Great Financial Crisis and Dollar Dominance

Enrico Cristoforoni* Boston College

Marco Errico Bank of Italy

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Abstract

This paper studies how large global shocks can undermine the dominance that the US dollar plays in the international monetary system. We show that, following the Great Financial Crisis and the temporary increase in the cost of US dollar financing, the share of total Chilean imports denominated in US Dollar (Chilean Peso) steadily decreased (increased) by almost 10% (7%) by the end of 2019, while no changes in the invoicing patterns took place on the exports side. Using the Chilean universe of international transactions from 2007 to 2019, we study the firm-level determinants of these aggregate patterns. We show that: i) the bulk of changes in aggregate invoicing shares is due to firms switching from US dollar to Chilean Peso, as opposed to reallocation between firms or firm entry; ii) the first importers to switch to Chilean Peso invoicing are large firms with wider US Dollar currency mismatches, suggesting that both natural hedging and strategic complementarities are relevant in shaping invoicing choices. We rationalize these findings with a currency choice model of an economy populated by importing firms that choose the currency of denomination of their trade credit for imported inputs, in the presence of natural hedging and strategic complementarities motives. We show how the introduction of sunk cost of currency management generates hysteresis in invoicing choices, yielding permanent changes in the aggregate invoicing share following a temporary shock in the cost of trade credit. Lastly, we test the key theoretical mechanism and study the implications of large changes in invoicing patterns for the whole macroeconomy.

JEL Codes: F14, F31, F33, F41.

Keywords: Exchange rate, invoicing currency, vehicle currency, dollar dominance, dominant currency, trade finance, working capital, firm-level trade.

*Enrico Cristoforoni: cristofe@bc.edu; Marco Errico: marco.errico@esterni.bancaditalia.it. We thank Rosen Valchev, Jaromir Nosal, Stefania Garetto, Gustavo Joaquim, Susanto Basu, Luigi Pollio, and the audience at the Boston College Workshop and the Bank of Italy for their comments and suggestions. The views expressed here do not necessarily reflect those of the Bank of Italy or the Euro-System.

1 Introduction

The global economy is characterized by the presence of a dominant currency, the US dollar, that is used to invoice the majority of international trade transactions, safe assets and international debt, and central banks' international reserves (Gopinath, 2015; Gopinath and Stein, 2021). Prior literature has expressed great interest to the implications of such dominance for several macroeconomics facts, including aggregate exchange rate pass-through, shocks transmissions and spillovers across countries, and the dynamics of external adjustment (Gourinchas et al., 2019; Adler et al., 2020). However, comparatively little attention has been devoted to understanding the forces and shocks that can undermine the widespread use of the US dollar and push the global economy out of dollar dominance.

This paper studies how large shocks to dollar financing, such as the Great Financial Crisis, impact invoicing decisions of international trade decisions. The majority of international trade transactions require external financing, usually heavily dollarized and locally sourced via domestic banks (Bruno and Shin, 2019; Niepmann and Schmidt-Eisenlohr, 2017). The scarcity of dollar financing in periods of distress such as the Great Financial Crisis (henceforth GFC) can impact firms' trade flows (Amiti and Weinstein, 2011; Ahn et al., 2011), but also their invoicing decisions.

Using data from Chile from 2004 to 2019, we show that the share of imports denominated in US dollar has declined by 10 p.p. starting after the Great Financial Crisis. The cost of short-term borrowing denominated in US dollar from local banks increased dramatically during the GFC in Chile, so that trade finance denominated in domestic currency (Chilean Peso) became cheaper. At the onset of the GFC, the share of Chilean imports invoiced in US dollar was around 90%. By the end of 2019, the share declined to approximately 80%. Simultaneously, the use of Chilean peso, virtually nonexistent before 2008, accounts for almost 7% of total imports by the end of 2019. Importantly, we do not find similar patterns on the export side, with the US dollar being steadily used to invoice around 95% of exported value. These patterns together suggest that, during an episode of severe scarcity of dollar financing such as the GFC, firms have substituted away the dominant currency, the US dollar, with an alternative currency (namely the Chilean Peso) to meet their international trade financing needs, i.e. imported goods.

We dissect the dynamics of the aggregate invoicing shares and show that the bulk of the aggregate dynamics is driving by within-firm invoicing choices. We leverage the granular nature of our Chilean customs data, which contains information on invoicing decisions at

the transaction level. We perform a dynamic Olley-Pakes decomposition with entry and exit in the spirit of Melitz and Polanec (2015) to understand which firms drive the change we observe at the aggregate level. We find that more than 80% of the aggregate change in the share of imports invoiced in US dollar is driven by incumbents firms, hence leaving a residual role to potentially different invoicing decisions of entrant and exiting firms. We also find that, within incumbent firms, most the aggregate dynamics is driven by within-firm forces, rather than between-firms. In other words, the relevant margin is that firms are now invoicing the same product from the same origin country in a different currency, and not that the market share of firms invoicing in US dollar decreased. This suggests that, during the GFC, firms actively switched away from dominant currency invoicing to an alternative currency, mainly the Chilean peso.

We investigate further to understand whether there exists selection in the decision to first switch away from dollar invoicing, and the forces that fueled the switching in invoicing over the decade after the GFC. We correlate firm's characteristics with the firm's decision to be among the first importers to abandon the US dollar to invoice transactions. We present evidence of selection along two main margins: i) firms most operationally unhedged in US dollar are the first to substitute away from dollar invoicing; ii) bigger firms are the first to switch away from the US dollar. The former suggests that the higher cost of financing firms face during a period of dollar financing scarcity such as the GFC is particularly relevant for those firms facing relatively more negative cash flow denominated in US dollar. This is specifically important for firms that are only importers or that do not export as much as they import in US dollar. The latter points in the same direction as larger importers might have larger financial needs. Moreover, the fact that the size of firms switching away from dollar invoicing decreases over time points to the presence of strategic complementarities in invoicing decisions.

Lastly, we show that, while several firms switched away from dollar invoicing during the GFC, the presence of strategic complementarities among firms, within-firm complementarities and operational hedging forces fueled the switching away from dollar invoicing for many years after the end of the GFC. We estimate the relevance of these margins departing from the standard empirical framework a la Amiti et al. (2022) and Crowley et al. (2020), leveraging the within-firm variation rather than the cross-sectional variation. We find that firms' invoicing decisions were also shaped by competitors' currency choices, as importers switched away from dollar invoicing even after the end of GFC and the scarcity of dollar financing. Similarly, we find that own past choices influence future invoicing decisions. These results

strongly lands support to the presence of both across-firm and within-firm complementarities in invoicing decisions over time. Lastly, we find evidence that firms have been actively trying to reduce their operational unhedged positions following the GFC.

Next, we develop a theoretical framework to rationalize the empirical findings on the invoicing choice dynamics focusing on the invoicing of firms' liabilities. A small open economy is populated by importing firms that choose the currency of denomination of their trade credit for imported inputs, in the presence of natural hedging and strategic complementarities motives. We treat imported inputs as working capital that requires financing in advance (Bahaj and Reis, 2020). The trade credit and import invoicing decision depend on the relative interest rate on trade credit denominated in domestic and vehicle currency. Asymmetric shocks to the financing costs in different currencies, such as the Great Financial Crisis, make trade credit in a particular currency more attractive, ultimately influencing invoicing patterns.

A key element of the model and novel theoretical contribution is the introduction of a sunk cost associated with the use of new currency for import invoicing. The presence of a sunk cost generates hysteresis in invoicing choices. Firms pay a sunk cost upon invoicing in a new currency, permanently lowering the fixed cost associated with the management of invoicing currency. This permanently alters the relative convenience of invoicing imports and trade credit in different currency, even in presence of temporary shocks. The mechanism allows to rationalize how a temporary shock to the financing costs in different currencies, such as the Great Financial Crisis, produces long-lasting effects in invoicing choices.

The theory further predicts that the threshold to use domestic or vehicle currency financing to finance imported inputs depends on strategic complementarities among importers and the firm's natural hedging. Strategic complementarity captures the idea that individual usage increases in the overall utilization. We introduce this mechanism by assuming that the firm-level fixed cost associated with the management of invoicing currencies decreases in the number of users of that currency. Natural hedging refers to the costly mismatch between costs and revenues due to exchange rate fluctuations that arises when imported inputs are invoiced in a currency different from the domestic. Trade credit denominated in vehicle currency is less appealing than trade credit denominated in domestic currency when firms rely more on imported inputs as they become more exposed to exchange rate fluctuations.

Lastly, we test the key mechanism of the model and study how the decline in dollar invoicing influenced the sensitivity of key macrovariables such as trade balance, terms of trade, and import inflation to exchange rate sensitivities. We show that changes in the differential

between dollar-invoiced and peso-invoiced financing negatively impact firms' dollar invoicing, and its effect is amplified by within and across firms complementarities. Moreover, we show that the decline in the aggregate share of dollar invoiced imports has relevant implications for the transmission of exchange rate fluctuations to domestic prices, the dynamics of the terms of trade and the trade balance, and, ultimately, macroeconomic policy. In line with previous literature, invoicing is a key determinant of the degree of exchange rate pass-through rates, with the pass-through being higher (lower) when transactions are invoiced in dominant (local) currency (Gopinath et al., 2010; Barbiero, 2021; Amiti et al., 2022). This suggests that large changes in invoicing patterns may have large macroeconomic impacts. We show that, in 2019, the sensitivity of import inflation to exchange rate fluctuations decreased by 5% compared to 2007, while the sensitivity of trade balance and terms of trade has decreased by approximately 30%.

Altogether, our analysis studies how large aggregate shocks, such as the Great Financial Crisis, can make a currency more or less international by influencing the individual and aggregate invoicing decisions, and their implications for macroeconomic policy.

Related Literature This paper is closely related to several strands of literature on dominant international currencies. Most models of dominance have in common the fact that they either define under which conditions a currency becomes dominant or they define under which conditions a currency remains dominant. Examples in this line of work are Eichengreen et al. (2018), Chahrour and Valchev (2022), Farhi and Maggiori (2018), and Gopinath and Stein (2021).[1] Fewer papers instead focus on forces and shocks that can perturb the current dollar dominant equilibrium. Chahrour and Valchev (2023) and Corsetti et al. (2022) share the same perspective in analyzing how geo-political fragmentation and Brexit, respectively, affect the current dominant currency equilibrium. Bahaj and Reis (2020) and Bahaj and Reis (2022) focus on currency competition in the central banks' swap line market as a channel through which the People's Bank of China jump-started the international use of the RMB, challenging the dominant role of the dollar. Our paper complements the literature because we shed light on how large macroeconomic events such as the Great Financial Crisis might impair the dominance of a single currency and the mechanism that could lead to the rise of another competitive currency.

Our theoretical framework emphasizes the role of trade finance. International trade trans-

[1]Other recent contributions such as Gopinath et al. (2020) and Mukhin (2022) focus on understanding the consequences that the US dollar dominance has on international trade dynamics, and the global economy in general. Refer to Gourinchas et al. (2019) for a survey.

actions require external financing, usually heavily dollarized and locally sourced via domestic banks (Niepmann and Schmidt-Eisenlohr, 2017). The forces giving rise to currency dominance in trade and finance are closely related. The availability of supply of safe and liquid short-term government-backed liabilities generates invoicing dominance as in Coppola et al. (2023) and Eren and Malamud (2022). Similarly, Chahrour and Valchev (2023) dominance arises from the need for both parties in an international trade transaction to collateralize. We complement this theoretical contributions and provide evidence that the scarcity of dollar denominated trade finance during the Great Financial Crisis not only impacted trade volumes (Bruno and Shin, 2019; Amiti and Weinstein, 2011), but also invoicing decisions, with potential long-run effects on dollar dominance.

The key theoretical mechanism we use to rationalize our empirical findings relies on the complementarity between the currency of denomination of their trade credit and imported working capital. Bruno and Shin (2019) and Drenik and Perez (2020) stress the importance of the choice in which firms decide to invoice their credit for financing working capital because it influences the degree of exchange rate pass-through to the firm's production costs.[2] The closest to our theoretical framework is Bahaj and Reis (2020), which we extend by introducing sunk cost in the use of currencies for international transactions (Crowley et al., 2020). This novel element is key to generate hysteresis in invoicing patterns as documented in the data.

We also contribute to the empirically oriented line of research on the firm-level determinants of invoicing choices and heterogeneous pass-through rate. Several papers have focused on the importance of variable markups and strategic complementarities in price-setting (Amiti et al., 2019,0), international input intensity and operational hedging (Amiti et al., 2014), firm characteristics such as size and productivity (Berman et al., 2012). See Burstein and Gopinath (2014), Itskhoki (2021), and Gopinath and Itskhoki (2022) for the most recent survey articles on this vast literature. We add to the literature showing that firm-level margins are relevant not only to understand cross-sectional differences in invoicing patterns, but also the gradual adoption of different currencies as firms change their invoicing choices after large aggregate shocks.

The rest of the paper is organized as follows. Section 2 describes our data. Section 3 presents the macro and micro-level evidence on invoicing choices. Section 4 presents and discuss the theoretical framework used to rationalize the empirical findings. Section 6 studies

[2] Gopinath and Stein (2021) focus on the complementarity between trade and finance but from the point of view of domestic banks, which extend dollar credit to domestic firms in order to match domestic households' dollar deposits.

the implications of invoicing choices for inflation dynamics, terms of trade, and trade balance. Section 7 concludes.

2 Data

The main data source we use covers the universe of Chilean trade transaction from the Chilean Customs Agency (*Aduanas*). The Chilean Customs Agency publishes information at the transaction level for each firm, product, destination/origin, currency and day, for both export and import. The following information is included: the origin or the destination country; the quantity exchanged in the transaction expressed in kilograms (KG) and in the unit of measure of the good; the classification of the goods exchanged at the 8-HS digit code; the value (both FOB and CIF) of the transaction expressed in US Dollar. Importantly, every transaction reports the currency in which the transaction was invoiced. All the major currencies are reported (US Dollar, Euro, Chilean Peso, UK Pound, and Chinese Yuan), together with minor regional currencies such as Latin-American currencies. The datasets have a time-invariant, anonymous, firm identifier which enables to create a panel of importers and exporters for Chile. More information on data, cleaning and summary statistics in Appendix A.

The data are available from 2007 to 2023 for export transactions, while import transactions are available from 2009 to 2023. Given our main interest is about the impact of the Great Financial Crisis on the usage of the US Dollar in international trade, we complement the main dataset from the Chilean Customs Agency with a similar dataset from Garcia-Marin et al. (2019).[3] This additional dataset contains the same information as official customs records starting from 2004, and thus it allows us to cover the time period right before the GFC, and exclude potential pre-trends. The only difference between the two different data sources is that the latter covers the customs transactions from the main trade partners of Chile. Nevertheless, the dataset covers 98% of the total Chilean transactions in terms of value and quantity when compared with the official data from the Chilean Customs Agency. This gives us confidence on the quality and validity of the data.

In addition, we use additional firm level information from the Chilean Tax Registry (SII, *Servicio de Impuestos Internos*). The Chilean Tax Registry covers the universe of firms active in Chile and regularly registered at it. The Registry provides information on firm size (such as the number of employee and total turnover), together with the sector in which

[3]We kindly thank Santiago Justel to share the dataset with us.

the firm operates and its equity. In conjunction with customs data, we are able to create measures of import and export intensity at the firm level.

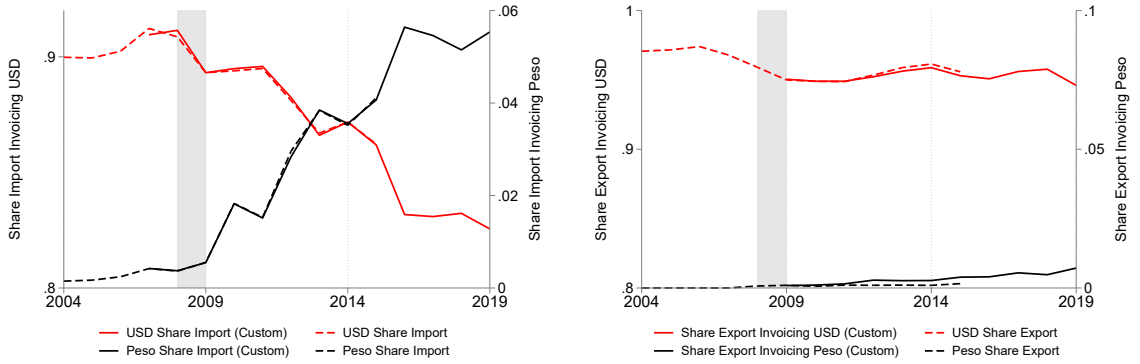
We also use data from the Chilean public authority responsible for regulating the financial and banking markets (CMF, *Comision para el Mercado Financiero*). They agency collects and provides data on the banking industry both at the aggregate and bank level, such as deposit and lending rates distinguishing domestic and foreign invoiced loans, different maturity and loan size, commercial and non-commercial clients. We leverage information on the commercial lending rates that Chilean banks charge on short-term (less than one year) loans denominated in domestic currency and US Dollar. Rates are aggregated at the monthly level. We consider short-term loan rates given that trade financing for international transactions relies heavily on this type of financing (Amiti and Weinstein, 2011; Ahn et al., 2011; Schmidt-Eisenlohr, 2013). The data span the period around the Great Financial Crisis until a change in regulation and data collection in 2013 does not allow a consistent comparison between domestic currency and US Dollar invoiced loans. Due to the fact that our coverage is limited to 2013, we are only able to document the dynamics of financing costs in the period 2007-2009 and adjacent periods. Because of this, our analysis excludes the COVID-19 episode and the global financing shock that occurred in 2020.

Lastly, we use a collection of standard macro-level variables from a variety of sources. For instance, we use daily bilateral exchange rates between Chilean Peso and the currency of Chilean trade partners for the time period under analysis, obtained from Bloomberg and Datastream; the domestic inflation rate for Chile and its trade partners from the Central Bank of Chile and the IMF, respectively.

3 Macro and Micro-level Invoicing Dynamics

In this section, we use firm-level transactions data and financing cost from Chile to document a set of macro and micro-level stylized facts about invoicing and the dynamics of invoicing choices. At the aggregate level, we show that: i) the share of total Chilean imports denominated in US Dollar (Chilean Peso) decreased (increased), while no changes in the invoicing patterns took place on the exports side; ii) during the Great Financial Crisis, the cost of US Dollar financing in Chile increased relatively more than the cost of financing in Chilean Peso. We further explore the micro-origin of the dynamics in the aggregate invoicing shares, and show that the bulk of changes in aggregate invoicing shares is due to firms switching from US dollar to Chilean Peso, as opposed to reallocation between firms or

Figure 1: Aggregate Invoicing Shares for Imports and Exports



Note: Figure 1 shows the time series of the aggregate share of imports denominated in US Dollar and Chilean Peso for Chile between 2004-2019. The left vertical axis of Figure 1 reports the share of Chilean imports denominated in US dollar. The right axis shows the share of Chilean imports denominated in Chilean Peso. Data from 2007 (2009) for imports (exports) are from Chilean Customs Agency. Data before 2007 (2009) are from Garcia-Marin et al. (2019). See Appendix A for additional details on data construction. The grey shaded area represents the NBER recession period.

firm entry. Lastly, we explore the micro-level characteristics of the first importers to switch to Chilean Peso invoicing. We find that there is selection in the first switchers, as they are large firms with wider US Dollar currency mismatches, suggesting that both natural hedging and strategic complementarities are relevant in shaping invoicing choices. These facts together point to the role that the financing costs of import purchases might play in import invoicing choices, in addition to standard forces such as natural hedging and strategic complementarities.

Aggregate. Following the Great Financial Crisis, we show that the share of imports invoiced in US Dollar declined by 10 p.p. while no change in invoicing patterns happened on the export side. In addition, the share of imports invoiced in Chilean Peso increased by a virtually 0% in 2004 to approximately 6% in 2019.

Figure 1 reports our main aggregate empirical finding. The left vertical axis of Figure 1 reports the share of Chilean imports denominated in US dollar. By contrast, the right axis shows the share of Chilean imports denominated in domestic currency, that is Chilean Peso. The solid red line and the dashed red line represent the US Dollar share of imports from two different sources. The former is from the Chilean Custom Agency (*Aduanas*) while the latter is from Garcia-Marin et al. (2019) and starts in 2004. The same applies for the black time series plotted for the Chilean Peso.

Figure 1 shows that, as the GFC starts, the share of imports denominated in US dollar is

approximately 90%. Over a time span of 10 years, it declines until it amounts to just above 80% leading to a decline of almost 10 p.p. Differently, the share of imports invoiced in Chilean Peso was virtually 0% in 2004 and it increased to approximately 6% in 2019. Notably, we do not observe such changes in the share of exports invoiced in different currencies. Indeed, the share of exports denominated in the main currencies (US Dollar, Euro, Chilean Peso, and other currencies) remain stable over time.[4]

Next, we turn our attention to the second main aggregate empirical finding. Figure 2 shows the variation over time in the sample of the difference between the short-term cost of borrowing for firms in Chile in US Dollar and in domestic currency. As the plot shows, the short-term cost of borrowing for Chilean firms becomes relatively cheaper in Chilean Peso compared to borrowing in US Dollar just at the start of the GFC and it reverts back to its previous pattern just after the end of the GFC. The red line represents the delta in the 1-year cost of borrowing between US Dollar and Chilean Peso adjusted for the realized 3-month ahead depreciation (or appreciation) in the bilateral nominal exchange rate between the two currencies. The blue dotted time series reports the same figure but unadjusted for realized variation in the bilateral nominal exchange rate. As expected, the time series taking into account future realization of the bilateral exchange rate is, on average, more distant from the 0-line.

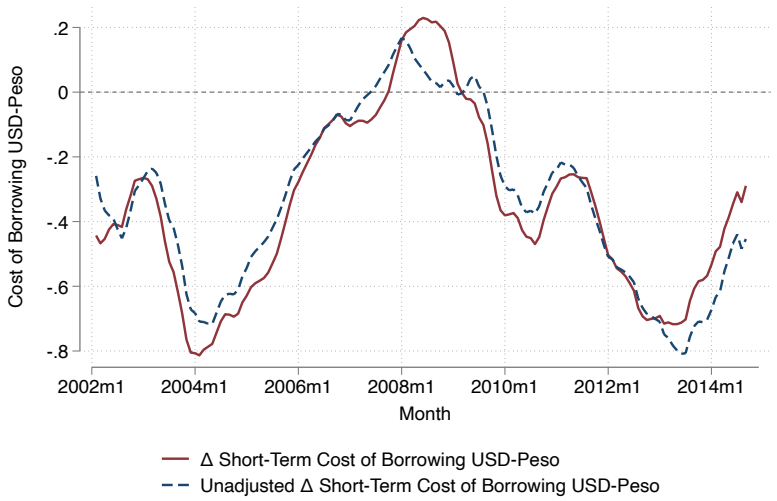
Firm Level Decomposition. To understand where the dynamics of the aggregate invoicing shares reported in Figure 1 originates from, we perform the following dynamics Olley-Pakes decomposition in the spirit of Melitz and Polanec (2015) to assess the role i) played by firms' entry and exit, ii) imports reallocation between and within firms, and iii) firms' sourcing strategies (origin and product level).

Let λ_{ikt} and s_{it} be the share of firm i's imports invoiced in currency k at time t and the import share of firm i at time t on the total imports of Chile, respectively.[5] Thus, the change in the aggregate share of total imports invoiced in currency k at time t, $\Delta\Lambda_{kt}$, can

[4] See Table 9 in Appendix C.

[5] Thus, $\lambda_{ikt} = \frac{\text{Imports of } i \text{ denominated in } k}{\text{Imports of } i}$ and $s_{it} = \frac{\text{Imports of } i}{\text{Total imports Chile}}$.

Figure 2: Relative Cost of Borrowing in US with respect to Chilean Peso



Note: Figure 2 shows the relative short-term (1-year) cost of borrowing in US Dollar with respect to the Chilean Peso. A value above zero implies that borrowing in Chilean Peso is relatively cheaper than in US Dollar.

be written as follow:

$$\Delta\Lambda_{kt} = \underbrace{\sum_{i\in inc} \lambda_{ikt} s_{it} - \sum_{i\in inc} \lambda_{ikt-1} s_{it-1}}_{\Delta\text{Incumbents}} + \underbrace{\sum_{i\in ent} \lambda_{ikt} s_{it} - \sum_{i\in ex} \lambda_{ikt-1} s_{it-1}}_{\text{Net Entry}} \tag{1}$$

$$= \underbrace{\lambda^{inc}_{kt} - \lambda^{inc}_{kt-1}}_{\Delta\text{Incumbents}} + \underbrace{\alpha^{en}_{kt}(\lambda^{en}_{kt} - \lambda^{inc}_{kt})}_{\text{Entry}} - \underbrace{\alpha^{ex}_{kt-1}(\lambda^{ex}_{kt-1} - \lambda^{inc}_{kt-1})}_{\text{Exit}}, \tag{2}$$

where a firm i is considered an incumbent (inc) when $s_{it} > 0$ and $s_{it-1} > 0$, entrant (en) when $s_{it} > 0$ and $s_{it-1} = 0$, and exiting (ex) when $s_{it} = 0$ and $s_{it-1} > 0$. In other words a firm is considered: an incumbent if it imports goods for two consecutive periods, an entrant firm it starts importing in the current period and, an exiting firm if it stops importing in the current period. In addition, let λ^{en}_{kt}, λ^{inc}_{kt} and λ^{ex}_{kt} denote the aggregate share of imports invoiced in currency k of all the firms entering in period t, of all the firms that survived between period t and $t-1$, and of all the firms that exit at period t, respectively. Lastly, α^{en}_{kt} and α^{ex}_{kt-1} represent the aggregate share of imports of entrant and exiting firms, respectively.

Equation (2) allows us to determine whether the aggregate variation observed in Figure 1 is mainly driven by incumbents firms or by the entry or exit of firms. Intuitively, if the aggregate change is due to incumbents firms, Equation (2) implies that the group of

incumbent firms have been importing less in US Dollar over time and thus contributing to the decline in the aggregate share we observe in the data ($\lambda_{kt}^{inc} < \lambda_{kt-1}^{inc}$). Similarly, Equation (2) captures the case in which entrant firms have been importing less in US Dollar over time with respect to a reference level given by the aggregate share of the surviving firms ($\lambda_{kt}^{en} < \lambda_{kt}^{inc}$). In addition, their contribution is properly weighted by their import market share α_{kt}^{en}. The same logic applies to the last terms in Equation (2) referring to the group of the exiting firms.

We further decompose Equation (2) to quantify the change in the aggregate share of incumbents that it is played by within firms dynamics and between firms reallocation:

$$\lambda_{kt}^{inc} - \lambda_{kt-1}^{inc} = \underbrace{\sum_{i \in inc} \Delta \tilde{s}_{it} \overline{\lambda_{ikt}}}_{\text{Incumbent - Between}} + \underbrace{\sum_{i \in inc} \Delta \lambda_{ikt} \overline{\tilde{s}_{it}}}_{\text{Incumbent - Within}}, \tag{3}$$

where $\overline{x_t} \equiv \frac{1}{2}(x_t + x_{t-1})$, $\Delta x_t \equiv x_t - x_{t-1}$, and $\tilde{s}_{it}$ denotes the import share of firm i at time t relative to the total import of incumbents firms.[6] The first term is the between-firm contribution and it assesses the role played by across firms reallocation in the share of imports denominated in US Dollar. By contrast, the second term quantifies the role played by within-firm substitution in the denomination of the same quantity of imports across different currency.

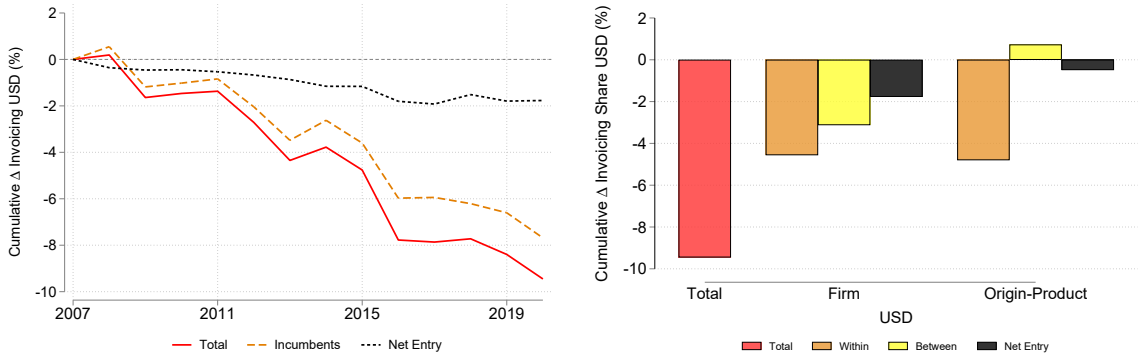
Lastly, we further decompose the within-firm component to understand whether the observed change in the US Dollar invoicing share of incumbent firms is driven by a shift in their sourcing strategies across origin×product, $o \times g$, or whether it is due to a simple reduction in the quantity of imports within origin×product. Specifically, the change in the share of i's imports invoiced in currency k, $\Delta\lambda_{ikt}$, can be decomposed as follows:

$$\begin{aligned} \Delta \lambda_{ikt} = & \underbrace{\sum_{o \times g \in I_{it}} \Delta \lambda_{ikto \times g} \overline{\hat{s}_{ito \times g}}}_{\text{Within origin-product}} + \underbrace{\sum_{o \times g \in I_{it}} \overline{\lambda_{ikto \times g}} \Delta \hat{s}_{ito \times g}}_{\text{Between origin-product}} + \\ & + \underbrace{\sum_{o \times g \in I_{it}^{+}} \lambda_{ikto \times g} \hat{s}_{ito \times g}}_{\text{Origin-Product entry}} - \underbrace{\sum_{o \times g \in I_{it}^{-}} \lambda_{ikt-1o \times g} \hat{s}_{it-1o \times g}}_{\text{Origin-Product exit}}, \end{aligned} \tag{4}$$

where I_{it}, I_{it}^{-} and I_{it}^{+} refer to the set of origin-product from which firm i imports both in

[6] Hence, $\tilde{s}_{it} = \frac{\text{Imports of } i}{\text{Total imports of } inc}$.

Figure 3: Decomposition Invoicing Share for US Dollar



Note: The right panel of Figure 3 plots the results of the first decomposition exercise reported in Equation (2) for the US Dollar. The left panel of Figure 3 plot the results of the decomposition specifications of Equation (3) and (4) for the US Dollar. Tables 3 in Appendix C reports the corresponding numbers of the decomposition.

t and $t-1$ (continuing origin-product), only in $t-1$ (exiting origin-product) and only in t (entrant origin-product), respectively. $\hat{s}_{ikto\times g}$ denotes the share of imports of firm i from origin-product $o\times g$ over the total import imports of firm i.[7] Appendix B provides additional details on the derivation of Equations (2) , (3), and (4).

We apply the decomposition specifications outlined above to the universe of Chilean import transaction from 2007, and show that the bulk of changes in aggregate invoicing shares is due to firms switching from US dollar to Chilean Peso within each origin×product). Firstly, the left panel of Figure 3 plots the results of the decomposition displayed in Equations (2) for the total variation in the share of imports denominated in US Dollar. Figure 3 shows that incumbent firms reduce the aggregate share of imports denominated in US Dollar by almost 8% by the end of 2019. Thus, the decline in the share of imports denominated in US Dollar is mainly driven by incumbents importers who started to reduce the use of the US Dollar to invoice transactions after the GFC. Moreover, the reduction in the aggregate share of imports invoiced in US Dollar due to net entry suggests the entrants use relatively less US Dollar than exiting firms.

Secondly, the right panel of Figure 3 reports the results of the decomposition exercise displayed in Equations (3) and (4). The first histogram in Figure 3 reports the total cumulative variation observed in the data for the share of imports invoiced in US Dollar. The three columns in the middle of Figure 3 report the results of Equation (3) while the three columns on the right display the results of the last decomposition exercise, that is Equation (4).

[7]Formally, $\hat{s}_{ikto\times g} = \frac{\text{Imports of } i \text{ from } o\times g}{\text{Total imports of } i}$.

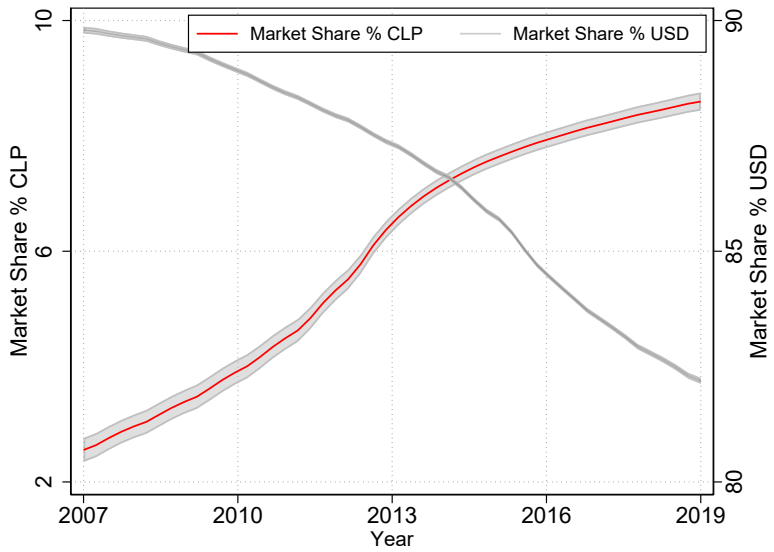
The decomposition of the incumbent firms variation shows that the bulk of it is driven by the within component. In addition, the third decomposition results implies that the within component of surviving firms is fully explained by the within origin×product term. In other words, the three layers decompositions implies the following. Before the GFC, surviving firms were importing a specific product from a given origin and in a given amount in US Dollar. After the GFC, the same surviving firms were importing the same product from the same origin and in the same amount but they started to invoice the transactions in a different currency.

In addition, we perform a series of robustness checks. Table 4 in Appendix C displays the results from a dynamic Olley-Pakes decomposition with entry and exit for imports at the origin level. Table 5 in Appendix C shows the results from a dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. Moreover, Table 6, Table 7, and Table 8 in Appendix C show the results from a Baily, Hulten, and Campbell decomposition, a Foster, Haltiwanger, and Krizan decomposition and, a Griliches and Regev decomposition, respectively. The decompositions are performed for imports at the firm level. Lastly, Table 9 in Appendix C displays the results from a dynamic Olley-Pakes decomposition with entry and exit for exports at the firm level.

Firm-level Adoption and Dynamics: Selection in Switching Next, we study which are the firm's characteristics that correlate with the decision to be among the first firms to switch away from the US Dollar in invoicing. Figure 4 shows the variation over time of the average share of value traded within origin for US Dollar (grey faded line) and for the Chilean Peso (red solid line). Consistent with the previous findings, the share of value traded using US Dollar within origin decreases by approximately 10 p.p. over a time span of 12 years. By contrast, the share of value traded invoiced in Chilean Peso within origin grows by the same amount over the same time horizon. Thus, Figure 4 suggest the evidence that, after the GFC, firms started to substitute US Dollar with Chilean Peso when invoicing import transactions.

In addition, Figure 5 provides evidence that it exists selection in being a first switcher, that is in being one of the first firm to substitute an alternative currency for US Dollar. We define an adopter (or a first switcher) a firm which, at time t, starts to use an alternative new currency and which is already importing by invoicing in US Dollar. Figure 5 reports the over time variation of the average market share within origin of adopters. As it is clear from the plot, those firms that started to substitute first US Dollar with an alternative currency

Figure 4: Market Share by Currency within Origin



Note: The left axis of Figure 4 reports the average share of value traded using Chilean Peso at each point in time. The right axis reports the same information for the US Dollar.

are firms that, on average, had the highest market share within origin at the time of the GFC. Moreover, Figure 5 implies that, as bigger firms start to adopt alternative currencies to invoice transactions, smaller firms follow.

Lastly, Figure 6 provides an additional piece of evidence. Figure 6 shows the over time variation of the average US Dollar exposure for those firms that switched away from the US Dollar at each point in time. We measure the US Dollar exposure as the difference between the total exports denominated in US Dollar and the total imports denominated in US Dollars normalized by the firm's total trade. A negative number implies that a firm is importing relatively more in US Dollar with respect to the amount it is exporting. Hence, the firm faces a currency mismatch and it is not naturally hedged. The y-axis reports the average percentage US Dollar exposure for firms that started to substitute away from the US Dollar at each point in time. Before the GFC started, Chilean firms were highly exposed to US fluctuations with a mean exposure of approximately 15%. This implies that Chilean firms were importing 15% more in US Dollar compared to what they were exporting. Figure 6 shows that as the GFC hits, the most exposed firms are the first to use an alternative currency followed by less exposed importers.

Figure 5: Firm Market Share at Time of First Adoption

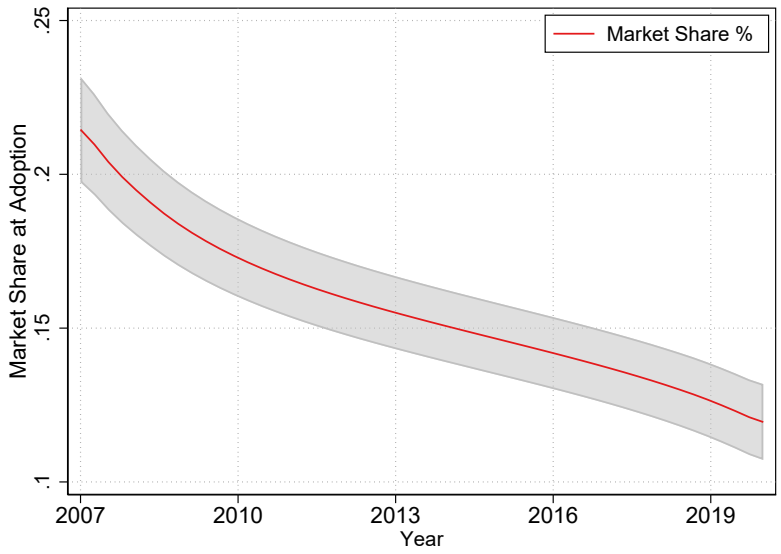
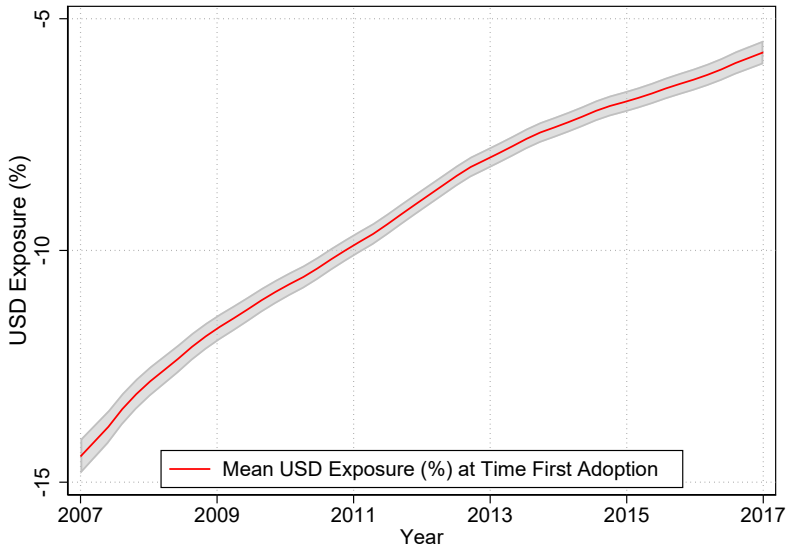


Figure 6: Firm USD Exposure at Time of First Adoption



In conclusion, in this section we provide evidence that I) firms substitute US Dollar for Chilean Peso, II) bigger firms are the first to switch away from the US Dollar, and III) firms most exposed to US Dollar fluctuations are the first to substitute US Dollar.

On Natural Hedging and Strategic Complementarities: Intensive Margin Recently, a lot of attention has been given to estimate the degree of strategic complementary in invoicing for exporters (recent examples include Amiti et al. (2022), Corsetti et al. (2022), and Crowley et al. (2020)). In this section, we depart from previous works in two different ways. First, we provide empirical evidence of the existence of strategic complementarity in invoicing for importers rather than for exporters. Secondly, previous research, because of the nature of their data, use the cross-sectional variation to estimate the degree of strategic complementarity in the use of currencies in international trade. Moreover, they estimate the existence of strategic complementarity by modelling the currency of choice as a binary problem, that is they focus on the extensive margin in the usage of currencies. In contrast, the variation induced by the GFC allows us to estimate the degree of strategic complementarity exploiting the over-time variation in the use of currencies across importers.

Let f be a firm, o origin, i product defined at the 8-HS digit code, s sector defined at the 6-HS digit code (to which the product i belongs), and t time. The main empirical specification for estimating the degree of strategic complementarity across importers in the use of US Dollar is:

$$\Delta \log s^{\$}_{foit+h} = \beta_h \Delta \log SC^{\$}_{(-f)sot} + \delta_h \Delta \log NH^{\$}_{ft+h} + \eta_h \Delta Size^{\$}_{ft+h} + FE + \nu_{foit+h}, \quad (5)$$

Let $SC^{\$}_{(-f)sot}$, $NH^{\$}_{ft}$, and $Size^{\$}_{ft}$ be a measure of strategic complementarity in the currency of choice, the degree of natural hedging of the firm, and a proxy of the market size of the firm, respectively. Let $s^{\$}_{foit}$ be the firm f's share of import from origin country o of product i denominated in US. Formally,

$$s^{\$}_{foit} = \frac{Import^{\$}_{foit}}{\sum_{c \in C} Import^{c}_{foit}},$$

where $C \in \{US, \text{Euro, Chilean Peso, other currencies}\}$ denote the set of possible currencies the firm can use. Next, we propose two different measures as proxies for the degree of natural hedging of the firm. First, let $NH^{\$}_{ft} = s^{\$}_{ft}$ be a proxy for the presence of natural hedging for firm f. Indeed, $s^{\$}_{ft}$ is firm f's share of export invoiced in dollar at time t:

$$s^{\$}_{ft} = \frac{Export^{\$}_{ft}}{\sum_{c \in C} Export^{c}_{ft}}.$$

An alternative measure for the degree of natural hedging of the firm can be measured by

the US Dollar net exposure of the firm. In this case, $NH^{\$}_{ft} = ns^{\$}_{ft}$:

$$ns^{\$}_{ft} = \frac{Export^{\$}_{ft} - Import^{\$}_{ft}}{\sum_{c \in C}(Export^{c}_{ft} + Import^{c}_{ft})}.$$

Then, we turn to the key measure we are interested into, that is that of strategic complementarity. We propose three different proxies. First, suppose that $SC^{\$}_{(-f)sot} = s^{\$}_{(-f)sot}$ proxies the degree of strategic complementarity across importers. The subscript $(-f)$ indicates the set of Chilean importers excluding importer f. Thus, $s^{\$}_{(-f)sot}$ is defined as the US Dollar invoicing share of firm f's competitors within Chile who import from origin country o at time t at the sector level s (defined at the 6-HS digit code):

$$s^{\$}_{(-f)sot} = \frac{\sum_{k \neq f} Import^{\$}_{ksot}}{\sum_{c} \sum_{k \neq f} Import^{c}_{ksot}},$$

where $Import^{c}_{ksot}$ is firm k's import value in currency c from origin country o in sector s and time t. Second, let $SC^{\$}_{(-f)sot} = \bar{s}^{\$}_{(-f)sot}$ be the mean competitor share of imports invoiced in US Dollar from origin country o in sector s at time t:

$$\bar{s}^{\$}_{(-f)sot} = \frac{1}{N_k} \sum_{k \neq f}^{N_k} \left[\frac{Import^{\$}_{ksot}}{\sum_{c} Import^{c}_{ksot}} \right].$$

Third, let $SC^{\$}_{(-f)sot}$ be the total value of imports invoiced in US Dollar by all the Chilean competitors $(-f)$ from origin country o in sector s at time t. Lastly, we use two different proxies for the market size of the firm. First, let $Size^{\$}_{ft+h} = TotImport^{\$}_{ft}$. That is, the market size of firm f is equal to its total value of import denominated in US Dollar at time t. Second, let the firm f's share of import invoiced in US Dollar be the measure of its market size $Size^{\$}_{ft+h} = s^{\$}_{ft}$.

Clearly, all the measures of strategic complementarity $SC^{\$}_{(-f)sot}$ introduced above may be endogenous to $s^{\$}_{foit}$. To address the potential endogeneity of $SC^{\$}_{(-f)sot}$ consider the following set of IV. We compute the within sector-origin import-weighted mean across all the Chilean competitors $(-f)$ of their I) US Dollar export intensity (IV_I) and of their II) total import value (IV_{II}). That is,

$$IV_I = \frac{Import_{ksot}}{\sum_{k \neq f} Import_{ksot}} \times \frac{Export^{\$}_{kt}}{\sum_{c} Export^{c}_{kt}},$$

$$IV_{II} = \frac{Import_{ksot}}{\sum_{k \neq f} Import_{ksot}} \times \sum_{c} Import^{c}_{kt}.$$

To grasp the intuition behind this set of IV, consider the first case of IV_I. IV_I should be correlated to the choice of firm f's usage of US Dollar in pricing its imports only through the variation that IV_I induces to any of the three measures of strategic complementarity $SC^{\$}_{(-f)sot}$. IV_I is correlated to the use of US Dollar in pricing imports for competitors in the following way. Because of the existence of natural hedging, competitors are more likely to invoice their imports in US Dollar, the more intense is the use of US Dollar in invoicing their exports transactions $(Export^{\$}_{kt}/\sum_c Export^{c}_{kt})$. However, the extent to which this choice matters for firm f's usage of US Dollar in imports transactions depends on how much competitors $(-f)$ weight in terms of their import market size $(Import_{ksot}/\sum_{k \neq f} Import_{ksot})$. For instance, if competitors $(-f)$ invoice most of their export transactions in US Dollar than this should translate in a higher usage of the US Dollar in imports. In turn, this implies a higher incentive for firm f to use the US Dollar in imports as long as competitors $(-f)$ import a relative high share within origin and sector.

Table 1 reports the results from the regression model in Equation (5). The dependent variable is the yearly growth rate of the firm level share of US Dollar invoiced import at the firm-origin-product-time. The first column displays the coefficient for the OLS specification. Column (2), (3), and (4) reports the IV specifications. In the main Table 1, we use $SC^{\$}_{(-f)sot} = \bar{s}^{\$}_{(-f)sot}$ as a measure of strategic complementarity and we instrument this variable with the first instrumental variable IV_I in the different specifications of Column (2), (3), and (4). Moreover, firm f's size is proxied by the second measure, that is $Size^{\$}_{ft+h} = s^{\$}_{ft}$. The degree of natural hedging of the firm is captured by its exposure to US Dollar variations, $NH^{\$}_{ft} = ns^{\$}_{ft}$.

Column (1) in Table 1 show the results from the OLS estimation of Equation (5) without any fixed effects. The three coefficients are all statistically different from zero at the 1% level. The estimated coefficient which captures the degree of strategic complementarity between firms in the usage of US Dollar in invoicing is equal to approximately 0.02%. This implies that if firm f's competitors increase their use of US Dollar in invoicing imports by 1% this is correlated to a 0.02% increase in the share of imports invoiced in US Dollar for firm f. A similar interpretation holds for the coefficient of the firm's size and for the coefficient associated with the firm's natural hedging. For instance, if the firm f's size grows by 1% over a time span of a year then this change is correlated with an increase in the use of US

Table 1: Dollar Invoicing of Imports

	(1) OLS	(2) IV	(3) IV	(4) IV
$\Delta \log SC^{\$}_{(-f)sot}$	0.019***	0.137**	0.178***	0.137**
	(0.002)	(0.058)	(0.056)	(0.056)
$\Delta \log Size^{\$}_{ft}$	0.162***	0.155***	0.154***	0.155***
	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta \log NH^{\$}_{ft}$	0.0002***	0.0002***	0.0002***	0.0002**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.001***	-0.001***		
	(0.000)	(0.000)		
Adjusted R^2	0.019	-	-	-
Year & Origin & HS6	No	No	Yes	No
Year & Origin & Firm	No	No	No	Yes
Cragg-Donald F-stat.	-	3399	3642	3578
Observations	1640830	1548588	1548403	1539105

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dollar for invoicing imports for firm f equal to almost 0.16% at the origin-product level. Column (2) in Table (1) estimate the baseline specification of Equation (5) without any fixed effects but it instruments the measure of the strategic complementarity used in Column (1) with IV_I. The Cragg-Donald F-statistics associated with IV_I is equal to almost 3400 and thus it strongly suggests that the instrument variable is a not a weak IV. Indeed, the OLS bias is seriously attenuated in the specification of Column (2). Now, the estimated coefficient of strategic complementarity is equal to approximately 0.14. This implies that if firm f's competitors invoice 1% more of their imports in US Dollar over a time span of a year, this should imply that firm f will invoice 0.14% more of its imports in US Dollar. The coefficients associated with the other two regressors are very similar in Column (1) and in Column (2). Moreover, Column (3) estimate the strategic complementarity in invoicing exploiting the cross-sectional variation across importers within origin, year and, product. Column (3) is therefore the empirical specification that follows most closely the empirical results presented in the sections above. Column (3) shows the strongest degree of strategic complementarity in invoicing estimated across the different specifications. Indeed, the coefficient is around 0.18%. Lastly, Column (4) concludes with the last specification and it exploits the across-firm variation within origin and year to estimate the desired coefficients.

4 A Model of Currency Choice

In this section, we propose a new theory to rationalize the empirical evidence observed among Chilean importers. The model in this section does so by combining in a simple setup the key elements from two growing literatures. The literature on invoicing currency choice in international trade and the one on invoicing currency choice in the denomination of borrowing cost for firms' working capital. The model includes standard forces such as natural hedging and strategic complementarities (Amiti et al. (2022) among others), while the environment for modelling the borrowing costs across currencies follows Bahaj and Reis (2020) (henceforth BR2020). Our novel contribution is the introduction of a sunk cost associated with the use of any new currency for invoicing into a model of currency choice and borrowing costs across currencies. The presence of a sunk cost generates hysteresis in invoicing choices after temporary shocks, helping us understand the empirical evidence in Section 3.

4.1 Environment

A small open economy has a continuum of importers indexed by $i \in [0,1]$. The firm sells a differentiated output domestically, pricing it in domestic currency. The demand faced by firm i in the domestic market d is $y_i^d = \left(\frac{p_i^d}{q^d}\right)^{-\theta}$, where q^d is a market specific demand shifter, and θ the constant demand elasticity ($\theta > 1$).

Each importer combines domestic labor, l, and imported inputs, x, using a CRS Cobb-Douglas production function:

$$y_i = A_i \left(l_i\right)^{1-\alpha_i} \left(x_i\right)^{\alpha_i}, \tag{6}$$

where y_i denotes the output of firm i, α_i the share of imported inputs used in production by firm i, and $A_i \equiv \left(\frac{1}{\alpha_i}\right)^{\alpha_i} \left(\frac{1}{1-\alpha_i}\right)^{1-\alpha_i}$ is a normalizing constant . Importantly, we assume that the imported inputs, x, are working capital and must be paid ahead of production, while labor can be paid later when revenues are generated.

We assume that in each period there are two sub-periods, a morning and an evening. In the morning, the firm must finance the imported inputs that are used as working capital and chooses the corresponding financing currency. The firm can borrow in either local d or vehicle currency v. Prices are nominally sticky and determined in the morning. In the evening, the firm buys its inputs, satisfies its demand given the sticky price, collects revenues and pays off its loans. The choice of working capital made in the morning affects the production

function in the evening because the exchange rate and the cost of credit in foreign currency are not known at the moment in which the firm chooses its input mix. Therefore, different realizations of the exchange rate have an impact on the future costs of production.

We assume that the firm faces the following production technology for imported inputs:

$$x_i = \min\left(\frac{x_i^d}{\eta_i}, \frac{x_i^v}{1-\eta_i}\right). \tag{7}$$

By choosing η_i, the firm chooses the relative shares of two imported inputs, x_i^d denominated in domestic currency d, and x_i^v denominated in vehicle currency v.

The firm must borrow to finance imported inputs and can choose between borrowing in domestic or foreign currency. We follow BR2022 and restrict our attention to the case in which the currency of financing coincides with the currency of invoicing of the imported inputs. This behaviour arises optimally because firms want to reduce the exchange rate risk originating from the mismatch between financing and input invoicing. The firm has two options: i) borrowing b_d units in domestic currency leads to a repayment of one unit the following period; ii) borrowing b_v units in vehicle currency requires a payment of ϵ units. Therefore the interest rate on a d (v) loan is $\frac{1}{b_d}$ ($\frac{\epsilon}{b_v}$). We assume that b_d, b_v, and ϵ are known when the borrowing decision is taken, while the exchange rate between the domestic currency and the vehicle currency s^v is not. This implies that the ex-post marginal cost of production for firm i expressed in domestic currency is:

$$C_i(s^v, \eta_i) = \frac{1}{A_i}\left[\frac{\eta_i \frac{1}{b_d}\rho_d + (1-\eta_i)\rho_v s^v \frac{\epsilon}{b_v}}{\alpha_i}\right]^{\alpha_i}\left[\frac{w}{1-\alpha_i}\right]^{1-\alpha_i}, \tag{8}$$

where w is the domestic wage rate; ρ_d and ρ_v are the price of the domestic and the imported intermediate inputs expressed in domestic and vehicle currency, respectively. We assume all prices and borrowing costs are exogenous. Importantly, it follows from standard theory that firms optimally invoice imported inputs entirely in domestic or vehicle currency, i.e. $\eta_i^\star = \{0, 1\}$.

We assume that the firms using currency j for international transactions incur into currency-specific fixed cost, F_i^j. In the spirit of Crowley et al. (2020), we assume that the fixed cost of currency j depends inversely on the number of firms using currency j for international transactions. We enrich their specification including a sunk cost in the use of new currencies, implying that each firm's fixed cost of using currency j depends on the last period's invoicing choice. We specify the following reduced-form representation for firm i's

fixed cost of invoicing in currency j at time t, F_{it}^j:

$$F_{it}^j = f_{it}^j - \gamma^j \widetilde{\omega_{t-1}^j}, \tag{9}$$

where $\widetilde{\omega_{t-1}^j}$ is the share of firms using currency j in period $t-1$, and $f_{it}^j = \kappa_0^j$ the first time firm i uses currency j, and $f_{it}^j = \kappa_1^j < \kappa_0^j$ for all subsequent periods. The first term in Equation (9) captures the firm-specific component of the fixed cost, and exhibits the presence of sunk costs.[8] The difference $\kappa_0^j - \kappa_1^j$ is the sunk entry cost of invoicing in a new currency, and captures the existence of one-time costs to managerial costs such as setting up foreign currency bank accounts. The second term in Equation (9) creates externalities in adoption and allows to capture the cost reduction due to complementarities in currency j usage, as the usage benefits increase in the number of users (Amiti et al, Crowley et al 2023, Alvarez et al 2023.).[9] The magnitude of these complementarities is governed by the parameter γ^j, with $0 < \gamma^j < f_{it}^j < 1$.

Lastly, to make progress in understanding the mechanism at play, we make the simplifying assumption that the exchange rate s_v is distributed log normal with mean μ and variance Σ.[10]

4.2 Working Capital Invoicing Choice

With these ingredients, we solve for the optimal invoicing choice and pricing decision, and discuss the key forces shaping them. Firms are risk neutral and maximize the expected profits after forming expectations on the exchange rate and on the cost of credit in different currencies. Different exchange rate realizations imply ex-post changes in the cost of credit in vehicle currency, generating deviations from the optimal markup over the marginal cost and reducing profits.

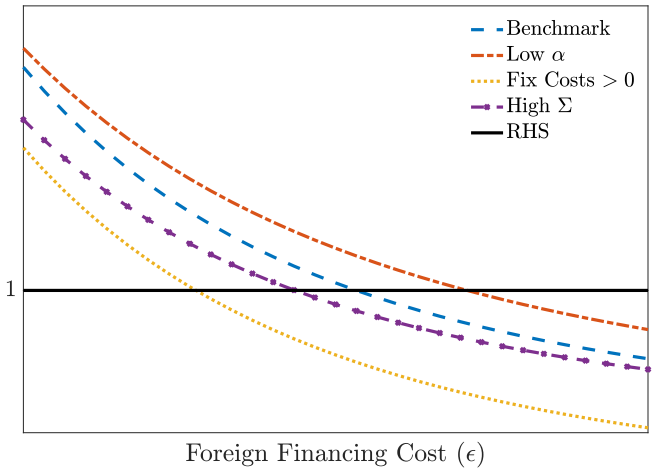
Given the isoelastic demand function and the imported inputs technology in Equation

[8] The firm-specific component depends only on last period's usage of currency j. We can relax this assumption and expand to richer specifications in which longer invoicing history is relevant, allowing a slower accumulation. See Alessandria et al 2023 for a review of sunk costs in the trade literature.

[9] In our framework, we capture complementarities in invoicing choices across firm. The decomposition in Section 3 shows that invoicing switching is not driven by specific destination-product pairs within each firm. Nevertheless, our framework can be easily extended to include multi-market firms, capturing both within-firm and across-firm externalities.

[10] While log-normality provides analytical solutions, the same intuition holds using a second-order approximation with a general distribution.

Figure 7: Invoicing Choice - Comparative Statics



(7), firm i maximizes the ex-ante profits:[11]

$$\max_{\eta_i, p_i^d} \mathbb{E}\left[\pi_i^j\right] = p_i^d \left(p_i^d\right)^{-\theta} - \mathbb{E}\left[C_i(s^v, \eta_i)\right] \left(p_i^d\right)^{-\theta} - \eta_i F_i^d - (1-\eta_i) F_i^v. \tag{10}$$

Thus, for a given η_i, the optimal domestic price is: $p_i^{d\star} = \frac{\theta}{\theta-1} E[C_i]$. Given $p_i^{d\star}$, firm i chooses to invoice imported inputs in vehicle currency ($\eta_i^\star = 0$) if the following condition is satisfied:

$$\eta_i^\star = 0 \qquad \text{iff} \qquad \mathbb{E}\left[\left(\frac{\rho_v}{b_v} s^v \epsilon\right)^{\alpha_i}\right]^{1-\theta} - \left(\frac{\rho_d}{b_d}\right)^{\alpha_i(1-\theta)} > \tau \left(F_i^v - F_i^d\right), \tag{11}$$

where τ is a collection of parameters, $\tau = \frac{1}{w^{1-\alpha_i}}$. Abstracting away from the presence of fixed costs ($F^v = F^d = 0$) and leveraging the log-normality of the exchange rate distribution, we can grasp more intuition on the forces at play by rewriting the cut-off condition as follow:

$$\eta_i^\star = 0 \qquad \text{iff} \qquad \log \epsilon < \log\left(\frac{\rho_d}{\rho_v}\frac{b_v}{b_d}\right) - \left[\mu + \alpha_i \Sigma\right], \tag{12}$$

where μ and Σ are the mean and variance of the exchange rate s_v, respectively.

Equation (12) shows that invoicing imported inputs in the vehicle currency v is optimal when the cost of financing in vehicle currency is sufficiently low to offset the uncertainty arising from the exchange rate realization (captured by Σ), after accounting for the cost of inputs (ρ_d, ρ_v) and the cost of credit (b_v, b_d). The firms' profits are maximized by keeping a

[11] Without loss of generality, we assume that the demand shifter q_d is normalized to one.

constant mark up over marginal cost. Invoicing in vehicle currency means that the ex-post marginal cost of production depends on the realization of the exchange rate, potentially creating costly departure from the optimal markup. Firms choose to invoice in vehicle currency only when the financing cost is cheaper than the cost of departing from the optimal constant markup.

Figure 7 graphically represents the optimal decision rule in Equation (11) by plotting the expected profits given domestic and vehicle currency financing for different levels of financing cost in vehicle currency, ϵ. Expected profits with domestic currency financing are independent of ϵ and normalized to one (horizontal line). Expected profits when working capital is invoiced in vehicle currency are decreasing in the cost of financing in vehicle currency as higher ϵ increases the marginal cost (downward-sloped line). The intersection between the two pins down the cut-off level in ϵ above which it is optimal to invoice in domestic currency, $\eta^\star = 1$.

Equation (12) shows that the trade-off between cheaper financing option and costly departure from the optimal markup depends on the exposure of the marginal cost to exchange rates, α_i, capturing firm's operational hedging motive (Amiti et al., 2022). *Ceteris paribus*, firms prefer to match their input currency with that of their revenues (e.g. domestic currency), and the incentive is stronger the larger the share of imported inputs (high α_i). Thus, the repayment in foreign currency that makes a firm indifferent between domestic and foreign financing is lower the larger the firm's share of imported inputs.[12] Figure 7 shows that a lower α_i shifts the line representing the expected profits when working capital is invoiced in vehicle currency to the right, making invoicing in vehicle currency more likely.

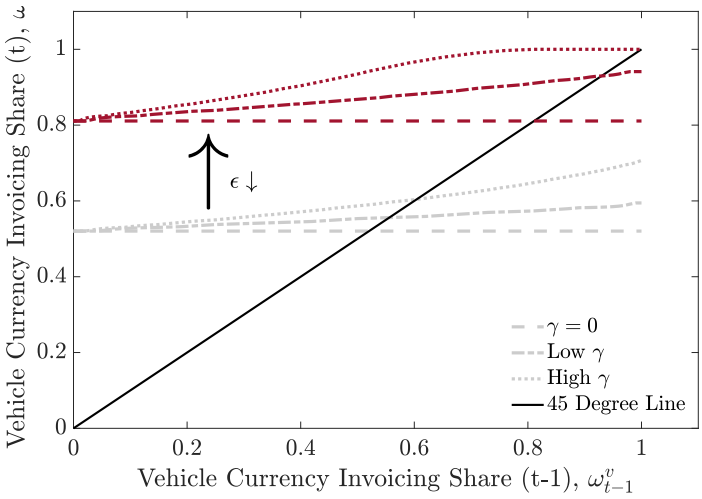
The term on the right hand side of Equation (11) captures how fixed costs in currency use influence the invoicing choice.[13] Assuming the fixed cost of using the vehicle currency is larger than the fixed cost for domestic currency ($F^v > F^d$), the firm optimally invoices in vehicle currency when the financing cost denominated in vehicle currency is sufficiently low to offset not only the costly departure from the optimal constant markup, but also the higher fixed cost. In line with this reasoning, Figure 7 shows that the presence of fixed costs shifts the line representing the expected profits when working capital is invoiced in vehicle currency to the right, making invoicing in vehicle currency less likely.

The last mechanism influencing invoicing choices is strategic complementarities, related

[12]Formally, let $\epsilon^\star : \log \epsilon^\star = \log\left(\frac{\rho_d}{\rho_v}\frac{b_v}{b_d}\right) - [\mu + \alpha_i \Sigma]$ be the repayment in foreign currency that makes a firm indifferent between domestic and foreign financing. It is immediate to show that $\epsilon^\star$ is decreasing in α_i.

[13]In deriving the optimal invoicing choice, we assume that firms do not internalize the effect that their invoicing choice has on the aggregate invoicing share and, thus, on fixed costs (Equation (9)).

Figure 8: Invoicing Choice - Transition



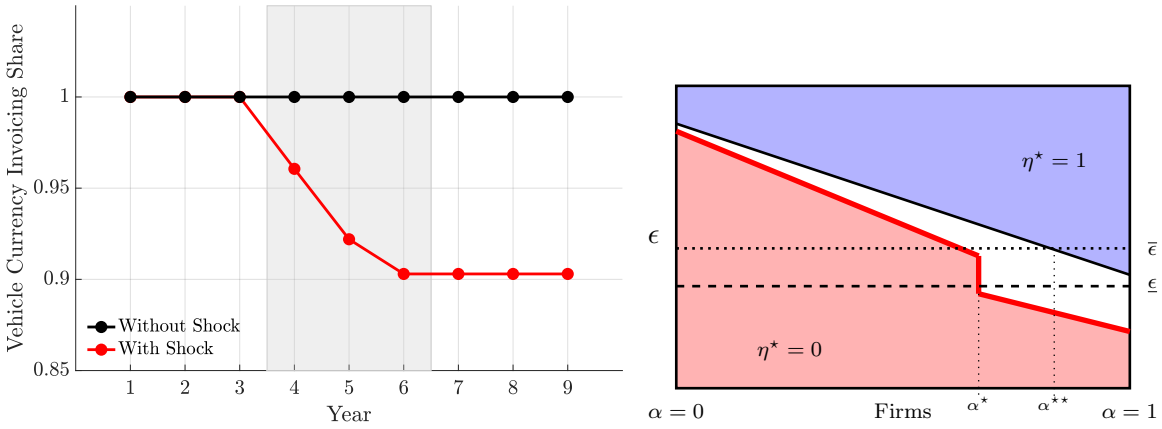
to the reduction in fixed costs in invoicing due to higher usage of a given currency. The idea behind complementarities is that usage increases in the overall utilization. The fixed cost of invoicing in currency j decreases in the number of firms using currency j to invoice their working capital, increasing the probability and the usage of currency j. The strength of the strategic complementarity in invoicing is governed by γ in Equation (9). Figure 8 illustrates how the share of imported inputs in vehicle currency evolves given different degrees of strategic complementarities. When $\gamma^v = 0$ (dash line), fixed costs do not depend on the overall utilization of vehicle currency, thus the share of imported inputs in vehicle currency does not change. In the presence of strategic complementarities, i.e. $\gamma^v > 0$ (dotted line), the overall level of utilization reduces the fixed costs of invoicing. Thus, the share of vehicle currency invoicing stabilizes to levels that are higher. When γ^v is high enough (or ϵ low enough, or both), the share of vehicle currency invoicing converges to an equilibrium in which all firms choose to invoice in vehicle currency only.[14]

4.3 Temporary Shocks, Invoicing Dynamics and Hysterisis

Our main focus in this paper is on how temporary changes in access to trade credit invoiced in different currencies alter imports invoicing choices at both firm and aggregate level, and their dynamics over time. We show that our theory can rationalize the main empirical findings of Section 3: i) a temporary increase in the cost of trade credit invoiced

[14]The invoicing decision in the presence of dynamic fixed costs cannot be solved analytically, and requires the problem to be solve computationally.

Figure 9: Shock to Vehicle Currency Financing



in vehicle currency generates long lasting effects on the individual and aggregate import invoicing patterns; ii) firms that are larger and more exposed to exchange rate are the first to switch to domestic currency invoicing, iii) invoicing dynamics are influenced by the presence of strategic complementarities. Figure 9 displays these results graphically.

We consider a rise in ϵ that permanently reverts after three periods to its previous level, as the short-term financing costs in USD in Chile around the GFC. We keep our model as tractable as possible assuming that all firms initially invoice in vehicle currency and start with no invoicing experience in domestic currency, so that firms have to pay the sunk cost to switch to domestic currency invoicing. Moreover, we assume that the share of imported goods in the production of output, α_i, is uniformly distributed: $\alpha_i \sim U[0,1]$.[15]

The right panel of Figure 9 graphically represents the invoicing choice of each firm i. On the horizontal axis firms are ranked so that the higher is i the higher is the share of imported inputs the firm uses, α_i. On the vertical axis is represented the cost of financing in vehicle currency, ϵ. For any level of ϵ, there is a threshold $\tilde{\alpha}$ such that firms with $\alpha_i < \tilde{\alpha}$ invoice in domestic currency ($\eta^\star = 1$), and firms with $\alpha_i > \tilde{\alpha}$ invoice in vehicle currency ($\eta^\star = 0$). The downward-sloped lines dividing the box in two areas, domestic (blue area) and vehicle (non-blue area) currency financing, represents the locus of $\tilde{\alpha}$ as a function of ϵ.

Following the rise in the cost of financing in vehicle currency, large and more exposed companies are the first to switch to domestic invoicing, consistent with the empirical presented in Section 3. The initial cost of financing in vehicle currency, $\underline{\epsilon}$, is such that it is optimal for all firms to invoice in vehicle currency. This is represented by $\underline{\epsilon}$ (dash horizontal

[15]The firm-level invoicing patterns presented in Section 3 support the assumption of absence of invoicing experience in domestic currency. The main insights are unchanged to the distributional assumption on α_i.

line) lying below the initial locus of $\tilde{\alpha}$ (solid black line). When epsilon increases from the initial level $\underline{\epsilon}$ to a higher level $\bar{\epsilon}$, i.e. foreign invoicing becomes less convenient, a mass of firms with $\alpha_i > \alpha^{\star\star}$ start borrowing and invoicing in domestic currency. Importantly, the first switchers are firms with high α_i, which represents a sufficient statistics for both their unhedged vehicle currency exposure and their market share in the imported inputs market.[16]

The presence of strategic complementarities generates a positive feedback of prior domestic currency invoicing which further extends the utilization of domestic currency in imports. The left panel of Figure 9 shows that the aggregate share of imports invoiced in vehicle currency keeps decreasing also after the shock in ϵ in period 4. The use of the domestic currency by a group of firms after the shock reduces the fixed cost of invoicing in the domestic currency for all the others, increasing the probability that other firms start using it. As in the data, firms with α_i lower relative to the initial switchers start using the domestic currency to invoice imported inputs as domestic invoicing becomes more convenient for them. Graphically firms with $\alpha^{\star} < \alpha_i < \alpha^{\star\star}$ gradually switch to domestic currency invoicing as fixed costs decrease.

Lastly, the sunk-cost model generates invoicing hysteresis: when ϵ permanently reverts to the original level $\underline{\epsilon}$, firms do not switch back to vehicle currency invoicing. The presence of sunk cost in invoicing implies that the relative convenience of domestic and vehicle currency invoicing permanently changes when a firm switches to domestic currency invoicing. Specifically, the difference between the fixed costs of invoicing in vehicle and domestic currency, $F^v - F^d$ in Equation (11), decreases, making domestic currency invoicing more permanently appealing than vehicle currency invoicing.

Graphically, this is represented by a downward shift in the threshold between domestic and vehicle currency invoicing for all those firms that start invoicing in domestic currency (i.e. with $\alpha_i > \alpha^{\star}$). The area in which domestic invoicing is optimal ($\eta^{\star} = 1$) extends to the area above the solid red line (i.e. the white area in addition to the original blue area). Thus, the new relevant cut-off rule implies that for firms with $\alpha_i > \alpha^{\star}$ is now optimal to invoice in domestic currency also when ϵ reverts to the original level $\underline{\epsilon}$.[17]

[16] The former follows immediately from the fact that firms are importers only, with revenues denominated in domestic currency. The latter follows from the fact that firms are assumed to have identical size. Thus, higher α_i implies more imported inputs and, thus, a larger market share in the input market.

[17] Notice that domestic currency invoicing is more appealing also for firms that have not paid the sunk cost, i.e. $\alpha_i < \alpha^{\star}$. The reason is that the fixed cost of invoicing in domestic currency decreases also for them because of the strategic complementarities force. Relative to the initial steady state, in which the share of invoicing in vehicle currency is one, the fixed cost of invoicing in vehicle currency is now higher because a subset of firms permanently switch to domestic invoicing. The higher fixed cost of invoicing in vehicle

At the aggregate level, this implies that the share of imports invoiced in domestic currency in Figure 9 does not increase back to one after ϵ reverts to the original level (in period 6), consistent with what we see in the data.[18] The fact that we do not observe in the data any partial reversion in the aggregate share of imports invoiced in domestic currency suggests that the sunk cost of domestic currency invoicing is large enough to make the switch permanent. If the sunk cost was smaller, it could be optimal for some firms to switch back to vehicle currency invoicing because the decrease in the fixed costs of domestic invoicing, F^d, is not enough to make domestic currency invoicing optimal at the original level of ϵ, $\underline{\epsilon}$.

5 Model Validation

In this section, we validate the model in two different ways. First, the model predicts that, as the cost of borrowing becomes relatively more expensive in US Dollar than in Chilean Peso, those firms that are more exposed to US Dollar fluctuations are more likely to substitute the US Dollar with the Chilean Peso. In other words, we expect that firms whose share of foreign imports denominated in US Dollars is higher are the first to switch away from the US Dollar. This first margin captures the degree of extensive margin in the use of the local currency to substitute the dominant currency. Second, because of the presence of fixed costs in the use of currencies, this mechanism is present also over time. Those firms whose share of foreign imports denominated in US Dollars is higher will substitute more intensively US Dollar with other currencies. This second margin captures the degree of intensive margin in the use of alternative currencies.

Extensive Margin in the Use of the US Dollar We run a simple linear probability model to measure the degree of extensive margin in the use of the US Dollar. The dependent binary variable takes value equal to one if the transaction is invoiced in US Dollar and zero if invoiced in the local currency. More precisely, we run the following specification:

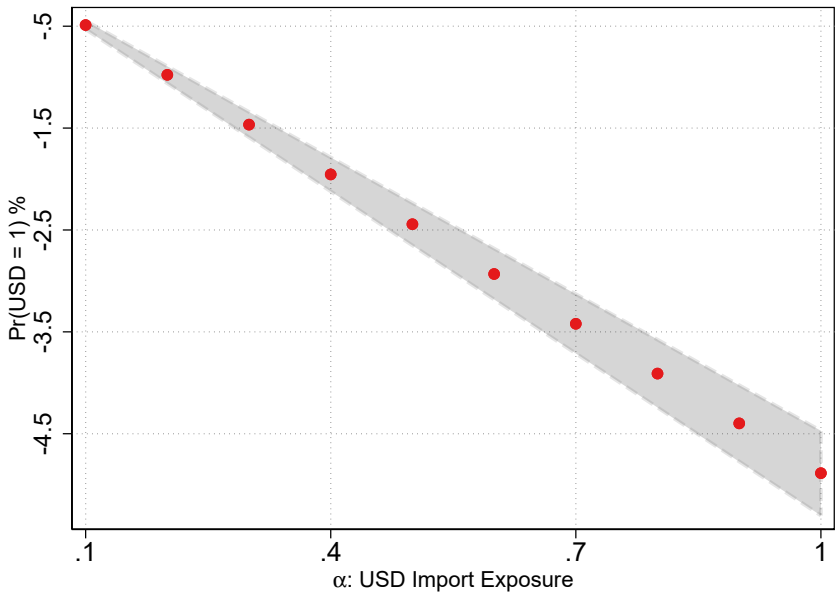
$$1(\text{USD}_{foit} = 1) = \beta_0 \alpha_{ft} + \beta_1 \Delta(i_t^{\$} - i_t^{CLP}) + \beta_2 \alpha_{ft} \times \Delta(i^{\$} - i^{CLP}) + FE + \nu_{foit}. \quad (13)$$

currency F^v makes domestic invoicing more competitive for all firms.

[18] Differently from the empirical evidence in Section 3, the model does not generate a slow-paced decline in the aggregate share after the shock is reversed. In the model, strategic complementarities depends only on last period aggregate share, while in real world it could time a longer amount of time for these forces to phase in. The model can be enriched to make the transition more sluggish.

Similarly to Equation (5), let f be a firm, o origin, i product defined at the 8-HS digit code, and t time. We use as a proxy for the share of foreign imported inputs in production invoiced in US Dollar (α_{ft}), the firm share of imports denominated in US Dollar. Thus, α_{ft} is Tot $\text{Imp}^{\$}_{ft}$/Tot Imp_{ft}. Lastly, $\Delta(i^{\$} - i^{CLP})$ is the difference at time t between the cost of borrowing in US Dollar and the cost of borrowing in Chilean Peso for a firm from a local bank. Table 11 in Appendix C reports the estimated coefficient from Equation (13).

Figure 10: Marginal Effect of Relative Cost of Borrowing on Pr(USD = 1)



Note: Figure 10 shows the % variation in the probability of invoicing in US Dollar as a function of the firm's exposure to US Dollar, for a given wedge in the cost of borrowing in US Dollar and in Chilean Peso $\Delta(i^{\$} - i^{CLP})$.

Given a wedge in the cost of borrowing in US Dollar and in Chilean Peso, $\Delta(i^{\$} - i^{CLP})$, Figure 10 displays a negative correlation between the probability of invoicing in US Dollar and the firm exposure to US Dollar fluctuations proxied by its import intensity in US Dollar. Indeed, suppose that the cost of borrowing becomes relatively more expensive in US Dollar compared to Chilean Peso as it was the case during the GFC and as assumed in Section 4.3. According to the model, the firms initially more exposed to US Dollar fluctuations, that is those firms with a high α, are the first to substitute US Dollar with the domestic currency. [19] Figure 10 confirms empirically this prediction. A firm whose import in US Dollar represents

[19] Table 10 in Appendix C repeats the same exercise of Equation (13) but the dependent variable takes value equal to zero when the transaction is not invoiced in USD. All the results are unchanged.

10% of their total imports has a -0.5% decreased probability of invoicing in US Dollar. By contrast, for a firm whose import intensity in US Dollar is 80% the probability of invoicing in US Dollar decreases by -4%. In other words, for a given difference in the borrowing cost across currencies, more exposed firms are more likely to start using the Chilean Peso to invoice their transactions in international trade.

Intensive Margin in the Use of the US Dollar Next, we turn to the degree of intensive margin in the use of the US Dollar. Indeed, the previous result suggests that as the cost of borrowing in US Dollar becomes relatively more expensive than in Chilean Peso, firms that are more exposed to US Dollar fluctuations are more likely to switch away from the US Dollar and start using the local currency. However, in the model this mechanism holds over time and the intensity in the substitution of US Dollar with the Chilean Peso is greater the higher is the exposure of the firms to US Dollar fluctuations. We run the following specification:

$$\begin{aligned}\Delta \log s^{\$}_{foit} = \beta_0 \alpha_{ft-1} + \beta_1 \Delta(i^{\$} - i^{CLP}) + \beta_2 \alpha_{ft-1} \times \Delta(i^{\$} - i^{CLP}) + \\ + \beta_3 \Delta \log SC^{\$}_{(-f)sot} + \beta_4 \Delta \log SC^{\$}_{(-f)sot} \times \Delta(i^{\$} - i^{CLP}) + \\ + FE + \nu_{foit}. \end{aligned} \tag{14}$$

The dependent variable $\Delta \log s^{\$}_{foit}$ is the growth rate in the firm f's share of import from origin country o of product i denominated in US Dollar between time t and $t-1$. α_{ft}, $\Delta(i^{\$} - i^{CLP})$ have the same definition as in Equation (10). $\log SC^{\$}_{(-f)sot}$ is defined as in Table 1 and it is instrumented with the same IV of Equation (5).

Table 2: Model Validation: Intensive Margin in the use of USD

	(1) (OLS)	(2) (IV)
$\Delta(i^{\$} - i^{CLP})$	0.003***	
	(0.001)	
		(0.061)
$\Delta(i^{\$} - i^{CLP}) \times \Delta \log SC^{\$}_{(-f)sot}$		0.265
		(0.260)
$\Delta(i^{\$} - i^{CLP}) \times \alpha_{ft-1}$		-0.015***
		(0.004)
		(0.002)
Constant	-0.002***	
	(0.000)	
R^2	0.016	-
FirmXOriginXHS6	YES	NO
FirmXOriginXHS6 Year	NO	YES
Cragg-Donald F-stat.		1192
Observations	1321825	1176873

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column (1) in Table (2) estimates the average unconditional effect of the relative cost of borrowing on the growth rate of the firms' share of import denominated in US Dollar. Column (2) shows the preferred specification. Crucially, the interaction term between the last period firm exposure to US fluctuations (α_{ft-1}) and the difference in the cost of borrowing across the two currencies ($\Delta(i^{\$} - i^{CLP})$) has an estimated negative coefficient equal to -0.015. Qualitatively, this implies that more exposed importers substitute the US Dollar more intensively relative to less exposed firms for a given wedge in the cost of borrowing. Quantitatively, a one unit increase in the firm US Dollar exposure at time $t-1$ is correlated with a decrease in the share of imports denominated in US Dollar of 1.5% between time $t-1$ and t.

In conclusion, this section validates the model in two different but complementarity ways. Consistent with the model predictions, we find empirically that firms whose share of imports denominated in US Dollar are higher are more likely to substitute the Chilean Peso with the US Dollar as the cost of borrowing in the latter becomes relatively more expensive than the former. Moreover, the mechanism also holds in the intensive margin as those more exposed firms will decrease more intensively their US Dollar usage over time as the borrowing in

Chilean Peso becomes relatively cheaper. We find that this is the case empirically too.

6 Aggregate Implications

In this section we quantitatively assess the macroeconomic implications of the large changes in invoicing shares after the GFC. We focus on the implications of invoicing choices on the dynamics of terms of trade and trade balance. We proceed as follow. We first estimate short-run and long-run price and quantities elasticities to exchange rate fluctuations accounting for the different invoicing currencies, building on existing empirical frameworks (Adler et al., 2020; Barbiero, 2021; Chen et al., 2022). We then leverage the estimated elasticities and consider actual and counterfactual invoicing shares in accounting counterfactual exercises (Auer et al., 2021). We find that the change in the invoicing shares after the GFC implies a trade balance elasticity to exchange rate which is 30% higher.

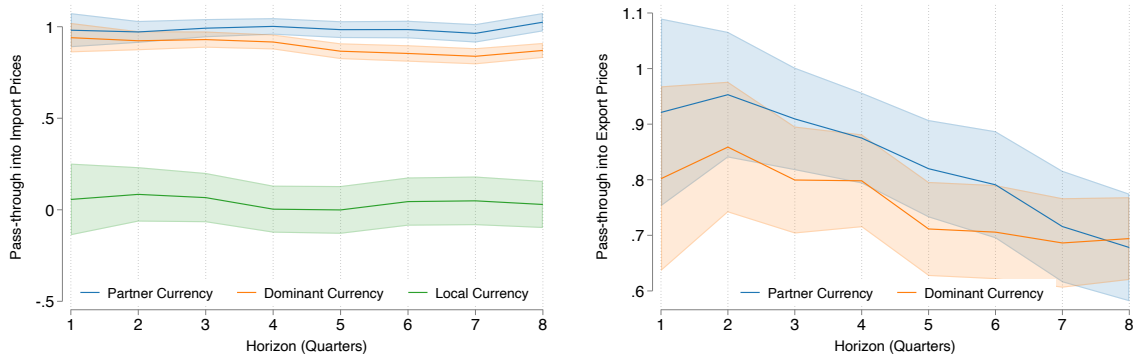
Price and Quantity Elasticities to Exchange Rate We first estimate the exchange rate pass-through to border prices and quantities, both in the short-run and in the long-run, conditioning on the currency of invoicing. Following existing econometric frameworks such as Adler et al. (2020), the benchmark specification is:

$$\Delta y_{jt} = \sum_l \Bigg[\underbrace{\beta_l^{y,CLP} D_j^{CLP}}_{\text{Chilean Peso}} + \underbrace{\beta_l^{y,p} D_j^{p}}_{\text{Partner}} \Bigg] \Delta e_{t-l}^{CLP/p} + \sum_l \underbrace{\beta_l^{y,D} D_j^{D} \Delta e_{t-l}^{CLP/\$}}_{\text{Dominant}} + \sum_l \underbrace{\beta_l^{y,D} D_j^{D} \Delta e_{t-l}^{\$/p}}_{\text{Dominant}} + \\ + \alpha_j + \phi x_{jt} + \delta_{t \times \Delta} + \varepsilon_{jt}, \tag{15}$$

where Δy_{jt} is the log difference between either the unit values (expressed in Chilean peso), quantity (expressed in kilograms), or values (expressed in Chilean peso) of good j between quarter t and the quarter of the last transactions. A good j is a unique combination of firm, 8-digit HS code, partner country, and invoice currency. The exchange rate $e_t^{CLP/p}$ is the log average Chilean Peso value per unit of currency p in quarter t. An increase in $\Delta e_t^{CLP/p}$ implies a depreciation of the Chilean peso with respect to currency p during the corresponding period t. D_j^{CLP}, D_j^p, D_j^D are dummy variables to capture whether the transaction is invoiced in local, producer or dominant currency, respectively. For dominant-priced products, we split the bilateral peso-partner exchange rate, $\Delta e^{CLP/p}$, into the two sub-components, the sensitivity to peso-dollar fluctuations and to partner-dollar fluctuations (Barbiero, 2021).

Figure 11 plots the estimates of the cumulative exchange rate pass-through into import

Figure 11: Price Sensitivities to Exchange Rates



(left panel) and export (right panel) prices obtained from the main specification in Equation (15). We show that exchange rate pass-through varies substantially across invoicing choices, both in the short-run and in the long-run. Pass-through into import prices is zero when transactions are invoiced in local currency (Chilean peso), while it is complete when transactions are invoiced in dominant and partner currencies. Pass-through rates into import prices remain at essentially the same level after two years. On the export side, pass-through rates are almost complete in the short-run when transactions are invoiced in dominant and partner currencies (80% and 90%, respectively).[20] In the long-run, the pass-through rate decreases to approximately 70% in both cases. These patterns are in line with previous findings and with the idea that prices are sticky in the currency in which they are invoiced (Chen et al., 2022; Gopinath et al., 2010).

Figure 13 in Appendix C reports the pass-through rates into import and export quantities. We show that different pass-through rates into prices translates into different response of quantities, providing evidence of allocative effects of invoicing choices (Amiti et al., 2022). Import quantities do not react in the short-run, independently of the invoicing currency. They decrease by 20% in the long-run when invoiced in dominant or partner currencies.[21] The long-run response of quantities remains essentially the same level when invoiced in local currency, in line with the fact that after a depreciation, Chilean-invoiced prices do

[20] We do not report the pass-through rate into export prices conditional on being invoiced in Chilean peso because of very noisy estimates due to a very restricted sample of only approximately 500 observations.

[21] The magnitude of the is smaller compared to estimates from the macro (Boehm et al., 2023) or trade literature (Broda and Weinstein, 2006). Nevertheless, the quantity response may be muted by the fact that we are working with customs prices, without considering additional rounds of incomplete pass-through into final consumer prices (Auer et al., 2021).

not change. The sluggish response of quantities is in line with expenditure switching forces toward domestic goods.

Thus, abstracting away invoicing choices can improperly inform on the effects of exchange rate fluctuations on the macroeconomy (Gopinath and Itskhoki, 2022; Barbiero, 2021). We now explore the quantitative relevance focusing on the dynamics of the terms of trade.

On the Effects on Trade Balance In traditional models of international economics (e.g. Mundell-Fleming), in which international prices are invoiced in the exporter's currency, exchange rates play a key role in external adjustment. Exchange rate changes induce changes in imported and exported quantities by influencing the relative price of domestic and foreign goods. However, the widespread use of dollar invoicing, together with the large differences in price and quantity elasticities documented above, impacts how the trade balance respond to exchange rate fluctuations. We focus on the dynamics of a country's external imbalance following a movement of its exchange rate vis-a-vis all other currencies, and how invoicing patterns at the aggregate level influence its response to exchange fluctuations.

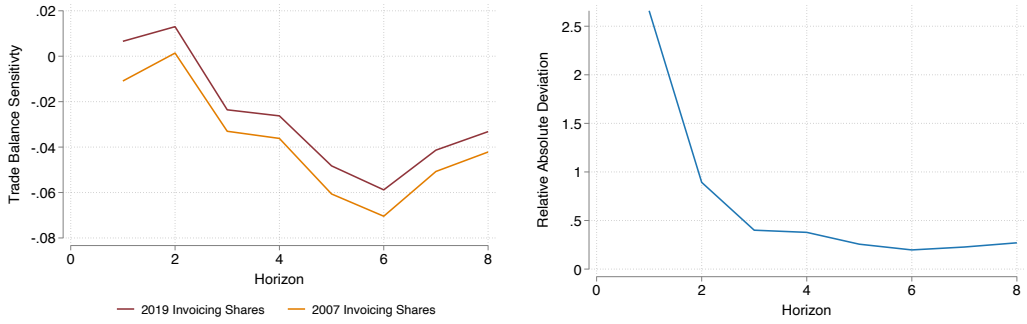
Let define the trade balance of Chile as the same of net export from the rest of the world, as follow: $TB_t = \sum_{i \in I} \left(P_{it}^X Q_{it}^X - P_{it}^M Q_{it}^M \right)$, where P_{it}^X and Q_{it}^X (P_{it}^M and Q_{it}^M) are the price and quantity of exports to (import from) country i, respectively. It follows that the effect of exchange rates on the trade balance (relative to GDP, Y_t) at horizon l is given by:

$$\frac{\Delta TB_t^l}{Y_t} = \Delta e \times \frac{X_t}{Y_t} \left[\sum_{\tau=0}^{l} \left(\beta_\tau^{PX,CLP} + \beta_\tau^{QX,CLP} \right) S^{X,CLP} + \left(\beta_\tau^{PX,D} + \beta_\tau^{QX,D} \right) S^{X,D} + \left(\beta_\tau^{PX,p} + \beta_\tau^{QX,p} \right) S^{X,p} \right]$$
$$- \Delta e \frac{M_t}{Y_t} \left[\sum_{\tau=0}^{l} \left(\beta_\tau^{PM,CLP} + \beta_\tau^{QM,CLP} \right) S^{M,CLP} + \left(\beta_\tau^{PM,D} + \beta_\tau^{QM,D} \right) S^{M,D} + \left(\beta_\tau^{PM,p} + \beta_\tau^{QM,p} \right) S^{M,p} \right],$$

where $S^{X,z}$ ($S^{M,z}$) the share of exports (imports) invoiced in currency z, and $\beta_\tau^{j,z}$ is the elasticity of j to exchange rates when invoiced in currency z at horizon τ, with j being import and export prices and quantities ($\{PX, PM, QX, QM\}$) and $z \in \{CLP, p, D\}$. In other words, the aggregate response of trade balance to a movement of the exchange rate vis-a-vis all other currencies is a weighted sum of the response of import and export prices and quantities, weighted by their respective invoicing shares.

Figure 12 shows that the large increase in the share of Peso invoicing after the GFC lowers the sensitivity of the Chilean trade balance at all horizons. In 2019, trade balance is approximately 30% less sensitive in the long-run, while the sensitivity flips sign and become

Figure 12: Trade Balance Sensitivity to Exchange Rates



positive in the short-run. The key driver is the fact that imports denominated in Peso have lower sensitivity at all horizons, especially in the short run. The lower sensitivity of trade balance raises questions about the benefits of exchange rate flexibility.[22]

On the Effects on Terms of Trade and Import Inflation We follow the same rationale to assess how the sensitivity of import inflation and the terms of trade evolved after the GFC.[23] Figure 15 in Appendix C shows that the import price index of Chile becomes less sensitive to exchange rate fluctuations by approximately 5% at all horizon, as a larger share of imports is non-sensitive to exchange rate fluctuations. Similarly, Figure 14 in Appendix C shows how lower import price sensitivity translates into a lower sensitivity for the terms of trade. In this case, following a depreciation, terms of trade decrease by less in 2019 compared to 2007, with a larger discrepancy in the short-run.

7 Conclusion

Our analysis showcases how large shocks to dollar financing availability weakens dollar dominance. We document a significant 10 percentage point decline in the share of Chilean imports denominated in US Dollars over a decade, coupled with a corresponding increase in Chilean Peso denominations. This shift is distinct from patterns observed in the export side. We conduct different decomposition exercises, and show that surviving firms emerge

[22]Notice that the trade balance is not following the standard J-curve dynamic after a depreciation of the exchange rate. This is a consequence of the Dominant Currency Paradigm, which departs from the producer-pricing assumption of the traditional models of international economics.

[23]Details on the derivations in Appendix C.

as the primary contributors to the observed change, accounting for approximately 80% of the aggregate variation. Larger firms, more exposed to fluctuations in US Dollar exchange rate, take the lead in substituting the dominant currency with the Chilean Peso. Moreover, natural hedging and complementarities within and across firms fuel the adoption of the Chilean Peso over time.

We develop a model in which firms decide on the currency of trade credit for imported inputs. A key aspect is treating imported inputs as working capital, requiring advance financing. The decision relies on the relative interest rates on trade credit denominated in domestic and vehicle currency. In the model, temporary shock, like those from the GFC, influences the invoicing patterns. Lastly, a sunk cost associated with using a new currency for import invoicing introduces hysteresis in invoicing choices, permanently altering the convenience of invoicing in different currencies. The theory predicts that the threshold to use domestic or vehicle currency financing depends on two forces, namely strategic complementarities and natural hedging. We test the key mechanism in the data and find evidence consistent with the theory.

We lastly explore the macroeconomic implications of large changes in invoicing patterns. We show that the sensitivity of trade balance, terms of trade, and import inflation is substantially lower in 2019 compared to 2007. Thus, our analysis demonstrates how significant shocks, such as the Great Financial Crisis, can have enduring effects on invoicing decisions at both micro and macro levels.

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A Appendix Data

B Decomposing Invoicing Share

Let i be a firm and k a currency. Let S_i be the share of firm i in total import (or export). Also, let Λ_{ik} be the share of import (export) denominated in currency k by firm i. Define for any variable X:

$$\Delta X_t \equiv X_t - X_{t-1},$$
$$\overline{X_t} \equiv \frac{1}{2}(X_t + X_{t-1}),$$
$$\Delta X_T \equiv X_t - X_0,$$

We can now decompose:

$$\Delta \Lambda_{kt} = \underbrace{\sum_i \overline{S_{it}} \Delta \Lambda_{kit}}_{\text{Within}} + \underbrace{\sum_i \Delta S_{it} \overline{\Lambda_{kit}}}_{\text{Cross}}. \tag{16}$$

It follows that:

$$\Delta_T \Lambda_k = \sum_t \sum_i \overline{S_{it}} \Delta \Lambda_{kit} + \sum_t \sum_i \Delta S_{it} \overline{\Lambda_{kit}}. \tag{17}$$

We account for firms' entry and exit. Let Ω_{kt} be the set of firms denominating in currency k at time t, $\overline{\Omega_{kt}}$ be the set of common firms between time t and $t-1$, Ω_{kt}^+ the set of new firms at time t, and Ω_{kt}^- the set of firms exiting between time t and $t+1$. We can then write:

$$\Delta \Lambda_{kt} = \underbrace{\sum_{i \in \overline{\Omega_{kt}}} \overline{S_{it}} \Delta \Lambda_{kit}}_{\text{Within}} + \underbrace{\sum_{i \in \overline{\Omega_{kt}}} \Delta S_{it} \overline{\Lambda_{kit}}}_{\text{Cross}} + \underbrace{\sum_{i \in \Omega_{kt}^+} S_{it} \Lambda_{kit} - \sum_{i \in \Omega_{kt-1}^-} S_{it-1} \Lambda_{kit-1}}_{\text{Net Entry}}. \tag{18}$$

C Additional Results

C.1 Additional Results: Imports

Table 3: Dynamic Olley-Pakes Decomposition with Entry and Exit: Imports at the Origin-Product Level

	USD	Peso	Euro	Others
-				
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	-1.769	0.778	0.813	0.178
Firm Entry	-2.618	0.856	1.872	-0.110
Firm Exit	0.850	-0.078	-1.059	0.288
Contribution Incumbents				
Total	-7.683	5.315	2.798	-0.430
Within Firm	-4.560	6.367	-1.337	-0.470
Between Firm	-3.123	-1.052	4.134	0.041
Within Firm				
Total	-4.560	6.367	-1.337	-0.470
Net Entry Origin	-0.489	0.875	-0.188	-0.198
Within Origin	-4.801	5.192	-0.213	-0.177
Between Origin	0.729	0.301	-0.935	-0.095

Notes: Table 3 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the origin-product level. It shows the corresponding numbers of Equations (2) , (3), and (4) in the main text.

Table 4: Dynamic Olley-Pakes Decomposition with Entry and Exit: Imports at the Origin Level

	USD	Peso	Euro	Others
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	-1.769	0.778	0.813	0.178
Firm Entry	-2.618	0.856	1.872	-0.110
Firm Exit	0.850	-0.078	-1.059	0.288
Contribution Incumbents				
Total	-7.683	5.315	2.798	-0.430
Within Firm	-4.560	6.367	-1.337	-0.470
Between Firm	-3.123	-1.052	4.134	0.041
Within Firm				
Total	-4.560	6.367	-1.337	-0.470
Net Entry Origin	0.634	0.080	-0.222	-0.491
Within Origin	-6.118	5.589	0.435	0.095
Between Origin	0.924	0.699	-1.549	-0.074

Notes: Table 4 reports the results from a dynamic Olley-Pakes decomposition with entry and exit for imports at the origin level.

Table 5: Dynamic Olley-Pakes Decomposition with Entry and Exit: Imports at the Firm Level

	USD	Peso	Euro	Others
$\bar{}$				
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	-1.769	0.778	0.813	0.178
Entry	-2.618	0.856	1.872	-0.110
Exit	0.850	-0.078	-1.059	0.288
Contribution Incumbents				
Total	-7.683	5.315	2.798	-0.430
Within	-4.560	6.367	-1.337	-0.470
Between	-3.123	-1.052	4.134	0.041
Contribution incumbents				
Total	-7.683	5.315	2.798	-0.430
Mean	1.086	2.086	-2.168	-1.005
Covariance	-8.770	3.229	4.965	0.576

Notes: Table 5 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. It shows the corresponding numbers of Equations (2) and (3). In addition, it displays the Olley-Pakes decomposition of the variation of incumbents firms between the unweighted mean change in the USD Dollar of their import share and the covariance change between their aggregate import share and their USD Dollar import share.

Table 6: Baily, Hulten, and Campbell Decomposition: Imports at the Firm Level

	USD	Peso	Euro	Others
$\bar{}$				
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	14.494	1.719	2.584	0.613
Entry	40.297	3.023	6.171	1.063
Exit	25.803	1.304	3.587	0.449
Contribution Incumbents				
Total	-23.945	4.374	1.026	-0.865
Within	-4.445	6.290	-1.375	-0.470
Between	-19.501	-1.916	2.401	-0.394

Notes: Table 5 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. It shows the corresponding numbers of Equations (2) and (3). In addition, it displays the Olley-Pakes decomposition of the variation of incumbents firms between the unweighted mean change in the USD Dollar of their import share and the covariance change between their aggregate import share and their USD Dollar import share.

Table 7: Foster, Haltiwanger, and Krizan Decomposition: Imports at the Firm Level

	USD	Peso	Euro	Others
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	-1.929	0.791	0.930	0.208
Entry	-2.798	0.892	1.948	-0.043
Exit	-0.869	0.101	1.018	-0.251
Contribution Incumbents				
Total	-18.266	-6.992	28.588	-3.330
Within	-9.816	0.143	11.579	-1.906
Between	-8.450	-7.135	17.009	-1.424
Contribution Covariance	10.744	12.293	-25.907	2.871

Notes: Table 5 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. It shows the corresponding numbers of Equations (2) and (3). In addition, it displays the Olley-Pakes decomposition of the variation of incumbents firms between the unweighted mean change in the USD Dollar of their import share and the covariance change between their aggregate import share and their USD Dollar import share.

Table 8: Griliches and Regev Decomposition: Imports at the Firm Level

	USD	Peso	Euro	Others
Aggregate Invoicing Share	-9.452	6.093	3.611	-0.251
Contribution Net Entry				
Total	-1.951	0.833	0.940	0.178
Entry	-2.709	0.868	1.918	-0.077
Exit	-0.758	0.035	0.977	-0.255
Contribution Incumbents				
Total	-7.501	5.260	2.670	-0.429
Within	-4.445	6.290	-1.375	-0.470
Between	-3.056	-1.030	4.045	0.041

Notes: Table 5 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. It shows the corresponding numbers of Equations (2) and (3). In addition, it displays the Olley-Pakes decomposition of the variation of incumbents firms between the unweighted mean change in the USD Dollar of their import share and the covariance change between their aggregate import share and their USD Dollar import share.

C.2 Additional Results: Exports

Table 9: Dynamic Olley-Pakes Decomposition with Entry and Exit: Exports at the Firm Level

	USD	Peso	Euro	Others
Aggregate Invoicing Share	0.488	0.009	-0.949	0.452
Contribution Net Entry				
Total	0.015	-0.000	-0.230	0.215
Firm Entry	-0.305	0.012	0.087	0.205
Firm Exit	0.319	-0.013	-0.317	0.010
Contribution Incumbents				
Total	0.473	0.009	-0.719	0.237
Within Firm	0.717	-0.326	-0.472	0.081
Between Firm	-0.244	0.335	-0.247	0.156
Within Firm				
Total	0.717	-0.326	-0.472	0.081
Net Entry Destination	-1.551	2.107	-0.528	-0.028
Within Destination	0.932	-2.445	1.272	0.242
Between Destination	1.336	0.013	-1.215	-0.133

Notes: Table 5 reports the results from the dynamic Olley-Pakes decomposition with entry and exit for imports at the firm level. It shows the corresponding numbers of Equations (2) and (3). In addition, it displays the Olley-Pakes decomposition of the variation of incumbents firms between the unweighted mean change in the USD Dollar of their import share and the covariance change between their aggregate import share and their USD Dollar import share.

C.3 Additional Results: Model Validation

Table 10: Model Validation: Extensive Margin in the use of USD

	(1) Pr(USD = 1)	(2) Pr(USD = 1)	(3) Pr(USD = 1)
$\Delta(i^{\$} - i^{CLP})$	0.010***	0.000	0.000
	(0.001)	(.)	(.)
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft}(\alpha)$		0.265***	
		(0.003)	
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft} \times \Delta(i^{\$} - i^{CLP})$		-0.023***	
		(0.002)	
Tot $\text{Imp}^{\$}_{ft}$/Tot Imp_{ft}(log)			0.050***
			(0.001)
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft} \times \Delta(i^{\$} - i^{CLP})$			-0.007***
			(0.001)
Constant	0.773***	0.566***	0.810***
	(0.000)	(0.002)	(0.000)
Adjusted R^2	0.783	0.768	0.766
FirmXOriginXHS6	YES	NO	NO
FirmXOriginXHS6 Year	NO	YES	YES
Observations	2615928	2539390	2539390

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes:

Table 11: Model Validation: Extensive Margin in the use of USD and Chilean Peso

	(1) Pr(USD = 1)	(2) Pr(USD = 1)	(3) Pr(USD = 1)
$\Delta(i^{\$} - i^{CLP})$	0.008***	0.000	0.000
	(0.000)	(.)	(.)
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft}(\alpha)$		0.106***	
		(0.002)	
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft} \times \Delta(i^{\$} - i^{CLP})$		-0.049***	
		(0.002)	
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft}(\log)$			0.042***
			(0.001)
Tot $\text{Imp}^{\$}_{ft}$/Tot $\text{Imp}_{ft} \times \Delta(i^{\$} - i^{CLP})$			-0.016***
			(0.001)
Constant	0.995***	0.883***	1.000***
	(0.000)	(0.002)	(0.000)
Adjusted R^2	0.534	0.541	0.543
FirmXOriginXHS6	YES	NO	NO
FirmXOriginXHS6 Year	NO	YES	YES
Observations	1999973	1999537	1999537

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes:

C.4 Additional Results: Counterfactual Exercises

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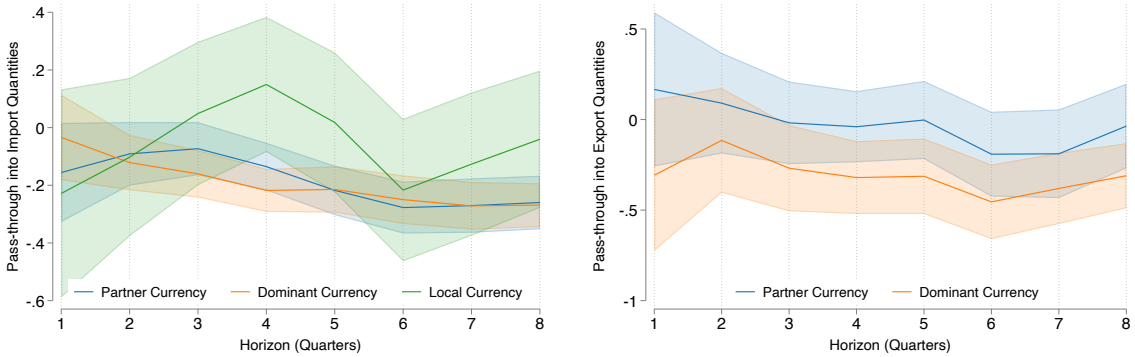
Figure 13: Quantity Sensitivities to Exchange Rates



Notes:

Figure 14: Terms of Trade Sensitivity to Exchange Rates

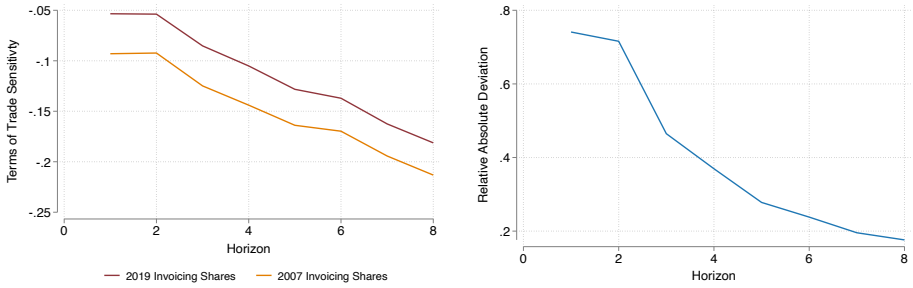


Figure 15: Terms of Import Inflation to Exchange Rates