Currency Hedging in Emerging Markets: Managing Cash Flow Exposure*

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Abstract

Foreign currency derivative markets are among the largest markets in the world, yet their role in emerging markets in particular, 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 2003, together with firm-level information on sales, international trade, trade credits, and debt. We uncover four stylized facts: (i) natural hedging of currency risk is limited, (ii) financial hedging is more likely to be used by larger firms, (iii) firms in international trade are more likely to use FX derivatives to hedge their gross (rather than net) cash currency risk, and (iv) firms are more likely to pay larger premiums for longer maturity contracts. We then use a policy reform to study the role of financial intermediaries in affecting the dynamics of the forward exchange rate markets. We show that a negative supply shock -reducing the liquidity of FX derivatives to firms- lowers firms use of FX derivatives and increases the forward premium.

Keywords: Foreign currency hedging, FX derivatives, cash flow, foreign currency debt, currency mismatch, trade credit.
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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 systemic 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 has seen an impressive development over the last decades becoming one of the largest financial markets in the world. 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, and the financial markets in general, 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 new facts about firm's use of FX derivatives in EMEs. 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. 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 tend to hedge larger amounts and pay extra for 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.

We study firms' use of foreign currency hedging instruments by employing a unique data-set 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 OTC –over the counter– in Chile over this period (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 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 financial 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

[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.

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 foreign-currency future claims and liabilities are only slightly correlated, suggesting that firms do not match these cash flows in foreign currency to be "naturally hedged". The correlation exports and imports trade credit, for example, is only 2%. Our data indicates that the median maturity of trade credit from imports is 86 days, while it is 186 days for trade credit from exports.[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 median maturity of foreign debt is about 2.5 years longer than the median maturity of exports. We then explore firms' use of derivatives both at the extensive and intensive margin.

Second, we document that firms that employ FX derivatives are larger (in employment, sales, debt, export and imports) and find that firms in international trade, and who use trade credits, 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 and year and industry fixed effects interacted, and excluding multinational firms and the mining sector.Exploiting the transaction level information of our data. We find that larger transactions (exposures) from trade credit are more likely to be hedged compared to smaller ones, suggesting that engaging in a financial contract also involves a fixed cost.

Third, at the intensive margin, we document that firms tend not to hedge net trade credit by using FX derivatives, but instead hedge their gross trade position in exports and imports. 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 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 (Shapiro, 1996) 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 explore the role of Pension Funds hedging requirements and study if (and how) lower liquidity in the FX derivatives market can affect non-financial firms hedging policies. Our analysis focuses on the role played by the largest institutional investor in Chile; Pension Funds (PFs) and how their hedging choices and constraints shape the market. In particular, we study a change to Pension Funds hedging requirements regulation, argue that it operated as a negative supply

[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 median trade credit for imports with banks is 120 days, whilst it is 259 days for exports.

shock which (through banks) resulted in less financial hedging by firms with opposite demanded FX exposure (importers).[4]

We document that this policy critically affected importers and foreign currency debt holders, as they reduced their outstanding long FX derivatives positions by 46% within a year. We then show that this reduction was more pronounced for short-term instruments with maturity less than six months. A back of the envelop calculation indicates that the fall in the flow of contracted FX derivatives – 4 billion USD – was in magnitude equal to 75% of Chilean imports. These facts suggest that the liquidity of the FX derivative market can substantially affect firms' hedging policy and, as a result, their resilience to exchange rate volatility. At the extensive and intensive margins, the share of firms participating in the FX derivative market and overall hedging activity were reduced. On the aggregate, our empirical results suggest that economies with less liquid FX derivative markets offer firms less ability to hedge the currency risk and, thus, are more exposed to systemic risk given the limitations of natural hedging.

Related Literature.

Our paper relates to the literature studying firms' hedging motives. As shown by Smith and Stulz (1985) and Froot et al. (1993) (among others), from a theoretical perspective, hedging can add value to the firm because of the presence different types of capital market imperfections: 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. Most papers have relied on information of net positions of listed or multinational firms, or survey data for mostly developed economies. Our detailed data allows us to take the analysis one step further by studying granular information for the universe of firms in an emerging economy, and measure more accurately variables for which only proxies were available in previous studies. Our policy shock analysis allows us also to quantify the effects of market developments on individual firm's hedging decisions.

Our result that natural hedging is limited is related to Allayannis et al. (2001), who use financial statements of a sample of multinational US firms for 1996-98, to explore how good substitutes operational and financial hedging are. The authors conclude operational hedging, measured by geographic dispersion (number of countries/regions of operation), is not a good substitute for financial hedging. Our paper takes this result one step further, as we dig deeper in the notion of non-financial hedging by exploiting transaction level data of imports, exports, debt and FX derivatives. In particular, we measure accurately foreign currency cash flows and evaluate the extent of natural hedging to conclude it is limited.

Our paper –which uses all the firms in the economy – documents that firms that use FX derivatives are larger and hedging is partial, which points in the direction of (but not restricted) 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 (2018). Our findings are also consistent with Geczy et al. (1997) who use 372 Fortune-500 firms with ex-ante foreign currency exposure. These authors argue that there are economies of scale in implementing and maintaining risk management programs within the firm, as firms who have used other type of derivatives are more likely to later use FX-derivatives.

[4]In December 2012, the Central Bank of Chile relaxed Pension Funds' (PFs[5]) requirement to hedge their currency risk and allowed them to hold a larger fraction of their foreign asset portfolio without FX hedge. As result, pension funds lowered their short positions in foreign currency forward and reduced their supply of foreign currency forward to firms.

Our results also relate to the empirical literature that 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) in Germany; Brazil, Rossi-Júnior (2012); Chile, Miguel (2016), Colombia, Alfonso-Corredor (2018)), and Mexico, Stein et al. (2021) among others). Our detailed data allows documenting that even firms with international trade and debt exposure do not fully exploit natural hedges and firms use financial derivatives to partially hedge gross positions.

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.[6] The disagreement in timing between payables and receivables in foreign currency, and their interaction with domestic currency obligations, opens for firms the need to use financial hedges of 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, and Liao and Zhang (2020) who study institutional investors' hedging choices and how they affect spot and forward exchange rates. 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.[7]

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 (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,

[6] An additional finding is that firms turn foreign currency exposure into local currency but keep their transactions in USD probably motivated by use of the dollar as unit of account/network-liquidity effects.

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

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. For every contract we observe the following characteristics: 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.

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, and foreign direct investment, for years 2003-2018 for around 900 to 1600 firms, –depending on the specific year–, RUT, currency denomination, maturity, interest rate, and coupon payments. Local currency debt is obtained from the credit registry.

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 (month), 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). This last piece of information is key for our analysis, as trade credit represents an asset (accounts receivable) or a liability (accounts payable) which exposes the cash flow of the firm to exchange rate volatility. Notably, we observe many aspects about trade credit: who is financing the credit and the maturity of operations.

4. **Balance sheet data:** We use firm-level yearly information from the Chilean Tax Authority ("Servicio de Impuestos Internos", SII). In particular, RUT, sales (bracket), number of workers, address, economic activity, and age.

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.[8] Firms' outstanding gross FX derivative positions reaches nowadays 15% of GDP. In Panel A in Table 1 we report the market activity for 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 (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 thereafter simple name them as firms.

[8]Our data contains financial and non-financial firms. Unless stated differently we will hereafter loosely refer to non-financial firms when we use the term "firms".

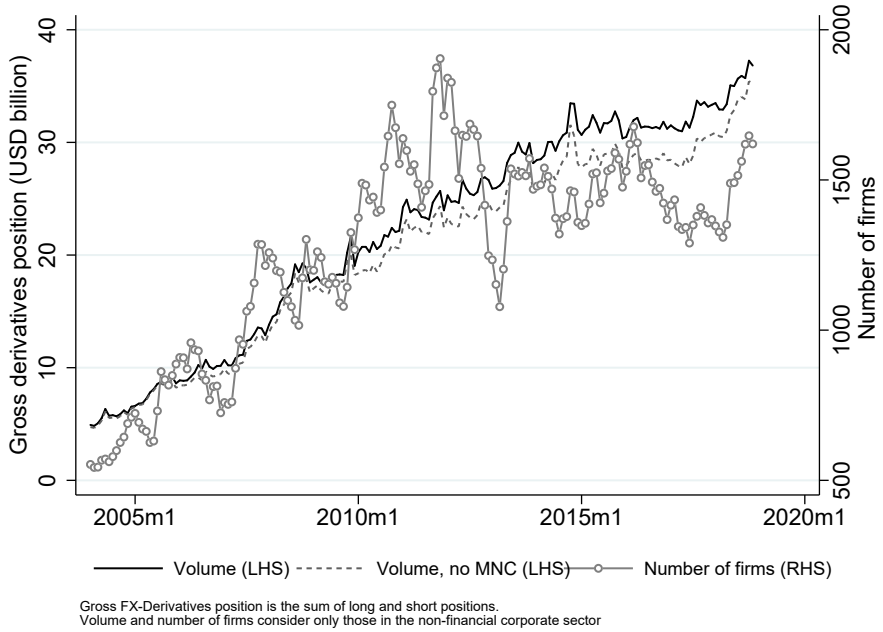

Figure 1: Number of firms and gross FX Derivatives positions

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 which hold positive stocks of FX derivatives.

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%).[9] We show in Appendix A 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 represent more than 90% of long and short FX positions in 2016. In our main specification, we exclude MNCs, as these firms could use FX derivatives to hedge the value of dividends in foreign currency, to hedge translation exposure, and their subsidiaries or headquarters abroad may undertake the financial hedging. To check the validity of our results, along the paper, we undertake several robustness with and without MNC. As mining sector accounts for an important share of Chilean exports, we realize robustness with and without the mining sector as well.

Beyond the granularity of the data, it is worth mentioning that Chile offers a good case to study due to the stability of its macroeconomic and institutional framework. Chile has shown a combination of responsible fiscal policy, freely floating exchange rate, and an inflation targeting regime implemented

[9] 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.

Table 1: Descriptive statistics FX derivatives contracts

A. By market

	All market					Non-Financial Firms				
Type	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)
Forwards	1,518,688	80.4	5630.0	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	0.0	1728.8	85.6	82.6
Call options	24,974	1.3	1436.4	159.2	91.6	21,414	3.0	716.1	164.4	91.2
Put options	15,677	0.8	1936.0	167.6	93.0	13,224	1.8	852.0	175.1	93.6
Swaps	502	0.0	7887.2	1382.4	74.3	234	0.0	6537.4	1690.6	56.8
FX swaps	271,427	14.4	12723.1	77.2	90.6	15,650	2.2	3901.7	77.7	37.0
CC Swaps	55,474	2.9	6505.3	1051.4	31.4	33,799	4.7	1566.6	684.8	5.5
Total	1,888,953	100.0	6,584.8	103.0	83.2	724,413	100.0	1,352.6	122.2	63.0

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

	Purchases					Sales				
Type	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)	Obs. (#)	Share (%)	Notional Median ($ 000)	Maturity Median (days)	Non-delivery (%)
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)
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	0.0	645.0	50.9	42.1
Call options	6,470	1.3	617.7	145.4	93.8	14,944	6.8	758.8	172.6	90.1
Put options	7,086	1.4	736.7	153.4	92.5	6,138	2.8	985.1	200.2	94.9
Swaps	141	0.0	7670.8	1839.6	61.7	93	0.0	4819.1	1464.8	49.5
FX swaps	11,810	2.3	4024.3	74.4	26.6	3,840	1.8	3524.6	88.1	69.0
CC Swaps	27,725	5.5	1120.0	635.9	2.7	6,074	2.8	3605.2	907.6	18.0
Total	505,676	100.0	1,360.9	113.5	54.7	218,737	100.0	1,333.5	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.

by an independent Central Bank (Albagli et al., 2020) for almost three decades.[10] 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).

[10]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.

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 receivables and payables 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.

(i) Outstanding positions and currency exposure. 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 study the correlation between the outstanding value of receivables and payables in foreign currency to check whether these flows are aligned. In our second exercise, we consider the maturity of the flows and check whether payables and receivables that mature at same period of time (month) are correlated. This second exercise is a more 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. 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 custom 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 monthly correlation between the value of outstanding import trade credit and outstanding export trade credit by using the following specification

$$X_{i,m}^{TC} = \alpha(M_{i,m}^{TC} + FCD_{i,m}) + \eta_i + \eta_{j,y} + \varepsilon_{i,m}, \tag{1}$$

where i, j, m and y denote firm, sector, month and year. $X_{i,m}^{TC}$ is the (log) outstanding exports trade credit and $M_{i,m}^{TC}$ is (log) outstanding imports trade credit held by firm i 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.[11] We cluster the standard errors at the firm level. The coefficient of interest is α, which captures the extend to which the value of payables and receivables in foreign currency are aligned. A value of α equal to one would imply full natural hedge, as all inflows and outflows in foreign currency would be highly correlated across time. Instead, α equal to zero would imply no correlation between these flows and no room for natural hedge.

[11] 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`.

Table 2: Natural hedging

A. Outstanding stocks

Dependent variable: (log) exports trade credit, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
M^{TC}	0.024**	0.023***					
	(0.008)	(0.006)					
$M^{TC} + FCD$			0.028***				
			(0.006)				
$M^{TC}\times$ 1(Trade Only)				0.009	0.016*	0.018**	0.036*
				(0.008)	(0.007)	(0.006)	(0.014)
$M^{TC}\times$ 1(Trade and FX)				0.022*	0.026***	0.025***	0.046**
				(0.008)	(0.008)	(0.007)	(0.015)
$M^{TC}\times$ 1(Trade and FCD)				0.052**	0.055**	0.051**	0.076*
				(0.018)	(0.019)	(0.019)	(0.031)
$M^{TC}\times$ 1(Trade and FX and FCD)				0.053*	0.072**	0.053**	0.068***
				(0.027)	(0.025)	(0.018)	(0.020)
Observations	1,367,449	1,354,886	1,354,886	1,372,486	1,367,449	1,354,886	173,820
R^2	0.0049	0.029	0.048	0.0034	0.0083	0.034	0.023
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. 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}	0.026***	0.022***					
	(0.008)	(0.005)					
$M^{CF} + FCD^{CF}$			0.020***				
			(0.005)				
$M^{CF}\times$ 1(Trade Only)				0.014	0.018**	0.017**	0.017**
				(0.008)	(0.007)	(0.005)	(0.005)
$M^{CF}\times$ 1(Trade and FX)				0.031**	0.037***	0.029***	0.029***
				(0.010)	(0.009)	(0.006)	(0.006)
$M^{CF}\times$ 1(Trade and FCD)				0.019	0.048**	0.039*	0.039*
				(0.017)	(0.016)	(0.016)	(0.016)
$M^{CF}\times$ 1(Trade and FX and FCD)				0.034***	0.034***	0.026**	0.026**
				(0.010)	(0.010)	(0.008)	(0.008)
Observations	1,484,735	1,472,050	1,472,050	1,489,806	1,484,735	1,472,050	1,472,050
R^2	0.0099	0.034	0.034	0.013	0.011	0.036	0.036
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.

Panel A of Table 2 presents the results. Column 1 presents a simple correlation between a firms' trade credit for export and imports. The estimated coefficient is statistically significant, but it is quantitatively very small. In particular, a one percent increase in imports trade-credit associates with only a 0.024% increase in 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. Importantly, the results do not change significantly when including foreign debt into the analysis. The estimated coefficient remains quantitatively very small and indicates that a one percent increase the value of foreign currency payables associates with only a 0.028% increase in the value of foreign currency receivables.

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 interactions 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 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 value of payables and receivables in foreign currency are only slightly correlated.

These regressions simply correlate the value of a firm's outstanding inflows and outflows in foreign currency, but they do not consider that these flows could imply different maturities and, hence, a firm might not be *in fact* naturally hedged even if outstanding values coincide. As an example, consider a firm that has the same value of import and export trade credits, but their maturity is 30 days and 180 days, respectively. Although the value of payables and receivables in foreign currency is equal, this firm would not be naturally hedged, as at the moment of paying back the imports trade credit (30 days), it would have not received the export trade credit (which would only be received after 180 days). This simple example shows that it is important to consider the different maturities of flows to assess whether a firm is in fact naturally hedged. With this end, we undertake a second exercise in which our variables of interest are cash-flows maturing in month t, and check the correlation between payables and receivables maturing in the same month. In particular, we re-estimate equation (1) by regressing the cash inflows maturing-in-t (from export trade credit: X^{CF}) on the cash outflows maturing-in-t (from imports trade credit and debt: $M^{CF} + FCD^{CF}$).

Results are presented in Panel B of Table 2. The estimated coefficients remain statistically significant, but as above, they are quantitatively very small. In particular, the coefficient in column 3—where both import trade credit and foreign currency debt are included—is 0.02 indicating that a one percent increase in a firm's payables in foreign currency maturing in the month t associates with a 0.02% increase in receivables in foreign currency in the same period. The estimated coefficients are similar in size across specifications.

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 opera-

tionally hedge the currency risk. Instead, these firms seems to be exposed to the currency risk, which – in turn – create room to use financial hedging. We assess below a potential reason that would explain this absence of natural hedging.

(ii) Maturity and the timing of flows. Last section showed that firms do not significantly engage in natural hedging. In this section, we consider a potential explanation: 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 management point of view—to align these flows. It is worth noting that this section does not aim to provide one conclusive explanation of why firms do not significantly engage in natural hedging. This 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.[12]

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

	Number of days					
	Mean	St. Dev.	p(10)	p(50)	p(90)	Num. Obs.
Imports trade credit	91	58	30	88	180	1,435,768
Exports trade credit	137	94	21	115	267	433,354
Foreign debt	1,375	1,291	90	1,099	2,880	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 further this idea, 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

$$CO_{i,m} = 2 \times \frac{\min\{X^{CF}_{i,m}, M^{CF}_{i,m}\}}{X^{CF}_{i,m} + M^{CF}_{i,m}}, \tag{2}$$

[12]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.

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 for exports and imports and, thus, lower is the natural hedge of the firm. Inversely, the higher $CO_{i,m}$ is, the higher the level of natural hedge. 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. 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 indicates that Chilean firms do not match their trade receivables and payables cash flows. Instead, it suggests that natural hedging is limited and firms are exposed to currency risk.

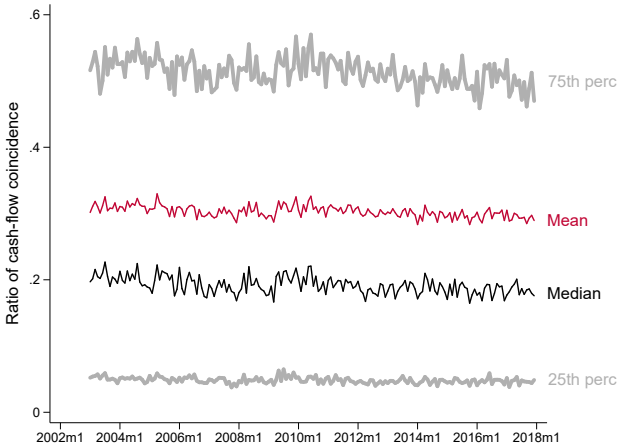

Figure 2: Coincidence of cash inflows and outflows from international trade credit

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 firms are exposed to the 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.

(i) 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). We document similar differences when restricting the comparison to firms that do not participate in international trade (Panel B), and 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.[13][14]

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

	2006			2016		
	Use FX	Not use FX	Δ	Use FX	Not use FX	Δ
A. Size: All firms						
Employment (workers)	4.34	2.75	1.59***	4.37	2.53	1.84***
Sales	2.48	1.14	1.34***	2.60	1.15	1.45***
B. Size: No trading firms						
Employment (workers)	3.51	1.76	1.75***	3.29	2.48	0.82***
Sales	1.89	0.71	1.18***	1.91	1.06	0.85***
C. Trading activity						
Imports	0.64	0.15	0.49***	0.59	0.11	0.48***
Exports	0.39	0.13	0.27***	0.29	0.09	0.20***
Exports, no-mining	0.36	0.11	0.25***	0.28	0.09	0.20***
Imports, no-mining	0.64	0.15	0.49***	0.60	0.11	0.49***
Imports, trade credit	0.62	0.14	0.48***	0.53	0.09	0.45***
Exports, trade credit	0.38	0.12	0.26***	0.27	0.08	0.19***
D. Financial Activity						
Foreign Debt	0.21	0.05	0.16***	0.20	0.03	0.16***

Notes.— All variables are expressed in logs. Employment is log of number of workers; sales and trading activity are log of millions of US dollars; foreign debt is log of millions of dollars. This table shows the difference in size (for several measures) between firms which have positive gross derivative positions and firms that do not. The Δ symbol denotes the difference between users and non-users of FX derivatives. Statistical significance H0: $\Delta = 0$: * p <0.1, ** p <0.05, *** p <0.01. Periods: 2006 and 2016.

(ii) 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. With this end, we match by 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 obtain a FX derivative to hedge a particular transaction. All we know is a firm's trade credit and its FX derivatives, but we do not know whether a FX derivatives contract x was purchased to hedge trade credit exposure y. We then rely on a matching procedure which we conduct, for comparability issues, on the sub-sample of

[13] 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 (2018) show that there is selection into foreign currency borrowing, as only high productivity firms employ this financing.

[14] Firms using FX derivatives typically engage in international trade and/or hold foreign debt, as we report in Figure A.4. Panel A plots the number of firms using FX derivatives by group of mutually exclusive firms (i.e. firms using 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) and shows that most firms using FX derivatives trade internationally. Panel B confirms this pattern by plotting the value of the FX outstanding position.

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.

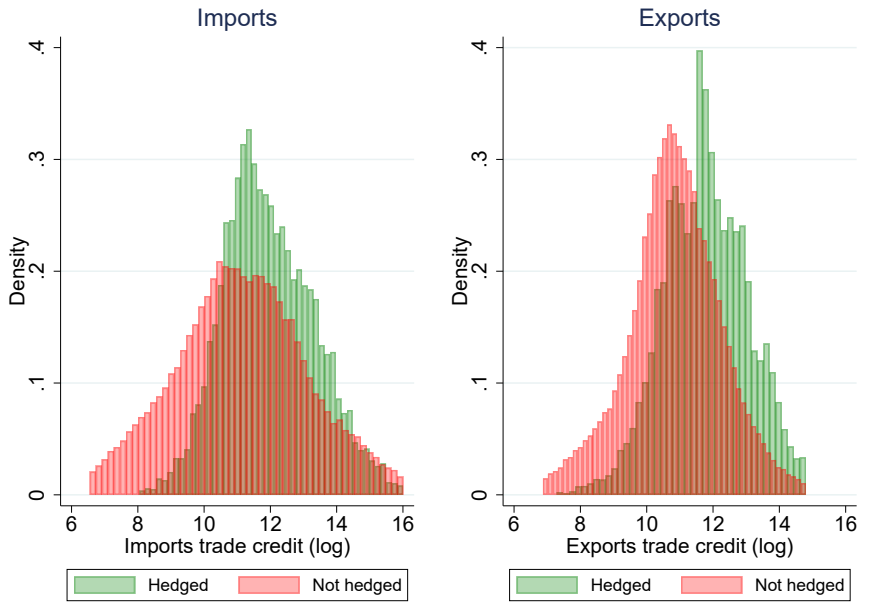

Figure 3: Hedging by amount size of trade credit contract

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.

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 differently, this figure suggests that imports and exports trade credit of smaller values are less likely to be hedged than larger value transactions. Additionally, in Figure A.6 we plot the histograms for the value of FX derivatives contracts —instead of trade credit—, conditional to finding a matching international

[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.[16] 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.

trade transaction. There is no evident difference in size between FX derivatives with and without a matching trade transaction, suggesting that our method is not mechanically leaving out smaller or larger transactions.

Finally, we go one step further and assess econometrically whether larger amounts of trade credit correlate with the use the matched hedging transactions. More formally, we estimate equation (3) at the contract-c level, where 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.

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

where $A_{c,i,m}$ is the contract-c amount for firm-i in month-m. We include firm fixed effects η_i, industry fixed effects η_j, 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 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) or our complete sample period (2005-2018) .

Table 5: Hedging by amount size of trade credit contract

A. Exports (amount of exports trade credit contracts, in logs)

	2006		2016		2005-2018	
	(1)	(2)	(3)	(4)	(5)	(6)
1(Hedged)	0.762***	0.762***	0.517***	0.517***	0.630***	0.626***
	(0.126)	(0.126)	(0.144)	(0.144)	(0.110)	(0.115)
Observations	14,948	14,948	6,576	6,576	213,364	195,989
R-squared	0.40	0.40	0.37	0.37	0.32	0.31
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	–	Yes	–	Yes	–	Yes
Month FE	–	–	–	–	Yes	Yes

B. Imports (amount of imports trade credit contracts, in logs)

	2006		2016		2005-2018	
	(1)	(2)	(3)	(4)	(5)	(6)
1(Hedged)	0.558***	0.558***	0.551***	0.551***	0.597***	0.600***
	(0.065)	(0.065)	(0.101)	(0.101)	(0.045)	(0.045)
Observations	15,146	15,146	8,224	8,224	196,104	168,404
R-squared	0.36	0.36	0.35	0.35	0.31	0.32
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	–	Yes	–	Yes	–	Yes
Month FE	–	–	–	–	Yes	Yes

Note.– Dependent variable is trade credit (log) from imports and exports. Sample considers only firms which hold no foreign debt.

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.

(i) 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

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

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: Use of FX derivatives: Extensive margin

Dependent variable FX=1(firm uses FX derivatives)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.020***			0.019***	0.022***	0.022***	0.020***
	(0.005)			(0.005)	(0.005)	(0.005)	(0.004)
M^{TC}		0.049***		0.048***	0.053***	0.052***	0.051***
		(0.005)		(0.005)	(0.006)	(0.006)	(0.005)
FCD			-0.014*	-0.013*	-0.011	-0.011	-0.006
			(0.005)	(0.006)	(0.007)	(0.006)	(0.006)
$X^{TC} \times M^{TC}$					-0.009**	-0.009*	-0.007*
					(0.003)	(0.003)	(0.003)
$X^{TC} \times FCD$					0.002	0.002	-0.000
					(0.003)	(0.002)	(0.002)
$M^{TC} \times FCD$					-0.006*	-0.006*	-0.005*
					(0.003)	(0.003)	(0.002)
Observations	2,091,293	2,091,293	2,091,293	2,091,293	2,091,293	2,102,357	2,121,848
R Squared	0.054	0.097	0.036	0.096	0.098	0.098	0.096
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.

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 0.02 percentage points. The probability of using FX derivatives is slightly higher for imports: 0.049 percentage 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) (see Appendix for additional robustness).

(ii) The intensive margin. We now turn to examine the intensive margin of firms' use of financial 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 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 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 5), indicates that a one percent increase export trade credit associates with a 0.047% 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.[18]. Notably, the result holds even when our definition of outstanding positions in FX derivatives includes cross-currency swaps, which are issued at longer terms (see Table 3) although they tend to correlate with the use of FC debt; see Appendix.

These regressions indicate that firms' FX derivative gross position (short or long) are associated with their gross cash flow 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

[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. Results are available upon request.

[18]This result holds true for all debt maturities (results available upon request

Table 7: Use of FX derivatives – intensive margin

A. Sales of FX derivatives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.048***			0.048***	0.047***	0.050***	0.037**
	(0.010)			(0.010)	(0.010)	(0.010)	(0.011)
M^{TC}		0.024*		0.022*			
		(0.010)		(0.010)			
FCD			-0.023	-0.024	-0.023	-0.024	-0.017
			(0.019)	(0.019)	(0.019)	(0.017)	(0.015)
M^{TC} by exporters					0.032**	0.032**	0.029*
					(0.012)	(0.011)	(0.014)
M^{TC} by non-exporters					0.010	0.010	0.011
					(0.011)	(0.010)	(0.011)
Observations	2,091,293	2,091,293	2,091,293	2,091,293	2,091,293	2,102,357	2,121,848
R Squared	0.053	0.022	0.0023	0.041	0.043	0.043	0.038
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}	0.008			0.004			
	(0.008)			(0.008)			
M^{TC}		0.150***		0.150***	0.150***	0.149***	0.141***
		(0.017)		(0.017)	(0.017)	(0.017)	(0.017)
FCD			0.030	0.033	0.033	0.032	0.032
			(0.023)	(0.024)	(0.024)	(0.022)	(0.020)
X^{TC} by importers					0.007	0.006	0.002
					(0.010)	(0.009)	(0.009)
X^{TC} by non-importers					-0.001	-0.000	-0.001
					(0.007)	(0.007)	(0.007)
Observations	2,091,293	2,091,293	2,091,293	2,091,293	2,091,293	2,102,357	2,121,848
R Squared	0.0095	0.15	0.031	0.17	0.17	0.18	0.17
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. 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.

mining sector as seen in columns (6) and (7) and including currencies different from the US dollar (see Appendix).

(iii) Aggregate trade credit and FX derivatives. The results in Table 7 suggest that the *gross* amounts 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 sales and purchases. 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 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.

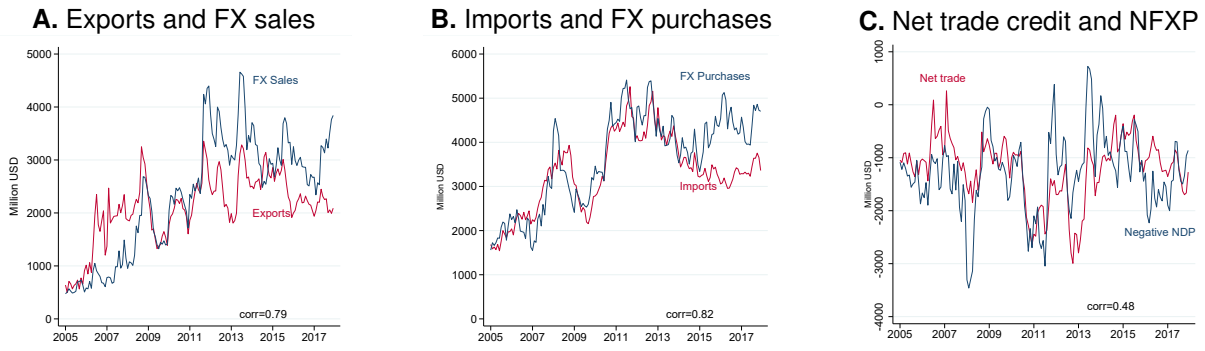

Figure 4: Trade Credit balances related to international trade and FX gross derivatives positions

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.We borrow the definition of Forward Premium in contract c, day d for maturity N from Shapiro (1996), and denote it by $FXP_{c,d,N}$, which can defined either for sales or purchases operations. 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 the one it pays to buy such dollars forward, at the same maturity; namely 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. For maturities less than 180 days, the forward premium is high, but the premium flattens for longer maturities. This downward slope implies that exporters benefit more from selling their foreign currency in the short term than in the long term and, hence, have incentives to sell their foreign currency receivables. 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.

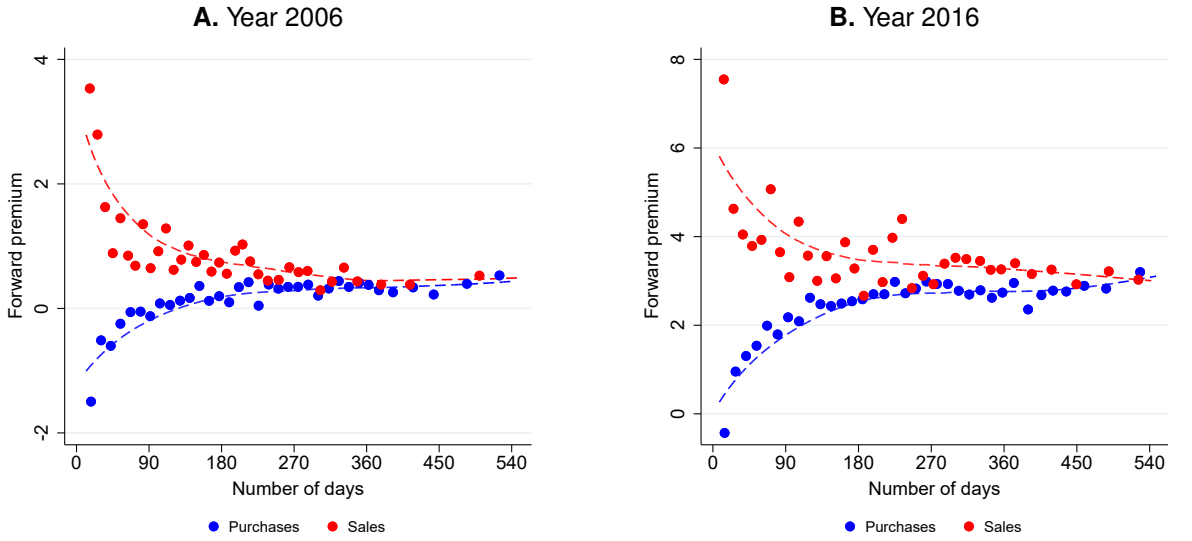

Figure 5: Forward premium by type of operation

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 econometrically, 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.

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

Table 8: Forward premium (percentage, contract level)

	FX Purchases		FX Sales	
	(1)	(2)	(3)	(4)
Maturity	0.428**	0.427**	-2.116***	-2.120***
	(0.197)	(0.197)	(0.384)	(0.384)
Sales	-0.157*	-0.156*	0.075	0.075
	(0.086)	(0.087)	(0.132)	(0.132)
Notional amount		0.014		-0.045
		(0.052)		(0.067)
Delivery instrument		0.155		-0.332
		(0.198)		(0.335)
Observations	343,688	343,688	133,477	133,477
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

that larger maturities are associated with a higher (daily) average forward premium. Importantly, this correlation persists even after controlling for time varying trends that control for trends in the exchange rate, the notional amount of the derivative and the delivery type instrument (column 2). Interesting, larger firms 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 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 – 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 by Pension Funds (PFs) with investments abroad. This regulatory change had a large impact on the FX derivatives markets as PFs 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.

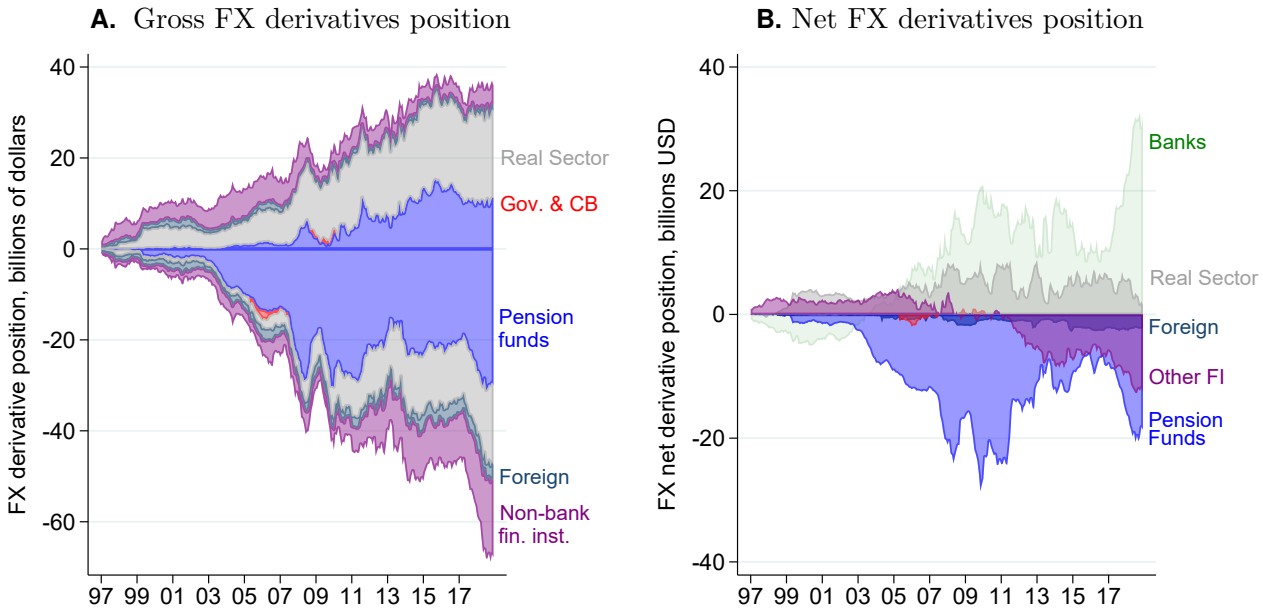

Figure 6: Pension Funds' gross and net FX derivative positions

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

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 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 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.1).[20] 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

[20]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`

different than the US dollar were hedged in the accounting currency of the portfolio which included them, usually the US dollar. 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. The change in supply from PFs was important to the market, as can be appreciated 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 of pension funds 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 their hedging decisions were affected.

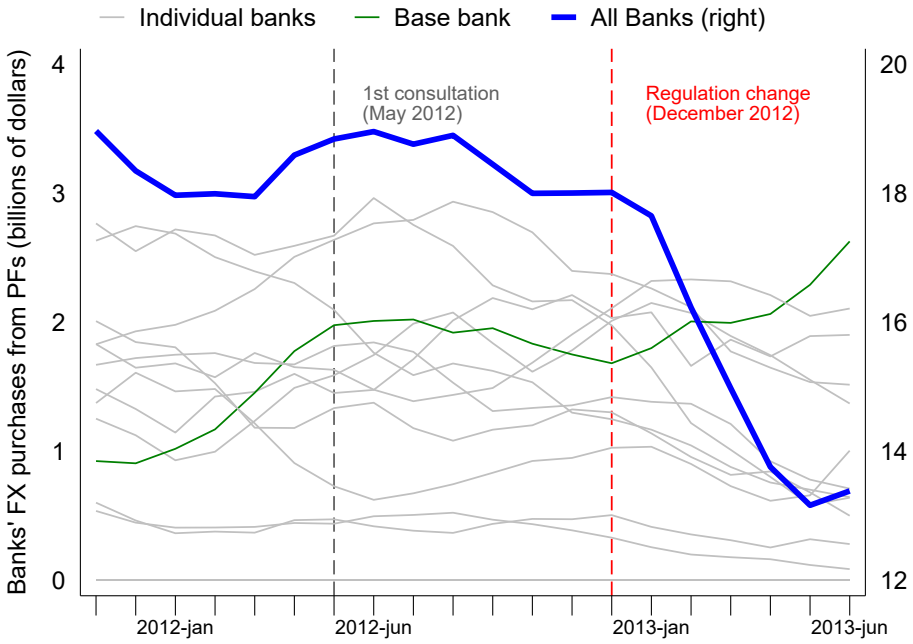

Figure 7: Outstanding FX purchases from Banks to Pension Funds ($ billions)

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 of 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 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 "four-month window", which cover 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. (2020) and exploit firms' multi-bank relationship to control for firms' demand of Fx derivatives.[21] 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 purchased more FX derivatives from pension funds 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 implementation of 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.

[21] In Khwaja and Mian (2008), Amiti and Weinstein (2018) and Alfaro et al. (2020) 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.

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.

4.3.1 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:

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

where τ denotes the period before and after the reform, $FX_{i,\tau}^{\text{Long}}$ is the (log) average outstanding long derivatives position of firm i in period τ (before or after the shock), and η_i and η_j are firm and industry fixed effects.

Table 9 presents the results of estimating equation (7) with our benchmark before/after time windows of 6 months in Panel A and shorter time windows of four months in Panel B. Columns 1 to 3 in both panels use as the dependent variable the (log) average outstanding long FX derivatives position. Columns 4 to 6, instead, use as dependent variable the annual growth rate of said variable. We include firm FE across all specifications, include industry FE in columns 2, 3, 5 and 6, and exclude mining and multinational corporations in columns 3 and 6. Results are robust to these choices. In particular, we see that after the change in regulation, firms contracted their purchases by around 8% and reduced their growth rate in half.

4.3.2 Banks' Individual Supply Changes of FX Derivatives

The above analysis does not control for changes in firms' hedging demand over time and, hence, it could be attributing changes in demand to the regulatory change on the pension funds. 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 to firms, once firms' demand for FX derivatives is already controlled for. In particular, we consider the following specification,

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)	(5)	(6)
1(Post)	-0.093**	-0.089*	-0.093**	-0.481***	-0.464***	-0.470***
	(0.044)	(0.045)	(0.046)	(0.095)	(0.098)	(0.098)
Observations	531	531	527	688	688	684
R Squared	0.00044	0.011	0.011	0.040	0.019	0.019

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

	Outstanding (log)			Annual Growth (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
1(Post)	-0.068	-0.076	-0.081*	-0.488***	-0.486***	-0.496***
	(0.047)	(0.048)	(0.049)	(0.098)	(0.101)	(0.101)
Observations	529	529	525	657	657	653
R Squared	0.0020	0.0089	0.0046	0.046	0.022	0.023
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	–	Yes	Yes	–	Yes	Yes
Includes Mining and MNC	Yes	Yes	—	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

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

where $D(FX_{i,b,\tau})$ is the change in firm i's (log) 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 to vary. 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.

Notably, the estimation of equation (8) requires defining a "base" bank $\tilde{b}$, and a "base" firm $\tilde{i}$, and therefore, all estimated coefficients $\hat{\alpha}_{i,\tau}$ and $\hat{\beta}_{b,\tau}$ are interpreted relative to them. To define our base bank we consider two criteria. First, it should have a stable FX derivative exposure to PFs around the time of the regulatory change and, thus, should not be significantly affected by it. Second, it should be sufficiently large in terms of bank-firm relationships and total gross FX positions, such that the comparison with this bank is meaningful. To illustrate the evolution of our base bank over time, we highlight its evolution with a green line in Figure 7. As shown the figure, this bank has relative stable

FX purchases from pension funds over the period under analysis.[22]

Table 10 presents the estimated coefficients $\hat{\beta}_{b,\tau}$. Column 1 and 3 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 $FXP_{i,b,t}$ (see equation 5). In particular,

$$D(FXP_{i,b,\tau}) = \alpha_{i,\tau} + \beta_{b,\tau} + \varepsilon_{b,i,\tau}, \tag{9}$$

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. As in the previous estimation, $\alpha_{i,\tau}$ captures the firm-specific demand channel, and $\beta_{b,\tau}$ absorbs the bank-specific supply channel.

We show the results of the estimation of equation (9) 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 $\hat{\beta}_{b,\tau}$ 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 (column 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 relied more heavily on PFs as their main counterparty for unwinding their currency risk, had to adjust more intensively in the post-reform period. Thus, one should observe a negative correlation between banks' ex-ante exposure to pension funds 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, 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.

- *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

[22]Due to confidentiality the agreement with the Central Bank of Chile we are not able to report the actual identity of such bank, nor provide information which may result in disclosing it indirectly.

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

A. Outstanding FX-derivatives purchases by firms					**B.** Forward premium				
	All firms		Firms in trade			All firms		Firms in trade	
	(1) $\beta_{b,\tau}$	(2) Cum. share	(3) $\beta_{b,\tau}$	(4) Cum. share		(1) $\beta_{b,\tau}$	(2) Cum. share	(3) $\beta_{b,\tau}$	(4) 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***	0.65	-0.481**	0.45	Bank e	1.261**	0.38	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***	0.90	-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.	806		695		Obs.	583		495	
R2	0.48		0.49		R2	0.65		0.70	

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. Clusterized standard errors at the bank level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

58% in the outstanding purchases of FX derivatives. This number 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.

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

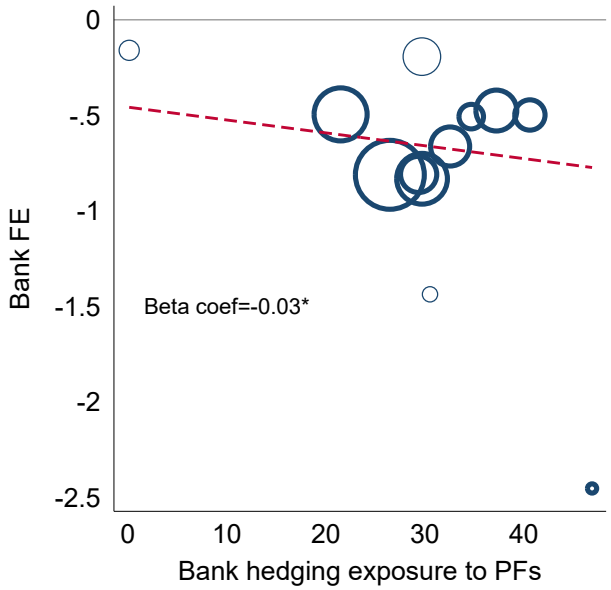

Figure 8: Estimated bank-specific supply shocks

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.

Table 11: Aggregate Effects of the Supply Shock

	Hedging Outstanding	Forward Premium
	(1)	(2)
All Firms	-0.579***	0.705*
	(0.069)	(0.373)
Int. Trade	-0.520***	0.775***
	(0.055)	(0.227)

Note.— Table shows participation-weighted-average bank fixed effects $\beta_{b,t}$ estimated from equation (8) and (9). 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 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. In the next section, we assess whether firms adjusted their currency exposures and FX derivatives choices after the shock.

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

$$Y_{i,m} = \beta_1 X^{TC}_{i,m} + \beta_2 M^{TC}_{i,m} + \beta_3 FC_{i,m} + Post_\tau \left(\beta_4 + \beta_5 X^{TC}_{i,m} + \beta_6 M^{TC}_{i,m} + \beta_7 FCD_{i,m}\right) + \eta_f + \eta_{j,m} + \varepsilon_{i,m}, \quad (10)$$

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 after the shock firms had a 2% lower probability of using FX derivatives. Column 2 presents the results on the intensive margin for FX purchases, and indicates the shock lowered firms' purchases of FX derivatives. Interesting, the dummy interacted with both imports and exports is negative and statistically significant indicating that the shock made import hedging more difficult, but it also deterred exporters – who are also importers – to buy FX derivatives. 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.

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 it 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

	1(Uses FX Der.)	Purchases	Sales
	(1)	(2)	(3)
Exports	0.025**	0.019	0.032**
	(0.009)	(0.015)	(0.014)
Imports	0.028***	0.081***	-0.002
	(0.008)	(0.015)	(0.011)
FC Debt	0.000	0.048**	0.006
	(0.009)	(0.021)	(0.024)
Post	-0.023***	0.003	-0.012***
	(0.002)	(0.003)	(0.003)
Post*Exports	-0.045***	-0.027***	-0.079***
	(0.006)	(0.008)	(0.012)
Post*Imports	0.001	-0.029**	0.016
	(0.005)	(0.012)	(0.009)
Post*FC Debt	0.007	-0.004	0.010
	(0.004)	(0.011)	(0.019)
Observations	111458	111458	111458
R Squared	0.068	0.25	0.0063
Firm FE	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes
Includes MNC	—	—	—
Includes Mining	—	—	—

Notes: All independent variables in logs. All regressions include firm level FE, and also control for (time varying) sales as a proxy of firm size. We report the marginal effects. Constant terms are not reported. Standard errors in parentheses * p <0.1, ** p <0.05, *** p <0.01.

Table 13: Contract amount by hedging decision: before/after shock

	Imports			Exports		
	(1)	(2)	(3)	(4)	(5)	(6)
1(Hedged)	0.505***	0.470***	0.468***	0.415***	0.420***	0.420***
	(0.078)	(0.073)	(0.073)	(0.111)	(0.102)	(0.102)
1(Post)	0.246***	0.206**	0.216***	0.201***	0.204***	0.216***
	(0.075)	(0.081)	(0.082)	(0.078)	(0.077)	(0.077)
1(Hedged)*1(Post)		0.133	0.132		-0.033	-0.035
		(0.108)	(0.109)		(0.151)	(0.151)
Observations	11809	11809	11808	18382	18382	18381
R-squared	0.38	0.38	0.38	0.33	0.33	0.33
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	—	—	Yes	—	—	Yes

Notes.— Dependent variable is log of trade credit from imports (columns (1) to (3)) and exports (columns (4) to (6)). Hedged indicator variable take the unitary value if the trade-credit exposure is financially hedged (explained in detail in Section 3). Pre/Post variable is defined as a dummy variable for the six month window starting December 2011/December 2012, respectively.

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 several 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.

We then showed firms that employ FX derivatives to be larger and employ these instruments to hedge larger transactions. We then assessed the use of FX derivatives at the extensive and intensive margins. We 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.

References

Albagli, E., Calani, M., Hadzi-Vaskov, M., Marcel, M. and Ricci, L. A. (2020), Comfort in floating: Taking stock of twenty years of freely-floating exchange rate in chile, IMF Working Papers 20/100, International Monetary Fund.

Alfaro, L. and Chen, M. X. (2018), 'Selection and market reallocation: Productivity gains from multinational production', *American Economic Journal: Economic Policy* **10**(2), 1–38.

Alfaro, L., Garcia-Santana, M. and Moral-Benito, E. (2020), 'On the direct and indirect real effects of credit supply shocks', *Journal of Financial Economics* ***forthcoming***.

Alfonso-Corredor, V. A. (2018), 'El uso de forwards peso dólar en las empresas colombianas del sector real.', *Borradores de Economía; No. 1058* .

Allayannis, G., Ihrig, J. and Weston, J. P. (2001), 'Exchange-rate hedging: Financial versus operational strategies', *American Economic Review* **91**(2), 391–395.

Amiti, M. and Weinstein, D. E. (2018), 'How much do idiosyncratic bank shocks affect investment? evidence from matched bank-firm loan data', *Journal of Political Economy* **126**(2), 525–587.

Antràs, P. and Foley, C. F. (2015), 'Poultry in motion: a study of international trade finance practices', *Journal of Political Economy* **123**(4), 853–901.

Avalos, F. H. and Moreno, R. (2013), 'Hedging in derivatives markets: the experience of chile', *BIS Quarterly Review March* .

Bae, S. C., Kim, H. S. and Kwon, T. H. (2018), 'Currency derivatives for hedging: New evidence on determinants, firm risk, and performance', *Journal of futures markets* **38**(4), 446–467.

Bekaert, G. and Hodrick, R. (2017), *International financial management*, Cambridge University Press.

Bernard, A. B., Jensen, J. B., Redding, S. J. and Schott, P. K. (2007), 'Firms in international trade', *Journal of Economic Perspectives* **21**(3), 105–130.

Bruno, V. and Shin, H. S. (2015), 'Capital flows and the risk-taking channel of monetary policy', *Journal of Monetary Economics* **71**, 119–132.

Calvo, G. A. and Reinhart, C. M. (2002), 'Fear of floating', *The Quarterly Journal of Economics* **117**(2), 379–408.

Céspedes, L. F., Chang, R. and Velasco, A. (2004), 'Balance sheets and exchange rate policy', *American Economic Review* **94**(4), 1183–1193.

Correa, R., Du, W. and Liao, G. Y. (2020), U.S. Banks and Global Liquidity, NBER Working Papers 27491, National Bureau of Economic Research, Inc.

Eichengreen, B. and Hausmann, R. (1999), Exchange rates and financial fragility, Technical report, National bureau of economic research.

Froot, K. A., Scharfstein, D. S. and Stein, J. C. (1993), 'Risk management: Coordinating corporate investment and financing policies', *The Journal of Finance* **48**(5), 1629–1658.

Geczy, C., Minton, B. A. and Schrand, C. (1997), 'Why firms use currency derivatives', *The Journal of Finance* **52**(4), 1323–1354.

Goldberg, L. S. and Tille, C. (2016), 'Micro, macro, and strategic forces in international trade invoicing: Synthesis and novel patterns', *Journal of International Economics* **102**, 173–187.

Gopinath, G. (2015), The international price system, Technical report, National Bureau of Economic Research.

Helpman, E., Melitz, M. J. and Yeaple, S. R. (2004), 'Export versus fdi with heterogeneous firms', *American economic review* **94**(1), 300–316.

Iacus, S. M., King, G. and Porro, G. (2012), 'Causal inference without balance checking: Coarsened exact matching', *Political analysis* pp. 1–24.

Ilzetzki, E., Reinhart, C. M. and Rogoff, K. S. (2019), 'Exchange arrangements entering the twenty-first century: Which anchor will hold?', *The Quarterly Journal of Economics* **134**(2), 599–646.

Khwaja, A. I. and Mian, A. (2008), 'Tracing the impact of bank liquidity shocks: Evidence from an emerging market', *American Economic Review* **98**(4), 1413–42.

Kuzmina, O. and Kuznetsova, O. (2018), 'Operational and financial hedging: Evidence from export and import behavior', *Journal of Corporate Finance* **48**, 109 – 121.

Liao, G. and Zhang, T. (2020), The hedging channel of exchange rate determination, International finance discussion paper 1283.

Lyonnet, V., Martin, J. and Mejean, I. (2016), Invoicing currency and financial hedging, CEPR Discussion Papers 11700, C.E.P.R. Discussion Papers.

Melitz, M. J. (2003), 'The impact of trade on intra-industry reallocations and aggregate industry productivity', *Econometrica* **71**(6), 1695–1725.

Miguel, F. L. (2016), 'The use of foreign exchange derivatives by exporters and importers: The chilean experience', *Economía Chilena* **19**(3), 90.

Morales, C. and Vergara, R. (2017), 'Desviaciones de la paridad cubierta de tasas de interés: experiencia internacional y el caso de chile', *Journal Economía Chilena (The Chilean Economy)* **20**(3), 082–100.

Rey, H. (2015), Dilemma not trilemma: the global financial cycle and monetary policy independence, Technical report, National Bureau of Economic Research.

Rossi-Júnior, J. L. (2012), 'Understanding brazilian companies' foreign exchange exposure', *Emerging Markets Review* **13**(3), 352–365.

Salomao, J. and Varela, L. (2018), 'Exchange rate exposure and firm dynamics'.

Shapiro, A. C. (1996), *Multinational Financial Management*, 5 edn, John Wiley and Sons, Hoboken, New Jersey.

Smith, C. W. and Stulz, R. M. (1985), 'The determinants of firms' hedging policies', *The Journal of Financial and Quantitative Analysis* **20**(4), 391–405.

Stein, H., García Averell, V., Levin-Konigsberg, G. and López Castañon, C. (2021), 'Currency hedging of international trade: Effects on firm outcomes.'.

A Appendix

A.1 Additional Figures

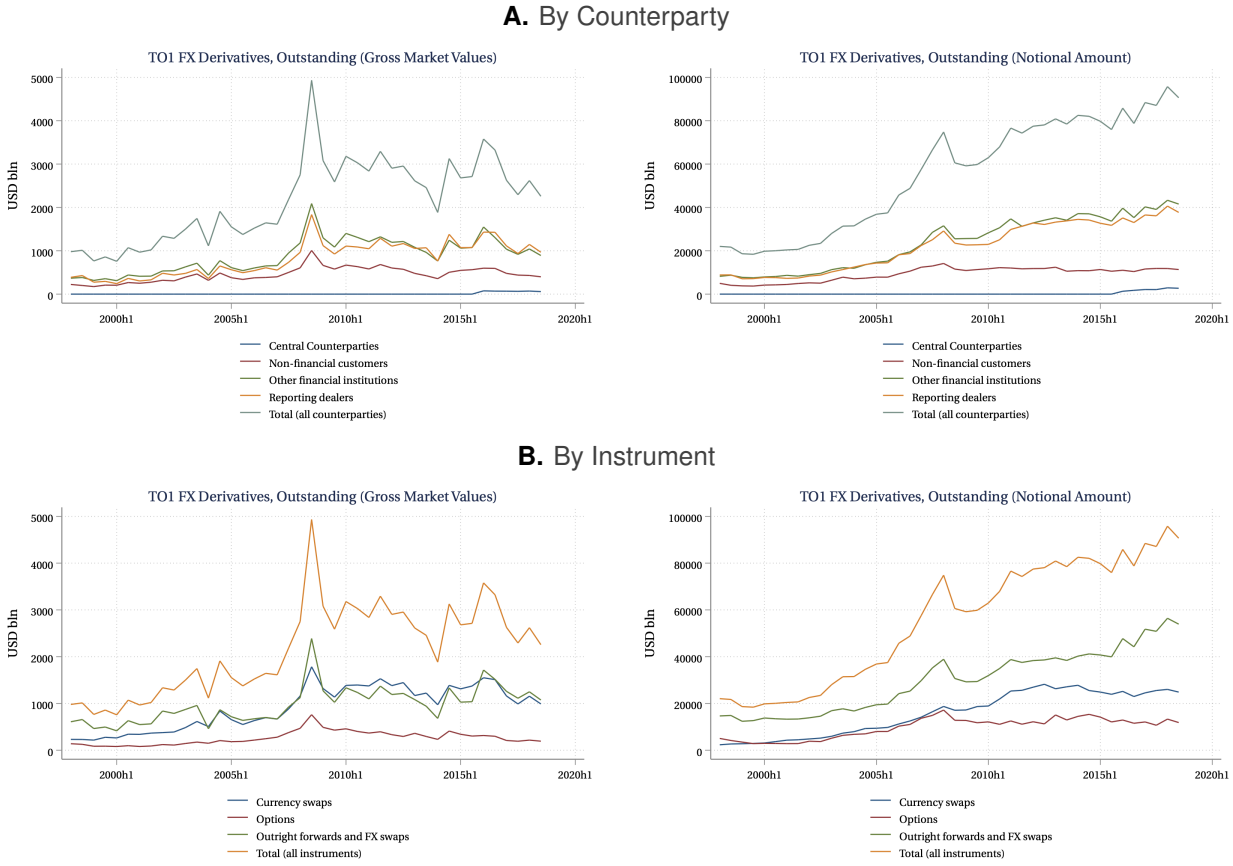

Figure A.1: FX-derivatives market size by counterparty and type of instrument

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.

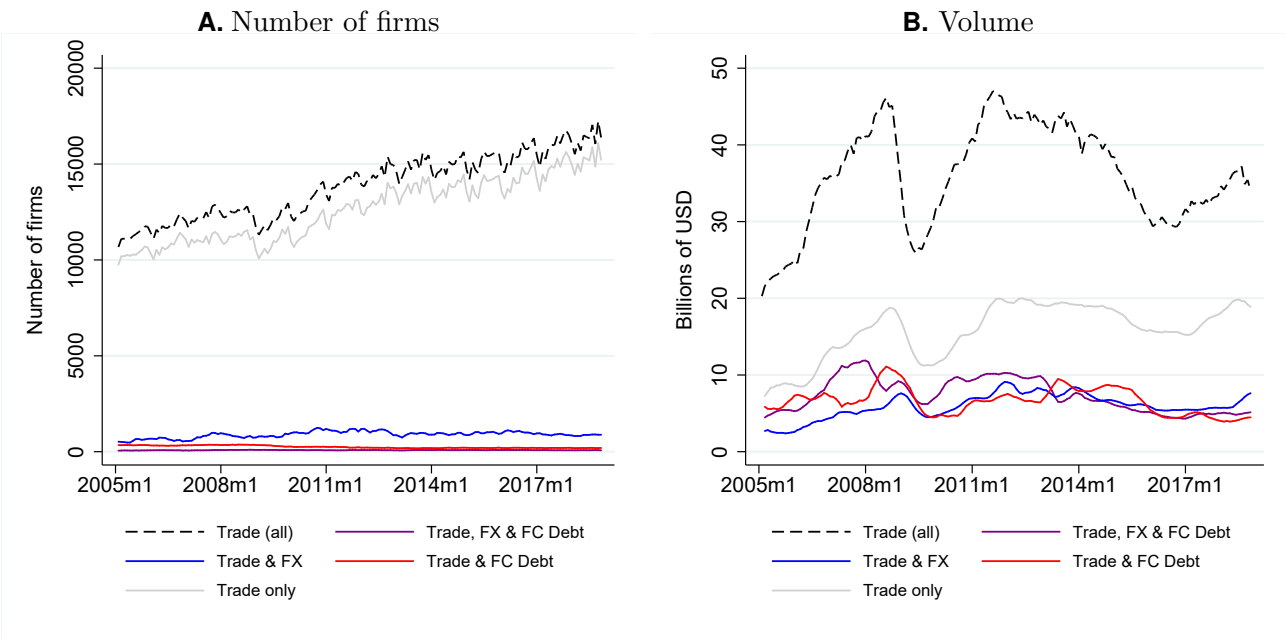

Figure A.2: International trade by type of firm

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

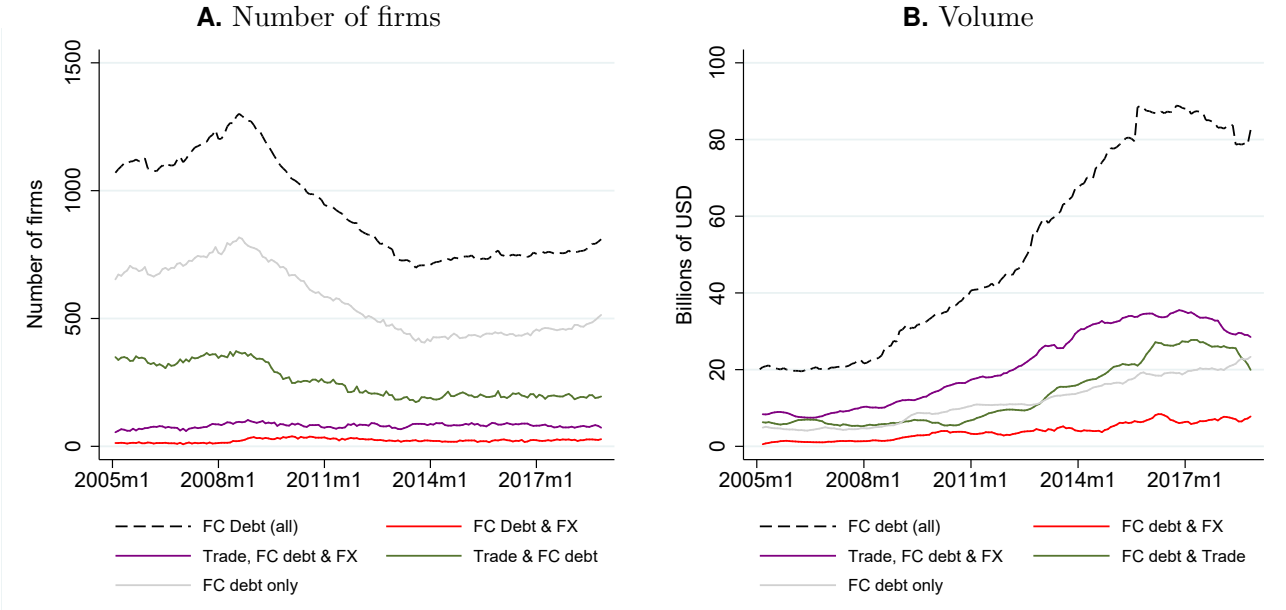

Figure A.3: Foreign debt (in foreign currency) by type of firm

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

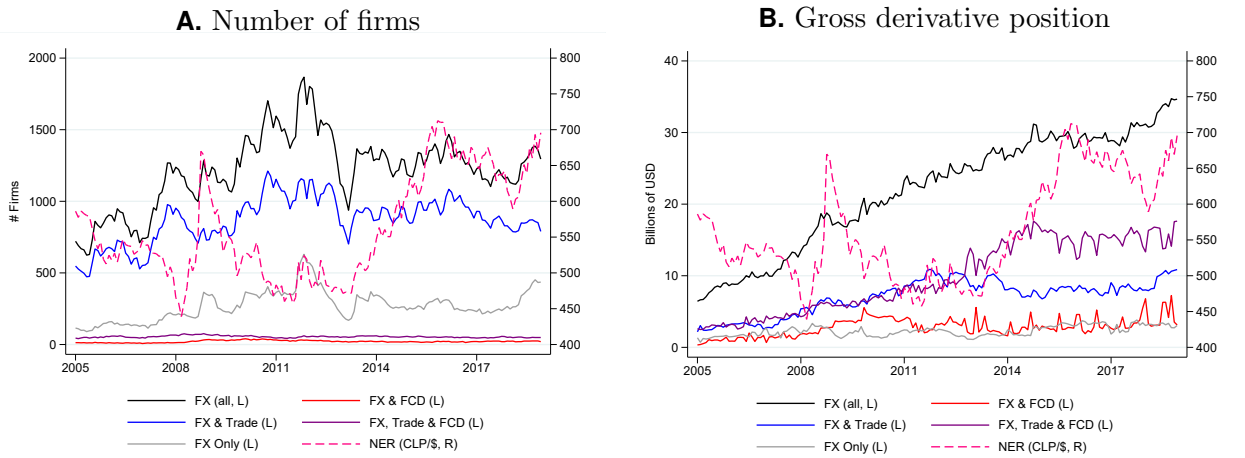

Figure A.4: Use of FX derivatives by type of firm

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.

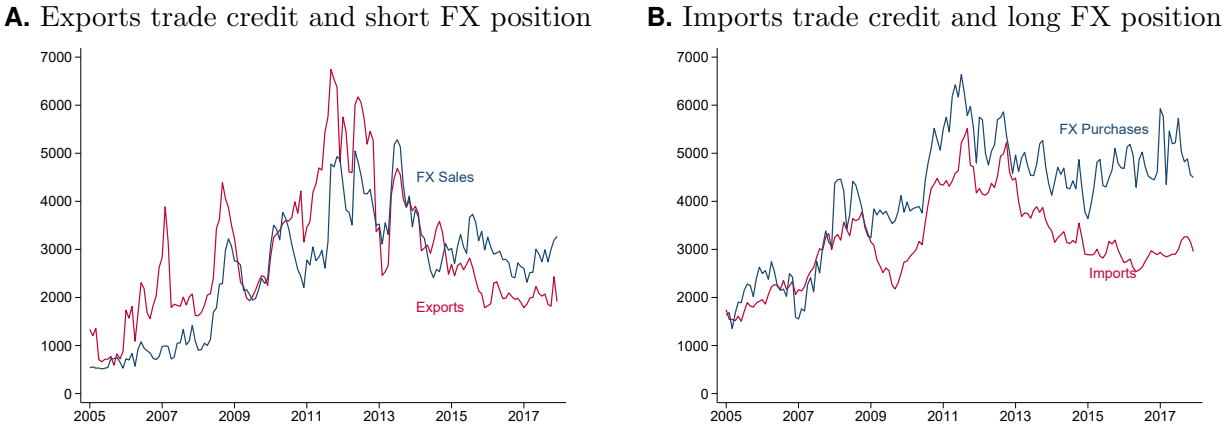

Figure A.5: Trade Credit balances related to international trade and FX gross derivatives positions

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%.

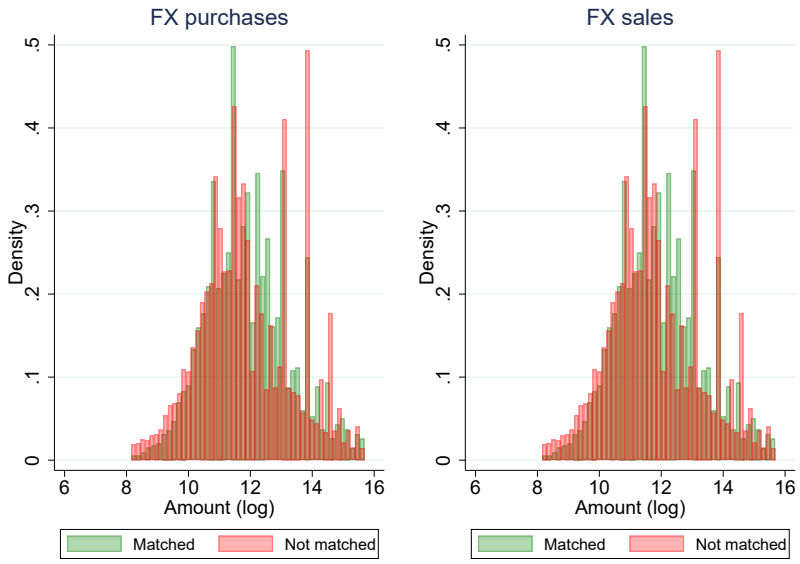

Figure A.6: Matching of FX derivatives to international trade by amount size of FX contract

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.

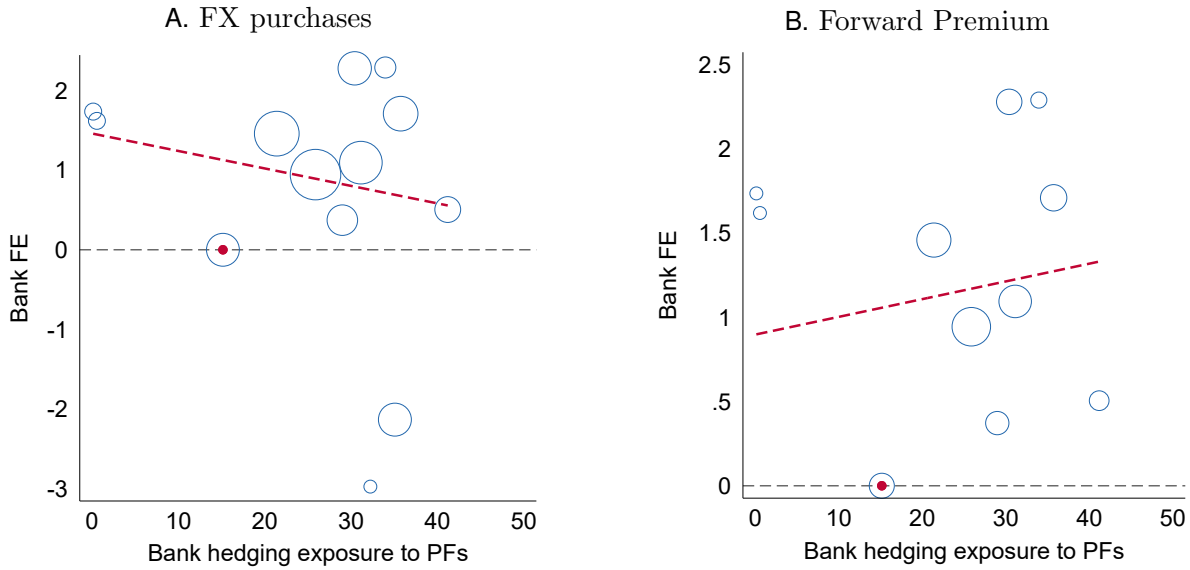

Figure A.7: Estimated supply shock in FX Premium and PFs in Banks' total FX purchases

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: 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.2: 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.3: Trade Credit Contracts (number)

			Imports					Exports				
			Currency					Currency				
Trade Credit	**Financed by**	**Term**	USD	EURO	CLP	Other	**TOTAL**	USD	EURO	CLP	Other	**TOTAL**
Yes	Supplier	< 1 year	1,212,865	30,043,785	5,104,294	901,078	37,262,022	-	12,625,796	819,781	28,819	13,474,396
		> 1 year	1,476	36,177	323	-	37,976	25	3,486	502	4	4,017
	Bank or Fin. Inst.	< 1 year	139,219	3,428,296	187,070	4,439	3,759,024	180	381,121	9,121	43	390,465
		> 1 year	897	3,411	170	4	4,482	270	116	1	-	387
No	No payment	-	56,853	1,986,171	183,937	16,252	2,243,213	540	492,960	19,781	1,604	514,885
	Other	-	22	398	41	-	461	164	461	19	1	645
	Paid in advance	-	391,366	10,019,579	1,508,614	315,180	12,234,739	99	1,128,052	22,126	10,669	1,160,946
	Cash	-	77,597	981,977	29,502	20	1,089,096	570,517	27	6	-	570,550
TOTAL			1,880,295	46,499,794	7,013,951	1,236,973	56,631,013	571,795	14,632,019	871,337	41,140	16,116,291

Notes: Period of analysis 1998-2018, monthly observations by firm.

Table A.4: Natural hedge (narrow definition)

	Dependent variable: Accounts receivable due to exports, log													
	Exports (30d)		Exports (60d)		Exports (90d)		Exports (120d)		Exports (180d)		Exports (270d)		Exports (360d)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Imports (30d)	0.002	0.002												
	(0.004)	(0.002)												
Imports (60d)			0.012	0.010*										
			(0.007)	(0.006)										
Imports (90d)					-0.002	-0.003								
					(0.006)	(0.007)								
Imports (120d)							-0.006	-0.008						
							(0.008)	(0.008)						
Imports (180d)									-0.031***	-0.028***				
									(0.009)	(0.009)				
Imports (270d)											-0.024	-0.021		
											(0.024)	(0.023)		
Imports (360d)													-0.004	-0.002
													(0.004)	(0.004)
N	952945	945388	910806	903063	716043	709240	533327	527127	414365	407978	226567	221493	20620	20487
R squared	0.00480	0.000984	0.00339	0.0137	0.000773	0.00742	0.00128	0.00443	0.000504	0.0107	0.00713	0.0119	0.0290	0.0571
Includes mining	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors clustered at the firm level reporten in parentheses. All regressions consider firms that have both import and export trade credit. *Source*: Own elaboration