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ABSTRACT

We revisit a central question for international macroeconomics: the response of export prices and quantities to movements in the exchange rate (ER). We use granular export data for Chile and study how the effects of ER movements vary over time with the currency of invoicing and the destination of exports. For prices, we find that the short-run effects of bilateral ER movements vanish when controlling for U.S. dollar ER, which supports dominant currency pricing. However, over longer horizons a more significant role is played by bilateral ER movements, in line with the predictions of producer currency pricing. These dynamics do not depend on the invoicing currency. The results we find for quantities support the view that bilateral exchange rate movements contribute to macroeconomic adjustment through export volumes over the medium term.

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1 Introduction

External adjustment is a central topic in international finance for academics and policymakers. The appropriateness of flexible versus fixed exchange rate regimes depends on how fluctuations in the nominal exchange rate affect relative prices and resource allocation. If exporters fix their prices using their home currency, a depreciation of the exporter's currency to the currency of the importer reduces the price of goods at the destination market. Hence, it increases, everything else constant, the volume of exports due to increased export demand. This pricing strategy, named Producer Currency Pricing (PCP), is a building block in the workhorse Mundell-Fleming open economy model. However, noting a low pass-through from the exchange rate to prices, an alternative pricing mechanism was proposed in which prices are set in the (local) currency of the destination market, dubbed Local Currency Pricing (LCP). A crucial implication of LCP is that exchange rate fluctuations do not promote external adjustment via exports.[1] As import prices at the destination remain fixed, expenditure switching from exchange rate movements remains limited, and thus external adjustment is impaired.

More recently, it has been noted that a large fraction of international transactions are invoiced and settled in U.S. dollars (USD), a fraction much larger than the role of the U.S. and dollarized economies in global trade.[2] This fact led to the so-called Dominant Currency Pricing (DCP) hypothesis, which states that firms settle and price their transactions in a handful of currencies, with the USD being the most salient. Under DCP, a bilateral depreciation of an exporter country's currency against any currency other than the USD does not induce price changes at the destination because they remain fixed in USD. Consequently, a bilateral depreciation does not generate expenditure switching, as import prices are set in USD, and the currency only depreciates against currencies different from the USD. Only changes in the value of the exporters' or importers' currency against the USD produces nominal and real effects.

In this paper, we estimate the effect of USD and bilateral exchange rates (BER) movements over time on export prices and, by studying quantities, whether they have allocative implications. To this end, we use customs data from the non-mining sector in Chile, where roughly 90 percent of exports settle in USD. We also study whether the effects of USD and BER movements depend on the currency of invoicing reported by firms in

[1] LCP evidence has been abundantly documented in Takhtamanova (2010); McCarthy (2007); Campa and Goldberg (2005); Gopinath and Rigobon (2008); Goldberg and Knetter (1997); Goldberg and Campa (2010). External adjustment may still occur under LCP through the real interest rate (Devereux, 2000).

[2] See Goldberg and Tille (2008), Gopinath (2016), and Gopinath et al. (2020).

individual custom reports.

Under PCP, theory predicts a complete exchange rate pass-through (ERPT) to destination prices from the destination's bilateral exchange rate to the Chilean peso (CLP). In contrast, under DCP this bilateral ERPT is zero, while the USD ERPT is one. We estimate the response of export prices, denominated in the importer's currency, to changes in the BER and the USD exchange rate. We find that, in the short run, the USD ERPT is almost one, while the BER ERPT is about zero. These results are consistent with DCP, as noted before (Gopinath et al., 2020), and form the basis for the argument that DCP is an essential factor in shaping external adjustment. However, after eight quarters, these levels of pass-through revert. The bilateral ERPT rises to 0.89, and the USD ERPT drops to 0.31. Therefore, the evidence for Chilean exports shows that while the pricing mechanism would be DCP in the short run, in the medium term, its behavior resembles the predictions associated with PCP, even when exports are invoiced in USD.

The medium-term resemblance of our results to PCP motivates us to refer to them as long-run PCP. The literature distinguishes between DCP, LCP, and PCP as the price at which international trade transactions are set and invoiced in the short run. For the long-run, we use indistinctly long-run DCP, LCP, or PCP, as appropriate, or optimal currency for setting prices. This indicates the currency used as a unit of account for setting optimal prices regardless of the currency in which prices settle in the short-run. Chile provides an interesting case since most of its invoicing is in USD, despite exporters, in the long-run, adjusting to their optimal price in CLP.

This result supports the idea that the bilateral exchange rate plays an important role in macroeconomic adjustment. Quantities do not react contemporaneously to BER movements but show allocative effects in the medium run, consistent with the evolution of prices. For example, a depreciation of the importer's currency to that of the exporter generates a decline in exports over time, with an implicit export volume elasticity to price changes of -1.5. In contrast, USD exchange rate movements do not significantly affect quantities despite the price increase in destination countries. The lack of significance might result from a limited short-run pass-through from prices at the dock to consumer prices and price resetting from exporting firms, undoing the USD exchange rate movements.

Finally, we analyze whether the previous results depend on the invoicing currency. Despite the overwhelming prevalence of the USD, there is a non-trivial share (around 10 percent) of Chilean exports invoiced in the destination's currency, mainly to some European and Asian countries. To examine the role of the currency of invoicing, we consider exports invoiced in USD and the destination currency separately and assess the differential effect the currency of invoicing may have. We conclude that the dynamic and magnitude of the bilateral ERPT to prices and adjustment on quantities is independent of the invoicing currency. That is, muted in the short run and rising in the next eight quarters. When transactions are set in the destination currency, other than the USD, there is a zero USD ERPT into prices and a non-significant response of quantities to the USD. This result proves that export prices are indeed sticky in the invoicing currency, whether the USD, the Yen or the Euro.

This paper builds upon the empirical contributions that document the overwhelming role of the USD in settling transactions in international trade (Goldberg and Tille, 2008; Boz et al., 2022), and the literature that documents that ERPT into import prices is high but incomplete.[3] We contribute to the literature that estimates different ERPTs according to the invoice currency. Gopinath and Rigobon (2008) is the first article that empirically quantifies the role of the currency of invoice for ERPT, focusing on US trade. Gopinath (2016) broadens the analysis to thirty-five developed and developing economies. Giuliano and Luttini (2020) and Gopinath et al. (2020) extend standard ERPT regressions, as in Burstein and Gopinath (2014), to account for the role of the invoicing currency. We use this empirical framework to show how the correlation of variations in export prices with variation in bilateral and USD exchange rate informs about the role of different exchange rates on external adjustment.

Our results indicating that USD ERPT is high in the short-run and lower in the long-run are in line with those of Giuliano and Luttini (2020), Gopinath et al. (2020), Chen et al. (2021), and Amiti et al. (2022). Empirical studies focusing on exogenous events such as the 2015 Swiss Franc appreciation (Auer et al., 2021), and the significant and persistent Sterling Pound depreciation after the Brexit referendum (Corsetti et al., 2022) find results like ours.[4] In particular, they find that for prices invoiced in local currency, local prices do not change with changes in the value of that currency. This result has also been noticed in studies using data from advanced economies (Chen et al., 2021; Corsetti et al., 2022; Amiti et al., 2022). More generally, we find that export prices are sticky in the currency of invoicing: LCP when invoiced in the domestic currency and DCP when invoiced in USD. Although we do not have invoicing in CLP, the ERPT's evolution suggests that firms adjust prices focusing on peso profitability, regardless of the invoicing currency. We provide evidence that prices are sticky in the invoicing currency, and that regardless of

[3]See Campa and Goldberg (2005) and Burstein and Gopinath (2014) for a review.

[4]Gagnon and Sarsenbayeb (2023) also find support for PCP in a panel of countries.

the invoice currency, they approach their optimal price as in the short-run prediction of PCP.

Our data allows us to estimate the effect of exchange rate movements on quantities. To our knowledge, we are the first to estimate the impact on export volumes from incomplete pass-through to destination prices in the case of a small open economy with flexible exchange rates. As far as we know, apart from Amiti et al. (2022), which estimate a trade elasticity for Belgium, evidence addressing temporal and composition concerns using microdata is virtually nonexistent. Our work differs from theirs in several dimensions. First, we consider a small open economy with a flexible exchange rate regime, while their evidence is for a country belonging to a currency union. Second, we estimate the impact of the BER and USD changes on quantities with a distributed lag specification and do not infer them from the trade elasticity. Our approach allows us to quantify that the response of quantities to the currency of invoicing is more muted than to the bilateral exchange rate. Although the trade elasticity we find for Chilean exports, -1.5, is strikingly similar to theirs. Third, we highlight the implications of global changes in the value of the USD, the importer's currency, and the Chilean peso. For example, when the USD multilaterally appreciates, and exports are settled in USD, prices at the destination increase; however, quantities remain stable. The stability suggests that while prices at the dock may increase one-to-one with the depreciation of the local currency, final consumer prices are sticky. It takes time for the depreciation to show in retail prices. Simultaneously, prices reset to reflect the optimal price in the exporter's currency, which does not change since the BER remains constant.

Our paper also contributes to understanding whether invoicing is an equilibrium outcome in which vehicle currencies eliminate the transaction cost of bilateral exchange for small open economies. With nominal rigidities, export prices are sticky in the invoicing currency; thus, the currency of invoicing has non-trivial consequences for firms. The literature on optimal currency choice suggests that, on the one hand, as Chile is an open economy, exporting in very diversified markets, firms would prefer to set invoicing currencies tailored to each destination, barring constraints.[5] On the other hand, as Chile is a small economy, firms might find that their scale limits their ability to have particular invoicing with buyers. Much like other emerging economies, an overwhelming fraction of Chilean exports are invoiced in USD. Krugman (1980) and Devereux and Shi (2013) establish that a vehicle currency emerges because of the lower transaction cost associated with

[5]For studies about the determinants of the optimal currency choice, see Engel (2006) and Gopinath et al. (2010). For more recent discussions, see Mukhin (2022) and Amiti et al. (2022).

settling transactions in currencies with more liquid markets. The prevalence of the USD suggests that the optimal currency choice theory bears limited insights for our empirical application. Nevertheless, we show that exporting firms in Chile that invoice in multiple currencies also employ more workers and display more significant export returns through a more diversified basket of products and to more destinations. These features are suggestive that scale has a bearing on the cost/benefit balance faced by Chilean firms in their choice among vehicle currencies.[6] This finding is also compatible with the role of strategic complementarities in the Belgian case presented in Amiti et al. (2022) for Belgian firms.

Except for Gopinath et al. (2020), which focuses on data from Colombia, the empirical literature has used chiefly data from advanced economies such as Belgium or France. Our work expands the scope of analysis to another emerging economy, Chile. It provides precisely estimated effects of Chilean export volume responses to exchange rate movements. Estimates of these effects have been elusive so far.

The rest of the paper organizes as follows. Section 2 provides a theoretical discussion to benchmark our empirical results. Section 3 discusses the methodology of our empirical exercises. Section 4 describes the data used in the analysis and present descriptive statistics about the currency of invoice in Chile. Section 5 presents the empirical results on the effect different exchange rate fluctuations have on export prices and quantities. Section 6 concludes.

2 Exports pricing and quantity effects

This section provides the conceptual framework for the empirical approach below. We first describe the problem the firm faces and its optimal price. Then, we focus on cases that depend on the different currencies of invoicing and pricing strategies.

2.1 Pricing in international markets

Consider the case in which a domestic (Chilean) exporting firm wants to set the optimal price of a specific good in the destination market, so as to maximize its *domestic currency*

[6] Benguria and Wagner (2022) notes that the invoicing currency of Chilean firms to Eurozone destinations shifted very rapidly from the USD to the Euro with its introduction. This pattern indicates that, on the whole, Chilean firms are *currency takers* in invoicing, and they have to adopt the most readily available invoicing currency at their destination.

profits.[7] We denote the optimal CLP price of a good exported by firm f, to destination j, at time t as $\tilde{P}^{CLP}_{f,j,t}$. Domestic currency profits are denominated by Π. This price is the solution to the following problem:

$$\tilde{P}^{CLP}_{f,j,t}(\Omega_t) = \arg\max_{P^{CLP}_{f,j,t}} \Pi\left(P^{CLP}_{f,j,t} | \, \Omega_t\right),$$

where Ω_t represents the information set at time t. In our setting, this includes the expected distribution of future BER fluctuations for countries i and j, denoted by $\mathcal{E}_{i,j,t}$, which is the price of currency i in terms of currency j at time t. When $\mathcal{E}_{i,j,t}$ increases, currency j depreciates with respect to i. We use the notation $p^{CLP}_{f,j,t} = \ln P^{CLP}_{f,j,t}$ as the log price of exports expressed in CLP from firm f to destination j at time t. For exchange rates we use $e_{i,j,t} = \ln \mathcal{E}_{i,j,t}$.

In order to get a simple formulation for price and quantity effects, we assume the exporting firm faces an iso-elastic demand curve in the destination market, setting its price in the domestic currency and constant marginal costs M. There are no strategic complementarities. Then, the problem becomes:

$$\begin{aligned} &\max_{P^{CLP}_{f,j,t}} \quad \Pi = P^{CLP}_{f,j,t} Q_{f,j,t} - M Q_{f,j,t}, \\ &\text{s.t.} \qquad Q_{f,j,t} = \left(P_{f,j,t}\right)^{-\mu} = \left(\mathcal{E}_{CLP,j,t} \tilde{P}^{CLP}_{f,j,t}\right)^{-\mu}, \end{aligned} \tag{1}$$

where $P_{f,j,t}$ corresponds to the price expressed in unit of the destination currency $j.Q$ is the quantity exported. For now we assume that under flexible prices, this price equals the optimal price set by firm f in its domestic currency. The solution is the classical constant markup over marginal cost:

$$\tilde{P}^{CLP}_{f,j,t} = \frac{\mu}{\mu - 1} M, \tag{2}$$

The demand depends on local prices, and hence, the quantity exported will be given by:

$$Q_{f,j,t} = \left(\frac{\mu}{\mu - 1} \mathcal{E}_{CLP,j,t} M\right)^{-\mu} = \psi M^{-\mu} \mathcal{E}^{-\mu}_{CLP,j,t}. \tag{3}$$

where $\psi \equiv \left(\frac{\mu}{\mu-1}\right)^{-\mu}$ is a constant. This is a standard Mundell-Fleming result for PCP. A depreciation of the exporter's currency reduces the local price ($\mathcal{E}_{CLP,j}$ declines), since the

[7] We use *domestic currency* to refer to the *exporter-producer's* currency, Chilean peso in our case. We use *local currency* or *destination currency* to refer to the *importer-consumer's* currency, a convention adopted in most of the literature.

price is set in the currency of the producer, and therefore demand for exports increases.

This analysis underpins the discussion in the next subsection, where we look at more cases than simply setting the optimal price in domestic currency. In what follows we distinguish the transaction currency under which prices are sticky or invoiced, and the currency for optimal prices. The idea is that prices are fixed in the invoicing currency, despite this may not be the currency in which firms set optimal prices. We will consider 6 cases, as the combination of two assumptions for price rigidity, in local or dominant (USD) currency for transactions, PCP or DCP respectively, and three optimal prices (long-run pricing), producer, importer's or dominant currency.

2.2 Sticky (or invoicing) prices vs. optimal prices: price and quantity adjustments

In the following discussion, we analyze six export pricing schedules and their implications for prices and quantities at the destination and for both short- and long-run. These cases provide the framework for our empirical analysis. In our empirical evidence presented below, we find that *prices are sticky in the currency of invoicing*; therefore, we will use indistinctly currencies in which prices are sticky and currencies of invoicing, which can be DCP, LCP, or PCP. In the long-run we consider the optimal or desired pass-through that may resemble short-run implications of the pricing strategies mentioned above. We abstract from the selection of a currency of invoicing to achieve a desired pass-through, as the lack of transactions invoiced in CLP suggests that Chilean firms are *currency takers*.

(A) PRICE STICKINESS IN THE DOMINANT CURRENCY (DCP) AND OPTIMAL PRICE IN PRODUCER'S CURRENCY (LONG-RUN PCP)

We consider first the case in which exports are invoiced (sticky) in USD, but the optimal price is expressed in the producer's currency (long-run PCP). When a firm sets its optimal prices in CLP at some time t, price (expressed in the destination currency) and quantity are:

$$p_{f,j,t} = \tilde{p}^{CLP}_{f,j,t} + e_{CLP,j,t}$$
$$q_{f,j,t} = \log \psi - \mu \left(m + e_{CLP,j,t} \right),$$

where $\tilde{p}^{CLP}$ is the log of price in the exporter's currency at time t.

Then, as time goes by for k periods and the firm has not been able to reset its price (which remains fixed in USD), the price and quantity exported at the destination are given by:

$$p_{f,j,t+k} = \tilde{p}^{CLP}_{f,j,t} + e_{CLP,USD,t} + e_{USD,j,t+k}$$
$$q_{f,j,t+k} = \log \psi - \mu \left(m + e_{CLP,USD,t} + e_{USD,j,t+k}\right)$$

Note that the price in USD ($\tilde{p}^{CLP}_{f,j,t} + e_{CLP,USD,t}$) is fixed at its value at t, and changes only with the bilateral exchange rate of the imports' currency with respect to the USD.

If we assume that in period $t+k$, a share $\theta(k)$ of firms have not been able to reset their prices, while the remaining have optimally reset them, then the average price at $t+k$ across all firms is given by:

$$p_{j,t+k} = \theta(k)\left(\tilde{p}^{CLP}_{j,t} + e_{CLP,USD,t} + e_{USD,j,t+k}\right) + (1-\theta(k))\left(\tilde{p}^{CLP}_{j,t+k} + e_{CLP,j,t+k}\right), \tag{4}$$

where we consider that $\theta(0) = 1$, $\lim_{k\to\infty} \theta(k) = 0$, $\theta'(k) < 0$, and we eliminate the subscript f since optimal price is constant across firms.

The change in local prices for those firms that keep their prices sticky in USD is given only by the change in the USD-local currency parity, while firms that reset to an optimal level in CLP have prices change according to the CLP-local currency parity. Therefore,

$$\Delta_k p_{j,t} = \theta(k)\Delta_k e_{USD,j,t} + (1-\theta(k))\Delta_k e_{CLP,j,t}, \tag{5}$$

where Δ_k is the k-difference operator, $\Delta_k x_t \equiv x_{t+k} - x_t$. Consequently, the change in quantities is given by:

$$\Delta_k q_{j,t} = -\mu\left[\theta(k)\Delta_k e_{USD,j,t} + (1-\theta(k))\Delta_k e_{CLP,j,t}\right], \tag{6}$$

(B) Price stickiness in the dominant currency (DCP) and optimal price in importer's currenty (long-run LCP)

As in the previous case, the sticky price is in USD, which implies that the fraction of firms that do not adjust prices have a one-to-one ERPT from movements in the USD, and changes in the bilateral exchange rate have no effects. Since firms want to keep their prices constant in the local currency, firms that reset prices return to the original local currency price, that is, $p_{f,j,t+k} - p_{f,t,j} = 0$. Since a fraction $\theta(k)$ keep their prices fixed, we have that:

$$\Delta_k p_{j,t} = \theta(k)\Delta_k e_{USD,j,t}. \tag{7}$$

As all firms start with a set price ($\theta(0) = 1$), the ERPT is 1 in the short-run and declines to zero over time ($\lim_{k\to\infty} \theta(k) = 0$). The quantity response of exports is given by:

$$\Delta_k q_{j,t} = -\mu\theta(k)\Delta_k e_{USD,j,t}. \tag{8}$$

(C) PRICE STICKINESS AND OPTIMAL PRICE IN THE DOMINANT CURRENCY

This case is simple to analyze. In the short-run, prices absorb a change in the USD exchange rate completely. Since that is also the currency in which optimal prices are set, adjustment is unnecessary. The bilateral exchange rate does not affect prices. The price instantly jumps to its new optimal level, proportional to the USD-local current exchange rate. The ERPT is complete:

$$\Delta_k p_{j,t} = \Delta_k e_{USD,j,t}. \tag{9}$$

Consequently,

$$\Delta_k q_{f,j,t} = -\mu\Delta_k e_{USD,j,t}. \tag{10}$$

(D) PRICE STICKINESS IN LOCAL CURRENCY (LCP) AND OPTIMAL PRICE IN PRODUCER'S CURRENCY (LONG-RUN PCP)

In the short run, prices are sticky in the local currency, and hence at $t + k$ a fraction $\theta(k)$ of firms will prices fixed at $p_{f,j,t+k} = p_{f,j,t}$. Firms that instead are resetting prices adjust to keep the price in producer currency. Therefore, they change their local price to $p_{f,j,t+k} - p_{f,j,t} = e_{CLP,j,t+k} - e_{CLP,j,t}$. The evolution of prices gradually changes to keep the prices in the currency of the producer constant:

$$\Delta_k p_{f,j,t} = (1 - \theta(k))\Delta_k e_{CLP,j,t}. \tag{11}$$

While quantities evolve according to:

$$\Delta_k q_{f,j,t} = -\mu(1 - \theta(k))\Delta_k e_{CLP,j,t}. \tag{12}$$

Only the bilateral exchange rate is relevant. The bilateral ERPT starts from zero and converges to 1 over the long-run, while the USD ERPT is always zero.

(E) PRICE STICKINESS IN LOCAL CURRENCY AND AND OPTIMAL PRICE IN DOMINANT CURRENCY (LONG-RUN DCP)

This case is unlikely to exist in practice, because there is no reason to price in the importer's currency when the preferred currency is the dominant one, in which is always possible to invoice and set prices. We present it for completeness. This case is similar to the previous one, but instead of the bilateral exchange rate, the USD exchange rate of the destination country is relevant for firms that are resetting prices, as they aim to keep them constant in USD. Since prices are sticky in the local currency, the ERPT for the USD starts from zero and converges to 1. The evolution of price and quantities are given by:

$$\Delta_k p_{f,j,t} = (1 - \theta(k))\Delta_k e_{USD,j,t}, \tag{13}$$

and

$$\Delta_k q_{f,j,t} = -\mu(1 - \theta(k))\Delta_k e_{USD,j,t}. \tag{14}$$

(F) PRICE STICKINESS AND OPTIMAL PRICE IN THE LOCAL CURRENCY

In this case, the optimal price and short-run fixed prices are denominated in local currency; therefore, the bilateral and USD ERPT are both zero in the short- and long-run. Exchange rate fluctuations do not have effects on prices or quantities.

3 Empirical strategy

In this section we detail the empirical approach to estimate the pricing and quantity responses of Chilean exporters, and to deduce from that evidence on pricing strategies.

3.1 Bilateral exchange rates

We begin by estimating the sensitivity of prices to bilateral exchange rate fluctuations. To examine the impact of the BER on prices at the destination, we regress quarterly changes in export prices on changes in contemporaneous and lagged bilateral exchange rates:

$$\Delta p_{f,g,j,c,t} = \lambda^P_{f,g,j,c} + \sum_{k=0}^{8} \beta^P_k \Delta e_{CLP,j,t-k} + \theta^P X^P_{j,t} + \varepsilon_{f,g,j,c,t}, \tag{15}$$

where $p_{f,g,j,c,t}$ is the log price of product g, from firm f to destination j, invoiced in currency c, at quarter t, and λ's are firm, country, destination, currency of invoicing fixed-effects. To control for changes associated with relative prices in the destination economy and domestic costs, $X^P_{j,t}$ includes log changes of the Consumer Price Index at the destination j and the Chilean Producer Price Index, respectively. Δ is the first difference quarterly operator, $\Delta x_t = x_t - x_{t-1}$.

The β_k^P parameters are the estimates for the impact on prices at t of a depreciation of the local currency against the CLP k quarters before. Thus, the term $\sum_{k=0}^{S} \beta_k^P$ captures the S-periods cumulative ERPT into prices. Fixed effects in the regression aim to capture individual heterogeneity at the firm, good, destination, and currency of invoicing level, for instance reflecting trade relationships, productivity, and marketing strategies, among others, that do not change over the period of estimation.

We also estimate the effects of bilateral exchange rates fluctuations on quantities:

$$\Delta q_{f,g,j,c,t} = \lambda_{f,g,j,c}^{Q} + \sum_{k=0}^{8} \beta_k^Q \Delta e_{CLP,j,t-k} + \theta^Q X_{j,t}^Q + \varepsilon_{f,g,j,c,t}, \tag{16}$$

where $q_{f,g,j,c,t}$ is the log of total exported quantities and X^Q, in addition to the variables included X^P, controls for external demand (measured by GDP in the destination economy). Because of the reduced form nature of these estimates, β_k^Q captures the response of quantities to supply and demand factors. We label this response as the *allocative effects* of exchange rates, so the S-periods allocative effects of exchange rates is given by $\sum_{k=0}^{S} \beta_k^Q$. The ratio $\frac{\sum_{k=0}^{S} \beta_k^Q}{\sum_{k=0}^{S} \beta_k^P}$ is a proxy for the export elasticity to the bilateral exchange rate.

The prediction of the PCP framework in Mundell-Flemming is $\sum_{k=0}^{S} \beta_k^P = 1$, for any time horizon S, because prices are fixed in the exporter's currency. In contrast, Betts and Devereux (2000) and Chari et al. (2002) advanced the idea that exporters set their prices in the importer's currency. Therefore exchange rate variations should have a *null* effect on prices, and both parameters (for quantities and prices) should be equal to zero as long as prices remain fixed, even in the long-run. The zero effect during a price-spell gives rise to an idea of exchange rate irrelevance in terms of its ability to induce current account adjustment. The empirical results should shed light on the relevance of either interpretation, which we tackle in the following subsection. We can also look at differences between the short and long-run responses of prices to different exchange rates.

3.2 Bilateral and dominant currency exchange rates

As noted, this empirical strategy might be incomplete as the USD or other major currencies can be used as a vehicle currency (Goldberg and Tille, 2008). That is, the currency used for pricing is neither the origin nor the destination, but a dominant currency. To jointly test the different pricing mechanisms, we extend specifications (15) and (16) to include USD exchange rate fluctuations. In particular, we estimate:

$$\Delta p_{f,g,j,c,t} = \lambda^{P}_{f,g,j,c} + \sum_{k=0}^{8} \beta_k^{P,USD} \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \beta_k^{P,BER} \Delta e_{CLP,j,t-k} + \theta^P X^P_{j,t} + \varepsilon_{f,g,j,c,t}, \tag{17}$$

$$\Delta q_{f,g,j,c,t} = \lambda^{Q}_{f,g,j,c} + \sum_{k=0}^{8} \beta_k^{Q,USD} \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \beta_k^{Q,BER} \Delta e_{CLP,j,t-k} + \theta^Q X^Q_{jt} + \varepsilon_{f,g,j,c,t}. \tag{18}$$

In these regressions, we have two pass-through coefficients; one from BER movements and another from USD exchange rate movements. We label them with superindices BER and USD, respectively. These equations allow us to jointly test the cases discussed in Section 2.2. So for instance, if firms fix local prices in USD, we should expect $\sum_k \beta_k^{P,BER}$ in (17) to play a significantly less important role than $\sum_k \beta_k^{P}$ in (15). Indeed, if in the short-term exports are invoiced in USD with prices sticky in that currency, we should expect $\beta_0^{P,USD} = 1$. If prices are settled in local currency instead, we should have that both $\beta^{P,USD}$ and $\beta^{P,BER}$ are equal zero.

What should we expect in the long-run? The answer to this depends on the currency used to set optimal prices and the effects of exchange rate movements on the optimal price chosen by the firm. It also depends on the economy's structure, competition, and cost structure, among other factors. For instance, if there are no strategic complementarities and all costs are in USD, then the long-run pass-through for the USD should be equal to one. If some costs are domestic, then the long-run pass-through should be smaller. Table 1 summarizes the implications of the discussion in Section 2.2. As an illustration, if firms set their prices optimally in CLP (long-run PCP), but prices are settled in USD (DCP), the predictions are those of column three for the short-run and column four for the long-run. The effects on quantities depend on demand and supply responses to price changes. This issue is relevant to our empirical results in the following sections.

Table 1: ERPT Predictions

Optimal currency	Price stickiness in local currency (LCP)		Price stickiness in dominant currency (DCP)	
	Short-run	Long-run	Short-run	Long-run
Producer	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=0$	$\sum_{k=0}^{8}\beta_k^{P,BER}=1, \sum_{k=0}^{8}\beta_k^{P,USD}=0$	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=1$	$\sum_{k=0}^{8}\beta_k^{P,BER}=1, \sum_{k=0}^{8}\beta_k^{P,USD}=0$
Local	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=0$	$\sum_{k=0}^{8}\beta_k^{P,BER}=0, \sum_{k=0}^{8}\beta_k^{P,USD}=0$	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=1$	$\sum_{k=0}^{8}\beta_k^{P,BER}=0, \sum_{k=0}^{8}\beta_k^{P,USD}=0$
Dominant	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=0$	$\sum_{k=0}^{8}\beta_k^{P,BER}=0, \sum_{k=0}^{8}\beta_k^{P,USD}=1$	$\beta_0^{P,BER}=0, \beta_0^{P,USD}=1$	$\sum_{k=0}^{8}\beta_k^{P,BER}=0, \sum_{k=0}^{8}\beta_k^{P,USD}=1$

3.3 Dominant and destination currency invoicing

We extend the analysis to consider different currencies of invoicing. We estimate similar price and quantity equations, allowing for different ERPT depending on whether transactions are set in the local currency of destination:

$$\Delta p_{f,g,j,c,t} = \sum_{k=0}^{8}\left(\beta_k^{P,USD} + \gamma_k^{P,USD} D_{f,g,j,c,t}^{LC}\right)\Delta e_{USD,j,t-k} + \sum_{k=0}^{8}\left(\beta_k^{P,BER} + \gamma_k^{P,BER} D_{f,g,j,c,t}^{LC}\right)\Delta e_{CLP,j,t-k} + \alpha D_{f,g,j,c,t}^{LC} + \theta^P X_{jt}^P + \lambda_{f,g}^P + \varepsilon_{f,g,j,c,t}, \quad (19)$$

$$\Delta q_{f,g,j,c,t} = \sum_{k=0}^{8}\left(\beta_k^{Q,USD} + \gamma_k^{Q,USD} D_{f,g,j,c,t}^{LC}\right)\Delta e_{USD,j,t-k} + \sum_{k=0}^{8}\left(\beta_k^{Q,BER} + \gamma_k^{Q,BER} D_{f,g,j,c,t}^{LC}\right)\Delta e_{CLP,j,t-k} + \alpha D_{f,g,j,c,t}^{LC} + \theta^Q X_{j,t}^Q + \lambda_{f,g}^Q + \varepsilon_{f,g,j,c,t}, \quad (20)$$

where $D_{f,g,j,c,t}^{LC}$ is a dummy variable equal to 1 if exports are invoiced in local currency and 0 if in USD. For simplicity, we exclude exports in CLP and other vehicle currencies different from the USD (e.g., exports to the Republic of Ireland in British Pounds).[8]

The β parameters have the same interpretation as above. The γ parameters denote the differential effects on prices and quantities from USD and bilateral exchange rate movements of exports invoiced in local currency. Thus, $\beta^{P,USD}$ ($\beta^{P,BER}$) represents the ERPT of the USD (bilateral) exchange rate to local prices of exports when they are invoiced in USD. In contrast, $\beta^{P,USD} + \gamma^{P,USD}$ ($\beta^{P,BER} + \gamma^{P,BER}$) represents the ERPT of the USD (bilateral) exchange rate to local prices of exports when they are invoiced in local currency. Likewise, for the effects of exchange rate movements on export quantities.

[8]Only 0.2% of exports in this sample are invoiced in CLP, and they mostly represent cigarette exports to specific destinations.

This setup implies that, for instance, if $\gamma_k^{P,USD} < 0$, the pass-through into local prices from a depreciation of the local currency to the USD is smaller when invoiced in local currency than when invoiced in USD. Similarly, if $\gamma_k^{P,BER} > 0$, the pass-through into local prices from local currency depreciation to the CLP is more significant when invoiced in local currency than when invoiced in USD.

4 Data and descriptive statistics

We describe the data sources we employ and present descriptive statistics that characterize our data. As reported in the literature, they replicate the overwhelming presence of invoicing in USD for Chilean exports.

4.1 Data source

The core of our data is drawn from Customs Export Declaration collected by Chile's National Customs Service. The data covers the relevant universe of Chilean non-mining exports at the transaction level.[9] From the Customs Export Declaration, we use information on FOB value, quantity, exporting firm, product code, invoicing currency, and destination country. Our study focuses on the 2010-2019 period. The database classifies goods using an 8-digit Harmonized System (HS8) classification system, equivalent to the U.S. 10-digit Harmonized System.

We add employment characteristics of the exporting firms using data from the Unemployment Insurance Administrator (AFC).[10] We obtain the economic sector of firms using data from the Internal Revenue Service of Chile.

A common limitation of customs declarations is that they do not contain explicit information on unit prices. Our dataset is not an exception. To solve this, we collapse for firm f, product g, invoiced in currency c, to destination country j, in period t as in Amiti et al.

[9]The initial sample considers Chile's top 30 trading partners in terms of exports. Once we exclude those without macroeconomic data, the baseline sample has 24 countries representing around 73 percent of non-mining exports from Chile. We do not include mining data for several reasons. Chile is one of the primary copper producers, and thus copper prices are likely not exogenous to the firms. Shocks to the price of copper have macroeconomic implications, and therefore the estimates of exchange rate effects on prices could suffer from simultaneity bias. Copper prices are set flexibly and thus do not share the stickiness that characterizes the debate on macroeconomic adjustment from exchange rate movements that motivates this paper.

[10]AFC data consider full-time or part-time employees with permanent or fixed contracts who work in the private sector. We exclude home contracts as employees.

(2022). Thus, for each tuple (f, g, j, c) the price in the period t is the unit value across all the relevant transactions i,

$$P_{f,g,j,c,t} = \frac{\sum_i \text{FOB}_{i,f,g,j,c,t}}{\sum_i Q_{i,f,g,j,c,t}}.$$

We exclude items exported by firms that have less than five employees. We also drop items with missing values in quantities or export returns and remove items exported by firms that do not report the economic sector. Additionally, we consider tuples observed for at least eight quarters consecutively. Finally, we remove observations with quarter-to-quarter FOB values growth rate above 200 percent or below −66 percent. Our final sample covers 1,441 Chilean exporting firms, 1,839 goods at HS8 level, 12 distinct invoicing currencies, and 24 destinations.

In addition, we use the Chilean Producer Price Index (PPI) from the National Statistics Institute of Chile and trade partners' Consumer Price Index (CPI) and Gross Domestic Product (GDP) series from IMF data.

4.2 Descriptive statistics

Table 2 displays the main descriptive statistics in our sample at the annual level. The first two columns show that the average firm has around 480 employees, while the median has 144. The skew to the right of the distributions is also apparent in the number of destinations, products, and total exports. These patterns are consistent with what has been observed for exporters and firms in general in the international trade literature.

Table 2: Descriptive statistics

	All		USD		Non USD	
	Mean	*Median*	*Mean*	*Median*	*Mean*	*Median*
# employees	482.3	144.3	464.1	134.2	705.5	392.1
# destinations	2.0	1.0	2.0	1	2.4	2.1
# products	2.7	1.6	2.6	1	3.3	2.9
# total exports (USD million)	13,19	1,06	13,38	0.95	11,69	2,66
# firms	680		622		58	

Notes: Total exports represent the FOB value of exports considering non-mining data. Firms that export at least 95% invoiced in USD are labeled as "USD", if not, they are labelled as "Non USD". *Source*: Author´s own calculations are based on Chile´s National Customs Service.

In the following two columns, we separate firms depending on whether they invoice in USD or not.[11] We observe that Non USD firms are on average larger than USD firms, either by the number of employees or total exports. Similarly, Non USD firms export to more destinations and more products. Finally, Table 2 also shows that around 90 percent of exporters invoice in USD.

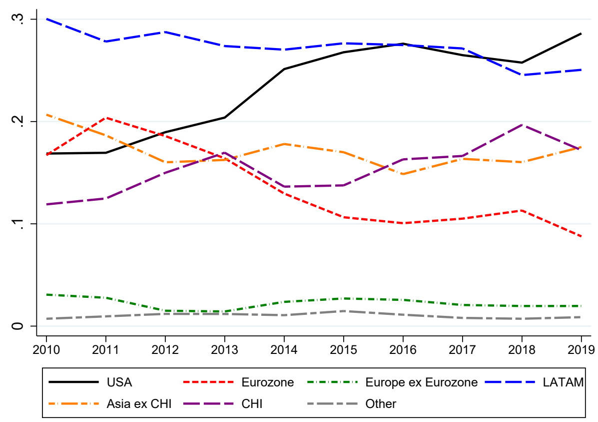
Figure 1a shows the export share of our sample by destination. Exports to the U.S. and Latin America (LATAM) each represent about a quarter of total exports. The export share to China grew considerably between 2010 and 2019, whereas the share to the Eurozone almost halved in the same period. Despite the distribution of destinations, Figure 1b shows that around 90 percent of exports are invoiced in USD, which is more than three times the corresponding share of exports going to the U.S. Exports invoiced in Euro are a mere 5 percent, which is considerably less than the share to the Eurozone. The CLP is contained in the "Other" category. The fact that the USD has such a lopsided role in invoicing of exports, with a much lower role for trade invoicing in either the currency of the origin country or the destination country, has been used as evidence of the dominant currency paradigm.

To complement the data description, Table 3 displays each major destination's export share distribution by currency. In Asia, the Yen plays a minor role compared to the overwhelming use of the USD for currency invoicing. In the Eurozone, the Euro plays a sizeable role relative to other regions but only is used for invoicing about a quarter of exports to that zone. At the same time, the USD is again the most important currency of invoicing. A similar pattern emerges for other destinations except for Europe no Eurozone, where the Sterling Pound (GBP) plays an important role, likely due to exports to Great Britain. In the case of LATAM, as no country has a currency used massively in international trade, most exports are invoiced in USD. This evidence portrays a picture similar to that observed in Gopinath et al. (2020) for Colombia, where exports invoiced in the USD are even more prevalent. Finally, Figure 1c classifies exports according to whether transactions are invoiced in vehicle, destination, or producer currency, thus considering the destination and the actual currency used. The USD is overwhelmingly used as a vehicle currency, and for transactions going to the U.S. and the Euro zone, there is a non-negligible role for their currencies.

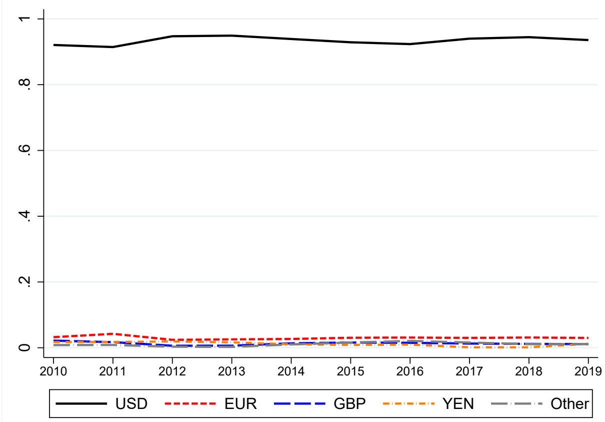
[11] Firms that export at least 95 percent invoiced in USD are labeled as "USD" in Table 2. If not, we label them as "Non USD".

Figure 1: Exports Share

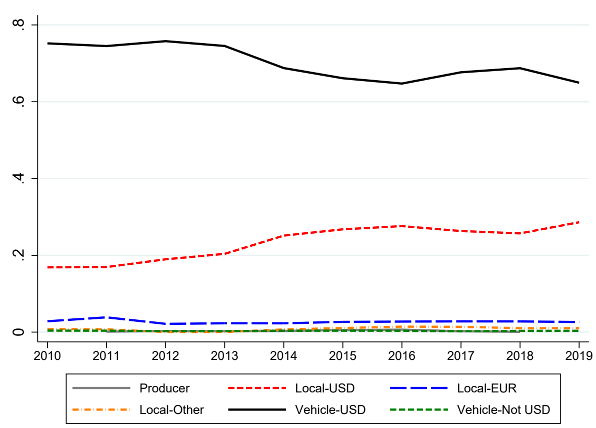
(a) By destination



(b) By currency



(c) By currency type



Notes: Exports share represent the FOB value percentage of exports considering non-mining data. *Source*: Author´s own calculations are based on Chile´s National Customs Service.

Table 3: Currency Distribution by Destination

Destination	Currency	Value (%)	Transaction (%)
Asia ex China	USD	93.47	92.57
	YEN	6.32	7.11
	EUR	0.21	0.31
China	USD	99.84	99.65
	EUR	0.10	0.21
	RMB	0.06	0.13
	YEN	0.00	0.01
Europe no Eurozone	GBP	58.56	72.6
	USD	31.19	20.38
	EUR	7.85	4.13
	Other	2.41	2.89
Eurozone	USD	79.33	47.02
	EUR	20.55	52.84
	CLP	0.12	0.13
	GBP	0.00	0.01
LATAM	USD	95.89	90.72
	Other	2.98	6.80
	CLP	0.76	0.51
	EUR	0.36	1.96
USA	USD	99.91	99.99
	CLP	0.09	0.01
Other	USD	99.53	99.66
	EUR	0.47	0.34

Notes: Value represent the FOB value percentage of exports and transaction represent the number of transactions in percentage both considering non-mining data. *Source*: Author´s own calculations are based on Chile´s National Customs Service.

5 Results

In this section we follow the approach outlined in Section 3, and report evidence on the ERPT from the bilateral exchange rate and USD exchange rate into prices and the exchange rates effects on quantities.

5.1 Adjustment of prices and quantities to the bilateral exchange rate

We begin our analysis by considering standard ERPT to prices and quantities regressions at firm-product-destination-currency level as in equation (15). Figure 2a plots the sum of β_k^P for $k = 0, ..., 8$. Short-run ERPT to local prices estimates range between 0.50 and 0.60; they are highly significant. Over time, ERPT becomes higher reaching a maximum in the range of 0.65 to 0.75. However, we cannot statistically reject that these magnitudes are different to those in the short-run. Our results are consistent with earlier findings in the literature: ERPT to border prices is high but incomplete.[12]

As for the effects on quantities, we find that movements in the bilateral exchange rates have real effects. Figure 2b plots the sum of β_k^Q from estimating equation (16). This is the impact over time of a depreciation of the domestic currency (appreciation of exporter's currency). Exploiting within variation at the firm-product-currency-destination level, we observe that a depreciation of the destination's currency with respect to the CLP is associated with a decline in exports. The effect of a nominal depreciation takes time to have allocative implications. Two quarters after the depreciation, there are small effects. They become significant from the third quarter onward and keep gradually increasing, reaching a demand elasticity of about -1.

5.2 Adjustment of prices and quantities to the bilateral and the USD exchange rates

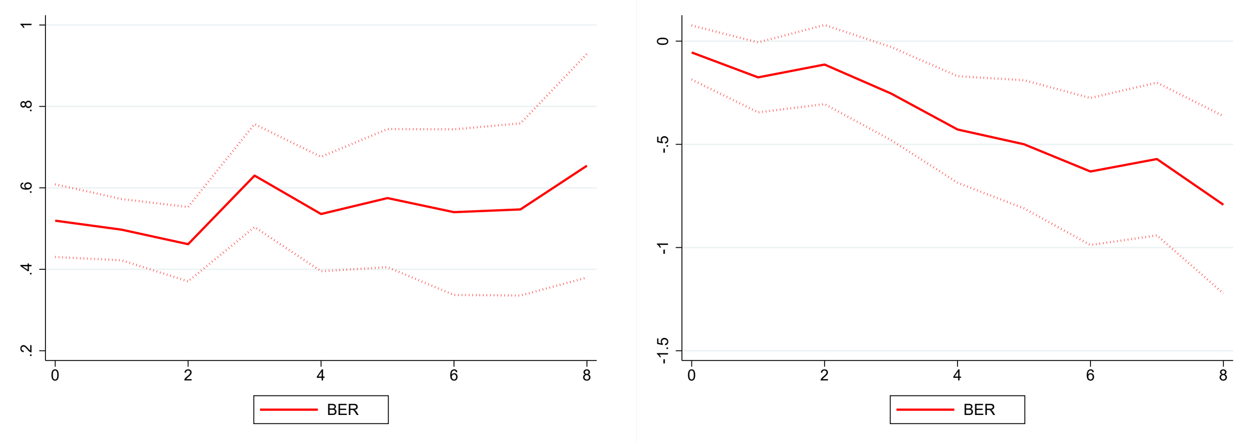
The separate identification of the pass-through to prices from both bilateral and USD exchange rates shed light on the pricing behavior of firms. We, therefore, shift our attention to ERPT regressions that include both the USD and the bilateral exchange rate and analyze its effects on quantities. In particular, we focus on transactions invoiced in USD to non-dollarized destinations to avoid confounding the effect of currency of invoicing with those of the country's exchange rate. Thus, we look at the use of the USD as a vehicle currency without being the local currency.

Figure 3 and Table 4 show the results of estimating (17) and (18). Panel 3a plots the cumulative sum of $\beta_k^{P,USD}$ and $\beta_k^{P,BER}$. In the short-run, we observe that the ERPT of USD to border prices is 0.89 and statistically equal to 1, which means is complete. The pass-through for the BER is 0.10, but statistically equal to zero. This last estimate contrasts to the results from (15) where the bilateral ERPT is around 50%. In the context of Table 1 this

[12]See, for example, Campa and Goldberg (2005) and Burstein and Gopinath (2014) .

Figure 2: Bilateral Exchange Rate Pass-through

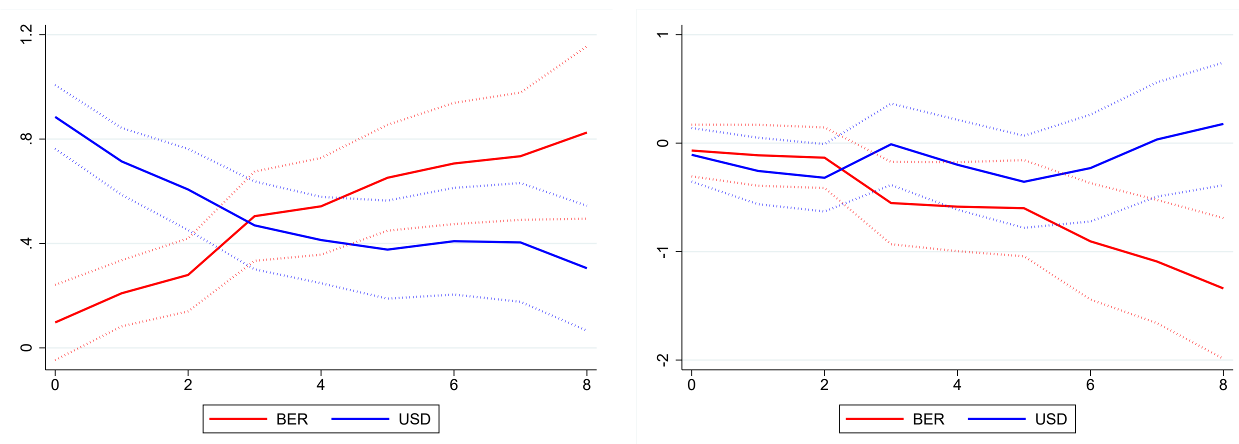
(a) Price (b) Quantity



Notes: Panel (a) plots the sum of β_k^P for estimation (15). Panel (b) plots the sum of β_k^Q for estimation (16). Both using all currencies and all destinations for non-mining sector. Areas between dotted lines represent 95% confidence intervals.

Figure 3: Bilateral and USD ERPT and Quantities

(a) Price (b) Quantity



Notes: Results for estimation (17) in panel (a) and (18) in panel (b), using non-mining sector and considerating USD to non-dollarized destinations. USD corresponds to the impact of depreciation of the local currency against the USD and BER to a depreciation of the local currency against the exporter's currency (CLP), Panel (a) plots the sum of $\beta_k^{P,BER}$ and $\beta_k^{P,USD}$. Panel (b) plots the sum of $\beta_k^{Q,BER}$ and $\beta_k^{Q,USD}$. Areas between dotted lines represent 95% confidence intervals.

Table 4: Bilateral and USD ERPT and Quantities

Dependent Variables:	price	quantity	price	quantity
Model:	(1)	(2)	(3)	(4)
β_0^{BER}	0.6189***	-0.0838	0.0975	-0.0683
	(0.0433)	(0.0736)	(0.0735)	(0.1216)
$\sum_{k=0}^{4} \beta_k^{BER}$	0.6335***	-0.5537***	0.5425***	-0.5858***
	(0.0726)	(0.1486)	(0.0945)	(0.2093)
$\sum_{k=0}^{8} \beta_k^{BER}$	0.7949***	-0.9084***	0.8251***	-1.3394***
	(0.1278)	(0.2375)	(0.1684)	(0.3309)
β_0^{USD}			0.885***	-0.1073
			(0.0622)	(0.126)
$\sum_{k=0}^{4} \beta_k^{USD}$			0.4133***	-0.1995
			(0.0844)	(0.2115)
$\sum_{k=0}^{8} \beta_k^{USD}$			0.3052***	0.1773
			(0.122)	(0.2883)
Fixed effects	Yes	Yes	Yes	Yes
Observations	71,679	71,679	71,679	71,679
R^2	0.1165	0.1037	0.1212	0.1043

Notes: Results for $\Delta y_{fgjct} = \lambda^Y_{fgjc} + \sum_{k=0}^{8} \beta_k^{Y,USD} \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \beta_k^{Y,BER} \Delta e_{CLP,j,t-k} + \theta^{Y\prime} X^Y_{jt} + \varepsilon^Y_{fgjct}$ in columns (3) and (4). For columns (1) and (2) is the same equation but without $\Delta e_{USD,j,t-k}$ as regressors, with Y denotes prices or quantities. In all the cases, β_0 is the contemporary effect, $\sum_{k=0}^{4} \beta_k$ and $\sum_{k=0}^{8} \beta_k$ is the sum of the coefficient at the 4 and 8 quarters, respectively. BER is for bilateral exchange rate effect between currency j and CLP. USD is for exchange rate effect between currency j and US dollar. Fixed effects at firm-product-currency-destination level. Controls for the prices equations include the Chilean Producer Price Index and the destination Consumer Price Indices. For quantities, we include as well the destination Gross Domestic Product. Observations at item level from Chile´s National Customs Service. Estimation of non-mining sector for USD and non-dollarized destinations. Clustered (firm) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

confirms the fact that USD is the currency of invoicing, and hence the source of stickiness. However, to now differentiate among the pricing strategies, we need to understand the longer run ERPT.

After eight quarters, we observe that bilateral ERPT has raised to 0.83 and we cannot reject that is statistically different to 1, or that the pass-through is complete. On the other hand, USD ERPT has collapsed to 0.31. Given our discussion in Section 2, this indicates that in the long-run, prices adjust as if firms' strategy is PCP. That is, their optimal price is set in CLP.[13] This result is one of the main findings of this paper that we examine further and provide robustness checks below.

In terms of the effects on quantities, Figure 3b plots the sum of estimates of $\beta_k^{Q,USD}$ and $\beta_k^{Q,BER}$. Consistent with the bilateral ERPT above, we can observe that quantities gradually fall after a bilateral depreciation of the importer's currency, in tandem with the increase in local prices. The implicit price elasticity of exports is about -1.5. This result points to the existence of real adjustment as implied by the Mundell-Flemming framework, which highlights that allocative effects still prevail even when controlling for USD exchange rate fluctuations.

For USD exchange rate fluctuations, there is no significant effect on exports. The lack of significance happens even though the reversal of USD ERPT into prices still needs to be completed after the eighth quarter. Then, we expect some negative and transitory effects on demand, which we fail to find in the data. We defer the discussion of this result to Section 5.4, where we explore this issue in greater detail. We advance that the explanation arises from frictions in the transmission of increased prices at the dock to retail prices, which tend to be more stable. That is, changes in distribution margins partially absorb the effect of exchange rate fluctuations on quantities.

The results of this section suggest that USD fluctuations have measurable effects on export prices over short horizons. The lack of evidence on a significant effect on quantities is suggestive of counterbalancing allocative implications on supply and demand for exports. However, the large and precisely estimated effects on quantities and prices resulting from bilateral exchange fluctuations show that over longer periods, prices behave as in PCP, with its consequent allocative effects on external adjustment. Our result contrasts to Gopinath et al. (2020) where they find that the USD exchange rate has allocative

[13]For completeness, we report in the Appendix the results for the sample that employs information from all currencies to all destinations and the sample that employs all currencies to non-dollarized destinations. This is shown in Appendix Figure A.1 and Appendix Figure A.2 respectively.

effects, but not the bilateral ones.[14]

5.3 Adjustment of prices and quantities when prices are set in destination currency or USD

The descriptive section of our data shows that even though the USD is the most prevalent currency of invoicing, a small fraction of exports are invoiced in other currencies. We proceed to evaluate the importance of different invoicing patterns to the adjustment process to exchange rate shocks; we do that by estimating equations (19) and (20). The sample contains USD invoicing, which is DCP when exported to non-dollarized economies, and LCP when exported to dollarized economies. We consider all destinations, and hence the sample is broader than the one of the previous section.

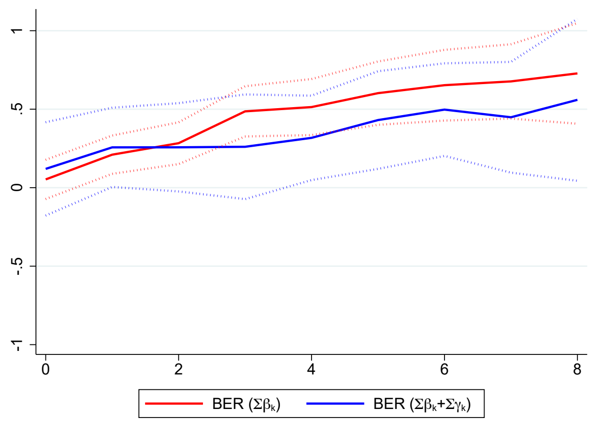
Figure 4 and the first two columns of Table 5 present the results. Recall that the dummy variable is one when exports are invoiced in local currency; therefore, the lines for $\sum \beta_k$ represent the impact of a depreciation of the local currency, against the exporter's currency (BER) or the USD, on local prices and quantities for exports invoiced in dollars. Similarly, the lines for $\sum \beta_k + \gamma_k$ are for exports invoiced in local currency. For transactions invoiced in local currency, Figure 4a and Figure 4c show that the dynamics of bilateral exchange rate movements into prices and quantities, respectively, are similar to the results presented in Section 5.2. On impact, there are no effects, and as time goes on, there is a gradual increase in local prices with a gradual decline in exports. Overall, the response of local prices and quantities to a change in the BER is the same for dollar and local currency invoices. In consequence, the Mundell-Fleming or PCP export adjustment to bilateral exchange rate movements is invariant to the currency of invoicing.

The previous results are for bilateral exchange rate movements, keeping the USD exchange rate constant. Figure 4b and Figure 4d display the dynamics of prices and quantities associated with USD movements, respectively, keeping the bilateral exchange rate constant. In this case, export prices have differential effects depending on the invoicing currency. When exports are invoiced in USD, we maintain the results from the previous sections; that is, in the short-run, the ERPT to prices is close to 1. In contrast, when exports are invoiced in the local currency, the pass-through into prices is not statistically different from zero at any horizon. The result is suggestive that price stickiness is indeed associated with the invoicing currency. Hence, when faced with movements in the USD

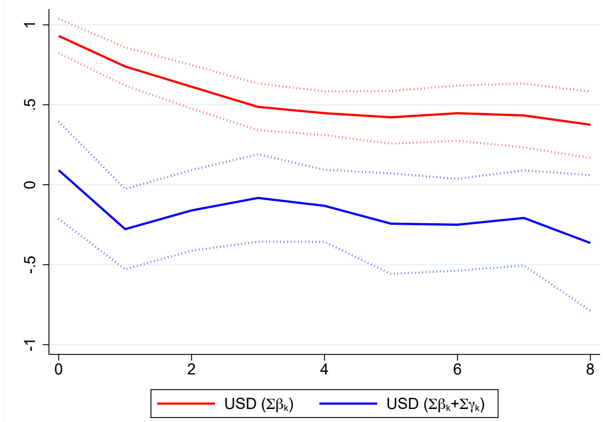
[14] See Table 24 in the Appendix of Gopinath et al. (2020).

Figure 4: Local Currency Invoicing vs USD Invoicing

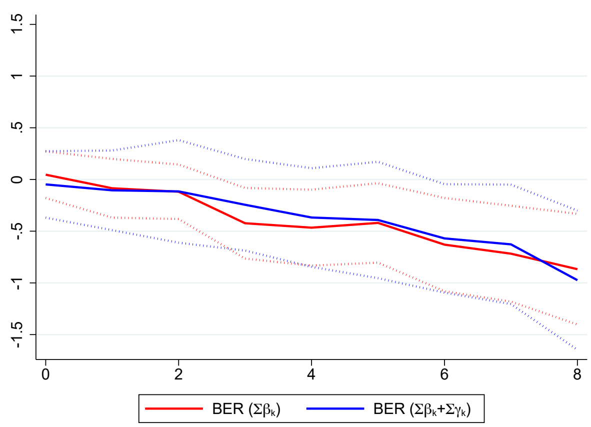
(a) Price, BER



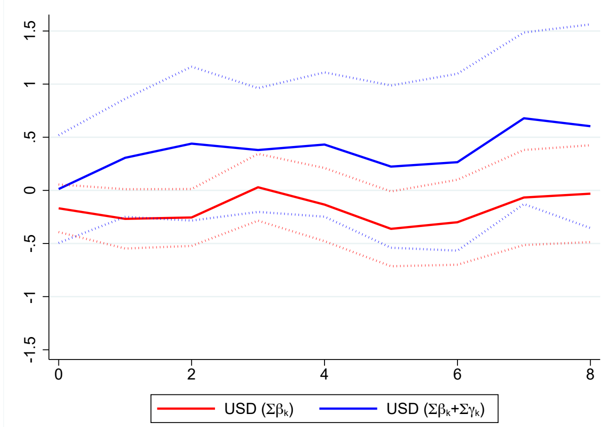
(b) Price, USD



(c) Quantity, BER



(d) Quantity, USD



Notes: Estimation results for (19) and (20). Panel (a) and (b) are for Δp, and Panel (c) and (d) are for Δq as dependent variables. In all panels, red line is the effect for exports invoiced in USD and blue line is the effect for exports invoiced in the currency of destination.Areas between dotted lines represent 95% confidence intervals.

Table 5: Local Currency and USD Invoicing

	Whole sample		Non-USD destinations		Only invoiced in USD	
Dependent Variables:	price	quantity	price	quantity	price	quantity
	(1)	(2)	(3)	(4)	(5)	(6)
β_0^{BER}	0.0528	0.0465	0.0647	0.0094	0.0668	0.015
	(0.0637)	(0.1152)	(0.0711)	(0.1186)	(0.0657)	(0.1158)
$\sum_{k=0}^{4}\beta_k^{BER}$	0.5137***	-0.4659***	0.5168***	-0.4907***	0.5261***	-0.4861***
	(0.0911)	(0.1874)	(0.0863)	(0.1849)	(0.0932)	(0.1898)
$\sum_{k=0}^{8}\beta_k^{BER}$	0.7281***	-0.8674***	0.7707***	-0.9486***	0.7618***	-0.9684***
	(0.1636)	(0.2731)	(0.1497)	(0.2723)	(0.1654)	(0.2757)
γ_0^{BER}	0.0671	-0.0941	-0.1748	0.0589	0.2255	-0.1659
	(0.1289)	(0.1747)	(0.1105)	(0.2119)	(0.1921)	(0.2399)
$\sum_{k=0}^{4}\gamma_k^{BER}$	-0.1961	0.0981	-0.2974**	-0.0489	-0.1608	0.1973
	(0.1231)	(0.2518)	(0.1378)	(0.3917)	(0.1664)	(0.2936)
$\sum_{k=0}^{8}\gamma_k^{BER}$	-0.1683	-0.1063	-0.2685	-0.8416*	-0.1107	0.264
	(0.1983)	(0.3136)	(0.1863)	(0.4567)	(0.29)	(0.394)
β_0^{USD}	0.9305***	-0.1685	0.9136***	-0.1255	0.9249***	-0.1604
	(0.0543)	(0.1143)	(0.0586)	(0.1162)	(0.057)	(0.1171)
$\sum_{k=0}^{4}\beta_k^{USD}$	0.4475***	-0.1337	0.4522***	-0.1489	0.4568***	-0.1914
	(0.07)	(0.1757)	(0.0697)	(0.1769)	(0.0723)	(0.179)
$\sum_{k=0}^{8}\beta_k^{USD}$	0.3753***	-0.031	0.3748***	0.0021	0.3638***	-0.0318
	(0.1056)	(0.2325)	(0.1035)	(0.2338)	(0.1101)	(0.2346)
γ_0^{USD}	-0.8393***	0.1812	-0.6565***	-0.2622		
	(0.148)	(0.2722)	(0.1366)	(0.3129)		
$\sum_{k=0}^{4}\gamma_k^{USD}$	-0.5793***	0.5652	-0.5315***	0.0731		
	(0.1149)	(0.3442)	(0.1323)	(0.3582)		
$\sum_{k=0}^{8}\gamma_k^{USD}$	-0.7399***	0.635	-0.6245***	0.2312		
	(0.2)	(0.4516)	(0.1788)	(0.4757)		
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	101,564	101,564	84,587	84,587	88,656	88,656
R^2	0.0838	0.0609	0.0887	0.0627	0.0881	0.0657

Notes: Results for $\Delta y_{fgjct} = \sum_{k=0}^{8}(\beta_k^{Y,USD} + \gamma_k^{Y,USD} D_{fgjct}^{LC})\Delta e_{USD,j,t-k} + \sum_{k=0}^{8}(\beta_k^{Y,BER} + \gamma_k^{Y,BER} D_{fgjct}^{LC})\Delta e_{CLP,j,t-k} + \alpha D_{fgjct}^{LC} + \theta^{Y\prime} X_{jt}^{Y} + \lambda_{fg}^{Y} + \varepsilon_{fgjct}^{Y}$ in columns (1) and (2). For columns (3) and (4) is the same equation but excluding $\Delta e_{USD,j,t-k}$ as regressors, Y denotes prices or quantities, D^{LC} is 1 if the export is invoiced in local currency and 0 if in USD. Results for $\Delta y_{fgjt} = \lambda_{fg}^{Y} + \sum_{k=0}^{8}(\beta_k^{Y,BER} + \gamma_k^{Y,BER} D_{fgjt}^{US})\Delta e_{CLP,j,t-k} + \sum_{k=0}^{8}\beta_k^{Y,USD}\Delta e_{USD,j,t-k} + \alpha D_{fgjt}^{US} + \theta^{Y\prime} X_{jt}^{Y} + \varepsilon_{fgjt}^{Y}$ in columns (5) and (6), where D^{US} is 1 if the destination is the US, and 0 otherwise. In all the cases, β^0 is the contemporary effect, $\sum_{k=0}^{4}\beta_k$ and $\sum_{k=0}^{8}\beta_k$ is the sum of the coefficient at the 4 and 8 quarters, respectively. γ^0 is the differential contemporary effect, $\sum_{k=0}^{4}\gamma_k$ and $\sum_{k=0}^{8}\gamma_k$ is the sum of the coefficient at the 4 and 8 quarters, respectively. For columns (1) to (4), γ is the differential effect for exports invoiced in local currency. For columns (5) and (6) γ is the differential effects for exports to the US. BER is for bilateral exchange rate effect between currency j and CLP. USD is for exchange rate effect between currency j and US dollar. Fixed effects at firm-product level. Controls for the prices equations include the Chilean Producer Price Index and the destination Consumer Price Indices. For quantities, we include as well the destination Gross Domestic Product. Observations at item level from Chile´s National Customs Service. Estimation of non-mining sector. Clustered (firm) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

exchange rate, the price response depends on the currency of invoicing.

The response of quantities also depends on the exchange rate we consider and the currency of invoicing. The implied elasticity with respect to the BER starts at zero in the short-run, and declines to -1, as in the previous section and regardless of the currency of invoicing. This result is the gradual decline in demand due to increased local prices. For the elasticity of exports to the USD exchange rate, the effect is nil when invoiced in either currency. When invoiced in USD, it replicates our results from the last section. When invoiced in local currency, the response of quantities to the USD is positive and statistically insignificant, consistent with the fact that the ERPT into prices is also absent.

We perform two additional exercises to assess the robustness of our findings. First, we repeat (19) and (20) but exclude the U.S. as a destination. The results are in columns 3 and 4 of Table 5 and in Figure 5. For exchange rate movements and currencies of invoicing, the pass-through and their dynamics are the same as those observed in Figure 4.

Second, we consider only exports invoiced in USD and analyze the pass-through when the destination is the U.S. and when it is not. This exercise allows us to test the USD as a local and as a vehicle currency. For this, we estimate:

$$\begin{aligned}\Delta p_{fgjt} =& \lambda^P_{fg} + \sum_{k=0}^{8}\left(\beta_k^{P,BER} + \gamma_k^{P,BER} D^{US}_{fgjt}\right)\Delta e_{CLP,j,t-k} + \sum_{k=0}^{8}\beta_k^{P,USD}\Delta e_{USD,j,t-k} \\ &+ \alpha D^{US}_{fgjt} + \theta^P X^P_{jt} + \varepsilon_{fgjt},\end{aligned} \tag{21}$$

$$\begin{aligned}\Delta q_{fgjt} =& \lambda^Q_{fg} + \sum_{k=0}^{8}\left(\beta_k^{Q,BER} + \gamma_k^{Q,BER} D^{US}_{fgjt}\right)\Delta e_{CLP,j,t-k} + \sum_{k=0}^{8}\beta_k^{Q,USD}\Delta e_{USD,j,t-k} \\ &+ \alpha D^{US}_{fgjt} + \theta^Q X^Q_{jt} + \varepsilon_{fgjt},\end{aligned} \tag{22}$$

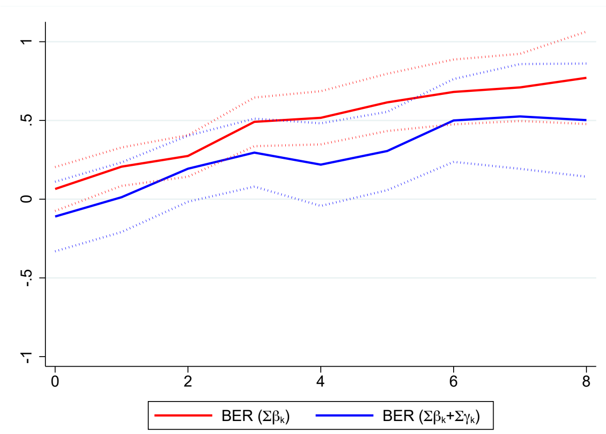
where D^{US}_{fgjt} is equal to one if the destination is the U.S., and zero otherwise.

The results are in columns 5 and 6 in Table 5 and in Figure 6. The results show that prices are sticky in USD regardless of the currency of the destination. Then, they adjust to the higher value of CLP over time, regardless of whether the local currency is the USD (panels (a) and (c)). Panels (b) and (d) consider a depreciation of the local currency respect to the USD, excluding the U.S. There is an ERPT close to one in the short-run, and in eight quarters prices revert partially to its original value since the bilateral exchange rate has remained constant.

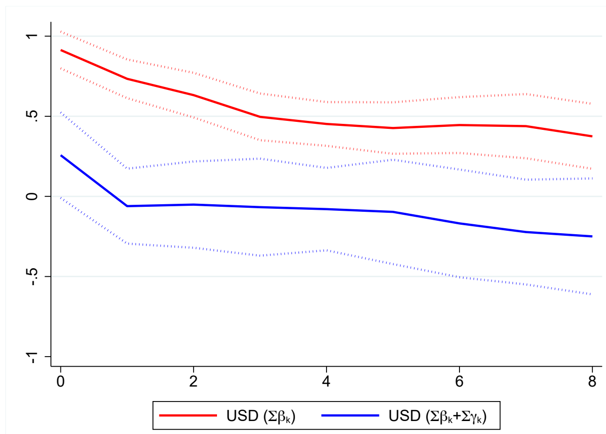
Put together, the last two exercises confirm the baseline. The adjustment of prices and

Figure 5: Local Currency vs USD Invoicing for non USD destinations

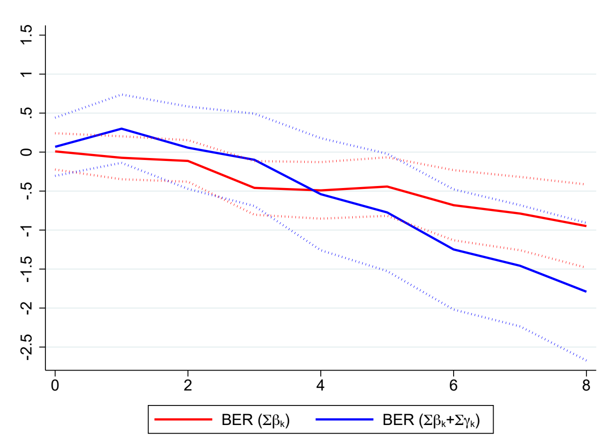
(a) Price, BER



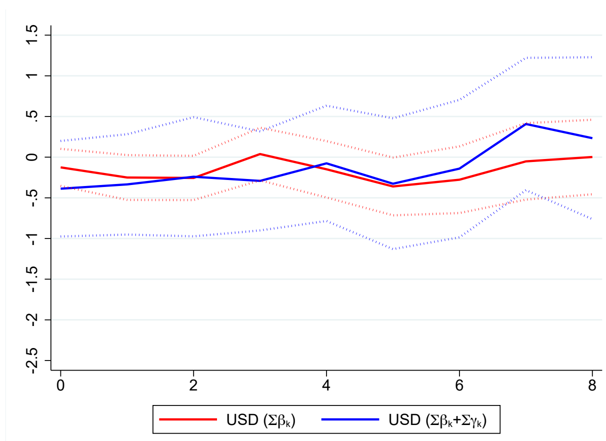
(b) Price, USD



(c) Quantity, BER



(d) Quantity, USD

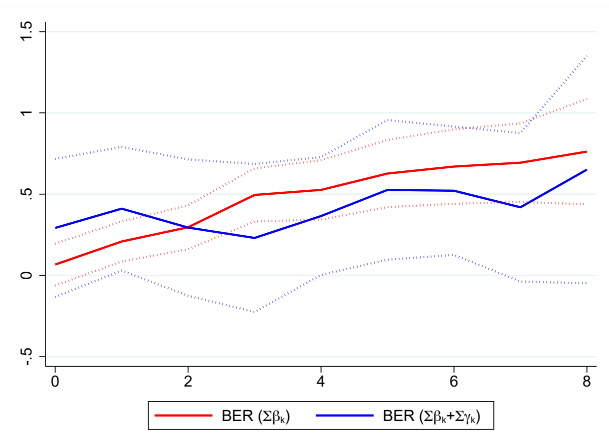


Notes: Results for estimations (19) and (20) but only using non-dollarized destinations, which in our is all countries but the US. Panel (a) and (b) is for Δp and Panel (c) and (d) is for Δq as dependent variable. In all panels, red line is the total effect for exports invoiced in USD and blue line is the total effect for exports invoiced in the currency of destination (local currency). Areas between dotted lines represent 95% confidence intervals.

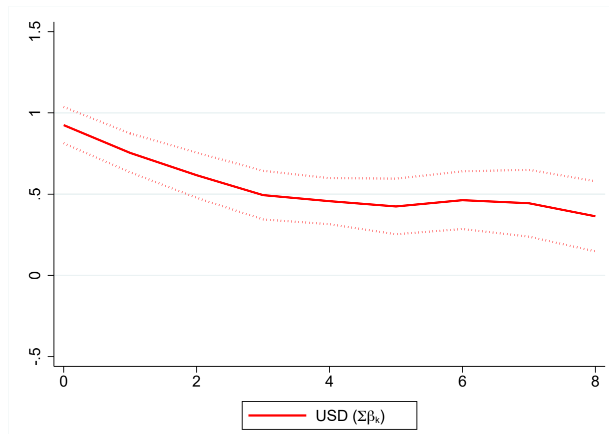
quantities to bilateral exchange rate changes is independent of the currency of invoicing. In the short-run, prices are fixed in the currency of invoicing, and in the long-run they adjust as in PCP.

Figure 6: Exports Invoiced in USD

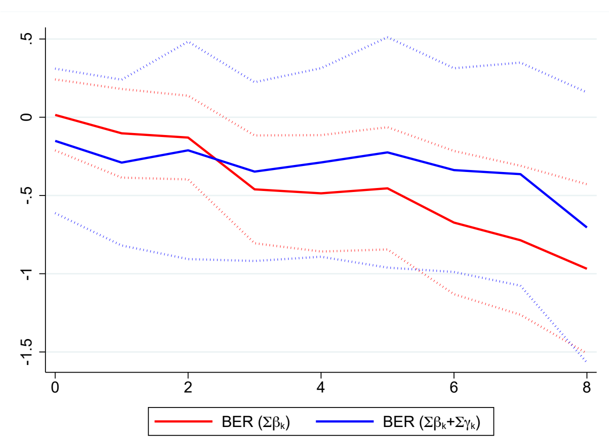
(a) Price, BER



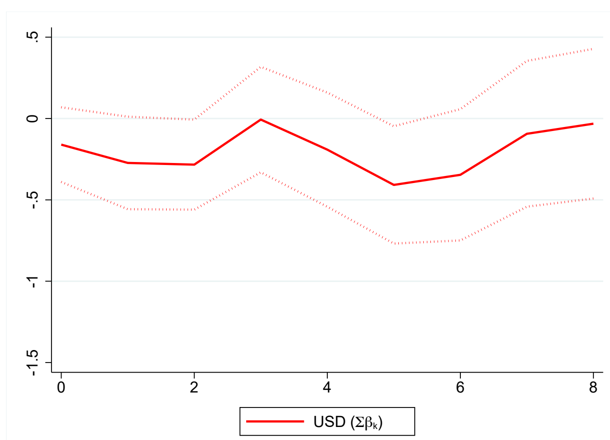
(b) Price, USD



(c) Quantity, BER



(d) Quantity, USD



Notes: Estimation for results for (21) and (22) but only using export invoiced in USD. Panel (a) and (b) is for Δp and Panel (c) and (d) is for Δq as dependent variable. In all panels, red line is the total effect for exports invoiced in USD not to the U.S. and blue line is the total effect for exports invoiced in USD to U.S. Areas between dotted lines represent 95% confidence intervals.

5.4 Quantity effects: A deeper look

For exports invoiced in USD, Figures 3 and 4 show that under a global appreciation of the USD, despite the immediate increase of export prices in local currency, there is a null effect on quantities. The price dynamics suggest that exports decline on impact, and return to their original level in the longer term. There may be other effects on the producers' side or the pass-through from import to retail prices. We explore in detail the quantity effects.

We can now examine the following cases:

(A) MULTILATERAL APPRECIATION OF THE USD. In this case $e_{USD,j}$ increases, while $e_{CLP,j}$ remains constant. This is equivalent to a bilateral depreciation of the CLP against the USD ($e_{USD,CLP}$ increases), while the peso-currency j value remains constant.

A multilateral USD appreciation is the result discussed in Figure 3. When the long-run price is determined in the producer's currency, the long-run USD ERPT is zero because the bilateral exchange rate is kept constant, and therefore exports should be the same at the initial level. However, with sticky prices in USD in the short-run, the local price rises with the depreciation of j to the USD; this is what the blue line of Figure 3a for prices show. The price increase should reduce demand immediately, but the blue line of Figure 3b shows that exports do not change significantly.

One way to interpret the lack of short-term adjustment may be the impact on distribution margins, the difference between consumer prices and prices at the dock. Sanyal and Jones (1982) theoretically show that local costs, e.g., a distribution sector, produce a wedge between domestic and international prices. Burstein et al. (2003), and Goldberg and Campa (2010) quantify the relevance of distribution costs in the domestic economy and evaluate how they affect the real exchange rate and the CPI, respectively; Nakamura and Zerom (2010) estimate that an increase in the international price of coffee beans takes approximately six months to pass through to the coffee retail price completely. Hence, it is arguable that while the price at the dock increases, the change in the final price is sluggish, and quantities remain stable in the short run. More work is needed to examine the pass-through from prices at the dock to retail.

(B) MULTILATERAL DEPRECIATION OF THE IMPORTERS' (j) CURRENCY. In this case $e_{USD,j}$ and $e_{CLP,j}$ increase. In order to examine this case, we use equations (19) and (20) and analyze the impact of multilateral depreciation for transactions invoiced in USD and domestic currency (other than the USD). The first two panels correspond to this case (figures 7a and 7b, while we discuss below the multilateral depreciation of the CLP.

The results show that in the short-run, local prices of goods invoiced in USD increase one-to-one with the depreciation, and then stay constant. This contrasts with quantities adjusting downwards gradually. Interestingly, the decline is not immediate, which is again suggestive of slow adjustment of prices at the level of the final consumer, despite the price at the dock rising immediately. When invoiced in the local currency, prices do not react for any horizon, nor do quantities.

For exports invoiced in the destination currency to non-US destinations, LCP, the price does not change (blue line) since the price is fixed in the invoicing currency, which is the same as the destination. Therefore, prices remain constant. The change in the quantity of exports is not significantly different from zero, consistent with no price change.

(C) MULTILATERAL DEPRECIATION OF THE CHILEAN PESO. This is equivalent to a bilateral appreciation of currency j with respect to the Chilean peso ($e_{CLP,j}$ increases), while the USD-currency j value remains constant. Results are in figure 7c and 7d. In Figure 7c, the vertical axis represents the price of exports in CLP. Since prices are fixed in the invoicing currency – USD or local currency – and the CLP declines in value, the price expressed in CLP increases one-to-one with the multilateral depreciation. The higher price leads to an increase in profits. The price in CLP rises above the PCP prediction, which remains fixed since it is a markup over marginal cost independent of the invoicing currency. Therefore, as time passes, firms will reset the price to a lower price in CLP. Foreign exports' demand increases, and thus total quantity as Figure 7 (b) shows.

Remarkably, for transactions settled in USD, the 8-quarters value of Figure 7 panels 7b and 7d red lines, with a flipped sign, are not statistically different. The result aligns with the predictions of equation 6, where the long-run adjustment of quantities equals the elasticity of demand, μ.

Overall, the results for quantities are consistent with the theoretical predictions of Section 2. The only caveat is that when the local currency depreciates against the USD, there is an instant price increase with no significant effect on quantities at all horizons. We rationalize this fact by incomplete pass-through from prices at the dock to consumer prices and firms' price settings reflecting domestic marginal costs. More empirical research on this issue is needed.

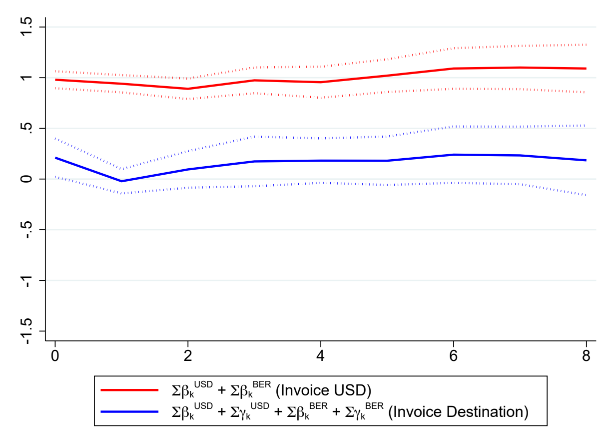
5.5 Sectoral results and robustness exercises

To make sure a particular specification does not drive our results, we extend the analysis carried out in (17) and (18) for different samples, data cleaning, or variables definition. We start by carrying out the same exercises but by economic sector. We do this to understand whether our results might be explained by specific sectors driving the results.

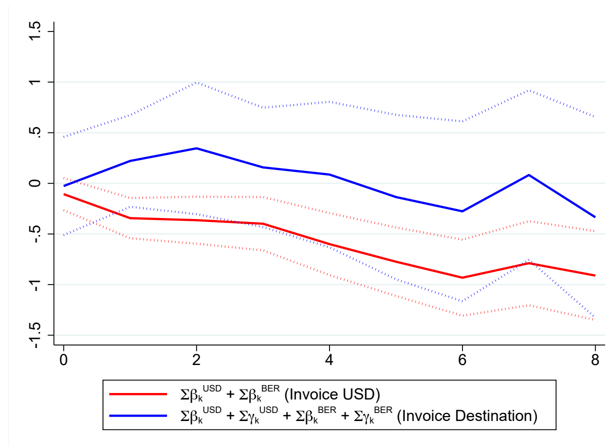
Table 6 presents results for estimating (17) using sectoral dummies. The nil result for

Figure 7: Multilateral depreciation

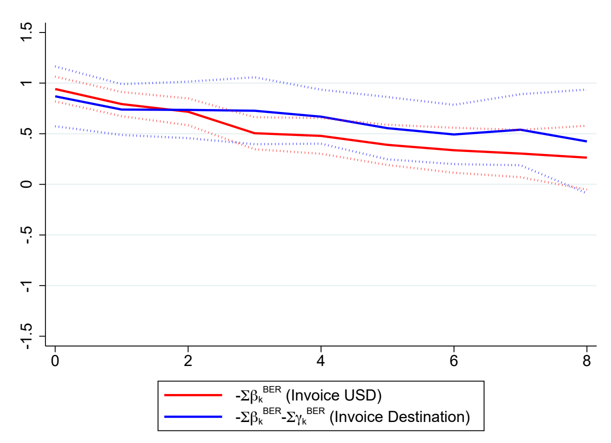
(a) Multilateral depreciation of curr j. Price



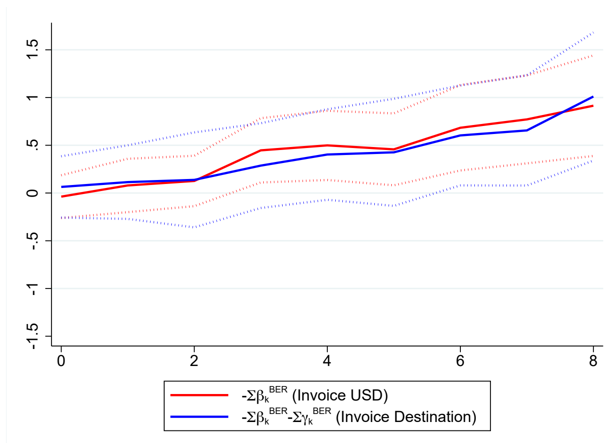
(b) Multilateral depreciation of curr j. Quantity



(c) Multilateral depreciation of CLP. Price



(d) Multilateral depreciation of CLP. Quantity



Notes: Estimation results for (19) and (20). Panel (a) and (b) is for a multilateral depreciation of currency j and panel (c) and (d) is for multilateral depreciation of CLP. In all panels, red line is the total effect for exports invoiced in USD and blue line is for exports invoiced in the destination currency. To facilitate discussion panels (c) and (d) present the price in domestic (CLP) currency in the vertical axis, in all other figures are in local currency.

bilateral ERPT in the short-run, and the consequent rise in the longer run is pervasive across sectors, with the exception of the Fishing industry and the Basic metal industry. Similarly, the immediate near complete pass-through of USD ER fluctuations, and the ensuing fall in eight quarters also holds for the majority of sectors. This is in line with the baseline results, but with substantial noisier estimates. A potential reason for those two specific sectors is that their products are more homogeneous and, hence, more similar to commodities, where prices are flexible and close to be taken as given by firms.[15]

Table 6: Bilateral and USD ERPT per Sector

Model:	Price					
Variable:	β_0^{BER}	$\sum_{k=0}^{4}\beta_k^{BER}$	$\sum_{k=0}^{8}\beta_k^{BER}$	β_0^{USD}	$\sum_{k=0}^{4}\beta_k^{USD}$	$\sum_{k=0}^{8}\beta_k^{USD}$
Fishing industry	0.5698***	0.6208***	0.6458***	0.2242***	0.3218***	0.3889**
	(0.0756)	(0.1246)	(0.1769)	(0.0929)	(0.1251)	(0.1804)
Food	0.0594	0.3934*	0.7369*	0.8813***	0.4747***	0.3331**
	(0.0987)	(0.2354)	(0.3896)	(0.0662)	(0.104)	(0.1514)
Alcohol, beverages and tobacco	-0.0279	0.2678***	0.4091***	0.8757***	0.3962***	0.343**
	(0.0608)	(0.1064)	(0.1697)	(0.0708)	(0.12)	(0.1633)
Wood products	-0.038	0.3414***	0.2788	0.8642***	0.1194	0.0919
	(0.1398)	(0.0981)	(0.1979)	(0.1121)	(0.1845)	(0.2442)
Pulp, paper and printing	0.3223	0.7027***	0.6093*	0.8032***	0.4208	0.5594**
	(0.32)	(0.301)	(0.3564)	(0.1566)	(0.3459)	(0.2839)
Chemical industries	0.0151	0.5915**	1.0749***	0.7732***	0.4768***	0.1619
	(0.1125)	(0.2654)	(0.4239)	(0.1363)	(0.186)	(0.2002)
Rubber and plastic	-0.2223	0.0246	0.439	1.3332***	0.8455***	0.6268**
	(0.2527)	(0.2785)	(0.4712)	(0.1777)	(0.2919)	(0.286)
Basic metal industry	0.1221	0.2207	0.1163	0.3889*	0.2195	0.3243
	(0.2321)	(0.3327)	(0.4909)	(0.2101)	(0.3614)	(0.3661)
Metal prod., machinery and equip.	0.2336	0.9931***	1.7285***	0.8905***	0.3048	-0.1275
	(0.297)	(0.3611)	(0.5604)	(0.2565)	(0.3528)	(0.477)
Other industries	0.1566	0.4648	0.3559	0.9083***	0.236	0.3773
	(0.2778)	(0.3122)	(0.6171)	(0.223)	(0.3581)	(0.4375)
Mean	0.1191	0.4621	0.6394	0.7943	0.3816	0.3079
Transaction-weighted mean	0.1061	0.4365	0.6366	0.8101	0.3954	0.3014
Value-weighted mean	0.1781	0.5285	0.6666	0.7334	0.3792	0.3295

Notes: Price baseline regression interacting with each relevant sector. A sector is relevant if Exports value (%) > 0.01 according to Table A.2, sectors with Exports value (%) < 0.01 are added in other industries category. Sectors according to economy activity code-42 from Harmonized System Codes (HSC). Fixed effects at firm-product-currency-destination level. Observations at item level from Chile´s National Customs Service. Sectors in descending order by Exports value. Clustered (firm) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

In addition, we perform some robustness exercises. First, we consider a different definition of prices, using median or mean prices instead unit values as computed in Section 3. Second, we use standard errors clustered at the time-destination level instead of the

[15] Appendix Table A.3 presents the results for quantities.

firm level, which is the clusterization used in Amiti et al. (2022). Third, we change the control variables, by omitting alternatively the destination's GDP, the destination's CPI, Chile's PPI, or a combination of those. Fourth, we improve the definition of a product by combining the HS8 classification with the units of measure of the export.[16] Finally, we clean the data in a less strict way to allow for more observations to be included in our regression. The results do not change substantially for all the cases mentioned above.

6 Conclusions

This paper shows that the USD exchange rate with respect to the destination currency is relevant to the price of Chilean exports over short horizons, even if the U.S. is not directly involved in the transactions. The result is strong evidence for DCP in the short-run. However, it is less so in the long-run, where bilateral exchange rates play the traditional role implied by the Mundell-Fleming open economy model, particularly regarding the effects on export volumes. This is, in the long-run prices adjust to the value of the producer's currency. We consider different variations of standard ERPT regressions to gauge the role of the USD and bilateral exchange rates in the macroeconomic external adjustment process. In all cases, price stickiness in the currency of invoicing seems a significant friction in the short-run, which lessens in the longer run in favor of pricing as in the currency of the exporter, the CLP.

Our results provide important policy implications for emerging market economies, where transactions are primarily settled in USD. We show that, in the short-run, global appreciation of the USD increases destination prices in local currencies, although exported quantities do not fall to a large extent. In the long-run, prices should return to its original level, keeping the BER constant. Therefore, the lack of quantity adjustment could be the result of limited short-run pass-through from prices at the dock to final consumer prices and the fact that price resetting from exporting firms undo the global appreciation of the USD. When exports are settled in local currency, changes in BER or USD ER are unlikely to affect prices and quantities in the short-run.

Over the long-run, predictions akin to PCP become a better description of the macroeconomic external adjustment process: prices adjust gradually to changes in the bilateral exchange rate, and quantities react to reflect movements in the demand curve as the standard Mundell-Fleming predicts, albeit in a delayed fashion. Remarkably, the dynamics of

[16]These can be meters, square meters, liters, metric tons, carats, dozen, hundred, among others.

the bilateral ERPT and its allocating implications are invariant to the invoice currency. On the policy front our results are more optimistic regarding external adjustment to exchange rate movements than the implications of DCP.[17]

Several directions for future work follow from our results. On the quantitative side, models studying the design of optimal monetary policy in the context of short-run DCP and price resetting towards the optimal price in the exporter's currency seem a helpful area of research for small open economies. On the empirical one, the availability of granular data from different sources at the firm level, coupled with transaction-level data between firms and at the consumer level, provides a fruitful avenue for further exploration of the nature of macroeconomic adjustment from exchange rate fluctuations.

[17]For a policy discussion see Adler et al. (2020)

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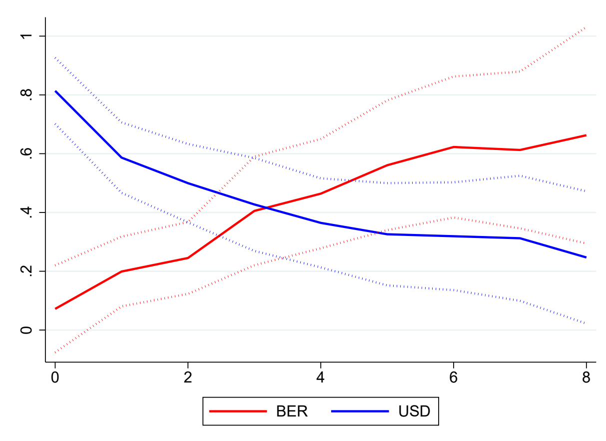
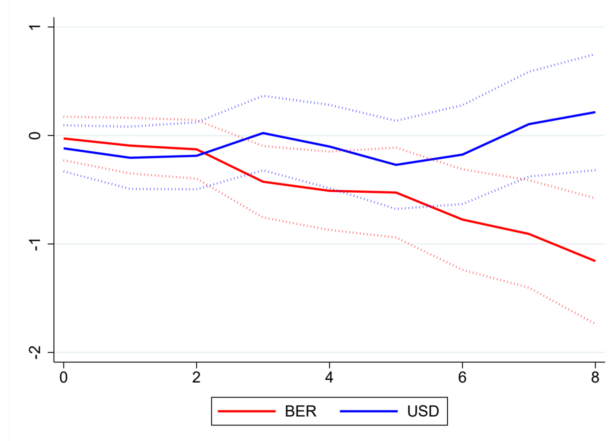
A Additional Tables and Figures

Figure A.1: All currencies, all destinations

(a) Price



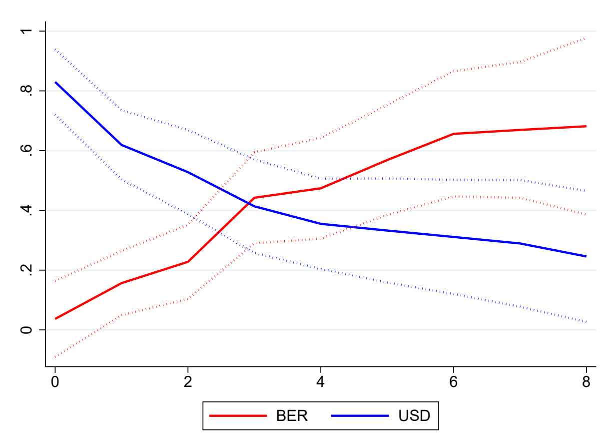
(b) Quantity



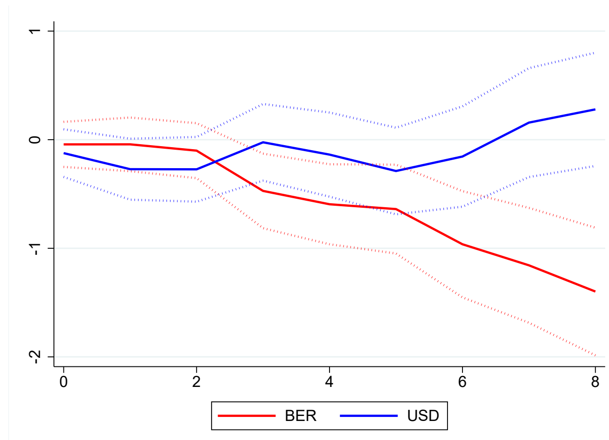
Notes: Results for estimation (17) in panel (a) and (18) in panel (b), using non-mining sector and considerating all currencies and all destinations. Panel (a) plots the sum of $\beta_k^{P,BER}$ and $\beta_k^{P,USD}$. Panel (b) plots the sum of $\beta_k^{Q,BER}$ and $\beta_k^{Q,USD}$.

Figure A.2: All currencies, non-dollarized destinations

(a) Price



(b) Quantity



Notes: Results for estimation (17) in panel (a) and (18) in panel (b), using non-mining sector and considerating all currencies and non-dollarized destinations. Panel (a) plots the sum of $\beta_k^{P,BER}$ and $\beta_k^{P,USD}$. Panel (b) plots the sum of $\beta_k^{Q,BER}$ and $\beta_k^{Q,USD}$.

Table A.1: Export Value and Transaction per Destination

Destination	Value(%)	Transaction(%)
USA	23.35	42.4
China	15.35	4.31
Japan	10.47	4.33
Brazil	9.57	6.92
Peru	6.10	13.86
Netherlands	5.78	1.94
Mexico	5.50	4.66
South Korea	4.47	2.02
Colombia	3.70	5.53
Italy	2.33	0.62
Belgium	2.08	0.28
United Kingdom	1.92	3.77
Canada	1.35	3.23
Spain	1.32	1.12
Germany	1.18	0.66
Costa Rica	1.07	1.15
Australia	1.01	1.23
Russia	0.97	0.96
France	0.93	0.39
Thailand	0.59	0.18
India	0.57	0.10
Sweden	0.30	0.28
Turkey	0.05	0.03
Switzerland	0.02	0.03

Notes: Value represent the FOB value percentage of exports and transaction represent the number of transactions in percentage both considering non-mining data. *Source*: Author´s own calculations are based on Chile´s National Customs Service.

Table A.2: Export Value and Transaction per Sector

Sector	Macrosector	Value (%)	Transaction (%)
Pulp, paper and printing prod. prod.	Manufacturing industry	24.14	4.53
Chemical industries	Manufacturing industry	18.03	7.15
Fishing industry	Manufacturing industry	15.57	16.73
Wood and furniture manufacture	Manufacturing industry	12.21	15.31
Rest of the food industry	Manufacturing industry	9.07	9.41
Wine elaboration	Manufacturing industry	5.72	18.85
Basic metal industry	Manufacturing industry	4.28	0.91
Metal prod., machinery and equip. manuf.	Manufacturing industry	3.88	9.20
Rubber and plastic production	Manufacturing industry	3.42	12.47
Other beverages and tobacco prod. elab.	Manufacturing industry	1.50	1.51
Fruit growing	Agricultural and Fishing	0.57	0.92
Textile industry	Manufacturing industry	0.49	1.55
Fishing	Agricultural and Fishing	0.42	0.15
Fuels elaboration	Manufacturing industry	0.20	0.07
Agriculture	Agricultural and Fishing	0.18	0.30
Non-metallic minerals manufacture	Manufacturing industry	0.15	0.57
Elect. gas and water supply	Elect. gas and water supply	0.12	0.17
Silviculture	Agricultural and Fishing	0.06	0.07
Ranching	Agricultural and Fishing	0.05	0.03
Other manufacturing industries	Manufacturing industry	0.01	0.12
Information services	Transport, info. and comm.	0.00	0.01

Notes: Sectors according to economy activity code-42 from Harmonized System Codes (HSC). Relevant sectors are those with Exports value (%) > 0.01, sectors with Exports value (%) < 0.01 are added in other industries category as shown in Table 6 and A.3. Sectors in descending order by Exports value.

Table A.3: Bilateral and USD Quantities per Sector

Model:	Quantity					
Variable:	β_0^{BER}	$\sum_{k=0}^{4}\beta_k^{BER}$	$\sum_{k=0}^{8}\beta_k^{BER}$	β_0^{USD}	$\sum_{k=0}^{4}\beta_k^{USD}$	$\sum_{k=0}^{8}\beta_k^{USD}$
Fishing industry	-0.1914	-0.494	-0.8178	0.2323	0.2615	0.7676
	(0.3112)	(0.389)	(0.5458)	(0.3161)	(0.4117)	(0.5767)
Food	-0.1038	-0.4326	-1.4729***	-0.3513*	-0.4575	-0.1175
	(0.1568)	(0.301)	(0.4469)	(0.1857)	(0.2993)	(0.3477)
Alcohol, beverages and tobacco	-0.0428	-0.7243***	-1.6233***	-0.0798	0.3618	0.8537**
	(0.1356)	(0.2615)	(0.4203)	(0.171)	(0.29)	(0.4089)
Wood products	0.0787	-0.4351	-1.0196	0.1281	-0.7305**	-0.1025
	(0.2915)	(0.4221)	(0.6577)	(0.2792)	(0.3311)	(0.4689)
Pulp, paper and printing	-0.5544	0.045	0.1425	0.2911	-0.2492	-0.0818
	(0.5478)	(0.3901)	(0.691)	(0.4394)	(0.4266)	(0.6174)
Chemical industries	0.055	-0.4899	-1.2126**	-0.0683	-0.12	0.2802
	(0.2654)	(0.4223)	(0.5981)	(0.2898)	(0.2828)	(0.3659)
Rubber and plastic	0.4549	-0.2798	-0.8454	-0.7157**	-0.5636	-0.4877
	(0.3853)	(0.5062)	(0.8421)	(0.3394)	(0.4216)	(0.6095)
Basic metal industry	-0.7785	-0.5278	-1.0257	0.3387	-0.9063	-1.4086
	(0.4845)	(0.7181)	(1.1053)	(0.6104)	(0.66)	(1.0477)
Metal prod., machinery and equip.	-0.0216	-0.9772	-1.6151*	-0.0614	0.4359	0.7226
	(0.382)	(0.5996)	(0.8295)	(0.353)	(0.5173)	(0.6022)
Other industries	0.328	-0.576	-0.4855	-0.7063*	0.3869	0.6037
	(0.372)	(0.5428)	(0.8466)	(0.3919)	(0.6272)	(0.7776)
Mean	-0.0776	-0.4892	-0.9975	-0.0993	-0.1581	0.1030
Transaction-weighted mean	0.0009	-0.5227	-1.1247	-0.1021	-0.0806	0.3084
Value-weighted mean	-0.1681	-0.3816	-0.8329	0.0445	-0.1784	0.1529

Notes: Quantity baseline regression interacting with each relevant sector. A sector is relevant if Exports value (%) > 0.01 according to Table A.2, sectors with Exports value (%) < 0.01 are added in other industries category. Sectors according to economy activity code-42 from Harmonized System Codes (HSC). Fixed effects at firm-product-currency-destination level. Observations at item level from Chile´s National Customs Service. Sectors in descending order by Exports value. Clustered (firm) standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.

Disclaimers:

The views expressed are those of the authors and do not necessarily represent the views of the Central Bank of Chile (CBC) or its board members.

This study was developed within the scope of the research agenda conducted by the CBC in economic and financial affairs of its competence. The CBC has access to anonymized information from various public and private entities, by virtue of collaboration agreements signed with these institutions.

To secure the privacy of workers and firms, the CBC mandates that the development, extraction and publication of the results should not allow the identification, directly or indirectly, of natural or legal persons. Officials of the Central Bank of Chile processed the disaggregated data. All the analysis was implemented by the authors and did not involve nor compromise the SII, Aduanas and AFC.

The information contained in the databases of the Chilean IRS is of a tax nature originating in self-declarations of taxpayers presented to the Service; therefore, the veracity of the data is not the responsibility of the Service.