NBER WORKING PAPER SERIES

CURRENCY HEDGING:
MANAGING CASH FLOW EXPOSURE

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Working Paper 28910
http://www.nber.org/papers/w28910

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2021

We thank José-Ignacio Cristi for outstanding research assistance. We thank comments by Maxim Alekseev, Pol Antràas, Paola Conconi, Dave Donaldson, Songuyan Ding, Alessio Galluzzi, Gordon Hanson, Victoria Ivashina, David Kohn, Robert Kollman, Philip Luck, Nicolas Magud, Ugo Panizza, José Luis Peydró, Hélène Rey, Adi Sunderam, and participants at BIS, ECARES, CEPR ESSIM IFM, Geneve Trade and Development Workshop, GW School of Business, Halle Institute, Harvard-MIT trade lunch, PUC-Chile, WEAI conference, 3rd Banking and Financial Stability Conference, 2020-ASSA and 2020-Winter Econometric Meetings for numerous comments and suggestions. We thank Alexander Hynes and Paulina Rodríguez for their help with the data. The opinions expressed in paper do not represent those of the Board of the Central Bank of Chile or the National Bureau of Economic Research.

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NBER Working Paper No. 28910
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JEL No. F31,F38,G30,G38

ABSTRACT

Foreign currency derivative markets are among the largest in the world, yet their role in emerging markets is relatively understudied. We study firms' currency risk exposure and their hedging choices by employing a unique dataset covering the universe of FX derivatives transactions in Chile since 2005, together with firm-level information on sales, international trade, trade credits and foreign currency debt. We uncover four novel facts: (i) natural hedging of currency risk is limited, (ii) financial hedging is more likely to be used by larger firms and for larger amounts, (iii) firms in international trade are more likely to use FX derivatives to hedge their gross --not net-- cash currency risk, and (iv) firms are more likely to pay higher premiums for longer maturity contracts. We then show that financial intermediaries can affect the forward exchange rate market through a liquidity channel, by leveraging a regulatory negative supply shock that reduced firms' use of FX derivatives and increased the forward premiums.

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1 Introduction

The use of foreign currency in trade and finance is prevalent in emerging markets economies (EMEs).[1] Foreign currency dominance can be a prominent source of risk associated to currency mismatches in cash flows and balance sheets rendering countries susceptible to changes in market sentiment, sudden stops and currency crises. Foreign exchange derivative contracts allow firms the possibility to hedge currency risk. Importantly, the FX derivative market—one of the largest markets worldwide—has seen an impressive development over the last decades surpassing spot transactions both in advanced and emerging economies (Figure A.1). Yet their growth in EMEs has received less attention and little is known about firms' use of currency derivatives in these economies. Which firms use FX derivatives? Do they fully hedge their currency risk? What shapes these decisions? And, at a broader policy level, does the development of the FX derivatives market affect firms' FX hedging decisions?

In this paper, we build a unique dataset on FX derivatives, trade credit and foreign currency borrowing in Chile to track firms' currency exposure and their hedging policies at monthly frequency over 2005-2018. We employ this detailed data to uncover four novel facts about firm's use of FX derivatives. First, we show that firms engaging in international trade and borrowing in foreign currency are significantly exposed to the currency risk, as the use of "natural hedging" is limited.[2] Second, we document that the use of FX derivatives is primarily driven by larger firms that are more likely to hedge larger amounts. Third, we show that, while hedging tends to be partial, firms tend to hedge payables and receivable separately, instead of hedging their net positions. Four, firms pay larger premiums for hedging transactions with longer maturities. Finally, we use a policy reform that reduced the supply of U.S. dollars forwards to firms in 2012/13 and show that the liquidity of the FX derivatives market is a key determinant of firms' hedging policies and the forward premium paid by firms.

We study firms' use of foreign currency hedging instruments by employing a unique dataset that merges information of foreign currency derivatives, foreign debt, international trade and sales and employment information for the universe of firms in Chile between 2005 and 2018. In particular, our data in foreign currency derivatives contains detailed transaction-level information at a daily frequency on all forward, futures, options, and swap contracts traded over the counter (OTC) in Chile over this period (i.e. ID for the contract, ID of firm, signing date, maturity date, ID of counterpart, currency denomination, forward exchange rate, etc.). We merge these data with foreign credit data which includes bond issuance, direct loans, and foreign direct investment in and by local firms, all of which are denominated in US dollars. International trade data comes from the Chilean Customs Agency and includes information on currency of invoice, delivery day

[1] Authors have emphasize different aspects of the foreign currency dominance in international trade, capital markets, funding for banks and non-financial firms, reserve currency and implications related to original sin, exchange rate regimes and fear of floating, and among others,(Eichengreen and Hausmann (1999); Calvo and Reinhart (2002); Céspedes et al. (2004); Goldberg and Tille (2016); Rey (2015); Gopinath (2015); Bruno and Shin (2015) Ilzetzki et al. (2019).)

[2] We use the terms "natural hedging" and "operational exposure" interchangeably along the paper to refer to whether firms match their payables and receivables in foreign currency.

and the trade credit received in each transaction at the firm-level. Importantly, our detailed trade data allows to observe not only the level of firms' exports and imports but also their trade credit and, thus, firms' actual exposure to the currency risk in these trade contracts.

The richness of our panel data allows us to track all firms' receivables and payables in foreign currency over time, as well as their use of FX derivatives. As such, we obtain a close characterization of firms' direct exposure to the exchange rate risk and whether they manage such risk by using natural or financial hedges. Our analysis constitutes an advance over previous studies in the literature that only focused on sub-samples of listed firms or surveys and—lacking information on FX derivatives contracts, amount of foreign currency debt and trade credit—cannot directly assess firms' cash flows exposure and the use of FX derivatives to hedge it.

We start by uncovering four main facts regarding the use of FX derivatives. First, we show that future claims and liabilities in foreign currency are only slightly correlated, suggesting that firms do not match these cash flows in order to be "naturally hedged". For instance, the correlation of exports and imports trade credit, is only 2%. This low correlation could arise from significant differences in the maturity of exports and imports financing. Indeed, our data indicates that the mean maturity of trade credit from exports is a 50% longer than that of imports (197 vs 91 days).[3] We also find that *money market hedging* –that would allow export receivables to be hedged using foreign currency debt– would also be hard to implement in terms of financial planning, as the mean maturity of foreign debt is about 3 years longer than the median maturity of exports.

Second, we document that firms employing FX derivatives are larger (in employment, sales, debt, export and imports) and that exporters and/or importers relying on trade credit are more likely to use FX derivatives. Our empirical results show that one percent increase in trade credit due to exports leads to a 2.4% increase in the probability of employing FX derivatives, and trade credit due to imports increases this probability by 5%. These results are robust to controlling for firm fixed effects, year and industry fixed effects interacted, and excluding multinational firms and the mining sector. Exploiting the transaction level information of our data, we show that larger transactions (exposures) from trade credit are more likely to be hedged, which could indicate that engaging in a FX derivative contract involves a fixed cost.

Third, at the intensive margin, we document that firms tend not to hedge *net* trade credit exposure with FX derivatives, but instead hedge their *gross* trade position exposures. Consistently, the unconditional correlation between net trade credit and net FX derivatives position is relatively low (40%), while the individual correlations between FX purchases and payables due to imports, and between FX sales and receivables due to exports are twice higher and exceed 80%. These results suggest that firms tend to buy USD forward when imports are financed through trade credit and—perhaps more interestingly—sell USD forward when exports generate future USD receivables. Our finding that firms use FX derivatives to separately hedge foreign currency

[3]Our data also reports information on trade credit with financial institutions, which account for less than 15% of total trade credit. This credit has typically longer maturities, but the difference in maturity between trade credit for imports and exports remains. The mean trade credit for imports with banks is 120 days, whilst it is 259 days for exports.

claims and liabilities—instead of hedging a net position—is not surprising when considering that the maturities of trade credits from exports and imports differ substantially.

Fourth, we dig deeper and exploit the transaction-level information of our data. The transaction level analysis allows us to characterize as well the forward premium of forward contracts. We document a positive (negative) premium for FX purchases (sales) which is increasing (decreasing) in maturity, reflecting the increasing spread a financial intermediary would obtain in order to intermediate longer maturity FX derivatives contracts.

In the last section of the paper, we exploit a quasi-natural experiment that reduced the market supply of FX forwards and assess how this shock affected firms' hedging policies.[4] In particular, we employ a regulatory change to Pension Funds' (PFs) hedging requirements in 2012/2013 and document that it reduced the sales of FX forwards to banks, which in turn, also reduced the supply of FX forwards to firms. We identify this supply shock by employing a difference-in-different approach in which we saturate the regressions with firm-time and bank-time fixed effects (as in Khwaja and Mian 2008, Amiti and Weinstein 2018 and Alfaro et al. 2021). Our econometric results indicate that banks more exposed to PFs reduced their supply of FX derivatives to firms relatively more. As a result, importers and foreign currency debt holders were most affected and decreased their outstanding long FX derivatives positions by 46% within a year. In line with the reduction in the supply of FX derivatives to firms, we find that the forward premium paid by firms purchasing FX derivatives forwards increased. At the extensive margin, we find that the share of firms participating in the FX derivative market and their overall hedging activity were reduced. A back of the envelope calculation indicates that the fall in the flow of contracted FX derivatives—4 billion USD—was in magnitude equal to 75% of Chilean imports.

Our analysis of the effects of this regulatory change suggests that the liquidity of the FX derivatives market can substantially affect firms' hedging policy and, as a result, their resilience to exchange rate volatility. Hence, economies with less liquid FX derivatives markets offer firms less ability to hedge their currency risk and, thus, are more exposed to exchange rate volatility given the limitations of natural hedging.

Related Literature.— Our paper relates to the literature studying firms' hedging motives. As shown by the pioneering works of Smith and Stulz (1985) and Froot et al. (1993), from a theoretical perspective, hedging can add value to the firm due to the presence different types of market imperfections, such as financial frictions, information asymmetries between management and stockholders, transaction costs, management ownership of firms' shares, and convex tax schedules.

The empirical literature has focused on understanding the use of currency derivatives. A first generation of papers relied on information of net positions of listed or multinational firms, or survey data –mostly– for developed economies. Notably, Allayannis et al. (2001) use geographic dispersion of U.S. multinationals (number of countries/regions of operation) and show that op-

[4]Along the paper, we refer to non-financial firms simply as firms. In case we refer to financial firms —as investment companies—we mention it explicitly.

erational hedging is limited. The literature also documents that the use of FX derivatives is more prevalent in firms with exchange rate exposure (Korea, Bae et al. 2018; Euro countries, Lyonnet et al. 2016; Germany, Kuzmina and Kuznetsova 2018; Brazil, Rossi-Júnior 2012; Chile, Miguel 2016; Colombia, Alfonso-Corredor 2018 and Mexico, Stein et al. 2021 among others). Our detailed data allows us to take the analysis one step further by studying granular information for the universe of firms and FX derivative contracts, and measuring more precisely variables for which only proxies were available in previous studies. This detailed information allows us to document that even firms with international trade and foreign currency debt exposure do not fully exploit natural hedges and use financial derivatives to partially hedge gross positions. Additionally, the use of a policy reform allows us to study the liquidity of the FX derivatives market and, thus, how its development affects firm's hedging decisions.

We document that firms that use FX derivatives are larger and hedging is partial, which points in the direction of (but not restricted to) the existence of fixed costs to risk management. This result echoes findings in international trade and finance costs (trade, Melitz, 2003; multinationals (MNCs), Helpman et al., 2004; Alfaro and Chen, 2018; foreign borrowing, Salomao and Varela, 2021). Our findings are also consistent with Geczy et al. (1997) who use 372 Fortune-500 firms with ex-ante foreign currency exposure to argue that there are economies of scale in implementing and maintaining risk management programs, as firms who have used other type of derivatives are more likely to later use FX-derivatives.

Overall, our findings highlight that the timing of operational and financial milestones—the signing of a contract, sale and delivery of a product or service, and payments—in the day-to-day operation of a firm, is key to understanding its foreign currency risk exposure. This refers not only to foreign currency cash-flows, but also domestic currency obligations. Longer deliveries and transportation times in international transactions exacerbate these differences increasing the need for working capital (Antràs and Foley, 2015). Moreover, important costs remain in local currency (wages, taxes, others), and they matter for cash flow management. Thus, natural hedging may still render firms vulnerable to currency fluctuations associated, for example, to working capital obligations. Our results also suggest that firms turn foreign currency exposure into local currency but keep their transactions in USD probably due to the use of the dollar as unit of account and network effects. The misalignment in timing between payables and receivables in foreign currency, and their interaction with domestic currency obligations, opens the need to use financial hedges for gross transactions and underscores the importance of liquidity and the FX derivatives markets.

Finally, our findings relate as well to the literature exploring the role of financial intermediaries in shaping exchange rate markets. Notably, the role of financial intermediaries in crisis periods has been recently put forward by Correa et al. (2020) who stress the role US Global systemically important banks, Liao and Zhang (2020) who study institutional investors' hedging choices and how they affect spot and forward exchange rates, and Du et al. (2018*a*) who point to the effect of banking regulation on CIP deviations. By exploiting a regulation change to Pension Funds hedging requirements which resulted in a supply shock to the short side of FX-derivatives market, we show that firms hedging decisions were affected, and their exchange rate exposure was temporarily increased.[5]

The paper is organized as follows. Section 2 describes the FX derivative market in Chile and datasets. Section 3 presents the main stylized facts. Section 4 advances additional results related to changes in regulation. The last section concludes.

2 Data

We use firm- and contract-level data from Chile between 2005 and 2018, which comprises census data on: over-the-counter FX derivatives, foreign currency debt, international trade (cash and trade credit on exports and imports), and employment. Our data comes from four different datasets: FX derivatives, foreign debt, customs data and tax data. We are able to merge these datasets due to the extended (and mandatory) use of the unique tax identifier number (*Registro Único Tributario*, RUT) for all Chilean residents. Each of the datasets contain the following information.

1. **FX Derivatives**. We observe daily information from 1997 to 2018 on the census of FX derivative contracts with a Chilean resident on either side of it. To match the coverage of other data sets, we start the analysis in 2005. This information is reported directly to the Central Bank of Chile (CBC) by all entities who participate in the "Formal Exchange Market" (FEM, or "Mercado Cambiario Formal" in Spanish), namely, hedge funds, insurance companies, pension funds, the government and, more prominently, commercial banks. We observe the following characteristics for every contract: RUT of reporter (FEM entity ID), RUT of counter-party (another FEM entity or a real-sector corporation), an ID for the contract, signing date, maturity date, economic sector of both parties, currency, forward price, and settling type (deliverable/non-deliverable). Our focus in this paper is on contracts which have a non-financial sector firm on one side of the contract and contracts with maturity longer than seven days.[6]

2. **Debt**. We observe foreign debt of Chilean residents, normally used to compute Balance of Payments statistics. In particular, we observe end-of-month stocks of loans, bond debt—currency denomination, maturity, interest rate, and coupon payments–and foreign direct investment between 2003-2018. Local currency debt is obtained from credit registry data.

3. **Customs data**. We rely on data from the Chilean Customs Agency which gathers information about the census of imports and exports for 1998-2018. In particular, for each international trade transaction we observe: date, RUT, country of origin for imports and industry for exports, 8-digit HS product code, currency of invoicing, value and quantity of import/export, and type of payment (cash or trade credit). The information on the type

[5] In line with Avalos and Moreno (2013), we show that Pension Funds are large players who had an important role in developing the currency derivatives market.

[6] Contracts with maturity less than 7 days represent 1.4% of the original dataset, close to 56.000 observations.

of payment is important to our analysis, as trade credit creates uncertainty by exposing firms to future exchange rate fluctuations, while trade paid in cash does not. Notably, we observe many aspects about trade credit: who is financing the credit and the maturity of operations.

4. **Firm-level activity:** We use firm-level yearly information from the Chilean Tax Authority ("Servicio de Impuestos Internos", SII). In particular, RUT (used to link plants belonging to the same firm), sales (bracket), number of workers, address, economic activity and age.[7]

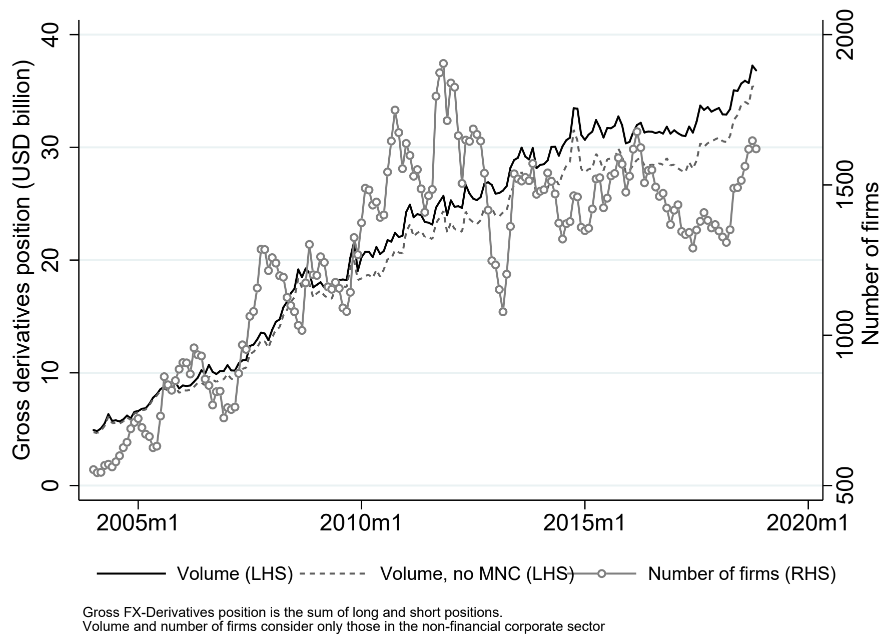

Figure 1: Number of firms and gross FX Derivatives positions

Note.— This figure shows in the left axis the outstanding volume (in billions of USD) of gross FX derivatives positions of all non-financial firms in Chile (solid black line), and the volume of gross FX derivatives positions of all non-multinational corporations (dashed gray line). The dotted line (read in the right axis) shows the number of firms in a given month holding stocks of FX derivatives.

The FX derivatives market in Chile has expanded rapidly over the last 15 years. As Figure 1 shows, the number of non-financial firms using FX derivatives has increased by more than two-fold, and their gross FX derivatives position has increased by four-fold, from 8 to more than 35 billion US dollars. Outstanding gross FX derivative positions reaches nowadays close to 45% of GDP. Panel A in Table 1 reports the market activity over the period 2005-2018 for the whole market (columns 1-5) and for non-financial firms (columns 6-11). We have information on roughly 1.9 million contracts, out of which 0.7 million contracts involve a non-financial firm (columns 1 and 7). Forwards are firms' most traded FX-derivative, representing nearly 90% of all contracts. Their median maturity is 88 days, with longer maturities for sales than purchases

[7]Figures A.2 and A.3 in the Appendix present an overview of the sample.

(Panel B). Also, around 80% (60%) of all sales (purchases) are settled with no delivery. The second most used derivatives are swaps (both cross-currency and FX swaps), which account for around 8% (5%) of purchases (sales) by non-financial firms. In the rest of the paper, we focus our analysis on non-financial firms, which for convenience, we hereafter simply refer to as firms..

To better identify firms' currency exposure and hedging decisions, we focus on transactions (trade, trade credit, foreign currency debt and FX derivatives) between U.S. dollars and Chilean Pesos. This restriction is without loss of generality, as the U.S. dollar is the dominant foreign currency in Chile and the majority of foreign currency transactions are with respect to this currency (more 85%).[8] We show in the Appendix (Tables A.1, A.3, and A.5) that our results hold true when we consider all currencies in our analysis. The lion's share of outstanding positions belongs to domestically-owned firm (more than 90%). Importantly, the use of FX derivatives is spread across all economic activities. The sectors using FX derivatives the most are retail trade, farming, electricity, water supply and gas, non-metallic manufacturing, financial intermediation, mining and transport and communication, which together account for more than 90% of long and short FX positions in 2016. In our main specification, we exclude MNCs for two reasons: MNCs could use FX derivatives to hedge the value of dividends in foreign currency to hedge translation exposure, and subsidiaries or headquarters abroad may undertake the financial hedging. To check the validity of our results, along the paper, we undertake several robustness exercises with and without MNC. Also, as mining sector accounts for an important share of Chilean exports, we conduct robustness exercises with and without this sector.

Beyond the granularity of the data, Chile offers a good case to study due to the stability of its macroeconomic and institutional framework. As detailed in the next section, the derivatives market is dominated by over-the-counter transactions (OTC) as in most developed economies; see BIS(2016, 2019). Moreover, Chile has shown a combination of responsible fiscal policy, freely floating exchange rate, and an inflation targeting regime implemented by an independent Central Bank (Albagli et al., 2020) for almost three decades.[9] Last by not the least, in recent years there is no evidence of persistent covered interest parity (CIP) violations except for a brief period amid the Global Financial Crisis (Morales and Vergara, 2017).

[8]In particular, in 2016, 94% of long FX positions and 87% of short FX positions had as counterpart the U.S. dollar. This was followed by the Euro with almost 5% and 6% long and short FX positions, respectively.

[9]Chilean sovereign debt during our period of analysis is investment grade (A1 by Moody's, A by Fitch, and A+ by S&P); the external debt represents around 60% of total GDP; the inflation targeting regime has been in place for 30 years and on average has met the target; the floating exchange rate regime has been in place for almost 20 years and exchange rate interventions have been exceptional; no capital controls are in place; and the country exhibits strong financial regulation after the 1982 domestic financial crisis.

Table 1: Descriptive statistics FX derivatives contracts

A. By market

	A.1 All Market					A.2 Non-financial firms				
	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)
Instrument	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Forwards	1,518,688	80.4	5630	71.1	83.5	639,736	88.3	1308.5	90.5	65.1
Futures	2,211	0.1	1684.4	43.3	96.8	356	0	1728.8	85.6	82.6
Call	24,974	1.3	1436.4	159.2	91.6	21,414	3	716.1	164.4	91.2
Put	15,677	0.8	1936	167.6	93	13,224	1.8	852	175.1	93.6
FX swaps	271,427	14.4	12723.1	77.2	90.6	15,650	2.2	3901.7	77.7	37
CC Swaps	55,976	3	14,393	2434	106	34,033	5	8,104	2375	62
Total	1,888,953	100.0	6584.8	103	83.2	724,413	100.0	1352.6	122.2	63

B. By type of operation, non-financial firms only

	B.1 Purchases					B.2 Sales				
	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)
Instrument	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Forwards	452,145	89.4	1324.2	80.9	57.5	187,591	85.8	1270.8	113.6	83.6
Futures	299	0.1	1935.5	92.2	90.3	57	0	645	50.9	42.1
Call	6,470	1.3	617.7	145.4	93.8	14,944	6.8	758.8	172.6	90.1
Put	7,086	1.4	736.7	153.4	92.5	6,138	2.8	985.1	200.2	94.9
FX swaps	11,810	2.3	4024.3	74.4	26.6	3,840	1.8	3524.6	88.1	69
CC Swaps	27,866	5.5	8,791	2476	64	6,167	3	8,424	2372	68
Total	505,676	100	1360.9	113.5	54.7	218737	100	1333.5	142.2	82.3

Note.— Sample period: 2005-2018. Obs. represents number of contracts traded, notional amounts are expressed in thousands of US dollars ($ 000's), maturity in days. Non-deliverable instruments are those contracts in which counter parties settle only the difference between the contracted NDF price or rate and the prevailing spot price or rate on an agreed notional amount. Real sector observations defined as those which have at least a real sector corporation on one side of the contract. This sample also excludes observations with maturity of less than seven days, and considers only as one observation the capital and interest payments in cross-currency swaps. This table includes instruments in which the foreign currency is USD only, which for the case of international trade accounts for almost all the contracts.

3 Firms' Use of FX Derivatives

This section unveils four novel facts about firms' use of FX derivatives. We first document that firms involved in international trade and/or holding foreign currency debt are exposed to the currency risk. We show that these firms are not "naturally hedged", as they do not match their payables and receivables in foreign currency (Fact 1). We then explore firms' use of financial hedging and show that firms using FX derivatives are larger and firms in trade tend to hedge larger amounts (Fact 2). Next, we document that firms are likely to hedge *gross* positions—payables and receivables separately—rather than *net* FX currency exposures (Fact 3). Lastly, we show that the forward premium increases in the maturity of the transaction (Fact 4).

FACT 1: *Firms' use of natural hedging is limited*

We start studying whether firms match their payables and receivables in foreign currency and/or the cash flows related to these exposures. We then assess one potential reason that limits natural hedging: differential maturity of payables and receivables in foreign currency.

Cash-flows and outstanding exposures.— We conduct two exercises to assess whether firms match their payables and receivables in foreign currency and, thus, the extend they use natural hedging. In our first exercise, we consider the cash-flows at maturity, and check whether payables and receivables due in the same period of time (month) are correlated. This exercise is a highly demanding test of natural hedging, because it checks whether a firm could be in fact using inflows in foreign currency to pay outflows in foreign currency, regardless of when exposures were originated. In our second exercise, we study the correlation between the outstanding value of receivables and payables in foreign currency to check whether these balances are aligned—a less stringent test.

Notably, to identify the currency risk exposure from international trade, we focus on *trade credit* rather than just imports and exports values, as measured typically by customs data. The distinction between trade credit and trade -broadly defined- is critical for our analysis, as cash flows instantaneously paid out do not entail currency risk. Instead, what entails currency risk is the trade credit, which carries uncertainty about the future value of payables and receivables in foreign currency.

In our first exercise, we consider the the cash flows maturing in month m and check the correlation between payables and receivables maturing in the same month,

$$X^{CF}_{i,m} = \alpha(M^{CF}_{i,m} + FCD^{CF}_{i,m}) + \eta_i + \eta_{j,y} + \varepsilon_{i,m}, \tag{1}$$

where i, j, m and y denote firm, sector, month and year, $X^{CF}_{i,m}$ denotes the (log) cash-flow maturing in month m, $M^{CF}_{i,m}$ is (log) cash outflows maturing-in-m, and $FCD^{CF}_{i,m}$ (log) is the cash flow from maturing debt in month-m. We include firm-level fixed effects—η_i—that absorb all firm and industry time-invariant characteristics, and industry and year fixed effects interacted—$\eta_{j,y}$— to control for industry-year specific shocks (such as demand shocks) that could affect firms in different industries heterogeneously.[10] We cluster the standard errors at the firm level. The coefficient of interest is α, which captures the extend to which the value of cash-flow payables and receivables in foreign currency are aligned. A value of α equal to one would imply full natural hedge, as all cash inflows and outflows in foreign currency would be fully correlated across time. Instead, α equal to zero would imply no correlation and, thus, no room for natural hedge.

Results are presented in Panel A of Table 2. Column 1 presents the results when only import trade credit is included as a regressor. The estimated coefficient is statistically significant, but it

[10] In particular, we use the economic sector categories defined by SII, which divide the economy into 22 sectors available at `http://www.sii.cl/ayudas/ayudas_por_servicios/1956-codigos-1959.html`.

is quantitatively very small. In particular, a one percent increase in cash-flow from imports trade-credit associates with only a 0.027% increase in cash-flow from exports trade credit. Column 2 excludes mining firms and shows that the coefficient remains statistically significant and similar in size (0.023%). In column 3, we add foreign currency debt to import trade credit and, thus, consider all foreign currency payables. Yet the estimated coefficient is still similar in size.

To check that our result are robust and do not hide substantial heterogeneity across groups of firms, we divide firms into four mutually excluding categories: (i) firms that trade (exports and/or imports), do not hold foreign currency debt and do not employ FX derivatives; (ii) firms that trade, use foreign FX derivatives and do not hold foreign debt; (iii) firms that trade and hold foreign currency, but do not use FX derivatives; and (iv) firms that trade, hold foreign debt and use foreign currency derivatives. We create dummy variables for each of these categories, interact them with import trade credits and re-estimate equation (1) with these interactions on the right hand side. Importantly, the estimated coefficients for these interaction terms remain very small (columns 4-7) and are stable across specifications, namely when we include MNC (column 4), include mining (column 5) and exclude both mining and MNC (column 6). Finally, in column 7, we restrict our sample to firms that both export and import, and our results remain unchanged. Overall, the results presented in Panel A provide little support to the hypothesis of natural hedging, as a firm's cash flow value of payables and receivables in foreign currency are only slightly correlated.

In our second exercise, we consider the monthly correlation between the balance of outstanding import trade credit and outstanding export trade credit. These less stringent regressions simply correlate the value of a firm's outstanding accounts payable and receivable in foreign currency, but they do not consider that these balances could imply different maturities and, hence, a firm might not be—in fact—naturally hedged even if outstanding positions coincide. In particular, we re-estimate equation (1) by regressing the outstanding export trade credit, (X^{TC}) on the outstanding from import trade credit and debt, ($M^{TC} + FCD$).

Panel B of Table 2 presents the results. Column 1 presents a simple correlation between a firms' trade credit for export and imports. The estimated coefficient remains statistically significant but, as above, is quantitatively very small. In particular, a one percent increase in imports trade-credit associates with only a 0.023% increase in exports trade credit. Column 2 excludes mining firms and column 3 adds foreign currency debt to import trade credit. In both cases, the coefficient remains statistically significant, but quantitatively very small (0.023 and 0.028, respectively). Columns 4-7 show that this pattern does not change when considering heterogeneous groups of firms. In the Appendix, we present additional robustness and show that these results remain valid when including FX swaps and other currencies than the dollar (Table A.1) and considering quarterly data (Table A.2).

In sum, the results presented in Table 2 provide little support to the hypothesis of natural hedging. Firms in our sample do not seem to be using cash inflows and outflows in foreign currency to operationally hedge the currency risk. Instead, these firms seem to be exposed to the currency risk, which in turn, creates room to use financial hedging. Next, we assess a potential reason that would explain limited natural hedging.

Table 2: Natural hedging

A. Flows maturing in the same period

Dependent variable: (log) Cash flows of exports trade credit at maturity, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
M^{CF}	0.027***	0.023***					
	(0.007)	(0.005)					
M^{CF}+FCD^{CF}			0.015***				
			(0.003)				
M^{CF} × 1(Trade Only)				0.017*	0.022**	0.019***	0.05***
				(0.008)	(0.007)	(0.005)	(0.012)
M^{CF} × 1(Trade and FX)				0.027**	0.034***	0.029***	0.063***
				(0.009)	(0.007)	(0.006)	(0.012)
M^{CF} × 1(Trade and FCD)				0.052**	0.058**	0.039***	0.079***
				(0.019)	(0.020)	(0.011)	(0.018)
M^{CF} × 1(Trade and FX and FCD)				0.033*	0.032*	0.041***	0.073***
				(0.013)	(0.015)	(0.012)	(0.020)
Observations	1,613,353	1,599,768	1,599,768	1,618,731	1,613,353	1,599,768	195,275
R Squared	0.85	0.83	0.83	0.85	0.77	0.83	0.88
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	-	-	-	Yes	-	-	-
Include Mining	Yes	-	-	Yes	Yes	-	-
X > 0 and M > 0	-	-	-	-	-	-	Yes

B. Outstanding stocks

Dependent variable: (log) exports trade credit, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
M^{TC}	0.023***	0.023***					
	(0.007)	(0.006)					
M^{TC}+FCD			0.028***				
			(0.006)				
M^{TC} × 1(Trade Only)				0.010	0.017**	0.018***	0.037***
				(0.008)	(0.007)	(0.005)	(0.014)
M^{TC} × 1(Trade and FX)				0.019**	0.024***	0.025***	0.044**
				(0.008)	(0.007)	(0.007)	(0.015)
M^{TC} × 1(Trade and FCD)				0.066***	0.071***	0.050***	0.080***
				(0.025)	(0.027)	(0.019)	(0.031)
M^{TC} × 1(Trade and FX and FCD)				0.038*	0.059***	0.058***	0.065***
				(0.022)	(0.018)	(0.018)	(0.017)
Observations	1,465,179	1,451,719	1,451,719	1,470,485	1,465,179	1,451,719	185,632
R Squared	0.88	0.87	0.87	0.88	0.88	0.87	0.91
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	-	-	-	Yes	-	-	-
Include Mining	Yes	-	-	Yes	Yes	-	-
X > 0 and M > 0	-	-	-	-	-	-	Yes

Note.— Clustered standard errors at the firm level reported in parentheses. All regressions include firm fixed effects and year-industry fixed effects. Notation: M^{TC} stands for (log) imports trade credit; X^{TC} stands for (log) exports trade credit; **1**(FCD) indicator variable for firms with positive foreign debt; **1**(Trade) for firms in international trade; **1**(FX) for firms in FX derivatives markets; M^{CF} for cash flows from imports trade credit maturing in month m; X^{CF} for cash flows from exports trade credit maturing in month m; and FCD^{CF} for cash flows from foreign debt maturing in month m. Sample only considers FX forwards in US dollars.

Maturity and the timing of flows.— We assess a potential explanation for limited natural hedging: different maturity of inflows and outflows in foreign currency. In particular, if payables and receivables in foreign currency have significantly different maturities, it could be difficult—from a risk management point of view—to align these flows. It is worth remarking that this section does not aim to provide one conclusive explanation of why firms do not significantly engage in natural hedging, which would require additional (and currently unavailable) information. Instead, we document some novel patterns that could explain the limits to natural hedging reported above.

We start by documenting main descriptive statistics for imports/exports trade credit and foreign borrowing. As Table 3 shows, trade credit from imports is paid on average in 91 days, while exports take 137 days. Foreign debt exhibits even longer maturities, with an average of 3.7 years. The different maturity between trade credit from imports and exports and foreign currency debt suggests that it would be difficult for firms to carry out operational hedging. This type of hedging would imply significant managerial skills and planning to match the maturities of multiple contracts.[11]

Table 3: Maturities in international trade credit and foreign currency debt

	Maturity in days							
	Mean	St. Dev.	Min	p10	Median	p90	Max	Num. Obs.
Imports trade credit	91	58	1	30	88	180	540	1,435,762
Exports trade credit	137	94	1	21	115	267	540	433,350
Foreign currency debt	1375	1291	30	90	1099	2880	10830	10,103

Note.— Only considers operations in international credit which are labeled as being financed either by counterparty in the international trade transaction or a banking or financial institution. Statistics are expressed in days. Last column shows number of observations used throughout the 2005-2018 period.

To explore this idea further, we focus on trade flows and examine the extent in which cash flows of accounts payable/receivable coincide at maturity, regardless of contracting dates. More precisely, consider equation (2) which captures the *coincidence* between cash inflows and outflows from maturing trade-credit for each firm in a given month. In particular, for firm i and month m, $CO_{i,m}$ measures the coincident amount of cash flows (hence, the min operator) in opposing directions that mature in m as a fraction of total cash flows maturing in the same period. The statistic—multiplied by two to be bounded between 0 and 1—is defined by:

$$CO_{i,m} = 2 \times \frac{\min\{X_{i,m}^{CF}, M_{i,m}^{CF}\}}{X_{i,m}^{CF} + M_{i,m}^{CF}}, \tag{2}$$

where $X_{i,m}^{CF}$ denotes the cash inflow maturing in month m from past export trade credit and $M_{i,m}^{CF}$ the cash outflow maturing in m from past import trade credit for firm i. The lower the value of this indicator, the lower is the coincidence between trade credit from exports and imports

[11]Notably, these different maturities make it unlikely for firms to engage in "money market hedge", which refers to an operation where a firm matches its receivables (payables) in foreign currency by borrowing (lending) in the same currency and maturity. For example, an exporter could borrow in foreign currency to hedge the currency risk implied in the future receivables. If the currency appreciates, she would receive lower income, but she would also have a lower debt repayment in foreign currency.

and, thus, lower is the realized natural hedge of the firm. Inversely, the higher $CO_{i,m}$ is, the higher the level of natural hedge.[12] Figure 2 plots the mean, median and interquartile range of $CO_{i,m}$ in the cross-section of firms for each month in the sample. The median coincidence is about 20%, and the percentiles 25 and 75 are close to 7% and 50%. This low coincidence ratio for the majority of firms in our sample suggests that Chilean firms do not match their trade receivables and payables cash flows. Instead, natural hedging seems to be limited and, thus, firms are exposed to the currency risk.

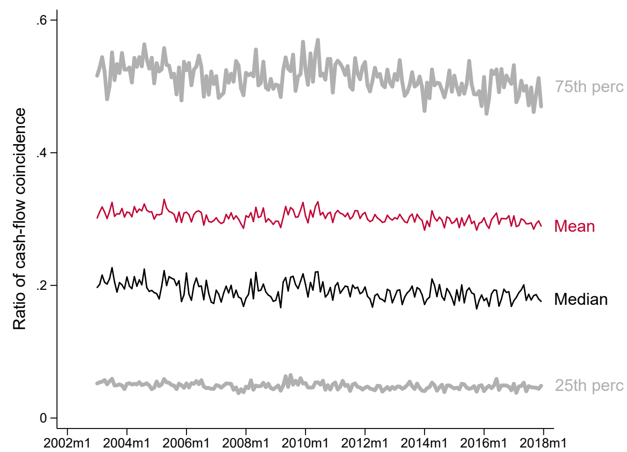

Figure 2: Coincidence of cash inflows and outflows from international trade credit

Note.– All series show moments of within-period distributions of the coincidence measure described in equation (2). Thick gray lines show the 25th and 75th percentiles, solid black line depicts the median, and the dashed black line the mean across observations within a month.

FACT 2. *Larger firms hedge; and tend to hedge larger amounts.*

Last section showed that the use of natural hedging is limited and hence, firms retain currency risk. In this section, we explore which firms employ FX derivatives to hedge this risk and which transactions they are more likely to hedge.

Larger firms hedge.— We start assessing the characteristics of firms using FX derivatives. As shown in Panel A of Table 4, these firms are larger in size (employment and sales) and this difference is statistically significant and persistent over time (i.e. we observe a similar pattern in 2006 and 2016). Firms using FX derivatives typically engage in international trade and/or hold foreign debt. This is shown in Panel A of Figure A.4 in the Appendix, where we plot the number of firms using FX derivatives by group of mutually exclusive firms (i.e. firms using

[12]For example: if a firm has \$100 cash inflow and \$100 cash outflow due in period m, $CO_{i,m}$ takes the value of 1. If instead, the firm has a maturing \$100 cash-inflow and \$0 cash outflow, then our measure of coincidence takes the value of zero.

FX derivatives and engaging in trade, firms using FX derivatives and holding FC debt, firms using FX derivatives and engaging in trade and holding FC debt, and firms using FX derivatives with no trade or FC debt activity). Panel B confirms this pattern by plotting the value of the FX outstanding position.[13] We document similar differences in size across different samples by firms' type: when restricting the comparison to firms that do not participate in international trade (Panel B), when considering trading activity (Panel C) and foreign debt (Panel D) as proxies of firm size. In all cases, firms using FX derivatives are larger.[14]

Table 4: Firm size and activity by use of FX-derivatives

	2006			2016		
	(1) Yes	(2) No	(3) Log-difference	(4) Yes	(5) No	(6) Log-difference
A. Size: All firms						
Employment (workers)	374.87	112.53	1.61***	452.64	106.96	1.84***
Sales (M$)	17.22	5.28	1.33***	20.85	5.63	1.50***
B. Size: No trading firms						
Employment (workers)	281.00	67.13	1.83***	339.63	98.36	0.65***
Sales (M$)	11.61	3.23	1.16***	13.37	4.57	0.86***
C. Size: Firms in international trade						
Employment (workers)	396.05	114.57	1.61***	480.93	108.53	1.84***
Sales (M$)	18.48	5.38	1.33***	22.72	5.82	1.50***
Exports (M$)	7.75	1.65	0.32***	2.08	1.38	0.18***
Imports (M$)	4.94	0.47	0.65***	4.25	0.37	0.76***
Exports TC (M$)	7.66	1.60	0.31***	1.99	1.29	0.17***
Imports TC(M$)	4.80	0.44	0.63***	3.85	0.31	0.71***
D. Size: Firms in Debt Market						
Employment (workers)	833.11	197.28	2.72***	1167.60	341.66	2.65***
Sales (M$)	27.34	6.30	2.04***	36.47	14.14	1.72***
Foreign Debt (M$)	105.94	15.08	1.98***	549.24	101.39	2.54***

Notes.— Columns are expressed in levels (number of workers or millions of dollars), except for columns (3) and (6) which are expressed as the log difference between groups of firms who use FX derivatives and firms that do not. Statistical significance H0: Log-Difference = 0: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Periods: 2006 and 2016.

Firms in international trade tend to hedge larger amounts.— The richness of our data allows us to explore further the transactions that firms hedge. In particular, we study whether firms are more likely to hedge large or small transactions. To this end, we match by

[13] The correlations between number of firms using FX derivatives and gross derivative positions and the exchange rate are -0.15 and 0.44, respectively.

[14] Our results echo existing literature showing that firms engaging in international trade are larger (Melitz 2003; Bernard et al. 2007; Helpman et al. 2004; Alfaro and Chen 2018). Similarly, Salomao and Varela (2021) show that there is selection into foreign currency borrowing, as only high productivity firms employ this financing.

maturity and size, trade credit transactions with FX derivatives transactions, and assess their characteristics. It is worth mentioning that this matching process is not perfect as we do not observe whether a firm obtains a FX derivative to hedge a particular transaction. While we do observe all FX derivatives transactions and trade credit exposure, all we know is a firm's trade credit and its FX derivatives, but we do not know whether a FX derivative contract x was purchased to hedge trade credit exposure y. Hence, we rely on a matching procedure which we conduct, for comparability issues, on the sub-sample of firms with no foreign debt.[15] In particular, we match FX contracts with trade credit data using the information on (a) firm ID, (b) maturity dates of both operations, and (c) notional amount. We use the Coarsened Exact Matching (CEM) algorithm by Iacus et al. (2012). For a given firm ID, the CEM algorithm exact-matches maturity dates and creates temporary coarser bins in the dominion of notional amounts. Then, it implements exact matching in these coarser bins. Once the match is created, then keeps the original un-coarsened amount.

Figure 3 shows the histograms for imports and exports trade credit operations. The horizontal axis shows the (log) trade credit value of each international trade operation, divided in two groups: those that are found to have a matching hedging transaction (green bars), and those that are found not to (red bars). We show imports trade credit operations in the left panel and exports trade credit in the right panel. The figure indicates that, conditional on not finding a matching FX-derivatives transaction (red bars), smaller international trade transactions are more likely to be observed. Put it differently, this figure suggests that imports and exports trade credit of smaller values are less likely to be hedged than larger value transactions.[16]

Finally, we test formally whether larger amounts of trade credit correlate with the use the matched hedging transactions. We estimate equation (3) at the contract-c level, in which we regress the amount of the (log) transaction value in international trade on the binary variable that takes value 1 if a matching hedging transaction is found, and 0 otherwise.

$$A_{c,i,m} = \alpha_1 \mathbf{1}(Hedged)_c + \eta_i + \eta_m + \epsilon_{c,i,m}, \tag{3}$$

where $A_{c,i,m}$ is the contract-c amount for firm-i in month-m. We include firm fixed effects η_i, and month fixed effects η_m. Panel A in Table 5 reports the results for exports trade credit and shows that—on average—hedged trade credit operations are 63% larger than non-hedged ones (complete sample period 2005-2018). Similarly, Panel B indicates that hedged trade credit

[15]We exclude firms with foreign debt from this exercise for two main reasons. First, because debt contracts are usually large-amount and long-term operations, it is difficult to match one or several FX derivatives to one operation. (We discuss foreign currency debt and swap contracts in the next section.) Second, firms with access to foreign capital markets might also hold assets denominated in foreign currency and, therefore, may not be hedging currency exposure through derivatives. Since we do not observe firms' assets denominated in foreign currency, we opt not to use information from these firms. Hence, by choosing a sub-sample of more homogeneous firms, we aim to be more conservative in our findings.

[16]Further, if we compare the notional value of FX derivatives contracts grouped by whether our matching method finds a matching international trade transaction, there is no statistical difference in size between FX derivatives with and without a matching trade exposure. This fact suggests that our method is not mechanically leaving out smaller or larger transactions. The corresponding figure can be found in Figure A.6 in the Appendix.

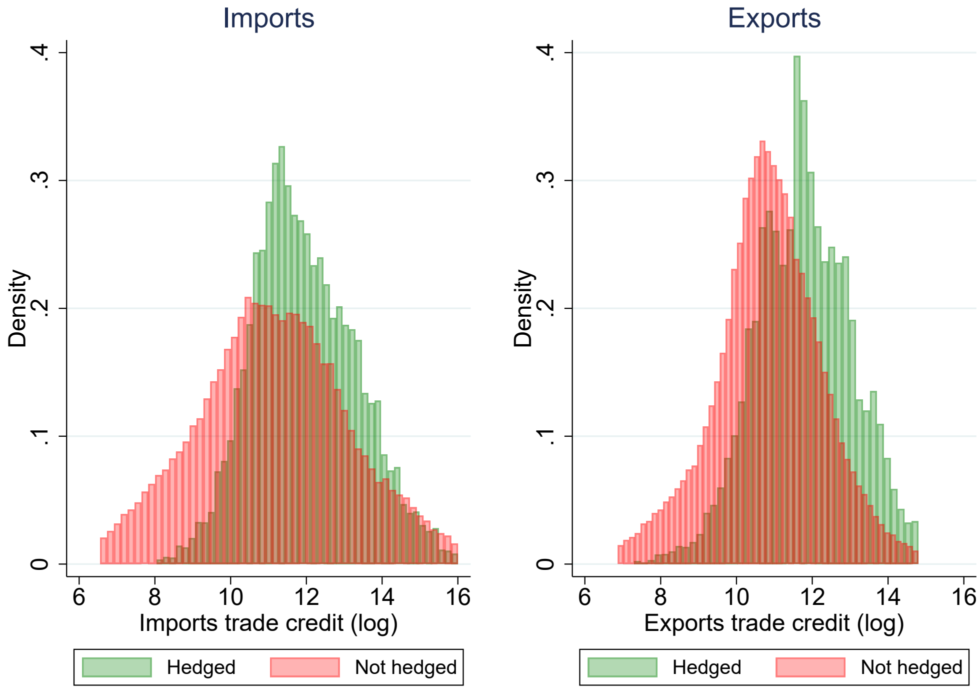

Figure 3: Hedging by amount size of trade credit contract

Note.– This figure shows the histograms of transaction-level matched data between FX derivatives contract and imports/exports trade credit, at the firm, maturity date, amount level. The horizontal axis is the size of the transaction. This exercise uses firms which participate in international trade and the FX derivatives market, but hold no foreign debt.

operations from imports are above 50% larger than non-hedged trade credit import operations. Our estimation is robust to focusing on one year only (2006, 2016 in columns 1 and 2 respectively) or our complete sample period (2005-2018 in column 3) .

FACT 3. *Firms' use of FX derivatives is related, at the extensive margin, to international trade and, at the intensive margin, to gross—rather than net—exposures.*

In this section, we characterize firms' use of FX derivatives at the extensive and intensive margins. At the extensive margin, we show that firms in international trade are more likely to employ FX derivatives. At the intensive margin, we show that firms using FX derivatives hedge gross—rather than net—currency risk exposures, which is consistent with the limited use of natural hedging.

The extensive margin.— We start by studying the decision of a firm to use FX derivatives by using nested versions of the following linear probability model:

Table 5: Size of international trade exposure by hedging policy

A. Exports trade credit (logs)

	2006	2016	2005-2018
	(1)	(2)	(3)
1(Hedged)	0.765***	0.516***	0.630***
	(0.123)	(0.144)	(0.110)
Observations	14,948	6,576	213,364
R-squared	0.40	0.37	0.32
Firm FE	Yes	Yes	Yes
Month FE	–	–	Yes

B. Imports trade credit (logs)

	2006	2016	2005-2018
	(1)	(2)	(3)
1(Hedged)	0.561***	0.545***	0.591***
	(0.065)	(0.103)	(0.047)
Observations	15,146	8,224	196,104
R-squared	0.36	0.35	0.31
Firm FE	Yes	Yes	Yes
Month FE	–	–	Yes

Note.– Dependent variable is trade credit (log) from imports and exports. Sample considers only firms in international trade with no foreign debt. Hedging definition considers use of FX forwards. Clustered standard error at the firm level.

$$FX_{i,m} = \beta_1 X^{TC}_{i,m} + \beta_2 M^{TC}_{i,m} + \beta_3 FCD_{i,m} + \eta_i + \eta_{j,y} + \varepsilon_{i,m}, \quad (4)$$

where $FX_{i,m}$ is a dummy equal to one if firm i has positive outstanding FX derivative position at the end of the month m, and zero otherwise. $X^{TC}_{i,m}$, $M^{TC}_{i,m}$ and $FCD_{i,m}$ are (log) end-of-month outstanding amounts of trade credit from exports and imports, and foreign currency debt, respectively. We include firm and industry-year fixed effects, and cluster the standard errors at the firm level.

Table 6 presents the results. Columns 1 and 2 show that the probability of using FX derivatives is positive and significantly correlated with international trade activity. In particular, column 1— which includes only export trade credit as a covariate— shows that a one percent increase in exports trade credit increases the probability of using FX derivatives 0.021 percentage points. The probability of using FX derivatives is slightly higher for imports: 0.055 percent-

Table 6: Use of FX derivatives: Extensive margin

	Dependent variable 1(firm uses FX derivatives)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.021***			0.020***	0.022***	0.022***	0.019***
	(0.004)			(0.004)	(0.004)	(0.004)	(0.004)
M^{TC}		0.055***		0.054***	0.058***	0.058***	0.057***
		(0.005)		(0.005)	(0.005)	(0.005)	(0.005)
FCD			-0.016***	-0.015***	-0.014**	-0.012**	-0.007
			(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
$X^{TC} \times M^{TC}$					-0.008**	-0.008**	-0.007**
					(0.004)	(0.004)	(0.003)
$X^{TC} \times FCD$					0.004	0.002	-0.000
					(0.003)	(0.003)	(0.002)
$M^{TC} \times FCD$					-0.006**	-0.006**	-0.006**
					(0.003)	(0.003)	(0.003)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
R Squared	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	-	-	-	-	-	Yes	Yes
Includes Mining	-	-	-	-	-	-	Yes

Notes.— All independent variables in logs. All regressions include firm level FE. X^{TC} stands for exports trade credit, M^{TC} for imports trade credit, and FCD for the outstanding stock in foreign debt. Constant terms are not reported. Clustered standard errors at the firm level reported in parentheses. * p <0.1, ** p <0.05, *** p <0.01.

age points (column 2). Column 3 shows only a marginal correlation (and of the opposite sign) between foreign debt and the probability of using FX derivatives.[17] In column 4, we include all three variables—export and import trade credits and foreign currency debt—and show that the estimated coefficients for trade remain statistically significant and similar in size. Finally, in columns 5 and 6, we control for exports, imports and foreign currency debt interacted, and show that the estimated coefficients for trade credit remain similar to our previous estimates. In the main specifications we exclude multinational and mining corporations, yet all results are robust to this decision and across time sub-samples as seen in columns (6) and (7). Our main specification focuses on dollar denominated FX forwards, which represent the lions' share of all FX derivatives, but the results hold after including swap contract and different currencies (see Table A.3 in the Appendix).

The intensive margin.— We now turn to examine the intensive margin of firms' use of FX hedging. We first study whether the outstanding balance of firms' FX derivatives positively correlates with their foreign-currency receivables and payables. In particular, we compute the

[17]The small correlation between foreign debt and the probability of using FX derivatives remains true even after separating outstanding stocks of debt according to their maturity. In most cases, the correlation becomes statistically non-significant.

end-of-month position (short and long) of FX derivatives (in logs), FX_m^{POS}, and re-estimate equation (4) using this measure as dependant variable. Panel A of Table 7 reports the results for sales (short positions) and Panel B the results for purchases (long positions).

Panel A shows that sales of FX derivatives positively correlate with holding trade credit from exports (columns 1 and 4). Interestingly, the covariate imports trade credit is also positive and statistically significant (columns 2 and 4). Yet this positive correlation is driven by firms that both import and export. To see this, we further split the sample between imports by exporters, and imports by non-exporters, and re-estimate our regression. Column 5 shows that the coefficient for imports is only statistically significant for imports by exporters. The estimated coefficient for export trade credit, once all controls are included in the analysis (column 7), indicates that a one percent increase export trade credit associates with a 0.046% increase in sales of FX derivatives. Note that foreign debt is not correlated with sales of FX derivatives in none of the specifications.

In Panel B, we present the results for purchases of FX derivatives. As expected, trade credit from imports is strongly related to buying dollars forward. The estimated coefficient implies that a one percent increase in imports correlates with a 0.15% increase in purchases of FX derivatives in the same month. Interestingly, the coefficient of foreign currency debt is non-statistically significant, suggesting that firms borrowing in foreign currency tend—on average—to not purchase FX derivatives to hedge their FC debt levels. This result holds true for all debt maturities (see Table A.4 in Appendix)

These regressions indicate that firms' FX derivative gross position (short or long) are associated with their gross exposure in foreign currency stemming from international trade credit. That is, importers hold long positions in FX derivatives (they "buy the forward dollar"), while exporters hold short positions in FX derivatives ("they sell the forward dollar"). The evidence presented in Tables 6 and 7 are robust to the inclusion/exclusion of multinational corporations, firms related to the mining sector as seen in columns (6) and (7), and including FX-swaps and currencies different from the US dollar (see Table A.5 in Appendix).[18]

Aggregate trade credit and FX derivatives.— The results in Table 7 suggest that the *gross* balances of imports and exports trade credit correlate with *gross* FX derivatives positions at the firm level. We now assess whether this correlation of gross positions is present at the aggregate level. With this end, we aggregate all export trade credit, all import trade credit and compare them with the FX derivatives short and long positions. Figure 4 presents these correlations. The correlation between exports trade credit and short FX positions—presented in Panel A—is high and reaches 0.79. Similarly, the correlation between imports trade credit and long FX positions—presented in Panel B—reaches 0.82. For comparison, in Panel C, we plot the correlation of net trade credit with net FX derivatives position. Interesting, the correlation using net exposures is much lower than the gross correlations and only reaches 0.48. Lastly, we

[18]Table A.6 in the Appendix shows that higher cash flow coincidence correlates with lower use of FX derivatives at the extensive margin and lower FX purchases. More complex firms (proxied by the number of exporting countries) are more likely to use FX derivatives and sell their foreign currency receivables forward.

Table 7: Use of FX derivatives – intensive margin

A. Sales of FX derivatives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.047***			0.047***	0.046***	0.045***	0.033***
	(0.008)			(0.008)	(0.008)	(0.008)	(0.009)
M^{TC}		0.014*		0.012*			
		(0.007)		(0.007)			
FCD			-0.015	-0.015	-0.015	-0.018	-0.012
			(0.013)	(0.013)	(0.013)	(0.012)	(0.011)
M^{TC} by exp.					0.022**	0.022**	0.027***
					(0.009)	(0.009)	(0.010)
M^{TC} by non-exp.					0.001	0.001	0.006
					(0.007)	(0.007)	(0.008)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
R Squared	0.54	0.54	0.54	0.54	0.54	0.54	0.53
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	-	-	-	-	-	Yes	Yes
Includes Mining	-	-	-	-	-	-	Yes

B. Purchases of FX derivatives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.005			0.001			
	(0.008)			(0.007)			
M^{TC}		0.155***		0.155***	0.155***	0.155***	0.146***
		(0.015)		(0.015)	(0.015)	(0.015)	(0.015)
FCD			-0.007	-0.005	-0.005	-0.004	-0.001
			(0.014)	(0.013)	(0.013)	(0.013)	(0.011)
X^{TC} by imp.					0.003	0.002	0.001
					(0.009)	(0.009)	(0.008)
X^{TC} by non-imp.					-0.004	-0.003	-0.003
					(0.007)	(0.007)	(0.006)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
R Squared	0.64	0.65	0.64	0.65	0.65	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	-	-	-	-	-	Yes	Yes
Includes Mining	-	-	-	-	-	-	Yes

Notes.— All regressors in logs. Supra-index TC stands for trade credit. All regressions include firm, year - industry fixed effects. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

conduct an additional test and assess these correlations from an ex-post perspective. That is, we consider cash flows at maturity date of FX contracts and obligations from derivatives positions, the same conclusion holds. Notably, the correlation between imports trade credit maturing in month m and FX long derivatives maturing in period m remains high at 0.9, and the correlation between exports trade credit maturing in m and FX short derivatives maturing in the same period is close to 0.8.

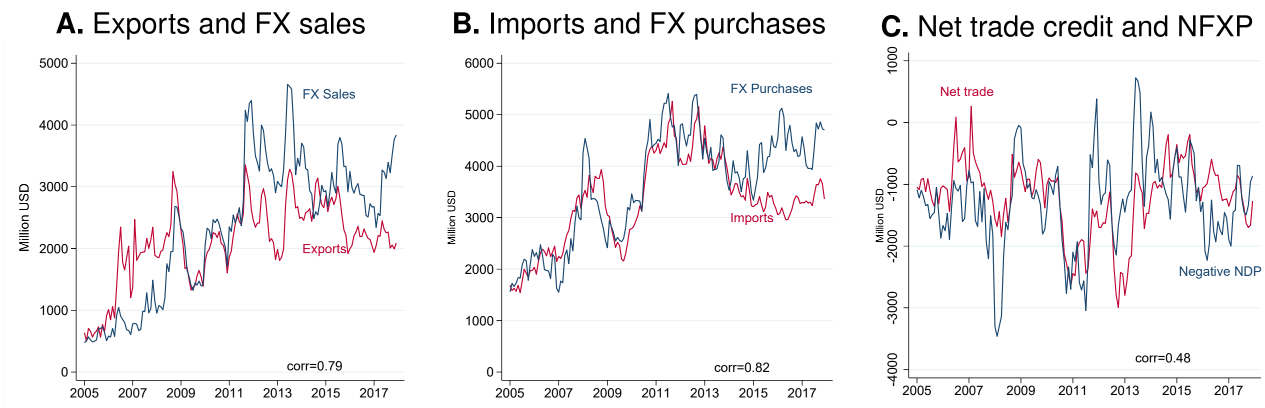

Figure 4: Trade Credit balances related to international trade and FX gross derivatives positions

Note.– End-of-month balance from trade credit from exports and FX derivatives sales (Panel A.), imports and FX purchases (Panel B.), and net trade credit and (negative) net FX position (short minus long positions, Panel C.). Expressed in millions of dollars. Sample used in this figure excludes firms with foreign debt, to avoid biasing upwards the estimation of the use of FX derivatives. Correlations between series are 0.79 for exports, and 0.82 for imports and 0.48 for net trade credit. Used sample also excludes multinational corporations, and mining companies. Inclusion of these firms does does not affect the results and can be seen in Figure A.5 in the Appendix.

FACT 4. *FX derivatives contracts are priced differently according to maturity.*

Focusing our analysis at the *transaction* level, we now explore patterns in the contracted forward exchange rates in each FX derivatives contract. Denote by $F_{c,d,N}$ the agreed forward exchange rate in an FX contract c, signed in day d and which matures in N days. Then, $F_{c,d,N}$ contains both, the expected currency depreciation and any premium. Also, denote by $FXP_{c,d,N}$ the forward premium in contract c, day d for maturity N, which can defined either for sales or purchases operations (see Shapiro 1996). Both the spot (S_d) and the forward exchange rates are defined in pesos per US dollar.[19]

[19]The lion's share of the FX derivatives contracts in our data are OTC instruments, which opens the possibility for different spreads and for financial intermediaries to potentially price discriminate across customers. Typically, a bank sells dollars forward at a higher exchange rate than what it pays to buy them at the same maturity; this is referred to as the Bid-Ask spread (Bekaert and Hodrick, 2017).

$$FXP_{c,d,N} = \frac{F_{c,d,N} - S_d}{S_d} \times \frac{360}{N} \times 100. \tag{5}$$

Figure 5 plots $FXP_{c,d,N}$ for purchases (blue) and sales (red) for years 2006 (panel A) and 2016 (panel B), against maturity (in days) N in the horizontal axis. The forward premium for sales of foreign currency is downward slopping and decreases significantly with maturity. This downward slope implies a discount that increases in maturity for selling foreign currency forward and, hence, exporters benefit more from selling their receivables in the short term than in the long term. Inversely, the forward premium for purchases is upward sloping and the premium increases with the maturity of the contract. Importers then pay a higher premium (per day) when they buy dollars at longer maturities.

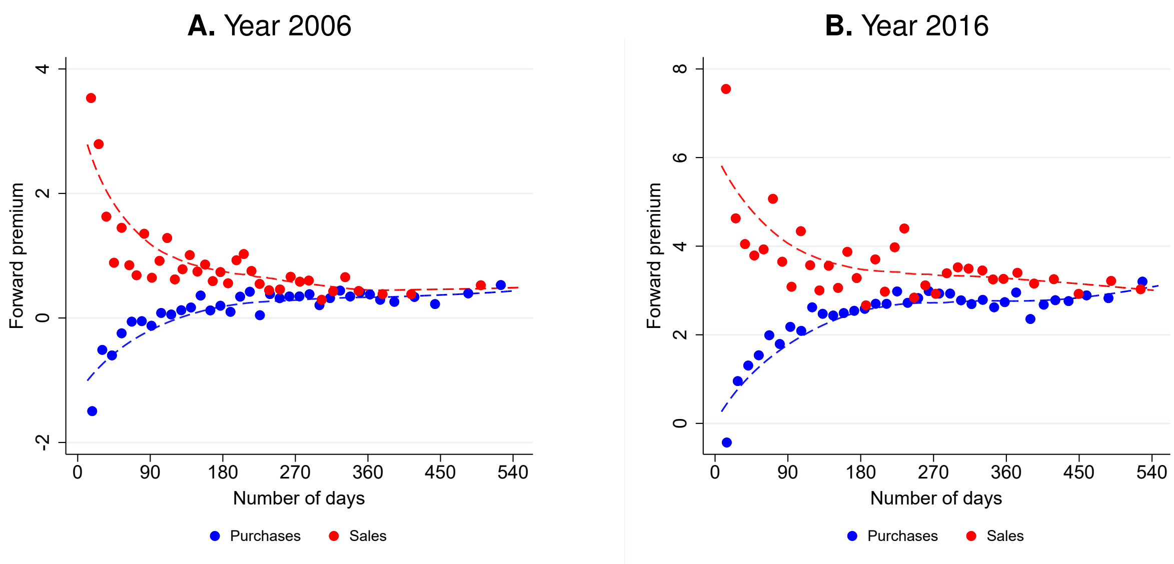

Figure 5: Forward premium by type of operation

Note.– Forward premium defined as in equation (5), and expressed in percentage points. Horizontal axis measured in days trimmed up to 550 for presentation purposes. Scatter points represent conditional mean within maturity bins. Dashed lines represented the outcome of locally weighted regressions. Red (Blue) objects are sales (purchases) of FX derivatives from the perspective of the firm.

To test these relationships statistically, we consider the following specification

$$FXP_{c,i,b,d} = \beta_1 A_{c,i,b,d} + \beta_2 N_{c,i,b,d} + \beta_3 D_{c,i,b,d} + \beta_4 \mathbf{X}_{i,y} + \eta_i + \eta_{b,m} + \eta_m + \varepsilon_{c,i,b,d}, \tag{6}$$

where A is the notional (log) amount of purchases/sales of FX derivatives contracts with maturity N (in log of days), settled with $D =$ delivery/compensation (1/0), for contract c, signed by firm i, with counter-party bank b in day d, and $\mathbf{X}_{i,y}$ are firms' sales. We include in the regression bank-month fixed effects ($\eta_{b,m}$) to control for bank-idiosyncratic expectation exchange rate changes. As above, we include firm and month fixed effects and cluster the standard errors at the firm level. Therefore, our specification captures the variation across contracts within firm and within bank and month.

Table 8: Forward premium (percentage, contract level)

	FX Purchases		FX Sales	
	(1)	(2)	(3)	(4)
Maturity	0.425**	0.425**	-2.117***	-2.120***
	(0.197)	(0.197)	(0.384)	(0.384)
Sales	-0.157*	-0.156*	0.075	0.076
	(0.086)	(0.087)	(0.132)	(0.132)
Notional amount		0.014		-0.046
		(0.052)		(0.067)
Delivery instrument		0.158		-0.330
		(0.198)		(0.336)
Observations	343,621	343,621	133,424	133,424
R Squared	0.18	0.18	0.22	0.22
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Bank-Month FE	Yes	Yes	Yes	Yes

Note.– Dependent variable defined as in equation (5) and specifications are based on equation (6). Notional amount is defined as the (log) of the amount hedged in a given contract. Maturity is calculated as days from signing of the contract to its maturity ($N_{c,i,b,d}$). Standard errors clustered at the firm level in parentheses. Statistical significance: * p <0.1, ** p <0.05, *** p <0.01

Table 8 presents the results. Columns 1 and 2 show firms' purchases of FX derivatives. Column 1 shows that maturity positively and significantly correlates with the forward premium, which implies that larger maturities are associated with a higher (per day) average forward premium. Importantly, this correlation persists even after controlling for time varying trends –such as month and bank-month FE interacted that control for trends in the exchange rate–, the notional amount of the derivative and the delivery type instrument (column 2). Interestingly, larger firms—measured by firms' sales volume—pay on average lower forward premium. Columns 3 and 4 show that the forward premium negatively correlates with FX sales. That is, when a firm wants to sell dollars forward, it gets a lower average daily premium the longer the maturity of the instrument. These results suggest that the financial intermediary is charging a higher bid-ask spread for transactions farther in the future, both for sales and purchases of FX derivatives. Interestingly, the contract notional amount does not seem to have a robust influence on the forward premium charged neither for purchases nor for sales.

In the next section, we study whether the level of development and liquidity of the foreign exchange rate market can affect firms' hedging decisions. In particular, we exploit a regulatory change to Pension Funds Managers (PFs)—which resulted in a temporary halt in their selling of FX derivatives in 2012/2013—to assess whether a negative supply shock affects firms' hedging choices. Finally, we revisit the potentially affected stylized facts in this section and document their sensibility to the shock.

4 A Market-Level Supply Shock

In 2012, the Chilean Pensions Supervisor Authority (Superintendencia de Fondos de Pensiones) relaxed the regulation on FX hedging of investments abroad by Pension Funds (PFs). This regulatory change had a large impact on the FX derivatives markets as PFs substantially decreased their sales of FX derivatives. These lower sales translated into a significant decrease in the supply of FX derivatives from banks towards firms. In this section, we analyze how banks transmitted this temporary liquidity shock and how it affected firms' hedging patterns. We start by presenting the regulatory change in the FX derivative markets and next describe the empirical strategy to identify the impact of the shock on firms' hedging decisions and prices in the forward market.[20]

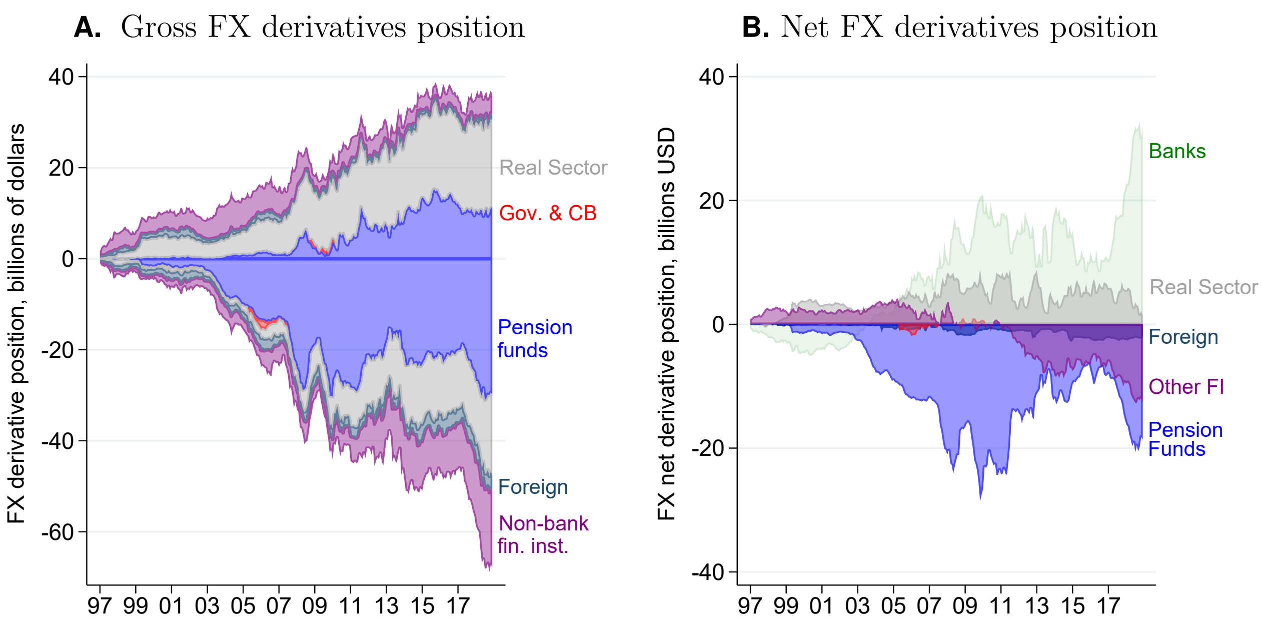

Figure 6: Pension Funds' gross and net FX derivative positions

Notes.— Panel A. deliberately leaves out the banking sector which is usually the main counterparty for every transaction. Measured in billions of dollars.

[20]In the Appendix, we develop the sketch of a model that rationalizes the findings of this section and shows how the liquidity of the FX derivative market affects firms' FX derivatives decisions.

4.1 The Regulatory Change of the FX Derivative Markets

Pension funds are the backbone of the funded pension system in Chile. All non-military formal workers save a mandatory 10% of their wages to finance their retirement income. They are the largest holders of gross positions of FX derivatives. By the end of 2018, they held 41.3 billions of U.S dollars in FX-derivatives, which is equivalent to 30% of the commercial banking credit and 15% of GDP (Panel A in Figure 6). Importantly, they are the agents with the largest net short FX derivatives position and, at times, the only net suppliers of U.S. dollars in the forward market (Panel B in Figure 6). As such, they are the natural counter-party of the corporate sector, which in net holds long positions. The supply of PFs' net short position is intermediated to firms via commercial banks through OTC FX derivatives.

Regulation dictates an upper limit, for each Fund, to the share of portfolio invested abroad that is not hedged. In May 2012, the Pension Supervisor consulted the Central Bank of Chile on their view of new limits for un-hedged portfolio invested abroad. After favorable assessment, on June of the same year, the regulator determined that starting on December 1st 2012, PFs would be allowed to increase their share of non-hedged portfolios from 15%-50% (depending on the investment Fund) to a general 50% (see Table A.7 in the Appendix).[21] In practical terms, this change in regulation implied that PFs were holding larger short position in FX derivatives than required by the new regulation.

This regulatory change translated into a temporary *negative supply shock* to the FX derivatives market. Upon the reform, PFs reduced their sales of FX derivatives and, thus, lowered the availability of FX forwards. Lower supply of FX derivatives affected firms seeking to take long FX positions (e.g. importers and foreign currency borrowers), as banks—who are the most common intermediaries—refrain from holding currency risk and passed this negative liquidity shock onto firms. The change in supply from PFs was important to the market, as shown in Figure 7. PFs' sales of FX derivatives to individual banks is depicted in gray lines. The blue line shows the total sales of FX derivatives of PFs to the banking system. In line with the announcement of the regulatory change (May 2012), the sales of FX derivatives by PFs started decreasing and saw its largest drop at the moment of the implementation of the regulatory change in December 2012. The drop between the moment before the first announcement, to six months after the regulation took place, was more than five billion USD.

In the rest of this section, we examine how this supply shock to banks translated into a supply shock to firms, and how it affected their hedging decisions.

[21] Resolution number 46 by the Superintendence of Pensions, referring to operations in foreign currency derivatives and currency risk hedging, available at `https://www.spensiones.cl/portal/institucional/594/w3-article-8717.html`. Additionally, the change in regulation incorporated the notion of hedging the currency of the underlying asset which generates currency risk. Before it, assets denominated in foreign currencies different than the US dollar were hedged in the accounting currency of the portfolio which included them, usually the US dollar. Appendix A.8 presents additional details.

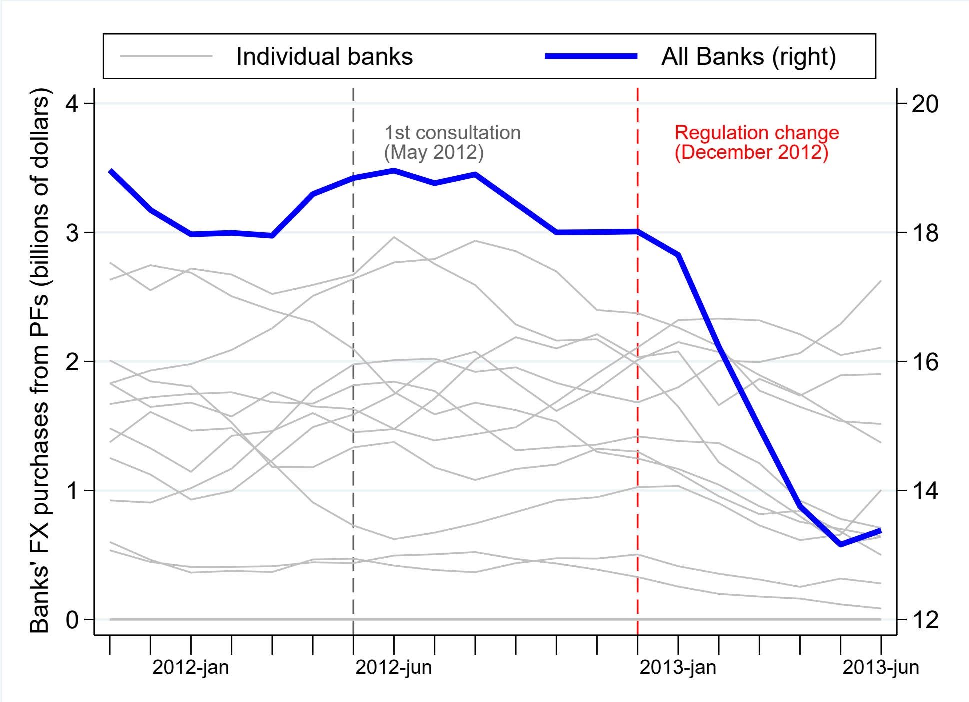

Figure 7: Outstanding FX purchases from Banks to Pension Funds ($ billions)

Note.— Figure shows outstanding FX derivatives purchased by banks to Pension Funds (in billions of USD). Each gray line represents outstanding positions by individual banks; blue line represents total outstanding (long) position of banks with pension funds; green line represents (long) outstanding position by one specific bank which we use as a benchmark case in empirical exercises.

4.2 Identification Strategy

In this section, we present the identification strategy and discuss possible concerns regarding the empirical analysis, such as identification of the supply shock, exogeneity of the regulatory change and heterogeneous effects across banks. It is worth noting that, because the reform reduced the supply of FX derivatives in the market, we focus our analysis to firms' purchases of FX derivatives.

The identification strategy of the effect of changes in market conditions on firms currency risk management is based on the 2012 change in regulation for PF's. To better identify the effect of the shock, we restrict our analysis to the six months before and after the regulatory change. Furthermore, since the reform was announced in May 2012 and PFs could have anticipated it, and started reducing their supply of FX derivatives before the implementation in December 2012 (as suggested in Figure 7), we define the "before" period as the six months earlier, from December 2011 to May 2012. We define the "after" period from December 2012 to May 2013. That is, we intentionally leave the months from June 2012 to November 2012 out of the analysis, as these months could be considered partially treated due to the anticipation to the reform by some PFs. This characterization has the additional advantage that it compares the same months (December to May) and deals with seasonality that could arise from firms' operating in different economic activities. We refer to this analysis as the "six-month window". To test that our results are not driven by the length of the window, we conduct robustness tests with a "four-month window", which covers December 2001- March 2012 and December 2012-March 2013 for the before and after periods.

An important concern of the empirical analysis is that a decrease in firms' demand for FX derivatives, rather than a negative supply shock, could arise from changes in firms' hedging policies. Because in Chile FX derivatives are mostly transacted through OTC market with the banking sector, we can follow Khwaja and Mian (2008), Amiti and Weinstein (2018) and Alfaro et al. (2021) and exploit firms' multi-bank relationship to control for firms' demand of FX derivatives.[22] In particular, we keep firms that have hedging activities with more than two banks and include in our regressions firm-time fixed effects. This allows us to control for firms' time-varying demand of hedging instruments and capture only the supply shock due to the regulatory change on pension funds. Furthermore, this identification strategy allows us to recover the decrease in the supply of FX derivatives of each individual bank and, hence, observe the heterogeneous impact of the regulatory shock across banks. As additional test, we check (and confirm) that the estimated coefficients for banks correlate with their pre-reform exposure to pension funds. More precisely, we show that banks that used to purchase more FX derivatives from PFs before the shock—and, hence, were more exposed to the regulatory change—experienced a larger decrease in the sales of FX derivatives to firms after the regulation.

The analyzed change in regulation was arguably exogenous to firms' individual hedging decisions. The general context around the regulatory change, and its timing make it unlikely that firms hedging decisions were endogenous to the policy change by the Pension Funds Supervisor. Furthermore, as mentioned above, we focus our analysis in the period before the announcement of the policy, so we can avoid any anticipation effect from firms and, hence, simultaneity bias.

4.3 Empirical Results

In this section, we study whether the decrease in the supply of FX derivatives issued by PFs affected firms' hedging activity by conducting four econometric exercises. First, we estimate a standard difference-in-difference model where we estimate the average response of firms across all banks. Second, we saturate our regressions with time-varying firm and bank fixed effects to control for changes in firms' hedging demand and capture banks' individual changes in the supply of FX derivatives to firms. Additionally, we assess whether these changes associate with changes in the forward premium and, hence, the price of FX derivatives. Third, we conduct a back-of-the-envelope calculation to assess the aggregate impact of the regulatory change on firms' hedging policies. Four, we study whether the supply shock affected firms' hedging decisions at the intensive and extensive margins.

[22] In Khwaja and Mian (2008), Amiti and Weinstein (2018) and Alfaro et al. (2021) the identification relies in disentangling the bank lending channel (the bank-specific shock) from the firm borrowing channel (the ability of firms to borrow from alternative sources). Our question is similar, but is not concerned with loans contracts but with hedging.

Average Effect Across Banks.— We start our analysis with a standard difference-in-difference estimator, in which we estimate the average impact of the regulatory change on firms' hedging positions across banks. With this end, we define a dummy variable $Post_\tau$ which takes the value of zero before the regulatory change and one after it. More precisely, we estimate:

$$FX^{\text{Long}}_{i,\tau} = \beta_1\, Post_\tau + \eta_i + \varepsilon_{i,\tau}, \tag{7}$$

where τ denotes the period before and after the reform, $FX^{\text{Long}}_{i,\tau}$ is the (log) average outstanding long derivatives position of firm i in period τ. Further, we estimate this regression using the annual growth rate of FX outstanding position as dependent variable.

Table 9: Firms' purchases of FX derivatives before and after change in regulation

A: 6 month window. Before: Dec 2011-May 2012, After: Dec 2012-May 2013

	Outstanding (log)		Annual Growth (%)	
	(1)	(2)	(3)	(4)
1(Post)	-0.245****	-0.248***	-0.550***	-0.545***
	(0.060)	(0.062)	(0.099)	(0.103)
Observations	660	658	616	614
R Squared	0.930	0.920	0.48	0.48

B: 4 month window. Before: Dec 2011-Mar 2012, After: Dec 2012-Mar 2013

	Outstanding (log)		Annual Growth (%)	
	(1)	(2)	(3)	(4)
1(Post)	-0.236***	-0.250***	-0.560****	-0.591***
	(0.066)	(0.068)	(0.107)	(0.111)
Observations	645	643	587	585
R Squared	0.910	0.910	0.480	0.490
Firm FE	Yes	Yes	Yes	Yes
Includes Mining and MNC	Yes	-	Yes	-

Notes.— Dependent variables are (log) of outstanding gross long derivatives positions (columns 1-3) and annual growth rate of gross long derivatives positions (columns 4-6). Regulation change entered into force in December 2012. Clusterized standard errors at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01

Table 9 presents the results. The estimated coefficients are negative and statistically significant in all specifications and indicate that, within the six months of the regulatory change, firms contracted their purchases by almost 25% (Panel A, columns 1-2) and reduced their growth rate by half (Panel A, columns 4-6). Our results are robust to including mining and MNC (columns 1 and 3) and to considering a four months window (Panel B).

Banks' Individual Supply Changes of FX Derivatives.— The above analysis presents suggestive evidence that firms decrease their use of long FX derivatives after the regulatory change. Yet the regressions did not control for changes in firms' hedging demand over time and, hence, they could be attributing these changes in firms' demand to the regulatory change on PFs. To assess whether the estimated coefficients correspond to the supply shock and not a lower demand of FX derivatives from firms, we conduct an additional exercise where we saturate our regressions with time-varying firm fixed effects and banks fixed effects. We exploit firms' multi-banking relationships to identify the supply shocks. This identification strategy allows us to obtain banks' individual coefficients that capture the change in the supply of FX derivatives available to firms, once firms' demand for FX derivatives is already controlled for. In particular, we consider the following specification

$$D(FX_{i,b,\tau}) = \alpha_{i,\tau} + \beta_{b,\tau} + \varepsilon_{i,b,\tau}, \tag{8}$$

where $D(FX_{i,b,\tau})$ is the change in firm i's outstanding FX-purchases from bank b between before ($\tau = 0$) and after ($\tau = 1$) the regulatory change, $\alpha_{i,\tau}$ is a firm-time fixed effect, $\beta_{b,\tau}$ is a bank-time fixed effect and $E[\varepsilon_{b,i,\tau}] = 0$. The empirical model in equation (8) separates the channels for outstanding hedging contracts between bank b and firm i. If hedging varies because a firm was hit by a firm-specific shock, our model will capture the decline in hedging demand in $\alpha_{i,\tau}$. Alternatively, if a bank can no longer sell forward the dollars it buys from firms and, therefore, cuts its supply of forward dollars, the model will capture that in $\beta_{b,\tau}$. Following Amiti and Weinstein (2018) we refer to the former as the "firm-specific demand channel", and to the latter as the "bank-specific supply channel". The parameter of interest for the specific shock we analyze is $\hat{\beta}_{b,\tau}$. That is, the supply channel of the regulatory change in the FX derivatives market.

Table 10 presents the estimated coefficients $\hat{\beta}_{b,\tau}$. The results in Panel A show that the regulatory change reduced banks' supply of FX derivatives to all firms (column 1) and firms in international trade (column 3). Most of the individual coefficients of banks are negative and statistically significant, meaning that each of these banks reduced their supply of FX derivatives to firms. Columns 2 and 4 show the cumulative market share of banks. We do not report market share of each bank in order to protect their actual identity. However, column 1 in Panel A shows that banks that reduced their FX derivatives supply (i.e. negative and statistically significant coefficient) account for 90% of the sales of FX derivatives to firms (excluding sales by the base bank $\tilde{b}$). This shows that the shock had not only a substantial effect on the supply of FX derivatives from PFs to banks, but also from banks to firms.

We next consider the same framework of analysis to assess the effects of the change in regulation on the forward premium $FXP_{i,b,t}$. In particular, we re-estimate equation (8) using the forward premium $D(FXP_{i,b,\tau})$ as dependent variable, where $D(FXP_{i,b,\tau})$ is the change in the median forward premium paid by each firm between before ($\tau = 0$) and after ($\tau = 1$) the regulatory change. We report the results in Panel B of Table 10. The decrease in the supply of FX derivatives led to an increase in the forward premium paid by firms. Furthermore, this increase is significant at the market level: banks for which we find a positive and significant coefficient

Table 10: Banks' sales of FX-derivatives to firms: supply side

A. FX-derivatives purchases by firms (Growth Rate)					**B.** Forward premium (pp.)				
	All firms		Firms in trade			All firms		Firms in trade	
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
	$\beta_{b,\tau}$	Cum. share	$\beta_{b,\tau}$	Cum. share		$\beta_{b,\tau}$	Cum. share	$\beta_{b,\tau}$	Cum. share
Bank 1	-2.454**	—	-2.478**	—	Bank a	2.100***	—	2.221***	—
	(0.634)		(0.622)			(0.441)		(0.314)	
Bank 2	-1.437***	—	-1.209***	—	Bank b	2.100**	—	1.658**	—
	(0.300)		(0.379)			(0.854)		(0.718)	
Bank 3	-0.832***	—	-0.764***	—	Bank c	1.772*	—	1.414	—
	(0.086)		(0.069)			(0.953)		(0.844)	
Bank 4	-0.812***	—	-0.801***	—	Bank d	1.701***	—	1.380***	—
	(0.126)		(0.131)			(0.503)		(0.395)	
Bank 5	-0.809***	0.49	-0.481**	0.47	Bank e	1.261**	0.40	0.098	0.43
	(0.169)		(0.187)			(0.416)		(0.394)	
Bank 6	-0.663***	—	-1.451**	—	Bank f	1.108***	—	1.165**	—
	(0.153)		(0.552)			(0.345)		(0.395)	
Bank 7	-0.507***	—	-0.455***	—	Bank g	0.945**	0.76	1.342**	0.81
	(0.128)		(0.147)			(0.342)		(0.459)	
Bank 8	-0.498**	—	-0.562***	—	Bank h	0.539	—	0.448	—
	(0.167)		(0.137)			(0.815)		(0.573)	
Bank 9	-0.495***	—	-0.615***	—	Bank j	0.100	—	-0.698	—
	(0.124)		(0.104)			(0.633)		(0.670)	
Bank 10	-0.475***	0.89	-0.440***	0.88	Bank k	-2.448	—	-10.718***	—
	(0.120)		(0.100)			(1.985)		(2.816)	
Bank 11	-0.193	—	-0.127	—	Bank l	-3.007**	—	-2.126***	—
	(0.143)		(0.130)			(1.007)		(0.685)	
Bank 12	-0.160	1.00	-0.118	1.00	Bank m	-4.491	1.00	-5.693	1.00
	(0.150)		(0.168)			(4.048)		(3.259)	
Obs.	697		599		Obs.	492		415	
R2	0.48		0.49		R2	0.41		0.91	

Note.— Table shows bank fixed effects $\beta_{b,t}$ in columns 1 and 3, and cumulative share in total sales of FX derivatives to firms by banks in columns 2 and 4. The order of banks in Panel A does not necesarily coincide with the order in Panel B. In each panel banks are ordered according to the sign and size of the estimated coefficient; from most to least negative in Panel A, and from most to least positive in Panel B. Cumulative shares are not shown on a by-bank basis to protect confidentiality of their identity. Banks' market shares exclude investment banks and base-bank. Firms exclude MNCs. Clusterized standard errors at the bank level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

$\hat{\beta}_{b,\tau}$ account for 76% of the total sales of FX derivatives from banks to firms (columns 1 and 2). This result is robust to considering only firms in international trade (columns 3 and 4).

Table 10 showed that the decrease in the supply of FX derivatives to firms was heterogeneous across banks. Even though the shock was large enough to affect the whole market, it is reasonable to expect that banks which were more exposed to PFs, adjusted relatively more after the regulatory change. Thus, one should observe a negative correlation between banks' ex-ante exposure to PFs and their reduction of FX derivatives to firms. We present this correlation in Figure 8. The horizontal axis is banks' ex-ante exposure to pension funds and the vertical axis is our estimated coefficients of Table 10, the bank-specific-supply effect. Every circle represents a bank, and its size is proportional to their market share as suppliers of FX derivatives to firms. The thick (thin) circles represent the estimated coefficients for which we can (cannot) reject the null hypothesis of $\hat{\beta}_{b,t}$ being different from zero at the 10% significance level. The correlation between $\hat{\beta}_{b,t}$ and banks' ex-ante exposure to PFs, albeit not large, is negative and statistically significant, confirming that more exposed banks decreased their supply of FX derivatives to firms after the regulatory change.[23]

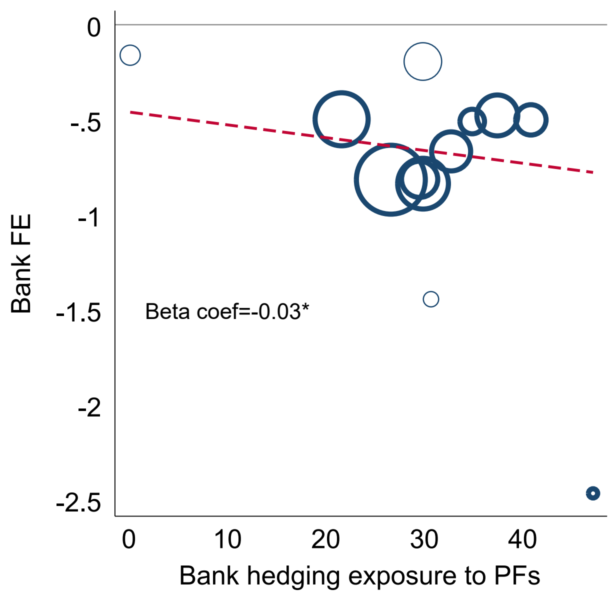

Figure 8: Estimated bank-specific supply shocks

Note.— Vertical axis shows estimated bank fixed effects from equation (8), horizontal axis shows Pension Funds' share (%) in each bank's total purchases of FX derivatives before the regulation change. Size of each circle represents share of bank in total sales of FX derivatives from banks to firms. Red dashed line represents weighted linear fit. Thick lined circles are significant bank-specific-supply effects at least 10% confidence level.

Aggregate Impact.— The magnitude of the aggregate estimated effect on both, outstanding purchases of FX derivatives and the forward premium, is sizeable. In Table 11, we present the market-share-weighted average of the bank-specific-supply channel estimated for each bank in Table 10. Column 1 in Table 11 shows that the contraction in the supply of FX derivatives accounted for a decrease of 58% in the outstanding purchases of FX derivatives. This number

[23] We obtain similar results when including swaps, see Table A.9 in the Appendix.

changes to 52% if we restrict the sample to firm-bank relations with firms in international trade only. Similarly, column 2 shows that the market-share-weighted average of forward premium increased by 0.7% and 0.77% for all firms and firms in international trade respectively, because of the supply shock.

Table 11: Aggregate Effects of the Supply Shock

	FX-derivatives purchase (Growth Rate)	Forward Premium (pp.)
	(1)	(2)
All Firms	-0.572***	0.705*
	(0.063)	(0.357)
Int. Trade	-0.549***	0.775***
	(0.060)	(0.179)

Note.— Table shows participation-weighted-average bank fixed effects $\beta_{b,t}$ estimated from equation (8) for outstanding FX-purchases, and Forward Premium, as $\sum_b \frac{L_b}{\sum_b L_b} \times \hat{\beta}_b$. Participation refers to the overall market share of total sales of FX-derivatives from banks to firms. Standard errors are clustered at the bank-level. * p <0.1, ** p <0.05, *** p <0.01.
Source: Authors' calculations.

The 2012 change in regulation implied a contraction in the supply of FX derivatives. The regulatory change allowed pension funds to have larger non-hedge positions and, hence, they reduced their sales of FX derivatives to banks. Without being able to hold significant open positions, banks passed on the reduction on the sales of FX derivatives to firms. This reduction was heterogeneous and higher for banks more exposed purchases of FX derivatives from pensions funds before regulatory change.[24] In the next section, we assess whether firms adjusted their currency exposures and FX derivatives choices after the shock.

4.4 Financial Market Development and Firm Hedging

This section studies how the negative supply shock affected firms' FX derivatives choices. In particular, we revisit some of the stylized facts presented in Section 3 and assess how the shock affected the intensive and extensive margin of FX derivatives.

Changes at the Extensive and Intensive Margins.—. To study the impact at the extensive and intensive margin, we estimate an augmented version of equation (4) by interacting

[24]Notably, in Appendix A.3 we document a CIP violation starting after the change in regulation which reached its maximum level six months after, and which affected mostly short term maturities.

all coefficients with a dummy variable that takes the value of one in the post-regulation. More precisely

$$\begin{aligned} Y_{i,m} =& \beta_1\, X^{TC}_{i,m} + \beta_2\, M^{TC}_{i,m} + \beta_3\, FC_{i,m} \\ &+ Post_\tau \left(\beta_4 + \beta_5\, X^{TC}_{i,m} + \beta_6\, M^{TC}_{i,m} + \beta_7\, FCD_{i,m}\right) + \eta_f + \eta_{j,m} + \varepsilon_{i,m}, \end{aligned} \tag{9}$$

where the dependent variable $Y_{i,m}$ is defined in three different ways (columns in Table 12): (i) a dummy variable that takes the value of one if the firm uses FX derivatives (column 1), (ii) (log) outstanding purchases of FX derivatives (column 2), (iii) (log) outstanding sales of FX derivatives (column 3).

Column 1 in Table 12 shows that the negative supply shock reduced the probability of using FX derivatives. In particular, the estimated coefficient for the post-reform dummy—$Post_\tau$—implies that firms had a 2% lower probability of using FX derivatives after the regulatory change. Column 2 presents the results on the intensive margin for FX purchases, and indicates the shock lowered firms' purchases of FX derivatives. The dummy interacted with imports is negative and statistically significant indicating that the shock made import hedging more difficult. Column 3 presents the results on FX sales and shows that these were also lower in the post-reform period. Notably, exporters refrained from selling their cash inflows in the forward markets. This last result may seem counter-intuitive as the change in regulation can be understood as a negative supply shock affecting mostly buyers of US dollars in forward markets. Yet most exporters are also importers, who usually hedge gross exposures separately. That is, they sell the dollars from their exports and buy the dollars needed for their imports. However, disruptions on one side of the market implies that these firms can no longer hedge imports trade credit as easily, and hence may refrain from selling their FX currency revenues. This speaks to the interconnection between both sides of the market and liquidity necessary for an OTC market to properly function.

Results presented in this section show that the ease in the cap of non-share portfolios of pension funds in 2012 translated into a decrease in the supply of FX derivatives to banks, which—in turn—passed on to firms. This negative supply shock led to an increase in the forward premium in the FX market to firms, making it more costly for them to hedge their currency exposure. At a result, the use of FX derivatives decreases both at the extensive and intensive margins. At the extensive margin, the probability of using FX derivatives drops after shock. At the intensive margin, importers reduce their FX purchases. Interesting, exporters reduce their sales of FX derivatives and seem to prefer to hold their cash flows.

Table 12: Use of FX derivatives after regulatory change

	Extensive margin	Intensive margin	
		Purchases	Sales
	(1)	(2)	(3)
X^{TC}	0.018**	-0.000	0.039***
	(0.008)	(0.008)	(0.006)
M^{TC}	0.029***	0.018**	0.016*
	(0.008)	(0.006)	(0.008)
FC Debt	0.004	0.028*	-0.010
	(0.010)	(0.016)	(0.023)
1(Post)*Exports	-0.047***	-0.003	-0.069***
	(0.006)	(0.006)	(0.007)
1(Post)*Imports	0.001	-0.017**	-0.001
	(0.005)	(0.007)	(0.070)
1(Post)*FC Debt	0.002	-0.012	-0.008
	(0.005)	(0.008)	(0.011)
1(Post)	-0.023***	-0.014	-0.040
	(0.002)	(0.079)	(0.082)
Observations	111,458	108,320	108,320
R Squared	0.053	0.76	0.68
Num. Firms	14152	14011	14011
Firm FE	Yes	Yes	Yes

Notes: All variables in logs, except for the binary variable Post. All regressions include firm level FE. Firms with no imports, exports and no FC debt, simultaneously, are dropped from the sample. Constant terms are not reported. Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5 Conclusion

This paper exploits a unique dataset covering the universe of FX derivative transactions in Chile over more than a decade to dissect which firms employ foreign currency derivatives and how they use it to hedge the currency risk. The granularity of our data allowed us to uncover four new facts.

First, we showed that firms, even those that could exploit it further, are not "naturally hedged", as their receivables due to exports and payables due to imports are only marginally correlated. Notably, this correlation remains small even when controlling for foreign currency debt. We then assessed a plausible reason for low natural hedge: different maturity between payables and receivables in foreign currency. We documented that indeed the trade credit for imports has a much lower maturity than it has for exports, suggesting that it would actually be very difficult for firms to be naturally hedged. Second, we showed firms that employ FX derivatives to be larger and employ these instruments to hedge larger transactions. Third, when assessing the use of FX derivatives at the extensive and intensive margins, w found that, at both margins, trade credit for exports and imports associate with a higher probability and use of FX derivatives. Interestingly, the size of the estimated coefficients is rather small, which suggests that firms hedge a small part of the trade credit and still have a large unhedged positions. Finally, we reported a maturity premium.

In the last section of the paper, we used a reform that decreased the liquidity in the FX derivative market for purchases purposes and showed that reduction in the supply of USD forward substantially lowers the use of FX derivatives for hedging imports. This exercise suggests that the more developed is the FX derivative market, the more firms would be able to hedge their imports arguably limiting systemic risk associated to currency exposure.

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A Appendix

A.1 Additional Figures

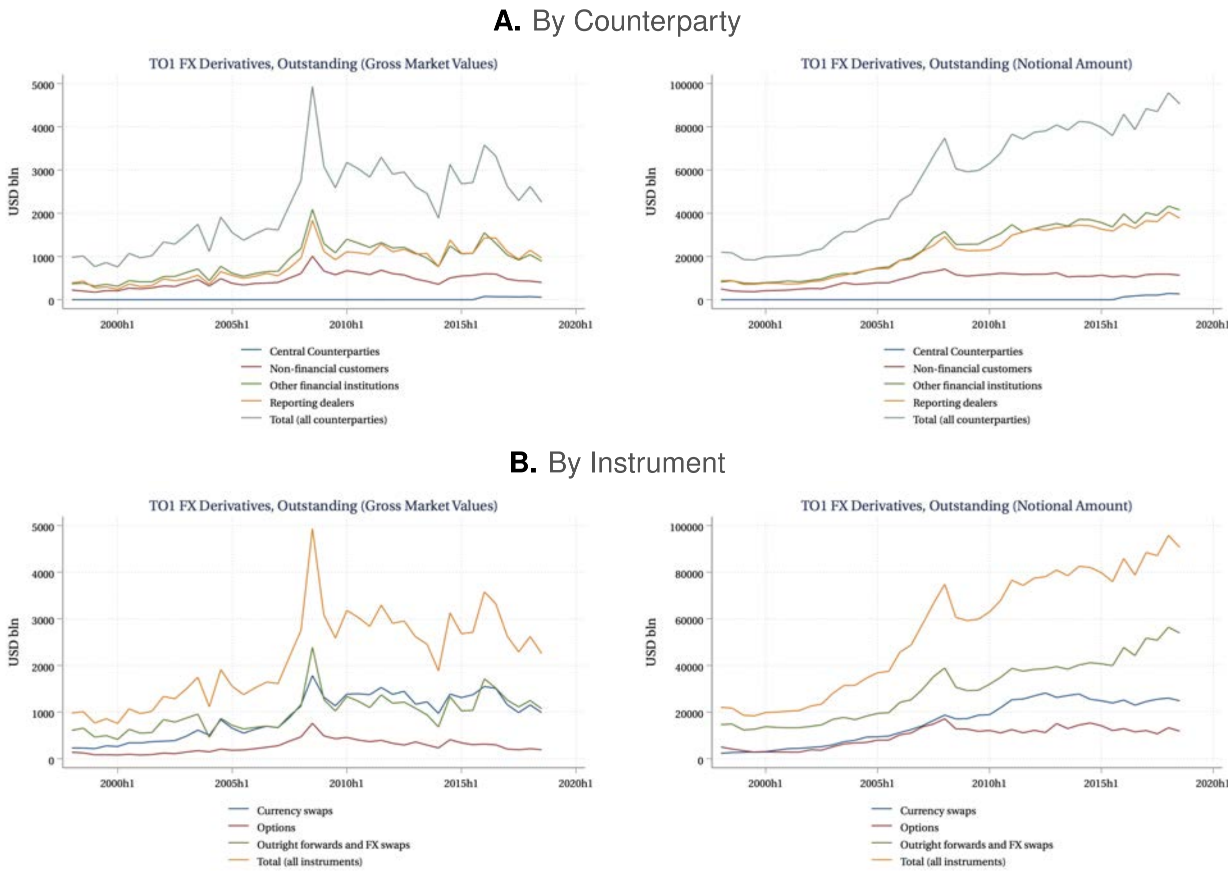


Figure A.1: FX-derivatives market size by counterparty and type of instrument

Note.— "Notional amount outstanding": Gross nominal value of all derivatives contracts concluded and not yet settled on the reporting date (Good as measure of total market size). "Gross market value": Sums of replacement market values of all open contracts (Good as proxy of potential risk transfers in instruments). *Units*: All figures are expressed in billions of USD. More info `https://www.bis.org/statistics/about_derivatives_stats.htm`. TO1 measure aggregates all the currencies as detailed in `https://www.bis.org/statistics/dsd_lbs.pdf`. For further reference, `https://www.bis.org/statistics/glossary.htm?&selection=209&scope=Statistics&c=a&base=term` is the dictionary of BIS terms.

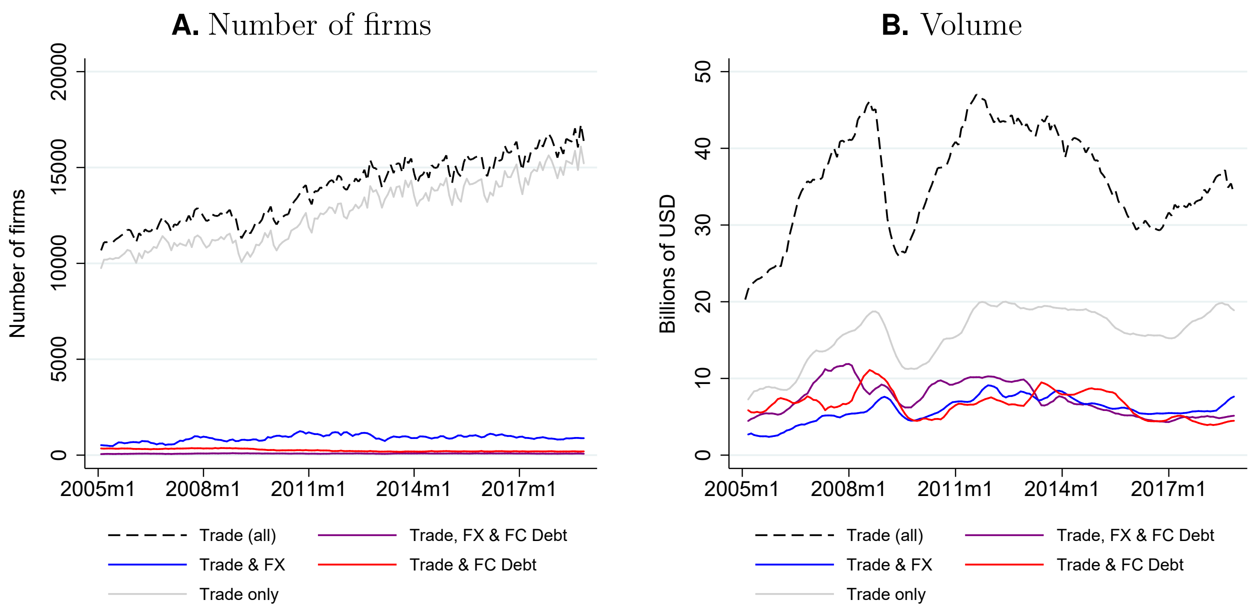


Figure A.2: International trade by type of firm

Notes.— Conditional on doing international trade, categories of firms are mutually exclusive.

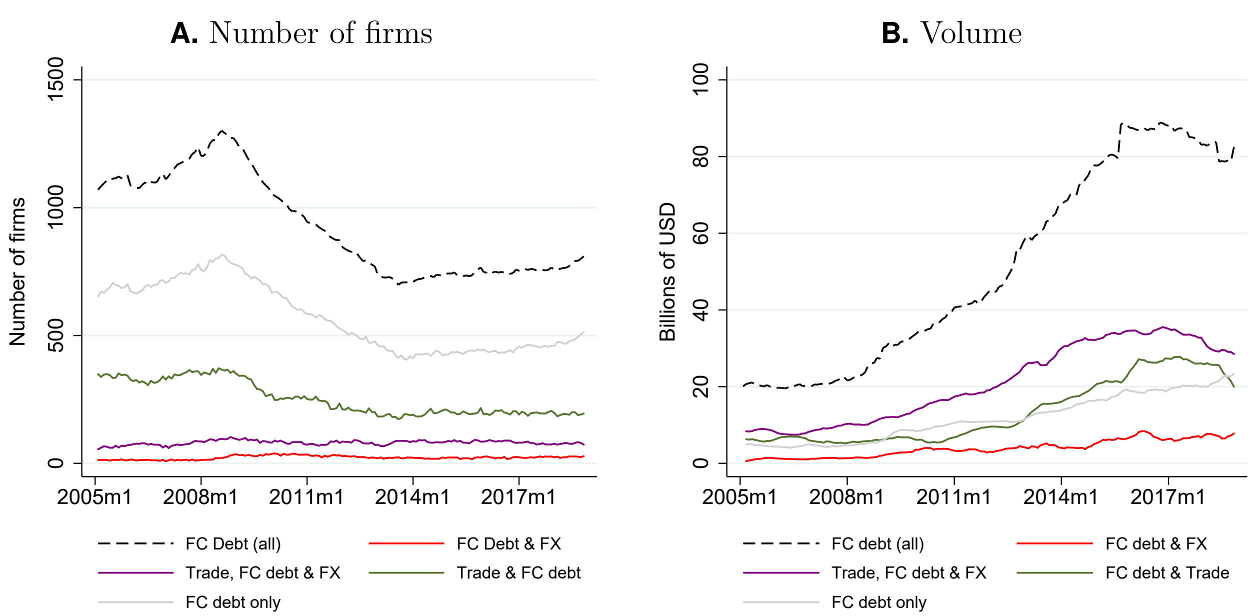


Figure A.3: Foreign debt (in foreign currency) by type of firm

Note.— Conditional on using foreign debt, categories of firms are mutually exclusive.

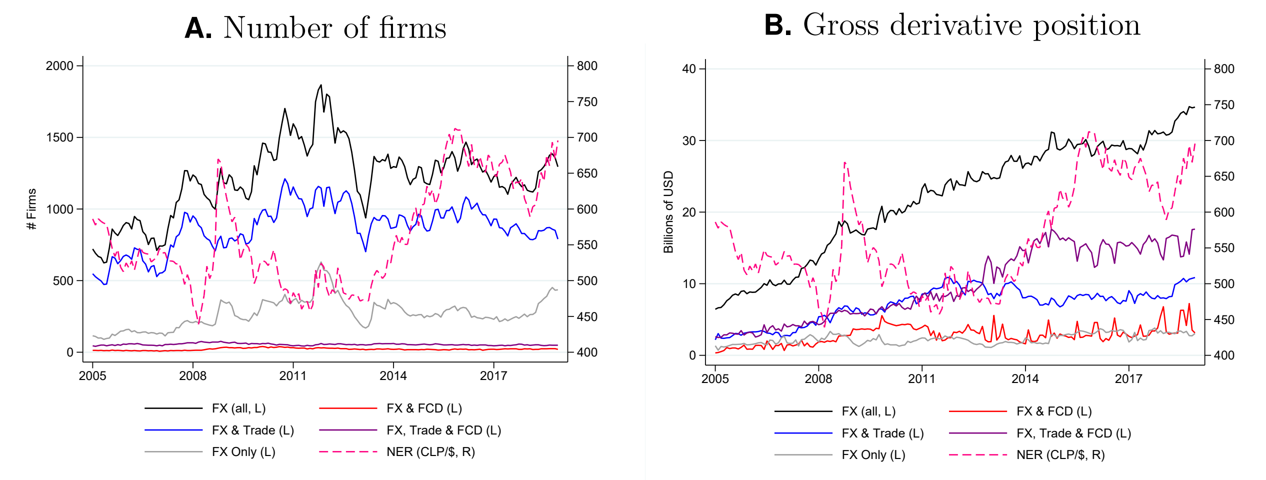


Figure A.4: Use of FX derivatives by type of firm

Note.— Categories of firms are mutually exclusive. “FX Only”: firms that hold gross derivatives positions only; “FX & Trade”: firms hold gross derivatives position and do international trade; “FX, Trade & FC debt”: firms hold gross derivatives position, do international trade and have foreign currency debt; “FX & FC debt”: firms hold gross derivatives position and foreign currency debt; “FX (all)”: firms which hold gross derivatives positions independently of their trade and debt status. “NER” is the nominal exchange rate pesos per U.S. dollar. The correlation of the nominal exchange rate with the gross derivative position is 20%** for FX (all), 26%** for FX, Trade and & FC debt, −4% for FX & Trade , −5% for FX & FC debt and 17%** for FX only, where ***, **, * denote statistical significant at 1, 5, 10 percent level.

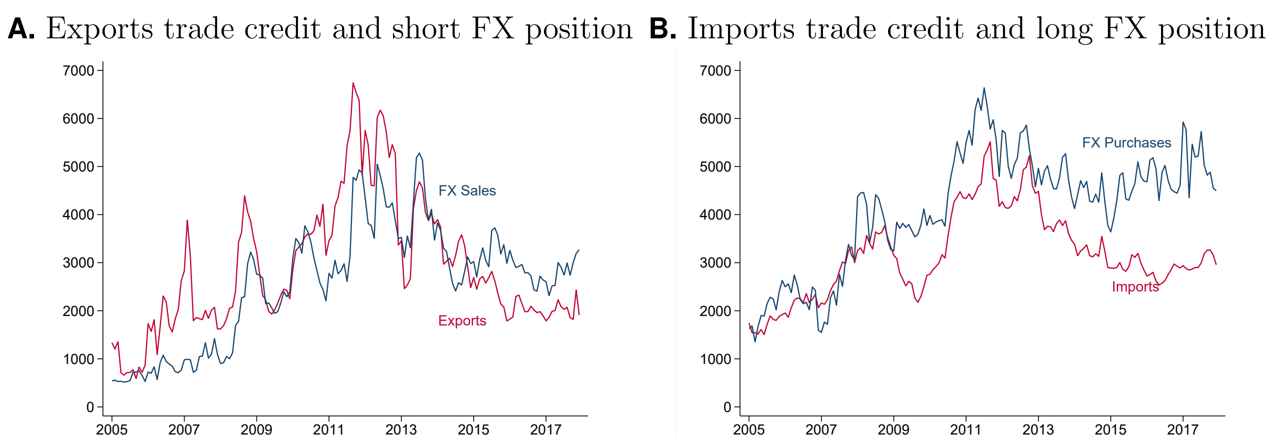


Figure A.5: Trade Credit balances related to international trade and FX gross derivatives positions

Note.— In millions of dollars. Red lines represent the end-of-month accounts receivable from trade credit from exports, and accounts payable from trade credit from imports. Blue lines represent the end-of-month gross FX positions. This figure includes MNC and mining firms. The correlation between FX sales and exports is 68% and the correlation between FX purchases and imports is 79%.

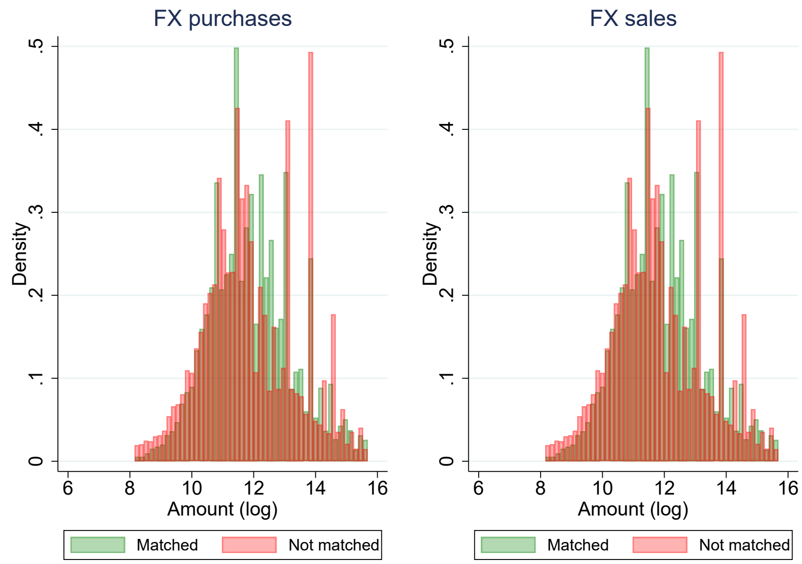


Figure A.6: Matching of FX derivatives to international trade by amount size of FX contract

Notes.— This figure shows the histograms of transaction-level matched data between FX derivatives contract and Imports/Exports transactions (only FX), at the firm, maturity date, amount level. The horizontal axis is the size of the transaction of FX derivatives. This exercise uses firms which participate in international trade and the FX derivatives market, but hold no foreign debt.

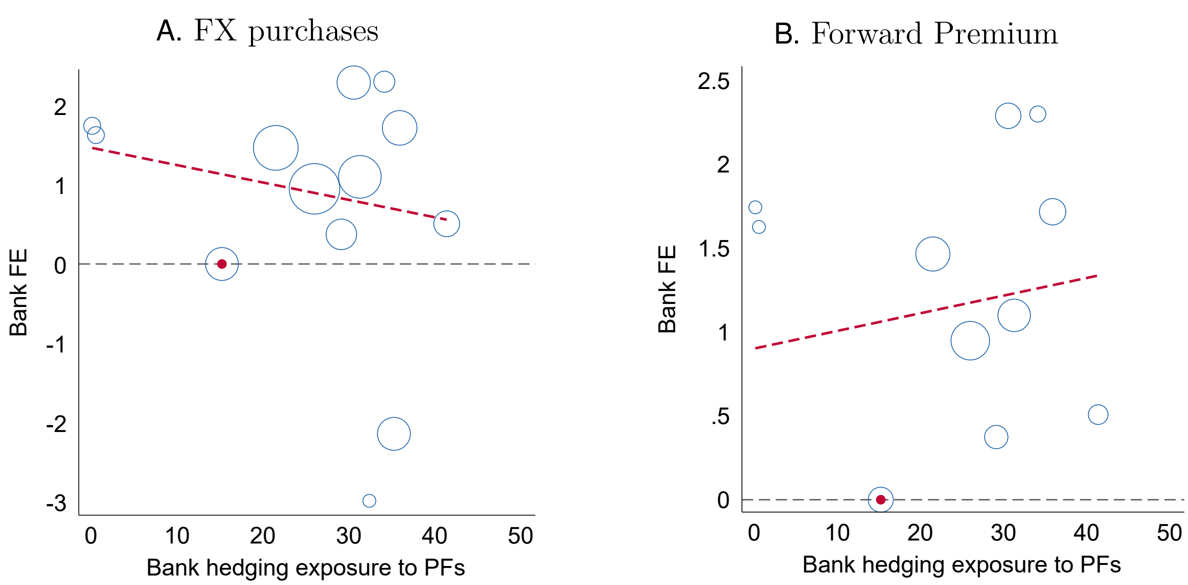


Figure A.7: Estimated supply shock in FX Premium and PFs in Banks' total FX purchases

Note.— Vertical axis shows estimated bank fixed effects from equation (8), with dependent variable change in FX premium and the horizontal axis shows Pension Funds' share in each bank's total purchases of FX derivatives before the regulation change. Size of each circle represents share of bank in total purchases of FX derivatives from banks by firms. Red dashed line represents weighted linear fit.

A.2 Additional Tables

Table A.1: Natural hedging – Robustness

A. Flows maturing in the same period

Dependent variable: (log) Cash flows of exports trade credit at maturity, X^{CF}						
	(1)	(2)	(3)	(4)	(5)	(6)
M^{CF}	0.022**	0.022**	0.025***			
	(0.008)	(0.008)	(0.007)			
M^{CF}+FCD^{CF}						
$M^{CF}\times$ 1(Trade Only)				0.054***	0.049***	0.055***
				(0.015)	(0.013)	(0.012)
$M^{CF}\times$ 1(Trade and FX)				0.068***	0.076***	0.082***
				(0.015)	(0.017)	(0.016)
$M^{CF}\times$ 1(Trade and FCD)				0.091***	0.074***	0.067***
				(0.026)	(0.021)	(0.017)
$M^{CF}\times$ 1(Trade and FX and FCD)				0.054*	0.084***	0.070***
				(0.025)	(0.015)	(0.013)
Observations	1618731	1618935	1822152	202785	202786	230217
R Squared	0.85	0.85	0.85	0.91	0.91	0.90
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	Yes	Yes	Yes	Yes
X > 0 and M > 0	-	-	-	Yes	Yes	Yes
Includes Swaps	-	Yes	Yes	-	Yes	Yes
All Currencies	-	-	Yes	-	-	Yes

B. Outstanding stocks

Dependent variable: (log) exports trade credit, X^{TC}						
	(1)	(2)	(3)	(4)	(5)	(6)
M^{TC}	0.017**	0.017*	0.021**			
	(0.008)	(0.008)	(0.008)			
M^{TC}+FCD						
$M^{TC}\times$ 1(Trade Only)				0.041***	0.039**	0.053***
				(0.015)	(0.015)	(0.014)
$M^{TC}\times$ 1(Trade and FX)				0.052***	0.057***	0.069***
				(0.016)	(0.017)	(0.016)
$M^{TC}\times$ 1(Trade and FCD)				0.114***	0.092**	0.105***
				(0.039)	(0.029)	(0.027)
$M^{TC}\times$ 1(Trade and FX and FCD)				0.075***	0.100**	0.109***
				(0.018)	(0.031)	(0.028)
Observations	1470485	1470485	1652039	192871	192871	219168
R Squared	0.88	0.88	0.88	0.93	0.93	0.93
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	Yes	Yes	Yes	Yes
X > 0 and M > 0	-	-	-	Yes	Yes	Yes
Includes Swaps	-	Yes	Yes	-	Yes	Yes
All Currencies	-	-	Yes	-	-	Yes

Note.— Clustered standard errors at the firm level reported in parentheses. All regressions include firm FE and year-industry FE. Notation: M^{TC} stands for (log) imports trade credit; X^{TC} for (log) exports trade credit; **1**(FCD) indicator for firms with positive foreign debt; **1**(Trade) for firms in international trade; **1**(FX) for firms with positive FX derivatives; M^{CF} (X^{CF}) for cash flows from imports (exports) trade credit maturing in month m; and FCD^{CF} for cash flows from foreign debt maturing in month m. Depending on the column sample considers swaps and other currencies different from the US dollar.

Table A.2: Natural hedging – Robustness, Quarterly

A. Flows maturing in the same period

Dependent variable: (log) Cash flows of exports trade credit at maturity, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
M^{CF}	0.028***	0.023***					
	(0.007)	(0.005)					
M^{CF}+FCD^{CF}			0.014***				
			(0.004)				
$M^{CF}\times$1(Trade Only)				0.020**	0.024***	0.019***	0.048***
				(0.008)	(0.008)	(0.005)	(0.013)
$M^{CF}\times$1(Trade and FX)				0.029***	0.035***	0.030***	0.064***
				(0.008)	(0.007)	(0.006)	(0.012)
$M^{CF}\times$1(Trade and FCD)				0.058***	0.051***	0.044***	0.090***
				(0.016)	(0.014)	(0.014)	(0.020)
$M^{CF}\times$1(Trade and FX and FCD)				0.025+	0.013	0.020	0.050*
				(0.016)	(0.016)	(0.016)	(0.026)
Observations	539866	535335	535335	541668	539866	535335	64936
R Squared	0.86	0.83	0.83	0.86	0.77	0.83	0.88
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IndustryxYear FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	-	-	-	Yes	-	-	-
Include Mining	Yes	-	-	Yes	Yes	-	-
X > 0 and M > 0	-	-	-	-	-	-	Yes

B. Outstanding stocks

Dependent variable: (log) exports trade credit, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
M^{TC}	0.022***	0.022***					
	(0.007)	(0.006)					
M^{TC}+FCD^{CF}			0.027***				
			(0.006)				
$M^{TC}\times$1(Trade Only)				0.008	0.016**	0.017***	0.034**
				(0.008)	(0.007)	(0.006)	(0.014)
$M^{TC}\times$1(Trade and FX)				0.018**	0.023***	0.023***	0.042***
				(0.008)	(0.007)	(0.007)	(0.016)
$M^{TC}\times$1(Trade and FCD)				0.066***	0.070***	0.049***	0.081***
				(0.024)	(0.027)	(0.019)	(0.031)
$M^{TC}\times$1(Trade and FX and FCD)				0.040*	0.059***	0.059***	0.063***
				(0.022)	(0.019)	(0.019)	(0.017)
Observations	488958	484470	484470	490726	488958	484470	61814
R Squared	0.88	0.87	0.87	0.88	0.88	0.87	0.91
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IndustryxYear FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include MNC	-	-	-	Yes	-	-	-
Include Mining	Yes	-	-	Yes	Yes	-	-
X > 0 and M > 0	-	-	-	-	-	-	Yes

Note.— Clustered standard errors at the firm level reported in parentheses. All regressions include firm FE and year-industry FE. Notation: M^{TC} stands for (log) imports trade credit; X^{TC} for (log) exports trade credit; **1**(FCD) indicator for firms with positive foreign debt; **1**(Trade) for firms in international trade; **1**(FX) for firms with positive FX derivatives; M^{CF} (X^{CF}) for cash flows from imports (exports) trade credit maturing in quarter q; and FCD^{CF} for cash flows from foreign debt maturing in quarter q.

Table A.3: Use of FX derivatives – Extensive margin (Robustness)

Dependent variable 1(firm uses FX derivatives)			
	(1)	(2)	(3)
X^{TC}	0.019***	0.021***	0.023***
	(0.004)	(0.004)	(0.004)
M^{TC}	0.057***	0.050***	0.049***
	(0.005)	(0.005)	(0.005)
FCD	-0.007	-0.005	-0.002
	(0.005)	(0.006)	(0.006)
$X^{TC} \times M^{TC}$	-0.007*	-0.007*	-0.007**
	(0.003)	(0.003)	(0.003)
$X^{TC} \times FCD$	-0.000	-0.001	-0.000
	(0.002)	(0.002)	(0.002)
$M^{TC} \times FCD$	-0.006*	-0.005*	-0.004
	(0.003)	(0.002)	(0.002)
Observations	2,296,913	2,307,470	2,537,888
R Squared	0.53	0.57	0.57
Firm FE	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes
Includes MNC	Yes	Yes	Yes
Includes Mining	Yes	Yes	Yes
Includes Swaps	-	Yes	Yes
All Currencies	-	-	Yes

Notes.— All independent variables in logs. All regressions include firm level FE. X^{TC} stands for exports trade credit, M^{TC} for imports trade credit, and FCD for the outstanding stock in foreign debt. Constant terms are not reported. Clustered standard errors at the firm level reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table A.4: Use of FX derivatives – Intensive margin (Robustness, Debt)

	(1)	(2)	(3)	(4)
M^{TC}	0.145***	0.145***	0.141***	0.141***
	(0.016)	(0.016)	(0.017)	(0.017)
FCD	0.001		0.032	
	(0.012)		(0.020)	
X^{TC} by imp.	-0.001	-0.001	0.002	0.001
	(0.009)	(0.008)	(0.009)	(0.009)
X^{TC} by non-imp.	-0.005	-0.005	-0.001	-0.001
	(0.006)	(0.006)	(0.007)	(0.007)
FCD, up to 6 months		0.008		0.019
		(0.012)		(0.015)
FCD, 7 to 1 year		0.017		0.029*
		(0.014)		(0.017)
FCD, 1 to 2 years		0.021		0.028
		(0.017)		(0.020)
FCD, more than 2 years		0.003		0.039*
		(0.012)		(0.021)
Observations	2112240	2112240	2121848	2121848
R Squared Fe	0.65	0.65	0.69	0.69
Firm FE	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes
Includes MNC	Yes	Yes	Yes	Yes
Includes Mining	Yes	Yes	Yes	Yes
Includes Swaps	-	-	Yes	Yes

Notes.— All regressors in logs. Supra-index TC stands for trade credit. All regressions include firm, year -industry fixed effects. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

Table A.5: Use of FX derivatives – Intensive margin (Robustness)

A. Sales of FX derivatives

	(1)	(2)	(3)
X^{TC}	0.033***	0.037***	0.046***
	(0.009)	(0.011)	(0.011)
M^{TC}			
FCD	-0.012	-0.014	-0.009
	(0.011)	(0.015)	(0.015)
M^{TC} by exp.	0.027**	0.030*	0.040**
	(0.010)	(0.013)	(0.014)
M^{TC} by non-exp.	0.006	0.011	0.020
	(0.008)	(0.011)	(0.011)
Observations	2,296,913	2,307,470	2,537,888
R Squared	0.53	0.62	0.62
Firm FE	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes
Includes MNC	Yes	Yes	Yes
Includes Mining	Yes	Yes	Yes
Includes Swaps	-	Yes	Yes
All Currencies	-	-	Yes

B. Purchases of FX derivatives

	(1)	(2)	(3)
X^{TC}			
M^{TC}	0.146***	0.141***	0.130***
	(0.015)	(0.017)	(0.015)
FCD	-0.001	0.034	0.041*
	(0.011)	(0.020)	(0.019)
X^{TC} by imp.	0.001	0.002	0.001
	(0.008)	(0.009)	(0.008)
X^{TC} by non-imp.	-0.003	-0.000	0.003
	(0.006)	(0.007)	(0.06)
Observations	2,296,913	2,307,470	2,537,888
R Squared	0.65	0.69	0.69
Firm FE	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes
Includes MNC	Yes	Yes	Yes
Includes Mining	Yes	Yes	Yes
Includes Swaps	-	Yes	Yes
All Currencies	-	-	Yes

Notes.— All regressors in logs. Supra-index TC stands for trade credit. All regressions include firm, year -industry fixed effects. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table A.6: Use of FX derivatives – Robustness (Coincidence and Complexity)

	FX=1(firm uses FX derivatives)		Sales FX derivatives		Purchases FX derivatives	
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.009	0.006	0.049***	0.044***	-0.003	-0.018
	(0.007)	(0.007)	(0.016)	(0.016)	(0.015)	(0.017)
M^{TC}	0.036***	0.031***	-0.001	0.012	0.160***	0.136***
	(0.008)	(0.008)	(0.014)	(0.017)	(0.025)	(0.029)
FCD	-0.007	-0.008	0.016	-0.001	0.017	0.009
	(0.007)	(0.006)	(0.028)	(0.022)	(0.032)	(0.025)
Coincidence	-0.019***	-0.018***	0.003	0.006	-0.025***	-0.021***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.008)
# Currency, Imp.	0.010	0.008	-0.003	-0.001	0.012	0.013
	(0.007)	(0.007)	(0.013)	(0.013)	(0.016)	(0.016)
# Currency, Exp.	0.013	0.015	0.041	0.049*	0.022	0.020
	(0.011)	(0.011)	(0.028)	(0.028)	(0.021)	(0.023)
# Country, Imp.	0.009+	0.006	0.015	0.007	0.002	-0.006
	(0.006)	(0.006)	(0.010)	(0.011)	(0.009)	(0.011)
# Country, Exp.	0.010**	0.011**	0.016**	0.016**	0.012	0.014+
	(0.005)	(0.005)	(0.007)	(0.007)	(0.009)	(0.009)
Observations	194,740	202,436	194,740	202,436	194,740	202,436
R Squared Fe	0.55	0.55	0.18	0.18	0.30	0.30
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	–	Yes	–	Yes	–	Yes
Includes Mining	–	Yes	–	Yes	–	Yes

Notes.— All regressors in logs. Supra-index TC stands for trade credit. All regressions include firm, year -industry fixed effects. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table A.7: Limit for the non-hedged share of Pension Funds portfolio in international assets

	Fund				
Effective from	**A**	**B**	**C**	**D**	**E**
Regulation before 2012	50%	40%	35%	25%	15%
December 2012	50% of investment-grade portfolio, by currency denomination if such currency represents more than 1% of the Fund				

Source: Chilean Pensions Supervisor.

Table A.8: Pension Funds FX gross short positions (millions of $)

	2013-March	2013-June	2013-Dec	June-March	Dec-June
7-30 days	201,217	242,606	154,243	41,389	-88,363
31-60 days	77,563	91,953	100,735	14,390	8,782
61-90 days	29,602	18,841	38,230	-10,761	19,389
91-120 days	38,075	25,168	27,958	-12,907	2,790
121 days-1 yr	67,586	45,978	132,499	-21,609	86,521
1 yr+	26,970	30,758	41,387	3,788	10,629
Total	441,012	455,303	495,050	14,291	39,747

Notes: Includes only forwards. FX gross derivatives positions.

Table A.9: Banks' sales of FX-derivatives to firms: supply side

Outstanding FX-derivatives (includes swaps) purchases by firms				
	All firms		Firms in trade	
	(1)	(2)	(3)	(4)
	β_{bt}	Cum. share	β_{bt}	Cum. share
Bank 1	-2.662***	—	-2.811***	—
	(0.653)		(0.618)	
Bank 2	-1.128***	—	-1.100***	—
	(0.180)		(0.322)	
Bank 3	-0.793**	—	-1.701**	—
	(0.313)		(0.617)	
Bank 4	-0.747***	—	-0.809***	—
	(0.046)		(0.051)	
Bank 5	-0.715***	0.49	-0.844***	0.43
	(0.074)		(0.099)	
Bank 6	-0.693***	—	-0.475**	—
	(0.132)		(0.153)	
Bank 7	-0.450***	—	-0.719***	—
	(0.070)		(0.061)	
Bank 8	-0.326***	—	-0.490***	—
	(0.099)		(0.101)	
Bank 9	-0.317**	—	-0.362*	—
	(0.131)		(0.169)	
Bank 10	-0.280***	—	-0.325***	—
	(0.085)		(0.084)	
Bank 11	-0.172*	0.98	-0.236*	0.95
	(0.089)		(0.121)	
Bank 12	-0.021	1.00	-0.103	1.00
	(0.118)		(0.148)	
Obs.	744		630	
R squared	0.42		0.45	

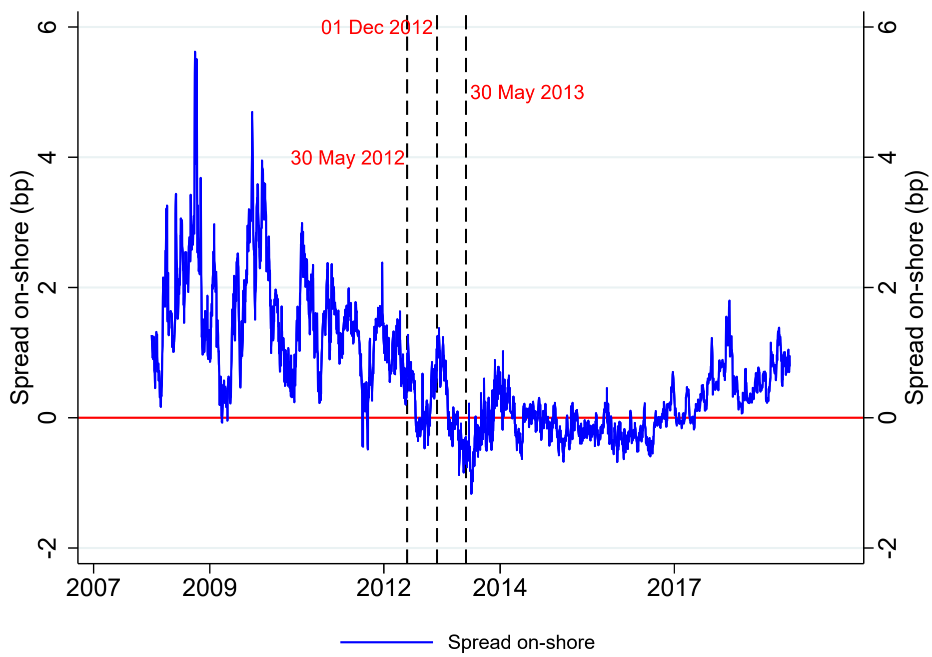
Note.— Table shows bank fixed effects $\beta_{b,t}$ in columns 1 and 3, and cumulative share in total sales of FX derivatives to firms by banks in columns 2 and 4. The order of banks does not necessarily correspond to that in Table 10. Banks are ordered according to the sign and size of the estimated coefficient; from most to least negative. Cumulative shares are not shown on a by-bank basis to protect confidentiality of their identity. Market share excludes investment banks and our choice of base bank. Clustered standard errors at the bank level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.3 CIP Violation around PF's change in regulation

Consider the Covered Interest Rate parity (CIP) arbitrage equation, with room for potential deviations as in Morales and Vergara (2017)[25]

$$(1 + i^*_{t,n} + x_{t,n}) = (1 + i_{t,n}) \times \frac{S_t}{F_{t+n}} \tag{10}$$

where $i^*_{t,t+n}$ and $i_{t,t+n}$ correspond to the n-year risk-free interest rates quoted at date t in U.S. dollars and Chilean pesos, respectively. Also, denote S_t the spot exchange rate, and $F_{t,t+n}$ the n-year outright forward exchange rate signed in t. Finally, denote by $x_{t,n}$ the measure of CIP deviation, i.e. the on-shore spread (Morales and Vergara, 2017). In particular, for the domestic rate, we use the 3-month prime deposit rate, and for the foreign rate, the 3-month libor rate.



Note.— On-shore spread ($x_{t,t+n}$) shown in basis points (10).

[25] Alternatively, an intimately related notion of CIP deviation is the cross-currency basis defined in Du et al. (2018*b*): $e^{ni^*_{t,t+n}} = e^{ni_{t,t+n}+nx_{t,t+n}} \frac{S_t}{F_{t,t+n}}$, which apart from the continuous compounding is only different from the equation (25) in that it considers the deviation with respect to the local rate instead to the foreign rate.

A.4 A Stylized Model of Market Thickness

In this section, we develop a simple model to illustrate how market liquidity is key for the FX derivatives market. Notably, this is not a theory of optimal hedging, but a stylized matching model which illustrates how the regulatory change we explore in Section 4 affected both, buyers' and sellers' (other than PFs) decisions to engage in financial hedging. This model builds on the stylized facts found in Section 3 that natural hedging is limited (Fact 1), buyers of FX derivatives are usually importers, and sellers are usually exporters (Fact 3) .

Hence, in this stylized model we consider a buyer of FX derivatives (usually an importer with trade credit exposure or a borrower in foreign currency), a financial intermediary which acts as market maker (usually a bank), and sellers of FX derivatives (usually an exporter with trade credit exposure, or Pension Funds). Figure A.8 displays the interaction between these agents. Notably, a firm may be both a seller and a buyer of FX derivatives, as firms hedge their gross, not net, positions (Fact 3).

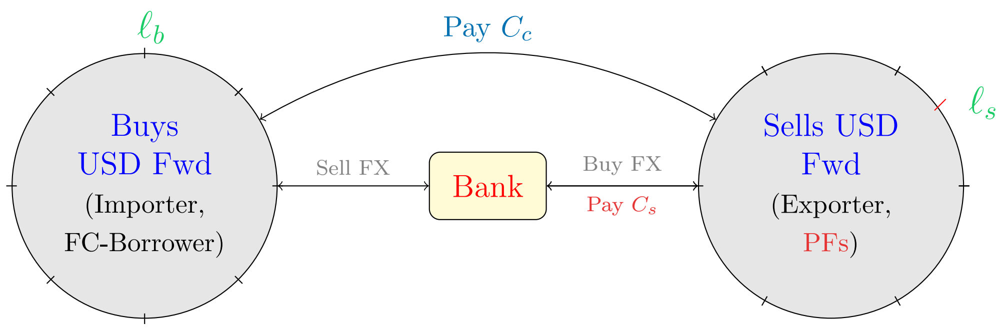


Figure A.8: OTC intermediation in FX derivatives market

Consider an importer with trade credit exposure, and hence a hedging need with indexed by ℓ_b, which summarize different contract characteristics (maturity,currency, etc.). The index ℓ_b is modelled as a random realization in the unitary circle on the left. If the importer firm hedges its currency risk buying a FX derivative from the bank, it gets a surplus

$$s_j^M = (\bar{s} - \underline{s})\varphi_j^M, \qquad \varphi_j^M \sim U(0,1) \tag{11}$$

where $\bar{s}, \underline{s}$ define a support for the benefits of hedging, and φ_j^M indexes firms by the gains from hedging and allows us to speak about the number of firms who decide to engage in financial hedging. The bank supplying the FX derivative is assumed to get a fixed fee $\omega^M < \underline{s}$. The bank can bear the currency risk implied in this contract at a cost. Hence, it will try to offset the original exposure buying a FX derivative to exporters of PFs. Bank pays a search cost f_S which allows it to observe the number of agents willing to sell a FX derivative n^X, and the fact that they are equi-spaced in the unitary circle. The bank, however, does not observe the exact position of the closest FX derivatives seller ℓ_s. If $\ell_b \neq \ell_s$ (with respect to an arbitrary but common zero), then the bank bears a cost that is proportional to the distance $z = |\ell_p - \ell_s|$, μz. We can think this proportional cost μz as the residual currency risk which banks tend to avoid if they can. Hence, a bank will only sell FX derivatives to an importer if this distance is small enough relative to the benefit ω^M.

Then, conditional on selling a FX derivative to importer-j, the bank makes positive profit from this contract if $\omega^M \geq \mu z$, which immediately defines a threshold distance (residual mismatch)

$$z^* = \frac{\omega^M}{\mu}$$

below which the bank always makes positive profits. Also, from the fact that the n^X sellers of FX derivatives are equi-spaced in the unitary circle, the bank knows that $z \sim U(0, \frac{1}{2n^X})$ and hence, it knows that if it decided to take on ℓ^b it will be ale to match it with probability $p = 2n^X \frac{\omega^M}{\mu}$. Notably, the probability of finding a matching exposure in the sellers' market is a function of the number of participants (contracts by exporters and PFs) in such market. We refer to this notion as "market thickness".

Further assume that importer-j pays a small entry fee f_E to participate in the FX derivatives market, and a cost $C_N > f_E$ should instead it decide to engage in natural hedging. Then, the expected profits of the importer from using FX derivatives are given by,

$$E(\pi_j^M | FX) = \left(2n^X \frac{\omega^M}{\mu}\right)(s_j^M - \omega^M) - f_E \tag{12}$$

while the profits of engaging in natural hedging are $E(\pi_j^M | NH) = s_j^M - C_N$. Then, we can characterize firms buying FX derivatives as those with $s_j^M \geq s^{M*}$, with

$$s^{M*} = \frac{f_E - C_N + 2n^X \frac{(\omega^M)^2}{\mu}}{2n^X \frac{\omega^M}{\mu} - 1} \tag{13}$$

with,

$$s^{M*} = \varphi^{M*}(\bar{s} - \underline{s})$$

where threshold φ^{M*}, together with $\varphi_j^M \sim U(0,1)$ helps us pin down the fraction $(1 - \varphi^{M*})$ of firms, from the total pool N^M (which we normalize to one) who buy FX derivatives, n^M. By symmetry we can also define s^{X*},

$$s^{X*} = \frac{f_E - C_N + 2n^M \frac{(\omega^X)^2}{\mu}}{2n^M \frac{\omega^X}{\mu} - 1} \tag{14}$$

where n^M is the number of importers in the buyers' market, and ω^X is the fixed fee banks charge to exporters for selling them FX derivatives. For given values of entry cost, natural hedging cost, bank fee and mismatch cost, (13) and (14) pin down n^X and n^M.

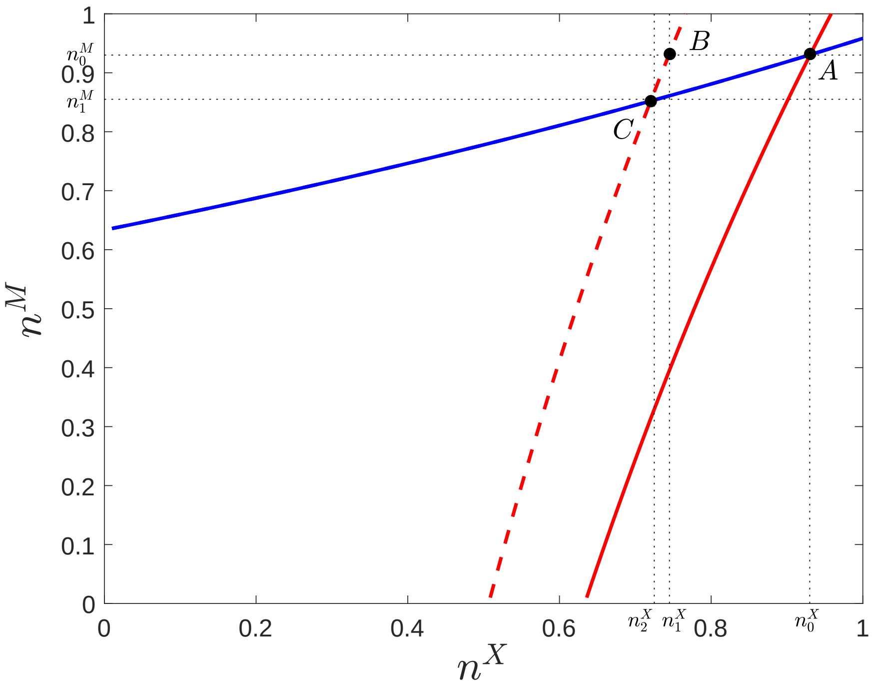


Figure A.9: Market thickness

Note.— This figure shows the joint determination of entrants in the OTC FX derivatives market. Blue line represents equation (13), red line represents equation (14), dashed red line represents (14) with a negative shock to the mass of the FX derivatives sellers.

So far, it is clear that the thickness in the counterparty market directly affects the probability of a firm engaging in financial hedging. That is, the thickness in the market of sellers of forward-dollars—the availability and heterogeneity of different currency/maturity contracts—affects the probability that a forward-dollar-buyer firm, who is assumed to pay an entry cost, engages in financial hedging. The same is true for sellers of FX derivatives about the market thickness in the buyers of forward dollars. The interplay of equilibrium conditions (13) and (13) (in blue and red respectively) is depicted in Figure A.9, where the intersection point A defines equilibrium market thicknesses $(n_0^X, n_0^M))$.

The regulatory change examined in Section 4 can be interpreted in this model as an exogenous decrease in market thickness in the sellers market, $n_0^X - n_1^X$, or going from point A to point B. By Equation (13) we know that the number of buyer firms will decrease (for sensible parameterization). What our stylized model highlights is that this decrease in the market thickness of buyers of FX derivatives results in further decrease in the market thickness of sellers of FX derivatives, beyond the initial drop due to the absence of Pension Funds' sell of short positions. This extra drop in market thickness can be seen in the figure as the distance $n_1^X - n_2^X$. This, in turn, is in line with the evidence in Table 12, column 3, which shows a negative coefficient for the sales of FX derivatives after a supply shock to this market.