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Granular Corporate Hedging Under Dominant Currency

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Abstract

This paper shows that, in a world dominated by vehicle currencies, firms engaging in international operations retain currency risk and hedge it real and financially. We employ a unique dataset covering the universe of trade credit, international trade, foreign currency debt, and FX derivatives contracts with firms' census data in Chile (2005-2018). We document that operational hedging is quantitatively limited, as different maturity, frequency, and amount of FX operations make it difficult to net these exposures. The granular firms complement real hedging using FX financial instruments, which improve their cash flow management and promote their trade and growth.

Keywords: Operational Hedging, FX hedging, FX derivatives, cash flow, foreign currency debt, currency mismatch, trade credit, dominant currency.

JEL: F14, F2, F31, F38, F4, G30.

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1 Introduction

International trade and finance are primarily denominated in a small number of dominant currencies, with the US dollar taking a focal presence. With many costs still invoiced in local currencies (wages, rent, taxes, distribution, etc.), a natural question to ask is: how do firms manage their foreign currency (FX) exposure when international trade and finance are denominated in vehicle currencies? Answering this question is key because the use of foreign currency has created significant disruptions in international trade and has been at the center of economic downturns and crises worldwide.[1] Yet, there is a major data availability challenge. To date, there was no detailed data on firms' cash flows in foreign currency merged with their use of FX financial instruments. This paper fills this gap by creating a unique dataset reporting the universe of trade (including its invoicing and financing), debt, and FX derivatives contracts by currency and maturity and using it to understand firms' decisions on FX exposure and hedging in Chile between 2005 and 2018.

We document that firms under dominant currency retain exchange rate exposure and actively engage in FX risk management by complementing their real hedging with financial hedging. We first measure "natural hedging" –namely matching payables and receivables in FX– and show that, although firms invoice their exports and imports and borrow in the same vehicle currency, natural hedging is quantitatively limited because cash inflows and outflows do not match in timing and amount even for the same currency pair. That is, our contract-level data reveals that most operations do not occur in the same period (be it a month or quarter) or have similar maturity, and, even in the small number of cases that they do, the amount of cash in and out differs largely such that exposure netting is small. We then show that the largest firms hedge this risk by actively using financial hedging, and, consistent with the different timing and amount of FX operations, they hedge their *gross* transactions.

Facing an intermediation cost that increases in maturity, firms concentrate their FX financial hedging on larger-amount and shorter-term exposures, primarily from international trade. Our results indicate that, given the nature of firms' day-to-day operations and costly external finance, FX real and financial hedges are complement tools to hedge currency risk, being real hedging between 3-8% of cash flows exposure and financial hedging between 35-50%.[2] Lastly, we exploit a policy reform that exogenously reduced the supply of FX derivatives to firms and show that firms grow approximately 10% by using them and that, by improving cash flow management, FX financial hedging entails real implications and adds value.

In this paper, we open the "black box" of firms' FX exposure and currency risk management by focusing on *FX transaction exposure*, which is contractual and well-defined. That is, for each transaction, there is a contract specifying the amount, date, maturity, and currency; hence, one can measure and precisely identify currency exposure. We then create a unique dataset that com-

[1]We review the literature below.

[2]It is worth noting that it might not be optimal to employ financial instruments to *fully* hedge the currency risk, as the optimal FX financial hedging depends on the nature of firms' investment and financial opportunities (see Froot, Scharfstein and Stein 1993).

bines census administrative information on FX derivatives, foreign currency debt, international trade, sales, and employment for the universe of non-financial firms (hereafter, *firms*) in Chile between 2005 and 2018. In particular, our data on FX derivatives contains detailed transaction-level information on all FX currency forwards, futures, options, and swap contracts traded over-the-counter (OTC) (i.e., including contract-, firm- and counterpart-ID, signing and maturity dates, currency, and forward exchange rate).[3] Our foreign currency credit data includes bond issuance, loans, and foreign direct investment. We merge these datasets with transaction-level data on international trade, including currency of invoice, delivery date, value, and financing through trade credit or upfront payment. The distinction between trade credit and upfront payment is key in our analysis, as the latter does not entail currency exposure.

Once combined, this detailed information allows us to obtain precise estimates of cash flows in foreign currency and their maturity for domestically-owned firms (hereafter, domestic firms). Our main analysis focuses on them because MNCs employ FX derivatives for a variety of reasons —including repatriating profits and accounting statements— and, as discussed below, domestic firms do not have stock of assets in foreign currency which our data does not report at the firm level. However, our robustness exercises show that all our results remain valid when including MNCs. Since the copper sector is important in Chile, we also show robustness with and without mining. It is worth noting that our sample includes both appreciation and depreciation phases. Hence, it captures different currency risks for all exporters, importers, and FX debt holders throughout the sample. Importantly, our data allows us to document new facts that could not be uncovered using surveys or low-frequency data and, thus, provides new insights about which transactions firms hedge financially, which instruments they use, how costly it is, how much they hedge and, ultimately, whether FX financial hedging entails real implications. Beyond the granularity of the data, the Chilean market is illustrative of the functioning of FX markets in general, as it has the same structure as advanced economies. The market is dominated by OTC contracts, as in Europe and the U.S. (BIS, 2019). Chile is a non-dollarized high-income economy with stable macroeconomic conditions, responsible fiscal policy, and a credibly floating exchange rate regime in our sample.[4] Lastly, its trade-to-GDP (57.4%) and corporate FX debt ratios (13%) are close to those of advanced economies.[5]

We first document that the FX derivatives market has seen a large development over the last fifteen years in Chile, which mimics its growth worldwide. By 2018, the number of firms participating in this market had grown by three times and their gross derivatives positions by

[3]Such detailed data on FX derivatives is exceptional. For example, in Europe, OTC FX derivatives were only mandatory to be reported after 2012 upon the EU Regulation 648/2012 (EMIR). Yet the data was of poor quality until November 2017, when more regulation was introduced to increase "data usability and quality" (ESMA 2019). Note that this data would still need to be merged into assets and liabilities in FX to measure FX exposure.

[4]It is worth remarking that the Central Bank of Chile only intervenes in the FX market exceptionally and with the purpose of reserves accumulation. As discussed in the IMF document (Chamon et al. 2019), over the last 20 years, since 2003, it made only two small and pre-announced interventions (in 2008 and 2011) where the "programs involved regularly scheduled purchases of US dollars to reach an international reserve target".

[5]The trade-to-GDP ratio is 64.4% for France, 62.4% in U.K., Italy 60.4%, Spain 67.6% in 2018 according to the OCDE. The share of FX loans in the corporate sector was 5% for Germany, 10% in Denmark, 8% in the United Kingdom, 14% in Greece in 2014 (Salomao and Varela, 2022).

four times (reaching more than USD 35 billion). Importers and exporters use FX derivatives extensively. The aggregate ratio of FX forward purchases (sales) over trade credit for imports (exports) is 94% (93%), and the median firm value is 50% (35%). Importantly, the use of FX derivatives is granular, as firms employing them are the largest exporters, importers, and FX debt holders. They account for almost 40% of total trade and are more than five times larger than the average importer and FX debt holder and twice as large as the average exporter.

We then measure cash flows in foreign currency by computing all firms' FX payables and receivables. More precisely, we consider all trade credit (which accounts for 80% of total trade), upfront payments from exports and imports, and FX debt flows to compute a firm's "net FX exposure" from cash flows due in the same period and the same currency pair. Our results indicate that exposure netting is quantitatively limited, as only 3% of firms have net exposure close to zero. Furthermore, the correlation between payables (trade credit and upfront payment for imports and FX debt payments) and receivables (trade credit and upfront payment for exports) is only 2% for flows due in the same month. Still, it only reaches 13% for cash flows due in the same year. This correlation remains low even if we compute it for *total* trade, without FX debt, for all outstanding credit and upfront payment, or estimate regressions by industries, firms' size, or with and without firm and industry-year fixed effects. Only for the largest firms that trade, borrow in FX, and employ FX derivatives, the correlation reaches a maximum of 20% when considering a *year* maturity.

We turn next to analyze the reasons why "natural" ("operational") hedging is quantitatively limited and show that cash flows in and out differ substantially by *frequency, maturity, and amount* within firms and currency pair. We first show that —although large exporters are also large importers (Amiti, Itskhoki and Konings 2014) and FX debt holders and operate using vehicle currencies (Amiti, Itskhoki and Konings 2022)— they might not have export and import due in the same period, and when they do, exports and imports differ substantially in size. In particular, these firms have positive cash flows from exports and imports only four months per year (*frequency*). Moreover, the *maturity* of their trade credit for exports and imports also differs substantially. Export trade credit with direct suppliers is twice as long as import trade credit (162 vs. 83 days) and, similarly, for trade credit with financial institutions. The maturity of foreign debt is much longer, with 1,330 days on average.[6] We then show that the median "coincidence" of exports and imports cash flows (by *amount*) reaches only 20%, 15%, 10% for flows due in the same month, quarter, and year, respectively.[7] These results indicate that even firms that could potentially be operationally hedged because they have both payables and receivables in FX are not, and retain currency risk.

Our next step is analyzing how firms hedge this risk using FX derivatives. We document that

[6]These results also imply 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.

[7]Note that the coincidence of exports and imports decreases with the length of the maturity, as longer maturities include firms that trade less frequently and for lower amounts. At the same time, firms that trade every month tend to trade for larger amounts.

the preferred instrument to hedge currency risk is the FX Forward, accounting for more than 88% of contracts and 86% of the notional value of FX derivatives held by firms. Notably, the median maturity of FX purchases (i.e., buy USD forward) and FX sales (i.e., sell USD forward) are 81 and 119 days and closely follow the maturity of trade credit for imports and exports, respectively, reported above. This provides suggestive evidence that firms mainly employ FX forwards to hedge their *gross* FX exposure from trade; a finding that is consistent with the different operational characteristics of exports and imports and that we confirm econometrically. After controlling for firm and industry-year fixed effects, we find that firms financially hedge 31% of their exposure arising from import trade credit and 5% from export trade credit. Along these lines, the aggregate correlations of FX purchases with imports trade credit, and FX sales with export trade credit, are twice as large as the net correlation. These results indicate that firms buy FX forward when imports are financed through trade credit and—perhaps more interestingly—sell FX forward when exports generate future FX receivables. Pointing to the complementarity of real and financial FX hedging, we also document that the lower the coincidence between payables and receivables in FX,—i.e., the lower the natural hedge—, the higher the firms' use of FX derivatives. It is worth noting that, although some firms hedge 8% of their FX debt exposure using FX forwards, FX bonds and loans tend to be hedged with cross-currency swaps that have a longer maturity and are the second most used instrument to hedge the currency risk. These results are robust, including proxies for management complexity, default risk, credit constraints, and exchange rate volatility and expectations.

Financial intermediation is costly, particularly in OTC markets as those of the FX forward, which work on bilateral relationships and with search-and-bargaining features. Using our contract-level data, we exploit within-firm variation and document that financially hedging *gross* transactions is substantially costly and shapes the transactions that firms use FX derivatives for. In particular, we show that firms pay a 0.4 (2) percentage points premium (discount) for FX purchases (sales) when doubling the maturity of the contract, which results in firms being more likely to hedge short-term transactions of (60%) larger amounts, primarily from trade.

Lastly, we show that, under dominant currencies, FX financial hedging can improve firms' real outcomes as firms using it are bigger and trade more.[8] We test this in two separate exercises. First, we estimate a propensity score matching and a coarsened exact matching and show that, after controlling for a full set of firms' and sector characteristics, firms that engage in using FX derivatives have higher sales (10%), exports (18%) and imports (10%). Second, we exploit a quasi-natural experiment that exogenously reduced the supply of FX forwards to firms and assess whether it affects firms' FX hedging policies and real outcomes. In particular, we leverage a regulatory change to Pension Funds' (PFs) hedging requirements in 2012/2013 that reduced their FX forward sales to banks. Banks —the main intermediaries in the derivatives market—, retain little to no currency mismatches because of regulation and pass this negative liquidity shock

[8] In the Modigliani and Miller (1958) frictionless neoclassical framework, there is no role for hedging as it adds no value to the firm. However, in the presence of market imperfections — such as financial frictions, transaction costs, and convex tax schedules— volatility can be costly, conveying a role to hedging (Smith and Stulz 1985, Froot, Scharfstein and Stein 1993, Rampini and Viswanathan 2010 and Rampini et al. 2014).

onto firms. The 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 by 10-15% within six months after the reform. This had real implications: firms decreased their imports by 14% and their employment by 3%. Being the use of FX financial hedges granular, the reform entailed significant aggregate implications. A back-of-the-envelope calculation implies that total imports dropped by 5% within the six months after the regulatory change.

Related Literature.— We relate to the literature in international trade and macroeconomics showing that, in a world of dominant currencies, firms tend to invoice in vehicle currencies and that this can have real effects (on trade, Goldberg and Tille 2009, 2016; Gopinath, Itskhoki and Rigobon 2010, Burstein and Gopinath 2014, Gopinath 2015, Gopinath et al. 2020, Corsetti et al. 2018, Gopinath and Itskhoki 2022; and on macro Gopinath and Stein 2020, Bahaj and Reis 2022, Egorov and Mukhin 2022, Bruno and Shin 2015*a*, among others). Our paper is closest to Lyonnet, Martin and Mejean (2016) and Amiti, Itskhoki and Konings (2022), who show that exporters'/importers' invoice currency correlates with their financial exposure and, hence, firms retain currency risk. Our analysis shows that the largest firms, which use vehicle currency in their foreign transactions, hedge this exposure by engaging in FX financial risk management. The lower the coincidence of cash inflows and outflows in FX, the higher their use of FX derivatives.

Our finding that the largest firms undertake FX financial risk management echoes the literature in international trade (Bernard et al., 2007; Melitz, 2003; Antràs, Fort and Tintelnot, 2017); multinational (Helpman, Melitz and Yeaple, 2004; Alfaro and Chen, 2018); foreign borrowing (Varela, 2018, Salomao and Varela, 2022), reporting selection into these markets. The aggregate implications of large, granular firms on macro, trade, and finance have also been documented by Gabaix (2011), Acemoglu et al. (2012), di Giovanni, Levchenko and Mejean (2014), Gaubert and Itskhoki (2021), Gabaix and Koijen (2020), among others. Our detailed data allows us to provide novel evidence that the different timing and amount of payables and receivables in FX are key to understanding the quantitative limitations of natural hedging and that these differences shape firms' FX financial risk management towards hedging of gross and short-term transactions for larger amounts, mainly related to trade. This finding is in line with Antràs and Foley (2015), who show that the different timing of operational and financial milestones increase the need for working capital, and to Klapper, Laeven and Rajan (2011), who document that time lags between receivables and payables are the norm in day-to-day operations in trade.

The literature in international economics has studied the emergence of currency mismatches and their implied vulnerabilities for firms and countries, especially during currency crises[9] (on macro, Eichengreen and Hausmann 1999; Céspedes, Chang and Velasco 2004; Rey 2015; Bruno and Shin 2015*b*; Ilzetzki, Reinhart and Rogoff 2019; Forbes 2021; on trade, Gopinath and Neiman 2014, Blaum 2019; balance sheet effects, Ranciere et al. 2010; Kim, Tesar and Zhang 2015; among others), but limited data availability has led it to abstract from firms' use of financial FX hedging.

[9]It is worth noting that most currency crises in the 1980s and 1990s occurred in countries with fixed exchange rates (*de facto* or *de jure*), bank crises and limited FX markets.

The recent development of the FX derivative markets has provided firms with new tools to hedge currency mismatches. Our paper shows that firms employ them extensively to complement their operational hedges, particularly for short-term liabilities from trade operations. This gap in the literature has been recently noticed by Du and Schreger (2021), who explore the use of derivatives in the financial system.[10]

The finance literature has gathered information from surveys and listed firms to obtain a first look at firms' use of FX derivatives. In a recent paper, Adams and Verdelhan (2021) advanced this literature and circumvented the lack of precise information on firms' FX operations and derivatives by using exchange gains and losses reported in income statements of publicly listed Japanese and U.S. firms. This allows them to document that listed firms do not fully hedge the direct impact of exchange rate changes, which we also report.[11] Our analysis is complementary to them in that our detailed data allows us to precisely identify transaction exposure and characterize operational and financial hedging strategies of all firms in the economy.

Our findings that financial frictions (i.e., non-having access to credit lines and having non-performing loans) affect firms' use of FX derivatives and that FX financial hedging adds value to the firm provide empirical support to the literature showing theoretically that, in the presence of market imperfections volatility can be costly and conveys a role to hedging (Smith and Stulz 1985, Froot, Scharfstein and Stein 1993, Rampini and Viswanathan 2010 and Rampini, Sufi and Viswanathan 2014). We show that a reduction in the supply of FX derivatives affects exporters (as in Jung 2021), but it also affects importers by reducing their trade and size. Our finding that the functioning of the FX derivative market—dominated by OTC activities and involving banks as intermediaries in the matching of buyers and sellers—can affect firms' FX financial management strategies is consistent with Duffie, Garleanu and Pedersen (2005), Chodorow-Reich (2014) and Hau et al. (2021) who underscore short-run stickiness of bank-firm relations.[12]

The paper is organized as follows. Section 2 describes data, the identification of FX cash flows, and the main features of the FX derivative market in Chile. Section 3 documents firms' operational hedging. Section 4 discusses firms' FX financial hedging. Section 5 analyses how FX financial hedging under vehicle currency improves firms' real outcomes. The last section concludes.

[10]Recent work by Verner and Gyöngyösi (2020) studies the role of currency mismatches on households.

[11]Other papers using data on sub-samples of firms are: Allayannis, Ihrig and Weston (2001); Bodnar, Graham, Harvey and Marston (2011); Jung (2021) (Korea); Rossi-Júnior (2012) (Brazil); Miguel (2016) (Chile). The importance of FX hedging on trade that we remark has also been highlighted by Fraschini and Terracciano (2021), who find that French exporters turn to invoice in U.S. dollars when they access FX derivatives. Gurkaynak et al. (2022) exploit S&P500 firms' differential issuances of long-term floating rate debt, fixed debt, and interest risk hedging and show that high cash flow exposure correlates with lower stock price decline during FOMC forward guidance surprises. Hedging mitigates the cash flow and the real effects of these shocks.

[12]Our findings are also consistent with Geczy, Minton and Schrand (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.

2 Data, Identification and FX Market in Chile

This section first introduces the data, then discusses the identification of firms' currency exposure, and finally, presents the main features of the FX derivative market in Chile.

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 the information on domestic currency debt with the banking sector from the credit registry for a subset of our analysis. In addition, we can cleanly merge these datasets due to the universal use of the unique tax identifier number (*Registro Único Tributario*, RUT) for all Chilean residents. Each of the datasets contains the following information.

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

International trade.— We use information from the Chilean Customs Agency, 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.[13]

Trade Credits.— Notably, we observe many aspects of trade credits associated with international trade transactions: who finances it (whether it is a financial institution or a direct vendor/client), upfront payment, amount, and maturity. The distinction between the *overall* value of imports and exports and trade credit is critical for our analysis, as what entails exchange rate exposure is the deferral of cash flows given the uncertainty on the future value of payables and receivables converted into local currency. Instead, upfront payments do not entail

[13] Trade credits are arrangements between sellers and buyers, allowing them to contract purchases today and pay on a specified future date. Trade credits are the dominant form of short-term financing among firms and are used both domestically and internationally, covering more than two-thirds of trade, BIS (2014).

exchange rate uncertainty.[14]

Foreign currency loans and bonds, and local credit.— Our data reports the foreign debt of Chilean residents, used to compute the balance of payments. In particular, it reports end-of-month stocks of loans, bonds—currency, maturity, interest rate, and coupon payments. Local currency debt is obtained from credit registry data at the firm-month level from 2009.

Foreign direct investment.— We collect data on direct investment between 2003-2018, coming from the balance of payment, to define Chilean and foreign MNCs.

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.

Firm/Company information.— Importantly, our data allows us to go beyond plants and establishments and assess the overall firm/company. This mapping is important because, for example, if a firm has its production and financial operations split into two different establishments, one would be unable to match the FX exposure and FX financial hedging strategies. To be able to do this analysis, one needs to have a mapping between establishments belonging to the same firm.

This data allows us to measure all domestic firms' cash flows in foreign currency, as we define in the next section.

2.2 Identification

We make five considerations to measure precisely all firms' cash flows in foreign currency. To check that these considerations do not drive our results, we conduct in parallel a large set of robustness tests without these restrictions.

First, we focus on the exposure that arises from firms' FX transactions. More precisely, contracts define the currency, maturity, and amount for each transaction and thus can be directly measured.[15] Then we can precisely measure exposure for domestic firms as we observe all their cash flows arising from international trade —that is, trade credit and upfront payment— as well as all their loans and bonds by amount, currency, and maturity.

Second, in our baseline estimations, we focus on domestic firms and exclude foreign and Chilean MNCs. By focusing on domestic firms, we have information on *all* assets and liabilities

[14]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.

[15]There other two types of currency exposure: "economic exposure" and "translation exposure". Economic exposure refers to unexpected changes in the exchange rate that affect a firm's competitive position. It is broadly defined and difficult to measure, as it depends on the market structure of the firm as well as the market structure of its competitors and general policies. For example, a depreciation of the Renmbini would affect the competitive position and, hence, economic exposure of a Chilean firm, even if it does not import, export, or hold FX debt. Still, it produces a substitute for Chinese goods. Translation or accounting exposure is ex-post and relates to how MNCs report their consolidated financial statements (see Eun and Resnick 2018, chapters 8-10; Lewis 2018; Servaes, Tamayo and Tufano 2009).

in foreign currency at the firm level. In particular, we observe contract-level information on all international trade, bonds, and loans with financial institutions. While we do not have administrative data on deposits and inter-company loans in foreign currency, focusing on domestic firms eliminates the latter, and, as shown by Albagli et al. (2020), the former are highly concentrated in MNCs in Chile, which we exclude. Second, MNCs could use FX derivatives to hedge the value of dividends in foreign currency, and subsidiaries or headquarters abroad may undertake financial hedging, which might be harder to track. Third, MNCs have foreign assets abroad or even report financial statements in foreign currency, affecting their motives and strategies to manage currency risk. Yet this exclusion is without loss of generality, as domestic firms represent 90% of the volume of FX derivatives and over 90% of the total firms (as shown in Figure 2).

Third, we concentrate on the same currency pair, namely U.S. dollars (USD) and Chilean Pesos (CLP). This restriction is without loss of generality, as the USD is the most used vehicle currency and most international trade (more than 85%), FX debt (more than 95%), and FX derivatives are denominated in USD in Chile.[16] 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 USD. The Euro follows this ranking from a distant second place, with almost 5% and 6% long and short FX positions, respectively.

Fourth, as commodity prices may correlate with the exchange rate, we exclude firms in the mining industry from our baseline sample and do robustness with them along the paper.

Finally, our primary sample 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.

In sum, by focusing on the transaction exposure of domestic firms and the same vehicle currency, we have information on all assets and liabilities in foreign currency of firms (both stocks and flows), and we can precisely identify firms' currency exposure and their associated FX risk management strategy. Moreover, as we report in the paper, our results are robust to the inclusion of all the above, sequentially and altogether.

Beyond the detailed data collected for nearly two decades, Chile offers an excellent case to study due to its macroeconomic and institutional stability during our time frame.[17] OTC transactions dominate the derivatives market 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

[16]See Gopinath and Itskhoki (2022), who document that the USD is the dominant foreign currency denomination in international trade and USD invoicing reaches 96% in Latin America.

[17]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 is credible and has been in place for 30 years and on average has met the target; the floating exchange rate regime is credibly flexible and has been in place for almost 20 years, 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.

Central Bank, (Albagli et al., 2020). Furthermore, Chile is a non-dollarized economy with domestic transactions priced in local currency. This can be illustrated by the small share of FX debt of the corporate sector — 13% of GDP in 2016, including MNCs' FX debt—, which is closer to the share reported in advanced economies (around 10%) than emerging markets (more than 50%) (Salomao and Varela 2022).[18] 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).

2.3 The FX derivatives market in Chile

The FX derivatives market in Chile has expanded rapidly over the last 15 years. As in developed countries, the market is dominated by OTC transactions intermediated by banks.[19] Figure 1 presents a scheme of the agents participating in the FX market in Chile and the direction of their net transactions. Other financial firms (such as pension funds, mutual funds, etc.) are net suppliers of FX derivatives to banks, and thus, they have opposite net positions. Since banking regulation caps currency exposure to banks in Chile, banks can not have open positions in FX and are net sellers of FX derivatives to non-financial firms (thereafter, firms).[20]

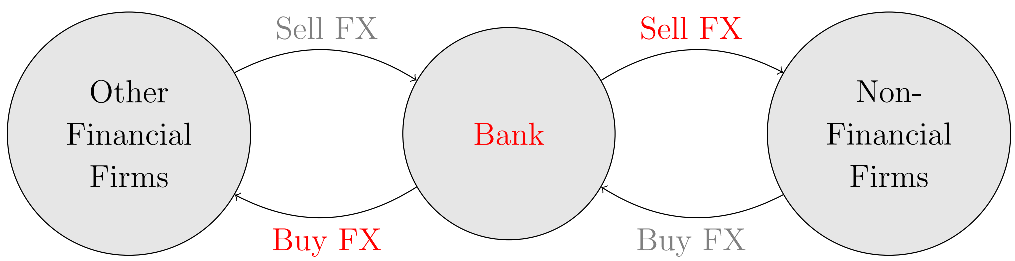


Figure 1: OTC Market: Outstanding FX purchases ans Sales

Firms have constantly increased the use of FX derivatives over the last fifteen years. Figure

[18]Chile is a typical country in which international trade and international debt are denominated in foreign currency, and like in other emerging markets –such as Mexico, Brazil, Korea, and South Africa– internal prices are set in domestic currency, in contrast to more dollarized economies as Peru. We caution that measures of the percentage of foreign currency deposits to total deposits in domestic banks tend to confound the everyday use of foreign currency as a unit of account and store of value and measures of availability of dollars due to capital controls or restrictions on foreign investment. For example, Argentina tends to be a highly dollarized economy. Still, it displays a low share of foreign deposits due to the widespread use of capital controls and distortions.

[19]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.

[20]This policy, which is applied in most countries in the region, has been extremely effective, limiting currency mismatches to less than 1%, see Albagli et al. (2020). Other financial firms also have a cap on their FX exposure per regulation.

2 (left panel) shows that the number of firms using FX derivatives has increased by three-fold, and their gross FX derivatives position has increased by four-fold, from 8 to more than USD 35 billion. This expansion has been common to both periods of appreciation and periods of depreciation, as shown in the right panel. It is worth noting that domestic firms dominate the use of FX derivatives in Chile, as they account for 95% of the gross derivative positions of firms (Figure 2, left panel).

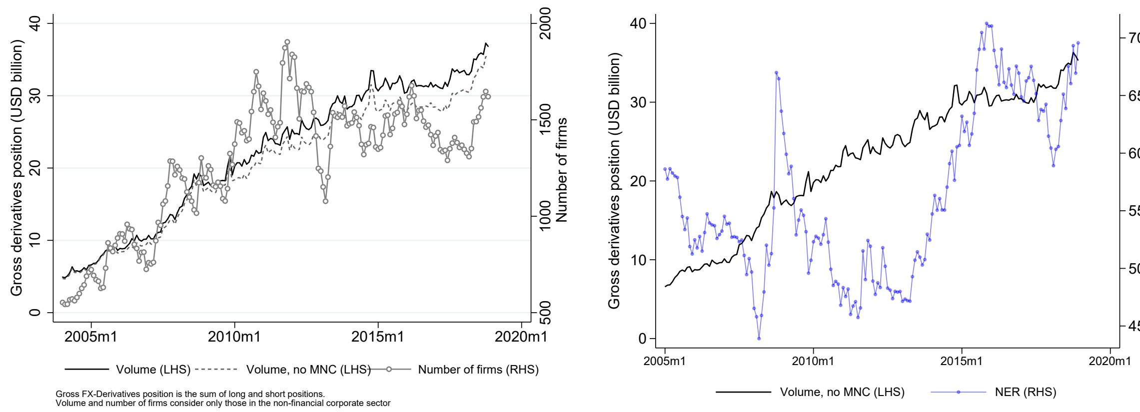


Figure 2: Number of firms and total gross FX Derivatives positions

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.

Table 1 takes a closer look at the FX derivatives markets. Panel A.1 reports the FX instruments and their main characteristics for the whole market —namely, financial and non-financial firms— (columns 1-5), and Panel A.2 focuses on non-financial firms (columns 6-11). Over the period 2005-2018, there were close to 1.9 million contracts, of which 0.7 million involved a non-financial firm. In Chile, as in most countries, the exchange rate derivative market is dominated by forwards, which constitute 80% of all FX derivatives contracts and close to 69% in notional value (Panel A.1). For non-financial firms, the use of forwards is more extended, accounting for 88% in volume and 86% in notional value (Panel A.2). For this firms, the bulk of forwards is relatively short-term with a median maturity of 92 days. The second more used instrument is swaps, both FX swaps and cross-currency swaps, which account for 2% and 4% of contracts, and 6% and 5% of face value, respectively.[21]

Panel B decomposes the data for non-financial firms between purchases and sales of FX derivatives. FX forwards remain the most used instrument with a share of 83% and 80% of the

[21]For comparison, in Europe, firms' outstanding FX derivatives position reaches 17.6 trillion Euros, which is dominated by FX forwards in USD. US firms' daily turnover of FX derivatives was $102.63 billion in 2018, (FRBNY, 2019), representing 9 times the daily total trade amount (census.gov). In Europe, the derivative market's notional amount in 2018 was 735 trillion euros, dominated by interest rate derivatives (75%) followed by currency derivatives (15%). Nominal transactions are mainly in swaps (56%), while currency derivatives are instead dominated by forwards in both nominal amount (59%) and number of contracts (69%), with USD being the main currency (63%). In Europe, non-financial firms' derivative contracts account for 51.5 trillion euros.

Table 1: **Descriptive statistics FX derivatives contracts**

Panel A: By market

	A.1. All Market						A.2. Non-financial firms					
	Contracts (#)	Share contracts (%)	Value median (thousand $)	Share Value (%)	Maturity median (days)	Share NDFX (%)	Contracts (#)	Share contracts (%)	Value median (thousand $)	Share Value (%)	Maturity median (days)	Share NDFX (%)
Forwards	1,518,688	80.4	5,630.0	68.7	71.1	83.5	695,612	88.8	1,326.8	85.8	92.4	66.5
Futures	2,211	0.1	1,684.4	0.0	43.3	96.8	357	0.0	1,724.4	0.1	85.3	82.6
Call options	24,974	1.3	1,436.4	0.3	159.2	91.6	22,038	2.8	823.1	1.7	165.2	90.8
Put options	15,677	0.8	1,936.0	0.2	167.6	93.0	13,609	1.7	977.1	1.2	176.2	93.5
Swaps	502	0.0	7,887.2	0.0	1,382.4	74.3	334	0.0	5,381.6	0.2	1,233.8	43.4
FX swaps	271,427	14.4	12,723.1	27.8	77.2	90.6	17,453	2.2	3,619.8	5.9	75.0	38.3
CC Swaps	55,474	2.9	6,505.3	2.9	1,051.4	31.4	34,018	4.3	1,639.3	5.2	686.3	5.7
Total	1,888,953	100.0	6,584.8	100.0	103.0	83.2	783,421	100.0	1,373.2	100.0	121.7	64.4

Panel B: by thpe of operation for non-financial firms

	B.1. Purchases						B.1. Sales					
	Contracts (#)	Share contracts (%)	Value median (thousand $)	Share Value (%)	Maturity median (days)	Share NDFX (%)	Contracts (#)	Share contracts (%)	Value median (thousand $)	Share Value (%)	Maturity median (days)	Share NDFX (%)
Forwards	480,484	89.7	1,312.1	87.1	80.6	58.6	215,128	86.9	1,359.8	83.1	118.6	84.4
Futures	300	0.1	1,929.5	0.1	91.9	90.3	57	0.0	645.0	0.0	50.9	42.1
Call options	6,675	1.2	641.9	0.6	146.1	92.3	15,363	6.2	901.8	3.9	173.5	90.1
Put options	7,126	1.3	741.8	0.7	154.9	92.0	6,483	2.6	1,235.8	2.3	199.7	95.2
Swaps	221	0.0	5,620.0	0.2	1,243.6	43.9	113	0.0	4,915.5	0.2	1,214.7	42.5
FX swaps	13,261	2.5	3,653.3	6.7	70.5	29.7	4,192	1.7	3,513.7	4.2	89.3	65.6
CC Swaps	27,822	5.2	1,196.1	4.6	637.3	2.9	6,196	2.5	3,629.2	6.4	906.4	18.4
Total	535,889	100.0	1,350.2	100.0	111.5	55.8	247,532	100.0	1,422.9	100.0	143.9	83.0

Note.— Sample period: 2001-2018. Obs. represents the number of contracts traded, notional amounts are expressed in thousands of US dollars, maturity in days. NDFX stands for non-deliverable instruments, which 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. Non-financial firm observations are defined as those with at least a non-financial firm 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.

face value of sales and purchases and 87% and 90% of contracts. It is worth noting the maturity of FX sales and FX purchases, where sales have longer maturities (119 days vs. 80 days) and are close to the maturity of trade credit for exports and imports reported in Section 3.3.1. Approximately 84% (59%) of FX sales (purchases) are settled with no delivery (which remained a legacy of the capital control era, which ended in 1998), which reduces the credit risk.[22] Figure B.2 in Appendix B presents additional features of the data. Table C.1 in Appendix C reports the firm size distribution on international trade, trade credit, FX derivatives, and FX debt.

It is worth noting that 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.

[22] Non-derivable contracts are also common in Korea, Brazil, India, and other emerging markets (EMEs) as a way to reduce risk (BIS 2019).

3 Operational Hedging

In this section, we assess the extent to which firms match their payables and receivables in foreign currency by engaging in operational/ natural hedging. We start in Section 3.1 by defining how we measure firms' cash flows in foreign currency. We next assess whether firms are operationally hedged in Section 3.2. Lastly, in Section 3.3, we document reasons why operational hedging could be quantitatively limited.

3.1 Measuring cash flows in foreign currency

We measure cash flows in foreign currency as all payables and receivables that a firm receives in cash or are due in a given time period for the same currency pair. To motivate this, consider a firm that exports, imports, and borrows in foreign currency. In period t, the firm exports X_t, receiving a fraction μ_{Xt} as upfront payment and extending trade credit for the remaining fraction $1-\mu_{Xt}$ due in t+1. This firm also imports and pays a fraction μ_{Mt} upfront, while $1-\mu_{Mt}$ is financed with trade credit due in $t+1$. Let the amount of trade credit from exports and imports be denoted by X_{t+1}^{TC} and M_{t+1}^{TC}, respectively. Additionally, the firm borrows using one-period debt B_t. For simplicity, assume that the same cash flows occur across periods and there is no uncertainty around them (these are important assumptions that we will remove later, but they help us to fix ideas in this introductory example). Then, net cash flow from trade credit due in $t+1$ NCF_{t+1}^{TC}, is

$$NCF_{t+1}^{TC} = X_{t+1}^{TC} - M_{t+1}^{TC} = (1-\mu_{Xt})X_t - (1-\mu_{Mt})M_t, \tag{1}$$

The firm also exports and imports new products and has net upfront payments for

$$NCF_{t+1}^{U} = X_{t+1}^{U} - M_{t+1}^{U} = \mu_{Xt+1}X_{t+1} - \mu_{Mt+1}M_{t+1}. \tag{2}$$

It issues new debt B_{t+1} and pays previous debt in the amount $(1+r_t)B_t$. Its net cash flows from debt are

$$NCF_{t+1}^{B} = B_{t+1} - (1+r_t)B_t. \tag{3}$$

Adding up flows from equations (1)-(3), all firm's net cash flows in $t+1$ become

$$\begin{aligned} NCF_{t+1} &= NCF_{t+1}^{TC} + NCF_{t+1}^{U} + NCF_{t+1}^{B} \qquad (4) \\ &= (X_{t+1}^{TC} + X_{t+1}^{U}) - (M_{t+1}^{TC} + M_{t+1}^{U}) + B_{t+1} - (1+r_t)B_t. \end{aligned}$$

More generally, if trade credit originates in different periods and debt lasts for more than one period, a firm's FX net cash flow in $t+n$ becomes

$$NCF_{t+n} = \left(\sum_{t=0}^{t+n-1} X^{TC}_{t\to t+n} + X^{U}_{t+n}\right) - \left(\sum_{t=0}^{t+n-1} M^{TC}_{t\to t+n} + M^{U}_{t+n}\right) + B_{t+n} - \sum_{t=0}^{t+n-1} B_{t\to t+n}(1+r_{t+n}), \tag{5}$$

which is the sum of all trade credit from exports originated in previous periods and due in $t+n$, less all imports trade credit maturing in $t+n$, plus net cash flow payments from trade, plus new debt issuance net of all debt repayment from previous periods due in $t+n$. In the next sections, we use this definition to identify operational hedging.

3.2 Are firms operationally hedged?

Having defined cash flows in foreign currency, the question that follows suit is whether firms match their payables and receivables in foreign currency and, thus, are operationally hedged. We first provide a motivating example and then present our econometric analysis and robustness tests.

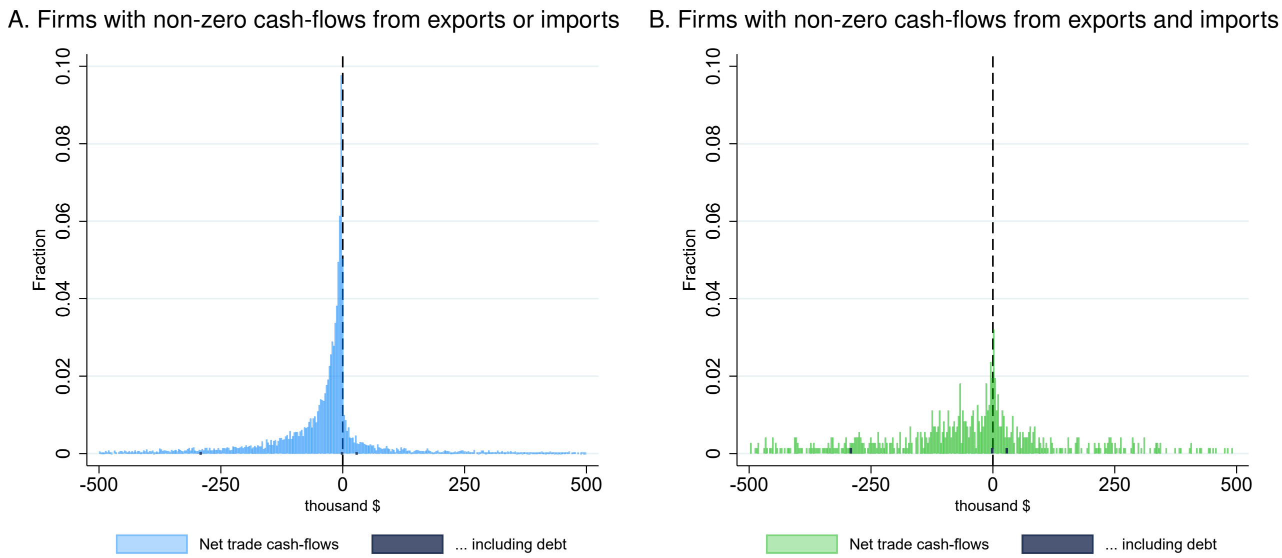
3.2.1 The cross-section of net cash flows in foreign currency

To motivate our analysis, we compute net cash flows as defined in equation (5). For illustrative purposes, we select cash flows in USD for January 2016. This choice is without loss of generality. We can observe that net cash flows are, in general, different from zero. We plot the distribution of firms' net cash flows in Figure 3. In the left panel, we include all firms with at least one positive cash flow in foreign currency. That is, firms with either non-zero receivables in dollars, non-zero payables in dollars, or both. In the right panel, we constrain our analysis to firms that have both receivables and payables positive in the same month and, hence, could potentially engage in operational hedging. To distinguish the net cash flows including FX debt, we highlight them in dark blue.

Figure 3 reveals two salient features. First, the bulk of FX cash flows arises from trade operations (which we show econometrically in the following sections). As the dark blue bars show, there are only a few operations involving FX debt flows —coupon payments or new debt issuance–. While this may seem surprising at first glance, this feature is not exclusive to Chile. As mentioned in Section 2.2, the Chilean FX debt market works similarly to advanced economies in that FX borrowing is not commonly extended, and the firms using it are mainly MNCs and not domestic firms. Second, Figure 3 also shows that whether we include all firms or focus on the subset of exporters that are also importers, the distribution of net cash flows in foreign currency is spread out, and cash flows in and out do not often coincide by amount –even within the same maturity and currency pair. In particular, the fraction of firms with in- and out-cash-flows in dollars that coincide and net out is only 3%. The remaining 97% have either positive or negative net cash flows, thus, some currency risk exposure.

An important remark is that we analyze cash flows that are due within a month. While this could seem restrictive, it is not from a practitioner's point of view. For example, a firm might need to pay the imports on the first of the month, but it might only receive the export payment at the end of the month. This gap creates a liquidity problem for the firm, which could be costly in a world of costly financial intermediation (Antràs and Foley 2015). Nevertheless, in the next section, we relax this and show that net cash flows in foreign currency do not generally coincide by amount, even considering longer maturities and flows due in the same quarter or year.

Figure 3: Net cash flows: firms in January 2016



Note.– Vertical axis shows the fraction of observations. Panel A shows net cash flows from all firms with cash flows from exports or imports or foreign currency debt in January 2016 (includes upfront payments and maturing trade financing in said period). Panel B zooms into the sample of firms that have non-zero cash flows from exports and imports in January 2016. Bars in dark blue in both figures highlight firms that in addition to cash flows from trade, have cash in- or out-flows from foreign debt.

3.2.2 Econometric Analysis

We turn now to assess econometrically whether firms match their FX payables and receivables and, hence, engage in operational hedging. To ensure that our results are not driven by the definition of cash flows, different maturities, fixed effects, or firms/ industry characteristics, we present a full set of robustness tests.

FX cash flows due in the same period (month, quarter, year)— A firm would be operationally hedged if it matches its FX cash flows in and out within the same maturity and currency pair. One can quantify this matching by assessing the correlation between FX cash flows in and out due in the same period and within the same USD-peso pair, as defined in equation (5). A high correlation would imply a high degree of operational hedging. A zero correlation would imply that firms are not able to use their FX cash inflows to meet their FX cash outflows and, thus, net their FX exposure. In particular, let $X_{i,t}^{CF}$ ($M_{i,t}^{CF}$) be the log of firm i's cash inflows (outflows) arising from (a) exports (imports) trade credit maturing in period-t,

(b) exports (imports) paid upfront in period-t; and $FXD^{CF}_{i,t}$ the (log of) cash inflow or outflow from contracting foreign currency debt and its repayment. We then assess the correlation between payables and receivables in foreign currency as

$$X^{CF}_{i,t} = \alpha(M^{CF}_{i,t} + FXD^{CF}_{i,t}) + \eta_i + \eta_{j,y} + \varepsilon_{i,t}, \tag{6}$$

where j, t and y denote sector, period (month, quarter, or year, according to the specification), and year. We 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 inflows is aligned with cash outflows. A value of α equal to one would imply full operational hedging, meaning that the firm completely eliminates currency risk. Instead, α equal to zero would imply no operational hedging and entail transaction exposure.

To assess if our results change with the maturity of the flows considered, we include different maturities –monthly, quarterly, and yearly— and present the results in Panel A of Table 2. Columns 1-5 report the correlation of cash flows maturing within the same month, columns 7-8 within the same quarter, and columns 9-10 within the same year. Columns 1-2 show the results when only cash flows of imports are included as 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 is associated with only a 0.02% increase in cash flow from exports trade credit. Column 2 confirms these results when excluding MNCs and mining firms. Finally, in column 3, we include cash flows from foreign currency debt and show that the estimated coefficient does not change in size or significance with respect to column 2. This result generalizes our previous example by showing that the bulk of the transaction exposure arises from trade and less from FX debt, given the scarce FX indebtedness by Chilean firms.

To check that our results do not hide substantial heterogeneity across groups of firms, in columns 4-6, we divide firms into four mutually excluding categories: (i) firms only in international trade, not using FX derivatives or FX debt; (ii) firms in international trade, using FX derivatives but not FX debt; (iii) firms that trade and have FX 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 (6) with these interactions on the right-hand side. Notably, the estimated coefficients for these interaction terms remain small and are robust to including mining firms and MNCs (column 4) or excluding them (column 5).

In column 6, we zoom in and restrict our analysis to firms that are simultaneously exporters and importers and, thus, having both cash flows in and out, could potentially be operationally hedged. However, the estimated coefficients remain small. For example, for the firms that are exporters, importers and hold FX debt —arguably large firms—, the correlation of FX payables

Table 2: Operational hedging of firms in international 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} + FX Debt^{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 Derivatives)				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 & FX Debt^{CF})				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, FX Debt^{CF} and FX Derivatives)				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)
Observations	1,625,296	1,606,109	1,606,109	1,625,296	1,606,109	196,380	711,943	110,387	261,262	47,579
R^2	0.85	0.83	0.83	0.85	0.83	0.87	0.87	0.89	0.91	0.93
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. Columns 1-6 present monthly maturities, columns 7-8 quarterly maturity, and columns 9-10 yearly maturities for cash-flows from exports X^{CF}, imports M^{CF}, and foreign debt FCD^{CF}. Cash flows from international trade consider those originated from trade credit at maturity date and operations paid upfront. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

and receivables reaches only 7%.

We then re-estimate specifications in columns 5 and 6, pooling cash flows at the quarterly- (columns 7-8) and yearly maturities (columns 9-10). At longer maturity, the correlation between cash inflows and outflows is higher but still quantitatively small. For the largest firms that are both exporters and importers, hold FX debt, and use FX financial derivatives, the correlation reaches a maximum of 20% for flows maturing within the same year. However, it is worth noting that a one-year maturity could imply substantial currency risk, as the window of time between FX payables and receivables in FX could be large. In Tables C.2, C.3 and C.4 of Appendix C, we present the full tables for each maturity for these different specifications.

Overall, these results suggest that operational hedging is quantitatively limited, even when focusing on different maturities, subsets of firms, or only large firms.

Robustness exercises— To assess the robustness of our results, we conduct a full set of additional exercises. First, we relax the assumption that cash flows should be due in the same period and consider the correlation of outstanding credits independently of their maturity. More precisely, define $X^{TC}_{i,t}$ and $M^{TC}_{i,t}$ as firm-i's in period-t outstanding (log) value of trade-credit from exports and imports, respectively; and $FXD_{i,t}$ the outstanding (log) value of foreign debt for firm i, in period-t. Then, we re-estimate equation (6) using these outstanding values in period-t, instead of maturing cash-flows in period-t. Note that this is a less stringent test, as a firm might not be operationally hedged even if outstanding positions coincide because its FX payables and receivables could have different maturity. Panel A of Table 3 shows that the correlations of FX cash in and out are still low, i.e., 3% within a month and a maximum of 8% when focusing on large exporters, importers, and FX debt holders for outstanding balances within a year.

In Panel B, we conduct an even less restrictive exercise and assess the correlation of total exports, imports, and FX debt that firms report in the same month, quarter, and year; that is, including all upfront payments and trade credit. Remarkably, the correlation between FX cash in and out is still very low, i.e., 1% for the average firm within a month and a maximum of 6% for the largest firms. For comparison, in Table C.5 in Appendix C, we show the monthly and quarterly estimation results of restricting to cash-flows originated from trade credit and debt contracts and excluding upfront payments of operations in international trade from equation (6). The estimated coefficients show an even lower correlation.

Second, to check that a particular sector does not drive our results, we estimate regressions by sector and show in Table C.6 in Appendix C that the correlations remain quantitatively small for each individual sector. Third, in Table C.7 in Appendix C, we remove the firm, industry-year, and year-fixed effects sequentially and show that the correlations remain at a maximum of 3%. Finally, to check that our coefficients are not misleading the importance of large firms, we estimate a weighted least squared by weighting on firms' sales and workers. Results presented in C.8 in Appendix C confirm a low operational hedging level.

In sum, the results in this section show that the correlation between FX payables and receivables is quantitatively low; hence, operational hedging is limited in data. This result is robust to including/excluding MNCs and mining companies, the definition of FX flows (total exports and imports, outstanding credit, trade credit + upfront cash flows, etc.), assessing different maturities (monthly, quarter, and year), sectors, set of fixed effects, and firms' size. In the next section, we assess potential reasons why this might be the case.

3.3 Why might operational hedging be difficult in practice?

Four factors can make it difficult for a firm to match its payables and receivables in foreign currency: *frequency, maturity, amount*, and *uncertainty* of transactions in foreign currency, even in a world dominated by vehicle currencies. We illustrate this with an example of an exporter that is also an importer and does not borrow in foreign currency. The omission of FX debt is without loss of generality because, as shown above, most firms' FX transaction exposure arises from trade credit flows. The firm lives for many periods, exports and imports, and, for simplicity, does not pay or receive upfront payments. We illustrate the flows in Figure 4.

In period t, the firm imports inputs for production and gets a trade credit due in period $t+1$ ($M_{t\to t+1}$). The firm also exports but —due to shipping delays– exports only arrive at the dock in $t+2$ and, hence, the firm's exports are only paid in $t+2$ ($X_{t\to t+2}$). Therefore, the firm is both an exporter and an importer, but its FX receivables are due one period later than when the payables are due, which creates FX exposure during this month. This illustrates that the *maturity* of trade credit matters. In $t+1$, the firm imports and issues a trade credit to be paid in $t+2$ ($M_{t+1\to t+2}$). Therefore, the firm could potentially match its export trade credit issued

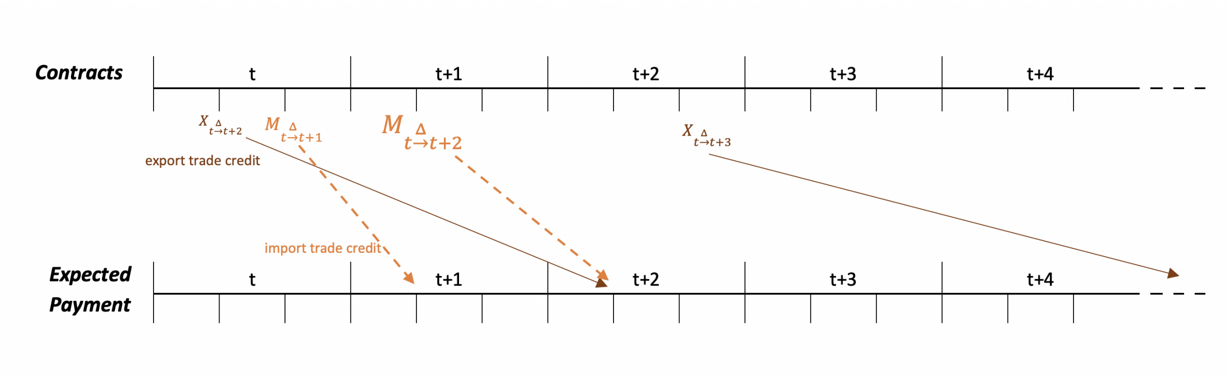
Table 3: Operational hedging: Outstanding balances and total volume of trade

Panel A. 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} + FX Debt			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 Derivatives)				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 & FX Debt)				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, FX Debt and FX Derivatives)				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)
Observations	1,470,485	1,451,719	1,451,719	1,470,485	1,451,719	185,632	547,932	62,058	166,690	15,868
R^2	0.88	0.87	0.87	0.88	0.87	0.91	0.86	0.91	0.86	0.92
Total Imports and Exports	B. Total exports in period-t									
	Monthly						Quarterly		Yearly	
	(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)	(5)	(6)
M	0.02**	0.02***								
	(0.01)	(0.01)								
M and FX debt			0.01***							
			(0.00)							
M $\times$ 1(Trade only)				0.01	0.01***	0.04***	0.01**	0.03**	0.01**	0.03*
				(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
M $\times$ 1(Trade and FX Derivatives)				0.02***	0.02***	0.05***	0.02***	0.04***	0.03***	0.04**
				(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
M $\times$ 1(Trade & FX Debt)				0.05*	0.03*	0.06**	0.02	0.04	0.03*	0.06
				(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
M $\times$ 1(Trade, FX Debt and FX Derivatives)				0.03*	0.05***	0.08***	0.05***	0.06***	0.06***	0.06**
				(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
Observations	1,727,197	1,707,389	1,707,389	1,727,197	1,707,389	193,733	757,809	65,811	277,287	17,401
R^2	0.86	0.83	0.83	0.86	0.83	0.88	0.84	0.89	0.87	0.91
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. The table presents monthly- (columns 1-6), quarterly- (columns 7-8), and yearly- (columns 9-10) firm-level regressions. Panel A 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. Panel B presents firm-level regressions of total exports X, on total imports M, and total foreign debt FCD. Columns (4) to (10) different firms into four mutually exclusive 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, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

in t with the import trade credit issued in $t+1$ and net its currency exposure in $t+2$. Yet the *amount* of these flows needs still to coincide ($M_{t+1\to t+2} > X_{t\to t+2}$ as imports could be larger than exports, or vice versa). Furthermore, timings in production and shipping can lag or leads to payments, which, together with credit risk, create *uncertainty* and could make FX exposure netting harder. Lastly, in $t+2$, the firm might export ($X_{t+2\to t+4}$) and issue a trade credit due in $t+4$, but it might not have any trade credit for imports due around that period, which illustrates

Figure 4: From Contracts to Expected Payments: Example on FX Trade Flows



Notes.—Illustrative example of the difference in frequency, maturity, amount, and uncertainty of trade credit for exports and imports.

that the *frequency* also matters. This simple example points outs that operational hedging can be complex in practice. Next, we elaborate on these ideas.

3.3.1 Maturity

We document novel evidence of the different maturities in trade credit and FX debt cash flows. Table 4 reports the main statistics of trade credit from imports and exports —breaking it down by creditor type, direct vendors or financial institutions—, and foreign currency debt. Trade credit with direct vendors accounts for the bulk of contracts: 84% of imports and 89% of exports. Importantly, there is a significant difference in the maturity of these flows. Trade credit from imports with direct vendors is paid on average in 83 days, and that from exports is paid in 162 days. This implies that expected receivables have maturity twice as long as expected payables, which creates a gap between FX future cash flows and could entail currency risk exposure during this period. A similar difference also shows in trade credit with financial institutions, with an average maturity of 134 days for imports and 196 days for trade credit from exports. Foreign debt exhibits even longer maturities, with an average of 3.7 years.

The different maturities between trade credit from imports, exports, and foreign currency debt could make it difficult for firms to carry out operational hedging. This type of hedging would imply considerable planning. The same argument applies to "money market hedging", in which a firm would match its receivables (payables) in foreign currency by borrowing (lending) in the same currency and maturity.

Table 4: Average maturities in international trade credit and foreign currency debt

	Maturity in days						
	Mean	St. Dev.	Min	p(10)	p(90)	Max	Num. Obs.
Imports trade credit							
By supplier	83	53	1	30	160	540	1,394,798
By financial institutions	134	56	0	60	180	540	262,186
Exports trade credit							
By supplier	162	99	0	25	70	540	553,560
By financial institutions	196	93	0	47	270	540	70,686
Foreign currency debt	1360	1266	30	90	3060	8280	12,212

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.

3.3.2 Frequency

If cash flows in foreign currency had *always* the same frequency within the same quarter/year, a firm could potentially match its FX payables and receivables even if their maturity differed. Moreover, flows could be recursively matched once we abstract from the initial and final period unbalances. We then analyze the frequency of cash flows within firms.

To better identify this frequency, since there are only a few observations with FX debt (shown above), we focus here on cash flows from trade. Furthermore, since operational hedging would only be possible for firms that report both cash flows from exports and imports, we zoom in on this group of firms. Importantly, this group represents 81% of the total volume of trade and 72% of exporters, as shown in columns 1 and 2 of Table 5. The number of exporters that are also importers that we find in Chile is similar to other studies. For example, Amiti, Itskhoki and Konings (2014) show that in Belgium, importers and exporters are 78% of firms (column 3).

Table 5: Share of Importers and Exporters on Total Trade

	Share on total trade		
	Volume	All exporters (Number of firms)	
		Chile	Belgium
	(1)	(2)	(3)
Exporter and importer	0.81	0.72	0.78
Only exporter	0.05	0.28	0.22
Only importer	0.15		

Notes.— The table considers yearly averages between 2005-2018 for all firms, excluding mining and MNC. We define a firm to be an importer (exporter) if it registers at least a non-zero import (export) operation in any given year.

Table 6 reports the frequency of transactions for exporters that are also importers. In column

1, we present cash flows — upfront payments plus trade credit— and report the number of months per year that a firm has positive cash flows from exports and imports and, for completeness, exports, and imports separately. The coincide between cash flows in and out within the same month is low. Only 4 months a year, an exporter has cash in from exports that could match with cash out from imports. In column 2, we broaden our analysis to all trade flows that a firm conducts over a year. The result remains unchanged. Only 4 months a year, a firm has positive exports and imports and, hence, could engage in exposure netting.

Table 6: Number of Months per Year with Export and/or Imports Operations

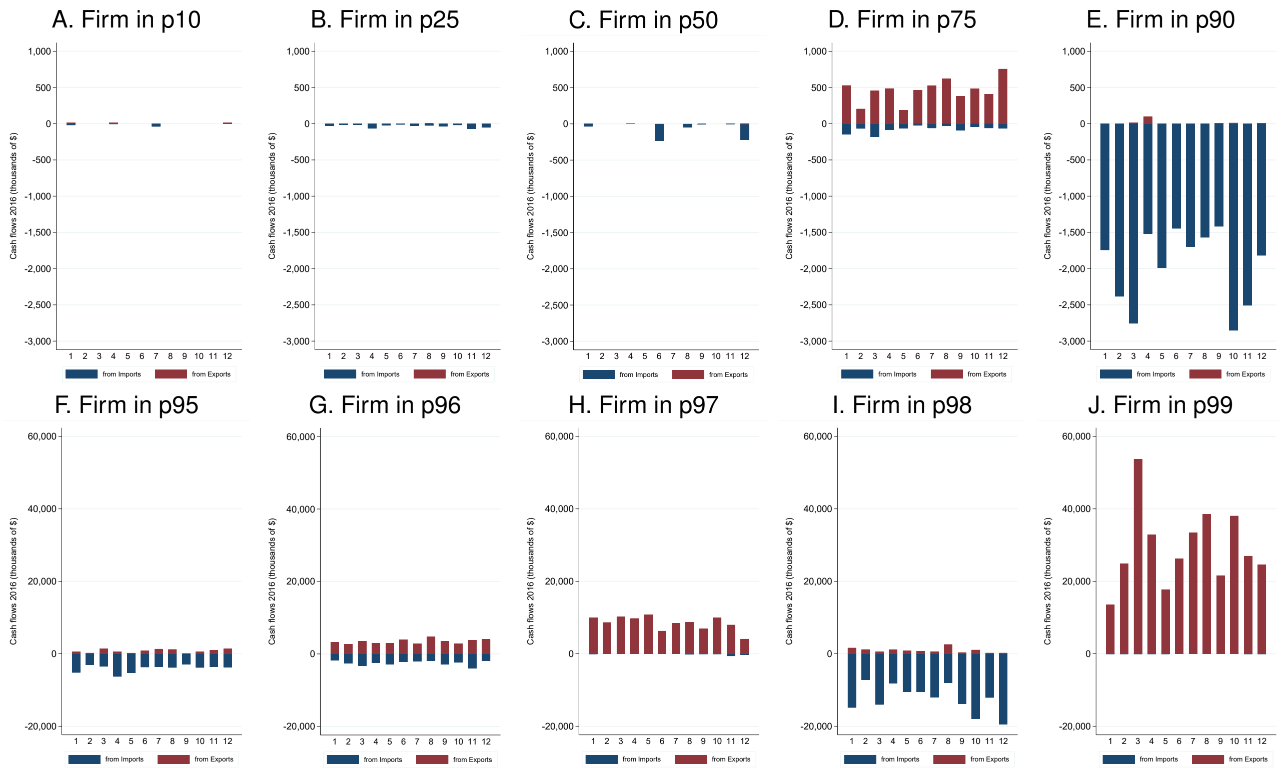
	Exporters and Importers	
	Cash Flows	Total Trade
	(1)	(2)
Number of months per year with positive X and M flows	4.2	4.1
Number of months per year with positive M flows	8.8	8.9
Number of months per year with positive X flows	6.0	7.5

Notes.— The table considers yearly averages between 2005-2018 for all firms in all sectors, excluding mining and MNC. We define a firm as an importer (exporter) if it registers at least a non-zero import (export) operation in any given year.

To illustrate this, in Figure 5, we plot the cash flows from exports and imports due in the same month in the year 2016 for the distribution of exporters that are also importers. On the horizontal axis, we report the months (January to December) and thousands of USD on the vertical axis. This figure points to two interesting results. First, the smaller firms have both cash flows from export and import, but not simultaneously. For example, a firm in the percentile 10 (measured as the volume of trade of these firms) has cash flows from exports and imports in January and April, but then it has cash flows due from imports in July to only receive cash flows from exports in December. This creates a 5-month gap between FX payables and receivables. Second, the larger exporters and importers have more frequent transactions (every month), but mostly on one side of the trade. If we zoom in on the percentile 95 and above (reported in the bottom graphs), we can see that these firms are unambiguously either net exporters or net importers. Firms in the p95 and p98 export and import every month, but their exports are negligible with respect to their imports. Firms in the percentiles 97 and 99 are net exporters and have small cash flows from imports only a few months a year.

This analysis illustrates that the frequency of cash flows from exports and imports is sparse enough that even the firms that have positive flows in both directions and could potentially be operationally hedged might find it difficult in practice. Importantly, Figure 5 also highlights another limitation to real hedging. Firms tend to be either net exporters or net importers, and hence, the cash inflows and outflows do not tend to coincide in amount, which we assess next.

Figure 5: Cash flows from imports and exports in year 2016



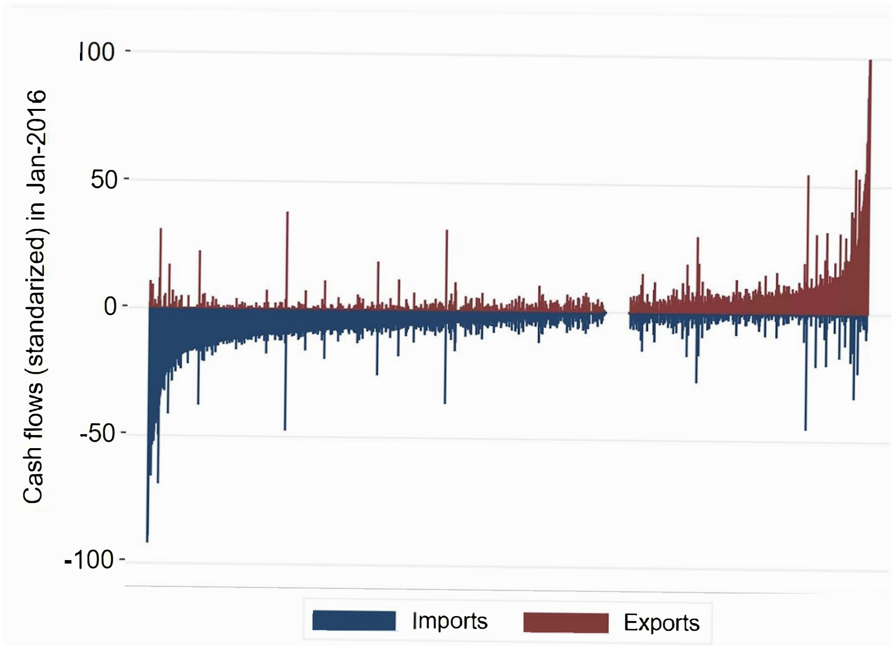
Note.– Vertical axis in thousands of US dollars. Horizontal axis represents months in the year 2016. Panels represent firms in percentiles 10, 25, 50, 75, 90, 95, 96, 97, 98, 99 in the cross-section distribution of yearly international trade activity. The sample only considers firms that are importers and exporters in the year 2016. Negative values represent outflows from imports, and positive values represent inflows from exports. Each bar represents effective cash flows in a given month.

3.3.3 Amount

To visualize the coincidence in the number of cash flows from exports and imports, we revisit our previous example of January 2016 and focus again on exporters that are also importers. Figure 6 reports the cash inflows from exports and cash outflows from imports (trade credit plus upfront payment) that a firm receives this month. To make flows comparable, we standardize them *within* firm and present one firm per bar. Confirming our previous result, this figure shows that the majority of firms tend to be either net exporters or net importers, and thus, net flows tend not to coincide. Only a few firms seem to have payables and receivables in FX that are similar in amount.

To explore this idea further, we construct an index of coincidence of cash inflows and outflows that mature within the same period. As such, we condition on maturity and compare whether flows coincide by amount. Our within-firm *coincidence* indicator —$CO_{i,t}$— is defined in equation (7). For a firm i and period t, $CO_{i,t}$ measures the coincident amount of cash flows in opposing directions that matures in t as a fraction of total cash flows maturing in the same period.

Figure 6: January 2016: cash flows from imports and exports within firms



Note.– This figure reports cash inflows and outflows for exporters that are also importers for January 2016. Each bar represents a firm. Flows are standardized within firms.

$$CO_{i,t} = 1 - \frac{|X_{i,t}^{CF} - M_{i,t}^{CF}|}{(X_{i,t}^{CF} + M_{i,t}^{CF})}, \tag{7}$$

where $X_{i,t}^{CF}$ denotes firm's i cash inflow from exports paid with trade credit maturing t and upfront payments in t, and similarly for imports $M_{i,t}^{CF}$. The lower the value of this indicator, the lower the coincidence between cash in and out from exports and imports, and, thus, the lower the operational hedging of the firm. Inversely, the higher $CO_{i,t}$ is, the higher operational hedging.

In Table 7, we present the mean and median of the coincidence index for month, quarter, and year maturities. The median (mean) exporter and importer that have both positive cash flows from exports and imports has a coincidence of 21% (31%) within a month. If we extend this analysis to a yearly frequency —namely exporters with positive imports at some point of the year— the median (mean) coincidence drops to 10% (23%). This drop in the coincidence index could be surprising at first view, but it is not as longer periods allow for more heterogeneity and firms that have only positive flow a few times a year. As we illustrated in Figure 5, trade flows tend to be sparse, particularly on the left side of the distribution. Lastly, it is worth remarking that the monthly maturity is the maturity that could give the highest operational hedging because it is conditioning on firms having positive inflows and outflows within the month.

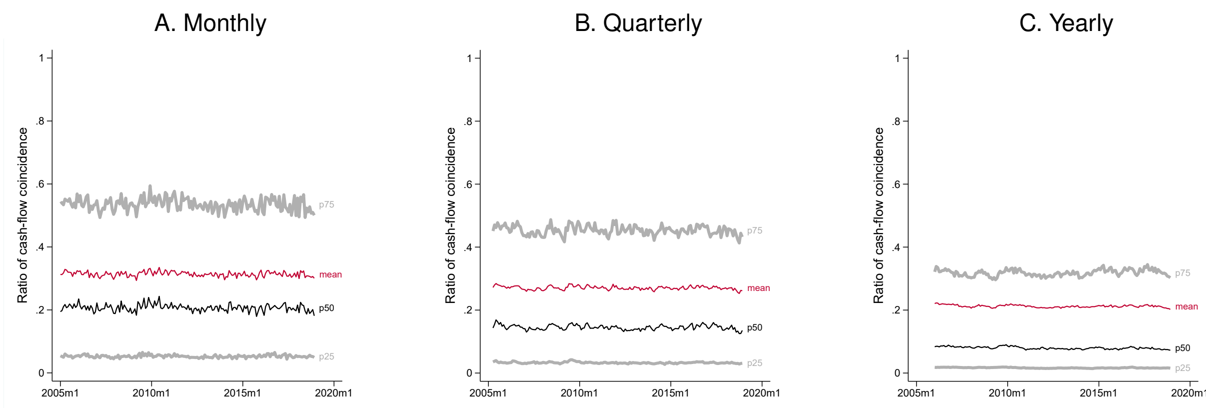
We illustrate this further by plotting in Figure 7 the mean, median and interquartile range of $CO_{i,t}$ in the cross-section of firms along our sample period. This figure illustrates that the lower coincidence of the amount of cash inflows and outflows for exporters that are also importers is present during the whole period with little variation across time.[23]

Table 7: Coincidence of cash-flows related to international trade

	Monthly		Quarterly		Yearly	
Index	mean	median	mean	median	mean	median
CO_{it}	0.31	0.21	0.28	0.15	0.23	0.10

Notes.— CO_{it} measures the coincidence index at t frequency. We condition on both in- and out-flows being positive during the period t analyzed.

Figure 7: Cash flows from imports and exports



Note.– Vertical axis shows $CO_{i,t} = 1 - \frac{|CF_t^X - CF_t^M|}{(CF_t^X + CF_t^M)}$. Panel A (B,C) considers coincidence within the same month (quarter, year) for firms that have $CF_t^M > 0, CF_t^X > 0$. Measures for quarters and year calculated based on rolling windows of last 3 and 12 months respectively.

The evidence presented in this section indicates that operational hedging is quantitatively limited, as firms only match a small fraction of their payables and receivables in foreign currency. As we have shown, FX transactions —exports, imports, and FX debt— have different maturities, frequencies, and amounts that make this matching difficult. Even when we focus on the subset of the largest firms that are exporters and also importers, the correlation of FX inflows and outflows is only 7% within a month and reaches a maximum of 20% if we consider flows that mature within the same year. These firms are unambiguously net exporters or net importers and have positive exports and imports typically only a few months a year. When they have, these flows do not coincide in amount or maturity. The difficulty in engaging in operational hedging becomes even more salient when considering the uncertainty implied around these flows. Credit

[23]Note that there is no firm-level data on cash balances for non-listed firms in foreign currency. 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 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.

risk and production and shipping delays can make exposure netting harder and more cumbersome to plan. In the next section, we assess whether firms complement operational hedging by engaging in FX financial risk management.

4 Financial Hedging

We turn to study if firms use FX financial instruments to hedge the exposure arising from their operations denominated in vehicle currencies. We first provide a descriptive analysis of the use of FX derivatives instruments and the firms using them (Section 4.1). We then assess the extensive margin (Section 4.2). We lastly dissect the intensive margin and evaluate how much and which transactions firms hedge, the cost of FX financial hedging, whether they hedge their gross or net exposure, the role of exchange rate uncertainty, and some robustness exercises (Section 4.3).

4.1 FX Financial Instruments: Which Use? Which Firms?

Use of FX financial instruments.— How much of firms' transaction exposure in dominant currency is hedged using FX derivatives? We first focus on exposure from trade operations, which —as discussed above— arises from trade credit and generates the bulk of firms' exposure. Trade credit is sizable: it accounts for 78% and 82% of the monthly volume of imports and exports, respectively (Table 8). When financially hedged, trade credit is typically hedged using FX forwards, which as shown in Table 1, account for almost 90% of FX derivatives contracts and more than 80% of their notional value. Consistently, FX forwards and trade credit are aligned in maturity. As Tables 1 and 4 show, the maturity of import trade credit with direct vendors is 83 days, and that of FX forward purchases is 81 days, and the maturity of export trade credit is 162 sales, and that of FX forwards sales is 119 days.

Firms engaging in FX risk management use FX derivatives extensively to hedge their exposure. Among them, the median importer has a ratio FX forwards purchases-to-import trade credit of 50%, and the median exporter a FX forwards sales-to-export trade credit of 35%. At the aggregate level, these ratios increase to 94% for forward purchases-to-import trade credit and to 93% for forward sales-to-export trade credit. When hedged, FX debt is mostly hedged using cross currency swaps (CCSwaps) that have a longer maturity than forwards (637 days see Table 1). The average ratio FX long CCSwaps-to-foreign currency debt is 65% for firms indebted in foreign currency and using CCSwaps. At an aggregate level, this ratio drops to 14% as some firms indebted in foreign currency do not hedge.

The Largest Firms Use of FX Derivatives.— We now describe the main characteristics of firms engaging in FX financial risk management. Table 9 shows the use of FX derivatives is

Table 8: Trade, Foreign Currency Debt, and FX Derivatives: Summary Statistics

	Imports (1)	Export (2)	Foreign Currency Debt (3)
Trade Credit/Trade (aggregate)	0.78	0.82	
Forward/ Trade Credit (median)	0.50	0.35	
Forward/ Trade Credit (aggregate)	0.94	0.93	
FX long (CC Swap)/Foreign Currency Debt (median)			0.65
FX long (CC Swap)/Foreign Currency Debt (aggregate)			0.14

Notes.— Sample 2005-2018. Rows 1, 3, and 5 show aggregate ratios; Rows 2 and 4 report the median of the cross-section of firms for firms that exhibit positive amounts in the numerator and denominator of the corresponding ratios.

granular, as firms using them are the largest in the economy.[24] They are more than three times larger (in sales and employment) than the average firm in our sample; whether we focus on the pooled sample of all firms (Panel A), on firms that do not trade internationally (Panel B), or on firms that trade (Panel C). They are also larger in terms of their import and export volumes and foreign currency debt (Panels C and D). In particular, they are ten (two) times larger than firms that import (export) and do not use FX derivatives, and are four times larger than firms that borrow in foreign currency and do not financially hedge. This difference is statistically significant and persistent over time (i.e., we observe a similar pattern in 2006 and 2016 and all years between). Notably, this table does not include MNCs, which we include in Table C.9 in Appendix C and confirm our results.[25] As Table C.1 in Appendix C shows, the top 5 percentile of firms account for more than 70% (60%) of the share of FX short (long) outstanding positions.

4.2 The Extensive Margin

We evaluate the decision of a firm to employ FX derivatives following a linear probability model:

$$FX_{i,m} = \beta_1 X_{i,m}^{TC} + \beta_2 M_{i,m}^{TC} + \beta_3 FXD_{i,m} + \eta_i + \eta_{j,y} + \varepsilon_{i,m}, \quad (8)$$

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. $X_{i,m}^{TC}$, $M_{i,m}^{TC}$ and $FXD_{i,m}$ are (log) end-of-month

[24] As noted by Gabaix (2011), Acemoglu et al. (2012), di Giovanni, Levchenko and Mejean (2014), Gaubert and Itskhoki (2021) 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 to be less diversified. Recent financial crisis episodes highlight the close link between the vulnerabilities of systemically large firms, bailout guarantees, and moral hazard; see Alfaro et al. (2019).

[25] Firms using FX derivatives typically engage in international trade and/or hold foreign currency debt. Panel A in Figure B.2 in Appendix B 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 FX debt, firms using FX derivatives and engaging in trade and holding FX debt, and firms using FX derivatives with no trade or FX debt. Panel B of the same figure confirms this pattern when considering the value of the FX outstanding position.

Table 9: The Largest Firms Engage in FX Financial Risk Management

	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$)	17.22	5.28	1.33***	20.85	5.63	1.50***
Panel B. Not trading firms						
Employment (workers)	281.00	67.13	1.83***	339.63	98.36	0.65***
Sales (M$)	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$)	4.80	0.44	0.63***	3.85	0.31	0.71***
Panel D. Firms in FX Debt Market						
Employment (workers)	833.11	197.28	2.72***	1167.60	341.66	2.65***
Sales (M$)	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) 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—a 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 the years 2006 and 2016, but results are stable and hold for all other years in the 2005-2018 sample.

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. To assess the effect of each covariate, we introduce them sequentially.

Table 10 shows that the probability of using FX derivatives is significantly correlated with international trade. In particular, column 1 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: 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.[26] 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 5-7, we control for

[26] The small correlation between foreign debt and the probability of using FX derivatives remains true even after separating debt according to its maturity. In most cases, the correlation is non-significant.

exports, imports, and foreign currency debt interacted and show that the estimated coefficients for trade credit remain similar to our previous estimates. All results are robust to including MNCs (columns 6 and 7), swap contracts, and all currency pairs (Table C.10 in Appendix C).

Table 10: Firms' use of FX derivatives at the extensive margin

	FX Derivative Dummy						
	(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)
FX Debt			-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)
$X^{TC} \times$ FX Debt					0.004	0.002	-0.000
					(0.003)	(0.003)	(0.002)
$M^{TC} \times$ FX Debt					-0.006**	-0.006**	-0.006**
					(0.003)	(0.003)	(0.003)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
R^2	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. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

4.3 The Intensive Margin

We exploit the detail of our data to dissect how firms use of FX derivatives to hedge the exposure arising from their contracts denominated in a dominant currency. In particular, we analyze how much firms hedge, which transactions they hedge, whether they hedge net or gross FX exposures, how costly FX forward purchases and sales are, and how the exchange rate affects firms' FX financial hedging decisions.

The intensive margin.— To assess the intensive margin of firms' use of FX hedging, we compute the end-of-month position (short and long) of FX derivatives (in logs), FX_m^{POS}, and re-estimate equation (8) using this measure as the dependent variable.

Table 11: 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)			
FX Debt			-0.015	-0.015	-0.015	-0.018	-0.012
			(0.013)	(0.013)	(0.013)	(0.012)	(0.011)
M^{TC} by exp.					0.022**	0.022**	0.027***
					(0.009)	(0.009)	(0.010)
M^{TC} by non-exp.					0.001	0.001	0.006
					(0.007)	(0.007)	(0.008)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,276,078	2,296,913
R^2	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)
FX Debt			-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
R^2	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.

Panel A in Table 11 shows that sales of FX derivatives positively correlate with trade credit balances from exports (columns 1 and 4-7). The estimated coefficient indicates that a one percent increase in export trade credit is associated with a 0.047% rise in sales of FX derivatives. In columns 5, 6 and 7, we show that our results remain unchanged when controlling for imports by exporters and non-exporters and including MNCs and mining firms. 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 in column 2 implies that a one percent increase in imports correlates with a 0.155% rise in purchases of FX derivatives in the same month. The coefficient of foreign currency debt is non-statistically significant, but it becomes significant when including CCswaps (see Table C.11 in Appendix C).

Full/partial hedging.— How much do firms financially hedge from the exposure arising from contracts denominated in vehicle currencies? To assess this, we re-estimate equation (8) with the end-of-month position (short and long) of FX derivatives for firms that have short and long positions positive. That is, we remove all observations for which firms do not report any FX sales or purchases. A coefficient equal to one would imply that the elasticity of FX sales (FX purchases) to export (import) trade credit is 100% and, thus, firms fully hedge their trade credit/FX debt exposure. A coefficient lower than one would imply partial hedging. Importantly, optimal FX risk management does not directly imply fully hedging —completely insulating from FX risk—, as the optimal hedging ratio depends on the correlation of FX risk exposure with a firm's investment opportunities (see Froot et al. 1993).[27]

Results in Table 12 show that firms partially hedge their FX exposure from export trade credit (columns 1-3, Panel A) and import trade credit (columns 4-6, Panel B). In particular, the elasticity of FX purchases to trade credit is 31%, indicating that importers engaging in FX financial risk management tend to hedge about a third of their future payables forward. The elasticity of FX sales is lower, indicating that exporters sell 5% of their USD receivables forward. It is worth noting that the coefficient on foreign currency debt is statistically significant; thus, firms (partially) hedge 8% of the FX exposure arising from it.

Which transactions do firms use FX derivatives for?— Even though we observe every import and export transaction, and every FX derivatives contract, we cannot know for certain which financial contract is used to hedge which trade credit exposure. Yet, the richness of our data allows us to infer this. To analyze which transactions firms hedge, we use a Coarsened Exact Matching (CEM) algorithm (Iacus, King and Porro 2012) and match FX derivative contracts with trade credit contracts using the information on (a) firm ID, (b) maturity dates of both operations,

[27] Appendix E sketches a simple model illustrating the potential complementary role of financial hedging under dominant currency pricing.

Table 12: Partial FX Financial Hedging

	Panel A. Sales of FX derivatives>0, log			Panel B. Purchases of FX derivatives>0, log		
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.050**	0.050**	0.052***			-0.002
	(0.020)	(0.020)	(0.019)			(0.040)
M^{TC}		0.013	0.007	0.315***	0.308***	0.308***
		(0.053)	(0.048)	(0.023)	(0.023)	(0.023)
FX Debt			0.042		0.081*	0.081*
			(0.038)		(0.044)	(0.044)
Observations	31,822	31,822	33,965	91,114	95,198	95,198
R^2	0.24	0.24	0.26	0.81	0.82	0.82
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes Mining	—	—	—	—	—	—
Includes MNC	—	—	—	—	—	—
Only FC Debt = 0	Yes	Yes	—	Yes	—	—

Note.— 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 * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

and (c) notional amount.[28] We then test whether larger amounts of trade credit correlate using FX derivatives contracts. Panel A in Table C.12 in Appendix C show that hedged export trade credit operations are, on average, 63% larger than non-hedged ones (entire sample period 2005-2018). Similarly, Panel B indicates that hedged import trade credit operations 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).[29]

[28]In particular, for a given firm ID, we use the CEM algorithm to exact match maturity dates and create temporary coarser bins in the dominion of notional amounts. Then, we implement exact matching in these coarser bins. Once the match is made, we then keep the original un-coarsened amount. In this exercise, we exclude firms with foreign debt because these 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. Hence, we aim to be more conservative in our findings by choosing a sub-sample of more homogeneous firms. Furthermore, as shown above, FX financially hedging is more related to trade operations.

[29]Figure B.5 in Appendix B shows the histograms for imports and exports trade credit operations. The horizontal axis shows the (log) trade credit of each international trade operation for those that have a matching hedging transaction (green bars) and those do not (red bars). The figure indicates that conditional on not finding a matching FX-derivatives transaction (red bars), smaller international trade transactions are more likely to be observed. Put differently; this figure indicates that imports and exports trade credits of smaller values are less likely to be hedged than larger value transactions. Further, we then 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, which suggests that our method is not mechanically leaving out smaller or larger transactions.

Hedging of Gross/Net Positions.— Results in Tables 11 and 12 showed that, within firms, export trade credit correlates with FX sales and import trade credit associates with FX purchases. 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").

To assess whether this correlation of gross positions is present at the aggregate level, 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 8) is high and reaches 0.79. Similarly, the correlation between imports' trade credit and long FX positions (Panel B in the same figure) reaches 0.82. For comparison, in Panel C, we plot the correlation of net trade credit with net FX derivatives position. Interestingly, the correlation using net exposures is much lower than the gross correlations and only reaches 0.48.[30]

Note further that, as discussed in Section 4.1, the maturity of forward purchases (89 days) is similar to that of import trade credits (88 days). In comparison, that of forward sales (113 days) is close to that of export trade credits (115 days) (Tables 1 and 4), which is consistent with firms hedging their gross FX exposure given the different maturity, frequency and amount of trade credit exposure.

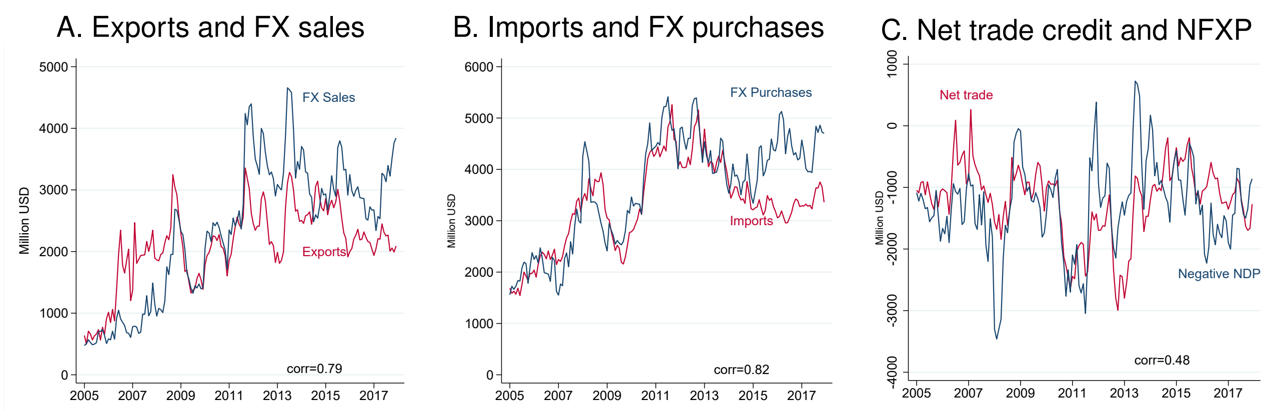


Figure 8: Trade Credit balances related to international trade and FX gross derivatives positions

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.

[30]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 export trade-credit maturing in m and FX short derivatives maturing in the same period is close to 0.8.

How costly are FX derivatives?— Our results provided evidence that, given the different frequency, maturity and amount of FX operations, firms tend to financially hedge their gross FX exposure. If the use of FX derivatives entails costs, this type of hedging is costly for firms as they hedge both sides of transactions.[31] We now employ our *transaction-level* data to study the cost of using FX derivatives. More precisely, we define the annualized cost of each forward contract c, on day d and maturity N as $FXP_{c,d,N} = \frac{F_{c,d,N}-S_d}{S_d} \times \frac{360}{N} \times 100$, and regress it on the maturity of the contract. After including a large set of controls including notional value, delivery of the instrument, firm fixed effects and bank-month fixed effects interacted, we find that the cost of using FX derivatives increases in maturity. In particular, as shown in Table C.13 in Appendix C, a 100% increase in maturity of FX purchases leads to a 0.42 percentage point rise in the forward premium. Similarly, when a firm wants to sell dollars forward, it gets a discount of 2 percentage points when doubling the maturity of the contract. Table C.16 in the Appendix C presents additional robustness tests controlling for firm characteristics.

FX financial hedging as a complement of operational hedging.— We have shown above that, even in a world where international trade and FX borrowing are denominated in a small number of vehicle currencies, firms retain currency risk. The analysis in this section shows firms complement operational hedging by engaging in FX financial hedging. However, the use of FX derivatives is concentrated mostly on the *largest firms* engaging in international trade. Importantly, given the nature of day-to-day trade operations —where the maturity of trade credit for exports and imports differs, firms might not export and import regularly and, when they do so, the amount might be different—, firms hedge their *gross* exposure, i.e., exports and imports separately. This hedging of gross exposure is costly, not only due to the search-and-bargaining cost characteristic of OTC markets (Duffie, Garleanu and Pedersen 2005) or costly financial intermediation (Rampini and Viswanathan 2010), but also because they are hedging flows in both directions, and there is a *maturity premium*, as we showed above. Given this cost, the largest firms focus their FX financial hedging on *short-term* transactions for *larger amounts* arising primarily from international trade, and they hedge *partially*.

Additional robustness and the role of the exchange rate.— Lastly, we conduct some robustness exercises. An important consideration in using FX derivatives is the evolution of the nominal exchange rate, as these instruments are conceived to hedge currency risk. Therefore, we assess whether the evolution of the exchange rate and the expectation of its future value, affect the intensive and extensive margins of firms' use of FX derivatives. To this end, we complement our data with information from the Survey of Financial Forecasters conducted by the Central Bank of Chile on a monthly basis, which reports exchange rate expectations for the main participants of the FX market in Chile. We then construct the following variables: the dispersion in the exchange rate forecasts across forecasters (dispersion), the realized exchange

[31] 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.

rate depreciation over the last year (realized depreciation), and the mean expected exchange rate changes at a 12-month horizon (expected depreciation).

Table C.14 in Appendix C shows the results of augmenting equation (8) 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 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.[32]

In Table C.15 in Appendix C, we conduct three additional robustness tests controlling for financial frictions, the coincidence between cash in and out in FX, and sophistication of companies. First, as discussed by Rampini and Viswanathan (2010) and Rampini, Sufi and Viswanathan (2014), financial constraints can affect firms' FX derivative choices and could potentially affect our estimations. To assess this, we re-estimate equation (8) and control for financial constraints by proxying them with two variables: (i) *delinquency*: a dummy variable equal to 1 if the firm has a non-performing loan; and (ii) *credit line*: a dummy if the firm has an available credit line with a bank.[33] Our results indicate that while financial frictions reduce firms' use of FX derivatives at extensive and intensive margins, they do not affect the size or significance of our coefficients. Our results thus remain valid to this control. Second, we test whether firms with a higher coincidence between FX cash inflows and outflows and, therefore, are more operationally hedged engage less in FX financial derivatives. As expected, we find that higher cash flow coincidence correlates with lower use of FX derivatives at the extensive margin and lower FX purchases; but our results remain unaltered. Finally, we show that more sophisticated companies (proxied by the number of countries that firms export and import) are more likely to FX hedge and use FX instruments more intensively.

5 Does FX Financial Hedging Affect Firms' Outcomes?

We have shown above that, in a world where international operations are denominated in a small number of vehicle currencies, firms retain currency risk. Yet operational hedging is quantitatively

[32]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, Cuñat, Fadinger and Liu (2022) and references therein.

[33]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.

limited, and firms complement it by engaging in FX financial hedging. Since the use of FX derivatives is costly, a natural question to ask is: does FX financial hedging affect firms' real outcomes and, by this means, add value to the firm?[34] We assess this question in two steps. We first employ econometric matching techniques to test whether firms using FX derivatives perform better. We next exploit an exogenous regulatory change reducing the supply of FX derivatives to firms to assess how this disruption affected firms' real activities.

5.1 Propensity Score Matching

We assess whether FX financial risk management firms perform better by employing a propensity score matching technique. More precisely, we estimate the *average treatment effect on the treated* (ATT) firms by comparing the performance of a firm that uses FX derivatives with the counterfactual of not using them. We identify ATT following three considerations. First, to match firms with similar observable characteristics, we consider proxies for size (employment), sector (industry), financial conditions (availability of credit line), and trade (outstanding trade credit for export and imports). Second, to avoid self-selection based on unobservables, we estimate our regressions in the first differences such that if unobservable characteristics are stable over time, our specification controls for them. Lastly, to avoid endogeneity concerns, we define a "pre-treatment" period t_0 and focus on firms that do not use FX derivatives in this period and either remain non-users (control group) or start hedging in the post-treatment period t_1 (treated group).

We then proceed in two steps. In the first step, we estimate a probit of (start) using FX derivatives in t_1 using the explanatory variables defined above. The predicted probability of hedging (or the propensity score), denoted by $P(X) = \Pr(FXD = 1|X)$, forms the basis of the matching procedure. In the second step, 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 $l(i) = \underset{j|FXD(j)=0}{\arg\min} \; |P_j(X) - P_i(X)|$ and the difference in the predicted probability of using a FX derivative is minimized for the initial period. The ATT of using FX derivatives is then inferred from the difference in the performance of the matched pairs[35]

$$\beta = E\left(Y_i\right) - E\left(Y_{l(i)}\right). \tag{9}$$

To check that results are not sensitive to a particular time period, we conduct this exercise in three different sample periods: 2010-2014, 2011-2015, and 2011-2017.

Table 13 shows that, after controlling for firms' observable characteristics, firms engaging in

[34] As noted by Froot, Scharfstein and Stein (1993), firms would only engage in FX financial risk management if it allows for better management of cash flow exposure and adds value to the firm, which could arise from capital market imperfections. Financial friction may, at the same time, limit its use (Rampini and Viswanathan 2010).

[35] 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.

FX hedging have higher sales (10%), export (18%), import (10%), and trade (18%) more (Panel A). All the results hold independently of the period considered (Panels B and C).[36]

Table 13: **Firm performance of firms that engage in FX hedging**

	Propensity Score Matching			
	Sales (1)	Imports (2)	Exports (3)	Total trade (4)
	Panel A: 2010-2014			
ATET (2010-14)	0.144***	0.103**	0.184***	0.179***
	(0.026)	(0.052)	(0.070)	(0.044)
Number of Firms	55,568	47,413	14,562	53,578
	Panel B: 2011-2015			
ATET (2011-15)	0.100***	0.221***	0.182**	0.271***
	(0.024)	(0.060)	(0.086)	(0.050)
Number of Firms	58,741	50,200	15,053	56,599
	Panel C: 2011-2017			
ATET (2011-17)	0.144***	0.103**	0.184***	0.179***
	(0.026)	(0.052)	(0.070)	(0.044)
Number of Firms	55,568	47,413	14,562	53,578

Notes.— The table 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.

5.2 A Supply Shock to the FX Derivative Market

We now leverage an exogenous (to the firm) shock to the FX derivatives market to assess the real effects of changes on firms' FX financial hedging activity. In particular, we exploit a regulatory change in Pension Funds Managers (PFs), which resulted in a temporary halt of their selling of FX derivatives in 2012/2013. We start by describing the regulatory change and the empirical strategy. We next assess how the supply shock affected firms' FX hedging policies and their real outcomes. We lastly present some robustness tests.

Regulatory Change of the FX Derivative Markets.— In Chile, 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), arguably

[36] As additional robustness, we also estimated a coarsened exact algorithm and control for market capitalization. All our results hold true and are available upon request.

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, their FX-derivatives position accounted for 30% of the commercial banking credit and 15% of GDP. 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 (Figure B.3 in Appendix B). As described above in Figure 1, being an OTC market, commercial banks act as intermediaries between the PFs and firms' demand of FX derivatives, which —in turn— are net buyers of FX forward.[37] Importantly, by regulation, banks retain minimal foreign currency exposure — if any at all— and, hence, they need to unwind any position they take in the forward or spot FX market.

PFs regulation dictates an upper limit to the share of PFs' 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%.[38] 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, thus, lowering the availability of FX forwards. A lower supply of FX derivatives affected firms seeking to take long FX positions (e.g., importers and foreign currency borrowers), as the commercial banking system refrained from holding currency risk by regulation and passed this negative liquidity shock onto firms. The change in supply from PFs was important to the market, as shown by the blue line in Figure 9, 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 and experienced a larger drop at the moment of implementation (December 2012). The decline between the moment before the first announcement to six months after the regulation took place was more than 5 billion U.S. dollars.[39]

Identification Strategy.— 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

[37]Note also that banks are in a good position to establish the required covenants, contracts, and lines of credit with firms. Appendix A elaborates banks' institutional arrangements in more detail.

[38]See Table C.17 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.18 presents additional details.

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

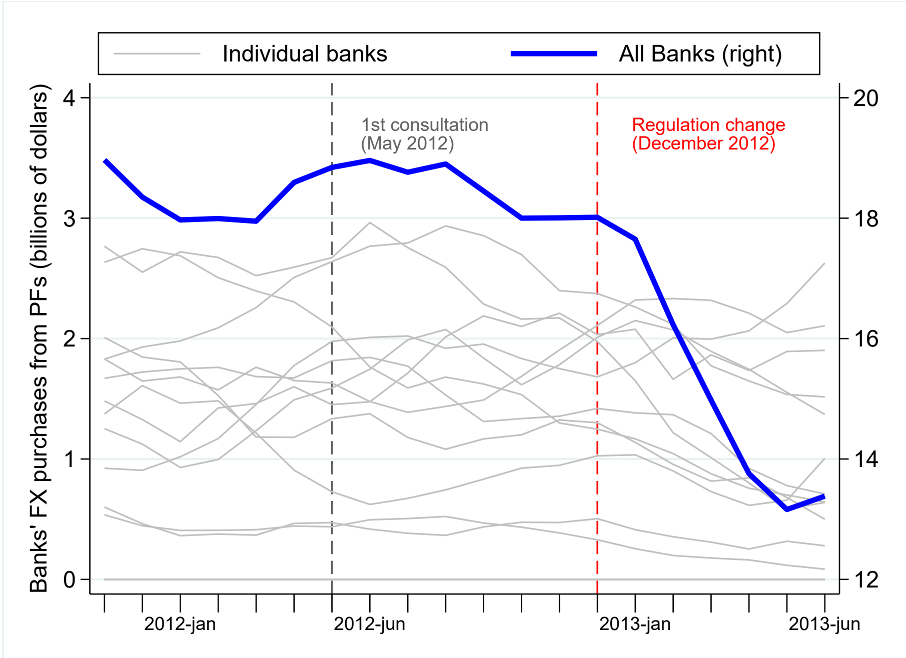


Figure 9: Outstanding FX purchases from Banks to Pension Funds ($ billions)

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.

it and started reducing their supply of FX derivatives before its implementation (as suggested in Figure 9). 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. Since the regulatory change reduced the supply of FX derivatives to firms, we focus on firms with long FX derivatives positions, i.e., importers and foreign currency debt holders.

Empirical Results.— We start our analysis by first checking whether the regulatory change affected firms' FX financial hedging policy. To this end, we define a dummy variable $Post_{\tau}$, which takes the value of zero before the regulatory change and one after it and estimate a difference-in-difference. More precisely, we regress:

$$FX^{\text{Long}}_{i,\tau} = \beta_1\, Post_\tau + \eta_i + \varepsilon_{i,\tau}, \tag{10}$$

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

We present the results estimated with a six-month window before and after the regulatory change in columns 1-4 in Panel A of Table 14. 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 9% (columns 1-2) and reduced their growth rate by 23% (columns 4-6). Our results are robust to including mining and MNCs (columns 1 and 3) and considering a four-month window (columns 4-8 in Panel B). In Table C.20 in Appendix C, we include FX swaps as robustness and show that our results remain valid.

Table 14: Firms' purchases of FX derivatives before and after the change in regulation

	Panel A. Six months window Before: Dec 2011-May 2012 / After: Dec 2012-May 2013				Panel B. Four months window Before: Dec 2011-Mar 2012 / After: Dec 2012-Mar 2013			
	Outstanding, log		Annual growth (%)		Outstanding, log		Annual growth (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post	-0.098**	-0.091*	-0.234***	-0.233***	-0.119**	-0.120**	-0.305***	-0.316***
	(0.045)	(0.046)	(0.085)	(0.087)	(0.047)	(0.049)	(0.089)	(0.092)
Number of Firms	1420	1412	1226	1220	1240	1234	1064	1060
R^2	0.92	0.92	0.44	0.44	0.92	0.92	0.45	0.45
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Incl. mining and MNC	Yes	—	Yes	—	Yes	—	Yes	—

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

Impact on Firms' Real Outcomes— To assess if the supply shock affected firms' real outcomes, we re-estimate equation (10) using as dependent variables: the change in imports, exports, employment, and gross short derivative position in a year. Table 15 shows that the contraction in the FX market—and the ensuing limitation for firms' cash flow management—is associated with a reduction in firms' imports by 14%. The shock also affected firms' size, as their employment dropped by 2.9%. Interestingly, the supply shock reduced firms' FX derivatives sales by 66.4%, implying that as 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. Albeit the coefficient on

Table 15: Firms' real effects before and after the change in regulation

	FX sales (1)	Imports (2)	Exports (3)	Employment (4)
	A: Window of N=6 months			
1(Post)	-0.664**	-0.141**	-0.204	-0.029**
	(0.324)	(0.061)	(0.154)	(0.013)
Number of firms	101	424	189	419
R^2	0.075	0.16	0.14	0.0024
	B: Window of N=4 months			
1(Post)	-0.662**	-0.141*	-0.164	-0.036***
	(0.309)	(0.016)	(0.159)	(0.012)
Number of firms	86	417	177	408
R^2	0.025	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.

exports is not statistically significant, the supply shock seems to have reduced exports as well.[40] These results indicate that a drop in the supply of FX derivatives to firms —limiting their FX risk financial management and, hence, cash flow management— reduces their imports and size. It, therefore, provides indirect evidence that FX risk management adds value to the firm, even in a world dominated by vehicle currencies where exports, imports, and FX debt are denominated in USD.

Additional Robustness: Banks' Individual Supply Changes of FX Derivatives.— Our previous exercise assessed the average reduction of the supply of FX derivatives from banks to firms. However, banks' FX outstanding exposure to PFs' supply of FX derivatives was heterogeneous. To check that firms' decrease in FX purchases was driven by the regulatory change and not something else, we take advantage of this heterogeneity and further explore the micro-level adjustment of the market. In particular, we exploit firms' multi-bank relationships and estimate the following regression:

$$D(FX_{i,b,\tau}) = \alpha_{i,\tau} + \beta_{b,\tau} + \varepsilon_{i,b,\tau}, \tag{11}$$

where $D(FX_{i,b,\tau})$ is the change in firm i's outstanding FX-purchases from bank b, $\alpha_{i,\tau}$ is a firm-time fixed effect and $\beta_{b,\tau}$ is a bank-time fixed effect. Our coefficients of interest are $\beta_{b,\tau}$, which capture the bank-specific supply channel once firms' time-varying demand for foreign currency

[40] 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.

is controlled for.[41] This allows us to recover the decrease in the supply of FX derivatives for each bank (to firms) and then compare it with their exposure to PFs. Table C.21 in Appendix C presents the estimated coefficients for $\hat{\beta}_{b,\tau}$ and shows that they are negative and statistically significant, which confirms banks' supply reduction of FX derivatives to firms. For robustness, in Panel B, we re-estimate equation (11) using the forward premium for each firm as the dependent variable. We show that –consistently with the decrease in supply—, it increased.[42] We then assess the correlation between banks' estimated coefficients and their pre-reform exposure to pension funds, which we report in Figure B.4 Appendix B. 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. As expected, the correlation between $\hat{\beta}_{b,t}$ and banks' ex-ante exposure to PFs is negative and statistically significant, indicating that banks that used to purchase more FX derivatives from PFs before the shock experienced a more significant decrease in the sales of FX derivatives to firms after the regulation. The magnitude of the aggregate estimated effects on outstanding purchases of FX derivatives is sizeable, as shown in Table C.22 in Appendix C. It accounts for a (market-share-weighted average) decrease of 58% in the outstanding purchases of FX derivatives.

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 frequency, amounts, and maturity between payables and receivables in foreign currency.

For example, the import trade credits have a much lower maturity than export ones, suggesting that it would be challenging for firms to be naturally hedged. Second, we show that FX derivatives are mostly used to hedge short-term financing in foreign currency, primarily arising from international trade. Firms that employ FX derivatives are large and employ these instruments to hedge larger transactions. 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.

[41] See Khwaja and Mian (2008), Amiti and Weinstein (2018) and Alfaro et al. (2021) for a similar use of this technique.

[42] We additionally include FX swaps in Table C.19 in Appendix C.

Finally, we show that FX financial hedging under vehicle currency improves firms' real outcomes. 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 and size. The reduction in the supply of USD forward substantially lowered the use of FX derivatives, increased forward premiums, and decreased the firm's operations. After controlling for a complete set of firms' and sector characteristics, propensity-matching exercises show similar results. 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.

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Online Appendix
(not for publication)

A 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".[43] Importantly, this regulation includes the over-the-counter market. The information required is detailed in Chapter IX of the Compendium of Standards of International Changes (CNCI) and its Manual of Procedures and Forms of Information (Manual).

A.1 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 counterparties 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 institution providing the FX derivative contract. Additionally, contracting parties sign a specific contract (and then report to the CBC). The minimum contents of these contracts—often referred to as Framework Agreements— are regulated by the CBC according to its CNCI. In particular,

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

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.

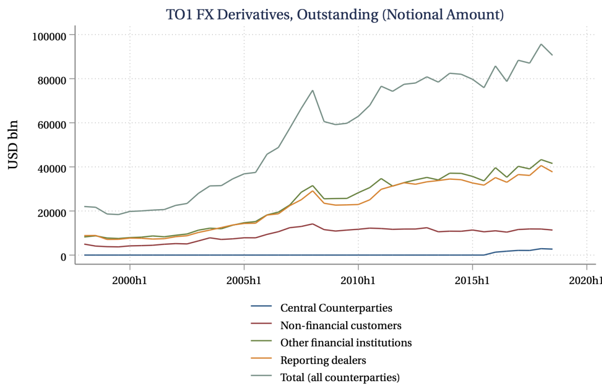
A.2 The local banking system

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 and applies to domestically-owned banks and subsidiaries. As a result, 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).

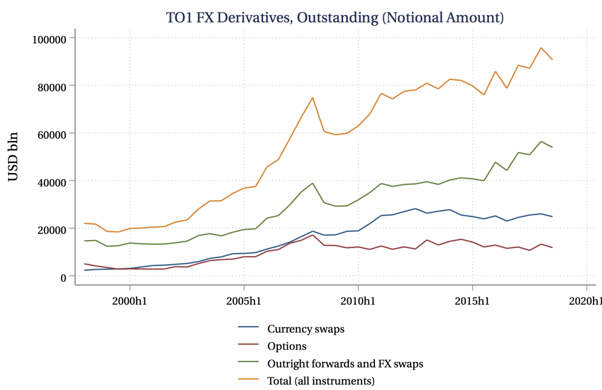
B Additional Figures

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

A. By Counterparty

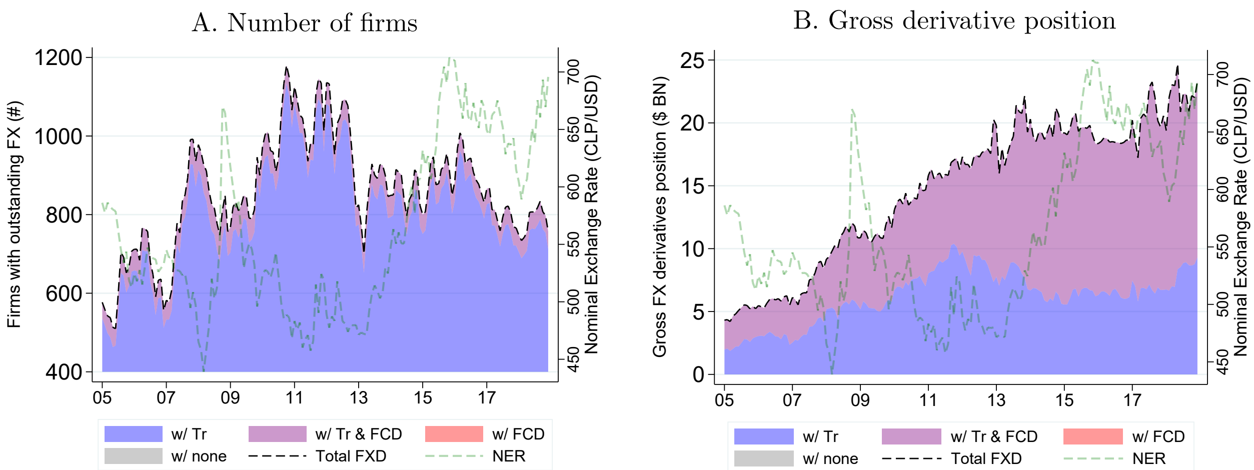


B. By Instrument



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). *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: Use of FX derivatives by firm type



Note.— Categories of firms are mutually exclusive. w/Tr.: includes firms with only trade credit. w/Tr & FCD: includes firms with trade credit and FX debt. w/FCD: includes firms with FC debt only. w/none: includes firms without FC debt or Trade credit. Total FXD: includes all firms with FX derivatives. NER is the nominal exchange rate pesos per U.S. dollar. Panel A reports the number of firms. Panel B reports gross derivative positions.

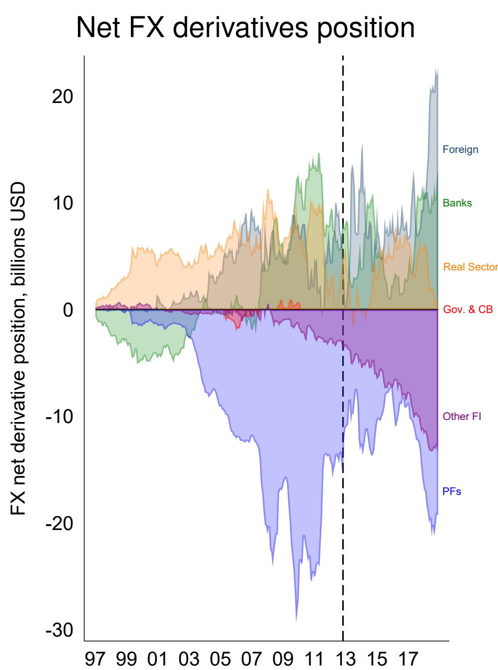


Figure B.3: Gross and net positions in the FX derivative market

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).

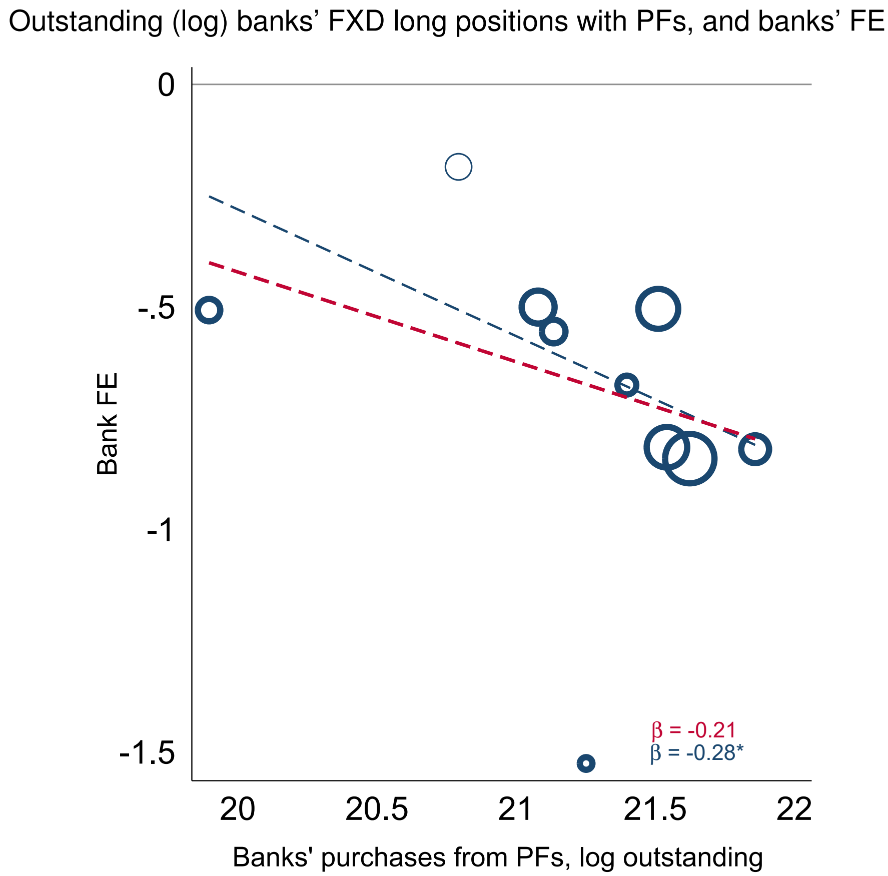


Figure B.4: Pension Funds’ gross and net positions in the FX derivative market

Notes.— The vertical axis refers to the estimated bank fixed effect $\beta_{b,\tau}$ in equation (11). The horizontal axis shows (log) outstanding purchase positions by banks from pension funds (PFs). 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.

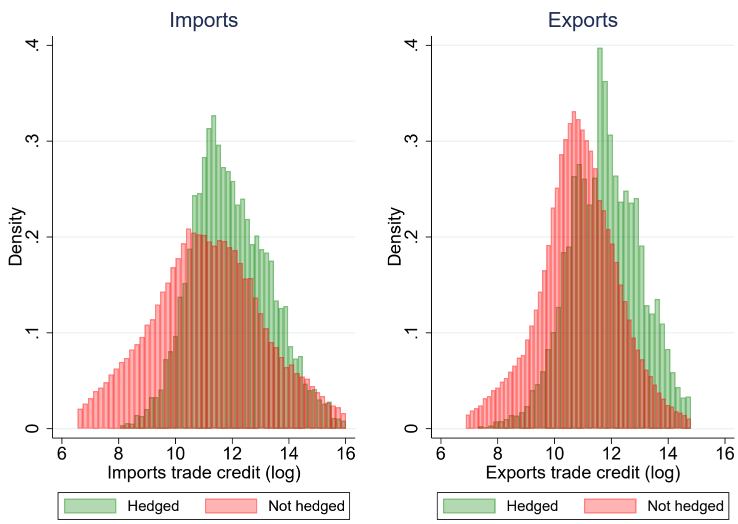


Figure B.5: Trade credit exposure amount by hedging category

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.

C Additional Tables

Table C.1: Summary Statistics: Firm Distributions

Percentile range, all firms	0-20	20-40	40-60	60-80	80-90	90-95	95-100
Number of firms in trade	2780	3273	1534	6036	2382	1325	1147
as % of firms in trade	14.8%	17.4%	8.1%	32.1%	12.6%	7.0%	6.1%
Share in exports volume (%)	0.6%	0.9%	1.4%	2.6%	2.9%	5.3%	86.3%
Share in imports volume (%)	0.9%	1.8%	3.5%	11.0%	13.3%	13.1%	56.4%
Share in exports TC volume (%)	0.6%	0.8%	1.4%	2.3%	2.4%	4.3%	88.2%
Share in imports TC volume (%)	0.7%	1.5%	2.9%	12.7%	14.9%	14.9%	52.4%
Number of firms in FX	58	87	168	362	385	304	450
as % of total firms in FX	3.2%	4.8%	9.2%	20.0%	21.2%	16.7%	24.8%
Share in FX derivatives long outstanding (%)	1.5%	1.1%	3.3%	8.9%	11.2%	12.5%	61.6%
Share in FX derivatives short outstanding (%)	1.5%	1.6%	3.6%	5.4%	7.3%	10.2%	70.4%
Number of firms in FX debt	49	47	49	82	79	65	130
as % of firms in FX debt	9.8%	9.3%	9.7%	16.4%	15.7%	13.0%	26.0%
Share in total FX debt outstanding (%)	3.8%	2.3%	0.8%	3.2%	4.9%	8.3%	76.8%

Notes.— Employment size bins correspond the number of workers 1-2, 3-6, 7-15, 16-46, 47-122, 123-292 and above 293 respectively. Shares calculated relative to total number of firm, total volume of exports, imports, trade credit; total outstanding volume of FX derivatives (long or short) and total volume of outstanding FX debt.

Table C.2: Operational 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} + FX Debt^{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 Derivatives)					0.03***	0.03***	0.03***	0.06***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade & FX Debt^{CF})					0.03	0.05**	0.03*	0.07***
					(0.02)	(0.02)	(0.01)	(0.02)
$M^{CF}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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} + FX Debt^{CF}				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 Derivatives)					0.02**	0.02***	0.02***	0.04***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade & FX Debt^{CF})					0.07***	0.07***	0.05***	0.08***
					(0.02)	(0.03)	(0.02)	(0.03)
$M^{TC}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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 FXD^{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.3: Operational 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} + FX Debt^{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 Derivatives)					0.05***	0.05***	0.05***	0.08***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FX Debt^{CF})					0.05**	0.06**	0.05*	0.09***
					(0.02)	(0.02)	(0.02)	(0.02)
$M^{CF}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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} + FX Debt^{CF}				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 Derivatives)					0.02**	0.02***	0.02***	0.04***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FX Debt^{CF})					0.07***	0.07***	0.05***	0.08***
					(0.02)	(0.03)	(0.02)	(0.03)
$M^{TC}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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 FXD^{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 FXD. 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.4: Operational 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} + FX Debt^{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 Derivatives)					0.09***	0.09***	0.08***	0.13***
					(0.01)	(0.01)	(0.01)	(0.01)
$M^{CF}\times$ 1(Trade and FX Debt^{CF})					0.10***	0.10***	0.09***	0.13***
					(0.01)	(0.02)	(0.01)	(0.02)
$M^{CF}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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} + FX Debt^{CF}				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 Derivatives)					0.02**	0.03***	0.03***	0.04**
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{TC}\times$ 1(Trade and FX Debt^{CF})					0.05*	0.06**	0.04**	0.08**
					(0.03)	(0.03)	(0.02)	(0.04)
$M^{TC}\times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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 FXD^{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 FXD. Only operations in US dollars, 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.5: Operational hedging of firms in international trade and foreign debt. Excludes all upfront payments

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} + FX Debt^{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 Derivatives)					0.01	0.02*	0.02**	0.06***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade & FX Debt^{CF})					0.03	0.05*	0.02	0.08***
					(0.02)	(0.02)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					-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^2	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 Derivatives)					0.03**	0.03***	0.03***	0.06***
					(0.01)	(0.01)	(0.01)	(0.02)
$M^{CF} \times$ 1(Trade & FX Debt^{CF})					0.02	0.02	0.02	0.07**
					(0.02)	(0.02)	(0.02)	(0.02)
$M^{CF} \times$ 1(Trade, FX Debt^{CF} and FX Derivatives)					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^2	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 FXD^{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.6: Operational hedging by sector

	Exports, log					
	(1)	(2)	(3)	(4)	(5)	(6)
Imports and FX Debt (log) by firms in ...						
— farming and fishing	0.01					
	(0.02)					
— mining and related		0.02				
		(0.01)				
— manufacturing			0.03***			
			(0.01)			
— construction and EGW				-0.00		
				(0.00)		
— retail					0.01	
					(0.00)	
— all the rest						-0.01
						(0.01)
Observations	98,391	150,793	242,822	61,880	995,993	181,448
R^2	0.80	0.84	0.88	0.95	0.76	0.77
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Include Mining	—	—	—	—	—	—
Include MNC	—	—	—	—	—	—
Both X and M	Yes	Yes	Yes	Yes	Yes	Yes

Notes.— Columns 1-2 do not include firm or industry-year FE, columns 3-4 include firm FE and year FE, and columns 5-6 include firm and industry-year FE. Columns 5-6 interact (log) imports with a dummy variable which takes the unitary value if the firm belongs to one of the quartiles Q1-Q4. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.7: Operational hedging: Without Firm and Industry-Year FE

	Exports, log					
	(1)	(2)	(3)	(4)	(5)	(6)
Imports, log	0.03***		0.02***		0.02***	
	(0.01)		(0.00)		(0.01)	
Imports and FX Debt, log		0.03***		0.01***		0.02***
		(0.00)		(0.00)		(0.00)
Observations	1,606,109	1,606,109	1,606,109	1,606,109	1,606,109	1,606,109
R^2	0.83	0.83	0.83	0.83	0.83	0.83
Firm FE	—	—	Yes	Yes	Yes	Yes
Industry-Year FE	—	—	—	—	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	—	—
Include Mining	—	—	—	—	—	—
Include MNC	—	—	—	—	—	—

Notes.— Firm-level regressions of exports X, on imports M, and foreign debt FXD. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.8: Operational hedging of firms: Volume of trade by firm size

	Exports, log					
					WLS (workers)	WLS (sales)
	(1)	(2)	(3)	(4)	(5)	(6)
Imports, log	0.03***		0.02***		0.02***	0.02*
	(0.01)		(0.00)		(0.01)	(0.01)
Imports and FX Debt, log		0.03***		0.01***		
		(0.00)		(0.00)		
Observations	1,731,327	1,731,327	1,731,327	1,731,327	1,574,075	1,381,617
R^2	0.83	0.83	0.83	0.83	0.83	0.83
Firm FE	—	—	yes	yes	yes	yes
Industry-year FE	—	—	—	—	yes	yes
Year FE	yes	yes	yes	yes	—	—
Include Mining	—	—	—	—	—	—
Include MNC	—	—	—	—	—	—

Notes.— Columns 1-2 do not include firm or industry-year FE, columns 3-4 include firm FE and year FE, and columns 5-6 include firm and industry-year FE. Columns 5-9 interact (log) imports with a dummy variable which takes the unitary value if the firm belongs to one of the quartiles Q1-Q4 of variable s. Columns 10-11 use a weighted least squares estimator with weight given by variable in parenthesis. Clustered standard errors at the firm level are reported in parentheses, $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

Table C.9: 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$)	17.32	5.30	1.34***	20.94	5.68	1.50***
Panel B. Not trading firms						
Employment (workers)	304.55	76.63	1.79***	337.93	100.46	0.65***
Sales (M$)	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$)	5.04	0.44	0.64***	3.84	0.31	0.71***
Panel D. Firms in FX Debt Market						
Employment (workers)	950.65	206.99	2.72***	1060.27	420.80	2.65***
Sales (M$)	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— the 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 the years 2006 and 2016, but results are stable and hold for all other years in the 2005-2018 sample.

Table C.10: Firms' use of FX derivatives, extensive margin: robustness to currency and contract

	FX Derivative Dummy					
	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)
FX Debt	-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)
$X^{TC} \times$ FX Debt		0.005*	0.000		0.002	-0.000
		(0.003)	(0.002)		(0.002)	(0.002)
$M^{TC} \times$ FX Debt		-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^2	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 FXD 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.11: Firms' use of FX derivatives, intensive margin: robustness to currency and contract

Panel A. Short position						
	Sales of FX derivatives, log					
	Other currencies - CLP			Forwards, Swaps and CC Swaps		
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.062***	0.059***	0.045***	0.045***	0.046***	0.034***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)
M^{TC}	0.020**			0.008		
	(0.009)			(0.009)		
FX Debt	-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
		(0.014)	(0.014)		(0.012)	(0.015)
M^{TC} by non-exp.		0.013*	0.017**		0.002	0.003
		(0.007)	(0.008)		(0.008)	(0.009)
Observations	2,486,869	2,486,869	2,520,309	2,273,980	2,285,736	2,306,632
R^2	0.58	0.58	0.57	0.63	0.63	0.63
Panel B. Long position						
	Purchases of FX derivatives, log					
	Other currencies - CLP			Forwards, Swaps and CC Swaps		
	(1)	(2)	(3)	(4)	(5)	(6)
X^{TC}	0.009			0.003		
	(0.007)			(0.007)		
M^{TC}	0.144***	0.143***	0.135***	0.144***	0.143***	0.135***
	(0.013)	(0.013)	(0.014)	(0.016)	(0.016)	(0.016)
FX Debt	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
		(0.010)	(0.009)		(0.010)	(0.009)
M^{TC} by non-exp.		0.006	0.006		0.002	0.003
		(0.006)	(0.006)		(0.006)	(0.006)
Observations	2,486,869	2,498,621	2,520,309	2,273,980	2,285,736	2,306,632
R^2	0.65	0.65	0.65	0.69	0.69	0.69
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
Includes all currencies	Yes	Yes	Yes	—	—	—
Includes Swaps	—	—	—	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.12: 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)
Hedged transaction	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 * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table C.13: Forward premium (percentage, contract level)

	FX Purchases		FX Sales	
	(1)	(2)	(3)	(4)
Maturity, log	0.425**	0.425**	-2.117***	-2.120***
	(0.197)	(0.197)	(0.384)	(0.384)
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 size (sales)	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Bank-Month FE	Yes	Yes	Yes	Yes

Note.— Dependent variable defined as $FXP_{c,d,N} = \frac{F_{c,d,N} - S_d}{S_d} \times \frac{360}{N} \times 100$, for contract c, day d and maturity N. Notional amount is defined as the (log) of the amount hedged in a given contract. Maturity is calculated as days from the signing of the contract to its maturity, and 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 C.14: 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)
FX Debt	-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.15: 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)
FX Debt	-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) are 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.16: 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	344,255	344,255	344,255	344,255	133,849	133,849	133,849	133,849
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 $FXP_{c,d,N} = \frac{F_{c,d,N} - S_d}{S_d} \times \frac{360}{N} \times 100$, for contract c, day d and maturity N. Notional amount is defined as the (log) of the amount hedged in a given contract. Maturity is calculated as days from the signing of the contract to its maturity. Firm sales are in logs, a proxy of firm size. Nonperforming loans (delinquency) are 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.17: 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.18: 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.19: 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.20: 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^2	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. * $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table C.21: Banks' sales of FX-derivatives to firms: supply side

Panel A. Quantities

	Firms' FX purchases (growth, %)			
	All firms		Firms in trade	
	(1) $\beta_{b,\tau}$	(2) Cum. share	(3) $\beta_{b,\tau}$	(4) Cum. share
Bank 1	-2.454**	—	-2.478**	—
	(0.634)		(0.622)	
Bank 2	-1.437***	—	-1.209***	—
	(0.300)		(0.379)	
Bank 3	-0.832***	—	-0.764***	—
	(0.086)		(0.069)	
Bank 4	-0.812***	—	-0.801***	—
	(0.126)		(0.131)	
Bank 5	-0.809***	0.49	-0.481**	0.47
	(0.169)		(0.187)	
Bank 6	-0.663***	—	-1.451**	—
	(0.153)		(0.552)	
Bank 7	-0.507***	—	-0.455***	—
	(0.128)		(0.147)	
Bank 8	-0.498**	—	-0.562***	—
	(0.167)		(0.137)	
Bank 9	-0.495***	—	-0.615***	—
	(0.124)		(0.104)	
Bank 10	-0.475***	0.89	-0.440***	0.88
	(0.120)		(0.100)	
Bank 11	-0.193	—	-0.127	—
	(0.143)		(0.130)	
Bank 12	-0.160	1.00	-0.118	1.00
	(0.150)		(0.168)	
Obs. (bank-firm relation)	697		599	
R^2	0.48		0.49	

Panel B. Prices

	Forward premium (pp.)			
	All firms		Firms in trade	
	(1) $\beta_{b,\tau}$	(2) Cum. share	(3) $\beta_{b,\tau}$	(4) Cum. share
Bank a	2.100***	—	2.221***	—
	(0.441)		(0.314)	
Bank b	2.100**	—	1.658**	—
	(0.854)		(0.718)	
Bank c	1.772*	—	1.414	—
	(0.953)		(0.844)	
Bank d	1.701***	—	1.380***	—
	(0.503)		(0.395)	
Bank e	1.261**	0.40	0.098	0.43
	(0.416)		(0.394)	
Bank f	1.108***	—	1.165**	—
	(0.345)		(0.395)	
Bank g	0.945**	0.76	1.342**	0.81
	(0.342)		(0.459)	
Bank h	0.539	—	0.448	—
	(0.815)		(0.573)	
Bank j	0.100	—	-0.698	—
	(0.633)		(0.670)	
Bank k	-2.448	—	-10.718***	—
	(1.985)		(2.816)	
Bank l	-3.007**	—	-2.126***	—
	(1.007)		(0.685)	
Bank m	-4.491	1.00	-5.693	1.00
	(4.048)		(3.259)	
Obs. (bank-firm relation)	492		415	
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. Number of observations correspond to bank-firm relationship. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.22: 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 (11) 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

D CIP Around PF's Regulation Change

Consider the Covered Interest Rate parity (CIP) arbitrage equation, with room for potential deviations as in Morales and Vergara (2017)[44]

$$(1 + i^*_{t,n} + x_{t,n}) = (1 + i_{t,n}) \times \frac{S_t}{F_{t+n}} \tag{12}$$

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.

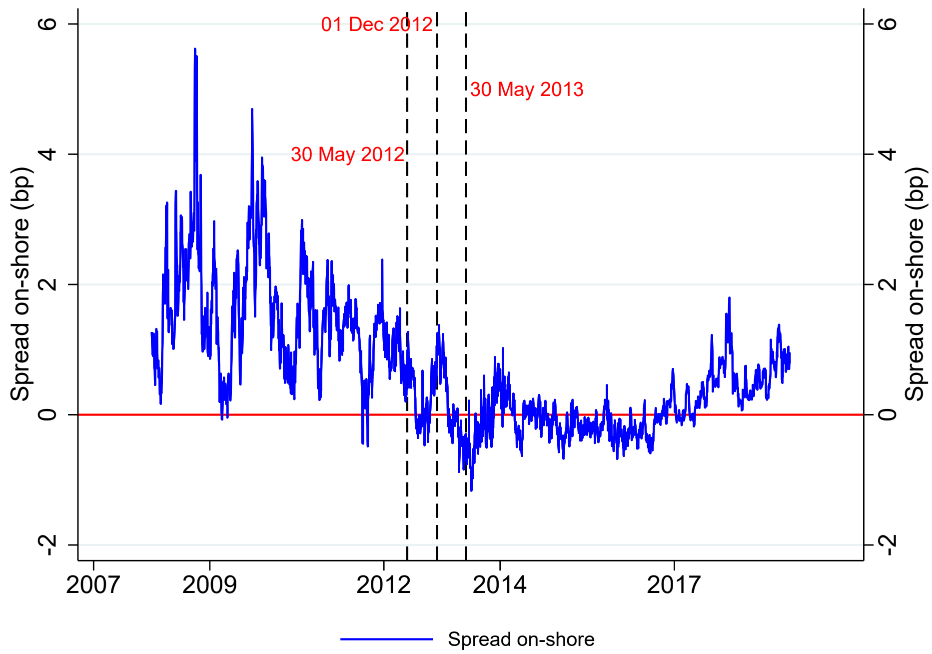


Figure D.1: Spread on shore, Chile, 2007-2020

Note.— On-shore spread ($x_{t,t+n}$) shown in basis points (12).

[44]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 (44) in that it considers the deviation with respect to the local rate instead to the foreign rate.

E A Stylized Model: FX Hedging under Dominant Currency

In the following, we sketch a simple three-period model in which firms use Dominant Currency Pricing (DCP) in trade and financing, along with financial hedging. Firms in Chile, as in many countries, predominantly use the dollar to price trade and foreign capital flows (see Gopinath (2015)).

Let P_{it}^{x} and P_{it}^{m} denote the prices of exports and imports, respectively, for firm i. Similarly, we define x_{it} and m_{it} as their quantities. Hence, the value of exports and imports are given by $X_{it} = x_{it}P_{it}^{x}$ and $M_{it} = m_{it}P_{it}^{m}$, respectively, and E_t denote the exchange peso to one USD at time t. The firm faces exchange rate shocks, $E_t \sim N(1, \sigma_E^2)$ that affect the value of their imports and exports. Within period 1, there are two times; one at the beginning of the period, which we denote by 1^-, and one at the end of the period, which we denote by 1^+. The shocks occur at the beginning of period 1, $t = 1^-$, and at the end of the period, $t = 1^+$.

Firms manage their cash flow at every t, which involves domestic and foreign currency flows and internal and external finance decisions, which, as in Froot et al. (1993), is costlier.[45] Firms start in period $t = 0$ with an initial net cash-flow NCF_0[46], and decide their hedging contracts h_{i0}^{M} and h_{i0}^{X}, which are delivered in $t = 1^-$ and $t = 1^+$ in order to hedge the value of their exports, imports, and foreign currency debt payments. To simplify the analysis, we focus on hedging of international trade-related transactions, which has been the main focus of the dominant currency pricing literature, and, as mentioned, dominates the observed hedging activities. However, similar intuition carries on to other variables that affect the cash flow.

In subperiods 1^- and period 1^+, M_0 and X_0 are received, along with domestic revenues, R_{1^+}. To further simplify the analysis, we assume the value of imports and exports are given at $t = 0$. The main point is that firm faces different exchange rates through production and payment cycles. Thus, the firm faces the last period with wealth determined by its initial endowment, the realization of imports and exports flows, potential debt payments, and domestic revenues received. Following as in Froot et al. (1993), we assume the discount rate is zero. The law of motion of a firm's net cash flows is as follows:

$$NCF_{1^+}^{TC} = NFC_0^{TC} + X_{1^+}^{TC}(h_0^X + (1 - h_0^X)E_{1^+}) - M_{1^-}^{TC}(h_0^M + (1 - h_0^M)E_{1^-}) \tag{13}$$

The firm's i in period t desired price is determined by the firm's marginal cost, which is a combination of domestic and international inputs, and its markup, as shown in Amiti et al. (2019), Amiti et al. (2022) and Gopinath and Itskhoki (2022), relates to a general class of models.

[45] This higher cost could result from a variety of factors, including bankruptcy costs and informational asymmetries between investors and outside investors.

[46] We define the net cash-flow as the sum of the net flows from trade credit, upfront payments of exports and imports, and debt payments: $NCF_{t+1} = NCF_{t+1}^{TC} + NCF_{t+1}^{U} + NCF_{t+1}^{B}$. For the moment, we assume there are no upfront nor debt payments, so $NCF_{t+1} = NCF_{t+1}^{TC} = X_{t+1}^{TC} - M_{t+1}^{TC}$ and, $X_{t+1}^{TC} = X_t$ and $M_{t+1}^{TC} = M_t$.

Writing the pricing equations in levels and USD:

$$P_{i,t}^x = \mathbb{E}[MC_{i,t+1}\mu_{i,t+1}] \tag{14}$$

where MC_{it} denotes the firm's marginal cost at time t and μ_{it} the firm's markup at time t.[47] Prices are chosen to equal marginal cost plus markup, which is a function of domestic inputs (e.g., wages, W_{it}) and international inputs, with some expenditure weights; A_{it}: a productivity shock; γ_{it} expenditure weigh. Writing in dollars terms:

$$MC_{it} = \left(\frac{W_t}{1-\gamma_{it}}\right)^{1-\gamma_{it}} \left(\frac{P_{it}^m}{\gamma_{it}}\right)^{\gamma_{it}} \frac{1}{A_{it}E_t} \tag{15}$$

Using (14) in (15) we get:

$$P_{it}^x = \mathbb{E}\left[\left(\frac{W_{t+1}}{1-\gamma_{i,t+1}}\right)^{1-\gamma_{i,t+1}} \left(\frac{P_{i,t+1}^m E_{t+1}}{\gamma_{i,t+1}}\right)^{\gamma_{i,t+1}} \frac{1}{A_{i,t+1}E_{t+1}}\mu_{i,t+1}\right] \tag{16}$$

Assuming $A_{it} = 1$, the value of exports is equal to

$$X_{it} = x_{it}\mathbb{E}\left[\left(\frac{W_{t+1}}{1-\gamma_{i,t+1}}\right)^{1-\gamma_{i,t+1}} \left(\frac{P_{i,t+1}^m E_{t+1}}{\gamma_{i,t+1}}\right)^{\gamma_{i,t+1}} \frac{1}{A_{i,t+1}E_{t+1}}\mu_{i,t+1}\right] \tag{17}$$

To further simplify the analysis, we impose the standard assumption in this literature that P_{it}^x and P_{it}^m are set in $t = -1$ and assume no domestic revenues. Substituting (17) in (13) and aggregating firms (dropping i index):

$$NCF_{1^+}^{TC} = NFC_0^{TC} + x_0\left[\left(\frac{W_{1^+}}{1-\gamma}\right)^{1-\gamma} \left(\frac{P_{1^+}^M \epsilon_{1^+}}{\gamma}\right)^{\gamma} \frac{1}{A_{1^+}\epsilon_{1^+}}\mu\right]\epsilon_{1^+} - m_0 P_0^M \epsilon_{1^-} \tag{18}$$

$$\epsilon_{1^-} = (h_0^M + (1-h_0^M)E_{1^-}) \tag{19}$$

$$\epsilon_{1^+} = (h_0^X + (1-h_0^X)E_{1^+}) \tag{20}$$

In the last period, $t = 1$, the firm decides its level of investment, I_{1^+}, with a production function $f(I_{1^+})$, with $f'(\cdot) > 0$ and $f''(\cdot) < 0$.[48] Thus, the net present value of investment expenditures is given by $F(I_{1^+}) = \theta f(I_{1^+}) - I_{1^+}$, where θ is defined as $\theta = \alpha_{1^-}(E_{1^-} - \bar{E}_{1^-}) + \alpha_{1^+}(E_{1^+} - \bar{E}_{1^+})$. The variable θ captures the correlation between investment opportunities and exchange rate realizations in $t = 1^-$ and $t = 1^+$ through the parameters α_{1^-} and α_{1^+}, respectively.[49] On the other hand, the firm finances its investment with internal wealth or outside sources, o_{1^+}. To

[47]In their setup, this corresponds to the log desired price in destination currency of firm i in period t being expressed as a linear combination of the firm's marginal cost, mc_{it}, and its local competitors' prices p_{-it}^*, $\tilde{p}_{it}^* = (1-\alpha_{it})(mc_{it} + e_t) + \alpha_{it}p_{-it}^*$; and $mc_{it} = (1-\gamma_{it})w_t + \gamma_{it}(v_t^l + e_t^l) - a_{it}$, where e_t is the producer-destination exchange rate, with $\alpha = 0$.

[48]The concavity of $f(I_{1^+})$ can be interpreted as decreasing returns to scale.

[49]For simplicity, we assume the shocks E_{1^-} and E_{1^+} are normally distributed with mean of 1 and variance σ_E^2.

capture this idea, we use an external cost function, $C(o_{1^+})$, with $C'(\cdot) > 0$ and $C''(\cdot) > 0$.[50] Figure E.1 plots the timeline.

Figure E.1: Timeline

$t = 0$	$t = 1^-$	$t = 1^+$	$t = 2$
Choose P^x, Choose P^m Choose h_0^M, Choose h_0^X	$-h_0^M M\left(\overline{E}_{1^-} - E_{1^-}\right)$ Amount received or paid due to hedge	$h_0^X X\left(\overline{E}_{1^+} - E_{1^+}\right)$ Amount received or paid due to hedge	NFC_{1^+} = Internal Wealth
Endowment NFC_0	$-M\left(E_{1^-}\right)$ Amount paid due to imports	$X\left(E_{1^+}\right) - R_{1^+}$ Amount received due to exports	Choose I_{1^+} to max $P(NFC_{1^+})$

Note: Net cash-flows, NCF_0 and NCF_{1^+}, correspond to w_0 and w in Froot et al. (1993), respectively.

Solving by backward induction, in the last period problem, the firm chooses its investment to maximize net expected profits, with a combination of internal, NCF_{1^+}, and outside financing, o_{1^+}:[51]

$$P(NCF_{1^+}) = \max_{I_{1^+}} \theta f(I_{1^+}) - I_{1^+} - C(o_{1^+}) \tag{21}$$

$$I_{1^+} = NCF_{1^+} + o_{1^+} \tag{22}$$

Then, in period $t = 0$, the firm chooses its hedging contracts, h_0^M and h_0^X, to maximize expected profits.

$$P(NCF_0) = \max_{h_0^M, h_0^X} \mathbb{E}[P(NCF_{1^+})] \tag{23}$$

$$NCF_{1^+} = NCF_0 - m_0 P_0^M (h_0^M + (1 - h_0^M) E_{1^-}) + x_0 P_0^X (h_0^X)(h_0^X + (1 - h_0^X) E_{1^+}) \tag{24}$$

Note that, due to equation (16), the value of the firm's exports is a function of its imports' value at $t = 1^+$, $P_{i0}^M \epsilon_{1^+}$. The first-order condition of this problem is given by:

$$\mathbb{E}\left[P_{NCF} \frac{\partial NCF}{\partial h_0^M}\right] = \mathbb{E}\left[P_{NCF} m_0 P_0^M (1 - E_{1^-})\right] = 0 \tag{25}$$

$$\mathbb{E}\left[P_{NCF} \frac{\partial NCF}{\partial h_0^X}\right] = \mathbb{E}\left[P_{NCF} x_0 P_0^X (1 - E_{1^+}) \gamma\right] = 0 \tag{26}$$

$$\tag{27}$$

[50] The concavity of $C(o_{1^+})$ comes from the idea that it is becoming more and more costly for the firm to resort to external financing as its financial burden increases.

[51] This problem analogous to that one posed by Froot et al. (1993) in the last period.

It also can be expressed in terms of covariances.[52]

$$\text{cov}(P_{NCF}, (1 - E_{1^-})) = 0 \tag{28}$$

$$\text{cov}(P_{NCF}P_0^X, (1 - E_{1^+})) = 0 \tag{29}$$

Note that the terms $(1 - E_t)$ and P_{NCF} are random variables, where the latter is random due to the presence of the investment opportunities, θ.[53] Without investment opportunities, the term P_{NCF} would be constant, and the optimal hedging would be $h_0^{X*} = 1$ and $h_0^{M*} = 1$ since they completely offset the covariance between the firm's marginal value with the exposure of its exports and imports.[54]

To obtain an analytical solution for h_0^*, we express the equations (28) and (29) as

$$\mathbb{E}\left[\frac{\partial P_{NCF}}{\partial E_{1^-}}\right] = 0 \tag{30}$$

$$\mathbb{E}\left[\frac{\partial (P_{NCF}P_0^X)}{\partial E_{1^+}}\right] = 0 \tag{31}$$

From this, we can compute the optimal hedging contracts.[55] Based on previous equations, we get the following system

$$h_0^{M*} = 1 - \alpha_{1^-}\frac{\mathbb{E}\left[\frac{f_I}{\theta f_{II}}\frac{\partial^2 P}{\partial NCF^2}\right]}{m_0 P_0^M \frac{\partial^2 P}{\partial NCF^2}} \tag{32}$$

$$\mathbb{E}\left[\frac{\partial P_{NCF}}{\partial E_{1^+}}P_0^X(h_0^{X*})\right] = -\mathbb{E}\left[\frac{\partial P_0^X}{\partial E_{1^+}}P_{NCF}\right] \tag{33}$$

Note that if $h_0^M = 1$, the firm is fully hedged, and pays in $t = 1^-$, $m_0 P_0^M \bar{E}_{1^-}$. Analogously, if $h_0^X = 1$, the firm is fully hedged and receives $x_0 P_0^X \bar{E}_{1^+}$ in $t = 1^+$ and hedging becomes a complement of dollar pricing considerations to manage the firm's cash flow.[56]

[52] By using the property $\mathbb{E}[xy] = \mathbb{E}[x]\mathbb{E}[y] + \text{cov}(x, y)$, with x and y random variables.

[53] Since $P_{NCF} = \theta f_I \frac{\partial I^*}{\partial NCF} - \frac{\partial I^*}{\partial NCF} - C_e\left(\frac{\partial I^*}{\partial NCF} - 1\right)$, P_{NCF} it is also a random variable.

[54] This result holds because we assume that shocks ϵ_t are IID.

[55] By using the property $\text{cov}(a(x), b(y)) = \mathbb{E}[a_x]\mathbb{E}[b_y]\text{cov}(x, y)$. See Rubinstein (1976) and Stein (1981) for a proof.

[56] In the case of Chile, the correlation between investment and exchange rate during our sample period is positive. Using HP-filtered quarterly data, the correlation between gross fixed capital formation in national income accounts and the exchange rate is 0.04; while the correlation for listed firms between investment (measured by changes in property, plant, and equipment) and the exchange rate was 0.43).