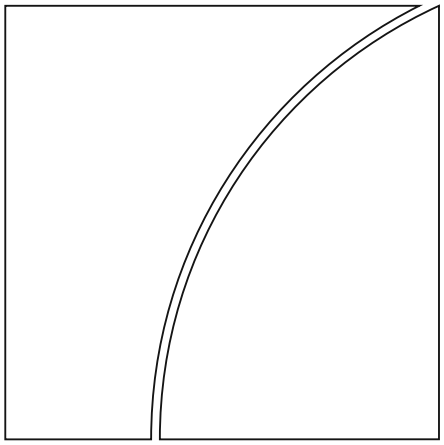

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Dollar exchange rate as a credit supply factor – evidence from firm-level exports

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Dollar and Exports

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Abstract: The strength of the U.S. dollar has attributes of a barometer of dollar credit conditions, with a stronger dollar associated with tighter dollar credit conditions. We find that following dollar appreciation, exporters that are more reliant on dollar-funded bank credit suffer a greater decline in credit and slowdown in exports, including those exporting to the United States. Our findings shed light on the role of the U.S. dollar in the interaction between financial globalization and international trade and show a novel channel of exchange rate transmission that goes in the opposite direction to the competitiveness channel. (*JEL* F40, F65)

We are accustomed to drawing an automatic link between exchange rates and export performance through the textbook trade competitiveness channel. For a non-U.S. firm exporting to the United States, an appreciation of the dollar would improve trade competitiveness. It would be tempting to conjecture that the firm's exports to the United States would increase. However, the facts show the opposite. Following a dollar appreciation, many non-U.S. firms suffer a slowdown in their exports to the United States, as well as to other destinations.

Our paper explores the impact on exports coming from the financial channel of exchange rates. The financial channel, proposed by Bruno and Shin (2015), draws a link between U.S. dollar appreciation and subdued credit supply amid diminished risk taking. The financial channel operates in the opposite direction to the competitiveness channel. A stronger dollar is good for trade competitiveness of non-U.S. firms exporting to the United States. However, a stronger dollar also sets in motion lender balance sheet effects that tighten credit supply and raise the cost of working capital of exporting firms, thereby dampening exports.

Our analysis shows the negative impact of the financial channel on international trade during a period of dollar appreciation. We show that the financial channel may even outweigh the positive improvements predicted by the textbook trade competitiveness channel when firms are highly exposed to dollar funding conditions. In this respect, our paper sheds light on the role of the dollar in the interaction between financial globalization and international trade.

Figure 1 is a striking illustration of how global trade activity fluctuates with the strength of the dollar. The chart plots the ratio of world goods exports to world gross domestic product (GDP) over the past 20 years or so.[1] We see the strong growth in exports

[1] 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

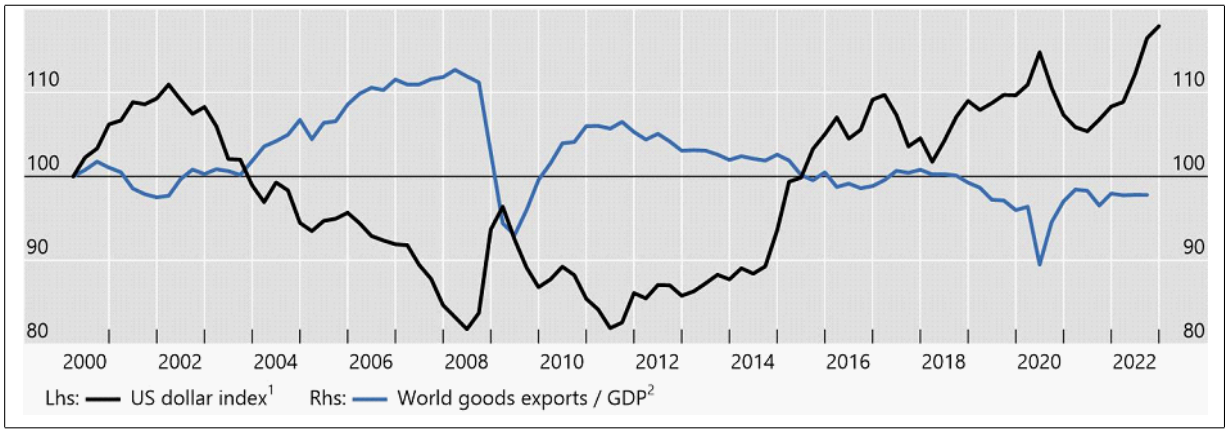

Figure 1
Global goods trade and the dollar The figure shows the ratio of world merchandise exports to world output (right axis) and a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners, based only on trade in goods (left axis). Data are normalized as of Q1 2000. *Sources*: Federal Reserve Bank of St Louis; IMF; World Trade Organization; national data; BIS.

before the 2007-2009 Great Financial Crisis, a deep decline as the crisis hit, and an equally sharp rebound in its aftermath. Thereafter, global trade was on a gentle declining trend relative to GDP until the COVID-19 pandemic struck. Figure 1 also plots the broad dollar index. What is striking is the negative correlation between global trade activity and the strength of the dollar. Trade activity is strong when the dollar is weak, but global trade suffers when the dollar is strong. This pattern is remarkable in its consistency and has remained intact even during and after the pandemic.

One candidate explanation for this striking pattern is that credit conditions for exporters' working capital track closely the trajectory of dollar strength, so that trade fluctuations are shaped by financial conditions. It is well known that merchandise trade is heavily dependent on bank finance for working capital due to the time lags between incurring costs and receiving payments (Amiti and Weinstein 2011; Niepmann and Schmidt-Eisenlohr 2017a) and that global banks play a pivotal role as intermediaries supplying trade finance (Niepmann and Schmidt-Eisenlohr 2017b; Caballero, Candelaria, and Hale

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. The underlying data for this figure are available here: https://www.bis.org/publ/work819.htm

2018; Claessens and Van Horen 2021). What is new and distinctive about our study is the focus on the U.S. dollar as a credit supply factor that introduces a countervailing force to the trade competitiveness channel.

Using finely disaggregated data on export shipments, we trace the impact of dollar strength on the shipments of exporters who have trade financing needs and show a novel channel through which exchange rates affect global trade activity. The sample of exporting firms in our study is from Mexico. We chose Mexico for several reasons. First, Mexico is in the top-10 exporters of manufactured goods (ranked seventh in WTO in 2019), with close links to the United States. Second, Mexico provides a setting that is data-rich for the empirical researcher, with detailed trade data that include the name the exporting firm, products, volumes, destinations and date of the shipment, available through a commercial data provider. Third, listed firms are required to disclose detailed information to the stock exchange, *Bolsa Mexicana*, on their capital structure, in particular loan amount and identity of the lender. Knowing the lender allows us to explore the financial channel at play. Overall, Mexico provides an ideal setting to observe firms' exposure to global financial conditions, while controlling for noncredit shocks.

Our empirical strategy rests on two pillars. First, 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. Specifically, by exploiting the cross-sectional variation in banks' dollar funding structures, we can detect which banks reduce credit more when faced with a dollar appreciation. We find that, following an appreciation of the U.S. dollar, banks with high reliance on dollar short-term funding reduce supply of credit more *to the same firm* relative to banks with low short-term dollar funding exposures. One immediate implication is that firms that borrowed from short-term dollar-funded banks will suffer a greater decline in credit following dollar strengthening.

We then trace the impact of tighter credit supply following dollar appreciation on the firm's exports. We examine how firms' export growth covaries with the extent of their reliance on short-term dollar-funded banks. Our hypothesis is that dollar appreciation will have larger adverse effects on exports of those firms more reliant on short-term dollar-funded banks, through the increased costs of working capital and reduced lending. Diminished credit supply would also affect adversely the operation of credit-intensive global value chains (GVC).

We test our hypothesis by using detailed export data containing information on the product, exporting firm, destination country of exports, volume, values and date of each shipment for the period from 2011 up to the first quarter of 2017. The bilateral trade information allows us to control for demand factors in the destination country. Specifically, we compare export growth by product-destination categories and combine it with the cross-section information of firms according to their reliance on banks with varying exposures to wholesale dollar funding. By using firm-product-destination information, we control for noncredit shocks.

We find that firms that are more exposed to short-term dollar-funded banks experience a greater slowdown in exports, even when controlling for noncredit explanatory factors. An exhaustive set of robustness tests confirm that changes in dollar credit conditions, and their associated impact on firms' financing costs and availability, are an important determinant of firm-level export performance.

Tellingly, we find that exports to the United States are subject to the same financial channel as exports to other destinations, even though a stronger dollar would entail an unambiguous improvement in trade competitiveness for the exporting firm. The evidence on exports to the United States allows us to disentangle the financial channel from the role of the currency of invoicing (Goldberg and Tille 2009; Gopinath et al. 2020), as exports to the United States are invoiced in the local currency of the importing economy. Prices

faced by domestic buyers are therefore unaffected by dollar appreciation from invoicing practices alone.

The impact of financial conditions driven by the dollar is felt more strongly for exports of goods that are further upstream in the production chain from the final consumption goods sector. One possible reason for this finding is that firms that are further upstream have higher working capital needs. Indeed, we find that financial conditions have only a mild impact on domestic sales, while exports are affected more severely.

Our results highlight the importance of dollar short-term funding and suggest that alternative sources of dollar funding are difficult to come by, at least in the short term. When we examine how firms respond to changes in the supply of short-term dollar-funded credit, we find that they reduce the provision of trade credit to downstream firms, as extending trade credit becomes costlier following dollar appreciation.

When taken together, our results add to the theme of bank credit as an enabler of exports, but from the distinctive angle of the dollar as a credit supply factor. The novelty of our analysis hinges on dollar appreciation as an alternative channel of transmission of credit supply conditions. Importantly, the financial channel highlighted by our results is not just a crisis-related story, where a crisis-induced credit crunch suppresses trade volumes. Instead, it is better viewed as having broad applicability as a general mechanism through which financial globalization and international trade interact.

Our results are particularly notable in the context of international trade. Exchange rates are well-known to affect trade competitiveness, but our paper introduces the dollar exchange rate as an important factor at play for trade finance and exports, which operates in the opposite direction to the traditional trade competitiveness channel. The negative impact on exports through tighter financial conditions associated with a strong dollar is especially visible in firms that are exposed (indirectly) to dollar funding conditions through the funding structure of their banks.

Our paper fits with the narrative emerging from an active literature on the U.S. dollar as a global factor in economic and financial activity (e.g., Bruno and Shin 2015; Rey 2015; Gourinchas 2019; Lilley et al. 2022; Avdjiev et al. 2019; Miranda-Agrippino and Rey 2020; Cao and Dinger 2022; Obstfeld and Zhou 2022), a financial market indicator that tracks deviations from covered interest parity in FX markets through its impact on bank leverage (Avdjiev et al. 2019), and a provider of world safe asset (Jiang, Krishnamurthy, and Lustig 2019).

1 The Financial Channel of Exchange Rates and the Dollar

The U.S. dollar plays a central role for trade financing and cross-border lending, as well as in the international monetary and financial system broadly speaking. Figure 2 is taken from the December 2022 BIS Quarterly Review and it shows that about half of cross-border loans and international debt securities are denominated in U.S. dollars. Around 85% of all foreign exchange transactions occur against the U.S. dollar. Furthermore, half of international trade is invoiced in U.S. dollar and international payments are made predominantly in the U.S. dollar.

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

In this paper we focus on the financial channel of exchange rates as modeled in Bruno and Shin (2015), where the broad U.S. dollar index plays the central role in the mechanism. In the model, borrowers have a currency mismatch, whereas lenders do not have a currency mismatch as they fund themselves in the USD wholesale market and lend in USD. The

Figure 2
The international role of the U.S. dollar Expressed as a percentage. *Source*: BIS Quarterly Review, December 2022.

broad U.S. dollar index is the relevant exchange rate in the model. Under a portfolio approach, a broad based appreciation or depreciation of the dollar affects the bank's global credit portfolio.

Specifically, the financial channel works through shifts in the effective credit risk faced by banks who lend to local borrowers with a currency mismatch. When the local currency appreciates, local borrowers' balance sheets become stronger, resulting in lower credit risk and hence expanded bank lending capacity through a value at-risk (VaR) constraint. This spare lending capacity is filled through an expansion in the supply of dollar credit that is funded through the dollar wholesale market. In this way, a local currency appreciation leads to an increase in bank leverage, greater risk-taking by banks, and ultimately financing conditions loosen. However, when the wheel turns and the dollar appreciates, credit risk increases, banks start deleveraging and reducing credit supply, and financial conditions tighten.

Figure 3 illustrates the association between exchange rates and dollar financial conditions in the aggregate. The left-hand-side panel of Figure 3 plots fluctuations of the broad dollar index and dollar-denominated credit. The panel shows the negative relationship

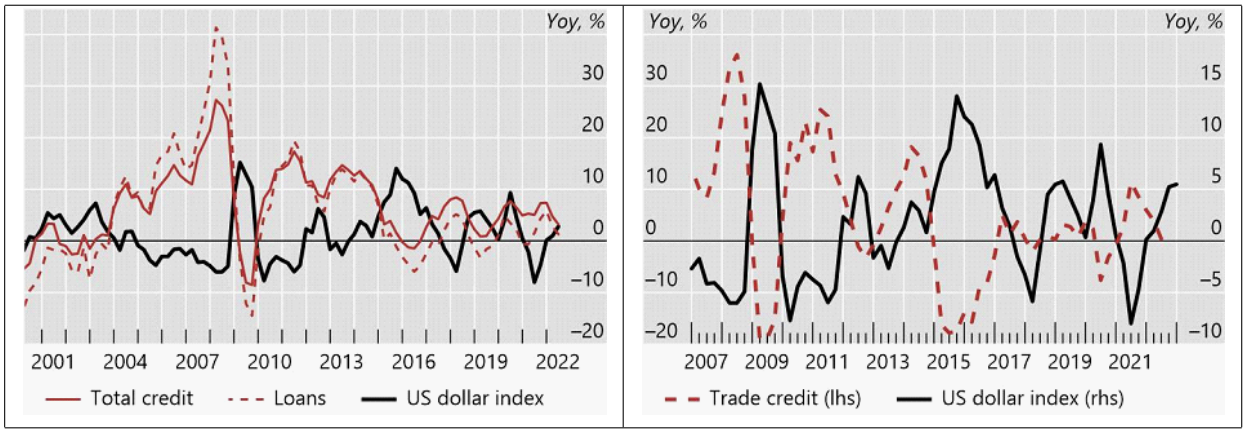

Figure 3
Exports and U.S. dollar credit The left-hand-side panel shows the annual growth of credit to nonbanks denominated in U.S. dollars and the annual growth of the Federal Reserve Board trade-weighted nominal dollar index, major EMEs. The right-hand-side panel shows the annual percentage change of outstanding amounts of trade credit reported by nine central banks to the BIS and the annual growth of the Federal Reserve Board trade-weighted nominal dollar index, major EMEs. *Sources*: BIS; Federal Reserve Bank of St Louis, FRED; Boissay, Patel, and Shin (2020).

between the four-quarter growth of dollar bank loans to emerging market borrowers and that in the broad dollar index. When the dollar is strong, lending in dollars slows. Historically, global trade finance volumes have also comoved negatively with the dollar, as the right-hand-side panel of Figure 3 shows. Taken together, Figure 3 shows that tighter dollar credit conditions go hand-in-hand with tighter trade finance conditions.

In this paper, by focusing on exports we explore one of the various effects on real economic activity deriving from the financial channel. For trade, the drop in dollar credit supply negatively affects working capital costs and the operation of supply chains with an negative effect on exports. When firms look to outside financing for working capital, it is normally bank-funded and often in U.S. dollar. Building and sustaining supply chains are finance-intense activities, so when financing conditions tighten and banks pull back from dollar funding, some global value chains may no longer be viable.

We also hypothesize that this association between dollar financing needs and supply chain production will hold with added force when firms have additional financing need due to extended supply chains, like in the case of intermediate goods or goods with longer

transportation times. This happens because alternative sources to fill the dollar funding needs are difficult to obtain at least in the short term, while working capital demands of exporting firms are increasing very rapidly with the lengths of the global value chains (Kalemli-Ozcan et al. 2014; Bruno et al. 2018). So, when banks pulls back dollar credit, global value chain will suffer.

1.1 Related literature

Some literature has shown that working capital is sensitive to financial conditions, but for different reasons than dollar funding conditions. Kashyap, Lamont, and Stein (1994) show that inventories of firms that depend more on external financing fall more sharply in response to a contraction in credit supply. 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. Manova and Yu (2016), Costello (2020), Shousha (2019), and Serena and Vashistha (2019) study the organization and operation of global supply chains and their sensitivity to financial conditions.

A strand of the literature documents how trade credit and trade finance contract following crisis episodes, and demonstrate that financial aspects are an important determinants of trade activity. For instance, Love et al. (2007) and Love and Zaidi (2010) document the contraction of trade credit in emerging markets following the 1997 Asian crisis. Ahn, Amiti and Weinstein (2011) show that economic models that do not incorporate financial frictions only explain about 70% to 80% of the decline in world trade that occurred in the 2008-2009 crisis, and Chor and Manova (2012) show that credit conditions are an important channel through which the financial crisis affected trade volumes. Amiti and Weinstein (2011) find that deteriorations in bank health explain the large drops in exports relative to output, and they have a much larger effect on exports than on do-

mestic sales because exporters need more working-capital financing than firms engaged in domestic transactions. Paravisini et al. (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.

We build on this literature by putting the U.S. dollar at the center of global credit conditions. Our transmission channel works through fluctuations in bank lending that accompany exchange rate changes, and it is a channel that operates also outside crises times. This mechanism is in the spirit of Gabaix and Maggiori (2015), who approach exchange rate determination through the intermediaries' risk-bearing capacity.

Effectively, financial frictions matter for trade and exports as well as macro-economic factors. Niepmann and Schmidt-Eisenlohr (2017a) find that a shock to a country's letters-of-credit supply by U.S. banks reduces U.S. export growth to that country. Claessens and Van Horen (2021) also find that foreign banks can be important for trade because they can increase the availability of external finance for exporting firms. Furthermore, working capital needs of the exporter will differ in the case of long versus short shipping times or between destination countries where products are more likely to sold on open accounts (Schmidt-Eisenlohr 2013; Antras and Foley 2015).

Our paper fits into the literature that puts financial frictions as an important factor explaining trade fluctuations by focusing on the U.S. dollar as a novel channel that affects credit supply and exports thereof. Typically, the trade literature and policy debates on exchange rate interventions are mostly focused on the trade competitiveness channel, thus mostly neglecting the credit channel and drawing a sharp distinction between trade and finance. Instead, merchandise trade is heavily dependent on bank finance so that the financial and real effects are two sides of the same coin.

In fact, 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. Rose (2021) shows that currency wars and unconventional monetary policies do not stimulate exports and Agarwal (2019) finds that currency depreciations are not always expansionary. By looking at the financial channel of exchange rates, we bring back credit supply at the heart of the trade channel and we explain how exchange rate fluctuations operate in the opposite direction to the competitiveness channel.

Along these lines, our paper is a conceptual bridge between the literature linking trade and finance and the literature that examines the impact of dollar invoicing of trade (Goldberg and Tille 2008, 2009; Gopinath and Stein 2021; Gopinath et al. 2020). The connecting link comes from the fact that dollar invoicing implies that the trade financing requirements also translate into a need for dollar credit. When exports are invoiced in dollars, dollar invoicing predicts that, if the destination country currency weakens against the U.S. dollar, there is a decline in exports. Dollar invoicing entails a trade-dampening role of a stronger dollar, but the mechanism is different from the financial channel because it assumes that prices are sticky and it does not appeal to the cost of working capital financing in dollar.

Last, but not least, the financial channel shares some similarities with studies that focus on banks' creditworthiness, although the underlying mechanism is different. Ivashina, Scharfstein, and Stein (2015) and Correa, Sapriza and Zlate (2021) have shown that an increase in dollar funding costs affects non-U.S. banks' lending behavior. U.S. 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 affected during the European crisis. Cetorelli and Goldberg (2011) find that during the Great Financial Crisis, bank-

ing groups that depended more on short-term U.S. dollar funding curtailed cross-border lending more. Along those lines, Schnabl (2012) and Morais, Peydro, Roldan-Pena and Ruiz-Ortega (2019) further show that bank lending is affected by international spillovers of liquidity or monetary policy shocks.

2 Banks and Exports

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

We create a list of firms headquartered in Mexico with financial data available from Capital IQ and manually match it with the list of exporters in Panjiva.[2] After an extensive process of data collection and cleaning, we successfully matched 368 nonfinancial firms with about 4.6 million export shipments over the period January 2011 to March 2017. We then aggregated export data at the quarterly frequency and construct the variable ΔX_{ipdt} as the log difference of the volume of exports between quarters t and $t-1$ within product-destination categories. Thus, X_{ipdt} is the sum of the volume of exports of product p to destination country d by firm i in quarter t. This gives us about 166,000 quarterly observations over the period from q1 2011 to q1 2017.

Next, we hand collect detailed information of the firms' debt structure from Capital IQ (Capital structure details module) and from the firms' interim reports. Listed nonfinancial firms are required to submit quarterly reports to the *Bolsa Mexicana de Valores*,

[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.

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

	2012		2016	
	mean	Median	mean	Median
No of lenders	4.7	3	3.7	2
Volume exports (mil kg)	2554	73.8	2,667.7	46.4
Value exports (mil USD)	1,274.5	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

where they report detailed information about their capital structure. By using the public accounting data, we find firm-level capital structure details for a subset of 57 listed firms.[3] We are then able to match borrowing firms and lending banks at the individual loan level. Table 1 reports summary statistics on firm-level exports, destinations and products for this matched sample.

Although we are limiting the analysis to listed firms for which we can measure their exposure to dollar-funded banks, we are still capturing a substantial and highly representative share of the Mexican economy. Nonfinancial listed companies in our sample make up an important part of the Mexican economy: in 2013, the market capitalization of nonfinancial listed firms was 39% of GDP, and foreign sales were 48% of total exports.

Our sample of bank credit captures a significant share of firm credit that is financed through dollar credit and direct-cross border flows and it is different from other studies, for example Morais at al. (2019), who consider mostly local lending by banks incorporated in Mexico. Table 2 gives us a snapshot of the amount of total credit to the 57 publicly listed firms in our sample for which we could find capital structure details (column 1). We first notice that financial institutions provide between 99% and 91% of total credit to firms (column 2) and that total credit decreased over time (column 1).

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

We then delve deeper into the lending banks' capital structure, specifically their reliance on U.S. dollar money market funding (MMF). In this way we can capture which banks, and ultimately which firms, are more exposed to the fluctuations in the short-term dollar funding and credit availability. A bank's exposure to U.S. dollar funding through its liabilities is reported in the banks' regulatory filings to the U.S. Securities and Exchange Commission (SEC), and it is obtained from Crane data. U.S. and non-U.S. global banks have access to wholesale dollar funding from MMFs in the form of commercial paper and certificate of deposits.[4]

Among all the banks, we find 22 MMF-reliant global banks ("MMF banks") that lend to Mexican firms. Ideally, to capture the magnitude of banks' and firms' exposures to U.S. dollar funding as a whole, we would need to include banks' total short-term dollar funding. Our variable on MMF funding therefore understates the size of total dollar funding. However, Table 10 (presented in the Internet Appendix) shows substantial magnitudes for MMF funding for global banks.

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

Local banks can be domestically owned (e.g., Banobras, CI Banco, Banca Afirme) or are subsidiaries of foreign banks (e.g., Banamex, HSBC Mexico, Santander Mexico, BBVA Bancomer). Banco Santander, HSBC, and Credit Agricole are the top-three global MMF banks in terms of aggregate credit to firms (131 billion, 111 billion, and 62.8 billion MXN pesos, respectively), while Bancomer, Banamex, and Banobras are the top three local

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

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

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

banks (293 billion, 89.8 billion, and 60.9 billion MXN pesos, respectively). Credit by global banks is predominantly in U.S. dollars (ranging from 83% to 100%), with two notable exceptions (Santander and HSBC) that also lend in Mexican pesos. Specifically, the ratio of lending in pesos is about 75% for Santander and 35% in the case of HSBC.

In Table 2, column 3, we see that banks reliant on U.S. money market funds (MMF banks) provided about 50% of total credit in 2012, but this ratio dropped to 33% in 2016. This decline in credit supply by global banks followed a worldwide trend.[5]

Subsidiaries of global banks are classified as local banks because their funding structure is typically deposits based. However, we also run robustness tests that consider possible internal capital markets between global parent banks and their affiliates that may contribute to the propagation of shocks as shown in Cetorelli and Goldberg (2012) and Morais et al. (2019).

U.S. MMFs are a significant source of short-term dollar funding for non-U.S. banks, although with a declining importance after the 2008 financial crisis. Before 2011, U.S.-based branches were also suppliers of dollar funding. Following Correa et al. (2021), we confirm from branch-level data from the FFIEC 002 reports that the dollar amount of

[5]For the sample of 22 non-U.S. 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. U.S. global banks saw an increase in total gross loans from 3,149 to 3,460 USD billions.

such branch-level dollar funding for global banking groups is minimal as compared to U.S. MMFs, and does not significantly change our estimation results.

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

Our analysis is centered on the period after the Taper Tantrum of 2013, which followed a surge in capital flows to EMEs driven by accommodative monetary policy in advanced economies and a global search for yield. Our working hypothesis is that banks and firms had increased their reliance on short-term dollar funding thanks to favorable liquidity conditions that accompanied a weak dollar, which spurred risk-taking.

Then, in May 2013 the Federal Reserve began to speak about reducing (or "tapering") the pace of its asset purchases, apparently catching market participants off-balance. Talk of tapering was greeted by market turbulence, as EMEs saw rapid currency depreciations and capital outflows.

To the extent that firms had taken advantage of the prolonged period of favorable dollar funding conditions, the reversal of those conditions would have had large adverse impact. Our approach is to look at what happened to those firms that accumulated the highest exposures to short-term dollar-funded banks in the period immediately before the Taper Tantrum. The exchange rate is an endogenous variable, and its relationship with macro aggregates will reflect two-way causation. However, we take advantage of the fact that each firm taken individually will have only limited impact on the exchange rate. Furthermore, the micro-level approach and the use of fixed effects and other control variables enables us to rule out spurious effects.

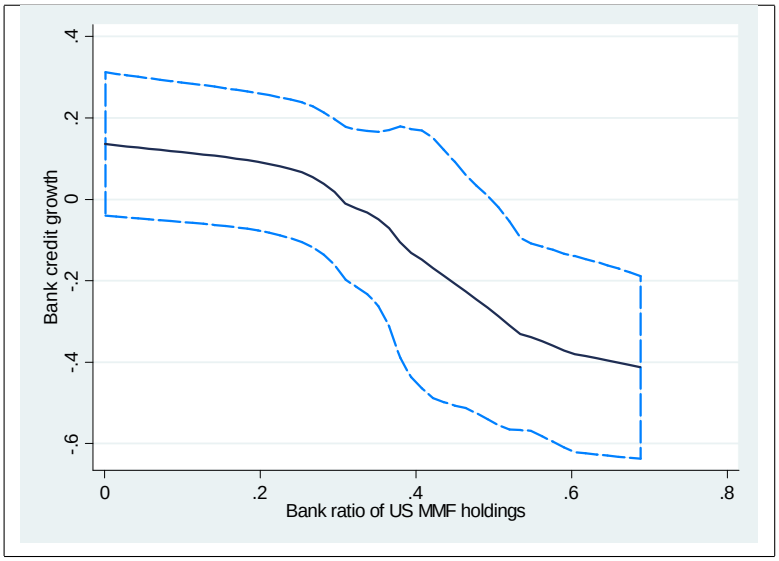

Figure 4
Credit supply and bank dollar funding This figure shows the Kernel-weighted local polynomial smooth plot of the growth in bank credit to firms versus non-U.S. banks' exposure to U.S. dollar funding, with local mean smoothing and 90% confidence intervals and for the period from 2013 to 2016. *Sources*: Crane; Capital IQ; and authors' computations.

2.1 The financial channel and bank credit

To examine the impact of dollar financing cost for working capital, we appeal to the financial channel of exchange rates in Bruno and Shin (2015), which works through global banks that intermediate U.S. dollar credit to local corporates. In the Bruno and Shin model, a broad appreciation of the dollar is associated with lower risk-taking by banks and a decline in their supply of credit.

Figure 4 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 U.S. money market funds scaled by short-term debt as of 2012 (MMF_b). The vertical axis captures the change in bank credit from bank b to firm i during the sample period, when the broad U.S. dollar index strongly appreciated (30% increase in 4 years, from 2013 to 2016) after a prolonged period of weakness in the immediate preceding years. The cross-section evidence across banks in Figure 4 suggests that credit growth is strongly (negatively) correlated with bank reliance on MMF funding.

Digging deeper, we show that banks that are more exposed to wholesale U.S. dollar funding reduce credit more compared to banks that are less dependent on wholesale U.S. dollar funding: as the U.S. dollar appreciates, risk and dollar funding costs increase, and lending drops. We consider the period after the Taper Tantrum of May 22, 2013, which started a prolonged period of dollar appreciation. The focus is on the cross-sectional variation in dollar funding as the key element in our identification exercise.

Our baseline specification is given by Equation (1), which is an ordinary least squares (OLS) regression that relates the credit of each firm-bank pair to the pre-2013 bank-level dependence on U.S. dollar funding as a function of the fluctuations in the broad dollar index during the period 2013 - 2016.

We trace the fluctuations in the supply of credit provided by bank b to firm i from q1 2013 to q1 2016 from the hand-collected capital structure details in Capital IQ and company reports. The baseline specification is as follows:

$$C_{ibt} = \alpha + MMF_b \cdot \Delta USDbroad_t + \varepsilon_{ibt}, \tag{1}$$

where C_{ibt} is the log of credit from bank b to firm i at time t, MMF_b is the ratio of U.S. MMFs liabilities of bank b to total short-term debt and as of end-2012, and $\Delta USDbroad_t$ is the percentage change of the U.S. dollar broad index. The variable *USDbroad* essentially captures the role of the dollar as a global credit supply factor.

Specification (1) includes firm-time and firm-bank fixed effects. Firm-bank fixed effects enables us to exploit variation within the same firm and bank over time, thus taking into account the possibility that firms are matched to banks (Giannetti and Ongena 2012). Firm-time fixed effects control for firm-demand. Time-varying bank-level controls, such as firm size, capitalization, profitability, and deposit ratio, are included in some cases. A range of robustness exercises tackles alternative channels of transmission that may affect credit supply decisions. Standard errors are clustered at the bank level. All regressions

are produced in STATA using *reghdfe* as described in Correia (2017). The within-firm estimator compares the change in the amount of lending by banks with different exposure to dollar funding to the same firm, allowing us to disentangle credit supply from credit demand.

Table 3 shows the estimation results. We start by restricting the sample to global banks with exposure to U.S. money market funding (i.e., $MMF_b > 0$). Column 1 shows that the coefficient estimate of $MMF_b \cdot \Delta USDbroad$ is negative and statistically significant at the 5.1% level, meaning that global banks that are more reliant on U.S. money market funds reduce their lending more to firms following U.S. dollar appreciation, which is consistent with the predictions in Bruno and Shin (2015).

In terms of economic magnitude, from column 1 we estimate that a bank with money market funding consisting of 10% of its short-term debt will decrease its average loan by 3% more than a bank with a 5% ratio for every 1% appreciation of the U.S. dollar.

In column 2 we confirm the evidence after excluding U.S. banks, and the coefficient estimate of $MMF_b \cdot \Delta USDbroad$ becomes statistically significant at the 1.7%.

Banks not only differ in exposure to dollar appreciation via their reliance on U.S. MMF but also differ in the share of lending they do in dollars versus pesos. In column 3, we rerun the benchmark specification after excluding lending that is denominated in Mexican pesos. We find that the estimated coefficient of $MMF_b \cdot \Delta USDbroad$ becomes more statistically significant and also larger (in absolute terms).

Next, we consider the possibility that the dollar funding exposure of subsidiaries (e.g., Banamex) is linked to their parent bank (e.g., Citigroup). We construct the variable MMF_{b+s} where the subsidiary/branch inherits the MMF exposure of the parent. For example, in the case of Citigroup and Banamex, the MMF exposure of Banamex is defined as being identical to that of Citigroup itself. If MMF funding by Citigroup headquarters flows to Banamex, then we can address the indirect dollar funding channel by using the

headquarters exposure to MMF funding as a proxy for the interoffice flows that come from internal capital markets. Cetorelli and Goldberg (2012) and Morais et al. (2019) find that global banks manage liquidity on a global scale using cross-border internal funding.

In column 4, the coefficient estimate of $MMF_{b+s} \cdot \Delta USDbroad$ remains negative but slightly smaller than in the case of MMF_b, and statistically significant at the 6.7%. The 2010 BIS report on "Funding patterns and liquidity management of internationally active banks" helps with understanding the different magnitude resulting from including the subsidiaries in the estimation. According to the BIS report, funding and liquidity management practices of international banks are diverse and cover a whole spectrum between centralized and decentralized operations. Japanese, French, and German banks fund most of their foreign activity from their home offices, whereas Spanish banks record the largest share of local funding among the major banking systems.

Given such differences in the funding structure, in column 5 we replicate column 4 estimation after excluding Spanish banks and subsidiaries. The magnitude of the coefficient $MMF_{b+s} \cdot \Delta USDbroad$ increases, as well as its statistically significance, confirming that funding and liquidity practices of global banks are diverse. All in all, the evidence from columns 1 to 5 confirms the effect coming from the financial channel of exchange rates through both the "local lending financial channel" and the "direct cross-border financial channel" as a function of funding and liquidity practices of international banks.

In the last two columns of Table 3, we augment the sample by including all non-MMF banks, that is, those banks with $MMF_b = 0$. In column 7, we also include firm-level time-varying control variables, such as size, profitability, capital, and liquidity ratios. The interaction term $MMF_b \cdot \Delta USDbroad$ continues remaining negative and significant, supporting the existence of an association between credit supply and shifts in financial conditions due to dollar appreciation.

Table 3

Bank credit and U.S. dollar funding This table shows panel regressions where the dependent variable is the volume of loans, in logs, from a bank to a firm over the period 2013-2016. The variable MMF captures the holdings of U.S. MMFs as reported in the banks' regulatory filings to the Securities Exchange Commission, scaled by short-term debt, as of 2012. Global banks are banks with positive MMF. In columns 4 and 5 the subsidiary/branch bank has the same MMF exposure of the parent bank. USDbroad is the percentage change in the U.S. broad dollar index. Firm-bank and firm-year fixed effects are included in all specifications. Column 7 include firm-level time-varying control variables. Standard errors are corrected by clustering at the bank level. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

Sample	(1) Global banks	(2) Global banks ex U.S.	(3) Global banks ex-Pesos	(4) Global banks and subs	(5) Global banks and subs ex ESP	(6) All banks	(7) All banks
$MMF_b \cdot \Delta USDbroad$	-60.0410*	-66.0161**	-76.5022***			-39.0776*	-37.3667*
	[29.3402]	[25.4348]	[25.2868]			[23.3549]	[21.7708]
$MMF_{b+s} \cdot \Delta USDbroad$				-52.7421*	-57.5501**		
				[27.7654]	[26.8187]		
Constant	3.8849***	4.0369***	3.5541***	3.7273***	3.8368***	3.1333***	10.1085
	[0.3016]	[0.2769]	[0.2624]	[0.2735]	[0.2694]	[0.0842]	[8.7089]
Observations	644	448	535	820	804	2,008	1,864
No. banks	28	22	28	32	31	133	112
R-squared	.712	.758	.559	.694	.697	.667	.673

2.1.1 Additional robustness tests.

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

In Table 11 reported in the Internet Appendix we show the results with MMF_b interacted with oil prices, GDP, the bilateral Mexico-U.S. exchange rate, the VIX, Term Spread, the U.S. rate, all with firm-time and firm-bank fixed effects. The interaction term $MMF_b \cdot \Delta USDbroad$ remains negative and statistically significant even after including these additional macro factors, confirming that the main channel of transmission is through dollar funding.

In Table 12 of the Internet Appendix, we verify that a drop in credit supply should be more visible for the firms that are more exposed to a currency mismatch. We confirm that our results survive when firms in the oil and energy sectors are excluded. We also show augmented regressions including the capital ratio and the liquidity ratio of banks. Interesting, we find that a higher deposit ratio helps counterbalance the bank exposure to the U.S. money market funding, but the bottom line is that a bank exposed to U.S. money market fund is still vulnerable to exchange rate fluctuations. Finally, we show that non-MMF banks do not substitute global MMF-bank credit, suggesting that dollar funding is unique and not easily replaceable.

3 The Financial Channel and Exports

In this section we investigate how firms' dependence on dollar credit affects (through their banks) the sensitivity of exports to dollar fluctuations. Our hypothesis is that the decline in dollar credit following dollar appreciation will affect firms' exports. Firms that rely on dollar-funded credit will be affected the most.

Figure 5 is a stark illustration of how reliance on dollar bank credit affects exports. The left-hand-side panel plots the median growth in quarterly export volumes for the subsample of firms with high exposure to U.S. dollar-funded banks (blue line) and those with low exposure dollar-funded banks (green line). Firms with a higher exposure to dollar funding through bank credit tend to have lower growth rates than firms with a lower exposure to dollar funding after the Taper Tantrum event. Also, the two groups of firms do not tend to move in tandem.

A striking correlation appears when we plot the quarterly percentage change of export volumes together with the broad U.S. dollar index. After the May 2013 event, the correlation between the percentage change of the broad dollar index (lagged by one quarter) and the percentage change of export volumes is -18% for the sample of firms with High MMF exposure (right-hand-side panel of Figure 5) and +22% for the sample of firms with Low MMF Exposure (not shown). All in all, Figure 5 tells the narrative of our paper: as the dollar appreciates, firms with higher dependence on dollar funding have a lower export growth rate than firms with lower dependence on dollar funding.

Motivated by Figure 5, we delve into a more detailed investigation of the relationship between dollar credit and export performance.

3.1 Empirical design

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

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

Second, we use firms' initial exposure to dollar-funded banks as a proxy for the sus-

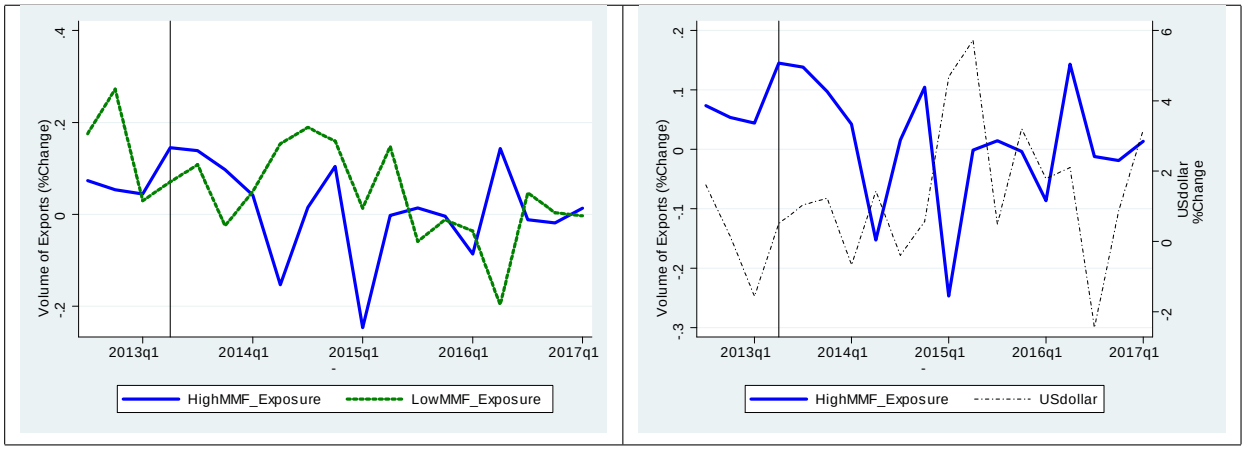

Figure 5
Exports and firm exposure to U.S. dollar funding The left-hand-side panel plots the median quarterly growth in the export volumes for the group of firms with high (High MMF exposure) or low (Low MMF exposure) exposure to dollar-funded banks. The right-hand-side panel plots the median quarterly growth in the export volumes for High MMF Exposure group of firms together with the quarterly percentage change of the broad U.S. dollar index.

ceptibility 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 negative effect on firm A's exports. We make use of such cross-section differences across firms. In particular, we focus on the cross-sectional variation in funding sources as the key element in our identification exercise.

Third, we consider the period after the Taper Tantrum episode of May 22, 2013, which started a prolonged period of dollar appreciation and capital outflows from emerging markets after a period of sustained dollar weakness and favorable liquidity conditions. Our approach is to look at what happens to the exports of those firms that accumulated the highest exposure to U.S. dollar-funded banks in the immediate period before the Taper Tantrum after which the wheel turned.

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

$$FMMF_i = \sum_b \omega_{ib} MMF_b, \tag{2}$$

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 U.S. 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 U.S. MMF funding, where the weight ω_{ib} captures the fraction of credit to firm i from bank b. Hence, $FMMF_i$ is a time invariant variable that captures the firm's exposure to banks more dependent on U.S. dollar wholesale funding pre-Taper Tantrum. A higher $FMMF_i$ indicator indicates that firms are more exposed to banks with higher U.S. money market funding. The variable $FMMF_i$ ranges from 0 (for those firms that do not receive credit from dollar-funded banks) to a maximum value of 0.85. The mean exposure $FMMF_i$ to dollar-funded banks is 0.07.

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

$$\Delta X_{ipdt} = \beta \cdot \Delta USDbroad_{t-1} \cdot FMMF_i + \varepsilon_{ipdt}, \tag{3}$$

where ΔX_{ipdt} is the quarterly log difference of the volume of exports, $\Delta USDbroad_{t-1}$ is the log difference of the dollar U.S. broad index with one quarter lag.

This specification allows us to compare the growth in exports of the same product and to the same destination across firms that borrow from banks with different exposure to dollar funding shocks. By taking each firm's exposure to U.S. dollar-funded banks as of 2012 and looking at the impact on exports post-2012, we mitigate the endogeneity

problem of regressing exports on the contemporaneous amount of bank credit taken by a firm. Hence, the coefficient estimate of $\Delta USDbroad_{t-1} \cdot FMMF_i$ captures the average sensitivity of the firm's credit to fluctuations in the dependence of the firm's *lenders* to U.S. dollar funding.

Importantly, by looking at dollar fluctuations, that is, at the interaction between FMMF (the firm dependence on money-market-funded banks) and the change in the broad dollar index, we can pinpoint the precise channel at play, that is, the financial channel of exchange rates.

Specification (3) is saturated with a plethora of fixed effects. The most stringent specification includes time-product-destination fixed effects to absorb demand fluctuations of product p and destination d at quarter t. The estimation period is q3 2013 to q1 2017, and standard errors are corrected for clustering at the firm level. We present robustness tests to account for alternative reasons that may bias the evidence on exports other than credit supply, including horseracing the broad dollar exchange rate with other channels, like U.S. monetary policy or global volatility. We also present a Bartik-style instrumental variable approach as an alternative estimation strategy.

3.2 Cross-sectional evidence across exporting firms

Column 1 of Table 4 shows a parsimonious specification in terms of fixed effects by using time-destination, product, and firm fixed effects separately, which allows to preserve the largest sample size. The coefficient of the interaction $\Delta USDbroad \cdot FMMF_i$ is negative and statistically significant, meaning that the greater the firm's exposure to dollar-funded banks, the lower is the growth of exports following dollar appreciation.

Column 2 further controls for product specific demand by using time-product, time-destination and firm fixed effects. Because of the presence of singletons, the sample is reduced by about 15%, however the interaction $\Delta USDbroad \cdot FMMF_i$ remains negative and statistically significant.

Banks may specialize by lending to firms in specific markets, hence banks and firms may not be randomly matched. In our setting, since the United States accounts for three quarters of the Mexican export value, it is likely that some banks (especially in the United States) may select firms that are exposed to the U.S. market. In column 3 we exclude the United States as the exports destination country, while continuing controlling for product, time and destination fixed effects, with qualitatively similar results.

In column 4 we fully control for destination and product specific demand at time t by using time-product-destination fixed effects concurrently with firm fixed effects. Because of singletons, introducing time-product-destination fixed effects reduces the sample by about 85%. Nevertheless, results remain statistically significant at the 5% level.

If we use the coefficient from column 4 of Table 4, for the median value of $FMMF_i$ the estimates give a lower growth in exports by 0.14% than for a firm with no exposure to dollar-funded banks. The average dollar appreciation between 2013 and 2016 was 1.3% on a quarterly average, which means that a firm with a median exposure has a lower growth of exports by 0.18% (on a quarterly average, which translate to an average annual difference of 0.7%). Given that the median difference in the growth of exports between a median FMMF firm and firms with $FMMF_i = 0$ is 0.65% on average per quarter, our estimates imply that the partial effect of dollar fluctuations can account for approximately a third of the lower export growth for a firm with a median exposure to dollar funding. Hence, the financial channel can account for a substantial fraction of the contraction in exports. All in all, our estimates highlight the importance of financial frictions linked to the U.S. dollar as the barometer of financial conditions and also outside crises times.[6]

[6] In general, according to Ahn et al. (2011), economic models that do not incorporate financial frictions only explain about 70% to 80% of the decline in world trade that occurred in the 2008–2009 crisis. For the case of Peru, Paravisini et al. (2014) estimate that the credit shock deriving from the GFC can account for approximately 8% of the missing volume of exports. Amiti and Weinstein (2011) study the Japanese financial crises from 1990 through 2010 and find that the partial effect deriving from a deterioration of bank health (captured by bank share decline) account for 46% of the drop in export growth in 1991, 22% in 1991, 30% in 1993, and 46% in 1998.

Table 4
Exports and U.S. dollar funding This table shows panel regressions where the dependent variable is the quarterly change in firms' exports within products-destinations for the period q3 2013-q1 2017. Exports are measured in volume (columns 1 to 4), value (columns 5 and 6), and unit of cargo capacity (column 7). USDbroad is the quarterly change in the U.S. dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Volume	Volume	Volume	Volume	Value	Value	TEU
$\Delta USDbroad \cdot FMMF_i$	-3.3875***	-4.5232*	-5.5570*	-8.7502**	-16.0813***	-12.6538***	-8.7448*
	[1.2672]	[2.5300]	[2.8640]	[3.7027]	[4.8443]	[4.6123]	[4.5933]
Constant	-0.0036***	0.0000	0.0026	-0.0112***	0.0335***	0.0186***	-0.0163***
	[0.0008]	[0.0017]	[0.0020]	[0.0022]	[0.0029]	[0.0026]	[0.0025]
Time-destination FE	✓	✓	✓				
Time-product-destination FE				✓	✓	✓	✓
Time-product FE		✓	✓				
Product FE	✓						
Firm FE	✓	✓	✓	✓	✓	✓	✓
Sample	All	All	U.S. excluded	All	All	U.S. only	All
Observations	59,492	50,436	38,399	6,400	6,470	4,318	6,550
R-squared	.097	.297	.312	.493	.465	.421	.496

Our estimation approach compares volumes of exports within product-destination markets. Volumes do not suffer potential confounding effects from changes in prices. In columns 5 and 6 we nevertheless use the percentage change in values rather than volumes. Column 5 shows that the estimations are in line with the previous evidence: an appreciation of the U.S. dollar negatively affects the export values of those firms that depend more on credit from dollar-funded banks.

Half of international goods trade is invoiced in dollars. Gopinath et al. (2020) show that the pass-through from the dollar exchange rates to prices and quantities varies across countries, but it depends on the share of dollar-invoicing for the importing country. The rationale is that dollar invoicing share is a good measure of the overall pass-through to domestic prices arising from dollar fluctuations. In column 6 we restrict the estimation sample to the exports to the United States as the destination country. Goods exported to the United States are likely to be invoiced in U.S. dollars, so that restricting the sample to exports to the United States allows us to disentangle the role of currency invoicing from the financial channel.

Column 6 shows that the coefficient of $\Delta USDbroad \cdot FMMF_i$ remains negative and statistically significant also in the case of exports to the United States, when fluctuations in dollar exchange rates do not feed mechanically into changes in domestic prices. This result shows that exports to the United States are subject to the same negative effect coming from the financial channel as exports to other destinations, even though the competitiveness channel would entail an unambiguous boost in exports. We conclude that the financial channel affects exports in a manner opposite to the improvements in trade competitiveness. In Table 8 we verify that this result holds also in the case of export volumes. We also examine the role of the dollar bilateral exchange rate.

Finally, in column 7 we use the percentage change in TEU, a unit of cargo capacity based on the volume of a 20-foot-long container, with qualitatively similar results.

The preceding identification strategy is based on the firms' initial exposure to dollar-funded banks as a proxy for the susceptibility to credit supply shocks and for exploiting the cross-section difference across firms. In October 2016, the U.S. money market reform was implemented. Although the reform was announced in 2014, most of the changes in the banks's MMF assets under management occurred within one year prior to the implementation deadline. In fact, Anderson, Du, and Schlusche (2021) find that the MMF new rules became relevant after October 2015. Hence, the final period of our estimation could be potentially affected by the MMF reform. In Table 5, we reestimate specifications 1 and 3 (with time-product-destination fixed effects), and exclude the "effective" period of the MMF reform. Columns 1 and 2 show that the results remain qualitatively unchanged.

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

$$B_{b,t} = MMF_b \cdot \Delta(MMF_{s,t} - MMF_{b,t}), \tag{4}$$

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

Table 5, column 3, shows the first stage estimation results from Specification 1 that looks at bank credit C_{ibt} from bank b to firm i over the period 2013 to 2015 (pre-MMF reform) and uses the instrument $B_{b,t}$ in lieu of MMF_b. The coefficient estimate of $B_{b,t}$ is positive and statistically significant, meaning that a dollar funding shock has a significant

effect on bank credit. The first-stage F-statistics is 16.5, which suggests a fair quality of the instrument. These results are consistent with the evidence shown in Ivashina et al. (2015) and Anderson, Du, and Schlusche (2021), who find that banks reduced their dollar loan origination in response to the negative funding shock from MMF during the European debt crisis.

In column 4 we take the fitted values $\widehat{C_{i,t}}$ from the first stage regression to construct a firm-level credit indicator with 2012 bank-level weights, and use it in specification 3 lieu of $\Delta USDbroad \cdot FMMF_i$ for the pre-2016 MMF reform implementation period with bootstrapped standard errors. The coefficient estimate of $\widehat{C_{i,t}}$ is positive and statistically significant, confirming the positive association between credit and exports.[7]

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

In unreported estimations, we also run a difference-in-difference analysis where the pre-Taper Tantrum period corresponds to q1 2012 – q2 2013 and the post period covers exports from q3 2013 to q4 2014. From the point of view of individual firms, the exchange rate shock following the Taper Tantrum can be taken as exogenous, even though it affects

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

Table 5
Exports and U.S. dollar-funding Columns 1 and 2 present regression results from specifications 1 and 3 after excluding the period related to the U.S. MMF reform implementation. Columns 3 and 4 implement an instrumental variable estimation. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)
Dependent variable	Bank credit	Exports	Bank credit first stage	Exports second stage
MMF_b	-2.7944***			
	[0.5933]			
$\Delta USDbroad \cdot FMMF_i$		-9.7172**		
		[3.8854]		
$B_{b,t}$			35.1771***	
			[8.6468]	
$\widehat{C_{i,t}}$				1.1030**
				[0.5161]
Constant	0.5482***	-0.0060***	0.5795***	-0.0376*
	[0.1409]	[0.0022]	[0.1523]	[0.0222]
Observations	213	5,439	210	4,923
R-squared	.325	.493	.324	.502

firms differently depending on their characteristics. The treated sample consists of firms exposed to dollar-funded banks, and the control sample consists of those firms unexposed to dollar-funded banks. We find that the treated sample is associated with a lower growth in exports than the controlled sample after the Taper Tantrum period. However, by using this specification we cannot pinpoint directly to the financial channel in action via the U.S. dollar exchange rate.

3.3 Evidence from intermediate goods

The preceding sections have shown that firms that are financed by banks exposed to U.S. dollar funding suffer a drop in credit supply following dollar appreciation, which negatively affects their exports. When the firm looks to outside financing for working capital, it is normally banks that supply financing, and very often in the U.S. dollar. If financing conditions tighten and banks pull back dollar funding, it is likely that some

global value chains will no longer be viable economically. Finding other sources of funding may take time. This may explain why a stronger dollar (as a barometer of global financial conditions) has not led to higher exports by EMEs, as a stronger dollar is generally associated with tighter funding conditions.

Firms managing their global value chains are like jugglers with many balls in the air at the same time. The balls are of different shapes and sizes. Some of them will be heavy, as they represent almost finished products of high value. Long and intricate GVCs mean many balls are in the air at the same time, signifying the need for greater financial resources to knit the production process together. In this context, looser financing conditions are like weaker gravity for the juggler. When financing conditions are loose, the firm juggling so many balls in the air finds that it can throw more balls up at the same time and manage to juggle them there at little financial cost. But when financial conditions tighten, it is more difficult to keep so many balls in the air at the same time. The large balls become especially heavy.

Building and sustaining supply chains are finance-intense activities, and so our hypothesis is that our results will hold with added force when firms have additional financing needs due to extended supply chains. Another way of saying this is that the financing need is non linear and it is a convex function of the length of the chain. Kalemli-Ozcan et al. (2014) show that upstream firms (supplier firms) have higher working capital needs compared to downstream firms (final product firms). Similarly, Gofman and Wu (2022) find that firms that are further from the consumption goods sector provide (and receive) more trade credit. Furthermore, Kalemli-Ozcan et al. (2014) and Gofman at al. (2020) show that upstream firms' working capital is more sensitive to fluctuations in financial conditions than it is for downstream firms. For instance, profit margins and net accounts receivable drop more for upstream firms than for downstream firms in the period 2008-09.

Bruno, Kim, and Shin (2018) show through a theoretical exercise that GVC length is

decreasing in the value of the dollar because longer supply chains entail greater financing needs, which increase in a nonlinear way with the length of the supply chain. Because of this feature, a negative financing shock will have a greater aggregate effect when supply chains are longer. However, Bruno et al. (2018) do not explore the credit supply shock originating from the banking sector and affecting working capital costs, and do not disentangle the financial channel from other channels, for example, invoicing aspects.

Building on the above discussion, we delve deeper in our empirical investigation to gauge whether the impact of financial conditions is felt more strongly for exports of goods that are further from the consumption goods sector. We classify each product as capital, intermediate, or consumption goods as defined by the U.S. International trade statistics.[8] We then split the sample between intermediate versus nonintermediate goods and run Specification (3).

Table 6 shows that the estimated coefficient of the interaction term $\Delta USDbroad \cdot FMMF_i$ is negative and statistically significant only for the subsample of intermediate products (column 1), also after with the inclusion of time-product-destination fixed effects (column 3). In contrast, the interaction term $\Delta USDbroad \cdot FMMF_i$ is statistically insignificant for the subsample of consumption goods (columns 2 and 4). Taken together, these results confirm that firms with higher financing needs to sustain their production chains suffer from dollar appreciation associated with a reduction in credit supply.

We also check for the means of transportation of exported goods. Amiti and Weinstein (2011) and Schmidt-Eisenlohr (2013) show that working capital considerations loom larger for firms shipping goods by sea relative to those exporting by air due to the greater delays in cashflows. We generate a dummy variable *Air* equal to one when the firm-product-destination is exported by air, and zero otherwise.

In Table 6, column 5, we interact the dummy *Air* with $\Delta USDbroad \cdot FMMF_i$. The

[8] https://unstats.un.org/unsd/tradekb/Knowledgebase/50090/Intermediate-Goods-in-Trade-Statistics. Classification is at the six-digit HS code.

Table 6
Exports and financing needs This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations. USDbroad is the quarterly change in the U.S. dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Air is a dummy variable equal to one when the firm-product-destination is exported by air, and zero otherwise. Standard errors are corrected for clustering of observations at the firm level. $p <.1$; $^{**}p <.05$; $^{***}p <.01$.

	(1)	(2)	(3)	(4)	(5)
Sample	Intermediate goods	Consumption goods	Intermediate goods	Consumption goods	All
$\Delta USDbroad$	-6.8094**	-1.2040	-12.4640***	7.7974	-5.1782**
$\cdot FMMF_i$	[2.5754]	[17.1682]	[3.1106]	[24.8968]	[2.1625]
$\Delta USDbroad$					8.7086*
$\cdot FMMF_i \cdot Air$					[4.7466]
Constant	0.0042*	0.0023	0.0083***	-0.0584***	0.0114***
	[0.0022]	[0.0055]	[0.0019]	[0.0142]	[0.0023]
			Fixed effects		
Time-product -destination			✓	✓	
Time-destination	✓	✓			✓
Time-product	✓	✓			✓
Transportation					✓
Observations	30,956	15,267	4,242	1,465	22,128
R-squared	.322	.325	.509	.468	.337

results indicate that dollar exchange fluctuations matter for firms that are exposed to dollar funding shocks and when do not export goods by air as the joint significance test $\Delta USDbroad \cdot FMMF_i + \Delta USDbroad \cdot FMMF_i \cdot Air$ is not significantly different from zero. This result suggests that when the dollar appreciates and credit supply declines, the shorter time needed for trade helps alleviating the increased financing costs, consistent with the fact that working capital considerations are larger for goods shipped by sea or land relative to those exported by air.

3.4 Evidence from domestic sales and accounts receivable

How do firms deal with changes in the supply of dollar-funded credit? We start by looking at domestic sales and collect data on domestic sales from Capital IQ (Geographic segment module) and Thomson Reuters at the quarterly frequency. Such data are available for an unbalanced panel of firms. Amiti and Weinstein (2011) find that the health of banks providing finance has a much larger effect on exports than on domestic sales because exporters need more working-capital financing than firms engaged in domestic transactions. Our focus is on the role of the U.S. dollar as a credit supply factor and the contrasting effect on domestic sales versus exports.

We compute the growth in quarterly domestic sales and regress it on $FMMF_i$ interacted with $\Delta USDbroad$, with firm and year fixed effects. In column 1 of Table 7 $\Delta USDbroad \cdot FMMF_i$ is not statistically significant, suggesting that the greater need for dollar-funded working capital is export specific, and not a general effect applicable to all sales. This evidence reinforces our earlier results by showing that exports are more sensitive to dollar funding shocks than domestic sales. The effect coming from the financial channel goes in the opposite direction to the trade competitiveness channel where dollar appreciation leads to increased foreign sales and reduced domestic sales (Dornbusch 1987).

Next we look at trade credit by regressing the quarterly percentage change of accounts receivable on $\Delta USDbroad \cdot FMMF_i$. Studies have found a negative impact on trade credit

Table 7
Domestic sales and trade credit This table shows panel regressions where the dependent variable is the quarterly percentage change in domestic sales (column 1) or accounts receivable (columns 2 to 5). USDbroad is the quarterly percentage change in the U.S. dollar broad index. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors are corrected for clustering of observations at the firm level and are reported in brackets. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)
Dependent variable	Domestic sales	Account receiv.	Account receiv.	Account receiv.
Sample		All	High exports	Low exports
$\Delta USDbroad * FMMF_i$	1.4017	-4.1103**	-5.6277***	3.9470
	[1.6462]	[1.6282]	[1.3672]	[5.9437]
Constant	0.0180***	0.0195***	0.0255***	0.0227***
	[0.0015]	[0.0011]	[0.0017]	[0.0035]
Firm FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
Observations	552	808	275	275
R-squared	.078	.055	.136	.162

following credit supply shocks. For instance, Love et al. (2007) find that during the Asian crisis firms that are financially more vulnerable to crises extend less trade credit to their customers. This happens because trade credit cannot be used as a substitute to bank credit during financial crises as alternative sources of financing become scarce.

Our focus is on dollar financing and firms' vulnerability to dollar funding outside crisis times. If financing conditions tighten and banks pull back dollar funding, some GVCs will likely no longer be viable economically because of higher working capital costs.

Column 2 of Table 7 shows that $\Delta USDbroad \cdot FMMF_i$ is negative and statistically significant, and this result is driven by the subsample of firms with a higher percentage of exports (column 3). This result suggests that dollar-funded exporters suffer a larger decline in trade credit following dollar appreciation because extending trade credit becomes costlier. The same evidence, however, does not apply to firms with low export intensity (column 4).

Taken together, the evidence in Table 7 is indicative of the broader consequences of dollar credit and U.S. dollar fluctuations. Tighter dollar financial conditions have a limited effect on domestic production, but they increase the cost of extending trade financing. However, not all firms are equally affected. The evidence is strongest for dollar-funded exporters, that is, firms that suffer a decrease in credit supply.

3.5 Which exchange rate?

Our analysis focuses on the broad U.S. dollar index as the relevant exchange rate capturing the financial channel. How about the bilateral exchange rates? Gopinath et al. (2020) have drawn attention to the prevalence of dollar invoicing: when exports are invoiced in dollars, if the destination country currency weakens against the U.S. dollar, there is a decline in exports due to the loss of competitiveness of the exporter. Conversely, when the destination country currency strengthens against the dollar, exports increase through enhanced competitiveness. Although the "invoicing channel" by Gopinath et al.

also predicts a decline in exports following U.S. dollar appreciation, the mechanism is different, and does not appeal to the cost of financing in dollars.

Column 1 of Table 8 reports the benchmark result from the most stringent specification with product-destination-time fixed effects (column 4 of Table 4), for the full sample of destination countries, with export volumes as dependent variable and the broad dollar index as exchange rate. The main message here is that the broad dollar index is the barometer of financial conditions and the proxy capturing the financial channel through which ultimately exports are affected.

A key result is in column 2, which reports estimation results from export volumes to the United States only. This subsample provides an important benchmark because the U.S. dollar is the currency of the destination country (as well as being the invoicing currency), hence we can eliminate the invoicing channel from consideration. The estimated coefficient on $\Delta USDbroad \cdot FMMF_i$ is negative and significant, meaning that exporters to the United States that are heavily exposed to dollar-funded credit are negatively affected by dollar appreciation. This result suggests that the broad dollar index is an indicator of bank balance sheet costs with an ultimate impact on exports.

Taken together, the evidence in column 2 of Table 8 on export volumes coupled with the evidence in column 6 of Table 4 on export values shows that the negative impact from the financial channel goes in the opposite direction to the competitiveness channel, and that the relative potency of the financial channel becomes stronger when the firm is more exposed to short-term dollar funding via its banks. This is so even though the competitiveness channel would entail an unambiguous boost in exports from dollar appreciation.

In column 3 we use the bilateral exchange rate of the export destination country vis-à-vis the U.S. dollar ($\Delta USD\_destination$) in lieu of the broad U.S. dollar index. The estimated coefficient of $\Delta USD\_destination * FMMF_i$ is negative and statistically insignif-

Table 8
Exchange rates This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products destinations for the period q3 2013-q1 2017 and with product-destination-time fixed effects. USDbroad is the quarterly change in the U.S. dollar broad index. USDdestination is the bilateral exchange rate of the export destination country vis-a-vis the U.S. dollar. Bilateral is the Mexican pesos bilateral exchange rate. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Standard errors corrected for clustering of observations at the firm level are reported in brackets. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta USDbroad \cdot FMMF_i$	-8.7502**	-8.1561*				
	[3.7027]	[4.6485]				
$\Delta USD\_destination \cdot FMMF_i$			-10.9661	-10.7910	-10.5291	
			[8.0565]	[8.8034]	[8.6174]	
$\Delta bilateral \cdot FMMF_i$						0.7472
						[2.6477]
Constant	-0.0112***	-0.0198***	-0.0154***	0.0020	0.0065*	-0.01747***
	[0.0022]	[0.0026]	[0.0008]	[0.0027]	[0.0033]	[0.0034]
Sample	All	U.S.	All	Exc U.S.	Exc fixed ex rate	All
Observations	6,400	4,220	6,400	2,179	1,714	6,400
R-squared	.493	.432	.493	.627	.660	.493

icant, and it remains so even after excluding exports to the United States (column 4) and fixed exchange rates regimes (column 5).

Finally in column 6 we consider the Mexican pesos bilateral exchange rate vis-à-vis the destination countries (from Banco de México). The interaction term $\Delta bilateral * FMMF_i$ is not statistically significant.

Taken together, these results are suggestive of a financial channel at work for dollar-funded firms: a broad dollar appreciation increases tail risks in the global credit portfolio and reduces spare credit capacity through a value-at-risk (VaR) constraint. Consequently, firms that are exposed to dollar-funded credit will be affected by dollar fluctuations.

3.6 Preeminence of the financial channel

Having demonstrated that the impact of the financial channel on exports exercises an opposite force to the competitiveness channel, a natural question is whether there are instances when the financial channel outweighs the competitiveness channel (and vice versa). Although a general equilibrium framework is beyond the scope of this paper, we can generate predictive evidence by looking at those firms that would be more or less affected by dollar funding conditions.

We first split the sample of firms between those with low exposure to dollar funding ($FMMF_i = 0$) and those with high exposure to dollar funding (upper tercile of $FMMF_i$). The financial channel is likely to have the strongest potency for firms with the highest exposure to dollar funding. In contrast, the competitiveness channel is likely to be at play for firms with low or no exposure to dollar funding. Second, we consider the broad U.S. dollar index as the relevant exchange rate for the financial channel and the bilateral exchange rate as the relevant one for the competitiveness channel. Bilateral exchange rate data are from Banco de México.

After making this sample selection, we run the benchmark specification with the volume of exports as dependent variable and with firm-product-destination fixed effects. This time, the relevant exchange rate variable is not interacted with $FMMF_i$ because we want to capture the overall effect on exports coming from exchange rate fluctuations. We also include time fixed effects, but only in the specification that uses the bilateral exchange rate. Furthermore, we consider two quarter lags effect coming from the exchange rate, so the reported coefficient captures the sum of the two lags.

Column 1 of Table 9 shows that as the Mexican bilateral exchange rate depreciates by 1%, exports go up by 1% for the sample of firms that are not exposed to dollar funding. This evidence shows a case in which the competitiveness channel is at play. Column 2 instead shows that the coefficient of the bilateral exchange rate is no longer statistically

Table 9
Preeminence of the financial channel This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017 and with firm-product-destination fixed effects. Columns 1 and 2 include quarter-year fixed effects. USDbroad is the quarterly change in the U.S. dollar broad index. Bilateral is the Mexican pesos bilateral exchange rate. Standard errors corrected for clustering of observations at the firm and quarter-year level are reported in brackets. $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

	(1)	(2)	(3)	(4)
Firm exposure				
to dollar funding	Low	High	Low	High
$\Delta bilateral$	0.9936***	0.2708		
	0.3296	0.3433		
$\Delta USDbroad$			-0.9584	-1.8066*
			1.1658	0.9850
Constant	-0.0513***	-0.0149***	-0.0002	0.0353***
	[0.0039]	[0.0037]	[0.0247]	[0.0062]
Firm-product-destination FE	✓	✓	✓	✓
Time FE	✓	✓		
Observations	10,268	8,969	12,785	10,591
R-squared	0.148	0.071	0.133	0.077

significant for the sample of firms that are exposed to dollar funding.

Columns 3 and 4 replicate the analysis with the broad U.S. dollar index in lieu of the bilateral exchange rate and without time fixed effects. Here, we see that the coefficient of the broad dollar index is negative and statistically significant in the case of firms that are exposed to dollar funding, but not for those firms where $FMMF_i = 0$. Taken together, this evidence suggests that when firms are exposed to dollar funding, the financial channel outweighs the competitiveness channel.

3.7 Additional robustness tests

Additional robustness tests and discussion of alternative channels are presented in the Internet Appendix. In Table 13 we control for firm characteristics, such as cash, size, profitability, or leverage, with unchanged results. We additionally look for potential firm-

level effects that may bias the evidence on exports for reasons other than credit supply shocks. For instance, exchange rate fluctuations may affect 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 14 we focus on alternative channels that may endogenously account for exchange rate shocks, for instance, U.S. monetary policy, global economic conditions, volatility, and local financial conditions. This analysis confirms the role of the broad dollar index in funding and lending decisions by global banks, with repercussions on firm-level exports.

4 Concluding Remarks

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

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 financial channel of exchange rates. Our results have made use of this opening made possible by the micro data. Horseracing tests and robustness analysis show that our results are robust to other possible confounding domestic or global

variables. The sample period of our study (2013-2017) was one when exchange rates were front and center of the financial commentary, and it serves as an ideal test period for the financial channel. The dollar index appreciated by 30% in 4 years, even as monetary policy action was less dramatic (the Fed Funds rate started to rise gently from December 2015).

At the micro-level, we find that the financial channel bears an opposite force to the competitiveness channel. The relative potency of the financial channel is larger for firms that are more exposed to dollar funding conditions, for whom the financial channel is powerful enough to outweigh the positive improvements from trade competitiveness. The case of exports to the United States is particularly notable as a clean illustration of the financial channel at play, given that the competitiveness channel would entail an unambiguous boost in exports. Our findings complement those in Gopinath et al. (2020), who show that dollar appreciation leads to a contraction in trade volume in the rest of the world under the assumption of sticky prices and dollar invoicing. Our work highlights an alternative mechanism at play, pointing to financial conditions that spill over to the real side of the economy. Some back-of-the-envelope calculations show that the financial channel can account for a substantial fraction of the slowdown in exports.

At the macro level, BIS (2016) shows that a 1% depreciation of the dollar is associated with a 0.6-percentage-point increase in the quarterly growth rate of dollar-denominated cross-border lending. Consequently, we would expect the financial channel to have a rapid impact on exports in the short term. In the case of Mexico, the impact on exports happens rapidly after one quarter lag, suggesting how a contraction in short-term financing has an immediate impact on exports. At longer horizons, as prices adjust, we may expect the competitiveness channel to be back in force.

Our study focuses on large firms in Mexico that are exposed to dollar funding conditions during a specific period where the dollar appreciated markedly. More broadly, the

financial channel has an effect also on other aspects of the real economy beyond exports and for a larger sample of countries. Obstfeld and Zhou (2022) find that for a panel of 26 EMEs an appreciation of the broad dollar index predicts declines in output, consumptions, investments, and exports during the period from 1990 to 2019. Avdjiev et al. (2019) show that for a large sample of EMEs, an appreciation of the broad dollar index predicts a decline in firms' capital expenditures. Furthermore, Bruno, Shim, and Shin (2022) find that a broad dollar appreciation affects stock prices, whilst the bilateral exchange rate has a smaller or muted impact. Our results suggest that delving deeper into the macro impact of dollar appreciation will present further promising lines of inquiry.

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Internet Appendix for "Dollar and Exports"

Table 10 reports summary statistics of the sample of global banks with access to U.S. money market funding.

Tables 11 and 12 present robustness tests related to Section 3.1 "The financial channel and bank credit." Here, we examine a number of alternative channels that may be linked to credit conditions, for instance changes in economic and financial conditions, or specific firm and industry characteristics. The goal is to test alternative economic channels that may affect banks that are exposed to money market funding. By interacting MMF_b with other macro-factors in lieu of the U.S. broad dollar index, we are not testing for the direct impact of macro-factors on firm-level supply of credit, instead we are evaluing their amplification effect on credit via those banks that have a different exposure to dollar money market funding.

In columns 1 and 2 of Table 11 we use use the percentage change in oil prices (global price of WTI crude as reported by FED FRED) and GDP growth, respectively, in lieu of the broad dollar index to test if an energy price shock or domestic economic conditions are 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 do not significantly interact with dollar funding for credit supply.

In column 3 of Table 11 we use the percentage change of the bilateral exchange rate Mexican pesos to U.S. 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.

In columns 4 and 5 of Table 11 we look at the VIX index and the term spread (obtained

Table 10
Banks' reliance on U.S. MMF funding This table reports summary statistics for the sample of non-U.S. global banks (22) and U.S. global banks (6) with U.S. money market funding. The column U.S. 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 U.S. 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 11
The financial channel and bank credit - Robustness tests This table shows panel regressions where the dependent variable is the volume of loans, in logs, from a bank to a firm over the period 2013-2016. The variable MMF captures the holdings of U.S. 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-U.S. exchange rate, VIX is the CBOE Volatility Index, the Term Spread is the 10-Year minus 2-Year Treasury rate, and U.S. rate is the Wu-Xia shadow federal funds rate. The specifications include firm-bank and firm-year fixed effects. The sample of banks consists of all banks providing credit, global and non-global banks. Standard errors are corrected by clustering at the bank level. $*p<.1$; $**p<.05$; $***p<.01$

	(1)	(2)	(3)	(4)	(5)	(6)
$MMF_b \cdot \Delta USDbroad$	-54.9773**	-59.9524***	-50.3948***	-48.1143**	-39.9882*	-43.5099**
	[24.0449]	[10.8667]	[17.5018]	[20.5340]	[22.8213]	[21.3194]
$MMF_b \cdot \Delta Oil\ price$	-2.9207					
	[2.1092]					
$MMF_b \cdot \Delta GDP$		102.3887				
		[95.2491]				
$MMF_b \cdot \Delta USD\_MX$			6.4628			
			[4.7130]			
$MMF_b \cdot VIX$				0.4855		
				[0.3184]		
$MMF_b \cdot Term\ Spread$					-113.3239	
					[83.7361]	
$MMF_b \cdot US\ rate$						38.2738
						[26.0488]
Constant	3.1658***	3.0577***	3.1390***	2.7456***	3.2425***	3.1704***
	[0.0831]	[0.1502]	[0.0809]	[0.3105]	[0.0512]	[0.0686]
Observations	2,008	2,008	2,008	2,008	2,008	2,008
R-squared	.667	.667	.667	.667	.667	.667

from the FED FRED) as possible indicators of global risk aversion. Also in these cases the interaction terms with MMF_b are statistically insignificant.

Finally, in column 6 we interact MMF_b with the U.S. Xia-Wu shadow rate, and the estimated coefficient is statistically insignificant. Taken together, we interpret these results as suggestive evidence that the broad dollar index is the global factor affecting dollar-funded credit supply decisions by global banks because it directly affects the banks' portfolio returns at the VaR constraints.

In Table 12 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 U.S. 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.

In columns 1 and 2 we run specification (1) after splitting the sample of firms at the median value of currency mismatch ratio, computed as the ratio of bank credit denominated in Mexican pesos over total credit as of 2012. Column 1 shows that the coefficient of the interaction term $MMF_b \cdot \Delta USDbroad$ is not statistically significant for the sample of firms with a high percentage (upper median) of bank credit denominated in pesos. In contrast, in column 2 the interaction term is negative and statistically significant for the sample of firms in the lower median value, meaning that firms with a higher currency mismatch of their liabilities suffer of a higher drop in credit supply.

Column 3 confirms that our results survive when firms in the oil and energy sectors are excluded from the benchmarked specification. Columns 4 and 5 augment specification (1) by including the capital ratio of bank b as of 2012 ($CapitalRatio_b$) and the liquidity ratio of bank b as of 2012 ($DepositRatio_b$) interacted with $\Delta USDbroad$. Column 5 shows that $DepositRatio_b \cdot \Delta USDbroad$ is positive and statistically significant, meaning that a higher deposit ratio helps counterbalancing the bank exposure to the U.S. money market funding.

Finally, in columns 6 and 7 we investigate if non-global banks substitute global banks' credit when firms exposed to dollar-funded banks suffer a drop in credit supply. To perform such a test, we construct the firm-level ratio of bank credit provided by 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-dollar-funded banks (column 6) or by the subsample of Mexican banks (column 7). In this way we test whether the credit supplied by non-dollar-funded banks increases during dollar strengthening and replaces the drop in credit by dollar-funded-banks. The interaction terms of *Global credit*$\cdot\Delta$*USDbroad* for both samples are statistically insignificant, meaning that non-global banks do not substitute for the decline in credit supply by dollar-funded banks. In untabulated regressions, we also verify that non-MMF banks do not step in for those firms that were highly exposed to dollar-funded banks. This evidence suggests that credit provided by dollar-funded banks is somehow special and cannot be easily replaced by other banking institutions.[9] It also suggests that alternative sources of finance cannot be found rapidly.

Tables 13, and 14 report robustness tests related to Section 4, "The Financial Channel and Exports."

When using time-product-destination fixed effects, the sample drops by about 90% because of singletons. We explores an alternative way to preserve a larger sample, while at the same time using time-product-destination fixed effects. Instead of using 8 digits HS industry level fixed effects as we do in Table 4 and subsequent tables, we use product-destination-time fixed effects with 6 digits industry HS code. Column 1 of Table 13 shows that the interaction coefficient $\Delta USDbroad \cdot FMMF_i$ continues remaining negative and highly statistically significant.

We then return to using the benchmark specification with product-destination-time fixed effects at the 8 digits HS code. In Table 13, column 2, we control for firm characteristics by adding to the main specification the ratio of cash to total assets (Cash), the logarithm of total assets (Size), profitability (ROA), and the ratio of liabilities to assets

[9]Hedging considerations may impinge our results and work against the financial channel as it would reduce the exposure to currency mismatches. Unfortunately, data on hedging are quite limited. Capital IQ reports data on hedging activities for a sample of 16 firms. For such firms, hedging is very small: for the entire period of the analysis, the centile of the ratio of hedging to total debt is 0.43% and only four firms report a hedging ratio between 5% and 25%. Based on the available data, we are less concerned that hedging may significantly bias our results.

Table 12

The financial channel and bank credit - Robustness tests This table shows panel regressions where the dependent variable is the volume of loans, in logs, from a bank to a firm over the period 2013-2016. The variable MMF captures the holdings of U.S. MMFs as reported in the banks' regulatory filings to the Securities Exchange Commission, scaled by short-term debt, as of 2012. Capital ratio is the ratio of equity over assets and Deposit ratio is the ratio of total deposits over assets, 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-bank and firm-time fixed effects, except columns 6 and 7 that include firm, time, and firm-bank fixed effects. Standard errors are corrected by clustering at the bank level. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample of firms	Low mismatch	High mismatch	Oil&Energy excluded	All	All	All	All
$MMF_b \cdot \Delta USDbroad$	-9.3981	-59.6910**	-54.3967**	-43.6852*	-47.2045**		
	[11.6357]	[28.9750]	[26.4112]	[24.0461]	[21.0794]		
$CapitalRatio_b \cdot \Delta USDbroad$				-41.3552			
				[29.0044]			
$DepositRatio_b \cdot \Delta USDbroad$					27.3233***		
					[8.6888]		
$GlobalCredit_i \cdot \Delta USDbroad$						-1.1981	-6.6339
						[6.5054]	[9.0481]
Constant	3.1057***	3.2669***	3.2052***	3.4446***	2.4475***	3.0213***	2.9472***
	[0.0393]	[0.1178]	[0.0987]	[0.2076]	[0.2131]	[0.1541]	[0.2447]
Observations	796	1,096	1,152	1,932	2,008	2,016	1,368
R-squared	.653	.675	.666	.671	.669	.555	.543

(Leverage) with unchanged results.

In column 3, we add the 2012 Z-score index computed in Capital IQ as a proxy for distress. The variable is not statistically significant, indicating that firm-level distress as broadly defined is not necessarily associated with lower exports or, alternatively, exports of firms in distress do not seem to be boosted by broad dollar appreciations.

We additionally control for potential firm-level effects that may bias the evidence on exports for reasons other than credit supply shocks. For instance, exchange rate fluctuations may affect certain types of firms more than others or banks that are exposed to some firms. In column 4, we look at the ratio of domestic (Mexican) sales to total sales ($Export\%_i$) in lieu of $FMMF_i$, available for a subsample of firms in the geographical segment of Capital IQ as of 2012, and we horserace it against $\Delta USDbroad \cdot FMMF_i$. The interaction term $\Delta USDbroad \cdot Export\%_i$ is not statistically significant, suggesting that more export-oriented firms are not necessarily affected by currency fluctuations, while also controlling for potential selection-bias concerns.

In column 5 we look at commodity goods and exclude the exports corresponding to commodity sectors (oil, metals, minerals, and agricultural products) with unchanged results. In column 6 we take into account the bilateral trade costs that my impinge the exports flows between two countries. We use the ESCAP-World Bank Trade Cost Database that includes all costs involved in trading goods internationally with another partner (i.e. bilaterally) relative to those involved in trading goods domestically. The variable *Trade Cost* captures trade costs in its wider sense, including not only international transport costs and tariffs but also other trade cost components, such as direct and indirect costs associated with differences in languages, currencies as well as cumbersome import or export procedures of manufacturing goods.[10] The estimated coefficient of $\Delta USDbroad \cdot Trade\ Cost$ is negative and statistically significant and the interaction term $\Delta USDbroad \cdot FMMF_i$ re-

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

Table 13
The Financial Channel and Exports - Robustness tests This table shows panel regressions where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the U.S. dollar broad index, lagged by one quarter. MMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. Cash is the ratio of cash to total assets, Size is the logarithm of total assets, ROA is return on assets, and Leverage is the ratio of liabilities to total assets. Distress the the Z-score index. Export is the ratio of Mexican sales to total sales. Trade costs is the bilateral trade costs. Standard errors corrected for clustering of observations at the firm-level are reported in brackets. *p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)	(5)	(6)
Δ *USDbroad*·*FMMF*$_i$	-10.3492**	-8.6020**	-8.4563**	-6.6954*	-8.5465**	-5.9565***
	[4.1842]	[3.7265]	[3.6456]	[3.3223]	[3.9054]	[1.8311]
Cash		0.6948*	0.7401			
		[0.3517]	[0.5214]			
Size		0.0988	0.0754			
		[0.0704]	[0.0857]			
ROA		0.0019	0.0071			
		[0.0141]	[0.0130]			
Leverage		-0.0008	-0.0014			
		[0.0006]	[0.0010]			
Distress			-0.0506			
			[0.0568]			
Δ *USDbroad*·*Export%*				8.2935		
				[6.1069]		
Trade costs						-0.0397
						[0.0895]
Δ *USDbroad*·*Trade costs*						-1.6915**
						[0.7992]
Constant	0.0009	-1.0330	-0.6536	-0.0916	-0.0140***	0.2881
	[0.0023]	[0.7157]	[0.9407]	[0.0559]	[0.0023]	[0.3927]
Time-product-destination FE	✓ 6*digit*	✓	✓	✓	✓	
Time-product FE						✓
Destination FE						✓
Firm FE	✓	✓	✓	✓	✓	✓
Observations	34,361	4,527	3,629	3,653	6,215	45,165
R-squared	.494	.531	.569	.469	.494	.251

mains negative and statistically significant, meaning that transport and other trade costs amplify the increasing financial costs following dollar appreciation.

In Table 14 we focus on alternative channels that may account for exchange rate shocks. We start by looking at the Wu-Xia shadow rate ($USrate$).[11] Column 1 shows that $USrate \cdot FMMF_i$ is not statistically significant. We horserace $USrate \cdot FMMF_i$ and $\Delta USDbroad \cdot FMMF_i$, and we observe that $\Delta USDbroad \cdot FMMF_i$ remains statistically significant (column 2). When running additional tests, we find that U.S. monetary policy is per se a factor associated with exports (when omitting time fixed effects, result not reported), but it does not have a statistically significant effect when interacted with the firms' exposure to dollar funding as column 1 shows. We interpret this as evidence that, although U.S. monetary policy may be an underlying force behind exchange rate changes, it is the fluctuation of the dollar exchange rate that operates on the balance sheets of banks, which in turn affects credit supply at the VaR constraints.

In column 3 we account for global volatility by using the VIX index $VIX \cdot FMMF_i$, while in column 4 we use the Baltic dry index (BDI), which is considered a proxy for shipping costs and. In both cases, $\Delta USDbroad \cdot FMMF_i$ remains negative and statistically significant. The coefficient of the interaction $\Delta BDI \cdot FMMF_i$ is also negative and statistically significant, indicating that global economic conditions have an amplification effect via the balance sheets of banks.

Finally, in column 5 we take into considerations local economic conditions by using the change in the share price index of Mexico ($\Delta StockMarket$, from the IFS). The resulting interaction term $\Delta StockMarket \cdot FMMF_i$ is positive and statistically significant, meaning that an improvement in the Mexican stock market conditions have a positive effect for the firms' financial conditions and, ultimately, their exports. The interaction term $\Delta USDbroad \cdot FMMF_i$ remains statistically significant. Take together, we interpret these

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

Table 14
The Financial Channel and Exports-Robustness tests This table shows panel regressions with time-product-destination and firm fixed effects, and where the dependent variable is the quarterly change in firms' export volumes within products-destinations form the period q3 2013-q1 2017. USDbroad is the quarterly change in the U.S. dollar broad index, lagged by one quarter. FMMF is an indicator capturing the firm's exposure to dollar wholesale-funded banks. USRate is the Wu-Xia shadow rate, lagged by one quarter. VIX is the CBOE Volatility Index, lagged by one quarter. BDI is the quarterly change in the Baltic Dry Index, lagged by one quarter. StockMarket is the quarterly change in the share price index of Mexico, lagged by one quarter. Standard errors corrected for clustering of observations at the firm-level are reported in brackets.*p <.1; **p <.05; ***p <.01.

	(1)	(2)	(3)	(4)	(5)
$\Delta USDbroad \cdot FMMF_i$		-8.9914**	-8.7917**	-12.1491***	-8.4875**
		[3.7107]	[3.9512]	[4.3734]	[3.6577]
$USrate \cdot FMMF_i$	-4.1382	-5.1048			
	[8.4507]	[8.5221]			
$VIX \cdot FMMF_i$			0.0143		
			[0.5828]		
$\Delta BDI \cdot FMMF_i$				-0.4987*	
				[0.2800]	
$\Delta StockMarket \cdot FMMF_i$					5.9225*
					[3.1227]
Constant	-0.0185***	-0.0135***	-0.0128	-0.0081**	-0.0139***
	[0.0041]	[0.0045]	[0.0636]	[0.0030]	[0.0025]
Observations	6,400	6,400	6,400	6,400	6,400
R-squared	.493	.493	.493	.493	.493

results as evidence of the important role of the broad dollar index in funding and lending decisions by global banks, with repercussions on firm-level exports, even after controlling for additional macro and global variables.

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