axis).

3.2 Banks' exposure to US dollar funding

We capture a bank's exposure to US dollar funding through its liabilities to US money market funds as reported in the banks' regulatory filings to the US Securities and Exchange Commission (SEC), obtained from Crane data. The sample consists of non-US global banks with access to wholesale dollar funding from MMFs in the form of repurchase agreements (repos), commercial paper, certificate of deposits and asset-backed commercial paper.[3] US MMFs are a significant

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

source of dollar funding for non-US banks, although with a declining importance after the 2008 financial crisis.

The right-hand panel of Figure 4 presents the aggregate outstanding liabilities to MMFs by the top 50 global banks, after removing seven US banks (left axis). We also plot the broad US dollar index in the same chart (right axis). We observe the negative comovement between liabilities to MMFs and the dollar, with a negative correlation of 0.86 between the two series. As the dollar appreciates, non-US global banks borrow less from MMFs. Our subsample of 22 global banks that lend to Mexican firms show a drop in liabilities to US MMFs, from 684 USD millions in 2012 to 442 USD millions at the end of 2015, while US banks' reliance on US MMFs declines from 217 USD millions to 192 USD millions over the same period.

We compute global banks' reliance on MMFs for funding by taking the sum of all liabilities to MMFs and scaling it by the bank's total short term debt (from Capital IQ), as measured at the end of 2012. We denote this normalized MMF dependence measure of bank b as MMF_b.

Ideally, to capture the magnitude of each bank's exposure 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 1 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.

3.3 Bank credit supply

We trace the fluctuations in the supply of credit provided by bank b to firm i from q1 2013 to q1 2016 by hand-collecting capital structure details from Capital IQ and company reports. We then compute the variable ΔC_{ibt} as the annual percentage change in credit supply by bank b to firm i in year t.

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

Table 1: **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 2: **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

public accounting data, we find firm-level capital structure details for a subset of 57 listed firms.[4]

Table 2 gives us a snapshot of the amount of bank credit to the firms in our sample. 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% in 2016. This decline in credit supply by global banks followed a worldwide trend.[5]

Over the period from q1 2013 to q1 2016, 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. 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

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

[5] 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 3: **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

consider possible internal capital markets between parent banks and their affiliates.

Table 3 reports aggregate statistics on firm-level exports, destinations and products.

3.4 Firms' dependence on wholesale dollar-funded banks

We match borrowing firms and lending banks at the individual loan level and construct an index for each exporting firm of its exposure to fluctuations in dollar credit conditions by using the information on the dependence of its *lending banks* to wholesale dollar funding. 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 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. We capture firm i's exposure to banks that rely on US dollar funding by constructing the variable:

$$FMMF_i = \sum_b \omega_{ib} MMF_b, \tag{6}$$

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.

3.5 Empirical design

Our identification strategy is based on the following two pillars. First, we want to identify credit supply fluctuations following dollar appreciation. Our assumption is that banks more exposed to wholesale US dollar funding reduce credit more compared to banks that are less dependent on US dollar funding. 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 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.

Second, we want to identify the effect of credit supply on exports. Here, we face the identification problem of disentangling demand and supply of credit. 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, similarly to Paravisini et al (2014).

We also 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.

3.5.1 Bank credit supply

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

$$\Delta C_{ibt} = MMF_b + firm\ FE + year\ FE + \varepsilon_{ibt} \tag{7}$$

where ΔC_{ibt} is the annual change in credit from bank b to firm i from $t-1$ to t and MMF_b is the ratio of US MMFs liabilities of bank b to total short-term debt and as of end-2012. The estimation period is from q1 2013 to q1 2016.

We start by using a parsimonious set of fixed effects, with firm fixed effects controlling for changes in credit demand by firm i, and year fixed effects controlling 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.

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

$$\Delta C_{ibt} = MMF_b \cdot \Delta USDbroad_t + firm\ FE + bank\ FE + year\ FE + \varepsilon_{ibt} \tag{8}$$

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 also using bank fixed effects, firm fixed effects, firm-level control variables or firm-time fixed effects that control for all the time-varying firm heterogeneity. A range of robustness exercises also tackle alternative channels of transmission that may affect credit supply decisions.

3.5.2 Firm-level exports

We estimate the effect on exports of a contraction of credit supply to the firm due to exchange rate fluctuations as:

$$\Delta X_{ipdt} = \beta \cdot \Delta USDbroad_{t-1} \cdot FMMF_i + \varphi_{ipd} + \upsilon_t + \varepsilon_{ipdt} \quad (9)$$

where ΔX_{ipdt} is the log difference of the volume of exports between quarter t and four quarters before $t-4$, $\Delta USDbroad_{t-1}$ is the log difference of the US dollar broad index with one quarter lag, and $\varphi_{ipd} + \upsilon_t$ are firm-product-destination and time (quarter-year) fixed effects.

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. The variable $FMMF_i$ is a time invariant variable that captures the firm's exposure to banks more dependent on US dollar wholesale funding pre-Taper Tantrum. 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 product-destination and time dummies absorb demand fluctuations of product p in destination d and general demand fluctuations at quarter t. Ideally, we would use quarter-product-destination fixed effects to control for destination and product specific demand at time t. Unfortunately, when we do so a large number of observations are dropped due to oversaturation and singleton groups, and only 20% to 90% of the sample depending on the specification used survives. We will discuss this set of additional results in the result and robustness sections.

The estimation period is q3 2013 to q2 2017, and standard errors are corrected for clustering by product-destination.

4 Credit supply and dollar appreciation

Figure 5 shows the local polynomial smooth plot of the annual growth in bank credit over the period 2013-2016 as a function of the bank's exposure to MMF funding. The horizontal axis plots the ratio of holdings of US money market funds scaled by short term debt as of 2012 (MMF_b). The vertical axis captures the change in bank credit from bank b to 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.

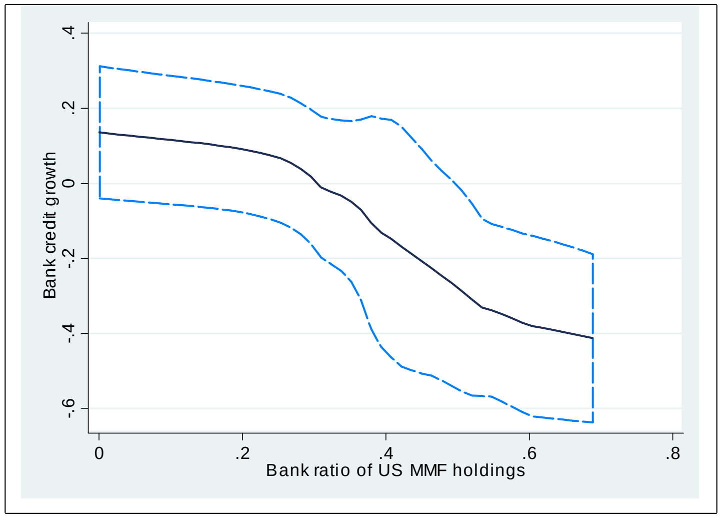

Figure 5: **Credit supply and bank dollar funding.** This figure shows the Kernel-weighted local polynomial smooth plot of the growth in bank credit to firms versus non-US banks' exposure to US dollar funding, with local mean smoothing and 90 percent confidence intervals and for the period from 2013 to 2016. Sources: Crane, Capital IQ, authors' computations.

Table 4 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 $\text{MMF}_b \cdot Global$ is negative and statistically significant (column 3), indicating that more dollar-funded banks reduce credit

Table 4: **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				✓	✓	✓

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 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 25% 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 5 we explore the role of the exchange rate as a global credit supply factor. 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.[6]

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,

[6] 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 5: **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				✓		

and industry fixed effects, estimated coefficients not reported) that explicitly control for firm specific characteristics potentially correlated with credit supply. The coefficient estimate of $MMF \cdot \Delta USDbroad$ remains negative and statistically significant. Taken together, the results in Tables 4 and 5 show the effect on credit supply from the shifts in financial conditions due to dollar appreciation.

4.1 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 5 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 5 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 10 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 11 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 at each 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 more 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 benchmarked specification, and also when we include year-industry fixed effects that account for time-varying industry shocks (results not reported). 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.[7]

5 Credit supply and exports

5.1 Exports and dollar appreciation

We now turn to the effect of a decline in credit supply on exports arising from dollar appreciation. We start by looking at the aggregate behavior of firms pre versus post the Taper Tantrum event by constructing a dummy variable $PostTT2yr$ ($PostTT1yr$), which is equal to 1 for the two years (one year) after the Taper Tantrum and 0 during the two years (one year) before. Columns 1 and 2 of Table 6 show that in the two and one year windows, exports declined for the entire sample of firms for which we have exports data.

When we use $\Delta USDbroad$ in lieu of the dummy variables (columns 3 and 4), we observe a negative correlation between exports growth and dollar appreciation. When the US dollar appreciates by 1%, exports on average declines by 1.5% or 2.2% depending on the sample period considered. So, as a rule of thumb, the elasticity of export decline to dollar appreciation

[7] 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.

Table 6: **Growth in Exports.** 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. PostTT2yr is a dummy variable that is equal to 1 from Q3 2013 to Q2 2015 and 0 from Q3 2011 to Q2 2013. PostTT1yr is a dummy variable that is equal to 1 from Q3 2013 to Q2 2014 and 0 from Q3 2012 to Q2 2013. USDbroad is the quarterly change in the US dollar broad index. Standard errors corrected for clustering of observations at the country-product level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)
Period	Q3 2011- Q2 2015	Q3 2012- Q2 2014	Q3 2011- Q2 2015	Q3 2012- Q2 2014
PostTT2yr	-0.2216***			
	[0.0238]			
PostTT1yr		-0.1595***		
		[0.0264]		
$\Delta\, USDbroad$			-1.5413***	-2.1867***
			[0.2522]	[0.5626]
Constant	0.1519***	0.1357***	0.1039***	0.0936***
	[0.0157]	[0.0154]	[0.0026]	[0.0013]
Firm-Product-Destination FE	✓	✓	✓	✓
Time FE	✓	✓		
Observations	104,727	60,030	104,727	60,030
R-squared	0.248	0.353	0.245	0.351

is around 2.

Figure 6 plots the local polynomial smooth chart corresponding to column 3 results. The vertical axis captures the quarterly growth in exports ΔX_{ipdt}, while the horizontal axis plots the quarterly change in the broad dollar index $\Delta\, USDbroad$. It shows that export growth is a negative function of the broad dollar index, i.e., an appreciation of the dollar is associated with a decline in the growth of exports.

5.2 Cross-section evidence across exporting firms

We now show cross-section results from specification (9), where our variable of interest is the interaction of $\Delta\, USDbroad$ with the index $FMMF_i$ capturing firm's exposure to banks with dollar wholesale funding. A higher $FMMF_i$ indicator indicates that firms are more exposed to banks with higher US money market funding. By taking each firm's exposure to US dollar funded

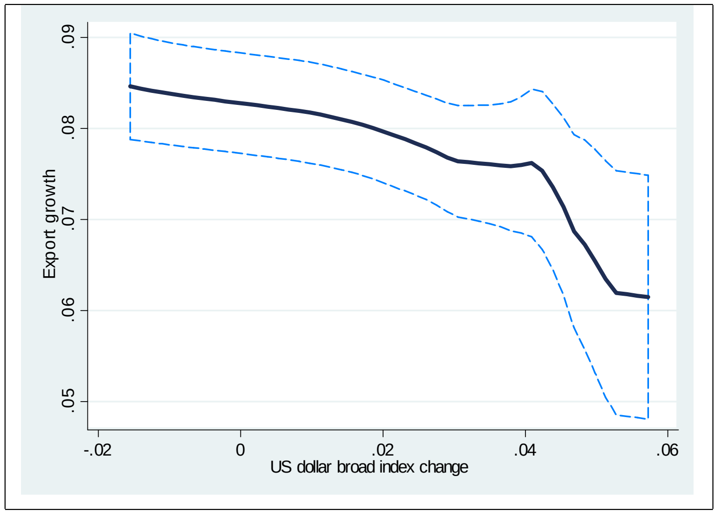

Figure 6: **Export growth and the US broad dollar index.** This figure shows the Kernel-weighted local polynomial smooth plot of the growth in export volumes versus the change in the broad US dollar index, with local mean smoothing and 90 percent confidence intervals, for the period q3 2011- q2 2015. Sources: Panjiva, Federal Reserve, authors' computations.

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. In Tables 4 and 5 we saw that banks with a higher fraction of US dollar funding reduced credit supply more when the dollar appreciated.

Column 1 of Table 7 shows that, in a specification without year-quarter fixed effects, the coefficient of $\Delta USDbroad$ is positive and statistically significant. This result indicates that the financial channel of dollar appreciation does not apply to firms that rely on non-dollar wholesale funded banks. Specifically, a one percent US broad dollar appreciation increases export volumes by about 1.3% for those firms that do not rely on dollar funded banks (i.e., for $FMMF_i = 0$). In contrast, 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.

Column 2 shows that results are robust to adding year-quarter fixed effects. On average, following a one percent US broad dollar appreciation, firms in the upper $FMMF_i$ tercile suffer a

Table 7: **Growth in exports, US dollar and exposure to US dollar funding.** This table shows panel regressions with firm-product-destination fixed effects where the dependent variable is the quarterly change in firms' exports within products-destinations form the period q3 2013-q2 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 product-destination 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
$\Delta\, USDbroad$	1.2973***						
	[0.4181]						
$\Delta\, USDbroad * FMMF_i$	-3.1165*	-4.0164**	-3.7622*	-3.4212*	-6.4764**	-13.0923***	-8.7088***
	[1.8448]	[1.8659]	[2.1653]	[1.7565]	[2.9842]	[4.9589]	[2.6179]
Constant	0.0163***	-0.3874***	-0.3349***	0.0344***	0.1158***	0.1643***	0.1371***
	[0.0056]	[0.0295]	[0.0349]	[0.0012]	[0.0208]	[0.0365]	[0.0236]
Firm-product- -destination FE	✓	✓	✓		✓	✓	✓
Time-product- -destination FE				✓			
Quarter FE		✓	✓	✓	✓	✓	✓
Firm FE				✓			
Sample	All	All	USA dest excluded	All	All	US dest only	All
Observations	49,500	49,500	34,134	43,597	22,393	6,694	22,407
R-squared	0.203	0.214	0.252	0.456	0.327	0.324	0.318

reduction of export volumes by 1.9% more than firms in the lower $FMMF_i$ tercile. In column 3 we exclude the United States as the exports destination country with qualitative similar results.

Columns 2 and 3 show results from a specification with firm-product-destination FE and quarter-year FE. Ideally, we would like to use quarter-product and quarter-destination fixed effects to control for destination specific and product specific demand. Unfortunately, we would overfit the specification and a large number of observations would drop because of singleton observations. We compromise between sample preservation and use of time fixed effects by using a specification with year-product-destination fixed effects which allows to preserve 88% of the original sample. Column 4 shows that our results are robust to using this alternative specification, and with a similar coefficient magnitude. In additional unreported results, we further saturate the base specification by using quarter year-product-destination FE. Our results still hold at the 10% statistically significant level, however the sample is reduced to about 5,200 observations due to a large number of dropped singleton observations.

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. Also, in column 6 we restrict the estimation sample to the exports to the United States as destination country. Goods exported to the US are likely to be invoiced in dollars only. Despite the smaller sample due to data availability of firm-level export values, 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.

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.

5.3 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. Based on the assumption that upstream firms (i.e. supplier firms of intermediate goods) have higher working capital needs compared to downstream firms (final product firms), we construct a firm-level proxy by using Panjiva data.

Specifically, we classify each product at the 8 digit HS code as capital, intermediate, or consumption goods as defined by the US International trade statistics[8]. We then construct an indicator *Intermediate* that captures the number of intermediate goods produced by a firm, weighted by their total value, as proportion of all the goods as of end-2012. The variable *Intermediate* ranges from 0.0001 to 1. The assumption is that firms that sell more intermediate goods are more closely integrated into supply chains and with longer GVCs than firms that sell final products. The prediction is that their exports are more sensitive to fluctuations in credit conditions.

Column 1 of Table 8 regresses the change in export volumes ΔX_{ipdt} over the interaction term $\Delta\, USDbroad * Intermediate$, in a panel regression with firm-product-destination fixed effects and time fixed effects as before. The estimated coefficient -4.85 is negative and statistically significant, suggesting that dollar appreciation has a negative effect on the exports of firms that produce more intermediate goods. This result is consistent with our hypothesis that intermediate good producers have higher financing needs than for producers of final goods, and hence that such firms will be more negatively affected by tighter financing conditions.

In Column 2 we explore cross-sectional differences with the triple interaction

$\Delta\, USDbroad * Intermediate * FMMF_i$. The coefficient estimates suggest that the financial channel applies less to firms producing final goods: when *Intermediate* is close to zero, the interaction $\Delta\, USDbroad * FMMF_i$ is positive and statistically significant. This result suggests

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

that firms exporting only final goods are less affected by changes in credit following fluctuations in the US dollar exchange rate than firms with longer production chains. For these firms the competitiveness channel prevails and dollar appreciation boosts their exports. In contrast, the exports of firms with more intermediate goods (i.e. with longer production chains than firms with final goods) are negatively affected by dollar appreciation ($\Delta\, USDbroad{*}Intermediate$ is negative and statistically significant), with an effect that is further amplified by the credit shock generated by the banks exposed to US money market funding ($\Delta\, USDbroad{*}Intermediate{*}FMMF_i$ is negative and statistically significant).

Columns 3 and 4 use a simpler specification to show the same result. Specifically, column 3 replicates column 1 specification for the subsample of firms that receive credit from banks exposed to dollar funding (i.e., $FMMF_i > 0$), while column 4 is for the subsample of firms that do not. Column 3 shows that the interaction $\Delta\, USDbroad{*}Intermediate$ is negative, confirming that the exports of firms selling intermediate goods that are dollar funded suffer a decline in exports from an appreciation of the dollar. In contrast, the exports of firms that receive credit from banks with no dollar funding are less affected by exchange rate fluctuations. Such firms continue sustaining their GVCs production and benefit from the trade competitiveness channel as the positive interaction term $\Delta\, USDbroad{*}Intermediate$ suggests (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.

Table 8: **Growth in exports, US dollar and supply chains.** This table shows panel regressions with firm-product-destination and time fixed effects 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 an indicator that proxies for the length of the production chains by capturing the share of intermediate goods by each firm as of 2012. Working capital is the ratio of working capital to total assets as of 2012. Standard errors corrected for clustering of observations at the firm-product-destination level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All	All	Dollar funded	Non-dollar funded	All	Dollar funded
$\Delta\,USDbroad$	-4.8529***	-3.8191***	-7.9645***	5.0193*		
$*Intermediate$	[1.1302]	[1.2576]	[1.2301]	[2.8193]		
$\Delta\,USDbroad*FMMF_i$		41.2449**				
		[20.9900]				
$\Delta\,USDbroad$		-44.4735**				
$*Intermediate*FMMF_i$		[21.3759]				
$\Delta\,USDbroad$					-13.9822***	-12.7742***
$*Working\ Capital$					[2.6729]	[2.6033]
Constant	-0.3755***	-0.3824***	-0.3348***	-0.6259***	-0.3658***	-0.3539***
	[0.0300]	[0.0302]	[0.0318]	[0.0893]	[0.0299]	[0.0314]
Observations	48,776	48,776	37,707	11,069	46,037	37,965
R-squared	0.216	0.216	0.200	0.298	0.217	0.197

5.4 Financial channel versus trade channel

In this section we replicate our base specification for a different sample of export-destination countries and different exchange rate indicators. Column 1 of Table 9 shows results with the real broad effective exchange rate for Mexico (from the BIS). The coefficient $\Delta MXbroad$ by itself is negative and significant, meaning that an appreciation of the Mexican peso negatively affects the exports, consistently with the trade channel. The coefficient is small, suggesting that the economic impact is not particularly high. The coefficient of the interaction term $\Delta MXbroad{*}FMMF_i$ is negative but statistically insignificant, meaning that the Mexican peso broad exchange rate is not the relevant exchange rate for capturing the financial channel.

In columns 2 and 3, we replicate our base specification for the subsample of goods exported to the US only. In particular, in column 2 we use the Broad US dollar index $\Delta USDbroad$, while in column 3 we use the bilateral US dollar/Mexican pesos exchange rate ΔUSD_MX. Results show that the interaction term $\Delta USDbroad{*}FMMF_i$ remains negative and statistically significant, meaning that the financial channel of dollar appreciation impacts goods exported also to the USA as it acts on the supply of credit available to Mexican firms.

In contrast, in column 3 the coefficient of the interaction term $\Delta USD\_MX{*}FMMF_i$ is statistically insignificant, consistent with the previous results showing the US broad dollar index is the relevant exchange rate for capturing the financial channel of currency appreciation also in the case of the United States because it acts on the global credit portfolio of global banks. The coefficient of the bilateral exchange rate ΔUSD_MX is positive and statistically significant, meaning that a depreciation of the Mexican pesos boosts export volumes of those firms that do not rely on dollar-funded banks, consistently with the trade channel.

Taken together, if we combine columns 2 and 3 results, we infer that the positive trade effect of a local currency depreciation (bilateral exchange rate ΔUSD_MX positive and significant) is counterbalanced by the decreasing credit availability following an appreciation of the dollar for those firms that are exposed to dollar-funded banks (financial channel of exchange rates, $\Delta USDbroad{*}FMMF_i$ negative and significant).

Table 9: **Financial channel versus trade channel.** 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. MMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. USDbroad is the quarterly change in the US dollar broad index. MXbroad is the quarterly change in the Mexican pesos broad index. USDMX is the bilateral US dollar-Mexican pesos exchange rate, EURMX is the bilateral Euro-pesos exchange rate, CADMX is the bilateral Canadian dollar-Mexican pesos exchange rate. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample of countries export destinations	All	USA	USA	Germany	Germany	Canada	Canada
$\Delta MXbroad$	-0.0199***						
	[0.0025]						
$\Delta MXbroad{*}FMMF_i$	-0.0054						
	[0.0117]						
$\Delta USDbroad$		1.7154**					
		[0.8133]					
$\Delta USDbroad{*}FMMF_i$		-6.3801**		-12.2164*		-29.9298***	
		[2.9128]		[6.6409]		[11.3200]	
ΔUSD_MX			2.1944***				
			[0.3736]				
$\Delta USD\_MX{*}FMMF_i$			0.3174				
			[1.8182]				
$\Delta EUR\_MX{*}FMMF_i$					1.4561		
					[3.5957]		
$\Delta CAD\_MX{*}FMMF_i$							4.2446
							[4.6460]
Constant	0.0051	-0.0009	-0.0345***	-0.1614	-0.1596	-0.3476**	-0.3439**
	[0.0033]	[0.0110]	[0.0087]	[0.2166]	[0.2255]	[0.1532]	[0.1556]
Time FE				✓	✓	✓	✓
Observations	49,500	15,366	15,366	470	470	1,647	1,647
R-squared	0.204	0.191	0.193	0.333	0.329	0.347	0.346

Finally, column 6 replicates the analysis for the subsample of goods exported to Germany and Canada, two major importers of Mexican goods after the USA. We see again the financial channel in action as $\Delta USDbroad{*}FMMF_i$ is negative and statistically significant (columns 4 and 6), while the coefficients of the respective bilateral exchange rates interacted with $FMMF_i$ are not (columns 5 and 7). Our results indicate the breadth of the impact of a broad dollar appreciation.

Overall, these results confirm 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 finding with the trade competitiveness channel. We still observe the positive effect on exports deriving from the trade competitiveness channel, but only for those firms that borrow from banks that are less or not exposed to dollar wholesale funding.

5.5 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, or profitability, 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.

Finally, in Table 13 we focus on alternative channels that may account for exchange rate shocks, e.g., monetary policy, economic conditions, uncertainty, 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.

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. 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 10 and 11 present robustness tests related to the section "Credit supply and dollar appreciation". In column 1 of Table 10 we use the percentage change in oil prices (global price of WTI crude as reported by FED FRED) and in column 2 we use GDP growth in lieu of the broad dollar index. The interaction terms of MMF_b with such variables are statistically insignificant, meaning that these factors are not statistically significant 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 this results as suggestive evidence that the broad dollar index is the global factor affecting credit supply decisions by global banks because it directly affects the banks' portfolio returns at the VaR constraints.

In Table 11 we run an additional set of robustness tests. 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 of bank credit denominated in pesos. In contrast, in column 2 the interaction term is negative and statistically significant for the sample of firms with a low ratio, 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 survives when firms in the oil and energy sectors are

Table 10: **Bank credit, dollar funding, and exchange rates - 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

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 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). 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.

Tables 12 and 13 report robustness tests related to Section 5, "Credit Supply 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) and profitability (ROA) with unchanged results. 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 2 we use 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. The interaction term $\Delta USDbroad *$Export$\%_i$ is not statistically significant, suggesting that the shock does not derive from a general decline in exports. Similarly, column 3 shows that exports of firms in distress do not seem to be boosted by broad dollar appreciations. The variable $Distress_i$ is the Z-score index as of 2012 as computed in Capital IQ.

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

Table 11: **Bank credit, dollar funding, and exchange rates - 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

Table 12: **Growth in Exports, US dollar and Exposure to US dollar funding-Robustness tests.** This shows panel regressions with time fixed effects where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q2 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 and ROA is return on assets. Export is the ratio of Mexican sales to total sales. Distress the the Z-score index. Standard errors corrected for clustering of observations at the product-destination level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
$\Delta\, USDbroad \cdot FMMF_i$	-4.1140**			-5.3744*	-3.8643**
	[1.8629]			[3.1433]	[1.7636]
Cash	0.2062				
	[0.1644]				
Size	0.0038				
	[0.0455]				
ROA	0.0244***				
	[0.0065]				
$\Delta\, USDbroad \cdot Export\%$		3.1987			
		[2.4163]			
$\Delta\, USDbroad \cdot Distress$			-0.3060		
			[0.1888]		
Trade Costs					-0.0162
					[0.0150]
Constant	-0.5619	-0.3735***	-0.3698***	-0.3786***	-0.3716***
	[0.4867]	[0.0346]	[0.0330]	[0.0342]	[0.1388]
Product-destination FE	✓	✓	✓	✓	
Product FE					✓
Observations	46,073	35,968	36,591	38,905	44,125
R-squared	0.223	0.220	0.224	0.223	0.072

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, currencies as well as cumbersome import or export procedures of manufacturing goods.[9] The estimated coefficient of *Trade Cost* is negative but statistically insignificant, while the interaction term $\Delta USDbroad \cdot \text{MMF}_i$ continue remaining negative and statistically significant. 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 using the Wu-Xia shadow rate (column 1) and the Mexican-US money market interest rate differential (column 2, from the IMF IFS) in lieu of the broad dollar exchange rate. The interaction terms with $FMMF_i$ are statistically insignificant. In column 3 we explicitly account for global uncertainty by using the VIX index. In column 4 we use the Baltic dry index (BDI), which is considered a proxy for shipping costs and, more general, global economic conditions. Finally, in column 5 we take into considerations the Mexican economic conditions by using the share price index of Mexico (from the IFS). The resulting interaction terms are statistically insignificant. Take together, we interpret these results as evidence of the role of the US broad dollar index in funding and lending decisions by global banks, with repercussions on firm-level exports.

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

Table 13: **Growth in Exports, US dollar and Exposure to US dollar funding-Robustness tests.** This shows panel regressions with time fixed effects and firm-product-destination fixed effects where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q2 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. Shadow Rate is the Wu-Xia shadow Federal Fund rate, Rate Differential is the difference between the Mexican money market rate and the U.S. money market rate, averaged over the quarter. VIX is the percentage change in the CBOE Volatility Index. BDI is the percentage change in the Baltic Dry Index. StockMarket is the percentage change the share price index of Mexico. Standard errors corrected for clustering of observations at the product-destination level are reported in brackets. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

	(1)	(2)	(3)	(4)	(5)
$ShadowRate \cdot FMMF_i$	-0.1671				
	[0.1735]				
$RateDifferential \cdot FMMF_i$		-0.0412			
		[0.0597]			
$\Delta VIX \cdot FMMF_i$			-0.0239		
			[0.2100]		
$\Delta BDI \cdot FMMF_i$				-0.0354	
				[0.1038]	
$StockMarket \cdot FMMF_i$					-0.0168
					[0.0110]
Constant	-0.0987***	-0.3779***	-0.3887***	-0.3879***	-0.3851***
	[0.0309]	[0.0596]	[0.0297]	[0.0297]	[0.0297]
Observations	29,152	49,500	49,500	49,500	49,500
R-squared	0.316	0.214	0.214	0.214	0.214

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