NBER WORKING PAPER SERIES

CURRENCY HEDGING:
MANAGING CASH FLOW EXPOSURE

Laura Alfaro
Mauricio Calani
Liliana Varela

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

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2021, Revised July 2022

We thank Maxim Alekseev, Pol Antràs, Paola Conconi, Dave Donaldson, Songuyan Ding, Alessio Galluzzi, Gordon Hanson, Galina Hale, Oleg Itskhoki, Victoria Ivashina, Sebnem Kalemli-Ozcan, David Kohn, Robert Kollman, Karen Lewis, Philip Luck, Nicolas Magud, Adriano Rampini, Ugo Panizza, José Luis Peydró, Hélène Rey, Veronica Rappoport, Adi Sunderam, Adrien Verdelhan, and participants at BIS, ECARES, CEPR ESSIM, IMF, Swiss National Bank, Geneve, GW, Halle Institute, Harvard-MIT trade lunch, NBER International Asset Pricing, NBER IFM, NBER Emerging and Frontier Markets, Women in Macro, Belgium, Shanghai, PUC-Chile, UC Davis, UC Santa Cruz, HK, EFA, ASSA, and Econometric meetings for comments. We thank José-Ignacio Cristi and Marco Piña for outstanding research assistance, and Alexander Hynes and Paulina Rodríguez for help with the data. The opinions expressed in paper do not represent those of the Board of the Central Bank of Chile or the National Bureau of Economic Research.

Currency Hedging: Managing Cash Flow Exposure
Laura Alfaro, Mauricio Calani, and Liliana Varela
NBER Working Paper No. 28910
June 2021, Revised July 2022
JEL No. F31,F38,G30,G38

ABSTRACT

Foreign currency use can be a source of risk associated with currency mismatches, which firms can hedge using FX derivatives. This paper uncovers five novel facts about firms' use of foreign currency (FX) derivatives employing a unique dataset covering the universe of FX derivatives transactions in Chile from 2005-2018, together with firm-level census data on employment, sales, international trade, trade credits, and foreign currency debt. (i) Natural hedging of currency risk is limited. (ii) FX hedging is more likely to be used by larger firms and for larger amounts. (iii) Firms in international trade are more likely to use FX derivatives to hedge their gross—not net—cash flow currency risk. (iv) The FX premium is heterogeneous across and within firms, higher for smaller firms and longer maturity contracts. (v) Macroeconomics conditions affect firms' hedging policies, as changes in the liquidity of the FX market affect firms' use. Our results indicate that financial constraints impact the use of FX derivatives, affecting how firms use these instruments to manage cash flow commitments.

Laura Alfaro
Harvard Business School
Morgan Hall 263
Soldiers Field
Boston, MA 02163
and NBER
lalfaro@hbs.edu

Mauricio Calani
Central Bank of Chile
Chile
mcalani@bcentral.cl

Liliana Varela
Houghton Street
Department of Finance
London School of Economics
London, WC2A 2AE
United Kingdom
L.V.Varela@lse.ac.uk

1 Introduction

The use of foreign currency in trade and finance is prevalent.[1] Foreign currency dominance can be a prominent source of risk associated with 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 manage currency risk. Importantly, the FX derivative market—one of the largest markets worldwide—has seen an impressive development over the last decades, surpassing spot transactions both in advanced and emerging economies (Figure B.1). Yet little is known about firms' use of currency derivatives. Which firms use FX derivatives? Do they fully or partially hedge their currency risk? What shapes these decisions? And, at a broader policy level, does the development of the FX derivatives market affect firms' FX hedging decisions?

In this paper, we study firms' use of foreign currency hedging instruments by creating a unique data set that combines census administrative information on foreign currency derivatives, foreign currency debt, international trade, sales, and employment for the universe of non-financial firms (hereafter, *firms*) in Chile between 2005 and 2018. Our data in foreign currency derivatives contains detailed transaction-level information on all forward, futures, options, and swap contracts traded over-the-counter (OTC) (i.e., including the ID for the contract, the ID of the firm, signing date, maturity date, the ID of counterpart, currency denomination, and forward exchange rate). Our foreign currency credit data includes bond issuance, loans, and foreign direct investment. We merge these datasets with international trade data reporting the invoice currency, delivery date, value, and financing through trade credit or upfront payment at the firm-transaction level. Once combined, this granular information allows us to obtain precise estimates of firms' foreign currency cash flows by currency and maturity and dissect their foreign currency transaction exposure arising from international trade and financing. This analysis constitutes an advance over previous studies in the literature that—by only focusing on sub-samples of listed firms or survey information on only a subset of firms' operations—could not precisely identify firms' FX transaction exposure and use of FX derivatives.

We uncover five facts regarding the use of FX derivatives. First, we show that payables and receivables in foreign currency are only slightly correlated, suggesting that firms do not match cash flows to be "naturally hedged". For instance, the correlation between exports and imports and various measures of cash flow and trade credits is only between 2% and 3% (8% and 9%) during any given month (quarter). This low correlation could arise from significant differences in the maturity of exports and imports financing. Indeed, our data indicate that the average maturity of trade credit from exports with direct vendors is 50% longer than that of

[1] Authors have emphasized different aspects of the use of foreign currency 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 among others; see Eichengreen and Hausmann (1999), Calvo and Reinhart (2002), Céspedes et al. (2004), Goldberg and Tille (2016), Rey (2015), Gopinath (2015), Bruno and Shin (2015), Gopinath et al. (2020), Ilzetzki et al. (2019), Amiti et al. (2022).

imports (137 vs. 91 days).[2] 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 3 years longer than the median maturity of exports.

Second, we document that firms employing FX derivatives are larger (measured in terms of employment, sales, debt, export, and imports). Larger firms use FX derivatives more at the extensive and intensive margins, even after controlling for the currency exposure. We also document that exporters and/or importers relying on trade credit are more likely to use FX derivatives. Our empirical results show that a one percent increase in trade credit from imports (exports) leads to a 0.06 (0.02) percentage points increase in the probability of the firm employing FX derivatives; and 0.16% (0.05%) larger purchases (sales) of FX derivatives. These results are robust to controlling for firm fixed effects, year and industry fixed effects interacted and excluding multinational firms, and mining-related firms. Exploiting the transaction level information of our data, we also find that larger transactions (exposures) from international trade credit are more likely to be hedged.

Third, at the intensive margin, we document that firms tend not to hedge *net* trade credit exposure with FX derivatives but instead hedge their *gross* exposures. Consistently, the unconditional correlation between net trade credit and net FX derivatives position is relatively low (40%). In contrast, 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 indicate that firms 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 a net position—is not surprising when considering that the maturities of trade credits from exports and imports differ substantially, as mentioned above. We also find that higher exchange rate uncertainty increases firms' use of FX derivatives, both at intensive and extensive margins.

Fourth, we dig deeper and exploit the transaction-level information of our data. As in most countries, the Chilean derivative market is predominantly OTC, implying bilateral relationships and search-and-bargaining features generally involving intermediaries (Duffie et al. 2005).[3] We document that contracts are priced differently *within* and *across* firms. In particular, we find that larger firms pay a lower premium when purchasing FX forward. In addition, firms pay a positive (negative) premium for FX purchases (sales) which is increasing (decreasing) in maturity, reflecting the increasing spread a financial intermediary would obtain to intermediate longer maturity FX derivatives contracts. These results are robust to including proxies for management complexity, default risk, credit constraints, and exchange rate volatility and expectations.

Finally, we exploit a quasi-natural experiment that exogenously reduced the supply of FX

[2] Our data also reports information on trade credit with financial institutions, which account for less than 15% of total trade credit. Typically, this trade credit has longer maturities, while the difference in maturity between trade credit for exports and imports is higher (259 vs. 120 days).

[3] See also Appendix A for institutional details about the FX derivatives markets and banking system in Chile.

forwards to firms to assess how market-level conditions affect their hedging policies. In particular, we leverage a regulatory change to Pension Funds' (PFs) hedging requirements in 2012/2013 that reduced their sales of FX forwards to banks. Banks, the principal intermediaries in the derivatives market, cannot hold open positions, per regulation, refraining from holding currency risk, and passed this negative liquidity shock onto firms. This lower supply of FX derivatives affected firms seeking to take long FX positions (e.g., importers and foreign currency borrowers), who substantially reduced their purchases of FX forwards. We show that, on average, firms reduced the purchases of FX forwards by 10-15% within six months after the reform. Given the OTC nature of the market, where bank-client relationships are first order, we analyze the micro-level adjustment to the shock. Our econometric results indicate that banks more exposed to PFs reduced their supply of FX derivatives to firms relatively more. In line with the reduction in the supply of FX derivatives, the forward premium paid by firms purchasing forwards increased, and the number of firms participating in the FX derivative market dropped by 16%.

The size of the shock was considerable enough—a drop of around USD 4 billion in the flow of contracted FX derivatives, equivalent to 75% of quarterly imports—to have real and financial short-term implications for firms, as they experienced a reduction in employment and trade. This analysis indicates that the liquidity of the FX derivatives market can substantially affect firms' hedging activities. Hence, less liquid FX derivatives markets offer firms less ability to hedge their currency risk and, thus, are more exposed to exchange rate volatility given the limitations of natural hedging.

Related Literature.— Our paper relates to the literature studying firms' hedging motives. Firms are exposed to a wide variety of risks, including market and commercial ones, in addition to exposure to political and external events.[4] In this paper, we focus on exchange rate transaction risk associated with movements in financial markets whose exposure is clearly defined as it is contractual and can potentially be managed using financial derivatives. In the Modigliani and Miller (1958) (MM) friction-less neoclassical framework, hedging does not add value to the firm. As shown by the works of Smith and Stulz (1985), Froot et al. (1993) and Rampini and Viswanathan (2010), from a theoretical perspective, in the presence of different types of market imperfections, such as financial frictions, transaction costs, and convex tax schedules, volatility can be costly, conveying a role to hedging by firms. Our findings contribute to this literature by uncovering new facts regarding the use of FX derivatives and documenting the firm's hedging strategies relate to cash-flow timing restrictions. We further show that FX hedging affects firms' real outcomes suggesting that risk management adds value to the firm.

On the empirical side, the literature has focused on understanding a firm's use of currency derivatives. A first generation of papers relied on balance sheet information on net positions of listed or multinational firms and/or survey data, mostly for advanced economies. Notably,

[4] Risk management strategies include a wide range of options from operational activities, such as the management of business activities (including payments, receivable, and location of activities), the transfer of risk to suppliers and customers (via pricing, contracts, or agreements), or self-insurance and buffers by accumulating foreign currency assets or liabilities, or to the use of financial products (options and derivatives), see Servaes et al. (2009) and Lewis (2018).

Allayannis et al. (2001) use geographic dispersion of U.S. multinationals (number of countries/regions of operation) and shows that operational hedging (proxied by geographical distance) was limited and not a perfect substitute for financial hedging. This literature has focused on the use of FX derivatives in non-financial corporations with prevalent exchange rate exposure.[5]

Our detailed data allows us to take the analysis one step further by studying granular information for the universe of all firms and the census of all FX derivative contracts and measuring more precisely variables for which only proxies were available in previous studies. This comprehensive information shows that even firms with international trade and foreign currency debt exposure do not fully exploit natural hedges and tend to use financial derivatives to hedge gross positions. We also document that higher currency volatility is associated with higher extensive and intensive use of FX derivatives, yet hedging is partial and tilted towards larger transactions. Our findings are consistent with recent evidence by Adams and Verdelhan (2021), using income statement information for publicly listed Japanese and US firms, documenting that firms do not fully hedge the direct impact of exchange rates with FX derivatives. Additionally, the use of a policy reform allows us to study the liquidity of the FX derivatives market and, thus, how its development affects a firm's hedging decisions.

We document that firms using FX derivatives are larger, which echoes findings in international trade and finance (international trade, Bernard et al., 2007, Melitz, 2003, Antràs et al., 2017; multinationals, Helpman et al., 2004, Alfaro and Chen, 2018; foreign borrowing, Varela, 2018, Salomao and Varela, 2022). This selection of larger firms into the FX derivatives market can be the result of fixed costs, but can also arise from financial frictions, limiting the use of financial hedging instruments, as analyzed by Rampini and Viswanathan (2010), and Rampini et al. (2014).

Overall, our findings highlight that the different timing of operational and financial milestones—the signing of a contract, production, 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. Longer deliveries and transportation times in international transactions exacerbate these differences increasing the need for working capital (Antràs and Foley, 2015).[6] 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, with working capital obligations. Our results suggest that firms turn foreign currency exposure into local currency but still use the dollar in their international transactions, possibly due to its role as a unit of account and network effects. The misalignment in timing between payables and receivables in foreign currency and their interaction with domestic currency obligations explains the use financial hedges for gross transactions.

[5] For the Euro countries, see Lyonnet et al. (2016), and France, Fraschini and Terracciano (2021); Korea, Jung (2021); Brazil, Rossi-Júnior (2012); Chile, Miguel (2016). See Bodnar et al. (2011) for a survey of risk managers' goals, policies, and perceptions.

[6] Under firms' different integration strategies into global value chains, exchange rate variations, in the presence of capital market imperfections and financial constraints, can limit firms' innovation and productivity, see Alfaro et al. (2022) and references therein.

We also document that the functioning FX derivative market—dominated by OTC activities and involving banks as intermediaries in the matching of buyers and sellers—can affect firms' use of hedging via transaction costs, economies of scale,[7] search and bargaining, and sticky relations in the short run. The findings are consistent with those of Hau et al. (2021), who using French data, argue that dealer-banks differentiate prices when dealing with non-financial firms in the OTC market, and Duffie et al. (2005), who note that OTC intermediaries can price discriminate among different customers even in markets with limited private information. More generally, our results underscore that the short-run stickiness of bank-firm relations (Chodorow-Reich, 2014) extends to the OTC market.

Our findings, then, relate to the literature exploring the role of financial intermediaries in affecting 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 of US global systemically important banks, Liao and Zhang (2020) who study institutional investors' hedging choices and how they affect spot and forward exchange rates, and Du et al. (2018) who point to the effect of banking regulation on CIP deviations. By exploiting a regulation change to Pension Funds hedging requirements—arguably the largest local market participant in this market (Avalos and Moreno, 2013)—, which resulted in a supply shock to the short side of the FX-derivatives market, we show that the supply of FX forward to firms decreased and, consistently, the forward premium paid by them increased. Further, we document that disruptions at the aggregate level that impair firms' hedging activities can have real effects. Our census data on firms' exposure allows us to show that a decrease in FX derivatives not only undermines firms' trade (as in Jung 2021) but also reduces their size and unveils the interaction between the timing of operations and firms' financing policies. It also underscores the importance of liquidity and the FX derivatives markets.

The paper is organized as follows. Section 2 describes the FX derivative market in Chile and datasets. Section 3 documents firms' currency exposure (*Fact 1*). Section 4 discusses firms' use of FX derivatives (*Facts 2-4*). Section 5 shows that macroeconomic conditions affect firms' hedging patterns (*Fact 5*). The last section concludes.

2 Data

2.1 Data sources

We use firm- and contract-level census data from Chile between 2005 and 2018 on over-the-counter FX derivatives, foreign currency debt, international trade (cash and trade credit on exports and imports), and sales and employment. We also use information on domestic currency debt with the banking sector from the credit registry for a subset of our analysis. We can cleanly merge these datasets due to the extended (and mandatory) use of the unique tax identifier number (*Registro Único Tributario*, RUT) for all Chilean residents. The combined data allows the study

[7] Our findings are also consistent with Geczy et al. (1997) who use 372 Fortune-500 firms with ex-ante foreign currency exposure to argue that there are economies of scale in implementing and maintaining risk management programs.

of the joint decisions of international trade, financing, and hedging policies at the firm level instead of at the plant level. Each of the datasets contains the following information.

FX Derivatives.— We observe transaction-level information on a daily frequency from 1997 to 2018 on the census of FX derivative contracts with a Chilean resident on either side of it. However, to match the coverage of other data sets, our analysis starts 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 each FX derivatives contract, we observe the following: ID of the informant entity, the ID of the counter-party (another FEM entity or a non-financial firm), an ID for the contract, signing date, maturity date, economic sector of both parties, currency, forward price, and settling type (deliverable/non-deliverable). In this paper, we focus on the use of FX derivatives contracts by non-financial firms for currency risk management. This sub-sample of contracts represents roughly 38% of all contracts in our sample period.

Foreign and local debt.— We observe the foreign debt of Chilean residents, normally used to compute the balance of payments statistics. In particular, we observe end-of-month stocks of loans, bond debt—currency denomination, maturity, interest rate, and coupon payments—and foreign direct investment between 2003-2018. Local currency debt is obtained from credit registry data at the firm-month level from 2009.

International trade.— We use information from the Chilean Customs Agency data, which gathers information about the census of imports and exports transactions for 1998-2018. For each international trade transaction, we observe the transaction date, firm ID, country of origin for imports, firm industry for exports, 8-digit HS product code, the currency of invoicing, value and quantity of import/export, and importantly, trade credits.

Trade credits are arrangements between sellers and buyers, allowing them to contract purchases today and pay on a specified future date. Notably, in our data, we observe many aspects of trade credit: who finances the credit, the upfront payment, the amount financed through trade credit in every transaction, and its maturity. International trade transactions are vastly dominated by US dollar denomination (Goldberg and Tille, 2016, Gopinath et al., 2020, Amiti et al., 2022), so it is not surprising that trade credit obligations stemming from such operations are denominated in US dollars. This feature, coupled with the delayed payment nature of trade credits, exposes firms to currency risk.

Firm-level activity.— We use firm-level yearly information from the Chilean Tax Authority ("Servicio de Impuestos Internos" or SII). In particular, we observe firm tax ID, sales (bracket), number of workers, address, industry, and age.

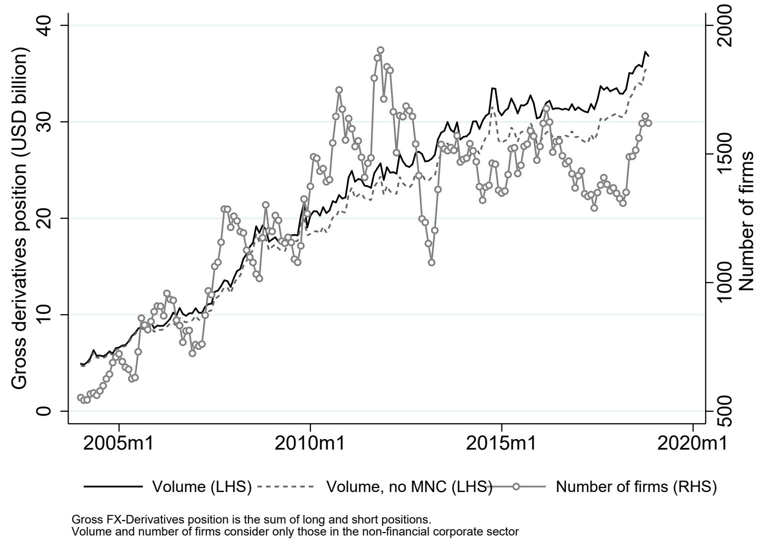


Figure 1: Number of firms and total gross FX Derivatives positions

Note.— This figure shows on 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), the volume of gross FX derivatives positions of all non-multinational corporations (dashed gray line) and the number of firms using FX derivatives in a given month on the right axis (gray line with circle markers). stocks of FX derivatives.

2.2 The FX derivatives market

The FX derivatives market in Chile has expanded rapidly over the last 15 years. Figure 1 shows that 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 USD 35 billion, which amounts to close 13% of annual GDP. Panel A in Table 1 reports the market activity over the period 2005-2018 for the whole market (columns 1-5) and non-financial firms (columns 6-11). We have information on roughly 1.9 million contracts, of which 0.7 million involve a non-financial firm (columns 1 and 6).

As expected, the market is dominated by over-the-counter transactions intermediated by a bank.[8] Forwards are firms' most traded FX-derivative, representing nearly 90% of all contracts with non-financial firms. Their median maturity is 88 days, with longer maturities for sales than purchases (Panel B). Also, approximately 80% (60%) of all sales (purchases) are settled with no delivery (which remained a legacy of the capital control era, which ended in 1998). This contract characteristic is also standard in Korea, Brazil, India, and other emerging markets (EMEs) as a way to reduce credit risk (BIS 2019). 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

[8]Appendix A provides a brief institutional arrangement description. Transactions between financial institutions (i.e., bank with a Pension Fund or bank-bank) tend to involve a Credit Support Agreement (CSA), which establishes agreed limits between the parties for a myriad of transactions, the collateral used in derivative transactions, and other particularities of the arrangements. In the case of non-financial corporations, the complexity of these contracts limits their use with some companies signing ISDA contracts, a simplified version of the CSA, or "contratos de condiciones generales". Our data does not disclose the firms that have signed these agreements.

firms. In the rest of the paper, we focus our analysis on non-financial firms, which we hereafter refer to as firms for convenience.

Our sample.— Our focus is on firms' currency exposure associated with delayed payments between the transaction date and the contractual settlement date —and hence clearly identified in data— and can be managed using FX financial derivatives.[9] We concentrate on transactions (trade, trade credit, foreign currency debt, and FX derivatives) using the same currency pair, namely U.S. dollars, and Chilean Pesos. This restriction is without loss of generality. Financial obligations with foreigners are almost exclusively denominated in U.S. dollars. Also, the U.S. dollar is the dominant foreign currency denomination in international trade, adding up to more than 85% of transactions in Chile. Not surprisingly, FX derivatives contracts are also primarily denominated in U.S. dollars. In particular, in 2016, 94% of long FX positions, and 87% of short FX positions, involved the U.S. dollar. The Euro follows this ranking from a distant second place, with almost 5% and 6% long and short FX positions, respectively.

The use of FX derivatives is spread across all economic activities. The sectors using FX derivatives more intensively are retail, farming, electricity, water supply and gas, non-metallic manufacturing, financial intermediation, mining, transport, and communications, which account for more than 90% of long and short FX positions in 2016. In our main sample, we exclude multinational corporations (MNCs) for two main reasons. First, MNCs could use FX derivatives to hedge the value of dividends in foreign currency to hedge translation exposure, and subsidiaries or headquarters abroad may undertake the financial hedging, which might be harder to track. Second, MNCs may have foreign assets abroad or even report financial statements in foreign currency, affecting their motives and strategies to manage currency risk. This exclusion is without loss of generality, as domestic firms represent over 90% of the total firms in the Chilean Economy. Also, as commodity prices may correlate with the exchange rate, we exclude firms in the mining industry in our baseline sample.

Our primary sample also excludes contracts with maturity shorter than 8 days—which represent 1.4% of the sample—, as these contracts are more likely related to exchange rate speculation rather than currency hedging. We also focus our analysis on outright forwards, representing close to 90% of all FX derivatives used by non-financial firms (see Table 1). In the robustness tests, we analyze more complicated instruments like FX swaps and cross-currency swaps, which in turn are more intensively used by MNCs. Note, however, that even though the sample we use for our main results excludes MNCs, mining sector firms, instruments and operations in currencies different than the U.S. dollar, and derivatives other than forwards of 8 days or more of maturity, our results are robust to the inclusion of all the above, sequentially and altogether. We point to robustness results that relax these data restrictions along with all results. Figures B.2 to B.5 in the Appendix B present some additional features of the data.

Beyond the granularity of the data collected for nearly two decades, Chile offers an excellent

[9]Firms can be subject to contractual or transaction exposure (changes in the value of foreign currency contacts as a result of exchange rate changes such as a change in the value of imports or debt in foreign currency); translation or accounting exposure (when reporting and consolidating financial statements requires conversion from foreign currencies); and operational exposure (exchange rate changes may change the future value of revenues and costs).

Table 1: Descriptive statistics FX derivatives contracts

Panel A. By market

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

Panel B. By type of operation for non-financial firms

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

Note.— Sample period: 2005-2018. Obs. represents the 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 counterparties 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 are defined as those with at least a real sector corporation on one side of the contract. This sample also excludes observations with a maturity of fewer than seven days and considers only one observation, the capital and interest payments in cross-currency swaps. This table includes instruments in which the foreign currency is USD only, which accounts for almost all the contracts in the case of international trade.

case to study due to the stability of its macroeconomic and institutional framework. As detailed in the next section, the derivatives market is dominated by over-the-counter transactions as in most developed economies (see BIS 2019). Moreover, in our sample period, Chile has shown a combination of responsible fiscal policy, a freely floating exchange rate, and an inflation-targeting regime implemented by an independent Central Bank for almost three decades, (Albagli et al., 2020).[10] Also, in the period under analysis, there is no evidence of persistent covered interest parity (CIP) violations except for a very brief period amid the Global Financial Crisis (Morales and Vergara, 2017).

3 Firms' FX Exposure

The following sections present novel facts about firms' exposure and use of FX derivatives. We first document that firms involved in international trade and/or holding foreign currency debt retain currency risk. Hence, there is room to use FX derivatives to manage their cash flow exposure. In particular, we show that firms are not "naturally hedged", as they do not match their payables and receivables in foreign currency (Fact 1).

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

To hedge its currency exposure, a firm can use financial FX derivative instruments. Alternatively, a firm can also manage it through different forms of operational transactions, i.e. "operational hedges". We start studying whether firms are naturally hedged, a form of operational hedging in which a firm matches its payables and receivables in foreign currency and/or the cash flows related to these exposures *in maturity* and *transnational amount*. We first explore the extent to which firms exploit natural hedging and conclude that it is quantitatively very limited. We also argue that an important potential reason for this is the difference in maturities of payables and receivables in foreign currency. We distinguish natural hedging from self-insurance—a strategy in which firms keep liquid foreign currency holdings to cover future commitments in foreign currency–, which we discuss at the end of this section.

Cash-flows and outstanding exposures.— We conduct three complementary exercises to assess the extent to which firms exploit natural hedging. In our first exercise, we consider all cash inflows and outflows in foreign currency at period t are related to debt and international trade credit at maturity t and upfront/in-cash payments at t, and check whether these are correlated. This exercise is a highly demanding test of natural hedging because it stems from an ex-post perspective on whether a firm could use cash inflows in foreign currency to meet cash outflows in foreign currency in the same period, regardless of when the involved exposures were originated. A second more conservative exercise considers only contracted-upon cash flows. That is, besides debt contracting and its repayment, we consider cash-flows from trade credits at maturity t and study if payables and receivables in foreign currency are correlated. In our third exercise, we study the correlation between the outstanding value of receivables and payables in foreign

[10] Chilean sovereign debt during our period of the analysis is investment grade (A1 by Moody 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 solid financial regulation after the 1982 domestic financial crisis.

currency and check whether these *balances* are aligned—independently of their maturity. This third exercise is the least demanding as we do not condition outstanding positions to mature in the same period.

The distinction between trade credit and the overall value of imports and exports (from customs data) is critical for our analysis, as what entails currency risk is the deferral of cash flows and the uncertainty it implies about the future value of payables and receivables in local currency.[11] Instead, cash flows paid out upfront do not entail currency risk. Information about *when* trade-credit matures is a notable feature of our data as it allows us to establish when cash flows in foreign currency occur more accurately.

In our first exercise, we examine the correlation between cash-inflows and outflows, that mature in period-t, from international trade and foreign currency debt, originated in any period $\tau_0 \leq t$. In particular, let $X_{i,t}^{CF}$ ($M_{i,t}^{CF}$) denote the log of firm i's total cash-inflows (-outflows) from (a) exports (imports) trade credit maturing in period-t, (b) exports (imports) paid-in-cash in period-t; and $FCD_{i,t}^{CF}$ the (log of) cash- inflow or outflow from contracting foreign currency debt and its repayment.[12] Our main specification, then, relates these three objects in,

$$X_{i,t}^{CF} = \alpha(M_{i,t}^{CF} + FCD_{i,t}^{CF}) + \eta_i + \eta_{j,y} + \varepsilon_{i,t}, \quad (1)$$

for sector j, period t and year y, and where we also include firm-level fixed effects (η_i) that absorb all firm and time-invariant industry characteristics and interacted industry and year fixed effects ($\eta_{j,y}$) to control for industry-year specific shocks (such as demand shocks) that could affect firms in different industries heterogeneously. We cluster the standard errors at the firm level.

The coefficient of interest is α, which captures the extent to which the value of cash-flow payables and receivables in foreign currency are aligned. A value of α equal to one would imply full natural hedging, as all cash inflows and outflows in foreign currency would be fully correlated across time. Instead, α equal to zero would imply no correlation and, thus, no natural hedging. We let t be a month, quarter, or year.

Results are presented in Panel A Table 2 for three different time frequencies. In monthly frequency, columns 1-2 show the results when only cash flows related to imports are included as

[11]This compounds the cash-flow management problem faced by firms in international trade ensuing from order/production and sales timing differences; resulting in maturity risk. Yet, maturity risk is different from the currency risk generated by future payables (receivables) in foreign currency, which is our object of analysis.

[12]In particular, consider firm i's import transaction $k(\tau_0, \tau_1)$, taking place in period τ_0 and with trade-credit maturing in τ_1, in the amount of $MT_i^{k(\tau_0,\tau_1)}$. We can construct the total cash flow for maturing-in-t imports trade credit as,

$$M_{i,t}^{CF} = \sum_{k(\tau_0,t)} MT_i^{k(\tau_0,t)}, \ \forall \ \tau_0 \leq t$$

Note that if $\tau_0 = \tau_1 = t$, total cash-flow measure $M_{i,m}^{CF}$ includes imports paid in cash in period-t. By the same token, define the total cash-flow from exports trade credit maturing in period-t, $X_{i,m}^{CF}$, and total cash-flow from foreign debt maturing in period period-t, $FCD_{i,m}^{CF}$ in the same way.

a regressor. The estimated coefficient is statistically significant, but it is quantitatively very small. In particular, a one percent increase in cash flow from imports trade-credit associates with only a 0.02% increase in cash flow from exports trade credit. Column 2 excludes MNCs and mining firms, showing that the coefficient remains statistically significant and similar in size (0.02%). In column 3, we also consider cash flows from foreign currency debt and, thus, all foreign currency payables. Yet the estimated coefficient is still similar in size. To check that our results are robust and do not hide substantial heterogeneity across groups of firms, we divide firms into four mutually excluding categories: (i) firms that engage only in international trade (exports and/or imports), do not hold foreign currency debt, and do not use FX derivatives; (ii) firms that trade, use FX derivatives but do not have FC debt; (iii) firms that trade and have foreign debt, but do not use FX derivatives; and (iv) firms that trade, have foreign debt and use FX derivatives. We create dummy variables for each of these categories, interact them with import-related cash flows, and re-estimate equation (1) with these interactions on the right-hand side. Notably, the estimated coefficients for these interaction terms remain very small (columns 4-6) and are robust to including mining firms and MNCs (column 4) or excluding them (column 5). Finally, in column 6, we restrict our sample to firms that are both exporters and importers, and our results remain unchanged. We re-estimate specifications in columns 5 and 6 in quarterly (columns 7-8) and yearly (columns 9-10) frequencies. At longer horizons, the correlation between total cash inflows and outflows is higher yet still quantitatively small. Overall, the results presented in Panel A provide little support to the hypothesis of natural hedging, as a firm's cash flow value of payables and receivables in foreign currency are only slightly correlated.[13]

The results of our second exercise confirm the same conclusions. In Table C.4 in Appendix C, we show the monthly and quarterly estimation results of estimating equation (1) considering only at-maturity cash-flows originated from trade credit and debt contracts and excluding upfront payments of operations in international trade. In this more demanding exercise, we obtain similarly low quantitative estimates.

In our third exercise, we consider the correlation between the balance (accounts receivable and payable) of outstanding import trade credit, foreign debt, and outstanding export trade credit at different frequencies. Let us denote the firm-i in period-t outstanding (log) value of trade-credit from exports (accounts receivable) and imports (accounts payable), $X_{i,t}^{TC}$ and $M_{i,t}^{TC}$ respectively; and the outstanding (log) value of foreign debt for firm i, in period-t, $FCD_{i,t}$ (accounts payable).[14] Then we re-estimate equation (1) using these outstanding balances in period-t instead of maturing cash-flows in period-t. As mentioned above, this exercise is a less stringent test of natural hedging as it does not consider that outstanding balances could

[13]These results are robust to different robustness exercises, which we present in the Appendix C. In table C.1, C.2 and C.3, we present monthly, quarterly, and yearly estimations of equation (1) with and without MNCs and mining firms.

[14]Consider firm i's import transaction $k(\tau_0, \tau_1)$ originated in period τ_0 with trade credit maturing in period $\tau_1 > \tau_0$, in the amount $MT_i^{k(\tau_0,\tau_1)}$. Then, firm i's outstanding balance in period-t $M_{i,t}^{TC}$ is defined by:

$$M_{i,t}^{TC} = \sum_{k(\tau_0,\tau_1)|\tau_0 \leq t < \tau_1} MT_i^{k(\tau_0,\tau_1)}$$

imply different maturities and, hence, a firm might not be—in fact—naturally hedged even if outstanding positions coincide.

Panel B of Table 2 presents the results of the estimation of equation (1) using outstanding balances instead of cash flows at the monthly frequency. Column 1 presents a simple correlation between firms' trade credit for exports and imports. The estimated coefficient remains statistically significant but, as above, is quantitatively small. In particular, a one percent increase in imports trade credit is associated with only a 0.02% increase in exports trade credit. Column 2 excludes MNC and mining firms, and column 3 adds foreign currency debt to import trade credit. The coefficient remains statistically significant in both cases but quantitatively very small (0.02 and 0.03, respectively). Columns 4-5 show that this pattern does not change when considering heterogeneous groups of firms. When we consider only firms that are both importers and exporters, results remain unchanged. Further, we re-estimate specifications in columns 5-6 with quarterly (columns 7-8) and yearly (columns 9-10) data and find that while our coefficients are positive and larger, they are still quantitatively small.

Overall, our results provide little support to the hypothesis that natural hedging is quantitatively significant. Firms in our sample do not seem to be using cash inflows and outflows in foreign currency to hedge the currency risk operationally. In turn, this creates room to use FX hedging to manage cash flow exposure. We turn now to assess a potential reason that would explain limited natural hedging.

Maturity and the timing of flows.— We assess a potential explanation for limited natural hedging: different maturity of inflows and outflows in foreign currency. In particular, if payables and receivables in foreign currency differ in maturity, aligning these flows from a risk management point of view could be challenging. Importantly, we do not claim this is the only explanation of why firms do not significantly engage in natural hedging—which would require additional and currently unavailable information–. Instead, we document some novel patterns that could explain to a large extent the limits to natural hedging reported above.

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 dispersion of timing of these payments is also considerable. The standard deviation of imports trade credit is 58 days, while it is 94 days for exports trade credit. The different maturities between trade credit from imports and exports and foreign currency debt suggest that it would be difficult for firms to carry out operational hedging. This type of hedging would imply considerable planning to match the maturities and amounts of multiple contracts.[15]

To explore this idea further, we focus on international trade operations and examine how cash flows of accounts payable/receivable coincide at maturity, regardless of contract dates.

Similarly, we can define firm i's outstanding balances of exports trade credit and outstanding debt in period-t, $X_{i,t}^{TC}$ and $FCD_{i,t}$, respectively. Note that outstanding balances refer only to trade-credit component (and not paid in-cash) of international trade operations.

[15]Notably, the same argument makes it unlikely for firms to engage in a "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.

Table 2: Natural hedging of firms in int. trade and/or with foreign debt

Panel A. Cash flows at maturity	Cash flows from exports, X^{CF}									
	Monthly						Quarterly		Yearly	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
M^{CF}	0.02**	0.02***								
	(0.01)	(0.01)								
$M^{CF} + FCD^{CF}$			0.02***							
			(0.00)							
$M^{CF}\times$ 1(Trade only)				0.02*	0.02***	0.05***	0.04***	0.07***	0.07***	0.12***
				(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FX)				0.03***	0.03***	0.06***	0.05***	0.08***	0.08***	0.13***
				(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FCD)				0.03	0.03*	0.07***	0.05*	0.09***	0.09***	0.13***
				(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
$M^{CF}\times$ 1(Trade, FCD and FX)				0.03	0.04**	0.04*	0.06**	0.07***	0.15***	0.20***
				(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Num. Obs. (thousands)	1625	1606	1606	1625	1606	196	712	110	261	48
R Squared	0.85	0.83	0.83	0.85	0.83	0.87	0.87	0.89	0.91	0.93

Panel B. Outstanding balances	End of period outstanding trade credit from exports, X^{TC}									
	Monthly						Quarterly		Yearly	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
M^{TC}	0.02**	0.02***								
	(0.01)	(0.01)								
$M^{TC} + FCD$			0.03***							
			(0.01)							
$M^{TC}\times$ 1(Trade only)				0.01	0.02***	0.04***	0.02***	0.03**	0.02***	0.03
				(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FX)				0.02**	0.02***	0.04***	0.02***	0.04***	0.03***	0.04**
				(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FCD)				0.07***	0.05***	0.08***	0.05***	0.08***	0.04**	0.08**
				(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
$M^{TC}\times$ 1(Trade, FCD and FX)				0.04*	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
				(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Num. Obs. (thousands)	1470	1452	1452	1470	1452	186	548	62	167	16
R Squared	0.88	0.87	0.87	0.88	0.87	0.91	0.86	0.91	0.86	0.92
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	—	—	Yes	—	—	—	—	—	—
Include MNC	Yes	—	—	Yes	—	—	—	—	—	—
Both X and M	—	—	—	—	—	Yes	—	Yes	—	Yes

Notes.— All regressions include firm and year-industry fixed effects. Panel A presents monthly- (columns 1-6), quarterly- (columns 7-8), and yearly- (columns 9-10) firm-level regressions of cash-flows from exports X^{CF}, on cash-flows from imports M^{CF}, and from foreign debt FCD^{CF}. Cash flows from international trade consider those originated from trade credit at maturity date and operations paid in cash or in advance. Panel B presents firm-level regressions of outstanding balances of exports trade credit (accounts receivable) X^{TC}, on outstanding balances of imports trade credit (accounts payable) M^{TC}, and foreign debt FCD. Only operations in US dollars, which represent close to 90% of all trade credit operations. Columns (4) to (10) different firms into four non-overlapping groups: (i) firms in int. trade (IT) only, (ii) firms in int. trade and who use FX derivatives but no foreign debt, (iii) firms in int. trade, with foreign debt but do not hold FX derivatives, (iv) firms in int. trade, with foreign debt and FX derivatives. Results in Panel A are the most demanding test of natural hedging, and conclusions from this exercise—a quantitatively very low correlation—are robust to the exclusion of upfront payments in int. trade and pooling of in/out cash-flows at quarterly/yearly frequency. See Tables C.1-C.4 in the Appendix. Clustered standard errors at the firm level reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table 3: Average maturities in international trade credit and foreign currency debt

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

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

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 a firm i and month m, $CO_{i,m}$ measures the coincident amount of cash flows (hence, the min operator) in opposing directions that matures in m as a fraction of total cash flows maturing in the same period. The statistic—multiplied by two to be bounded between 0 and 1—is defined by,

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

where $X_{i,t}^{CF}$ denotes the cash inflow from exports of periods $\tau < t$, paid with trade credit maturing in period-t, and $M_{i,t}^{CF}$ the cash outflows from imports of periods $\tau < t$ to be paid with trade credit maturing in period-t, for firm i and monthly frequency. The lower the value of this indicator, the lower the coincidence between trade credit from exports and imports, and, thus, the lower is the realized natural hedge of the firm. Inversely, the higher $CO_{i,m}$ is, the higher the level of natural hedge. 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%, which means that for the median firm, for every USD 10 in total cash flow from imports and exports, only USD 1 received from exports can be used to pay for accounts payable from imports. Likewise, the 25th and 75th percentiles are close to 7% and 50%. This analysis confirms our results in Panel A in Table 2, that Chilean firms do not match their trade receivables and payables cash flows.

More generally, differences in the timing of operational and financial milestones—the signing of the contracts, the paying of the contracts, and the honoring of the contract—are key to understanding firms' cash flow and risk management challenges. Potentially, a firm could reduce its cash-flow exposure to currency risk through different means; exploiting natural hedging, using financial instruments, or self-insuring by maintaining foreign currency cash buffers/reserves. We reasonably capture cash in/out-flows using detailed information from trade credit data to conclude that natural hedging is limited.

While completely ruling out that firms could self-insure by maintaining dollar cash reserves would require unavailable information, our proxies and robustness provide consistent evidence

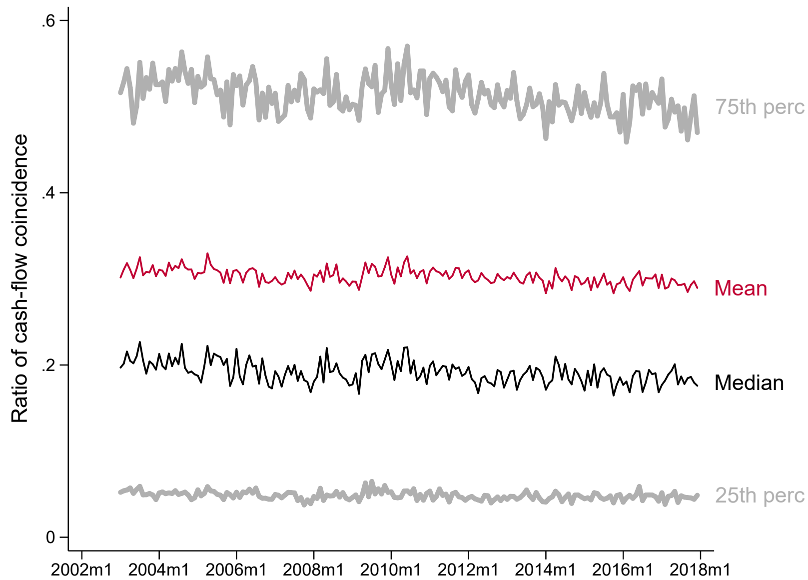


Figure 2: Coincidence of cash inflows and outflows from international trade credit

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; a solid black line depicts the median, and the dashed black line the mean across observations within a month.

of limited natural hedging.[16] Notably, evidence in the next section shows firms reduce currency risk to a large extent via the derivatives market.

4 Firms' Use of FX Derivatives

This section unveils three additional facts about firms' use of FX derivatives. We explore firms' use of FX 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 differs within and across firms and, in particular, increases in the maturity of the transaction decrease with firm size (Fact 4).

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

The last section showed that the use of natural hedging is limited; hence, many firms retain currency risk. This section explores which firms are more likely to employ FX derivatives to

[16] Cash balances for non-listed firms are hard to document, and more so, cash balances denominated in dollars. Data from Compustat shows that during 2005-2018, Chilean firms kept, on average, enough cash balances to cover 25 percent of their short-term expenditures. This is consistent with an analysis by the Central Bank of Chile that at the onset of the Covid Crisis—for the largest listed firms—overall cash holdings were approximately enough to cover for 4-8 weeks of short-term liabilities. That is, cash buffers held by firms are generally limited, and it is reasonable to argue that cash buffers in foreign currency are even more so.

hedge this risk and which transactions they are more likely to hedge.

Larger firms hedge.— We start assessing the characteristics of firms using FX derivatives. As shown in Panel A of Table 4, these firms are larger in size, measured as total employment and annual sales, and this difference is statistically significant and persistent over time (i.e., we observed a similar pattern in 2006 and 2016 and all years in between). We document similar differences in size across different samples by firms' type: when restricting the comparison to firms not participating in international trade (Panel B), firms in international trade (Panel C), and firms with foreign debt (Panel D). In all cases, firms using FX derivatives are larger. Note that this is the case even when Table 4 does not include MNCs, which we include in Table C.5 and confirm our results.

Table 4: Firm size by use of FX-derivatives

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

Notes.— Columns (1) and (4) include firms that use FX derivatives. Columns (2) and (5) includes firms which do not use FX derivatives. We exclude multinational corporations from this comparison. Columns (1), (2), (4) and (5) are expressed in levels—number of workers or millions of dollars—depending on the proxy for firm size. Columns (3) and (6) are expressed as the *log* difference between groups of firms who use FX derivatives and firms that do not, thus H0: Log-Difference = 0: * p <0.1, ** p <0.05, *** p <0.01. In this table we show years 2006 and 2016, but results are stable and hold for all other years in the 2005-2018 sample.

To more formally test that firm size is positively correlated with the use of FX derivatives, we estimate three sets of regressions with three different dependent variables: a dummy that takes a unitary value if the firm uses FX derivatives (extensive margin), the log of FX purchases and the log of FX sales (intensive margins), on our two proxies of firms' size: (log) sales, and (log) employment. Table 5 shows that both sales and employment are positively correlated with the probability of using FX derivatives, FX sales, and FX purchases, even after controlling for foreign exchange rate exposure (exports, imports, and FX debt), and year and industry fixed effects interacted in all the specifications. We also consider firms' sales and employment in the initial year and add firm fixed effects for robustness. These results confirm that larger firms are more likely to use FX derivatives at the extensive and intensive margins.

Table 5: Firm size use of FX derivatives

Panel A. Size proxied by employment						
	Firm hedges		FX purchases		FX sales	
	(1)	(2)	(3)	(4)	(5)	(6)
Workers, log	0.012***		0.126***		0.064***	
	(0.001)		(0.012)		(0.010)	
Init. workers, log		0.019***		0.212***		0.110***
		(0.001)		(0.007)		(0.005)
Observations	2,052,973	2,248,485	2,052,973	2,248,485	2,052,973	2,248,485
R^2	0.53	0.53	0.40	0.38	0.24	0.24
Firm FE	Yes	—	Yes	—	Yes	—
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Size proxied by total sales						
	(1)	(2)	(3)	(4)	(5)	(6)
Sales, log	0.005***		0.051***		0.024***	
	(0.000)		(0.004)		(0.003)	
Init. sales, log		0.009***		0.118***		0.049***
		(0.000)		(0.004)		(0.002)
Observations	2,083,707	2,261,977	2,083,707	2,261,977	2,083,707	2,261,977
R^2	0.54	0.53	0.40	0.38	0.24	0.24
Firm FE	Yes	—	Yes	—	Yes	—
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes.— Dependent variable in columns (1) and (2) is a dummy variable that takes unitary value in the firm uses FX derivatives; the extensive margin. Columns (3)-(6) are (log) firms' purchases and sales of FX derivatives. All regressors are in logs. Initial workers (sales) are the (log) of the number of workers (dollars in sales) in the initial year the firm appears in the sample. Thus, regressions on these variables exclude firm fixed effects. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Firms in international trade tend to hedge larger amounts.— The richness of our data allows us to explore further which exposures it is that firms hedge. For this, we move our analysis to exploit our data at the *transaction level*. We find that firms are more likely to hedge larger transactions/exposures. We come to this conclusion by matching transaction-level information on trade credits from imports and exports with transaction-level information from FX derivatives contracts. We rely on statistical matching because, even though we observe all FX derivative contracts and all trade-credit exposures, we cannot observe whether a given FX derivative contract is bought to hedge a particular trade-credit exposure. Thus 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 made, then keep the original un-coarsened amount. In this sub-section, we focus on firms in international trade that engage in FX hedging but do not have foreign debt. This allows us to perform a cleaner and more conservative exercise.[17]

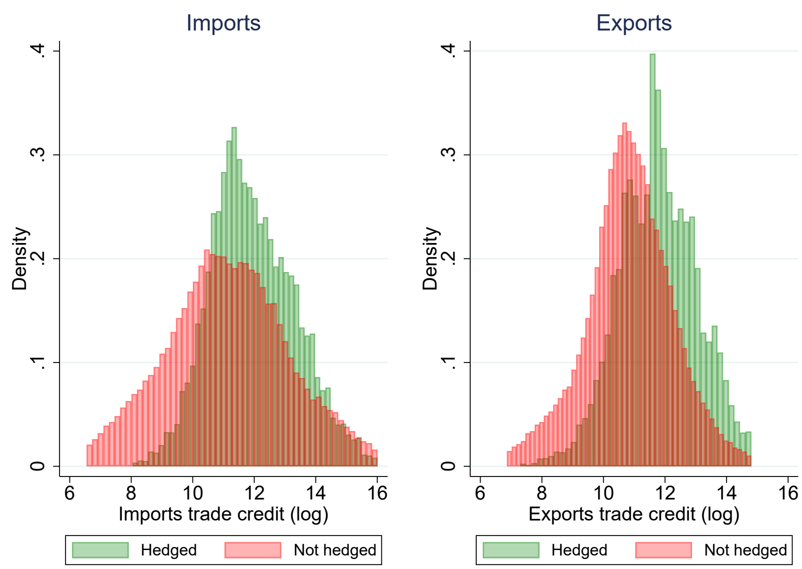


Figure 3: Trade credit exposure amount by hedging category

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, and amount level. The horizontal axis is the size of the transaction. This exercise uses firms participating in international trade and the FX derivatives market but holding 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 into 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

[17]In this exercise, we exclude firms with foreign debt from this exercise debt contracts are usually large-amount operations that can be hedged with more than one FX contract or only partially. Not being able to find *one* hedge for a debt contract—which is at least partially hedged with more than one instrument—would bias our results towards concluding that larger amounts go un-hedged. Note also that 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.

more likely to be observed. Put differently, this figure suggests that imports and exports trade credits of smaller values are less likely to be hedged than larger value transactions.[18]

We test formally whether larger amounts of trade credit correlate finding a matching FX derivatives contract. We estimate equation (3) at the transaction level,

$$A_{c,i,m} = \alpha \times Transaction_c\ hedged + \eta_i + \eta_m + \epsilon_{c,i,m}, \tag{3}$$

where $A_{c,i,m}$ is the trade-credit exposure (log of U.S. dollar amount) from operation-c for firm-i in month-m, $Transaction_c\ hedged$ is a dummy variable with unitary value if a match between trade-credit exposure and a hedging contract has been found, η_i denotes firm fixed effects, and η_m month fixed effects. Panel A in Table 6 reports the results for exports trade credit and shows that—on average—hedged trade credit operations are 63% larger than non-hedged ones (entire sample period 2005-2018). Similarly, Panel B indicates that hedged trade credit operations from imports are above 59% larger than non-hedged trade-credit import operations. These results are robust to focusing on one year only (2006, 2016 in columns 1, 2, 4, and 5) or our entire sample period (2005-2018 in columns 3 and 6).

Table 6: Size of international trade exposure by hedging policy

	A. Exports trade credit (logs)			B. Imports trade credit (logs)		
	2006	2016	2005-2018	2006	2016	2005-2018
	(1)	(2)	(3)	(4)	(5)	(6)
Trans. hedged	0.765***	0.516***	0.630***	0.561***	0.545***	0.591***
	(0.123)	(0.144)	(0.110)	(0.065)	(0.103)	(0.047)
Observations	14,948	6,576	213,364	15,146	8,224	196,104
R^2	0.40	0.37	0.32	0.36	0.35	0.31
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	–	–	Yes	–	–	Yes

Note.– Dependent variable is (log) trade credit from imports (Columns (1-3)) and exports (Columns (4-6)). Variable *Trans. hedged* takes unitary value if trade-credit exposure is found to have a matching FX derivatives contract for a similar amount, maturing in the same period. The sample considers only firms in international trade with no foreign debt. Hedging definition considers the use of FX forwards. Standard errors clustered at the firm level in parentheses * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Our results showing that firms that engage more in FX derivatives—both at the extensive and intensive margins—are larger, echo existing literature showing that firms in international trade are larger (Bernard et al. 2007; Melitz 2003; Antràs et al. 2017; Helpman et al. 2004; Alfaro and Chen 2018). Similarly, Salomao and Varela (2022) reports that only high productivity firms use

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

foreign currency borrowing.[19] The findings are also consistent with Rampini and Viswanathan (2010) who argue that larger firms engage in risk management while small firms do not. However, our analysis digs deeper into firms' decisions and shows that firms are more likely to hedge transactions for larger amounts. This finding suggests not only that there is selection in the FX derivatives markets at the firm level but also that there is selection at the *transaction level*, suggesting the existence of a fixed cost at such level.

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.*

This section characterizes firms' use of FX derivatives at extensive and intensive margins. At the extensive margin, we show that firms in international trade are more likely to employ FX derivatives.[20] At the intensive margin, we show that firms using FX derivatives hedge gross—rather than net—currency risk exposures, consistent with limited use of natural hedging. This result contrasts with most of the literature focused on net positions.

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 a 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 debt, respectively. We also include firm fixed effects η_i, and industry and year fixed effects interacted $\eta_{j,y}$ and cluster the standard errors at the firm level.

Table 7 presents the results for the extensive margin. 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 export trade credit increases the probability of using FX derivatives by 0.02 percentage points. The probability of using FX derivatives is slightly higher for imports:

[19] As noted by Gabaix (2011), Acemoglu et al. (2012), di Giovanni et al. (2014), shocks to larger firms can affect aggregate output as these do not get diversified in the aggregate. Granularity effects are likely to be even more critical in emerging markets, which tend be less diversified. Recent financial crisis episodes highlight the close link between the vulnerabilities of systemically large firms, bailout guarantees, and moral hazard; see discussion in (Alfaro et al. (2019).

[20] Firms using FX derivatives typically engage in international trade and/or hold foreign debt. Panel A in Figure B.4 in the Appendix shows the number of firms using FX derivatives by mutually exclusive firm groups: 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. Panel B of the same figure confirms this pattern when considering the value of the FX outstanding position.

Table 7: Firms' use of FX derivatives at the extensive margin

	Firm uses FX derivatives						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.021***			0.020***	0.022***	0.022***	0.019***
	(0.004)			(0.004)	(0.004)	(0.004)	(0.004)
M^{TC}		0.055***		0.054***	0.058***	0.058***	0.057***
		(0.005)		(0.005)	(0.005)	(0.005)	(0.005)
FCD			-0.016***	-0.015***	-0.014**	-0.012**	-0.007
			(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
$X^{TC} \times M^{TC}$					-0.008**	-0.008**	-0.007**
					(0.004)	(0.004)	(0.003)
$X^{TC} \times FCD$					0.004	0.002	-0.000
					(0.003)	(0.003)	(0.002)
$M^{TC} \times FCD^{TC}$					-0.006**	-0.006**	-0.006**
					(0.003)	(0.003)	(0.003)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
$R2$	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	—	—	—	Yes	Yes
Includes Mining	—	—	—	—	—	—	Yes

Notes.— All regressors variables in logs. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. X^{TC} stands for outstanding exports trade credit, M^{TC} for outstanding imports trade credit, and FCD for the outstanding stock in foreign debt. Constant terms are not reported. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. Clustered standard errors at the firm level are reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

0.06 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.[21] 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 as seen in columns (6) and (7) and across time sub-samples. Also, our main specification focuses on dollar-denominated FX forwards, which represent the lion's share of all FX derivatives. Still, the results hold after including swap contracts and different currencies (see Table C.6 in the Appendix).

The intensive margin.— We now turn to examine the intensive margin of firms' use of

[21] 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.

FX hedging. We first study whether the outstanding balance of firms' FX derivatives positively correlates with their foreign-currency receivables and payables. In particular, we compute the 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 8 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 positive trade credit balances from exports (columns 1 and 4-7). Interestingly, the covariate imports trade credit is also positive and statistically significant (columns 2 and 4). Yet this positive correlation is driven by firms that both import and export. To see this, we further split the sample between imports by exporters and imports by non-exporters and re-estimate our regression. Column 5 shows that the coefficient for imports is only statistically significant for imports by exporters. Once all controls are included in the analysis (column 5), the estimated coefficient for export trade credit indicates that a one percent increase in export trade credit is associated with a 0.046% rise 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 strongly relates to buying dollars forward. The estimated coefficient implies that a one percent increase in imports correlates with a 0.16% rise 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—not to purchase FX forwards to hedge their FC debt levels. Further, the result is robust to dissecting outstanding FCD into different maturities and all currencies; (see Tables C.7 and C.8 in Appendix).[22] These results indicate that firms' FX derivative gross (short or long) position is associated with their gross exposure in foreign currency stemming from international trade credit. That is, importers hold long positions in FX derivatives (they "buy the forward dollar"). In contrast, exporters hold short positions in FX derivatives ("they sell the forward dollar").

Next, we assess whether the correlation of gross positions is present at the aggregate level. To this end, we aggregate all exports' trade credit and all imports' trade credit and compare them with aggregate FX derivative's short and long positions, respectively. The correlation between exports trade credit and short FX positions Panel A of Figure (4) is high and reaches 0.79. Similarly, the correlation between imports' trade credit and long FX positions (presented in Panel B of the same figure) 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.[23] Note further from comparing

[22]Note that, only when we include FX swaps in the purchase-of-FX derivatives regression, the coefficient of foreign currency debt is significant for maturities lower than one year and non-statistically significant for longer periods, suggesting that firms purchase FX forwards to manage the cash flow within a year.

[23]For robustness, we conduct an additional test and assess these correlations from an ex-post perspective. That is, we consider cash flows at the 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. The correlation between exports trade-credit maturing in m and FX short derivatives maturing in the same period is close to 0.8.

Table 8: Firms' use of FX derivatives at the intensive margin

Panel A. Short position							
	Sales of FX derivatives, log						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.047***			0.047***	0.046***	0.045***	0.033***
	(0.008)			(0.008)	(0.008)	(0.008)	(0.009)
M^{TC}		0.014*		0.012*			
		(0.007)		(0.007)			
FCD			-0.015	-0.015	-0.015	-0.018	-0.012
			(0.013)	(0.013)	(0.013)	(0.012)	(0.011)
M^{TC} by exp.					0.022**	0.022**	0.027***
					(0.009)	(0.009)	(0.010)
M^{TC} by non-exp.					0.001	0.001	0.006
					(0.007)	(0.007)	(0.008)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
$R2$	0.54	0.54	0.54	0.54	0.54	0.53	0.53
Panel B. Long position							
	Purchases of FX derivatives, log						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
X^{TC}	0.005			0.001			
	(0.008)			(0.007)			
M^{TC}		0.155***		0.155***	0.155***	0.155***	0.146***
		(0.015)		(0.015)	(0.015)	(0.015)	(0.015)
FCD			-0.007	-0.005	-0.005	-0.004	-0.001
			(0.014)	(0.013)	(0.013)	(0.013)	(0.011)
X^{TC} by imp.					0.003	0.002	0.001
					(0.009)	(0.009)	(0.008)
X^{TC} by non-imp.					-0.004	-0.003	-0.003
					(0.006)	(0.006)	(0.006)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
$R2$	0.64	0.65	0.64	0.65	0.65	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	—	—	—	Yes	Yes
Includes Mining	—	—	—	—	—	—	Yes

Notes.— All variables in logs. Dependent variables are end-of-month balances of sales (Panel A.) and purchases (Panel B.) of FX derivatives. Regressors are outstanding balances of export/import trade credit and foreign debt. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

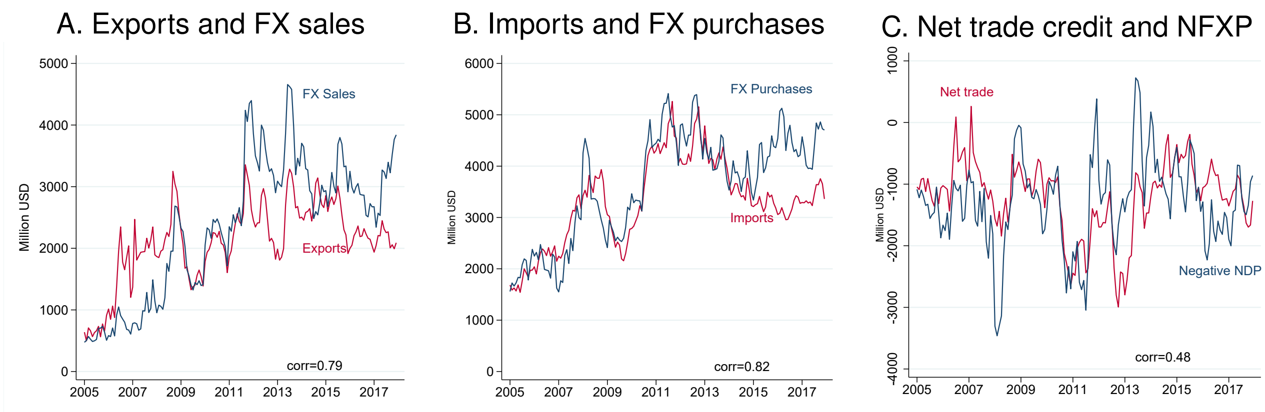


Figure 4: Trade Credit balances related to international trade and FX gross derivatives positions

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. The sample in this figure excludes firms with foreign debt to avoid biasing the estimation of FX derivatives upwards. Correlations between series are 0.79 for exports, 0.82 for imports, and 0.48 for net trade credit. The used sample also excludes multinational corporations and mining companies. Inclusion of these firms does not affect the results and can be seen in Figure B.5 in the Appendix.

Table 1 Panel B and Table 3 that the median maturity of forward purchases (89 days) is similar to that of import trade credits (88 days) while that of forward sales (113 days) is close to that of export trade credits (115 days). Consistent additional evidence is given by the fact, that higher cash flow coincidence correlates with lower use of FX derivatives at the extensive margin and lower FX purchases, as shown in Table C.9 in the Appendix. These results provide additional supportive evidence that firms use FX derivatives to hedge *gross* —rather *net*— exposures, driven by the different timing of flows.

Altogether, these findings further confirm that firms do not use all foreign currency receipts to naturally hedge, as documented in Section 3 or self-insure. Instead, they rely on the financial derivative market to manage the timing differences between payables and receivables.

The role of exchange rate dynamics at the extensive and intensive margins.—. An important consideration in using FX derivatives is the evolution of the nominal exchange rate, as these instruments are conceived to hedge currency risk. We assess whether the evolution of the exchange rate and the expectation over its future value affect the intensive and extensive margins of FX derivatives.

To this end, we complement our data with information from the Survey of Financial Forecaster, conducted by the Central Bank of Chile on a monthly basis. We then construct several variables: the dispersion in the exchange rate forecasts across forecasters (dispersion), the realized exchange rate depreciation over the last year (realized depreciation), and the mean expected exchange rate changes at a 12-month horizon (expected depreciation).

Table C.11 in the Appendix C shows the results of augmenting equation (4) to include these variables. We find that the higher the disagreement of forecasters about the future exchange rate change, the higher the use of FX derivatives at the extensive and intensive margins. In particular, one standard deviation increase in the dispersion of forecasts is associated with a 5.1 percentage point higher probability of using FX derivatives (Column 2). Forecast dispersion also increases the purchases and sales of foreign currency forwards, as shown in columns 3-6. This indicates that uncertainty about the future value of the exchange rate leads firms to use more FX hedging. Columns 3-6 show that *expected* depreciation is associated with higher purchases and lower sales of foreign currency forward. Realized depreciation is associated with lower purchases and higher sales of foreign currency forward. Interestingly this would suggest that firms have some mean reversion in their expectations. Yet the estimated coefficients for realized depreciation are one order of magnitude smaller than the expected depreciation, indicating that future trends are more important in firms' FX hedging decisions.

FACT 4. *FX derivatives contracts are priced differently.*

To further understand firms' use of FX derivatives, we zoom in and employ our *transaction-level* data to assess patterns in the contracted forward exchange rates in each FX derivatives contract.[24] We then exploit the OTC nature of the FX derivative market in Chile to assess whether there is heterogeneity in the forward premium within and across firms.

Denote by $F_{c,d,N}$ the agreed forward exchange rate in an FX contract c, signed in day d and matures in N days. Then, $F_{c,d,N}$ contains both the expected currency depreciation and any premium. Also, denote by $FXP_{c,d,N}$ the forward premium in contract c, day d for maturity N, which can defined either for sales or purchases operations (see Shapiro 1996). The spot (S_d) and the forward exchange rates are defined in pesos per US dollar.

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

To test these relationships statistically, we consider the following specification

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

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

[24] As discussed in Duffie et al. (2005), Bekaert and Hodrick (2017) and Hau et al. (2021), in OTC markets, financial intermediaries tend to price discriminate across customers.

Table 9: Forward premium (percentage, contract level)

	FX Purchases		FX Sales	
	(1)	(2)	(3)	(4)
Maturity	0.425**	0.425**	-2.117***	-2.120***
	(0.197)	(0.197)	(0.384)	(0.384)
Firm size	-0.157*	-0.156*	0.075	0.076
	(0.086)	(0.087)	(0.132)	(0.132)
Contract notional amount		0.014		-0.046
		(0.052)		(0.067)
Delivery instrument		0.158		-0.330
		(0.198)		(0.336)
Observations	343,621	343,621	133,424	133,424
R^2	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 ($N_{c,i,b,d}$), firm size is calculated using firms' sales. Standard errors clustered at the firm level in parentheses. Statistical significance: * p <0.1, ** p <0.05, *** p <0.01.

Table 9 presents the results. Columns 1 and 2 show firms' purchases of FX derivatives. Column 1 shows that maturity positively and significantly correlates with the forward premium, which implies that larger maturities are associated with a higher (per day) average forward premium. Importantly, this correlation persists even after controlling for time-varying trends—such as month and bank-month fixed effects interacted that control for trends in the exchange rate—, the notional amount of the derivative, and the delivery type instrument (column 2). Interestingly, larger firms—measured by sales volume—pay a lower forward premium on average. 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 instrument's maturity. It is worth noting that the notional contract amount does not significantly affect the forward premium charged for purchases or sales. Table C.10 in the Appendix presents additional robustness tests controlling for firm characteristics.

These results indicate that financial intermediaries charge a higher premium for transactions farther in the future, both for sales and purchases of FX derivatives, and that larger firms enjoy lower premiums for FX purchases.

Taking Stock

Firms in international trade are prone to cash-flow currency mismatches. Our results indicate that firms employ FX derivatives to manage cash flow exposure, arguably motivated by market imperfections that deviate from the Modigliani-Miller assumptions. For example, financial hedging can add value to the firm in the presence of costly external finance and costly financial distress (Froot et al. 1993). Capital market imperfections may, at the same time, limit its use (Rampini and Viswanathan 2010). In the remainder of this section, we examine how different deviations from the frictionless neoclassical framework shape firms' hedging decisions.

The first set of results concerns frictions in the timing and maturity of payments, which contribute to explaining the low correlation between (cash-flows from) trade credit for exports, imports, and FC debt (*Fact 1*). Thus, firms' limited natural hedging indicates that firms are exposed to the currency risk, which in turn provides a motive for using FX derivatives.

Additional results present further evidence. Firms with lower cash inflow-outflow coincidence, as measured by coincidence indicator in equation (2), tend to use more FX derivatives at the extensive and intensive margins—see Table C.9 in the Appendix—. Timing frictions are also consistent with firms' use of FX derivatives for hedging gross rather than net exposures, as seen in Figure 4, (*Fact 3*). Also, higher currency risk is associated with higher use of FX derivatives at the extensive margin and intensive margins, as shown in Table C.11 in the Appendix. That the timing and maturity of cash-flows matters are also consistent with maturity premium that is heterogeneous across firms and contracts (*Fact 4*).

The second set of results suggests the presence of costs for firms operating in this market. Not only are larger firms more likely to use FX derivatives, but hedging is partial, with larger transactions more likely to be hedged (*Fact 2*), suggesting a fixed cost at the transaction level—on top of any cost at the firm level—which could potentially arise from costly financial intermediation in OTC markets.[25] Table C.9 in the Appendix points out that more complex firms employ FX hedges more, as firms importing and exporting to a larger set of countries have a higher probability of using FX hedges and use them more intensively.

Selection of larger firms into the FX derivative market (*Fact 2*), though, is also consistent with the presence of financial frictions, as discussed by Rampini and Viswanathan (2010) and Rampini et al. (2014). To assess whether and how financial constraints affect firms' FX derivative choices, we re-estimate equation (4) and control for financial constraints. More precisely, we proxy financial frictions with two variables: (i) *Delinquency*: a dummy variable equal to 1 if the firm has a non-performing loan and 0 otherwise; and (ii) *credit line*: a dummy if the firm has an available credit line with a bank. We employ credit line as a proxy for financial frictions following Sufi (2007), who shows it is a powerful proxy for financial constraints and superior to other measures used in the literature.

Table 10 presents the results on financial frictions. At the extensive margin, Column (1) shows that financial frictions associate with less use of FX hedging at the firm level. In particular, having a non-performing loan is associated with a lower probability of using FX hedging by 2 percentage points. At the intensive margin, having a non-performing loan associates with lower sales of FX hedges by 0.8% (Column (3)) and purchases by 1.6% (Column (5)). Columns (2), (4), and (6)

[25] Such fixed cost could be associated with managerial constraints as discussed in Geczy et al. (1997). Similarly, Hau et al. (2021) document heterogeneity transaction costs related to client sophistication using data for France in 2016.

Table 10: Use of FX derivatives : Financial Constraints

	Firm uses FX derivatives		Sales FX derivatives		Purchases FX derivatives	
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.020***	0.019***	0.047***	0.046***	0.000	0.000
	(0.004)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)
M^{TC}	0.054***	0.054***	0.012*	0.012*	0.155***	0.155***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.015)	(0.015)
FCD	-0.015***	-0.016***	-0.015	-0.015	-0.005	-0.005
	(0.005)	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Delinquency	-0.024***	-0.022***	-0.008**	-0.008**	-0.016***	-0.015**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Credit line		0.011***		0.005**		0.007***
		(0.002)		(0.002)		(0.002)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326
R^2	0.53	0.53	0.54	0.54	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes.— All regressors in logs. Supra-index TC stands for trade credit. All regressions include firm, year -industry fixed effects. Non-performing loans (delinquency) is a dummy variable equal to 1 if the firm is in default in the banking system. The credit line is a dummy variable equal to one if the firm has a credit line in the banking system. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

add firm-level credit line as a covariate and show that, as expected, access to credit increases firms' use of FX hedging. Both the probability of using FX derivatives and purchases and foreign currency sales forwards increase in the access to credit. Interestingly, the credit line variable does not overpower the negative impact of having a non-performing loan in the use of FX hedging, confirming that financial frictions lower firms' ability to use FX hedges. Furthermore, financial constraints—as measured by our proxies—do not affect the forward premium (Table C.10 in the Appendix). This is an expected result given several institutional features of the market, including that more than 75% of the forward contracts are non-deliverable (see Appendix A).

Importantly, accounting for financial constraints does not affect our main results—namely, exports and imports associated with higher use of FX hedges— as the main coefficients remain statistically significant and similar in magnitude to those of Tables 7 and 8.

Overall, our interpretation of the results is that firms' use of FX derivatives is consistent with underlying frictions for cash-flow management, notably the timing of payments. At the same time, transaction-level fixed costs and financial constraints at the firm level limit the use of FX derivatives (see Alfaro and Calani, 2022). The evidence suggests that using financial derivatives adds value to the firm, as firms employ them even in the presence of fixed costs and financial frictions and more so when faced with higher exchange rate volatility. In the Appendix E, we present additional results based on propensity score matching and coarsened exact matching.[26]

In the next section, we go one step further and study whether the liquidity of the foreign exchange rate market can affect firms' hedging decisions and operations and their effects by exploiting a regulatory change to Pension Funds Managers (PFs) that resulted in a temporary halt in the selling of FX derivatives to firms.

5 Macroeconomic Adjustment: A Supply Shock to the FX Derivative Market

In this section, we leverage an aggregate, exogenous (to the firm) shock to the FX derivatives market to better understand firms' hedging policies at the extensive and intensive margins and assess the ensuing financial and real effects of changes in their hedging activity. In particular, we exploit a regulatory change to Pension Funds Managers (PFs), which resulted in a temporary halt of their selling of FX derivatives in 2012/2013—an aggregate liquidity shock—. We start by describing the regulatory change and the empirical strategy. We next study how the supply shock affected firms' FX hedging policies, the forward premium paid by firms, and firms' financial and real outcomes. Lastly, we conduct a back-of-the-envelope calculation to evaluate its aggregate impact.

5.1 Regulatory Change of the FX Derivative Markets—An Aggregate Shock

All non-military formal workers save a mandatory 10% of their wages from financing their retirement income through a fully funded pension system. These savings are managed by Pension Funds (PFs), which are arguable, the largest and most important institutional investors in the economy. Not surprisingly, PFs are among the largest holders of gross positions in FX derivatives. By the end of 2018, they held 41.3 billion U.S dollars in FX-derivatives, which amounts to 30% of the commercial banking credit and 15% of GDP (Panel A in Figure 5). More prominently, they are the largest net sellers of FX derivatives and, at times, the only net suppliers of U.S. dollars in the forward market (Panel B in Figure 5). Firms, as shown above, both sell and buy FX derivatives but are on the net, on the buyer side of the market. Yet, PFs and firms seldom transact derivatives directly. In this OTC market, instead, almost all operations go through commercial banks who act as (decentralized) intermediaries—they are in a good position to establish the required covenants, contracts, and lines of credit with firms— and potential arbitrageurs (Figure 6). Importantly, by regulation, banks retain minimal foreign currency exposure, if any at all. They tend to unwind any position they take in the forward or spot FX market. Appendix A elaborates in more detail banks' institutional arrangements.

[26] Note that risk exposure need not entail fully hedging—completely insulating from hedgeable risk—to be optimal; see discussion in Froot et al. (1993).

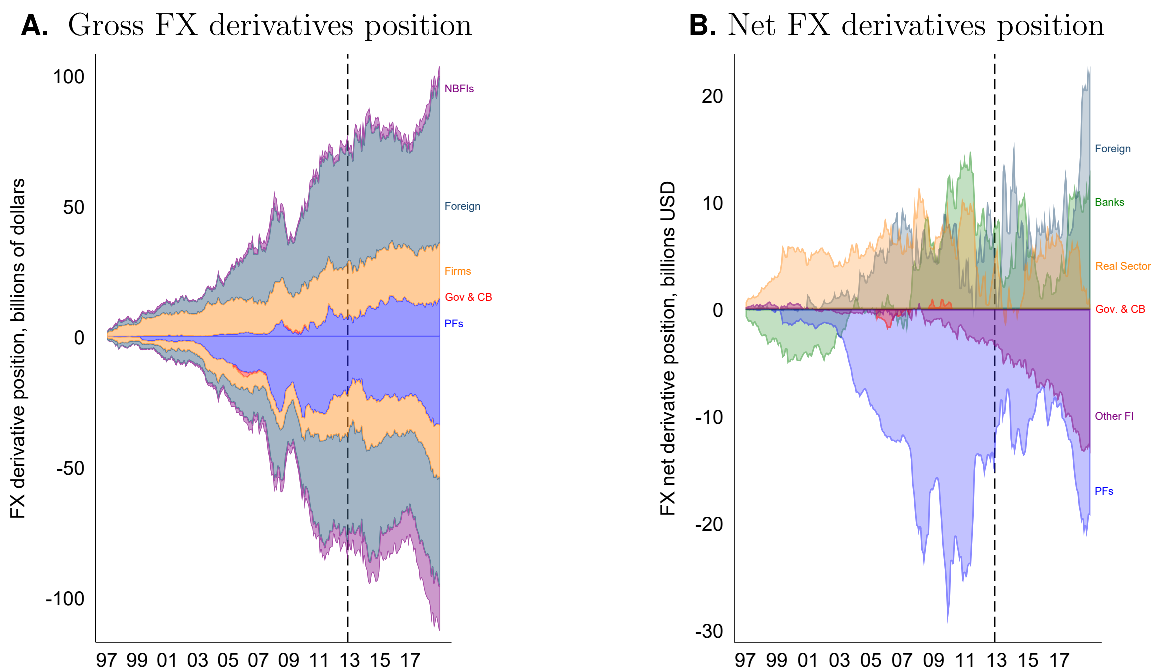


Figure 5: Pension Funds' gross and net positions in the FX derivative market

Notes.— Panel A. shows gross positions for every agent type, with all counterparties. Banks intentionally omitted in this figure to better visualize other agents' positions. Banks are the counterparty for most of the transactions included in this panel and are one of the largest sellers and buyers of FX derivatives. Official statistics report only banks' positions with other agents, leaving out non-bank intermediated transactions. Data corrected to account for discrepancies (see Appendix A for further discussion). Panel B., net positions. Both panels are in billions of dollars.

PFs regulation dictates an upper limit, for each Fund, to the share of the portfolio invested overseas that is *not* hedged. In May 2012, the Pension Supervisor consulted the Central Bank of Chile regarding new limits for the un-hedged portfolio invested abroad. After the favorable assessment, in June of the same year, the regulator determined that starting on December 1st, 2012, PFs would be allowed to increase their share of non-hedged portfolios from 15%-50% (depending on the investment Fund) to a general 50%.[27] In practical terms, this change in regulation implied that PFs were holding a 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

[27]See Table C.12 in the Appendix. Resolution number 46 by the Superintendence of Pensions, referring to operations in foreign currency derivatives and currency risk hedging, available at `https://www.spensiones.cl/portal/institucional/594/w3-article-8717.html`. Additionally, the change in regulation incorporated the notion of hedging the currency of the underlying asset, which generates currency risk. Before it, assets denominated in foreign currencies different than the US dollar were hedged in the accounting currency of the portfolio, which included them, usually the US dollar. Appendix C.13 presents additional details.

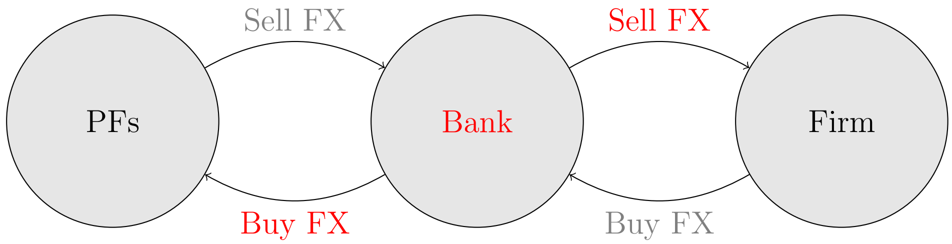


Figure 6: OTC Market: Outstanding FX purchases ans Sales—Pensions, Banks, Firms

positions (e.g., importers and foreign currency borrowers), as the commercial banking system—the most common intermediaries— refrained from holding currency risk by regulation and passed this negative liquidity shock onto firms. The change in supply from PFs was essential to the market, as shown by the blue line in Figure 7 which reports the total sales of FX derivatives of PFs to the banking system. In line with the announcement of the regulatory change (May 2012), the sales of FX derivatives by PFs started decreasing. They saw their most significant drop at the moment of implementation of the regulatory change in December 2012. The decline between the moment before the first announcement to six months after the regulation took place was more than five billion U.S. dollars.[28]

Identification Strategy.— The nature of the (negative and temporary supply) shock described above makes it exogenous from the market participants' perspective. This is especially true for firms. 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 PFs. 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 but only implemented in December 2012, PFs could have anticipated it and started reducing their supply of FX derivatives before its implementation (as suggested in Figure 7). To address this concern, we define the "before" period as 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 of the reform by some PFs. This characterization has the additional advantage of comparing the same months (December to May) and dealing with seasonality that could arise from firms' operating in different economic activities. We refer to this analysis as the "six-month window". To test whether the length of the window does not drive our results, we conduct robustness tests with a "four-month window", which covers December 2001- March 2012 and December 2012-March 2013 for the before and after periods.

The analyzed change in regulation was arguably exogenous to firms' individual hedging de-

[28] Notably, foreign banks can operate in Chile by forming a new (domestic) bank or installing a branch. In either case, the same regulation applies as with local banks (art. 34, General Banking Bill). This includes liquidity and capital requirements and risk weights on currency mismatches.

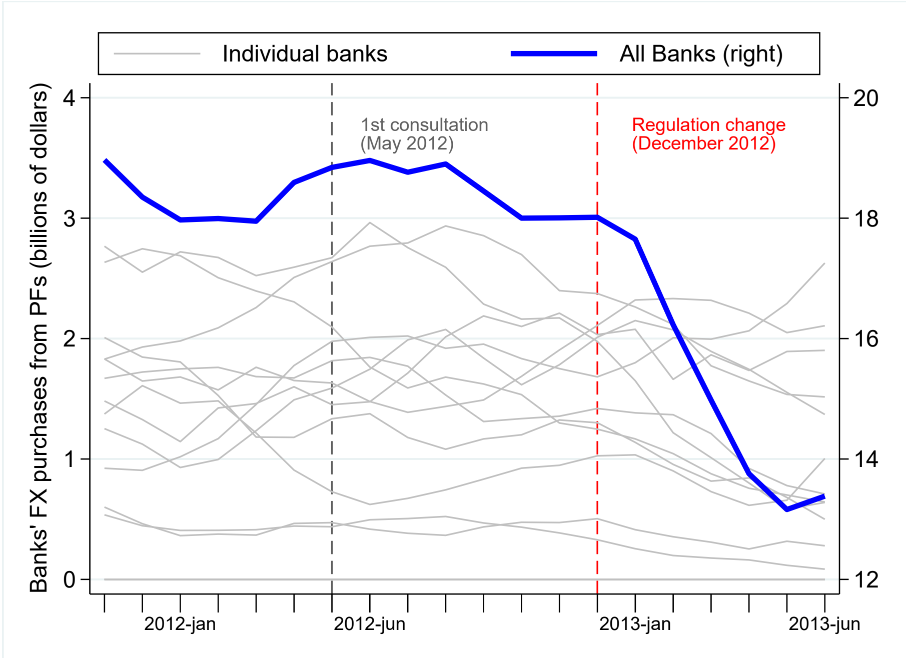


Figure 7: Outstanding FX purchases from Banks to Pension Funds ($ billions)

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 (unreported names due to confidentiality restrictions); the blue line represents the total outstanding (long) position of banks with pension funds; the green line represents (long) outstanding position by one specific bank, which we use as a benchmark case in empirical exercises.

cisions. 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 on the period before the announcement of the policy to avoid any anticipation effect from firms and, hence, simultaneity bias.

5.2 Empirical Results

In this section, we study whether the decrease in the supply of FX derivatives issued by PFs affected firms' hedging activity. First, we exploit the regulatory change and estimate a difference-in-difference model where we estimate the average response of firms across all banks.

Average Effect Across Banks.— We start our analysis with a difference-in-difference estimator, in which we estimate the average impact of the regulatory change on firms' hedging positions across banks. To 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:

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

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. Further, we estimate this regression using the annual growth rate of FX's outstanding position as the dependent variable.

Table 11: Firms' purchases of FX derivatives before and after change in regulation

Panel A. Six months window Before: Dec 2011-May 2012 / After: Dec 2012-May 2013								
	Firms with multibanking				All firms			
	Outstanding, log		Annual growth (%)		Outstanding, log		Annual growth (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post	-0.140**	-0.150**	-0.445***	-0.441***	-0.098**	-0.091*	-0.234***	-0.233***
	(0.067)	(0.070)	(0.098)	(0.104)	(0.045)	(0.046)	(0.085)	(0.087)
Observations	458	458	434	434	1420	1412	1226	1220
R squared	0.93	0.93	0.50	0.51	0.92	0.92	0.44	0.44

Panel B. Four months window Before: Dec 2011-Mar 2012 / After: Dec 2012-Mar 2013								
	Firms with multibanking				All firms			
	Outstanding, log		Annual growth (%)		Outstanding, log		Annual growth (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post	-0.158**	-0.171**	-0.520***	-0.530***	-0.119**	-0.120**	-0.305***	-0.316***
	(0.076)	(0.079)	(0.107)	(0.112)	(0.047)	(0.049)	(0.089)	(0.092)
Observations	450	450	423	423	1240	1234	1064	1060
R squared	0.91	0.91	0.52	0.52	0.92	0.92	0.45	0.45
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Incl. mining	Yes	—	Yes	—	Yes	—	Yes	—

Notes.— Dependent variables are (log) of outstanding gross long derivatives positions (columns 1-2) and annual growth rate of gross long derivatives positions (columns 3-4). Regulation change entered into force in December 2012. Clustered standard errors at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

Table 11 presents the results. In columns 1-4 we present the results for all firms that had FX contracts with more than one bank. In columns 5-8 we include all firms. The estimated coefficients are negative and statistically significant in all specifications. They indicate that, within the six months of the regulatory change, firms contracted their purchases by almost 15% (Panel A, columns 1-2) and reduced their growth rate by half (Panel A, columns 4-6). Our results are robust to including mining and MNCs (columns 1 and 3) and to consider a four months window (Panel B).

Heterogeneous Effects: Banks' Individual Supply Changes of FX Derivatives.— To dig deeper and explore the impact and adjustment of the shock across the financial system and firms, we exploit that in Chile, FX derivatives are mostly transacted through the OTC market with the banking sector. We employ firms' multi-bank relationships to control for firms' demand of FX derivatives, to further explore the micro-level adjustment of the market.

Although the reform can be unambiguously defined as a negative supply shock to firms, and we limit our analysis to six months after the shock to avoid any confounding force, firms could have potentially changed their demand for FX derivatives during the period under study. In particular, we saturate our regressions with time-varying firm and bank fixed effects and obtain banks' individual coefficients that capture their 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.

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

where $D(FX_{i,b,\tau})$ is the change in firm i's outstanding FX-purchases from bank b between before ($\tau = 0$) and after ($\tau = 1$) the regulatory change, $\alpha_{i,\tau}$ is a firm-time fixed effect, $\beta_{b,\tau}$ is a bank-time fixed effect and $E[\varepsilon_{b,i,\tau}] = 0$. The empirical model in equation (8) separates the channels for outstanding hedging contracts between bank b and firm i. If hedging varies because a firm-specific shock hits a firm, 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 Khwaja and Mian (2008), Amiti and Weinstein (2018), and Alfaro et al. (2021), 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.In particular, we keep firms with hedging activities with more than two banks and include firm-time fixed effects in our regressions. This allows us to control firms' time-varying demand for hedging instruments and capture only the supply shock due to the regulatory change on pension funds. Furthermore, this exercise allows us to recover the decrease in the supply of FX derivatives of each bank and, hence, observe the heterogeneous impact of the regulatory shock across banks.

Table 12 presents the estimated coefficients $\hat{\beta}_{b,\tau}$. The results in Panel A show that the regulatory change reduced banks' supply of FX derivatives to all firms (column 1) and firms in international trade (column 3). Most of the individual coefficients of banks are negative and statistically significant, meaning that each of these banks reduced their supply of FX derivatives to firms. Columns 2 and 4 show the cumulative market share of banks. We do not report the market share of each bank 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 substantially affected the supply of FX derivatives from PFs to banks and from banks to firms.

We next consider the same framework of analysis to assess the effects of the change in regulation on the forward premium $FXP_{i,b,t}$. In particular, we re-estimate equation (8) using the forward premium $D(FXP_{i,b,\tau})$ as dependent variable, where $D(FXP_{i,b,\tau})$ is the change in the

Table 12: Banks' sales of FX-derivatives to firms: supply side

Panel A. Quantities					*Panel B. Prices*				
	Firms' FX purchases (growth, %)					Forward premium (pp.)			
	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***	0.49	-0.481**	0.47	Bank e	1.261**	0.40	0.098	0.43
	(0.169)		(0.187)			(0.416)		(0.394)	
Bank 6	-0.663***	—	-1.451**	—	Bank f	1.108***	—	1.165**	—
	(0.153)		(0.552)			(0.345)		(0.395)	
Bank 7	-0.507***	—	-0.455***	—	Bank g	0.945**	0.76	1.342**	0.81
	(0.128)		(0.147)			(0.342)		(0.459)	
Bank 8	-0.498**	—	-0.562***	—	Bank h	0.539	—	0.448	—
	(0.167)		(0.137)			(0.815)		(0.573)	
Bank 9	-0.495***	—	-0.615***	—	Bank j	0.100	—	-0.698	—
	(0.124)		(0.104)			(0.633)		(0.670)	
Bank 10	-0.475***	0.89	-0.440***	0.88	Bank k	-2.448	—	-10.718***	—
	(0.120)		(0.100)			(1.985)		(2.816)	
Bank 11	-0.193	—	-0.127	—	Bank l	-3.007**	—	-2.126***	—
	(0.143)		(0.130)			(1.007)		(0.685)	
Bank 12	-0.160	1.00	-0.118	1.00	Bank m	-4.491	1.00	-5.693	1.00
	(0.150)		(0.168)			(4.048)		(3.259)	
Obs.	697		599		Obs.	492		415	
R^2	0.48		0.49		R^2	0.41		0.91	

Note.— Table shows bank fixed effects $\beta_{b,t}$ in columns 1 and 3, and cumulative share in total sales of FX derivatives to firms by banks in columns 2 and 4. The order of banks in Panel A does not necessarily 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 the confidentiality of their identity. Banks' market shares exclude investment banks and base-bank. Firms exclude MNCs. Clustered standard errors at the bank level in parentheses * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

median forward premium paid by each firm between before ($\tau = 0$) and after ($\tau = 1$) the regulatory change. We report the results in Panel B of Table 12. 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 (columns 3 and 4).[29]

As an additional exercise, we explore the relationship between banks' estimated coefficients and their pre-reform exposure to pension funds. Table 12 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, given the OTC nature of the market, we explore the short-run adjustment of banks more exposed to PFs. We calculate the correlation between banks' ex-ante exposure to PFs and their reduction of FX derivatives to firms. In Figure 8, the horizontal axis is banks' ex-ante exposure to pension funds, and the vertical axis is our estimated coefficients of Table 12, the bank-specific supply effect. The vertical axis in Panel A is the banks' (log) outstanding purchase positions by banks from pension funds (PF), while Panel B shows the change in the position before and after the 2012 regulatory change. Every circle represents a bank, and its size is proportional to its market share as a supplier 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. In the 6 months frame, the correlation between $\hat{\beta}_{b,t}$ and banks' ex-ante exposure to PFs is negative and statistically significant.

We find that banks that used to purchase more FX derivatives from PFs before the shock—and, hence, were more exposed to the regulatory change—experienced a more significant decrease in the sales of FX derivatives to firms after the regulation. Interestingly, OTC relations meant a heterogeneous and slow (sticky) adjustment to the shock. Similarly, banks that changed their FPs positions changed the supply of FX derivatives to firms more positively.

Results presented in this section showed that the ease in the cap of non-share portfolios of pension funds in 2012 translated into a decrease in the supply of FX derivatives to banks, which—in turn—passed on to firms. This reduction was heterogeneous, and this negative supply shock led to an increase in firms' forward premium in the FX market, making it more costly for them to hedge their currency exposure. As a result, the use of FX derivatives decreases at the extensive and intensive margins. The probability of using FX derivatives drops after the shock at the extensive margin. At the intensive margin, importers reduce their FX purchases. We next assess the aggregate impact and the real and financial impact on firms' outcomes of this regulatory change.

[29]We obtain similar results when including swaps, see Table C.14 in the Appendix.

A. Outstanding (log) banks' FXD long positions with PFs, and banks' FE

B. Change in banks' FXD long position with PFs (%), and banks' FE

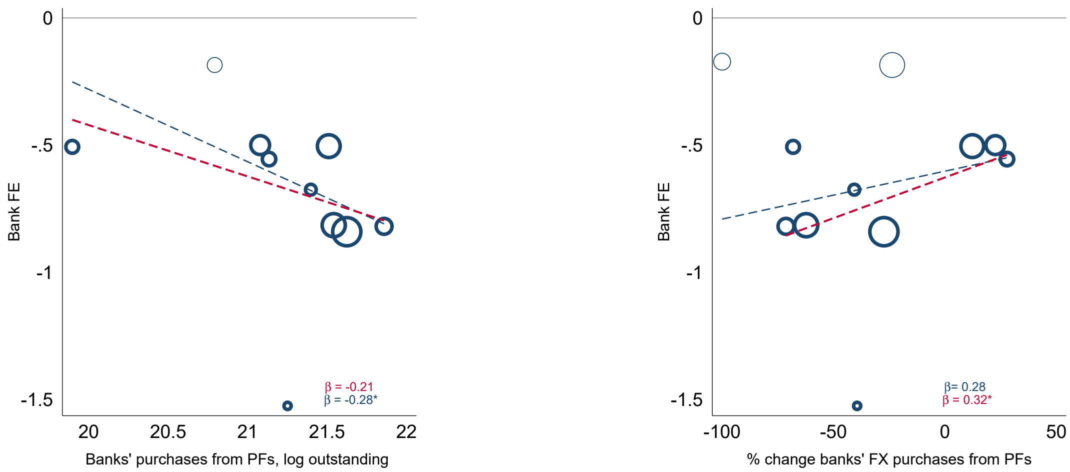


Figure 8: Pension Funds' gross and net positions in the FX derivative market

Notes.— The vertical axis in both panels refers to the estimated bank fixed effect $\beta_{b,\tau}$ in equation (8). The horizontal axis in Panel A shows (log) outstanding purchase positions by banks from pension funds (PFs) and in Panel B shows the change (%) in the outstanding purchase position by banks from pension funds before and after the 2012 regulatory change. Thick lined circles refer to statistically significant coefficient estimators of said coefficient. Red (blue) thick (thin) dashed line shows the weighted-by-market-share linear fit of significant (all) observations. The partial autocorrelation in each linear fit is shown at the bottom right part of each panel.

5.3 Aggregate Impact, Real and Financial Implications

FACT 5. *Macroeconomic conditions affect firms' hedging policies, as liquidity of the FX derivatives market is a key determinant of firms' hedging policies and the forward premium paid by firms.*

The magnitude of the aggregate estimated effects on both outstanding purchases of FX derivatives and the forward premium is sizeable. Table 13 presents the market-share weighted average of the bank-specific-supply channel estimated for each bank in Table 12. Column 1 in Table 13 shows that the contraction in the supply of FX derivatives accounted for a (market-share-weighted average) decrease of 58% in the outstanding purchases of FX derivatives. The sample restricted to firm-bank relations for firms that only engage in international trade shows a similar reduction, 52%. In turn, column 2 shows that the (market-share-weighted average) forward premium increased by 0.7pp and 0.77pp for all firms and firms in international trade, respectively.[30]

We now assess whether the supply shock had a negative impact on firms' financial and real outcomes. With this end, we re-estimate equation (7) using as dependent variables: the change in imports, exports, employment, leverage, and gross short derivative position in a year. Table 14 shows the contraction in the FX market—and the ensuing limitation for firms' cash

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

Table 13: Aggregate Effects of the Supply Shock

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

Note.— Table shows participation-weighted-average bank fixed effects $\beta_{b,t}$ estimated from equation (8) for outstanding FX-purchases, and Forward Premium, as $\sum_b \frac{L_b}{\sum_b L_b} \times \hat{\beta}_b$. Participation refers to the overall market share of total sales of FX-derivatives from banks to firms. Standard errors are clustered at the bank-level. * p <0.1, ** p <0.05, *** p <0.01.

flow management—is associated with a reduction in firms' imports growth by 14%. The shock also affected firms' (slightly) financing and size, as their leverage and employment dropped by 2.3% and 2.9%, respectively. The supply shock seems to have affected exports as well. Export dropped (albeit the coefficient is not statistically significant), and FX sales dropped by 66.4%.[31] Interestingly, the reduction in FX sales implies that when the liquidity of the FX derivatives market drops, exporters are less willing to sell their foreign currency forward, deepening the initial supply PF's shock. As such, the non-financial sector reduced both their long and short positions (Tables 12 and 14).

Overall, the supply shock affected real outcomes, while firms got smaller.[32] This exercise suggests that the thicker the FX derivative market, the more firms would be able to hedge their exposure, arguably limiting the systemic risk associated with currency exposure.

[31]The reduction is firms' export is in line with Jung (2021) who shows that foreign exchange market regulations limiting the sale of FX derivatives reduced exports of Korean firms.

[32]Propensity score matching results in the Appendix E point to similar results.

Table 14: Firms' financial and real effects before and after change in regulation

	FX sales (1)	Leverage (2)	Imports (3)	Exports (4)	Employment (5)
A: Window of N=6 months (before = Dec 2011-May 2012, after = Dec 2012-May 2013)					
1(Post)	-0.664**	-0.023*	-0.141**	-0.204	-0.029**
	(0.324)	(0.01)	(0.061)	(0.154)	(0.013)
Obs.	101	426	424	189	419
R^2	0.075	0.0072	0.16	0.14	0.0024
B: Window of N=4 months (before = Dec 2011-Mar 2012, after = Dec 2012-Mar 2013)					
1(Post)	-0.662**	-0.023+	-0.141*	-0.164	-0.036***
	(0.309)	(0.134)	(0.016)	(0.159)	(0.012)
Obs.	86	414	417	177	408
R^2	0.025	0.002	0.15	0.14	0.0018

Notes.— Regulation change entered into force in December 2012. Dependent variables are the annual growth rate of gross short derivative positions (1), leverage growth (2), the (log) of imports the following year (3), the log of exports the following year, (4), and growth in the number of workers (5). Clustered standard errors at the firm level in parentheses + $p<0.15$, * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

6 Conclusion

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

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

In the last section of the paper, we used a reform that decreased the liquidity in the FX derivative market for purchase purposes. We show that shocks affecting the availability of hedging instruments to banks are also passed by to firms—due to the OTC nature of the market—and that—by affecting firms' currency exposure—can impact firms' production, size, and financing opportunities. The reduction in the supply of USD forward substantially lowered the use of FX derivatives, increased forward premiums, and decreased the firm's operations. Although currency risk exposure, by itself, need not imply the use of FX derivatives hedging to be optimal, our results, taken together, show that financial derivatives and hedging may mitigate systematic risk concerns, with financial and real implications. At the same time, market thickness and liquidity support broader use.

References

Acemoglu, D., Carvalho, V. M., Ozdaglar, A. and Tahbaz-Salehi, A. (2012), 'The network origins of aggregate fluctuations', *Econometrica* **80**(5), 1977–2016.

Adams, P. and Verdelhan, A. (2021), 'Exchange Rate Transaction and Translation Risk', *Working Paper* (MIT Sloan).

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).

Alfaro, L., Asis, G., Chari, A. and Panizza, U. (2019), 'Corporate debt, firm size and financial fragility in emerging markets', *Journal of International Economics* **118**, 1–19.

Alfaro, L. and Calani, M. (2022), 'Exchange Rate Hedging and Capital Market Imperfections', *Working Paper* (WP).

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., Cuñat, A., Fadinger, H. and Liu, Y. (2022), 'The real exchange rate, innovation and productivity', *Journal of the European Economic Association,* (forthcoming).

Alfaro, L., Garcia-Santana, M. and Moral-Benito, E. (2021), 'On the direct and indirect real effects of credit supply shocks', *Journal of Financial Economics* **3**, 895–921.

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., Itskhoki, O. and Konings, J. (2022), 'Dominant Currencies: How Firms Choose Currency Invoicing and Why it Matters', *The Quarterly Journal of Economics* **01**.

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.

Antràs, P., Fort, T. C. and Tintelnot, F. (2017), 'The margins of global sourcing: Theory and evidence from u.s. firms', *American Economic Review* **107**(9), 2514–64.

Avalos, F. H. and Moreno, R. (2013), 'Hedging in derivatives markets: the experience of Chile', *BIS Quarterly Review* (3).

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.

BIS (2019), 'International Banking and Financial Market Development', *BIS Quarterly Review* (12).

Bodnar, G., Graham, J., Harvey, C. and Marston, R. (2011), 'Managing risk management', *SSRN Electronic Journal* (1787144).

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.

Chodorow-Reich, G. (2014), 'The employment effects of credit market disruptions: Firm-level evidence from the 2008-09 financial crisis', *Quarterly Journal of Economics* **129**(1), 1–59.

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.

di Giovanni, J., Levchenko, A. A. and Mejean, I. (2014), 'Firms, destinations, and aggregate fluctuations', *Econometrica* **82**(4), 1303–1340.

Du, W., Tepper, A. and Verdelhan, A. (2018), 'Deviations from covered interest rate parity', *The Journal of Finance* **73**(3), 915–957.

Duffie, D., Garleanu, N. and Pedersen, L. H. (2005), 'Over-the-Counter Markets', *Econometrica* **73**(6), 1815–1847.

Eichengreen, B. and Hausmann, R. (1999), Exchange rates and financial fragility, Technical report, National Bureau of Economic Research.

Fraschini, M. and Terracciano, T. (2021), 'Thinking forward: Fx hedging, currency choice, and the international role of the us dollar', *Working Paper* .

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.

Gabaix, X. (2011), 'The granular origins of aggregate fluctuations', *Econometrica* **79**(3), 733–772.

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.

Gopinath, G., Boz, E., Casas, C., Díez, F. J., Gourinchas, P.-O. and Plagborg-Møller, M. (2020), 'Dominant currency paradigm', *American Economic Review* **110**(3), 677–719.

Hau, H., Hoffmann, P., Langfield, S. and Timmer, Y. (2021), 'Discriminatory pricing of over-the-counter derivatives', *Management Science* .

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.

Jung, H. (2021), 'The real consequences of macroprudential fx regulations', *FRB of New York Staff Report* (989).

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.

Lewis, K. (2018), 'International Corporate Finance', *Lecture Notes, University of Pennsylvania* .

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.

Modigliani, F. and Miller, M. H. (1958), 'The cost of capital, corporation finance and the theory of investment', *The American Economic Review* **48**(3), 261–297.

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.

Rampini, A. A., Sufi, A. and Viswanathan, S. (2014), 'Dynamic risk management', *Journal of Financial Economics* **111**(2), 271–296.

Rampini, A. A. and Viswanathan, S. (2010), 'Risk management, and the distribution of debt capacity', *Journal of Finance* **65**(6), 2293–2322.

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

Rosenbaum, P. R. and Rubin, D. B. (1983), 'The central role of the propensity score in observational studies for causal effects', *Biometrika* **70**(1), 41–55.

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

Salomao, J. and Varela, L. (2022), 'Exchange rate exposure and firm dynamics', *Review of Economic Studies* **89**(1), 481–514.

Servaes, H., Tamayo, A. and Tufano, P. (2009), 'The theory and practice of corporate risk management*', *Journal of Applied Corporate Finance* **21**(4), 60–78.

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.

Sufi, A. (2007), 'Bank Lines of Credit in Corporate Finance: An Empirical Analysis', *The Review of Financial Studies* **22**(3), 1057–1088.

Varela, L. (2018), 'Reallocation, Competition, and Productivity: Evidence from a Financial Liberalization Episode', *The Review of Economic Studies* **85**(2), 1279–1313.

Online Appendix
(not for publication)

A Institutional Background

This section provides some background on the relevant institutional arrangements in the OTC FX derivatives market and the banking system.

A.1 The foreign-exchange market or "Mercado Cambiario Formal"

According to its Organic Constitutional Bill, the Formal Foreign-Exchange Market (FEM) comprises banks and other financial institutions determined by the Central Bank of Chile (CBC). Requisites for belonging to the FEM are defined in Chapter III of the Compendium of International Exchange Regulations (CNCI, for its acronym in Spanish) available at the CBC's website (https://www.bcentral.cl/web/banco-central/areas/ compendio-de-normas-de-cambios-internacionales).

The CBC can determine that certain foreign exchange operations are to be performed exclusively by participants in the FEM, such as certain types of deposits, cross-border loans, and operations in the Foreign Exchange market. In particular, FEM participants must inform the CBC of the operations that "are generated or emanate from contracts: futures, forwards, swaps, options, credit derivatives and combinations of these, which refer to foreign currencies; foreign interest rates; fixed or variable income instruments; commercial loans; commodities, and stock indices, which are traded on foreign Stock Exchanges, whether the contracts mentioned above are carried out on the Stock Exchange or outside of it".[33] Importantly, this regulation includes the over-the-counter market. The detail of information requirement is defined in Chapter IX of the Compendium of Standards of International Changes (CNCI) and its Manual of Procedures and Forms of Information (Manual).

A.2 FX derivatives in the OTC Market

Options and futures are usually transacted on the Stock Exchange. Forwards and Swaps are transacted outside the Stock Exchange in the over-the-counter (OTC) market. Forwards and Swaps are contracts with known (and fixed) maturity dates. Table 1 in the paper shows that the lion's share of FX derivatives are NDF (non-deliverable) forward contracts, meaning that contract counter-parties settle on the difference between observed and contracted NER at the maturity date. One party "compensates" the other only on such difference per dollar. Alternatively, the contracts under-delivery clause imply that one party delivers pesos in exchange for dollars for the entire amount contracted as a notional contract amount. To mitigate counterparty/credit risk, it is not unusual that a firm will be required to show financial solvency by the financial

[33] Excerpt from Chapter IX.An in CNCI, CBC.

institution providing the FX derivative contract. Additionally, a specific contract is signed (and then reported to the CBC) between contracting parties. The minimum contents of these contracts—often referred to as Framework Agreements— are regulated by the CBC according to its CNCI. In particular, the CBC recognizes framework agreements denominated "1992 ISDA Master Agreement" and, more generally, contracts approved by the *International Swaps and Derivatives Association, Inc. (ISDA)*; the General Conditions for FX derivatives in Local Market approved by the Banks and Financial Institutions Association; the Complementary Agreement on General Conditions for Derivatives Contracts in Local Market (SINACOFI); among others detailed in Annex 1 of the CBC's Agreement No. 2337 available here. One example of a "General Conditions Contract" drafted by a local bank can be found here. These contracts enumerate many clauses. Notably, they may often require the client to constitute a guarantee or sign on a credit line in case of a negative result at the contract's maturity date.

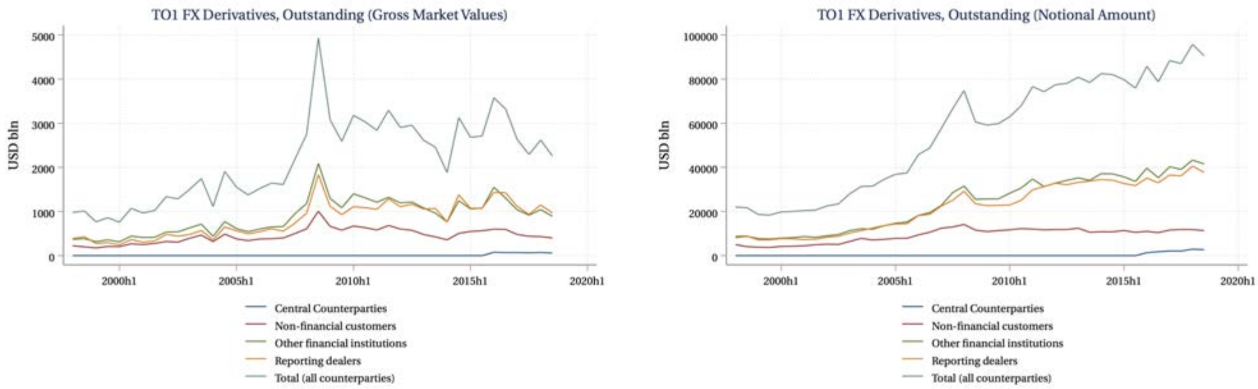
A.3 The local banking system

The Chilean banking system is characterized, as in many EMEs, by two groups of banks: locally-established banks (including subsidiaries) and branches/representative offices from foreign banks. Regulated by Title II of the General Banking Bill, there are two forms under which foreign banks may be incorporated in Chile and are specified in articles 32 (to establish a subsidiary) and 33 (to maintain a representative office), respectively. In the latter case (art. 33), the representative offices will not be able to carry out activities related to bank business. They will only be able to advertise their parent company's products and services. On the contrary, those subsidiaries authorized under the figure established by article 32 may operate similarly to local banks. Notably, Article 34 establishes that these subsidiaries comply with the same regulation as a purely domestic bank. This last point is essential, as banking regulation (e.g., capital and liquidity requirements) caps currency exposure applies to domestically-owned banks and subsidiaries. Subsidiaries cannot hold larger currency mismatches than domestically owned banks. On average, currency mismatches at the balance sheet level are less than 1% of total assets. The list of established banks in Chile and representative offices of foreign banks are published in the website of the Banking Regulator, the Financial Markets Commission (CMF).

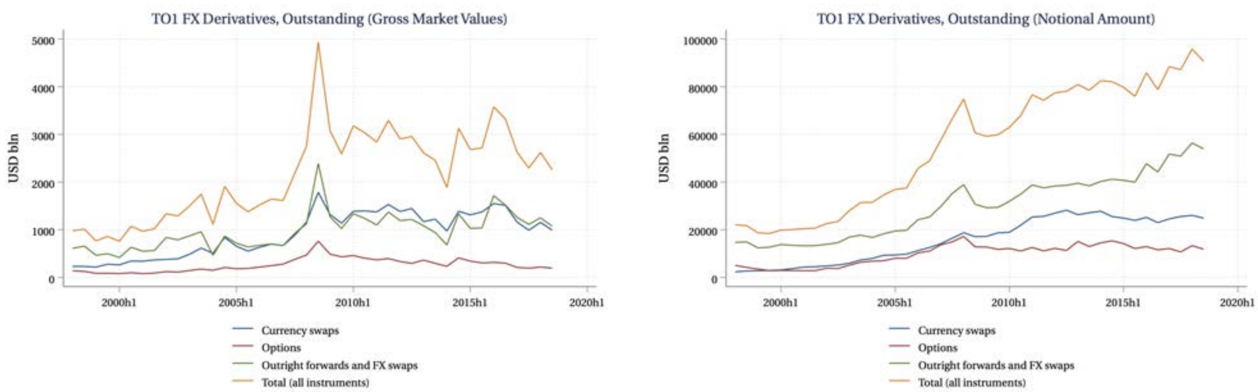
B Additional Figures

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

A. By Counterparty

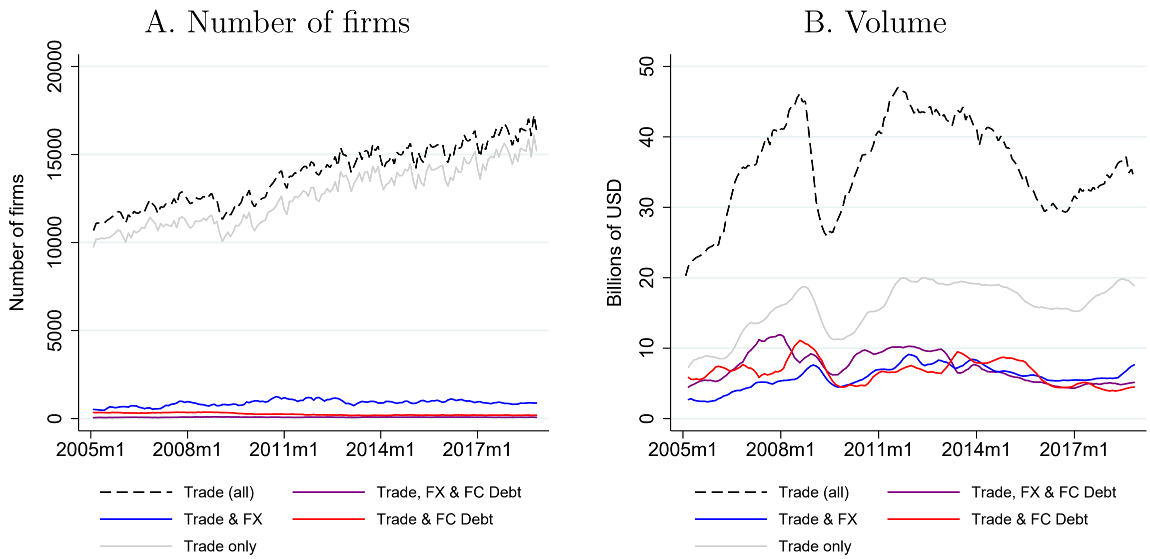


B. By Instrument



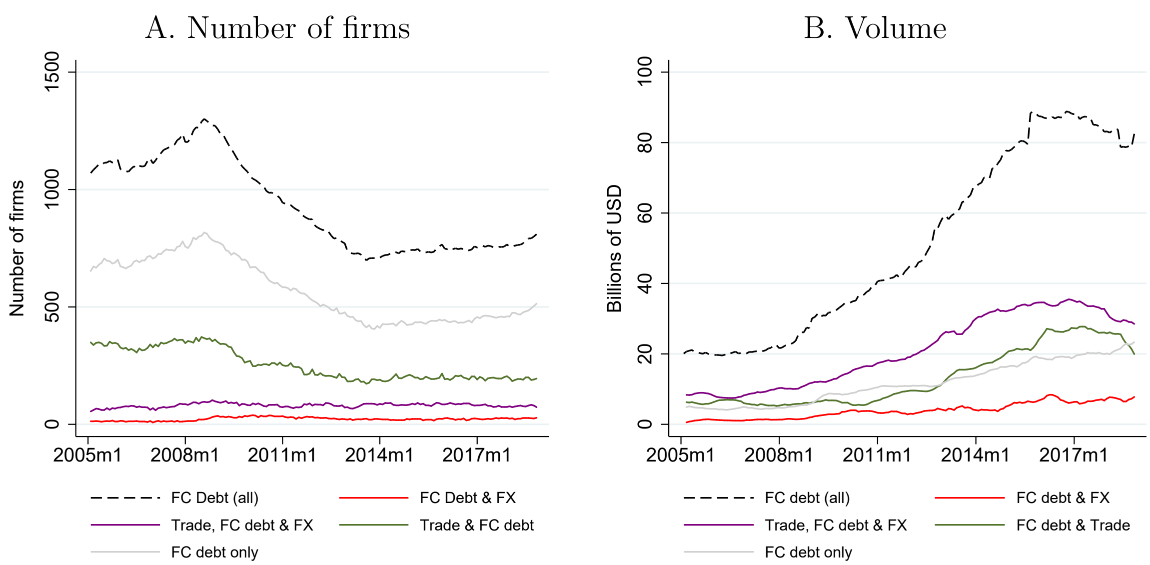
Notes.— "Notional amount outstanding": Gross nominal value of all derivatives contracts concluded and not yet settled on the reporting date (Good as a measure of total market size). "Gross market value": Sums of replacement market values of all open contracts (Good as a proxy of potential risk transfers 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 B.2: Chile: International trade by type of firm



Notes.— Monthly data. Trade (all): includes all firms in international trade (imports or exports); Trade only: firms in international trade with no reported activity in FX or FCD markets; Trade & FX: firms in international trade and FX markets with no FCD; Trade & FCD Debt: firms in international trade and foreign currency debt and no FX market activity; Trade, FX & FC Debt: firms in all three markets. Panel A shows the number of firms in each group; Panel B shows the volume transacted.

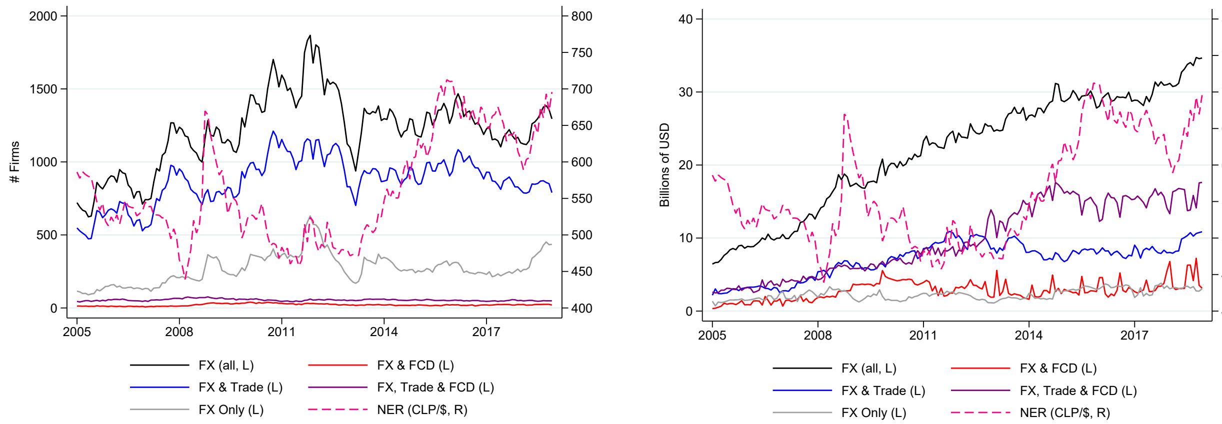
Figure B.3: Chile: Foreign debt (in foreign currency) by type of firm



Note.— Monthly data. FC Debt (all): firms with foreign debt; FC Debt only: firms with FC debt only and not in international trade or FX market; FC Debt & FX: firms with foreign debt and FX market only; Trade & FC debt: firms with foreign debt and in international trade; Trade, FC debt & FX: firms in all three markets. Panel A shows the number of firms in each group, and Panel B shows outstanding balance.

Figure B.4: Chile: Use of FX derivatives by type of firm

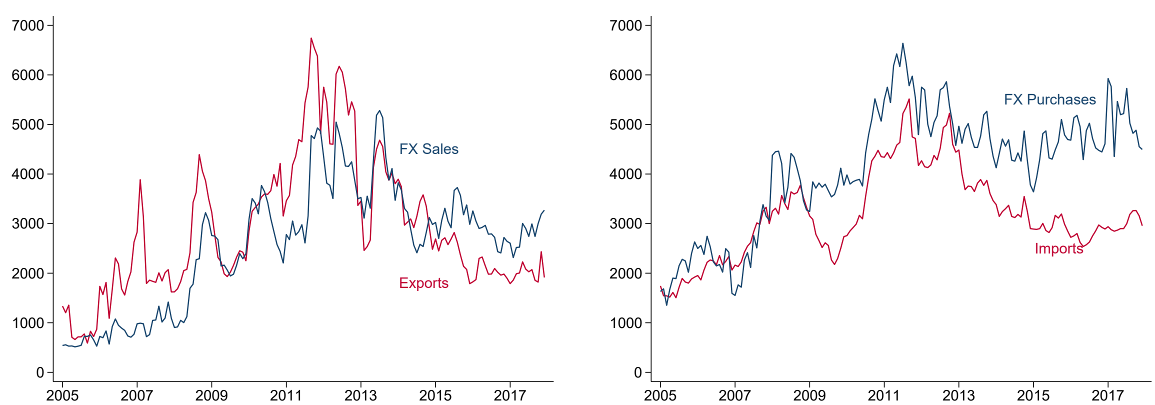
A. Number of firms B. Gross derivative position



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, engage in 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 correlations between firms using FX derivatives and gross derivative positions and the exchange rate are -0.15 and 0.44, respectively. 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.

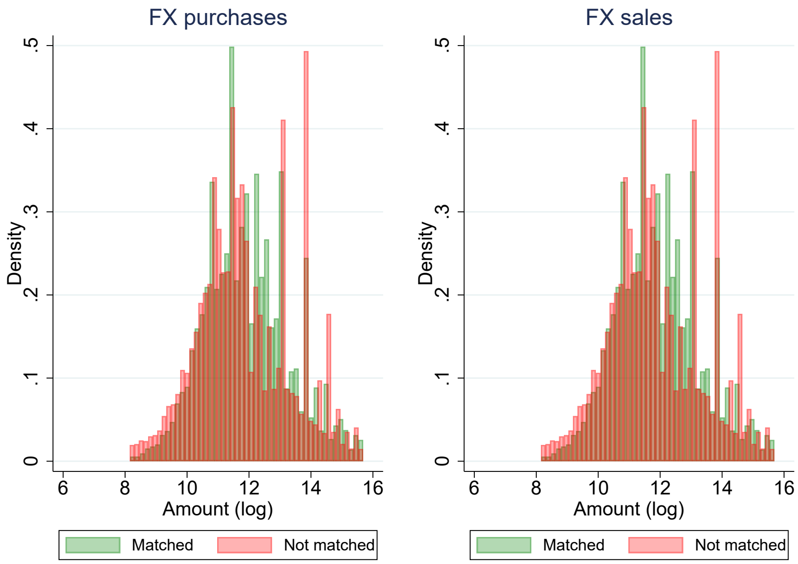
Figure B.5: Chile: Trade Credit balances related to international trade and FX gross derivatives positions

A. Exports trade credit and short FX position B. Imports trade credit and long FX position



Notes.— 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 MNCs and mining firms. The correlation between FX sales and exports is 68%, and the correlation between FX purchases and imports is 79%.

Figure B.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, and amount level. The horizontal axis is the size of the transaction of FX derivatives. This exercise uses firms participating in international trade and the FX derivatives market but holding no foreign debt.

C Additional Tables

Table C.1: Natural hedging of firms in international trade and foreign debt (monthly)

Panel A. Cash flows at maturity								
	Monthly cash flows from exports, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{CF}	0.02**	0.03***	0.02***					
	(0.01)	(0.01)	(0.01)					
$M^{CF} + FCD^{CF}$				0.02***				
				(0.00)				
$M^{CF} \times$ 1(Trade only)					0.02*	0.02**	0.02***	0.05***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF} \times$ 1(Trade and FX)					0.03***	0.03***	0.03***	0.06***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF} \times$ 1(Trade & FCD)					0.03	0.05**	0.03*	0.07***
					(0.02)	(0.02)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade, FCD and FX)					0.03	0.03	0.04**	0.04*
					(0.01)	(0.02)	(0.01)	(0.02)
Observations	1,625,296	1,619,888	1,606,109	1,606,109	1,625,296	1,619,888	1,606,109	196,380
R Squared	0.85	0.85	0.83	0.83	0.85	0.85	0.83	0.87

Panel B. Outstanding trade credit from intl. trade credit and foreign debt								
	End of month outstanding trade credit from exports, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{TC}	0.02**	0.02***	0.02***					
	(0.01)	(0.01)	(0.01)					
$M^{TC} + FCD$				0.03***				
				(0.01)				
$M^{TC} \times$ 1(Trade only)					0.01	0.02**	0.02***	0.04***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{TC} \times$ 1(Trade and FX)					0.02**	0.02***	0.02***	0.04***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC} \times$ 1(Trade & FCD)					0.07***	0.07***	0.05***	0.08***
					(0.02)	(0.03)	(0.02)	(0.03)
$M^{TC} \times$ 1(Trade, FCD and FX)					0.04*	0.06***	0.06***	0.06***
					(0.02)	(0.02)	(0.02)	(0.02)
Observations	1,470,485	1,465,179	1,451,719	1,451,719	1,470,485	1,465,179	1,451,719	185,632
R Squared	0.88	0.88	0.87	0.87	0.88	0.88	0.87	0.91
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	—	—	Yes	Yes	—	—
Include MNC	Yes	—	—	—	Yes	—	—	—
Both X and M	—	—	—	—	—	—	—	Yes

Notes.— All regressions include firm and year-industry fixed effects. Panel A presents monthly firm-level regressions of cash-flows from exports X^{CF}, on cash-flows from imports M^{CF}, and from foreign debt FCD^{CF}. Cash flows from international trade consider those originated from trade credit at maturity date and operations paid in cash or in advance. Panel B presents firm-level regressions of outstanding balances of exports trade credit (accounts receivable) X^{TC}, on outstanding balances of imports trade credit (accounts payable) M^{TC}, and foreign debt FCD. Only operations in US dollars, which represent close to 90% of all trade credit operations. Columns (4) to (10) different firms into four non-overlapping groups: (i) firms in int. trade (IT) only, (ii) firms in int. trade and who use FX derivatives but no foreign debt, (iii) firms in int. trade, with foreign debt but do not hold FX derivatives, (iv) firms in int. trade, with foreign debt and FX derivatives. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.2: Natural hedging of firms in international trade and foreign debt (quarterly)

Panel A. Cash flows at maturity	Quarterly cash flows from exports, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{CF}	0.05***	0.05***	0.04***					
	(0.01)	(0.01)	(0.01)					
$M^{CF} + FCD^{CF}$				0.04***				
				(0.01)				
$M^{CF}\times$ 1(Trade only)					0.04***	0.04***	0.04***	0.07***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FX)					0.05***	0.05***	0.05***	0.08***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FCD)					0.05**	0.06**	0.05*	0.09***
					(0.02)	(0.02)	(0.02)	(0.02)
$M^{CF}\times$ 1(Trade, FCD and FX)					0.06**	0.06**	0.06**	0.07***
					(0.02)	(0.02)	(0.02)	(0.02)
Observations	799,706	797,566	791,142	791,142	719,613	717,799	711,943	110,387
R Squared	0.87	0.87	0.85	0.85	0.88	0.88	0.87	0.89

Panel B. Outstanding trade credit from intl. trade credit and foreign debt	End of quarter outstanding trade credit from exports, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{TC}	0.02**	0.02***	0.02***					
	(0.01)	(0.01)	(0.01)					
$M^{TC} + FCD$				0.03***				
				(0.01)				
$M^{TC}\times$ 1(Trade only)					0.01	0.02***	0.02***	0.03**
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{TC}\times$ 1(Trade and FX)					0.02**	0.02***	0.02***	0.04***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FCD)					0.07***	0.07***	0.05***	0.08***
					(0.02)	(0.03)	(0.02)	(0.03)
$M^{TC}\times$ 1(Trade, FCD and FX)					0.04**	0.06***	0.06***	0.06***
					(0.02)	(0.02)	(0.02)	(0.02)
Observations	554,684	552,915	547,932	547,932	554,684	552,915	547,932	62,058
R Squared	0.88	0.88	0.86	0.86	0.88	0.88	0.86	0.91
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	—	—	Yes	Yes	—	—
Include MNC	Yes	—	—	—	Yes	—	—	—
Both X and M	—	—	—	—	—	—	—	Yes

Notes.— All regressions include firm and year-industry fixed effects. Panel A presents quarterly firm-level regressions of cash-flows from exports X^{CF}, on cash-flows from imports M^{CF}, and from foreign debt FCD^{CF}. Cash flows from international trade consider those originated from trade credit at maturity date, and operations paid in cash or in advance. Panel B presents firm-level regressions of outstanding balances of exports trade credit (accounts receivable) X^{TC}, on outstanding balances of imports trade credit (accounts payable) M^{TC}, and foreign debt FCD. Only operations in US dollars, which represent close to 90% of all trade credit operations. Columns (4) to (10) separate firms in four non-overlapping groups: (i) firms in int. trade (IT) only, (ii) firms in int. trade and who use FX derivatives but no foreign debt, (iii) firms in int. trade, with foreign debt but do not hold FX derivatives, (iv) firms in int. trade, with foreign debt and FX derivatives. Clustered standard errors at the firm level reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.3: Natural hedging of firms in international trade and foreign debt (yearly)

Panel A. Cash flows at maturity	Yearly cash flows from exports, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{CF}	0.08***	0.08***	0.08***					
	(0.01)	(0.01)	(0.01)					
$M^{CF} + FCD^{CF}$				0.07***				
				(0.01)				
$M^{CF}\times$ 1(Trade only)					0.08***	0.08***	0.07***	0.12***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FX)					0.09***	0.09***	0.08***	0.13***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FCD)					0.10***	0.10***	0.09***	0.13***
					(0.01)	(0.02)	(0.01)	(0.02)
$M^{CF}\times$ 1(Trade, FCD and FX)					0.14***	0.14***	0.15***	0.20***
					(0.03)	(0.03)	(0.03)	(0.03)
Observations	309,614	308,978	306,417	306,417	263,876	263,435	261,262	47,579
R Squared	0.90	0.90	0.89	0.89	0.91	0.91	0.91	0.93

Panel B. Outstanding trade credit from intl. trade credit and foreign debt	End of year outstanding trade credit from exports, X^{TC}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{TC}	0.02	0.03***	0.02***					
	(0.01)	(0.01)	(0.01)					
$M^{TC} + FCD$				0.03***				
				(0.01)				
$M^{TC}\times$ 1(Trade only)					0.01	0.02***	0.02***	0.03
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FX)					0.02**	0.03***	0.03***	0.04**
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FCD)					0.05*	0.06**	0.04**	0.08**
					(0.03)	(0.03)	(0.02)	(0.04)
$M^{TC}\times$ 1(Trade, FCD and FX)					0.04	0.06**	0.06***	0.06***
					(0.03)	(0.02)	(0.02)	(0.02)
Observations	168,640	168,198	166,690	166,690	168,640	168,198	166,690	15,868
R Squared	0.88	0.88	0.86	0.86	0.88	0.88	0.86	0.92
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	—	—	Yes	Yes	—	—
Include MNC	Yes	—	—	—	Yes	—	—	—
Both X and M	—	—	—	—	—	—	—	Yes

Notes.— All regressions include firm and year-industry fixed effects. Panel A presents quarterly firm-level regressions of cash-flows from exports X^{CF}, on cash-flows from imports M^{CF}, and from foreign debt FCD^{CF}. Cash flows from international trade consider those originated from trade credit at maturity date and operations paid in cash or in advance. Panel B presents firm-level regressions of outstanding balances of exports trade credit (accounts receivable) X^{TC}, on outstanding balances of imports trade credit (accounts payable) M^{TC}, and foreign debt FCD. Only operations in US dollars, which represent close to 90% of all trade credit operations. Columns (4) to (10) different firms into four non-overlapping groups: (i) firms in int. trade (IT) only, (ii) firms in int. trade and who use FX derivatives but no foreign debt, (iii) firms in int. trade, with foreign debt but do not hold FX derivatives, (iv) firms in int. trade, with foreign debt and FX derivatives. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.4: Natural hedging of firms in international trade and foreign debt. Only credit operations

Panel A. Monthly	Monthly trade credit cash flows from exports, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{CF}	0.01	0.02	0.01*					
	(0.01)	(0.01)	(0.01)					
$M^{CF} + FCD^{CF}$				0.01*				
				(0.00)				
$M^{CF} \times$ 1(Trade only)					0.01	0.01	0.01*	0.05**
					(0.01)	(0.01)	(0.00)	(0.02)
$M^{CF} \times$ 1(Trade and FX)					0.01	0.02*	0.02**	0.06***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade & FCD)					0.03	0.05*	0.02	0.08***
					(0.02)	(0.02)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade, FCD and FX)					-0.01	-0.01	0.01	0.03
					(0.01)	(0.02)	(0.01)	(0.02)
Observations	937,658	933,090	923,626	923,626	937,658	933,090	923,626	109,003
R Squared	0.84	0.84	0.82	0.82	0.84	0.84	0.82	0.88

Panel B. Quarterly	Quarterly trade credit cash flows from exports, X^{CF}							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M^{CF}	0.03**	0.03***	0.03***					
	(0.01)	(0.01)	(0.01)					
$M^{CF} + FCD^{CF}$				0.02***				
				(0.01)				
$M^{CF} \times$ 1(Trade only)					0.02*	0.02**	0.02***	0.05***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF} \times$ 1(Trade and FX)					0.03**	0.03***	0.03***	0.06***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade & FCD)					0.02	0.02	0.02	0.07**
					(0.02)	(0.02)	(0.02)	(0.02)
$M^{CF} \times$ 1(Trade, FCD and FX)					0.01	0.01	0.02	0.01
					(0.02)	(0.02)	(0.03)	(0.03)
Observations	423,187	421,356	417,429	417,429	333,985	332,441	329,131	58,536
R Squared	0.86	0.86	0.85	0.85	0.88	0.88	0.86	0.90
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	Yes	Yes	—	—	Yes	Yes	—	—
Include MNC	Yes	—	—	—	Yes	—	—	—
Both X and M	—	—	—	—	—	—	—	Yes

Notes.— All regressions include firm fixed effects and year-industry fixed effects. Panel A (B) presents firm-level monthly (quarterly) regressions of cash-flows from exports X^{CF}, on cash-flows from imports M^{CF} and foreign debt FCD^{CF}. Cash flows from int. trade consider only those originating from trade credit—excluding cash or in-advance payments——only operations in US dollars, representing close to 90% of all trade credit. Columns (5)-(8) independent firms into four non-overlapping groups: (i) firms in international trade only, (ii) firms in int. trade who use FX derivatives but no foreign debt, (iii) firms in int. trade with foreign debt but do not hold FX derivatives, (iv) firms in int. trade, with foreign debt and FX derivatives. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.5: Firm size by use of FX-derivatives (including MNCs)

	2006			2016		
	(1) Yes	(2) No	(3) Log-difference	(4) Yes	(5) No	(6) Log-difference
Panel A. All firms						
Employment (workers)	386.45	113.87	1.63***	453.68	109.38	1.84***
Sales (M$)	17.32	5.30	1.34***	20.94	5.68	1.50***
Panel B. trading firms						
Employment (workers)	304.55	76.63	1.79***	337.93	100.46	0.65***
Sales (M$)	11.80	3.25	1.16***	13.30	4.65	0.84***
Panel C. Firms in international trade						
Employment (workers)	404.97	115.73	1.63***	482.58	111.03	1.84***
Sales (M$)	18.57	5.40	1.34***	22.85	5.87	1.50***
Exports (M$)	14.86	1.82***	0.34	2.19	1.54	0.19***
Imports (M$)	5.18	0.47***	0.66	4.22	0.37	0.76***
Exports TC (M$)	14.58	1.77***	0.33	2.09	1.45	0.17***
Imports TC (M$)	5.04	0.44***	0.64	3.84	0.31	0.71***
Panel D. Firms in Debt Market						
Employment (workers)	950.65	206.99	2.72***	1060.27	420.80	2.65***
Sales (M$)	27.92	6.41	2.04***	35.97	15.15	1.72***
Foreign Debt (M$)	116.66	14.16	2.08***	463.93	97.47	2.20***

Notes.— Sample in this table includes multinationals. Columns (1) and (4) include firms that use FX derivatives. Columns (2) and (5) include firms that do not use FX derivatives. We exclude multinational corporations from this comparison. Columns (1), (2), (4), and (5) are expressed in levels—number of workers or millions of dollars—depending on the proxy for firm size. Columns (3) and (6) are expressed as the *log* difference between groups of firms who use FX derivatives and firms that do not, thus H0: Log-Difference = 0: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. In this table, we show years 2006 and 2016, but results are stable and hold for all other years in the 2005-2018 sample.

Table C.6: Firms' use of FX derivatives, extensive margin: robustness to currency and contract type

	Firm uses FX derivatives					
	Other currencies - CLP			Forwards, Swaps and CC swaps		
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.027***	0.028***	0.024***	0.019***	0.023***	0.020***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
M^{TC}	0.053***	0.055***	0.054***	0.047***	0.051***	0.050***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
FCD	-0.012**	-0.012**	-0.005	-0.013**	-0.010*	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
$X^{TC} \times M^{TC}$		-0.004	-0.005*		-0.009***	-0.007**
		(0.003)	(0.003)		(0.003)	(0.003)
$X^{TC} \times FCD$		0.005*	0.000		0.002	-0.000
		(0.003)	(0.002)		(0.002)	(0.002)
$M^{TC} \times FCD^{TC}$		-0.004	-0.004*		-0.005**	-0.005**
		(0.003)	(0.003)		(0.003)	(0.002)
Observations	2,486,869	2,486,869	2,520,309	2,273,980	2,285,736	2,306,632
R Squared	0.54	0.54	0.54	0.56	0.56	0.56
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	Yes	—	—	Yes
Includes Mining	—	—	Yes	—	—	Yes
Include all currencies	Yes	Yes	Yes	—	—	—
Includes Swaps	—	—	—	Yes	Yes	Yes

Notes.— All regressors variables in logs. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. X^{TC} stands for outstanding exports trade credit, M^{TC} for outstanding imports trade credit, and FCD for the outstanding stock in foreign debt. Constant terms are not reported. Columns (1) to (3) are based on the sample of operations denominated in any foreign currency for trade and debt operations and contracts between any foreign currency and Chilean pesos for FX derivatives. Columns (4) to (6) are based on sample only, including operations in U.S. dollars and Swaps and Cross-Currency Swaps besides outright forwards. Clustered standard errors at the firm level are reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table C.7: Firms' use of FX derivatives, intensive margin, short position: robustness to currency, type of contract and debt maturity

Panel A. Short position									
	Sales of FX derivatives, log								
	Other currencies - CLP			Forwards, Swaps and CC Swaps			Different debt maturities		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
X^{TC}	0.062***	0.059***	0.045***	0.045***	0.046***	0.034***	0.045***	0.046***	0.033***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)
M^{TC}	0.020**			0.008			0.008		
	(0.009)			(0.009)			(0.009)		
FCD	-0.009	-0.008	-0.004	-0.026	-0.024	-0.017			
	(0.014)	(0.014)	(0.011)	(0.018)	(0.016)	(0.015)			
M^{TC} by exp.		0.034**	0.040***		0.021*	0.019		0.021*	0.019
		(0.014)	(0.014)		(0.012)	(0.015)		(0.012)	(0.015)
M^{TC} by non-exp.		0.013*	0.017**		0.002	0.003		0.002	0.003
		(0.007)	(0.008)		(0.008)	(0.009)		(0.008)	(0.009)
FCD due in $\leq$ 6m							-0.007	-0.015	-0.013
							(0.017)	(0.014)	(0.014)
FCD due in 7m to 12m							0.019	0.009	0.013
							(0.019)	(0.016)	(0.015)
FCD due in 1y to 2y							0.021	0.012	0.018
							(0.024)	(0.021)	(0.020)
FCD in $\geq$ 2y							-0.008	-0.007	-0.000
							(0.021)	(0.019)	(0.017)
Observations	2,486,869	2,486,869	2520309	2273980	2,285,736	2,306,632	2273980	2,285,736	2306632
R Squared	0.58	0.58	0.57	0.63	0.63	0.63	0.63	0.63	0.63
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	Yes	—	—	Yes	—	—	Yes
Includes Mining	—	—	Yes	—	—	Yes	—	—	Yes
Includes all currencies	Yes	Yes	Yes	—	—	—	—	—	—
Includes Swaps	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes

Notes.— All variables in logs. Dependent variables are end-of-month balances of sales (Panel A.) and purchases (Panel B.) of FX derivatives. Regressors are outstanding balances of export/import trade credit and foreign debt. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table C.8: Firms' use of FX derivatives, intensive margin, long position: robustness to currency, type of contract and debt maturity

Panel B. Long position									
	Sales of FX derivatives, log								
	Other currencies - CLP			Forwards, Swaps and CC Swaps			Different debt maturities		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
X^{TC}	0.009			0.003			0.003		
	(0.007)			(0.007)			(0.007)		
M^{TC}	0.144***	0.143***	0.135***	0.144***	0.143***	0.135***	0.144***	0.143***	0.135***
	(0.013)	(0.013)	(0.014)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
FCD	0.001	0.001	0.004	0.039*	0.035	0.034*			
	(0.014)	(0.013)	(0.012)	(0.023)	(0.022)	(0.020)			
M^{TC} by exp.		0.012	0.007		0.002	-0.000	0.006	0.013	0.016
		(0.010)	(0.009)		(0.010)	(0.009)	(0.018)	(0.016)	(0.014)
M^{TC} by non-exp.		0.006	0.006		0.002	0.003	0.025	0.026*	0.030**
		(0.006)	(0.006)		(0.006)	(0.006)	(0.018)	(0.016)	(0.015)
FCD due in $\leq$ 6m							0.029	0.029	0.033*
							(0.021)	(0.019)	(0.018)
FCD due in 7m to 12m							0.048*	0.044*	0.041**
							(0.025)	(0.023)	(0.020)
FCD due in 1y to 2y								0.002	-0.001
								(0.010)	(0.009)
FCD in $\geq$ 2y								0.002	0.003
								(0.006)	(0.006)
Observations	2,486,869	2,498,621	2,520,309	2,273,980	2,285,736	2,306,632	2,273,980	2,285,736	2,306,632
R Squared	0.65	0.65	0.65	0.69	0.69	0.69	0.69	0.69	0.69
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	Yes	—	—	Yes	—	—	Yes
Includes Mining	—	—	Yes	—	—	Yes	—	—	Yes
Includes all currencies	Yes	Yes	Yes	—	—	—	—	—	—
Includes Swaps	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes

Notes.— All variables in logs. Dependent variables are end-of-month balances of sales (Panel A.) and purchases (Panel B.) of FX derivatives. Regressors are outstanding balances of export/import trade credit and foreign debt. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

Table C.9: Firms' use of FX derivatives: Robustness to managerial and financial frictions

	Firm uses FX		Sales FX, log		Purchases FX, log	
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.018***	0.017***	0.042***	0.042***	-0.002	-0.002
	(0.004)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)
M^{TC}	0.052***	0.052***	0.010	0.010	0.154***	0.154***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.015)	(0.015)
FCD	-0.015***	-0.015***	-0.015	-0.015	-0.005	-0.005
	(0.005)	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Delinquency	-0.023***	-0.021***	-0.007**	-0.006**	-0.015***	-0.014**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Credit line		0.010***		0.005**		0.007***
		(0.002)		(0.002)		(0.003)
Coincidence	-0.009***	-0.009***	0.003	0.003	-0.016***	-0.016***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
# Import countries	0.009***	0.008***	0.008**	0.008**	0.006*	0.006*
	(0.002)	(0.002)	(0.002)	(0.0003)	(0.0003)	(0.003)
# Export countries	0.004***	0.004***	0.009***	0.009***	0.006*	0.006*
	(0.003)	(0.003)	(0.002)	(0.002)	(0.0003)	(0.0001)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326
R^2	0.53	0.53	0.54	0.54	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Incl. MNC	—	—	—	—	—	—
Incl. Mining	—	—	—	—	—	—

Notes.— All regressors in logs. Regressors are outstanding balances of export/import trade credit and foreign debt. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. Nonperforming loans (delinquency) is a dummy variable equal to 1 if the firm is in default in the banking system. The credit line is a dummy variable equal to one if the firm has an available credit line in the banking system. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.10: Forward Premium and Financial Constraints (Percentage, Contract Level)

	FX Purchases				FX Sales			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maturity	0.426**	0.426**	0.426**	0.426**	-2.139***	-2.142***	-2.142***	-2.141***
	(0.197)	(0.196)	(0.196)	(0.196)	(0.384)	(0.384)	(0.384)	(0.384)
Firm size	-0.154*	-0.153*	-0.153*	-0.153*	0.076	0.075	0.075	0.077
	(0.086)	(0.087)	(0.087)	(0.087)	(0.129)	(0.129)	(0.129)	(0.129)
Notional amount		0.013	0.013	0.013		-0.039	-0.039	-0.040
		(0.052)	(0.052)	(0.052)		(0.067)	(0.067)	(0.067)
Delivery instr.		0.148	0.148	0.148		-0.323	-0.323	-0.322
		(0.197)	(0.198)	(0.197)		(0.334)	(0.334)	(0.334)
Delinquency			-1.185	-1.184			-0.005	-0.002
			(1.607)	(1.606)			(1.375)	(1.373)
Credit line				-0.016				-0.490
				(0.178)				(0.371)
Observations	344255	344255	344255	344255	133849	133849	133849	133849
R^2	0.18	0.18	0.18	0.18	0.22	0.22	0.22	0.22
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note.– Dependent variable defined as in equation (5) and specifications are based on equation (6). The notional amount is the (log) amount hedged in a given contract. Maturity is calculated as days from signing of the contract to its maturity ($N_{c,i,b,d}$). Firm sales are in logs. Nonperforming loans (delinquency) is a dummy variable equal to 1 if the firm is in default in the banking system. The credit line is a dummy variable equal to one if the firm has a credit line in the banking system. Coincidence is as defined in equation (2). Standard errors clustered at the firm level are in parentheses. Statistical significance: * p <0.1, ** p <0.05, *** p <0.01.

Table C.11: Firms use of FX derivatives and nominal exchange rate dynamics

	Firm uses FX derivatives		Sales FX derivatives		Purchases FX derivatives	
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.020***	0.020***	0.047***	0.047***	0.001	0.001
	(0.004)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)
M^{TC}	0.054***	0.054***	0.012*	0.012*	0.155***	0.155***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.015)	(0.015)
FCD	-0.015***	-0.015***	-0.015	-0.015	-0.005	-0.005
	(0.005)	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Dispersion						
Std. forecasts (%)	0.051***	0.051***	0.031***	0.016***	0.017**	0.028***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)
Depreciation						
Forecast, median (%)	-0.010	-0.011	-0.183***	-0.112***	0.110***	0.058***
	(0.008)	(0.007)	(0.009)	(0.007)	(0.008)	(0.008)
Realized deprec. (%)		-0.000		0.005***		-0.004***
		(0.000)		(0.000)		(0.000)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326
R^2	0.53	0.53	0.54	0.54	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	—	—	—	—	—	—
Includes mining	—	—	—	—	—	—

Notes.— All regressors in logs. Regressors are outstanding balances of export/import trade credit and foreign debt. All regressions control for (log) firm sales (not reported), firm FE, and year-industry FE. Sample based on (trade, debt, and derivatives) operations denominated in U.S. dollars and outright forwards for FX derivatives. The exchange rate forecast captures the 12-month ahead expected depreciation and standard deviation across forecasters from the Financial Traders Survey conducted by the Central Bank of Chile. Realized depreciation uses the observed market value of Chilean Pesos per U.S. dollar. Constant terms are not reported. Standard errors clustered at the firm level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.12: 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 C.13: 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 C.14: Banks' sales of FX-derivatives to firms: supply side (Includes swaps)

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

Note.— Table shows bank fixed effects $\beta_{b,t}$ in columns 1 and 3 and cumulative share in total sales of FX derivatives to firms by banks in columns 2 and 4. The order of banks in Panel A does not necessarily 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 the confidentiality of their identity. Banks' market shares exclude investment banks and base-bank. The sample includes swaps. Clustered standard errors at the bank level in parentheses * p <0.1, ** p <0.05, *** p <0.01.

Table C.15: Firms' purchases of FX derivatives before and after change in regulation (Includes Swaps)

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	—
Includes Swaps	Yes	Yes	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. Sample includes swaps. Clustered standard errors at the firm level in parentheses * p <0.1, ** p <0.05, *** p <0.01

D CIP Violation around PF's change in regulation

Consider the Covered Interest Rate parity (CIP) arbitrage equation, with room for potential deviations as in Morales and Vergara (2017)[34]

$$(1 + i^*_{t,n} + x_{t,n}) = (1 + i_{t,n}) \times \frac{S_t}{F_{t+n}} \tag{9}$$

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

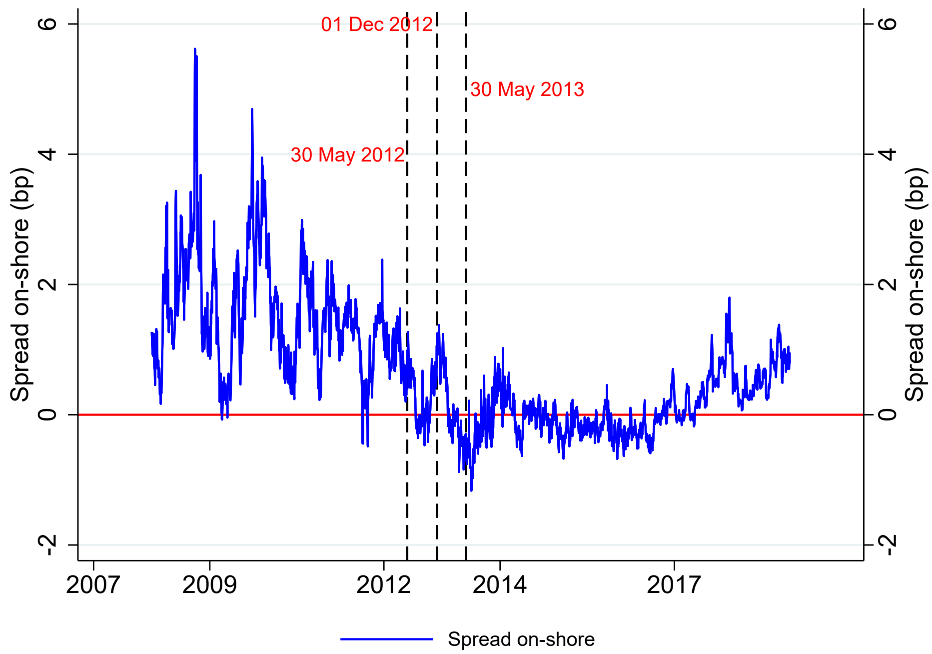


Figure D.1: Spread on shore, Chile, 2007-2020

Note.— On-shore spread ($x_{t,t+n}$) shown in basis points (9).

[34]Alternatively, an intimately related notion of CIP deviation is the cross-currency basis defined in Du et al. (2018): $e^{ni^*_{t,t+n}} = e^{ni_{t,t+n}+nx_{t,t+n}} \frac{S_t}{F_{t,t+n}}$, which apart from the continuous compounding is only different from the equation (34) in that it considers the deviation with respect to the local rate instead to the foreign rate.

E Importance of Engaging in FX Hedging

Under Modigliani-Miller assumptions, in particular, in the absence of financial frictions, hedging should not affect allocations or firm performance. Yet, we have documented that firms engage in FX hedging even though our evidence suggests it can be costly. What is the value of engaging in FX hedging? One way to shed some light on this question is using matching techniques and taking hedging as a treatment variable that may or may not affect firm performance.

For this, let Y_0 represent the outcome variable of interest for a firm which does not receive the treatment, and Y_1 the outcome variable for a firm that receives it. We examine four different outcome variables Y, in this exercise: (i) firm sales, (ii) total exports, (iii) total imports, and (iv) total international trade. Formally, we would like to compare the mean outcomes for a hedging firm, with the (hypothetical) counterfactual in which the *same* firm does not hedge,

$$\beta \equiv E\left(Y_1 | \, FXD \; heding = 1\right) - E\left(Y_0 | \, FXD \; hedging = 1\right), \tag{10}$$

where β denotes the effect of FXD hedging, and $\hat{\beta}$ is the average treatment effect on the treated statistic (ATT). Note that we have one ATT statistic for each of our four outcome variables. Put differently, the above equation represents the difference in performance between a firm that uses FX derivatives (the first right-hand-side term), and the *same* firm had it not purchased FX derivatives (the second right-hand-side term). The latter, however, is an unobserved counterfactual. The matching method is a strategy of constructing the unobserved counterfactual by identifying a match with similar economic characteristics for each firm. The underlying assumption is that the matched pairs, conditioning on the observed characteristics X, would perform similarly under the same circumstances. Hence, the above equation can be rewritten as:

$$\begin{aligned} \beta = {} & E\left(Y_1 | \, FXD \; hedging = 1, X\right) - E\left(Y_0 | \, FXD \; hedging = 0, X\right) \\ & - \left[E\left(Y_0 | \, FXD \; hedging = 1, X\right) - E\left(Y_0 | \, FXD \; hedging = 0, X\right)\right], \end{aligned} \tag{11}$$

where the first difference on the right-hand side of the above equation represents the observed difference in performance between firms that use FX derivatives and firms that *do not* use FX derivatives, the second difference represents the selection bias. That is, the difference in performance between firms using derivatives, under the hypothetical circumstances that they had not purchased them, and firms without them. Our goal is to minimize selection bias through the matching process. The choice of the set of confounding variables X should be such that after controlling for X, treatment is as good as random, i.e.

$$(Y_0, Y_1) \perp FXD \; hedging \mid X$$

A second challenge in our application makes it different from the simplest treatment impact evaluation; potential self-selection of unobservables. This comes from the fact that the treatment under study is not decided exogenously, but rather, firms choose to use FX derivatives or not. Using the outcome variables in the first differences, ΔY, we can overcome this limitation. Then, even if treated firms differ in important ways from control firms, as long as that difference is stable over time, the specification in the first differences can eliminate this bias.

Consistently, our choice of confounding variables includes the following variables: the number of workers, industry, available line of credit, and outstanding accounts payable and receivable, all in the initial pre-treatment period. A second important feature of our exercise is that we study firms that do not use FX derivatives in the pre-treatment period t_0 and either remain non-hedgers (control group with outcome variables Y_0) or start hedging in the post-treatment period t_1 (treated group with outcome variables Y_1). Given the large dimension of observable characteristics, we employ two techniques: Propensity Score Matching and Coarsened Exact Matching. Importantly both approaches deliver very similar results.

First, for propensity score matching,[35] we proceed in two stages. In the first stage, we estimate a probit model of firms that start using FX derivatives in t_1 using the information on firm size, measured by total employment, firm industry, availability of credit lines, and outstanding balances of trade credit as explanatory variables. The predicted probability of hedging (or the propensity score), denoted by $P(X) = \Pr(FXD\ hedging = 1|X)$, forms the basis of the matching procedure. In the second stage, we adopt one-to-one nearest neighbor matching and identify a firm in the control group j, for each firm that engages in FX hedging in the post-treatment period i, such that

$$l(i) = \underset{j|FXD\ hedging(j)=0}{\arg\min} \left| P_j(X) - P_i(X) \right|, \tag{12}$$

That is, the difference in the predicted probability of owning FXD in minimized.[36]

The average treatment effect of engaging in FX hedging can then be inferred from the average performance difference of matched pairs, that is,

$$\beta = E\left(Y_i\right) - E\left(Y_{l(i)}\right). \tag{13}$$

Our second approach is the Coarsened Exact Matching (CEM)[37], which can also be described as a two-step procedure. In the first step, group firms into two groups; a control group with firms that used FX derivatives neither in the pre-treatment period nor in the post-treatment period; and a treated group with firms that did not use FX derivatives in the pre-treatment period but did use FX derivatives in the post-treatment period. Then we coarsen all confounding variables—except for the firm industry, which is already coarsened—temporarily, exact-match according to these coarsened bins between control and treatment groups, and then discard the coarsened version of confounding variables. Observations from any group whose strata do not contain control and treatment observations are also discarded. Thus, the CEM algorithm provides a

[35]This technique, proposed in Rosenbaum and Rubin (1983), has become increasingly popular in recent empirical research along with other matching estimators developed to estimate average treatment effects.

[36]As is standard, in the matching procedure, we exclude observations outside the common support. The common support is bound by the lowest propensity score of a treatment observation and the highest propensity score of a control observation.

[37]Proposed by Iacus et al. (2012).

balanced sample by construction without needing to check ex-post for common support. In the second step, with a balanced sample, one can estimate (13) and have an estimation of the ATT statistic.

Results are presented in Table E.1. Panel A presents the results from the coarsened exact matching, and Panel B the results from the propensity score matching. For each method, we use different pre-and post-treatment periods. Recall that the matching is performed using the value of the confounding variables X in the pre-treatment period. The first set of results uses a pre-treatment period year 2010 and as post-treatment period years 2011-14. The second set of results, 2011 as pre-treatment and 2012-2015 as post-treatment periods. Finally, the last set of results uses 2011 as the pre-treatment period and 2012-2017 as the post-treatment period. The outcome variables are four. First, (log) sales, for which we find that, on average, firms that hedge are between 8 and 14% larger, depending on the method and sample. In the case of imports, we find that firms that hedge import between 10 to 19% more than comparable firms that do not hedge. In the case of exports, we find no significant results under the CEM method, but PSM points to firms that hedge exporting between 10 to 20% more than comparable firms that do not hedge. Finally, when one pools exports and imports, we find that firms that hedge trade between 11 to 27% more than comparable firms that do not hedge.

Table E.1: **Firm performance firms in FX**

	Panel A: CEM				Panel B: PSM			
	Sales (1)	Imports (2)	Exports (3)	Total trade (4)	Sales (1)	Imports (2)	Exports (3)	Total trade (4)
ATET (2010-14)	0.083***	0.108***	0.012	0.115***	0.144***	0.103**	0.184***	0.179***
	(0.018)	(0.038)	(0.065)	(0.034)	(0.026)	(0.052)	(0.070)	(0.044)
Observations	17964	16159	2542	17419	55568	47413	14562	53578
ATET (2011-15)	0.129***	0.186***	0.068	0.222***	0.100***	0.221***	0.182**	0.271***
	(0.019)	(0.036)	(0.057)	(0.031)	(0.024)	(0.060)	(0.086)	(0.050)
Observations	17947	16539	2468	17595	58741	50200	15053	56599
ATET (2011-17)	0.127***	0.166***	0.069	0.190***	0.144***	0.103**	0.184***	0.179***
	(0.017)	(0.030)	(0.056)	(0.027)	(0.026)	(0.052)	(0.070)	(0.044)
Observations	21245	19819	2872	20821	55568	47413	14562	53578

Notes.— Panel A shows results from the coarsened exact matching algorithm in Iacus et al. (2012), Panel B shows results from Propensity Score Matching, using nearest neighbor matching. Each estimation shows the average treatment effect on the treated (ATET). Matching is performed at the initial year in each time window. We use differences for (log) sales, log(exports), log(imports), log(total international trade), log(market capitalization) to account for self selection based on unobservables.

F A Stylized Model of Market Thickness

In this section, we develop a simple model illustrating how market liquidity is critical for the FX derivatives market. Notably, this is not a theory of optimal hedging but a stylized matching model which illustrates how the regulatory change we explore in Section 5 affected both buyers' and sellers' (other than PFs) decisions to engage in financial hedging. This model builds on the stylized facts found in Section 4 that natural hedging is limited (Fact 1), buyers of FX derivatives are usually importers, and sellers are generally exporters (Fact 2, 3).

Hence, in this stylized model, we consider a buyer of FX derivatives (usually an importer with trade credit exposure or a borrower in foreign currency), a financial intermediary which acts as a market maker (usually a bank), and sellers of FX derivatives (usually an exporter with trade credit exposure, or Pension Funds). Figure F.1 displays the interaction between these agents. Notably, firms may be both sellers and buyers of FX derivatives, as firms hedge their gross, not net, positions (Fact 3).

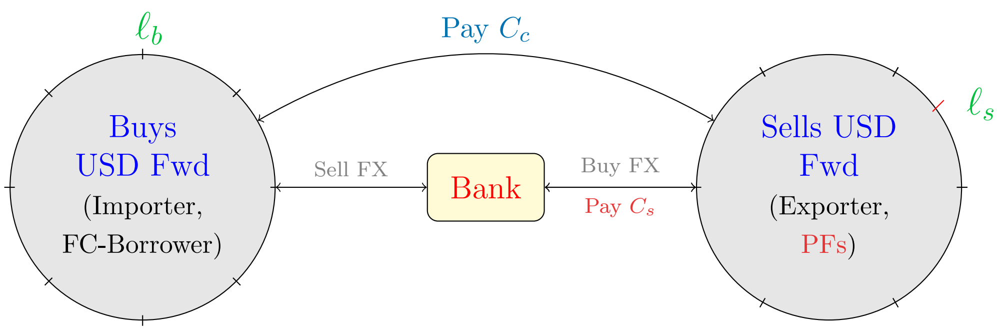


Figure F.1: OTC intermediation in FX derivatives market

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

$$s_j^M = (\bar{s} - \underline{s})\varphi_j^M, \qquad \varphi_j^M \sim U(0,1) \tag{14}$$

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

μz. We can think of this proportional cost μz as the residual currency risk, which banks tend to avoid if they can. Hence, a bank will only sell FX derivatives to an importer if this distance is small enough relative to the benefit ω^M.

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

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

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

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

$$E(\pi_j^M|FX) = \left(2n^X \frac{\omega^M}{\mu}\right)(s_j^M - \omega^M) - f_E \tag{15}$$

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

$$s^{M*} = \frac{f_E - C_N + 2n^X \frac{(\omega^M)^2}{\mu}}{2n^X \frac{\omega^M}{\mu} - 1} \tag{16}$$

with,

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

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

$$s^{X*} = \frac{f_E - C_N + 2n^M \frac{(\omega^X)^2}{\mu}}{2n^M \frac{\omega^X}{\mu} - 1} \tag{17}$$

where n^M is the number of importers in the buyers' market, and ω^X is the fixed fee banks charge to exporters for selling FX derivatives. For given values of entry cost, natural hedging cost, bank fee and mismatch cost, (16) and (17) pin down n^X and n^M.

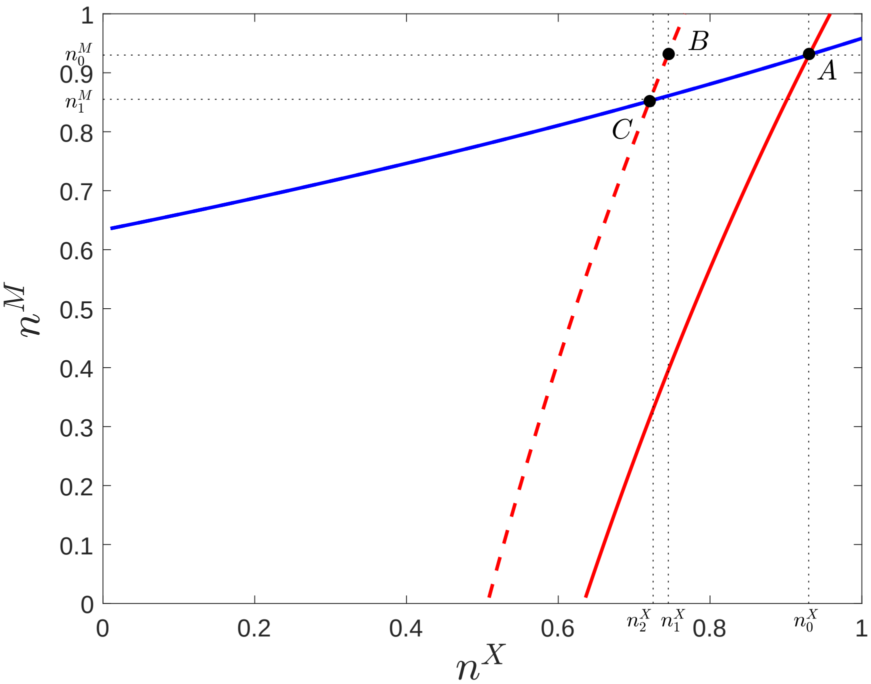


Figure F.2: Market thickness

Note.— This figure shows the joint determination of entrants in the OTC FX derivatives market. Blue line represents equation (16), red line represents equation (17), dashed red line represents (17) with a negative shock to the mass of the FX derivatives sellers.

So far, it is clear that the thickness of the counterparty market directly affects the probability of a firm engaging in financial hedging. That is, the thickness in the market of sellers of forward dollars and the availability and heterogeneity of different currency/maturity contracts— affect the probability that a forward-dollar-buyer firm, which is assumed to pay an entry cost, engages in financial hedging. The same is true for sellers of FX derivatives about the market thickness in the buyers of forward dollars. The interplay of equilibrium conditions (16) and (16) (in blue and red respectively) is depicted in Figure F.2, where the intersection point A defines equilibrium market thicknesses $(n_0^X, n_0^M))$.

The regulatory change examined in Section 5 can be interpreted in this model as an exogenous decrease in market thickness in the seller's market, $n_0^X - n_1^X$, or going from point A to point B. By Equation (16) we know that the number of buyer firms will decrease (for sensible parameterization). Our stylized model highlights that this decrease in the market thickness of buyers of FX derivatives results in a further reduction in the market thickness of sellers of FX derivatives, beyond the initial drop due to the absence of Pension Funds sell of short positions. This extra drop in market thickness can be seen in the figure as the distance $n_1^X - n_2^X$. This, in turn, is in line with the evidence in Table 14, column 3, which shows a negative coefficient for the sales of FX derivatives after a supply shock to this market.