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Full Length Articles

The real effects of invoicing exports in dollars☆

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ABSTRACT

Exporting firms face foreign exchange risk when the export contract is invoiced in a foreign currency. For instance, for firms located outside of the United States, the US dollar is often used as a vehicle currency. The cost of hedging against this risk represents an additional trade cost for exporters, which is specific to the targeted destination. In this paper, we exploit an episode of heightened tensions in the USD/EUR foreign exchange market in July 2011, which increased the cost of hedging against US dollar fluctuations for French exporters. Using disaggregated information on bank balance sheets, bank-firm relationships and individual export flows for France, we show that exporters with a higher propensity to use hedging instruments reduced more their exports to “US dollar destinations” after this shock. For the average “treated” individual export flow in our sample, the increased hedging cost is equivalent to a counterfactual rise in trade costs by about 3 percentage points.

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1. Introduction

The dominant role of the US dollar in international transactions appears as an important feature of global trade. This empirical pattern has been documented in recent work based on detailed transaction data for advanced or emerging economies.¹ The dominant role of the US dollar contributes to explaining important macroeconomic puzzles, such as the low pass-through of exchange

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¹ Gopinath et al. (2010) show that 87% of the US total value of imports from France is priced in US dollars.

rate movements into the price of internationally traded goods and inflation (Gopinath et al., 2010; Casas et al., 2017; Chen et al., 2018; Amiti et al., 2020; Crowley et al., 2020) or the muted effects of exchange rate movements on traded volumes between countries (Boz et al., 2017; Casas et al., 2017).

We show in this paper that an increase in the cost of hedging against fluctuations in the US dollar exchange rate can have an important impact on the export performance of firms located outside of the United States but invoicing their transactions in US dollars. Invoicing exports in US dollars indeed exposes non-US exporters to a *currency mismatch*, as the (foreign) currency of invoicing differs from the (domestic) currency in which the firm pays for its main production costs (such as wages, taxes etc.). This problem is exacerbated in international transactions because payment is generally delayed by a few months corresponding to the shipment delays, while the terms of invoicing tend to be sticky.² To hedge against this foreign exchange risk, some (but typically not all) exporters commonly turn to their banks to purchase hedging instruments.³ The hedging cost faced by the exporting firm is directly linked to the liquidity of the euro-dollar exchange market where banks fund the protections they sell. An increase in the cost of hedging against US dollar fluctuations is then equivalent to an increase in trade costs (a financial trade cost) affecting (i) export flows to destinations where US dollar invoicing prevails, and (ii) exporters that rely more on financial hedging instruments in normal times. This is a different mechanism compared with a classical bank lending channel, whereby the exports of a given firm would be impacted by the capacity of its bank(s) to supply credit.

Our analysis exploits a major liquidity squeeze in international interbank markets in the second half of 2011, which increased the cost of US dollar funding for all European banks and their clients. The sequence of events is well documented in Ivashina et al. (2015): As the euro area sovereign crisis escalated in the summer of 2011, US money market funds started to worry about the creditworthiness of European banking groups and cut their dollar-denominated exposure to European banks across the board. The resulting tensions in the euro-dollar foreign exchange market materialized in sharp deviations from the covered interest parity and the cost of dollar funding increased for all European banks.⁴ For their customers, the price of hedging instruments against US dollar exchange rate fluctuations (henceforth, “dollar hedging”) soared. The tensions in the EUR/USD market then abated progressively at the end of 2011 and during the first semester of 2012, as, notably, the European Central Bank adjusted downward the rate charged on its dollar lending facility (financed through the ECB’s swap facility with the US Federal Reserve) in November 2011.

We investigate how this sudden increase in the cost of US dollar hedging impinged on the export performance of French exporters over the period from July 2010 to July 2012. For this purpose, we exploit two sources of heterogeneity in the data for our identification strategy: (1) Across destination markets and (2) Across exporters.

- (1) Hedging instruments against US dollar exchange rate fluctuations are more likely to be used in export destinations or in product categories where US dollar invoicing prevails. In the analysis, we will denote these countries (or products) as “dollar destinations” (or “dollar products”). The decision to invoice exports in a given currency is highly idiosyncratic among firms, products, and destinations. In the data reporting information on US dollar invoicing in French exports, the country dimension, alone, represents about 10% of the overall variance, and it is arguably exogenous to individual firms’ export performance in each market. We also show in the descriptive section of the paper (4.2) that the invoicing patterns in US dollars across extra-eurozone destinations in French exports is highly heterogeneous and economically meaningful. Accounting for the product dimension of invoicing allows to exploit some additional variance in the data, as there is substantial heterogeneity across products categories, and helps in terms of identification.
- (2) All exporters do not hedge against exchange rate fluctuations (Lyonnet et al., 2016), meaning that they are not all exposed to an increase in the USD hedging cost. Indeed, French exporters invoicing their export contracts in euros, or those who do not grant payment delays, do not need to hedge against exchange rate fluctuations of the US dollar. Some exporters invoicing in US dollars may also simply not hedge against exchange rate fluctuations. In our analysis, we will use a measure of the intensity of the credit relations between French exporters and USD specialized banks (or “dollar banks”) – a firm-level US dollar “hedging” index – as a proxy for French exporters’ reliance on EUR/USD hedging instruments. In normal times, these banks (identified through their USD liabilities vis-à-vis the USA over total assets) have a very good access to the liquidity in US dollar and are more able to help exporters by providing financial services such as hedging instruments against exchange rate fluctuations. We show in Section 4.1 that indeed French exporters invoicing more in US dollars are more closely linked to dollar banks (note that the firm dimension in invoicing data represents alone about 30% of the overall variance). In a validation exercise based on a sub-sample of French exporters, we show that the intensity of the credit relation with dollar banks (firm-level USD index) is also a good predictor of the use of hedging instruments as reported in a survey conducted among European firms in 2008 (EFIGE). This motivates the use of the links between dollar banks and exporters (in the French credit register) as a proxy for French firms’ reliance on USD hedging instruments. Throughout the paper, we will refer to this indicator as the firm-level USD “hedging” index, which de facto measures the firm’s proximity to “dollar banks”.

² Demir and Javorcik (2018) or Ahn (2015) document the wide use of post-shipment payments and the resulting long payment delays in international transactions.

³ For instance, a euro-area exporting company that expects a payment in dollars in three months and wants to hedge against a future depreciation of the US dollar may simply buy from her bank a forward contract that secures in advance a given USD/EUR exchange rate.

⁴ See also the analysis presented in (Sushko et al., 2016) with in particular measures of CIP deviations.

The empirical question explored in this paper has been largely overlooked so far, although anecdotal evidence suggests it is an important concern for internationally active firms.⁵ A plausible reason for this neglect is the difficulty to gather detailed enough data to track convincingly the effects of financial frictions in currency markets on firm-level exports. The granularity of our database allows to perform this exercise properly. Our dataset covers almost all individual banks and exporting firms in France over the period from mid-2010 to mid-2012. We collect individual information on French banks' cross-border borrowing in US dollars with US-based financial institutions and other bank balance sheet items from the French bank supervisor, and obtain the universe of credit links between resident banks and firms in France from the French credit register. We then merge this rich bank-firm information with exhaustive data on individual French exports provided by the French customs, which provides detailed information on all export flows by firm, destination and product, including, after 2011, the currency of invoicing.

Using this merged dataset, we estimate an empirical model of the growth in exports by firm, product (at the HS-4 level) and destination. The log variation of exported values, between the twelve months prior to July 2011 and the twelve months consecutive to the shock, is explained by our main variable of interest: The firm-level USD "hedging" index (our proxy for USD hedging), interacted with the share of USD invoicing in each country of destination (in the Tables: USD index $f \times$ USD invoicing j). This interaction term identifies export flows (firm \times destination) being more "exposed" to an increase in the USD hedging cost. We therefore expect that an increase in the US dollar hedging cost should reduce more exports in these "highly exposed" flows than in "weakly exposed" ones relying less on US dollar.

The set of selected destinations covers twelve extra-eurozone OECD countries: This choice allows to identify the effects of the rise in the USD hedging cost in the summer of 2011 on export flows across destinations with a similar level of economic development.⁶ These countries are however very heterogeneous as regards the invoicing practices faced by French exporters: In 2011, US dollar invoicing accounted for about 70% of aggregate French exports to the United States against about only 7% of exports to Switzerland and 15% of exports to Japan.

In all our cross-sectional regressions, which are expressed in difference before / after the shock in 2011, we include firm and country-product fixed effects. These fixed effects control for all unobserved potential firm-specific supply shocks (such as productivity shocks) and for destination-product-specific demand shocks that could additionally impact the export growth of French firms during the period of the analysis. We control for firm size (with the total value of its exports before the shock) and for two characteristics of the *ex ante* bank-firm relationship(s), which may be correlated with the dollar-specialization of the banks: (1) The (credit-weighted) average size of the banks lending to each exporter, and (2), the number of bank relationships of each exporter. All these variables are interacted with the share of USD invoicing in each destination country. This notably wipes out the potential benefit of being connected to more banks (in terms of bargaining power with lenders) or larger, international banks for exporting with success to dollar destinations, independently of the ability of these lenders to provide cost-efficient dollar hedging instruments. Larger (more profitable) firms may also be able to absorb part of the heightened dollar hedging cost.

We find that, after July 2011, export flows that were more exposed to the heightened cost of US dollar hedging (high firm-level USD index and high USD invoicing in destinations) had a lower growth in exports compared to the least exposed flows. For the baseline specification, an increase in the firm-level USD "hedging" index by one standard deviation (2.3 percentage points) leads to a reduction in exports to the United States by 5.4% relative to Switzerland. For firms in the top third in the USD index (i.e. highly exposed trade flows), the drop in relative exports to the United States is about 16%, compared to least exposed flows. This finding is robust to alternative definitions of the share of dollar invoicing across destinations, measured in terms of volumes exported or of number of shipments.

We then look for heterogeneous effects across products, based on their likelihood to be invoiced in US dollar. We derive our measure of the US dollar invoicing propensity of products from a regression step where the USD invoicing dummy by firm, destination and product is explained by firm, destination, and product fixed effects. We then back-out the product fixed effects, which we use to derive the product-level USD-invoicing propensity index clean from firm and destination effects. We define "dollar products" as products having a value of the fixed effect above the mean among all product categories. We then split the estimation sample into two sub-samples, contrasting exports of products, which are less likely versus more likely to be invoiced in US dollars, whatever the destination market. We find that the overall effect of heightened dollar hedging costs on French exports in dollar-destinations is entirely driven by fluctuations in exports of dollar-invoicing-prone products (we obtain a similar result in estimations where we used an interaction term rather than estimations on sub-samples of products, see the Appendix). For such products, the impact of the shock is still significant even when the United States are excluded from the list of possible destinations. This confirms that the issue we highlight is not specific to the US market but relates more broadly to the use of US dollars in many destinations as a vehicle currency.

Additional tests confirm the robustness of our main result. In a placebo estimation, we show that the estimated impact vanishes when the timing of the shock is moved 12 months ahead of the actual shock (i.e., July 2010 instead of July 2011), which vindicates the usual parallel trends assumption. We also confirm that our findings still hold when we rely on a Propensity Score Weighting (PSW) estimator instead of ordinary least squares.

Last, we perform two additional exercises to shed light on the mechanisms underlying our results. First, we derive export prices from the available information on values and quantities (unit values) in the Customs' database and find the effect of the

⁵ Two reports by the French public finance watchdog (Inspection Générale des Finances) warned public authorities in 2012 and 2013 about the difficulties faced by French exporters to obtain dollar funding or hedging at a reasonable price from their banks (IGF, 2012, 2013).

⁶ Economic development could for instance correlate with payment delays or more broadly with the quality of institutions, which could affect the relative export performance of French firms in these destinations, on top of the relative USD invoicing shares.

heightened cost of dollar hedging on export values is entirely driven by a contraction in the quantities sold, while export prices do not seem to react. Second, we exploit complementary information on firms' regular use of FX hedging instruments for the subsample of exporters, which is covered by the EFIGE survey of 2008. We find that the firms which reported in 2008 a regular use of specific financial instruments to hedge against exchange rate fluctuations were hit harder in 2011 by the rise in the EUR/USD hedging cost, in terms of their export performance to the United States.

1.1. Related literature

This paper contributes to the literature on the role of trade finance for exporters.⁷ Trade finance instruments indeed play an important role in facilitating international trade activity, by providing liquidity to exporters who need to finance their working capital, hedge against exchange rate risk, or insure them against the risk of default by importers. There is evidence that frictions in the provision of trade finance contributed to the great trade collapse relative to domestic output in 2008–2009 (Ahn, 2011; Ahn et al., 2011; Chor and Manova, 2012; Bricongne et al., 2012).⁸ Schmidt-Eisenlohr (2013), Niepmann and Schmidt-Eisenlohr (2017) and Antràs and Fritz Foley (2015) show that the choice of the contract between the exporter and the importer (open account, cash in advance, or letter of credit) is endogenous and responds to the characteristics of the source and destination countries in terms of financial and legal conditions. Demir and Javorcik (2018) show that exporters tend to grant importers more trade credit in more competitive environments. Demir et al. (2017) use the experience of the adoption of Basel II and show that the share of exports backed by letters of credit declines with the cost of this trade finance instrument.

Different strategies have been contemplated in order to identify the mechanisms underlying the transmission of financial shocks to firms' trade activities via their banks. Amiti and Weinstein (2011) use information about banks' financial health in Japan to establish a causal impact of trade finance on Japanese firms' export performance. Feenstra et al. (2014) rationalize a working capital financing channel in a theoretical framework, and find empirical support based on a sample of Chinese exporters. Paravisini et al. (2015) exploit the experience of the drought of foreign financing of banks in Peru during the Great Recession and identify a causal effect of bank credit on firms' exports at the intensive margin. This last paper highlights the importance played by the *bank-lending channel* for exports in the case of a developing economy, with foreign banking shocks affecting the stability of the local banks and their credit supply.⁹

The role of hedging instruments in facilitating exports is explored in Berman and Martin (2012) and Manova et al. (2015). Fauceglia et al. (2014) and Lyonnet et al. (2016) provide evidence on the determinants of currency hedging for exporters, while Amiti et al. (2014) show how natural hedging through exports and imports affects the pass-through of exchange rates into export prices.

We contribute to this line of research by providing evidence that changes in the cost of hedging against foreign exchange risk in a major foreign currency for trade – the US dollar – can have important implications for the export performance in specific markets. Our paper also contributes to the assessment of a largely overlooked central bank instrument, the foreign exchange swap lines between central banks, which have played a key role in smoothing foreign exchange market tensions during the recent financial crises. More precisely, we highlight here the real costs associated with the temporary mispricing of the swap facility between the US Federal Reserve and the ECB, which actually failed to alleviate the dollar funding stress until the beginning of 2012. As such, our paper therefore also relates to the ongoing efforts at assessing the costs and benefits associated with the various unconventional policies engineered by the major central banks during the recent financial crisis (Drechsler et al., 2016; Andrade et al., 2019).

The paper is organized as follows. Section 2 presents the US dollar funding shock in the Summer of 2011. Section 3 presents the different datasets we use, explains how we construct our firm-level dollar hedging index and provides descriptive statistics of the estimation sample. Section 4 presents a set of stylized facts regarding the currency of denomination (euros or dollars) of French exports. Section 5 details the empirical strategy. Section 6 presents our results as well as a series of robustness checks. Section 7 investigates specific transmission channels. Section 8 presents a quantification of the US dollar funding shock in terms of “tariff equivalent”. The last section concludes.

2. The 2011 dollar funding strain episode

The US dollar is by far the most borrowed foreign currency in France. Drawing on data from the Bank for International Settlements (BIS), Table 1 reports that the turnover of US dollar purchased through derivatives for France is about ten times the turnover of the second most purchased foreign currency, namely the British Pound, over 2007–2013. Most transactions are carried out by large financial institutions reporting to the BIS triennial survey. It is hence quite rare for exporters and importers to directly negotiate foreign exchange instruments on the market for FX derivatives. They rather obtain such products through their banks. The instruments most used are foreign exchange swaps. They involve an exchange of principal at the start of the contract

⁷ Evidence of the role of finance for aggregate trade is provided by Berthou (2010) or Manova (2013). There is also evidence that firm-level financial health is related to firms' export and import performance (Berman and Héricourt, 2010; Bas and Berthou, 2012; Muûls, 2015), although the evidence is much debated (Greenaway et al., 2007).

⁸ In contrast, Levchenko et al. (2010) challenge this view as they find no conclusive evidence in the case of US that trade finance explained the drop in product-level exports and imports during the early years of the crisis.

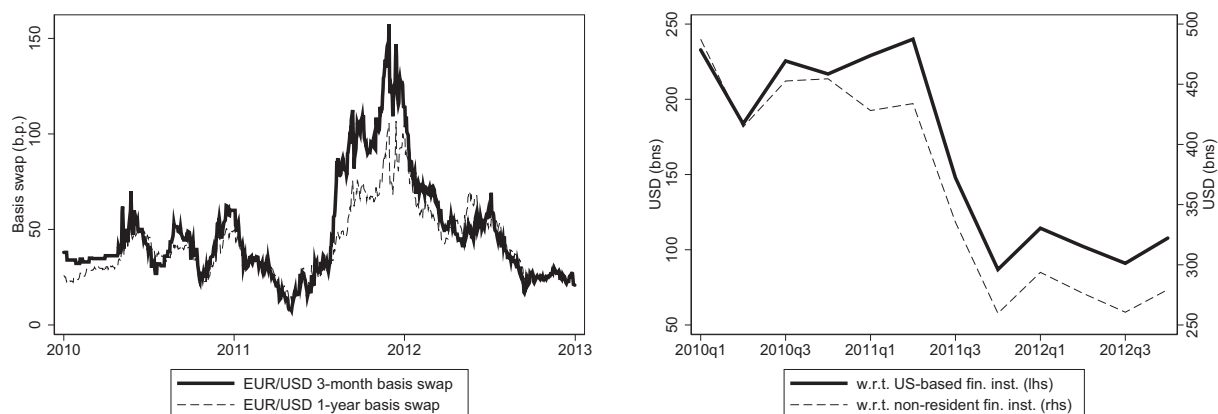
⁹ See also Chodorow-Reich (2014) or Cingano et al. (2016) for more evidence on the bank lending channel based on credit register data.

Table 1

Foreign exchange instruments: turnover.

| | April 2007 | April 2010 | April 2013 |
|------------------------------|------------|------------|------------|
| Total | 127 | 152 | 190 |
| Currencies | | | |
| EUR / USD | 51 | 64 | 81 |
| EUR / GBP | 5 | 9 | 9 |
| EUR / CHF | 2 | 3 | 3 |
| Counterparty | | | |
| Reporting dealers | 84 | 101 | 116 |
| Other financial institutions | 34 | 39 | 62 |
| Non-financial institutions | 9 | 11 | 12 |
| Instrument | | | |
| FX swaps | 89 | 108 | 138 |
| Spot transactions | 25 | 27 | 37 |
| Outright forwards | 7 | 10 | 9 |
| Options | 6 | 6 | 5 |

Note: This table reports the turnover of foreign currencies and OTC foreign exchange instruments for France, expressed in daily averages in billions of US dollars. Source: BIS triennial surveys. Reporting dealers include commercial and investment banks, securities houses and other entities that are active dealers and report turnover to the survey. Other financial institutions include the smaller non-reporting banks and all hedge funds, pension funds and other non-bank financial institutions that are customers of the dealers. Non-financial institutions consist mostly of exporters and importers.

**Fig. 1.** The 2011 dollar liquidity squeeze in international interbank markets.

Note: Foreign exchange swaps involve an exchange of principal at the start of the contract at the spot rate, and a reverse exchange at the end of the contract at the pre-agreed forward rate. In a EUR/USD cross currency swap, the basis is the negative spread added to the non-USD leg of the payments. The left hand side chart reports inverted basis spread, so that it shows the premium paid to obtain US dollars against euros in the foreign exchange swap market for a specified period of time. Data are downloaded from Bloomberg. The right hand side chart shows French banks' crossborder US dollars liabilities vis-à-vis financial institutions in the US and worldwide. The underlying granular data are the BIS Locational Banking Statistics (LBS).

at the spot rate, and a reverse exchange at the end of the contract at a pre-agreed forward rate. Hence, French banks often raise US dollar by exchanging euros for US dollars at the current exchange rate, while agreeing to reverse the transaction at a future date. Such contracts are typically short-term, since the typical maturity of a FX swap is three months. This dollar-funding model turns out to be quite expensive during episodes of tension in currency markets, both for the banks and for their customers.

We exploit a major shock to the availability and cost of US dollar funds for European banks in the summer of 2011. During this phase of the euro area sovereign debt crisis, soaring sovereign bond yields in the European “periphery” heightened concerns of foreign investors, and notably US money market funds, about the creditworthiness of European banks loaded with sovereign bonds issued by crisis-hit governments. Conditions in international US dollar markets deteriorated and became particularly stressed during the summer of 2011 for transactions against the euro. As the left-hand side panel of Fig. 1 depicts, the EUR/USD basis spread at 3 months and at 1 year, i.e., the premium paid to secure US dollars in the FX swap market at these maturities, was strongly positive over the period 2010–2012, with a peak at about 157 basis points in November 2011.¹⁰ More expensive FX

¹⁰ The increased cost of FX swaps entailed a marked deviation from the Covered Interest Parity (CIP) between the euro and the US dollar at that time, as documented by Miu et al. (2012) or Sushko et al., 2016.

swaps for banks translated into costlier hedging instruments for French firms in search of an insurance against a future depreciation of the US dollar.¹¹

Major central banks routinely agree to open bilateral swap lines, so as to be able in periods of stress to provide the needed foreign currency to their domestic banks, albeit at a penalty rate. Importantly, this was the case in the euro area at that time, but this policy remained ineffective until the very end of 2011. In May 2010, the US Federal Reserve arranged such a swap line with the ECB, which allowed the latter to lend dollars to squeezed European banks throughout the sovereign debt crisis. However, European banks made little use of this dollar lending facility because the interest rate charged on funds remained quite high relative to the EUR/USD basis spread for most of 2011. As the market cost of borrowing dollars by the way of FX market swaps eventually soared above the rate of the ECB dollar tender, the US Federal reserve and the ECB agreed in November 30, 2011 to cut the borrowing rate on the dollar liquidity swap line by 50 basis points. Euro area banks then tapped this facility again and the amounts borrowed in dollar from the ECB peaked above 100 USD billion in January 2012.¹²

We report in the right-hand side panel of Fig. 1 that the value of cross-border US dollar liabilities of French banks vis-à-vis US-based financial institutions plummeted by some USD 150 billion, or –60%, in the third quarter of 2011.¹³ Note that, over the 12 months following the summer of 2011, this decline in French banks' cross-border US dollar liabilities vis-à-vis US-based financial institutions was not compensated by any rise in US dollar borrowing from other non-resident financial institutions (such as UK-based ones). This shock did not go unnoticed at the time. Indeed, as mentioned in the introduction, several official reports by French governmental agencies noted that French banks' access to dollar funding was temporarily constrained and expressed concerns that this negative dollar funding shock could be detrimental to exports.

To get an intuition of why a severed access of French banks to cheap funding in US dollars may affect a French firm that exports to a country where imports are mostly invoiced in US dollars, such as the US, let us consider a simple example. Let us suppose that a French firm exports wines to Chicago in September 2011 and accepts to get paid only in December 2011, i.e. post-shipment, a certain amount of dollars X . This exporter needs to hedge against EUR/USD fluctuations. More precisely, she will incur a loss if the euro appreciates against the dollar within the next three months. The French exporter then turns to her bank and asks for the provision of a forward contract, by which the bank commits to buy the dollar value X of the exported goods in three months at a pre-agreed exchange rate F (here quoted in euros per dollar). Ideally, the exporter wishes to secure a high value of F , for instance above the spot rate S . In order to hedge, the bank then borrows the dollar value of the contract at the 3-month LIBOR rate r^{USD} , converts the proceeds immediately in euros at the spot exchange rate S , and places this amount at the Euribor interest rate r^{EUR} . The covered interest parity (CIP) is used to determine the forward USD/EUR exchange rate F : $F = S(1 + r^{EUR})/(1 + r^{USD})$. An increase in the cost of US dollar borrowing for Eurozone banks – as in the second semester of 2011 – adds a premium k^{USD} to the dollar interest rate r^{USD} , therefore pushes down the agreed forwards exchange rate $F = S(1 + r^{EUR})/(1 + r^{USD} + k^{USD})$. This increases the cost of hedging for the exporter. Possibly, the bank and the exporter will not be able to strike a deal given the adverse market conditions and the exporter may then prefer to delay its exports. Otherwise, she will have to pass on this additional destination-specific financial trade cost to the customer, which will increase the cost of exporting.

All European banks did face the liquidity dry-up in interbank dollar markets, be they directly threatened by the euro area sovereign crisis (such as Italian or Spanish banks) or not (such as French and German ones). However, not all banks are specialized in selling hedging instruments against FX risk. As a matter of fact, banks which in normal times borrow heavily in US dollars from US-based financial institutions, are the best equipped to serve customers in need of such products. As a consequence, exporting firms relying more on US dollar hedging instruments for their operations are more likely to establish a relation with a bank selling these contracts. These are the firms that we denote as having a high reliance on USD hedging (in the empirical exercise: High firm-level USD index). We identify “exposed” trade flows as export transactions made by exporters with a high USD index (due to their links with dollar banks) in destinations where USD invoicing prevails. We expect that the heightened cost of US dollar hedging in the second semester of 2011 should be more detrimental to these exposed trade flows compared to less exposed ones.

In the empirical analysis presented below, we consider cumulative monthly export flows over two consecutive 12-month periods. First, the period before the shock, denoted by T_0 in what follows, covers the 12 months from July 2010 to June 2011. The second period, which we denote T_1 , covers the 12 months from July 2011 to June 2012.

3. Data

This section presents the datasets we use throughout: Bank balance sheet information and bank-firm credit information, disaggregated information on French exports, and survey information on the use of FX hedging instruments by a subset of exporters. We then explain how we merge and clean these datasets for the purpose of our study.

¹¹ Ivashina et al. (2015) show that this rise in the cost of US dollar funding for European banks contributed to a sharp reduction in US dollars loans by European banks to US companies during the period of the Great Recession.

¹² Cf. Miu et al. (2012) for a detailed account of this episode.

¹³ US-based financial institutions include here the branches and subsidiaries of French banks located in the US. These affiliates of French banks borrow locally in US dollars, notably from US money market funds, both to serve their US customers and to lend dollars to their parent companies in France.

3.1. Bank and credit register data

We measure banks' "dollar specialization" using granular data from the French contribution to the BIS Locational Banking Statistics (LBS). This data is collected by the Banque de France every quarter at the bank-level for more than 300 banks in France. The LBS dataset provides us with information on the currency decomposition of cross border bank liabilities, along with the country and sector of their counterparts. Foreign-based financial institutions account for almost all the cross-border dollar liabilities of banks resident in France from 2011 to 2013. Balance sheet items for banks located in France (such as total assets) are provided by the French Supervisory Authority (ACPR).

Bank-firm credit links are measured using bilateral loan data from the French credit register, held by the Banque de France. A bank has to report its credit exposure to a given firm as soon as it is larger than EUR 25,000. Our measure of the bank-firm credit exposure adds up the loans already granted (drawn credits) and the bank's commitments on credit lines (or undrawn credits). Over the period from July 2010 to June 2011, this data covers more than 2.5 millions bank-firm credit relationships, corresponding to more than 1.7 million of firms, with monthly frequency.

3.2. Customs data

Detailed information on individual export flows and exporting firms is taken from the French Customs' data. This data details firm-level French exports by product at the 8-digit level of the Combined Nomenclature (CN8) and by destination country, with monthly frequency. We aggregate it at the 4-digit level (HS4) in order to avoid the noise induced by frequent changes in the nomenclature of products at the 8-digit level. Keeping detailed information about the products sold allows us to account for product-level demand shocks in the empirical specification, and focus the analysis on the effects of the rising cost of USD hedging.

Outside of the EU, the reporting threshold for French exports at the firm-product level (over the period considered in the analysis) is 1000 euros per transaction. Inside the EU, a high reporting threshold applies in order to limit the reporting burden and facilitate intra-EU trade accordingly.¹⁴ Our analysis however focuses on French exports to 12 non-EU (OECD) countries, and it is therefore not subject to the high reporting threshold for intra-EU transactions.¹⁵

Exports at the firm-destination-product level are cumulated over two periods of twelve months, T_0 , which covers the pre-shock period from July 2010 to June 2011, and the period of the shock, T_1 , from July 2011 to June 2012. Importantly, the monthly frequency of the French customs data allows to properly account for the timing of the shock.

Last but not least, we obtained from the Customs the currency of denomination of each individual export flow. This very rich information, which is not publicly shared, is however only available since the beginning of 2011, only a few months before the episode of interest. While this short history makes it difficult to identify *ex ante* stable invoicing patterns at the firm or firm-product level before the shock, we nevertheless use these records over the years 2011–2017 in order to pick up products which are routinely invoiced in US dollars across destinations. We also compute annual measures of the share of dollar invoicing in French exports by country of destination. We consider either the ratio of the yearly value of dollar-invoiced exports to total exports or the ratio of the number of firm-product shipments invoiced in US dollars to the total number of shipments in each destination. These country-specific measures of dollar-invoicing practices are very stable through time, reflecting structural patterns of international trade. We use the 2011 values in what follows to identify so-called "dollar destinations".

3.3. Survey on the use of FX hedging instruments by exporters

The EFIGE (European Firms in a Global Economy) database is provided by the Bruegel institute (Altomonte and Aquilante, 2012).¹⁶ It combines measures of firms' international activities (e.g. exports, outsourcing, FDI, import) with quantitative and qualitative information on around 150 items including R&D and innovation, labor organization, financing and organizational activities and pricing behavior. The data consists of a representative sample, at the country level and for the manufacturing industry, of almost 15,000 surveyed firms (above 10 employees) in seven economies.¹⁷ The data was collected in 2010, thus covering the years from 2007 to 2009. Special questions relating to the behavior of firms during the crisis have also been included in the survey. The survey data is matched to balance-sheet data from the AMADEUS database using a unique firm identifier. For firms located in France, this is the SIREN number. In the public version of this data, the SIREN identifier is anonymized. We had access however to the private version of this data, and were able to merge the EFIGE survey data with a subsample of our estimation data using SIREN numbers. To answer our research question, we used a single specific question of the survey (E17A): "How do you deal with the exchange rate risk? Which of the following statements is similar to what your firm do?": (1) "I use a foreign exchange risk protection"; (2) "I do not normally hedge against exchange rate risk". Using this information, we coded a new variable, which takes a value equals to one when the exporter uses foreign exchange risk protection, and equals zero when the exporter responds that it is not using foreign exchange risk protection.

¹⁴ The intra-EU threshold for detailed reporting was 150,000 euros up to 2010. It was raised to 460,000 euros per year after 2010. Importantly for our measure of total annual exports at the firm level, a useful proxy for firm size, we harmonize this threshold to make it constant over the time period considered.

¹⁵ The selected destinations include: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States.

¹⁶ Link to the EFIGE dataset: <https://www.bruegel.org/publications/datasets/efige/>.

¹⁷ The surveyed economies are: Germany, France, Italy, Spain, the United Kingdom, Austria, and Hungary.

3.4. Data cleaning

We merge data on exports and on firms' relationship banks using common bank identifiers (BIC codes) and firm identifiers (SIREN codes). We apply a few restrictions on banks, firms and bank-firm relationships.

The sample of banks is restricted to French banks reporting to the LBS statistics as of June 2011. We exclude Dexia, a large player in municipal lending which has been restructured between July 2010 and June 2012, and we also drop a few small outlier banks, whose total assets increased by more than 50% or less than -50% over 12 months after July 2011, suggesting that they took part in mergers and acquisitions or were restructured.¹⁸ This leaves us with a population of 63 banks headquartered in France.¹⁹ These banks account for 78% of domestic bank loans to resident non-financial firms in France.²⁰ They also account for 99% of the crossborder dollar liabilities vis-à-vis US-based financial institutions of the whole French banking system. The selected banks are quite heterogeneous both in terms of size and in terms of their dollar funding abroad. Banks in the first quartile of assets size have assets worth less than 2 billions euro, against 240 billions euro for banks in the top decile of the size distribution. Furthermore, most banks borrow zero or almost zero dollars from US-based banks: The share of these dollar-denominated liabilities in total liabilities is lower than 0.2% for 90% of the banks. In contrast, four banks, including two large international players, exhibit a ratio of dollar-denominated debt towards US-based banks to their total liabilities above 2%, with a maximum around 8%.²¹

We keep in our sample only firm-(HS4) product pairs for which at least one export flow to the US is observed over 2010–2012. In doing this, we focus on firms and products, which prove able to reach the largest and most competitive extra-EU market. These firms are likely to sell these products in other foreign markets as well, which is required for identification as our regressions compare exports within firm-product pairs and across destinations.²² We exclude firms whose total credit growth lies in the bottom 2% or top 2% of the credit growth distribution between the two periods considered. Finally, we exclude observations in the bottom 1% or top 1% of export growth rates at the firm-destination-product level. We end up with a sample of 7642 firms. The average firm exports for some 16 millions euro of goods to the selected non-EU destinations in period T_0 . It exports about 2 products to 3 countries among the selected destinations.

4. US dollar invoicing and firms-level hedging

Our empirical strategy requires constructing measures of (i) country-specific USD invoicing propensity in French exports; (ii) an indicator of firm-level reliance on USD hedging (firm-level USD index). In this section, we explain how we construct these measures, then provide some stylized facts on dollar invoicing practices across destination countries and products. Last, we present descriptive statistics for the variables used in the econometric analysis.

4.1. Measuring firms-level reliance on EUR/USD hedging

Measuring how firms rely on hedging instruments in US dollars is not straightforward, as this information is usually not reported in official statistics. In our analysis, we use an indirect measure, a firm-level USD "hedging" index, which measures the proximity of French exporters to "dollar banks", and captures the likelihood that a firm relies on the use of hedging instruments in US dollars. In practice, only a few large banks active in EUR/USD swap markets are specialized into selling currency hedging instruments to their clients. These banks are characterized by a high value of cross-border US dollar liabilities in percentage of their total assets. The connection of individual exporters with these banks provide us with a useful information about the availability of USD hedging instruments to individual exporters. In the descriptive evidence presented later in this section, we show that exporters invoicing a higher share of their exports in US dollars are more likely to be connected to "dollar banks". In addition, being connected to dollar banks increases the likelihood to use FX hedging contracts in the EFGE survey.

In practice, we proceed in two steps. Combining the information from the Locational Banking Statistics dataset and bank balance sheet information, we first measure the *ex-ante* "dollar specialization" of each bank b as the ratio of the bank's cross-border US dollar liabilities from US-based financial institutions before the shock over its total assets (Eq. 1):

$$USD\ Specialization_b = \frac{USD\ liabilities\ with\ banks\ in\ USA_{b,T_0}}{Total\ Assets_{b,T_0}} \quad (1)$$

Second, we construct a firm-level USD "hedging" index, which relies on (i) firm-level credit links with banks; (ii) the USD specialization of firms' banks. This index (denoted as $USD\ Index_f$, expressed in %, see Eq. 2) is a proxy for French firms' proximity to

¹⁸ These outliers make up all together less than 1% of total credit to firms

¹⁹ Note that three of these "banks" are in fact aggregates of the regional institutions belonging to three major cooperative networks. Such regional banks pool their liquidity (including their cash holdings in dollars) with their network's central institution (or *caisse centrale*), which may be a holding parent or a subsidiary of the local ones and acts as a delegated liquidity manager. The total number of individual chartered banks covered by our sample therefore amounts to 155, not 63.

²⁰ Leasing and factoring loans are excluded here. Many French banks that do not report to the LBS statistics are indeed small, specialized credit institutions, notably leasing and factoring firms. When these two types of loans are included, the ratio drops to 71% only.

²¹ Table A1 in the appendix provides detailed descriptive statistics.

²² The US is the most important export destination for French firms outside the EU.

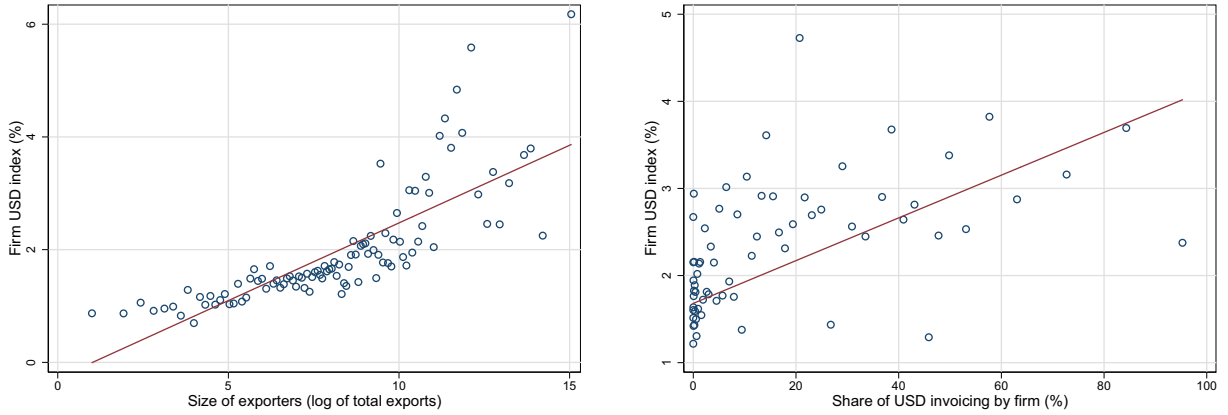


Fig. 2. The use of EUR/USD hedging tools (proxy: Firm-level USD index) linked to other firm characteristics.

Note: This Figure plots our proxy for firms' reliance on EUR/USD FX hedging tools (the firm-level USD index in the vertical axis) versus (i) a measure of firm size (log of total exports by firm, left panel) and (ii) the share of firms' exports invoiced in USD in their total extra-EU exports (right panel), on average over 2011–2018.

“dollar banks” and for their likelihood to purchase dollar hedging instruments against EUR/USD exchange rate fluctuations. It is measured *ex ante*, i.e. before the shock.

$$USD\ Index_f = \sum_b \frac{L_{fb,t_0}}{L_{f,t_0}} USD\ Specialization_b \quad (2)$$

where L_{f,t_0} denotes the total bank debt of firm f at time T_0 , while L_{fb,t_0} denotes its borrowings from bank b only. As discussed above, we will use in our analysis this variable as a proxy for the use of USD hedging instruments by individual exporters, irrespective of the export destination. Note that this variable departs from a Bartik instrument, which would be a weighted average of a set of shocks.²³

Fig. 2 plots the firm-level USD “hedging” index against a measure of firm size (left panel) and a measure of firms' propensity to invoice exports in dollars (right panel). The measure of firm size is the (log) of the firm's total exports in the pre-shock period. For each firm, we compute its propensity to invoice exports in dollars as the average over 2012–2018 of the share of dollar-denominated exports in the firm's annual extra-EU exports.

The Figure first clearly shows that larger exporters have a higher value of the USD index, meaning that they are more closely connected to dollar banks. Intuitively, large firms export their products in many destinations, and are frequently dealing with the use of various currencies. Note however that exporting and importing in US dollars does not necessarily provide these exporters with a natural hedging, as the maturities of assets and liabilities could differ, thus creating a currency mismatch. This is one of the reasons why large and international firms tend to be connected to large, international banks, which provide them with a wide range of financial services, including USD hedging contracts. Although this type of assortative matching is expected, this clearly calls for controlling also for the size of a firm's lenders in our regressions.

Fig. 2 also shows a positive correlation between the firm-level USD hedging index and the propensity to invoice exports in dollars (as measured in 2011). The correlation is highly significant, even when controlling for product fixed effects. This implies that the firm-level USD index captures well the firm dimension of the US dollar invoicing decision (the firm-level dimension accounts for about 30% of the overall variance in USD invoicing across firms, products and destinations, see Table A4 in the Appendix Section). One should keep in mind, however, that the share of USD invoicing is a very imperfect measure of an exporters' need to hedge against EUR/USD fluctuations. Indeed, some exporters invoicing in US dollars simply do not extend payment delays to the foreign importer, and are for this reason not exposed to exchange rate uncertainty.

Last but not least, the firm-level USD hedging index appears as a good predictor of the use of FX hedging instruments when this information is available in the EFIGE survey. For the reporting firms, we regress a dummy that takes the value of one when the firm reports “a regular use of FX hedging instruments” on our dollar hedging proxy variable. Table 2 shows the results. The coefficient of the firm-level USD index is positive and highly significant. It is also robust to the inclusion of a control for firm size and of sector fixed effects (defined as the HS2 level of the product classification).

To summarize, the firm-level USD hedging index, obtained by combining information on bank-to-firm “proximity” and bank-level degree of “dollarization” on the liabilities side, is a good proxy for the likelihood that individual exporters actually use EUR/USD hedging instruments. We will use this variable throughout the analysis to categorize firms, and, together with the information about the importance of USD invoicing by destination market, identify *ex-ante* trade flows that are the most exposed to the increase in the cost of EUR/USD hedging in the summer of 2011.

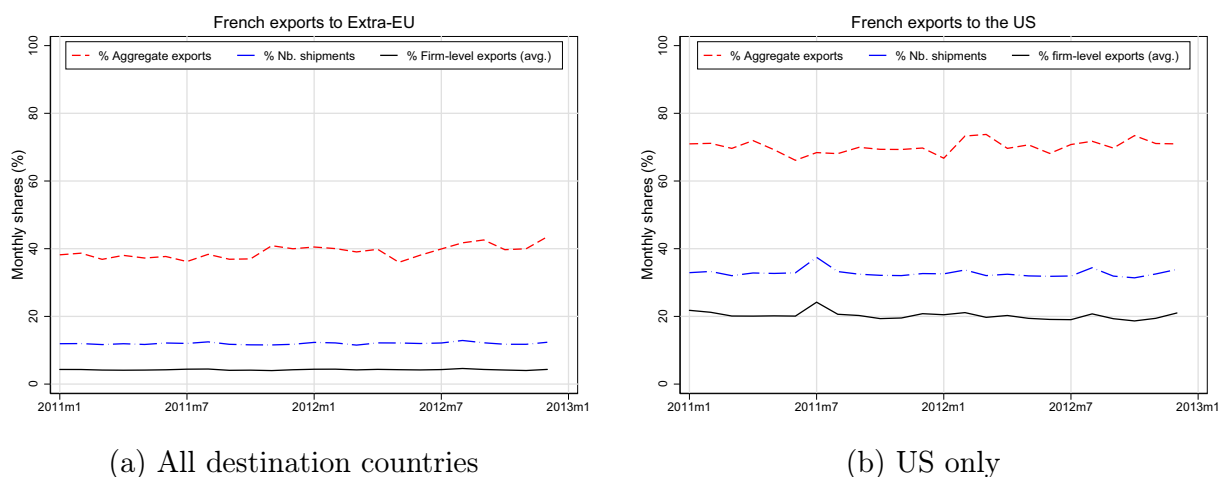
²³ Also called Shift Share Instrument Variable, Bartik instruments have been used to study the effects of changes in bank lending on economic activity during the Great Recession (Greenstone et al., 2020). Their use is widespread in the trade, migration and labor literatures, supporting a recent literature discussing the conditions for their validity (Adao et al., 2019; Borusyak et al., 2021; Goldsmith-Pinkham et al., 2020).

Table 2

Firm-level reported use of hedging instruments (EFIGE) and the USD index of the firm (based on credit links).

| Dep. var. | (1) Firm-level hedging dummy | (2) | (3) | (4) |
|---------------------------------|---------------------------------|---------------------|--------------------|---------------------|
| USD Index _{ft0} | 0.027*** (0.009) | 0.022*** (0.008) | 0.020** (0.010) | 0.023*** (0.008) |
| ln total exports _{ft0} | | 0.096*** (0.004) | | 0.094*** (0.005) |
| Sector FE (HS2) | No | No | Yes | Yes |
| R ² | 0.01 | 0.35 | 0.19 | 0.46 |
| Obs. | 631 | 631 | 631 | 631 |

Note: This table presents the results of regressions based on the “EFIGE sub-sample” of the main dataset. The dependent variable is a dummy indicating whether the firm is using or not financial instruments to hedge against exchange rate fluctuations, as reported in the EFIGE survey. The right hand side variable is the firm-level USD index, our proxy for the firm's likelihood to use EUR/USD FX hedging instruments. See the main text for details on the construction of this variable. Sector fixed effects are HS 2-digit product fixed effects.

**Fig. 3.** USD-invoicing of French exports outside the EU, 2011–2013.

Note: Share of USD-invoicing in French extra-EU exports (in pp). Export shares are computed either as (1) the share of USD-invoiced goods in aggregate exports, (2) the share USD-invoiced shipments in the number of shipments, or (3) the average across firms of the firm-level share of USD-invoiced exports in total exports. Left panel: All French extra-EU exports. Right panel: Exports to the United States only. Source: French Customs data, extra-EU (Document Administratif Unique, DAU).

4.2. Dollar invoicing by destination and product: stylized facts

We provide in this section some stylized facts about the role of the US dollar as an invoicing currency in French exports. Note that the numbers presented here are based on the entire population of export flows reported to the French Customs, i.e. before we merge export data with bank-firm data and apply filters to get the final estimation sample.

The left panel of Fig. 3 displays the share of USD invoicing in French extra-EU exports over the years 2011–2013 according to three alternative measures: The ratio of dollar-denominated exports to aggregate exports, the share of dollar-denominated shipments in total shipments and the average share of dollar-denominated firm-level exports across all exporters.²⁴ The value of USD-denominated exports represents about 40% of French extra-EU exports and this share is quite stable over time.²⁵ However, the share of shipments that are invoiced in USD is much smaller (about 12%), while the share of dollar-denominated exports in the average firm drops to only a few percentage points, since most French exporters invoice all their exports in euros. These patterns imply that USD invoicing practices are very concentrated in a relatively small number of large exporters. They are also very sticky, as reported for instance in Corsetti et al. (2018), meaning that firms do not have in general the possibility (or do not want) to switch to a different currency of invoicing. Interestingly, the role of the US dollar as an invoicing currency becomes more important across all three measures when one looks at French exports to the USA only, as shown in the right panel of the Figure. This echoes previous studies pointing to a dominant role of the US dollar as an invoicing currency in US imports.

²⁴ Shipments are defined here at the Exporter - HS4 product - destination level.

²⁵ This is in line with work based on invoicing data for different countries. For instance, Chen et al. (2018) show that in the case of imports in the United Kingdom, about half of these imports is invoiced in a vehicle currency, mainly the US dollar.

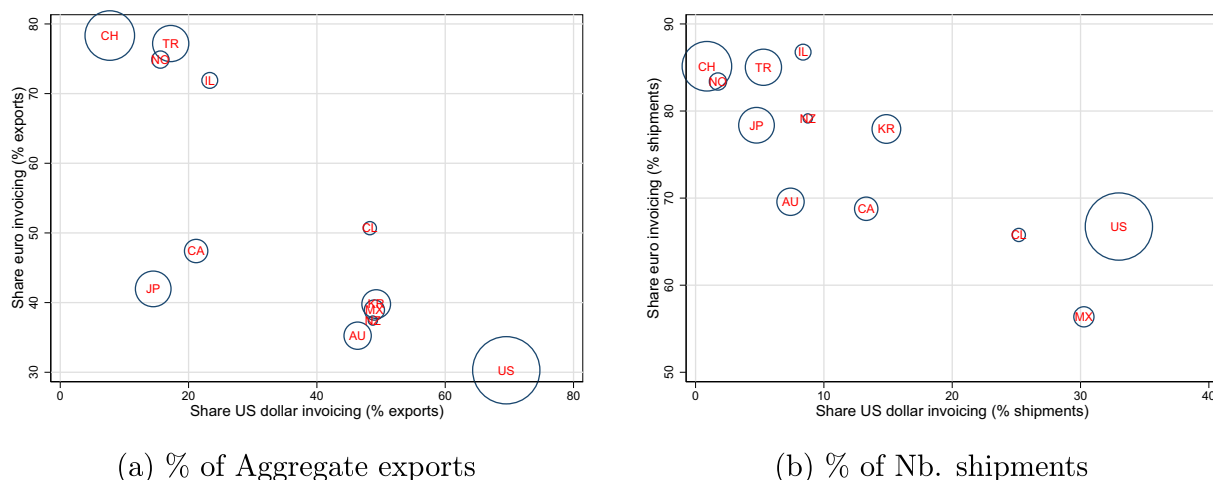


Fig. 4. USD- and EUR-invoicing of French extra-EU exports (2011).

Note: This Figure shows the shares of USD- and EUR- invoicing in French extra-EU exports by destination (in percent of the total). The relative size of the circles matches the relative importance of destination countries in aggregate French exports in 2011. Left panel: Shares computed using export values. Right panel: Shares computed based on the number of shipments. Source: French Customs data (Document Administratif Unique, DAU).

Fig. 4 sheds light on the dollar and euro invoicing patterns of French exports across major non-EU destination countries in 2011. Again, the Figure contrasts two alternative measures of the role of each invoicing currency in trade: The share of, e.g., US dollar-denominated exports in the total value of exports (left panel) and the share of US dollar-denominated shipments in the total number of shipments (right panel). The size of the circles in each graph is proportional to the size of French exports to each country. The currency of invoicing appears mostly as a binary decision based on these two currencies (as most countries are located on the -45 degree line). For instance, French exports to Switzerland are massively invoiced in EUR (about 80% of the value of French exports) while slightly less than 20% is invoiced in USD. Conversely, about 70% of French exports to the United States in 2011 are invoiced in USD while the rest (about 30%) is invoiced in EUR. Exceptions are Japan, where the EUR represents a bit more than 40% of exports and the USD less than 20%, the remaining 40% being invoiced in JPY. A similar pattern appears when looking at the numbers of shipments, but this time the share of EUR invoicing appears larger, which confirms that USD invoicing is also dominated by large exporters whatever the destination.

Importantly, the Figure also reveals that some important destinations for French exports – such as the United States of course, but also Australia or South-Korea – are destinations where the US dollar is widely used as an invoicing currency. This exposes French exporters to a currency risk. For other destinations such as Switzerland or Japan, the risk exposure is much weaker in aggregate given the smaller share of exports that are invoiced in USD. This heterogeneity across destination countries helps for the causal identification in our empirical set-up, as we compare destinations with low vs high shares of US dollar invoicing in French exports.

Fig. 5 further shows that there is also a strong heterogeneity in the invoicing patterns across products: Exports of some products are almost always invoiced in US dollars (in steel and metal industries, aeronautics, or chemicals) while for others the share of USD invoicing is close to zero.

Last but not least, we ran an analysis of variance to shed light on the main determinants of the decision to invoice exports in US dollars, following the approach in [Amiti et al. \(2020\)](#).²⁶ In practice, this amounts to running regressions where the dependent variable is a dummy which takes a value of one if the firm-product-destination-time trade flow is invoiced in USD, and zero otherwise. Regressors are different sets of firm, product, and destination fixed effects along with their interactions. We find that the firm-level heterogeneity contributes the most to the variance of the USD invoicing dummy (about 30%). In our empirical exercise, this dimension of the invoicing data is captured by the firm-level USD index, our proxy for the firm USD hedging likelihood, which is positively correlated with the share of USD invoicing by firm.

The heterogeneity in terms of invoicing in US dollars across destinations represents 9% of the variance, while the product-level heterogeneity represents 4%. Destination-by-product fixed effects explain about 18% of the overall variance.²⁷ We will make use of this dimension in the data in our empirical strategy, as we interact the firm-level USD index with information on USD invoicing by destination. We additionally use information about USD invoicing by product in a robustness exercise. This information about USD invoicing in French exports, by destination or by product, is arguably more exogenous to firm-level export performance in specific destinations than the granular information on invoicing by destination at firm-level. We will therefore use this aggregate information on invoicing throughout the empirical analysis.

²⁶ See Table 15 in the online appendix for details

²⁷ The results are roughly unchanged when we run export-weighted regressions instead of standard OLS regressions.

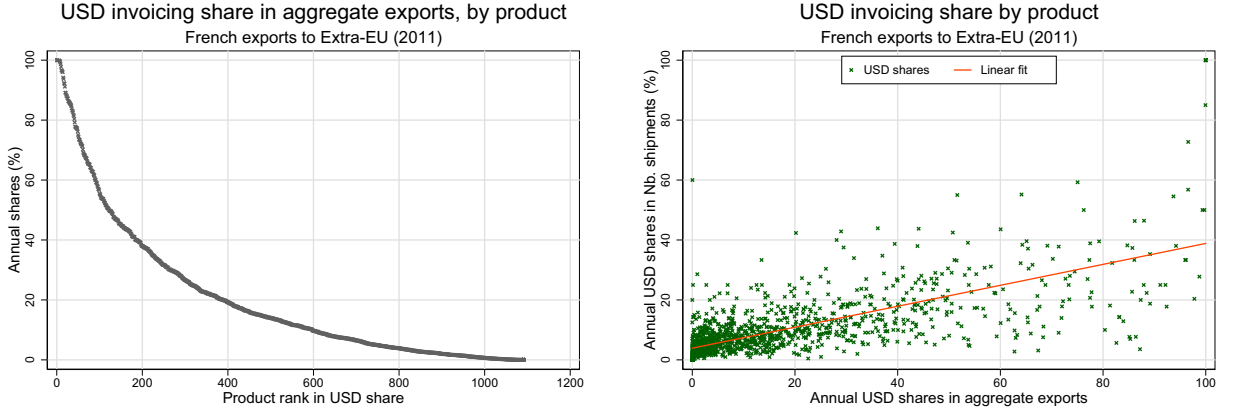


Fig. 5. Share of USD-invoiced exports in French extra-EU exports, by product (% of total, 2011).

Note: The Figure shows the share of USD invoicing by HS4 product in aggregate French exports in 2011. Left-hand panel: Products ranked by their USD-invoicing share within each HS4. Right-hand panel: Correlation between two measures of the product-specific share of dollar invoicing (as a percentage of total export values within each HS4, or as a percentage of the number of USD-invoiced shipments within each HS4 category). Source: French Customs data (Document Administratif Unique, DAU).

4.3. Descriptive statistics

This section provides descriptive statistics based on the estimation sample. Due to the systematic inclusion of firm fixed effects in our cross-sectional regressions, firms with only one exported product to one unique country are dropped. The estimation sample includes export growth observations for 4734 different firms, exporting to one of the 12 extra-EU OECD destination countries used in the analysis, and exporting at least once to the United States during the period covered (2010–2012).²⁸

Table 3 presents descriptive statistics for all the variables which we use in the regressions. The estimation sample includes nearly 29,000 observations, where the unit of observation is a firm-product-destination triplet. The average export growth (in logs) for surviving exporter-products over the two 12-month periods surrounding the dollar funding shock is 4.5%. The average observation relates to a firm connected to 4.5 banks which exports some 161 millions euro of goods in extra-EU OECD markets in 2010–2011. The dollar hedging index of this average firm is equal to 2.2%.

The main regressor of interest in our regressions is the interaction between the firm-level USD hedging index and the country-specific share of exports invoiced in US dollars: This interaction term allows to identify in our data individual export flows that are more exposed to an increase in the USD hedging cost (firms being more likely to use USD hedging instruments and destinations characterized by USD invoicing).

In our estimations, we account for possible confounding factors related to the heterogeneity in firms' size, or the size of firms' banks interacted with the share of dollar-invoicing by destination. The table shows the distributions of these interacted variables.²⁹

5. Empirical model

The empirical model we estimate is akin to a triple difference-in-differences regression. Identification hinges at the combination of two dimensions of heterogeneity: Firm-level heterogeneity in terms of propensity to use dollar hedging tools (the firm-level USD hedging index), and a geographic dimension that relates to the dollar invoicing habits across countries. The baseline cross-sectional regression therefore reads (Eq. 3):

$$\Delta \ln v_{f, t_1/t_0} = \beta \text{USD Index}_{f, t_0} \times \text{USD Invoicing}_j + \text{Controls}_{f, t_0} \times \text{USD Invoicing}_j + \alpha_f + \gamma_{pj} + \epsilon_{fpj} \quad (3)$$

where $\Delta \ln v_{f, t_1/t_0}$ is the growth rate of cumulated exports between the twelve months prior to July 2011 and the twelve months starting in July 2012, α_f denotes firm fixed effects and γ_{pj} product-destination fixed effects. $\text{Controls}_{f, t_0}$ stand for a set of *ex ante* firm-level controls, including firm-level total exports as a measure of firm size as well as variables controlling for other characteristics of the firms' lenders, which may correlate with the dollar hedging variable. We detail why we pick up these controls below.

In this equation, $\text{USD Index}_{f, t_0}$ is the *ex-ante* dollar (hedging) index of firm f , as defined in Section 4, and USD Invoicing_j is the aggregate share of US dollar invoicing by French exporters in destination j in 2011. The product of these two variables, which has a firm \times destination dimension, measures the *exposure* of each individual trade flow to a rise in the USD hedging cost. β is the main

²⁸ Table A2 in the appendix provides detailed statistics on the firms in the final estimation sample. Unsurprisingly, the average firm in the estimation sample without these singletons is slightly larger as before: it sells 18 millions euro of goods to non-EU, OECD countries in period T_0 , is connected to 3.7 banks and exports 2.3 products to 3.6 countries among the selected destinations. In this sample of firms, the distribution of the dollar hedging index is quite heterogeneous and ranges from zero to 8.2% (i.e., the value of the dollar specialization variable for the most specialized bank).

²⁹ More information about the correlations among covariates is available in the appendix. See Table A3.

coefficient of interest. We expect that $\beta < 0$, as the heightened cost of dollar hedging weighs down on the export performance of regular hedging users in destinations where dollar invoicing prevails.

In this exercise, we measure the share of dollar invoicing at the destination level instead of the exporter level, and this for two reasons. First, exporters' choice to invoice their shipments in dollars is highly correlated with the firm-level dollar index constructed based on bank-firm data (see above and Fig. 2). This index is also a good predictor of the use of financial hedging instruments as reported in the EFIGE survey, which is the information that we would like to capture ideally at the firm-level. Second, USD invoicing does not necessarily induce a financial risk for the firm, for example if the payment is made at the time of (or before) delivery. Conversely, the financial risk associated with invoicing in US dollars for French exporters requires post-shipment payment (i.e. trade credit). Third, individual firms' decision to invoice exports in USD for some destinations in the post-shock period is highly endogenous. For instance, it may explain the export performance of individual firms in normal times if invoicing in US dollars instead of EUR provides the firm with a competitive advantage over competitors. This is an attenuation bias, which would play against the role of heightened USD hedging costs. Conversely, the aggregate invoicing pattern at the destination level is stable over time and arguably exogenous to firm-level characteristics such as firm-level productivity level.

As a robustness check, we use an alternative measure of the USD invoicing share of French exports by destination: The share of USD-denominated transactions (shipments) in the total number of transactions per destination (instead of the sum of exports in USD). This definition dampens by construction the role played by large exporters, which are more likely to invoice their exports to "dollar destinations" in US dollars. Besides, as detailed below, we also replicate our baseline estimation by focusing on the subset of products that are more often invoiced in US dollars by French exporters (see above and Fig. 5). This is tantamount to interacting (i) the firm-level USD index with (ii) the share of dollar invoicing by destination country (whatever the product sold) and (iii) the USD invoicing propensity by product (whatever the targeted market).

The unbiased estimation of parameter β requires that the interacted term of interest $USD\ Index_{f,t0} \times USD\ Invoicing_{FR,j}$ is uncorrelated with the error term in Eq. (3). We address potential concerns as follows. First, unobserved demand shocks are captured using product-destination fixed effects ($\gamma_{pj2011/10}$). These fixed effects allow to control for changes in demand specific to each product in each destination, which may be correlated with French exporters' demand for US dollar hedging from their banks prior to the shock. This set of fixed effects also controls for real exchange rate variations between the euro and each destination's currency of invoicing (including the US dollar) during the period of the analysis. This is an important control, as there was a sharp depreciation of the euro vis-à-vis the US dollar of about 15% between August 2011 and July 2012. As we will see later, this depreciation however plays against our result, as it improved the competitiveness of French products in the US market. This exchange rate variation should have increased, rather than decreased, the relative export performance of French firms in the United States (and other dollar-invoicing countries).

Second, the firm fixed effects in Eq. (3) control for unobserved firm-specific shocks. This allows us to control for firm-level shocks that may have an impact on exports to all destinations, such as changes in the firm's default risk or productivity, but also unobserved firm-level characteristics which could drive the choice of bank relationship.

Last, we include in Eq. (3) additional controls for observable firm characteristics *ex ante* which may be correlated both with our firm-destination-specific measure of exposure to the dollar strain episode and with the outcome. We first control for the number of banks supplying credit to each firm, as having more banks may help firms in needs of some financial products to alleviate the effects of the funding stress. Omitting this control would then tend to bias β towards zero if exporters connected to more banks are also better performers. Second, we also control for the average size of each firm's banks, as trading in international markets may require to be in relation with large, global banks, which may be more able to provide the firm with trade finance instruments and are more likely to also be "dollar specialists". Omitting this control would also tend to bias β towards zero if exporters connected to larger banks perform better. Third, we control for the size of the firm in terms of its total exports, as the size or experience of the exporter may affect its capacity to grow in some markets relative to others. We interact these covariates with the variable indicating the share of US dollar invoicing of French exports in each destination: This allows us to control for the possibility that the size of the banks in relation to a given exporter, or the size of the firm, can impact differently the exports towards some but not all destinations. All these additional firm-level controls, when not interacted, are otherwise absorbed by the firm fixed effects.

Table 3

Estimation sample: descriptive statistics.

| | N | mean | sd | p25 | p50 | p75 | p99 |
|--|--------|--------|--------|--------|--------|--------|---------|
| Export growth f_{pd} | 28,784 | 4.47 | 103.41 | −49.49 | 4.66 | 58.78 | 274.15 |
| USD Index f_{t0} | 28,784 | 2.26 | 2.58 | 0.11 | 1.14 | 3.75 | 8.16 |
| USD Index $f_{t0} \times \% \text{ of USD invoicing } j$ | 28,784 | 0.88 | 1.31 | 0.03 | 0.29 | 1.18 | 5.67 |
| Avg. bank size f_{t0} (EUR bns) | 28,784 | 535.99 | 311.27 | 304.13 | 588.00 | 768.19 | 1034.14 |
| ln Avg. bank size f_{t0} | 28,784 | 5.82 | 1.39 | 5.72 | 6.38 | 6.64 | 6.94 |
| Number of banks f_{t0} | 28,784 | 4.48 | 3.75 | 2.00 | 3.00 | 6.00 | 19.00 |
| ln number of banks f_{t0} | 28,784 | 1.20 | 0.78 | 0.69 | 1.10 | 1.79 | 2.94 |
| Total exports f_{t0} (EURmns) | 28,784 | 160.97 | 703.72 | 1.71 | 9.30 | 52.44 | 2127.77 |
| ln total exports f_{t0} | 28,784 | 9.17 | 2.58 | 7.45 | 9.14 | 10.87 | 14.57 |

Note: Firm-level descriptives based on the observations included in the final estimation sample. USD index (f) is our proxy for the US dollar hedging demand of exporters.

Table 4

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Baseline estimation.

| Dep. var. | Export growth | | | |
|--|-------------------|----------------------|----------------------|----------------------|
| | Non-eurozone OECD | | | |
| Destinations | (1) | (2) | (3) | (4) |
| USD Index $_{f,t0} \times \% \text{ USD invoicing }_j$ | −1.960 (1.198) | −3.768*** (1.327) | −3.840*** (1.453) | |
| USD Index T2 $\times \% \text{ USD invoicing }_j$ | | | | −15.215 (9.391) |
| USD Index T3 $\times \% \text{ USD invoicing }_j$ | | | | −25.242** (9.881) |
| ln Avg. bank size $_{f,t0} \times \% \text{ of USD invoicing }_j$ | | 6.775*** (2.562) | 6.853** (2.802) | 7.048** (2.789) |
| ln number of banks $_{f,t0} \times \% \text{ of USD invoicing }_j$ | | −2.400 (3.886) | −2.590 (4.440) | 3.240 (4.619) |
| ln total exports $_{f,t0} \times \% \text{ of USD invoicing }_j$ | | | 0.202 (1.946) | −0.388 (1.835) |
| Firm FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.31 | 0.32 | 0.32 | 0.31 |
| Obs. | 28,784 | 28,784 | 28,784 | 28,784 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . USD index, T2 and USD index, T3 are dummy variables which correspond to the second and third terciles of the distribution of the dollar index across firms. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

6. Results

6.1. Baseline estimation results

We now estimate the baseline empirical model, as detailed in Eq. (3). Table 4 shows the results for various sets of controls in columns (1–3). Our main variable of interest is the (firm-destination-specific) interaction of the firm-level USD (hedging) index with the share of US dollar invoicing in French exports in each destination market j . For simplicity, we refer to the destinations where French exports are predominantly denominated in US dollars as “dollar destinations” (see Fig. 4).

The estimated coefficient of interest, β , is negative as expected. Controlling for firm and destination-product fixed effects (which absorb all unobserved productivity shocks, local demand shocks, changes in tariffs and exchange rate variations etc.), firms being more likely to use EUR/USD hedging instruments reduced relatively more their exports to dollar destinations over 2010–2012. The absolute value of the coefficient increases when we include the interaction terms between the other firm controls (the average size of the banks and the number of banks that lend to a firm) and the share of US dollar invoicing in each destination. This suggests that exporters that thrive in dollar destinations are both, on average, connected with larger banks (and more banks) and more often customers of dollar-specialized lenders. Omitting these covariates, as in column 1, thus entails an attenuation bias in the estimate of β . The result remains qualitatively and quantitatively similar when we also include the interaction term between the size of the exporter (in terms of total exports ex-ante) and the share of US dollar by destination (column 3).

Finally, the results reported in Column (4) of the table show that the effect of the US dollar funding strain is highly non-linear: Its negative impact on exports to dollar destinations concentrates on exporting firms reporting the highest USD index (firms ranked among the top third in the index).

All these results are robust to controlling for firm-product fixed effects instead of firm-level fixed effects. They are equally robust to the inclusion of other country-specific, macroeconomic variables (such as GDP per capita or the level of domestic interest rates) interacted with the firm-specific dollar index.³⁰

The estimated effect of the 2011 USD hedging cost shock on export growth to dollar destinations for hedging firms is economically significant: Given the value of the estimated coefficient in column (3) of Table 4 (−3.8), an increase in the firm-level dollar hedging index by one standard deviation (about 2.3 percentage points, see Table A2) is associated with a reduction in exports to the United States relative to Switzerland (a country with low US dollar invoicing) by about 5.4% during the period of the shock (see also Table 10 for the quantification). The estimated coefficients in column (4) also implies that firms which are the most likely to use dollar hedging instruments (top 33% of the index) reduced their exports to the United States relative to Switzerland by about 15% compared to firms in the bottom third of the index distribution (see the quantification in Table 11).

³⁰ See, respectively, Tables A5 and A10 in the appendix for details.

6.2. Robustness

6.2.1. Using the share of transactions invoiced in US dollars

In the baseline specification, we measure cross-country heterogeneity in terms of US dollar invoicing practices as the ratio of dollar-denominated exports to total French exports in each destination. This measure, however, may imperfectly reflect the US dollar invoicing practice of French exporters across different destinations, if USD invoicing is dominated by very large exporters while other smaller exporters more often invoice in euros or in a different currency. Note that, while we see indeed that dollar invoicing is dominated by large exporters (see Fig. 3), the ranking of destination countries in terms of the share of dollar invoicing only weakly depends on the way we measure this share (see Fig. 4). The United States, but also Mexico or Chile, appear as US dollar destinations whenever the share of the dollar is measured in proportion of aggregate exports, or as a share of the total number of individual transactions.

We nevertheless check formally that our results are robust to this measurement issue. For this purpose, we ran the same regressions as before while this time interacting the dollar hedging index with the share of transactions (shipments) which are invoiced in dollars in each destination country. Table 5 shows the results, which are qualitatively unchanged compared to the baseline. The estimation coefficients, however, appear slightly larger because the dollar invoicing shares are smaller when they are measured as a proportion of the number of transactions, as discussed before.

6.2.2. Using the product-level dimension of US dollar invoicing

So far we focused on the geographic dimension as a source of heterogeneity in terms of US dollar invoicing. The descriptive evidence presented in Section 4 however also points to a large variance of dollar invoicing practices across exported products (see Fig. 5). For the sake of robustness, we investigate here how these two sources of variance interact to explain the causal impact of the 2011 dollar funding shock on French exports.

For this purpose, we recover the product fixed effects obtained from the analysis of variance performed in Section 4. We then rank HS4 products into categories with “High” or “Low” USD invoicing propensity based on the value of the product fixed effect. Products with a fixed effect above zero are classified among goods being highly dollarized, whereas other products are classified as weakly (less) dollarized. Note that the estimation of these fixed effects is done out of sample, and is based on the full population of French export flows for which the invoicing currency is reported over the period 2012–2018 (and excluding the year 2011 which might be impacted by the dollar shock). This estimation also controls for exporter, destination and time fixed effects.

We report in Table 6 the estimation results based on two sub-samples in our data: First, products being weakly dollarized (column 1: Low), and second, products highly dollarized (column 2: High). The estimation results are significant only when we focus on products more likely to be invoiced in USD. We obtained similar results when the share of dollar invoicing per destination is assessed using the number of transactions instead of the value of exports (see columns 4–5 of the Table).

Table 5
Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: USD invoicing by destination measured as the share of transactions.

| Dep. var. | Export growth | | | |
|---|-------------------|---------------------|---------------------|-----------------------|
| | Non-eurozone OECD | | | |
| Destinations | (1) | (2) | (3) | (4) |
| USD Index $f_{to} \times \% \text{ flows with USD invoicing } j$ | −4.724 (3.421) | −9.073** (3.739) | −8.932** (4.022) | |
| USD Index T2 $\times \% \text{ flows with USD invoicing } j$ | | | | −30.086 (26.718) |
| USD Index T3 $\times \% \text{ flows with USD invoicing } j$ | | | | −70.743** (27.699) |
| ln Avg. bank size $f_{to} \times \% \text{ of USD invoicing } j$ | | 6.029** (2.523) | 5.977** (2.715) | 6.907** (2.721) |
| ln number of banks $f_{to} \times \% \text{ of USD invoicing } j$ | | −2.125 (3.903) | −1.985 (4.432) | 2.834 (4.555) |
| ln total exports $f_{to} \times \% \text{ of USD invoicing } j$ | | | −0.152 (1.919) | −0.358 (1.826) |
| Firm FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.31 | 0.31 | 0.31 | 0.31 |
| Obs. | 28,784 | 28,784 | 28,784 | 28,784 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated transactions in French exports to each destination j . USD index, T2 and USD index, T3 are dummy variables which correspond to the second and third terciles of the distribution of the dollar index across firms. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

Table 6

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: “Dollar products”.

| Dep. var. | Export growth | | | | | |
|---|-------------------------------|---------------------|---------------------|--------------------------|----------------------|---------------------|
| | Non-eurozone OECD incl. US | | | excl. US | | |
| Destinations | | | | | | |
| | Low | High | High | Low | High | High |
| Dollar-invoicing at product level | Share in agg. exports | | | Share in nb. trade flows | | |
| Dollar-invoicing at destination level | (1) | (2) | (3) | (4) | (5) | (6) |
| USD Index $f_{to} \times \% \text{ of USD invoicing } j$ | −2.197 (1.836) | −5.969** (2.482) | −8.905** (4.511) | | | |
| USD Index $f_{to} \times \% \text{ flows with USD invoicing } j$ | | | | −4.580 (5.230) | −13.795** (6.644) | −12.209 (11.618) |
| In Avg. bank size $f_{to} \times \% \text{ of USD invoicing } j$ | 5.835* (3.462) | 10.364** (4.722) | 9.760 (7.361) | 5.172 (3.340) | 8.949** (4.484) | 4.127 (6.643) |
| In number of banks $f_{to} \times \% \text{ of USD invoicing } j$ | −2.604 (5.291) | −4.608 (7.729) | −7.839 (12.802) | −2.216 (5.297) | −3.391 (7.642) | −3.121 (12.693) |
| In total exports $f_{to} \times \% \text{ of USD invoicing } j$ | −0.241 (2.137) | 2.010 (3.115) | 2.281 (5.106) | −0.510 (2.119) | 1.445 (3.069) | −0.165 (5.063) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.34 | 0.35 | 0.39 | 0.34 | 0.35 | 0.39 |
| Obs. | 16,507 | 10,584 | 6872 | 16,507 | 10,584 | 6872 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . We sort HS-4 products according to how frequently exports are invoiced in USD. This assessment is based on a regression of a dollar-invoicing dummy on product, firm and destination fixed effects over 2011–2018. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

6.2.3. Groups of “dollar destinations”

We further investigate in this section potential non-linear effects of the country-specific share of dollar invoicing, by considering two thresholds, depending on how we identify dollar destinations. To do so, we first defined dollar destinations as countries with a share of USD invoicing in the aggregated value of exports above 30% (in our sample of OECD destinations): Australia, Chile, Korea, Mexico, New-Zealand and the United States. Alternatively, we defined dollar destinations as countries with a share of USD invoicing in the total number of transactions above 15%: Chile, Mexico, and the United States.

We then created dummy variables for each of these two groups of countries and interacted these dummies with the firm-level USD index as in the baseline. We ran separate regressions on the whole estimation sample, on exports of products less frequently invoiced in US dollars, and on exports of products which are frequently invoiced in US dollars.

Estimation results are reported in the appendix (see Table A6). The results confirm that the 2011 dollar liquidity squeeze induced a relative drop in French exports to dollar destinations for firms being more likely to use dollar hedging tools. The effect is limited to exports of products frequently invoiced in dollars, in line with our previous results.

6.2.4. Excluding the United States from the sample of destinations

As shown above in Section 4, the share of dollar invoicing in French exports is the highest in the US market. Elsewhere, the share of dollar invoicing is on average much lower, and among OECD destinations, dollar invoicing of exports is relatively frequent in only a few other destinations, notably Mexico and Chile.

One may therefore be concerned that the US dollar shock in 2011 could be correlated with another macro shock that simultaneously happened in the US and hit particularly hard French exporters related to dollar-specialized banks. The baseline cross-sectional regression includes destination-product fixed effects and, therefore, does control for supply or demand shocks that would occur specifically in the US.

As a robustness check, we re-estimate the baseline regression while dropping the United States from our set of destinations. Table 6 shows the results for the two alternative measures of country-level shares of dollar invoicing (columns 3 and 6 respectively). We ran these regressions on the sample of products with a high propensity to be invoiced in US dollars only. Excluding exports to the US tends to weaken our main estimation result. This is not surprising as the US is also the main destination for French exports outside the EU, so that we lose some 40% of our observations. However, we still find that the rise in the cost of USD hedging in 2011 significantly reduced French firms' exports to “dollar” destinations relative to “non-dollar” ones, among firms having a high propensity to hedge against exchange rate fluctuations (column 3). This result is qualitatively similar in column 6 when we identify “dollar” destinations using the share of transactions in USD instead of the aggregate share of exports. The estimated coefficient, however, loses significance. Again, this is not really surprising as this is a very restrictive specification, since we dropped from our sample the main destination in French exports among OECD extra-EU countries.

Table 7

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Additional robustness tests.

| Dep. var. | Export growth | | | |
|---|-------------------|-------------------|---------------------|-----------------------|
| | Non-eurozone OECD | | | |
| | Placebo | | PSW | |
| Destinations | Non-eurozone OECD | | Non-eurozone OECD | |
| Estimation | Placebo | PSW | Placebo | PSW |
| | (1) | (2) | (3) | (4) |
| USD Index $f_{t0} \times \% \text{ of USD invoicing } j$ | −0.036 (1.579) | | −3.971** (1.577) | |
| USD Index, T2 $\times \% \text{ of USD invoicing } j$ | | 0.958 (10.232) | | −11.225 (9.533) |
| USD Index, T3 $\times \% \text{ of USD invoicing } j$ | | 5.655 (10.858) | | −22.807** (10.030) |
| In Avg. bank size $f_{t0} \times \% \text{ of USD invoicing } j$ | 1.181 (2.662) | 0.182 (2.807) | 8.951*** (3.173) | 8.475*** (3.131) |
| In number of banks $f_{t0} \times \% \text{ of USD invoicing } j$ | 6.062 (4.654) | 5.365 (4.827) | 2.968 (4.451) | 9.066* (4.635) |
| In total exports $f_{t0} \times \% \text{ of USD invoicing } j$ | −0.244 (1.875) | −0.523 (1.837) | 0.050 (2.020) | −0.475 (1.939) |
| Firm FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.35 | 0.35 | 0.36 | 0.36 |
| Obs. | 21,335 | 21,335 | 27,332 | 27,332 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

6.2.5. Placebo test

Identification may fail if firms with a smaller relative export growth in dollar destinations happen to be systematically matched *ex ante* to dollar-specialized banks. The baseline specification controls for unobserved firm-specific shocks with firm-level fixed effects and accounts for assortative matching between banks and exporters (by including the average size of banks interacted with the destination-specific variable). Unobservable characteristics to the bank-firm relationship may however still bias our estimates if the usual assumption of *ex ante* parallel trends across “treated” and “control” firm-country pairs is violated. We discard this possibility by running a placebo regression where the dependent variable is export growth by firm-product-destination as measured *one year ahead* of the shock. More precisely, export growth is now defined as the log variation of cumulated exports between period T_{-1} (12 months between July 2009 to June 2010, i.e.) and period T_0 (12 months between July 2010 to June 2011, i.e. before the shock). As the US dollar funding shock is posterior to period T_0 , we expect that the USD index of French exporters had no impact on their relative export performance in dollar destinations over these two years.

Table 7, columns (1) and (2), shows the results of the placebo regressions (allowing or not for non-linearity). Before the US dollar funding shock, there was no systematic relationship between the exporters' reliance on hedging tools and their relative exports performance in dollar destinations. We can therefore reject the hypothesis that some assortative bank-firm matching based on unobservable factors explains our main result.

6.2.6. Propensity score weighting

A common concern in difference-in-differences style regressions is that treated and control units can be quite different in terms of observable covariates, so that including these covariates is not enough to correct potential biases in the estimated coefficient of interest. This could be the case here if highly performing exporters in dollar markets are systematically connected to dollar-specialized banks, while less performing firms are systematically connected to other banks.

To deal with this potential concern, we use a propensity score weighting (PSW) procedure in order to improve the overlap in the covariates across “treated” and “control” groups. For this purpose, we assign observations to two groups, depending on whether the dollar index of the associated firms are above or below the sample median. We then compute for each observation its propensity score, namely the probability to be assigned to the group of higher than median indexes, conditional on firms' characteristics, banks' characteristics, and their interactions. We restrict the estimation sample to observations with a score ranging from 0.1 to 0.9, since observations out of this range lack counterfactuals. A standard test for balanced covariates (Imbens and Wooldridge, 2009) suggests that there is indeed a concern in the full sample, but that trimming observations with extreme propensity scores is enough to alleviate it.³¹

We then re-estimate the same model using WLS regressions, where we weight each observation either by the inverse of the propensity score for those assigned to the treated group, or the inverse of one minus the score for those in the control group. This

³¹ To save space, the results of this test are presented in Table A7 in the appendix.

reduces the impact on the coefficient estimate of observations for which “counterfactuals” are nearly absent in the data, i.e.: Those in the treated group with a high probability of being treated, and those in the control group with a low probability of being treated. Conversely, this procedure overweights observations for which we may find enough counterfactuals in the sample, namely observations in the treated group with a low probability of being treated and those in the control group with a high probability of being treated.

Results of the PSW regressions are reported in Table 7, columns (3) and (4). The negative effect of the dollar shock appears similar as in the baseline. The estimate of coefficient of interest reaches now -3.9 , which is comparable to our baseline estimate -3.8 . Everything else equals, this PSW estimate implies that a one standard deviation increase in the firm-level dollar index reduces the growth of firm-level exports to the United States relative to Switzerland by about 5.46% (see the quantification in Table 10).

7. Inspecting mechanisms

In this section, we try to highlight the underlying mechanisms at play. First, we ask whether the shock was transmitted to export values through changes in export prices vs export volumes. Second, we focus on the sub-sample of firms that reported to the 2020 EFIGE survey. For these firms, we can directly test for the role played by firms' demand of financial hedging instruments.

7.1. Impact on export unit values and quantities

Intuitively, the increased cost of hedging against dollar exchange risk should transmit into an increased export cost for French exporters, which are constrained to invoice their shipments in dollars. The decline in the export value of goods sold in dollar markets by exposed French exporters should therefore not be explained by a decline in unit values (prices), but rather by a drop in export quantities.

To check that this is indeed the case, we break down the export value growth of French exporters into (i) the change in volumes (quantities) exported within each HS 4-digits product category, and (ii) the change in unit values, defined at the same level of disaggregation.

We then estimate the same equation as before, but using alternative dependent variables: Export growth expressed in values (v), quantities (q) and unit values (p). Table 8 displays the results. Columns (1–3) show estimates obtained for the whole sample of products, whereas columns (4–6) report results for the set of products with a high propensity to be invoiced in US dollars. Estimation results confirm that the largest impact on export values is obtained when the sample is restricted to products which are more frequently invoiced in dollars (see column 4 versus column 1). Columns 2 and 5 confirm that the estimated impact of costly dollar hedging tools on export value growth is entirely driven by the change in exported quantities. In contrast, the estimated impact on export prices (unit values), is not significant (columns 3 and 6).

Table 8
Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Unit values versus quantities.

| Dep. var. | Export growth | | | | | |
|---|----------------------|----------------------|-------------------|---------------------|----------------------|--------------------|
| | Non-eurozone OECD | | | | | |
| Destinations | | | | | | |
| Product USD propensity | All | All | All | High | High | High |
| Variable | v | q | p | v | q | p |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| USD Index $f_{t0} \times \% \text{ of USD invoicing } j$ | −3.840*** (1.453) | −3.476* (1.857) | −0.364 (1.263) | −5.969** (2.482) | −6.359** (3.214) | 0.390 (2.091) |
| In Avg. bank size $f_{t0} \times \% \text{ of USD invoicing } j$ | 6.853** (2.802) | 10.095*** (3.770) | −3.241 (2.246) | 10.364** (4.722) | 16.118*** (5.962) | −5.754* (3.461) |
| In number of banks $f_{t0} \times \% \text{ of USD invoicing } j$ | −2.590 (4.440) | −9.006 (6.087) | 6.415* (3.639) | −4.608 (7.729) | −9.456 (9.847) | 4.848 (5.127) |
| In total exports $f_{t0} \times \% \text{ of USD invoicing } j$ | 0.202 (1.946) | 2.434 (2.539) | −2.232 (1.487) | 2.010 (3.115) | 2.743 (4.141) | −0.734 (2.303) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.32 | 0.33 | 0.36 | 0.35 | 0.35 | 0.36 |
| Obs. | 28,784 | 28,784 | 28,784 | 10,584 | 10,584 | 10,584 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . We sort HS-4 products according to how frequently exports are invoiced in USD. This assessment is based on a regression of a dollar-invoicing dummy on product, firm and destination fixed effects over 2011–2018. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

Table 9

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Evidence based on the EFIGE survey.

| Dep. var. | Export growth | | | | |
|---|-------------------|---------------------|---------------------|---------------------|---------------------|
| Destinations | United States | | | | |
| Sample | Hedging = no | Hedging = yes | All matched firms | | |
| | (1) | (2) | (3) | (4) | (5) |
| USD Index _{f,t0} | 4.281 (4.035) | −6.125** (2.626) | 4.207 (3.143) | 4.674 (3.165) | 4.009 (3.219) |
| USD Index _{f,t0} × Hedging _{f,t0} | | | −7.624** (3.616) | −8.109** (3.694) | −8.890** (3.977) |
| ln Avg. bank size _{f,t0} | −1.249 (6.339) | 4.120 (2.644) | 1.391 (2.589) | 0.835 (2.747) | 0.717 (3.017) |
| Hedging _{f,t0} | | | 7.709 (11.595) | 13.364 (14.113) | 16.781 (15.990) |
| ln total exports _{f,t0} | | | | −1.580 (1.688) | −2.023 (1.759) |
| Sector FE | Yes | Yes | No | No | Yes |
| R ² | 0.11 | 0.08 | 0.01 | 0.01 | 0.07 |
| Obs. | 328 | 275 | 631 | 631 | 618 |

Note: OLS regressions for firm-level exports growth. The only destination in this estimation is the United States. The dependent variable is the log change in exports of firm f for product p to the United States, between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. The sample consists of firms in both our main sample and the EFIGE survey for the United States. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level. Harmonized System 2-digit product dummies included as sector-level fixed effects.

Different reasons may explain why we do not observe any significant impact on export unit values for “treated” observations.³² In standard trade models with CES demand, one could expect an increase in the FOB export prices as firms pass-through the increase in their costs. In competitive markets with price-taker exporters, however, increasing costs lead to a reduction in firm-level profits. Exporters may decide therefore to reduce the volume of their shipments and wait for better financial conditions, or to reallocate some of their exports to different markets. Exporters may also decide to grant their foreign clients shorter payment delays, in order to reduce their exposure to exchange rate risk. While this would reduce exported volumes due to a reduction in non-price competitiveness, this type of information is not available in the French customs data that we are using.

7.2. Survey-based evidence on the use of hedging instruments

For the sub-sample of exporters which reported to the 2010 EFIGE survey, we now provide complementary evidence on the role of firm-level hedging for exports in times of rising hedging costs.

For this purpose, we merged the EFIGE survey with our main dataset and generated a dummy variable, which takes the value of one when a firm reports having used financial instruments to hedge against FX risk (whatever the currency) in the years 2007–2009. The merged sample covers much fewer firms than in our baseline, as we were able to match only 253 exporters with the EFIGE survey. Among these firms, 68 reported that they were regular users of financial instruments for hedging purpose.

The new empirical specification is quite similar to the main one: We now have a new interaction term between the USD index of the firm and the dummy variable identifying firms using FX hedging instruments (USD Index_{f,t0} × Hedging_f). The empirical specification also entirely relies on exports to the US destination (Eq. 4).

$$\Delta \ln v_{fp,us,t_1/t_0} = \alpha \text{USD Index}_{f,t_0} + \beta \text{USD Index}_{f,t_0} \times \text{Hedging}_f + \theta \text{Controls}_{f,t_0} + \gamma_{p,us} + \epsilon_{fp,us} \quad (4)$$

As there are much fewer observations than before, the product fixed effect $\gamma_{p,us}$ is defined at the coarser HS 2-digit level. We denote these fixed effects as sector fixed effects accordingly. The main variable of interest is now the interaction term between the dollar index of the firm and the EFIGE dummy for a regular use of hedging instruments.

Table 9 shows the results. Comparing columns (1) and (2) confirms that a higher USD index of the firm (i.e. a greater reliance on dollar banks) during the period of the rising USD hedging cost, is only detrimental for exporters using financial instruments to hedge against exchange rate fluctuations. This result holds when we consider all firms in the sample and introduce the interaction term between the firm-level USD index and the EFIGE hedging dummy (columns 3–5). Overall, the results presented in the table vindicate our interpretation of the mechanisms at play during this episode of dollar funding stress.

³² In unreported estimations, we re-estimated our empirical model using HS6 instead of HS4 data in order to measure unit values at a finer level of disaggregation. Empirical results remained, however, unchanged.

Table 10

Quantification of the impact on exports of a 1 s.d. increase in the firm USD index.

| | Estimation | | |
|---|------------|----------------------|-------|
| | Baseline | Non-linear (top 33%) | PSW |
| Elasticities (β) | −3.84 | −25.25 | −3.90 |
| Effect 1 s.d. of firm USD index (2.26 p.p.) | −8.68 | – | −8.81 |
| – United States vs Switzerland | −5.38 | −15.66 | −5.46 |

Note: β parameters taken from previous estimation tables (Baseline estimation and non-linear estimation in Table 4, PSW refers to Propensity Score Weighting estimation in Table 7. Summary statistics used for the quantification are from Table A2). The United States vs Switzerland exercise presents the differential impact of the demand for dollar risk hedging on firm-level exports, when the share of US dollar invoicing is the one observed in the United States (about 70% in French total exports) compared to Switzerland (about 8% in French total exports) – i.e. a difference of about 62% in the share of USD invoicing.

8. Quantification of the increase in trade costs

In this section, we compute a trade cost equivalent of the heightened cost of dollar hedging tools induced by the 2011 dollar liquidity squeeze. This computation relies on two parameters: (1) β , the estimated effect on exports, and (2) available estimates of the tariff elasticity of exports obtained in the empirical trade literature and based on similar data. In particular, Berthou and Fontagné (2016) provide an estimate of this elasticity, denoted as ρ in Eq. (5) below, which they get using data on French exports to extra-EU destinations at the firm-product level similar as ours. Their empirical model reads:

$$\Delta \ln v_{fijt} = \rho \Delta \ln (1 + \text{Tariff}_{ijt}) + \alpha_{ft} + \gamma_{jt} + \epsilon_{fijt} \quad (5)$$

The baseline estimate Berthou and Fontagné (2016) is $\rho = -2.5$, which implies that a 1% increase in the import tariff of a foreign country reduces the value of French firm-product-level exports by 2.5%.

Table 10 reports the effect on exports of a change by one standard deviation in the firm-level USD index (2.26 percentage points), considering all destinations in sample, or considering only the United States and Switzerland, where respectively some 70% and 8% of French exports were invoiced in US dollars in 2011. We use three different estimates of the β coefficient (from the baseline linear specification, coefficient for the top 33% of firms in the non-linear specification, and PSW estimate). A one standard deviation in the dollar hedging index of the firm reduces export growth to the United States relative to Switzerland by about 5.3% according to the coefficient estimate obtained in the linear specification. However, the estimated effect is much larger for the firms that are the most likely to use dollar hedging instruments (a relative decline of exports of about 16% for the top tercile of firms).

In Table 11, we evaluate the effects of the shock for different levels of the firms-level USD index and compute the corresponding trade cost equivalent. We provide this quantification for the median firm in terms of USD index, the average firm, so-called

Table 11

Trade cost equivalent of the 2011 USD hedging cost shock.

| | Impact on exports (% variation) | |
|--|---------------------------------|--------|
| | Estimation | PSW |
| Firm-level USD index (%) | Baseline | |
| Median = 0.47 | −1.12 | −1.14 |
| Mean = 1.59 | −3.79 | −3.84 |
| Treated (Avg. above median) = 3.00 | −7.14 | −7.25 |
| Top 10% = 4.80 | −11.43 | −11.61 |
| Top 33% (non-linear estimates) | −15.66 | |
| Trade cost shock equivalence (p.p. increase) (Tariff elasticity of export value = −2.5) | | |
| Firm-level USD index (%) | Estimation | PSW |
| | Baseline | |
| Median | 0.45 | 0.45 |
| Mean | 1.51 | 1.54 |
| Treated (Avg. above median) | 2.86 | 2.90 |
| Top 10% | 4.57 | 4.64 |
| Top 33% (non-linear estimates) | 6.26 | |

Note: Authors' calculations based on the estimated elasticity of exports vis-à-vis firms' dollar hedging index before the dollar shock (β). Elasticities: baseline = −3.84; Propensity score weighting = −3.90. The trade cost equivalent is calculated for each level of the dollar hedging index as the ratio of the estimated change in exports given the firm-level hedging index over 1 minus the tariff elasticity ($\rho = -2.5$). The tariff elasticity is taken from Berthou and Fontagné (2016).

“treated” firms (average value of the index above the median) or the firms in the top decile. We also provide a quantification of the trade impact for the top 33% based on our non-linear estimates. As in the previous table, we also compare the effects on exports to the United States and to Switzerland. The impact on export growth is fairly limited for the median exposed exporter in our sample (about -1.1% when we compare exports to the US relative to Switzerland), while firms with a high USD index value were more strongly affected (about -11% for firms in the top decile). For “treated” exporters (average USD index above median), the reduction in relative exports is about 7% in OLS and PSW regressions.

Based on these estimated trade effects, we can derive an equivalent of this financial shock in terms of a counterfactual tariff increase. For the average treated firm, and comparing the US and Switzerland, the financial trade cost for exporting to the United States has the same effect as would have a counterfactual increase in relative tariffs by about 2.9 percentage points. For firms in the top decile of the USD index, the counterfactual increase in tariffs needed to entail the same trade costs reaches 4.6 percentage points. These results emphasize that financial frictions, which raise the cost of hedging against EUR/USD exchange risk, can lead to a substantial increase in the variable trade costs faced by exporters.

9. Conclusion

We analyze in this paper the effects of an heightened cost of hedging against dollar exchange risk on the export performance of French firms in countries where imports are frequently invoiced in US dollars (“dollar destinations”). The liquidity squeeze in interbank markets for dollar funds faced by French banks in the second half of 2011, during one of the most acute phase of the euro area sovereign debt crisis, triggered a sharp deviation from the covered interest parity in the EUR/USD market. As a consequence, the price of financial contracts protecting exporters to dollar destinations against a future depreciation of the dollar soared. This episode therefore offers a unique quasi-natural experiment to investigate how financial frictions in currency markets may affect the export performance of firms to some – but not all – destinations through the induced increase in the cost of foreign exchange hedging solutions offered by banks to exporters.

Since, for most exporters, no direct information is available at the firm-level on the regular use of hedging instruments against dollar exchange risk, we construct a proxy for firms’ usual demand for dollar hedging tools (a “firm-level dollar index”) using their degree of reliance before the shock on French banks, which we identify *ex ante* as “dollar specialists” based on their large dollar-denominated liabilities with banks located in the US. We find evidence that the disruption of EUR/USD exchange markets in the summer of 2011 had large effects on French exports in dollar destinations for firms reporting a high US dollar index – our proxy for the regular use of dollar risk hedging tools. For the top tercile of exporters in terms of our dollar index, export growth to the United States (a destination where USD invoicing represents a *high* share of French exports) relative to Switzerland (a destination where USD invoicing represents a *low* share of French exports) was reduced by about 16%. We also find that the estimated effect is entirely driven by the sales of products, which are usually invoiced in US dollars. We show that, for the most exposed trade flows (firms with a high USD index *and* dollar invoicing destinations) the estimated impact was akin to an increase in tariffs by about 3 percentage points, and can reach more than 6 percentage points.

Last but not least, our results bear novel policy implications for the FX swap lines between central banks, which are now an important element of the international financial architecture (Bahaj and Reis, 2018). As said above, the borrowing rate at the dollar facility of the ECB, which was backed since 2010 by the ECB’s swap line with the US Federal Reserve, was a penalty rate, which remained above the EUR/USD basis spread during most of the second semester of 2011 and therefore failed to alleviate the tensions on the European interbank market for dollar funds until it was cut at the end of November 2011. With its focus on the induced FX hedging costs faced by exporters to sell goods in dollar invoicing markets, our study sheds new light on the real costs associated with the mispricing of this lending-of-last-resort facility. It therefore also contributes to the ongoing efforts at assessing the costs and benefits of central bank interventions during the last financial crisis.

Appendix A. Appendix

A.1. French banks reporting to the LBS statistics: descriptive statistics

Table A1

Selected banks: descriptive statistics.

| | Nb.Obs. | Mean | Std.Dev. | p25 | Median | p75 | p90 |
|---------------------------------|---------|--------|----------|-------|--------|-------|--------|
| Total Assets (bns) | 53 | 98.990 | 241.008 | 1.82 | 3.98 | 24.10 | 311.22 |
| Loans (/Assets) | 53 | 38.483 | 24.682 | 18.26 | 34.66 | 49.98 | 75.71 |
| Interbank Assets (/Assets) | 53 | 20.247 | 18.491 | 8.02 | 13.04 | 26.69 | 48.38 |
| Capital (/Assets) | 53 | 7.595 | 11.983 | 3.84 | 5.27 | 7.12 | 12.42 |
| Interbank Liabilities (/Assets) | 53 | 30.489 | 23.991 | 12.20 | 26.46 | 43.82 | 71.57 |
| Deposits (/Assets) | 53 | 45.641 | 25.751 | 22.39 | 49.15 | 62.34 | 81.56 |
| Dollar Liab. viz. US (/Assets) | 53 | 0.443 | 1.563 | 0.00 | 0.00 | 0.01 | 0.47 |

Note: Descriptive statistics on banks included in the final estimation sample.

A.2. Firms in the final estimation sample: descriptive statistics

Table A2

Estimation sample: firm-level descriptive statistics.

| | N | mean | sd | p25 | p50 | p75 | p99 |
|--|-------|-------|-------|------|------|------|--------|
| USD Index _{f,t0} | 4,734 | 1.59 | 2.27 | 0.02 | 0.47 | 2.47 | 8.16 |
| total exports _{f,t0} (EURmns) | 4,734 | 17.82 | 99.11 | 0.33 | 1.79 | 7.47 | 301.89 |
| Number of banks _{f,t0} | 4,734 | 3.66 | 2.97 | 1.00 | 3.00 | 5.00 | 14.00 |

Note: Firm-level descriptives based on the firms (legal units, not observations which combine exporters with products and destinations) included in the final estimation sample. USD index is our proxy for the US dollar hedging demand of exporters.

A.3. Estimation sample: covariance matrix of covariates

Table A3

Estimation sample: covariance matrix of covariates.

| | USD index | Avg. bank size | Nb. of banks | Total exports |
|-----------------|-----------|----------------|--------------|---------------|
| USD Index | 1.00 | | | |
| Avg. bank size | 0.44 | 1.00 | | |
| Number of banks | 0.01 | 0.06 | 1.00 | |
| Total exports | 0.34 | −0.07 | 0.38 | 1.00 |

Note: Covariance matrix from the estimation sample. Average bank size, Number of banks, and total exports are taken in logarithms. USD Index is our proxy for the US dollar hedging demand of exporters.

A.4. US dollar invoicing: variance decomposition and estimation of the product fixed effects

We provide a variance decomposition of the decision of French exporters to invoice their exports in US dollars. The approach is similar to [Amity et al. \(2020\)](#). In the case of our study, we start from the full sample of the French customs that detail the firm-level exports by firm identifier, destination, product (CN 8-digits) and month. This data is then aggregated at the exporter, destination, HS 4-digits product. The variance decomposition is performed before the data is merged with the main estimation sample, so we keep here all available exporters, products and extra-EU destinations. This allows to perform the variance decomposition using very detailed and exhaustive data. Note that we drop the observations for the year 2011 when the dollar shock strikes.

To perform the variance decomposition, we estimate with OLS a linear probability model of the decision to invoice in US dollars ([Eq. E1](#)). The dependent variable, D_{fpjct} , is a dummy variable indicating whether the individual export flow is invoiced in US dollars (in which case it is equal to 1) or in a different currency (in which case it is equal to 0):

$$D_{fpjct} = \psi_f + \psi_p + \psi_j + \psi_t + \epsilon_{fpjct} \quad (\text{E1})$$

where ψ_f is the firm fixed effect, ψ_p is the HS4 product fixed effect, ψ_j is the destination fixed effect, and ψ_t is the time (year) fixed effect. ϵ_{fpjct} is the error term. The variance decomposition results are reported in [Table A4](#). The results emphasize the important role of firm-level factors for the choice of the invoicing currency. However, when we use more detailed two-way fixed effects (firm-product, firm-destination), we also see that the reported R-square is inflated, which means that exporters also tend to invoice in US dollars or in a different currency depending on the exact destination or the exact product of the export flow.

Table A4

Choice of the invoicing currency: variance decomposition.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|----------------|--------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Dep. var. | Dollar invoicing dummy (fpjct) | | | | | |
| Fixed effects | One dimension | | | Two dimensions | | |
| R ² | Unweighted | | | | | |
| Obs. | 0.30 7,603,408 | 0.04 7,668,157 | 0.09 7,668,157 | 0.37 6,902,171 | 0.18 7,646,189 | 0.60 7,247,909 |
| R ² | Weighted | | | | | |
| Obs. | 0.29 2,524,521 | 0.04 2,564,229 | 0.09 2,564,233 | 0.37 2,181,437 | 0.16 2,563,497 | 0.53 2,456,952 |
| Period | 2011–18 | | | | | |
| Fixed effects | f,t | p + t | j + t | fp,t | pj,t | fj,t |

Note: French Customs data, annual export value by firm (siren, f), product(HS4, p), destination(Country, j), Currency (c) and year (t). The dependent variable equals one if the exporting flow is invoiced in US dollars, and zero otherwise. In the second panel, observations are weighted by the value of the export flow.

A.5. Baseline estimation controlling for firm-product fixed effects

Table A5

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Controlling for firm-product fixed effects.

| Dep. var. Destinations | Export growth | | | |
|---|-------------------|---------------------|---------------------|-----------------------|
| | Non-eurozone OECD | | | |
| | (1) | (2) | (3) | (4) |
| USD Index $f_{t0} \times \% \text{ of USD invoicing } j$ | −1.235 (1.283) | −3.439** (1.413) | −3.500** (1.551) | |
| USD Index, T2 $\times \% \text{ of USD invoicing } j$ | | | | −7.835 (9.778) |
| USD Index, T3 $\times \% \text{ of USD invoicing } j$ | | | | −20.674** (10.225) |
| In Avg. bank size $f_{t0} \times \% \text{ of USD invoicing } j$ | | 8.367*** (2.609) | 8.434*** (2.852) | 8.532*** (2.856) |
| In number of banks $f_{t0} \times \% \text{ of USD invoicing } j$ | | −2.046 (4.055) | −2.220 (4.711) | 2.729 (4.938) |
| In total exports $f_{t0} \times \% \text{ of USD invoicing } j$ | | | 0.178 (2.039) | −0.275 (1.938) |
| Firm-Product FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.45 | 0.45 | 0.45 | 0.45 |
| Obs. | 24,305 | 24,305 | 24,305 | 24,305 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . USD index, T2 and USD index, T3 are dummy variables which correspond to the second and third terciles of the distribution of the dollar index across firms. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

A.6. Non-linear effect of USD invoicing

We report here the results of an alternative estimation reported in Table A6, where the firm-level dollar hedging index is interacted with a dummy variable identifying extra-eurozone OECD destinations in French exports where more than 30% of aggregate exports is invoiced in US dollars (Australia, Chile, Korea, Mexico, New Zealand and the United States), or where more than 15% of individual export flows is invoiced in US dollar (Chile, Mexico, the United States).

Table A6

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Non-linearity in USD invoicing patterns.

| Dep. var. Destinations | Export growth | | | | | |
|---|---------------------|-------------------|---------------------|---------------------|-------------------|--------------------|
| | Non-eurozone OECD | | | | | |
| | All | Low | High | All | Low | High |
| Product USD propensity | (1) | (2) | (3) | (4) | (5) | (6) |
| USD Index $f_{t0} \times \% \text{ dollar share } > 30\%$ | −1.451** (0.697) | −0.535 (0.896) | −2.798** (1.179) | | | |
| USD Index $f_{t0} \times \% \text{ dollar flows } > 15\%$ | | | | −1.555** (0.686) | −1.082 (0.921) | −1.924* (1.104) |
| In Avg. bank size $f_{t0} \times \% \text{ of USD invoicing } j$ | 5.858** (2.706) | 4.769 (3.396) | 9.754** (4.588) | 5.713** (2.643) | 5.464* (3.244) | 7.730* (4.315) |
| In number of banks $f_{t0} \times \% \text{ of USD invoicing } j$ | −1.918 (4.407) | −2.004 (5.295) | −4.054 (7.620) | −1.798 (4.402) | −2.357 (5.289) | −2.410 (7.559) |
| In total exports $f_{t0} \times \% \text{ of USD invoicing } j$ | −0.242 (1.926) | −0.702 (2.111) | 1.721 (3.077) | −0.280 (1.891) | −0.404 (2.109) | 0.951 (3.026) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.31 | 0.34 | 0.35 | 0.31 | 0.34 | 0.35 |
| Obs. | 28,784 | 16,507 | 10,584 | 28,784 | 16,507 | 10,584 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . We sort HS-4 products according to how frequently exports are invoiced in USD. This assessment is based on a regression of a dollar-invoicing dummy on product, firm and destination fixed effects over 2011–2018. Aggregate dollar invoicing share $> 30\%$: countries are AU CL KR MX NZ US. Percentage of trade flows with dollar invoicing $> 15\%$: countries are CL MX US. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

A.7. Test for balanced covariates

Table A7 describes the heterogeneity in exporters' characteristics conditionally to their dollar hedging index. Observations are sorted into two bins, depending on whether the firm's dollar hedging index is above the sample median (so-called treated observations) or below the median (control observations). As the table shows, firms in the treated group tend to be larger, and to be connected to more banks and to larger banks.

To assess to what extent these differences matter, the third and fourth columns of Table 17 report measures of the distribution of firm-level variables across treatment status. The third column displays the standardized difference in the average values between "treated" and "control" observations for each covariate. As a rule of thumb, a variable is not enough balanced across groups when this statistic is larger than 0.25 in absolute value, cf. Imbens and Wooldridge (2009). The results shown in column 3 suggest that our covariates are not sufficiently balanced across groups.

To deal with this potential concern, we use a propensity score weighting (PSW) procedure. For this purpose, we compute for each observation its propensity score, namely the probability to be assigned to the group of higher than median hedging indexes (to be "treated"), conditionally on firms' characteristics, banks' characteristics, and their interactions. The fourth column shows the standardized difference when the sample is trimmed, i.e., when observations with estimated propensity scores below 0.1 or above 0.9 are discarded. All covariates now pass the test and can be viewed as perfectly balanced across groups in this corrected sample.

Table A7

Descriptive stat for firms in the sample: balancing of observable characteristics.

| | Treated | Controls | Standardized Diff. | |
|---|---------|----------|--------------------|----------------|
| | Mean | Mean | Full sample | Trimmed sample |
| ln Avg. bank size $_{f,t0} \times \% \text{ of USD invoicing } _j$ | 2.856 | 1.713 | 0.754 | 0.014 |
| ln number of banks $_{f,t0} \times \% \text{ of USD invoicing } _j$ | 0.576 | 0.332 | 0.504 | −0.005 |
| ln total exports $_{f,t0} \times \% \text{ of USD invoicing } _j$ | 4.216 | 2.709 | 0.636 | 0.005 |
| Obs. | 14,333 | 14,451 | 28,784 | 26,431 |

A.8. Impact on imports

A natural question to ask is whether the US dollar funding shock in 2011 also affected firm-level imports from "dollar destinations". At first sight, the answer seems to be yes as the importer typically has to secure an access to dollars in a few months time in order to pay for its imports post-shipment. However, it may not necessarily be the case, since the hedging mechanism is here different from the previous one.

To see the point, let us consider an example that is symmetric to the one in Section 2. A French importer commits in September 2011 to pay in December 2011, i.e. post-shipment, a certain amount of dollars for the goods purchased from a US exporter. Intuitively, this importer also needs to hedge against EUR/USD fluctuations. More precisely, she will incur a loss if the euro depreciates against the dollar within the next three months. The French importer then turns to her bank and signs a forward contract, by which the bank agrees to sell dollars to the importer in three months at a pre-agreed exchange rate F (quoted in euros per dollar). Ideally, the importer wishes a low value of F , for instance below the spot rate S . In order to hedge, the bank then borrows the euro value of the contract at the rate r^{EUR} , converts the proceeds immediately in US dollars at the spot exchange rate S , and places this amount at the US interest rate r^{USD} . The covered interest parity (CIP) is used to determine the forward USD/EUR exchange rate F : $F = S(1 + r^{EUR})/(1 + r^{USD})$. As before, a higher cost of US dollar borrowing for Eurozone banks adds a premium k^{USD} to the dollar interest rate r^{USD} , therefore pushes down the proposed forward rate F . This tends however to decrease, not increase, the cost of hedging for the importer. No negative impact of the US dollar funding shock in 2011 is therefore expected on French imports that are invoiced in US dollars.

To formally test for the impact of the US dollar funding shock on French imports, we estimate Equation (E2), which is a modified version of our baseline export Equation. The dependent variable is now the value of imports of firm f in product p from origin country j . We use the same set of variables and fixed effects as for the export equation, but the $USD \text{ Invoicing}_{j,FR}$ is now calculated as the share of US dollar invoicing in French total imports from each country of origin. As in the case of exports, we keep the same sample of twelve non-EU but OECD partner countries.

$$\Delta \ln m_{fpj,t1/t0} = \beta \text{ USD index}_{f,t0} \times \text{USD Invoicing}_j + \theta \text{Controls}_{f,t0} \times \text{USD Invoicing}_j + \alpha_f + \gamma_{pj} + \epsilon_{fpj} \quad (\text{E2})$$

Estimation results are reported in Table A8. The results confirm that the 2011 US dollar funding shock had no significant impact on firm-level imports in France through the identified hedging cost channel.

Table A8

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level imports.

| Dep. var. | Import growth | | | |
|---|-------------------|------------------|-------------------|--------------------|
| Destinations | Non-eurozone OECD | | | |
| | (1) | (2) | (3) | (4) |
| USD index $_{f,t0} \times \% \text{ of USD invoicing } _j$ | 0.585 (1.544) | 0.483 (1.793) | 0.606 (1.930) | |
| USD index T2 $\times \% \text{ of USD invoicing } _j$ | | | | −0.763 (14.739) |
| USD index T3 $\times \% \text{ of USD invoicing } _j$ | | | | −0.616 (15.345) |
| In Avg. bank size $_{f,t0} \times \% \text{ of USD invoicing } _j$ | | 0.379 (2.821) | 0.062 (3.449) | 0.766 (3.627) |
| In number of banks $_{f,t0} \times \% \text{ of USD invoicing } _j$ | | 0.703 (4.961) | 1.336 (5.953) | 1.000 (6.047) |
| In total exports $_{f,t0} \times \% \text{ of USD invoicing } _j$ | | | −1.802 (1.966) | −1.678 (1.902) |
| Firm FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.30 | 0.30 | 0.29 | 0.29 |
| Obs. | 18,853 | 18,853 | 17,392 | 17,392 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in imports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French imports from each country of origin j . *USD index*, *T2* and *USD index*, *T3* are dummy variables which correspond to the second and third terciles of the distribution of the dollar index across firms. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

A.9. Robustness test to Table 6: dollar products

In this exercise, we complete the estimations provided in the main text, Table 6, where we explore the role played by the heightened cost of dollar risk hedging at the product-level. We adopt a specification with a triple interaction term that allows capturing the effect of the dollar shock, for product categories, which we identified as more frequently invoiced in US dollars (whatever the export destination). As in the main Table, we use a dummy variable for identifying such products.

The specification of the empirical model is detailed in Equation (E3) below. We now have two variables of interest: $USD index_{f,t0} \times USD Invoicing_j$, which is the variable of interest in the main part of the analysis, and $USD index_{f,t0} \times USD Invoicing_j \times High product USD_p$, which is the triple interaction term. We expect coefficients on both variables to be negative, as the increase in the cost of US dollar funding is expected to impact more firms and products in need of US dollars for hedging reasons.

A notable difference with the main specification is that we now include firm-product fixed effects as controls, while we had a firm fixed effect and a destination-product fixed effect in the main specification. This allows to absorb the $USD index_{f,t0} \times High product USD_p$ term (with a firm-product dimension) that would be otherwise required in the empirical specification. An other interest of doing so is that we now focus the analysis on multi-product firms, which allows to identify the role of the dollar-invoicing propensity across products within firms. A drawback of this approach is that we are losing some exporters shipping only one product, so the number of observations is also reduced.

$$\Delta \ln v_{fjpT_1/T_0} = \beta USD index_{fT_0} \times USD Invoicing_{FRj} + \beta USD index_{fT_0} \times USD Invoicing_{FRj} \times High product USD_p + Controls_{fT_0} \times USD Invoicing_{FRj} + \alpha_{fp} + \gamma_{pj} + \epsilon_{fpj} \quad (E3)$$

The empirical approach remains very similar to the main empirical specification, and gives similar empirical results that we detail in Table A9 below. In columns (1) and (2) based on the full sample of destinations, we find that the triple interaction term has a negative and significant coefficient as expected. We confirm this empirical result when we exclude the United States from the sample of destinations in columns (3) and (4).

Table A9

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Dollar products, triple interaction.

| Dep. var. | Export growth | | | |
|---|-----------------------|----------------------|----------------------|---------------------|
| Destinations | Non-eurozone OECD | | | |
| | incl. US | | excl. US | |
| USD invoicing variable | Share in agg. Exports | | | |
| | (1) | (2) | (3) | (4) |
| USD index $f_{t0} \times \% \text{ of USD invoicing } j$ | −0.841 (1.859) | | 2.761 (3.751) | |
| ... \times High product USD p | −7.256** (2.846) | | −12.939** (5.207) | |
| USD index $f_{t0} \times \% \text{ dollar share } > 30\%$ | | −0.209 (0.888) | | 0.372 (1.286) |
| ... \times High product USD p | | −3.606*** (1.341) | | −4.117** (1.789) |
| Firm-product FE | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes |
| R ² | 0.45 | 0.45 | 0.47 | 0.47 |
| Obs. | 24,305 | 24,305 | 15,718 | 15,718 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . The United States are excluded from the sample of destinations in columns (3) and (4). We sort HS-4 products according to how frequently exports are invoiced in USD. This assessment is based on a regression of a dollar-invoicing dummy on product, firm and destination fixed effects over 2011–2018. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

A.10. Robustness: additional interactions

In this robustness section, we ask whether the main result presented in the paper remains valid if we introduce additional interaction terms between the firm-level dollar hedging index and other country-level variables. We are particularly interested in variables, such as the GDP per capita of the destination, the level of productivity, or the interest rate, which correlate with the degree of economic development, financial tensions, and could be linked as well to US dollar invoicing.

Table A10

Impact of the 2011 increase in the EUR/USD hedging cost on firm-level exports: Additional interactions.

| Dep. var. | Export growth | | | | |
|--|-----------------------|---------------------|---------------------|---------------------|--------------------|
| Destinations | Non-eurozone OECD | | | | |
| | Share in agg. Exports | | | | |
| USD invoicing variable | (1) | (2) | (3) | (4) | (5) |
| USD Index $f_{t0} \times \% \text{ of USD invoicing } j$ | −3.800*** (1.461) | −3.903** (1.544) | −3.281** (1.545) | −3.287** (1.547) | −3.386* (1.796) |
| USD index $f_{t0} \times \text{Real GDP per cap. } j$ | −0.323 (0.887) | | | 0.280 (1.394) | |
| USD index $f_{t0} \times \ln \text{TFP } j$ | | 0.272 (2.014) | | | 0.329 (2.580) |
| USD index $f_{t0} \times \text{Short-term interest rate } j$ | | | 0.126 (0.200) | 0.159 (0.267) | 0.139 (0.229) |
| $\ln \text{Avg. bank size } f_{t0} \times \% \text{ of USD invoicing } j$ | 6.862** (2.802) | 6.855** (2.801) | 5.064* (3.046) | 5.063* (3.044) | 5.063* (3.044) |
| $\ln \text{number of banks } f_{t0} \times \% \text{ of USD invoicing } j$ | −2.596 (4.438) | −2.596 (4.441) | −5.874 (4.754) | −5.877 (4.756) | −5.877 (4.756) |
| $\ln \text{total exports } f_{t0} \times \% \text{ of USD invoicing } j$ | 0.200 (1.947) | 0.202 (1.946) | 0.777 (2.078) | 0.780 (2.078) | 0.779 (2.078) |
| Firm FE | Yes | Yes | Yes | Yes | Yes |
| Country-Product FE | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.32 | 0.32 | 0.33 | 0.33 | 0.33 |
| Obs. | 28,784 | 28,784 | 23,926 | 23,926 | 23,926 |

Note: OLS estimations based on a sample of non-Eurozone OECD destinations: Australia, Switzerland, Chile, Norway, Israel, Turkey, Japan, Korea, Mexico, Canada, New-Zealand, and the United States. The dependent variable is the log change in exports of firm f for product p to destination j , between the 12 months prior to the US dollar liquidity shock of July 2011 and the 12 months consecutive to the shock. USD index (f) is the proxy for firms' use of hedging instruments against dollar exchange risk. It is interacted with the share of dollar-denominated value in French exports to each destination j . Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the firm level.

To do so, we complete our baseline estimation by introducing additional interaction terms between the firm-level dollar index and (1) the GDP per capita of the destination; (2) The Total Factor Productivity; (3) The short-term interest rate expressed in levels. Data on real GDP per capita and Total Factor Productivity are from the Penn World Tables. Short-term interest rates by country are downloaded from the OECD website; they measure the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market. In this OECD data on interest rates, two countries are missing: Canada and Turkey.

Estimation results are reported in Table A10. They confirm our baseline estimation result: Firms more likely to demand hedging against dollar exchange risk when they export to dollar destinations suffered more from the increasing cost of protection instruments in 2011 and contracted (in relative terms) their exports to these destinations.

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