From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports

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Abstract

We revisit a central question for international macroeconomics, which is the pass-through from exchange rate (ER) movements into export prices and quantities. To do so, we use a large and comprehensive dataset for Chile, and study how the effects vary over time with the currency of invoicing and the destination of exports. For prices, we find that the effect of bilateral ERs collapses when we control for U.S. dollar (USD) ER, which lends support to the dominant currency paradigm. However, this only holds in the short-run. The longer the horizon, the larger the role is played by bilateral ERs, which lends support to the producer currency paradigm. More striking is that this dynamic does not depend on the invoicing currency. Finally, we find consistent results for quantities. Therefore, bilateral ERs do play an important role in resource reallocation.

Keywords: Currency of invoicing, Emerging markets, Dominant currency paradigm
JEL codes: F14, F31, F41.

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1 Introduction

External adjustment is a central topic in international finance, from both an analytical point of view as well as with regards to policy recommendations. The appropriateness of flexible versus fixed exchange rates depends, among other things, on the impact that fluctuations in the nominal exchange rate have on relative prices and resource reallocation. In the Mundell-Fleming workhorse model – an extension to the open economy of the single good Keynesian macroeconomic model – exporters fix their prices in their home currency. Therefore, a depreciation of the exporter's currency with respect to the currency at destination reduces the price of the good in foreign currency at the destination market, hence increasing the volume of exports due to the downward slope of export demand, everything else constant. This pricing paradigm is denominated Producer Currency Pricing (PCP). However, noting a low pass-trough from exchange rate to prices,[1] an alternative pricing mechanism was proposed, in which prices are set in the (local) currency of the destination market. This has been dubbed Local Currency Pricing (LCP). A mayor implication of LCP is that exchange rate fluctuations do not promote external adjustment. As export prices in the destination market and import prices in the domestic market both remain fixed, neither production nor expenditure switching occurs from exchange rate movements and thus external adjustment is impaired.

More recently, it has been noted that a large fraction of international transactions is invoiced in US dollars (USD); a fraction in fact much larger than the role of the US and dollarized countries in global trade.[2] This led to the idea that firms carry out Dominant Currency Pricing (DCP) (Gopinath et al., 2020), and this being the USD. Under DCP, a depreciation of a country's currency, solely against non-dollarized economies, does not induce changes in export prices in the destination country's currency, because prices are fixed in USD. Consequently, the bilateral depreciation does not generate production switching effects through a higher demand for exports. Neither does it generate expenditure switching effects, as import prices are also set in USD, and the currency is only depreciating against non-dollarized currencies. A depreciation of the currency only against the USD dollar does not impact export volumes in any destination (prices remain fixed in USD), but does reduce imports, since the price in local currency increases.

In this article we quantify the degree of PCP, LCP, and DCP over different time hori-

[1] This has been extensively documented in Takhtamanova (2010); McCarthy (2007); Campa and Goldberg (2005); Gopinath and Rigobon (2008); Goldberg and Knetter (1997); Goldberg and Campa (2010).

[2] The first paper to explore the use of a *third* currency was Goldberg and Tille (2008) when they coined the term Vehicle Currency Pricing (VCP).

zons, we also assess whether movements in the USD and bilateral exchange rates have allocative implications. Using customs data from Chile, a country in which roughly 90% of their exports are invoiced in USD, we characterize the degree of exchange rate pass-through using detailed information about the currency in which transactions are settled. The degree of USD and bilateral exchange rates pass-through is informative of the degree of PCP, LCP, and DCP. We show that over shorter horizons there is strong evidence of price stickiness in the currency of invoicing, either the USD or the destination currency; this is consistent with DCP and LCP. In the case of the USD we find that it has allocative implications. At longer horizons, however, exporters reset their prices according to the PCP benchmark, with quantities reacting accordingly. To the best of our knowledge, this is the first article that provides evidence that the adjustment process of the bilateral exchange rates is independent of whether transactions are invoiced in USD or the destination country currency, in addition to the USD having no effect on transactions invoiced in other currencies.

Most Chilean exporting firms invoice their products in USD, yet it is not obvious that the prevalence of USD invoicing is borne out of optimal currency choice considerations. Chile is a small open economy, with free trade agreements across the globe, and thus it is natural that the currency for conducting foreign trade should be the most readily used currency, and that is the USD. Then, Chile is a *currency taker* with most firms invoicing in USD, and only a small fraction invoicing in a different currency. This leads price stickiness to potentially be in the USD, which in turn can be due to menu costs or other frictions including the role of the USD in global financial flows and trade invoicing, but it does not necessarily follow that it is the optimal currency choice to set prices as discussed for example in Engel (2000). As a non-dollarized economy, in which the financial statements of Chilean firms are overwhelmingly accounted in Chilean pesos (CLP), it is quite possible that profit maximization considers domestic profits and returns in the long run in CLP. This is borne also out of informal discussions with local exporters. There is home bias and without frictions they could set their price in CLP, something consistent with the evidence we report in this paper. Perhaps some firms can choose more readily their currency of invoicing, but as our data show, they tend to be larger firms.

Although the long-run Chilean peso returns are the critical profitability constraint, the costs of permanently adjusting their prices to the USD could result in short term price stickiness in the invoicing currency. Thus, being the USD an important invoicing currency for most of exports, it is natural to presume that in the short run prices are sticky in USD, but as time goes by, prices would be reset looking at the optimal price in their preferred

currency, i.e., the CLP. Over the long run the pricing outcome for exporters could be more similar to PCP. The extent to which this short-term versus long-term pricing behaviour of exports can be discerned from an empirical analysis. In particular, the correlation between the movements in the price of exports in the destination currency, and movements with respect to both the destination's exchange rate and with respect to the importer's currency/USD exchange rate. This is distinct from the issue of the prevalence of a certain invoicing currency such as the USD in international trade transactions.

The response of export prices in the destination market's currency, to both bilateral exchange rate fluctuations and the destination's exchange rate to the USD, can shed light on the prevalence of different pricing strategies over different time horizons. To simplify the argument, consider two destinations for Chilean wine exports: the US and the UK. If exporters base their pricing decision on a DCP paradigm, that is the USD price of wine is constant, a depreciation of the British pound against the CLP, keeping constant the Sterling Pound (GBP)/USD exchange rate, should not change wine prices in the UK when expresseed in GBP. However, a depreciation of the GDP against the USD, keeping constant the GBP/CLP exchange rate, should increase the price of wine in the UK when expressed in GBP. If, on the other hand, export prices are sticky in GBP, because of LCP considerations, the wine price in GBP is constant irrespective of the GBP/USD or GBP/CLP exchange rate. Finally, if exporters aim at keeping the price of wine constant in Chilean pesos, a depreciation of the GBP vs the CLP will increase the wine price in GBP. If the GBP instead solely depreciates against the USD, then the price of wine in GBP will remain constant. These different reactions of export prices in the destination currency can be identified through the correlation of export prices in the destination currency and exchange rate fluctuations. Note that we have made this discussion without referring to the currency of "invoicing." However, it is likely that the currency of invoicing is precisely the currency in which prices are sticky in the short run, something we confirm in this paper.

Estimating the dynamics of exchange rate pass-through (ERPT) of bilateral as well as USD exchange rates to prices at destination (local prices in local currency), we find that in the short run (one quarter) they conform with a DCP paradigm. Keeping constant the destination currency exchange rate against the USD, its depreciation against the CLP does not change the price of exports in the destination currency. However, its depreciation against the USD does increase the price of exports almost one to one. These two results are consistent with the DCP paradigm, and they have been noted before, forming the basis for the argument that DCP is an important factor in shaping external adjustment (Gopinath et al., 2020). However, over a longer time horizon, we find that the size of these

correlations change over time. On the one hand, after eight quarters the bilateral depreciation gives rise to a material change in the price of exports, and the USD depreciation leads to a more muted effect on export prices. This is suggestive, in our view, that over that horizon pricing of exports is closer to a PCP paradigm. This result has been visible in previous research (Gopinath et al., 2020), but not been appropriately highlighted. Indeed, the evidence for Chilean exports, shows that the proper paradigm would be *from short term DCP to long term PCP*. Moreover, as this paper shows, regardless the currency of invoicing, the price moves to the PCP counterpart over the medium term.

In our dataset a small, but non-negligible fraction of exports, are invoiced in currencies other than the USD. Around 9% of exporting firms invoice in other currencies, and these are firms that are larger (median employees are 2.6 times and median exports 4.7 times larger than USD invoicing firms) and more diversified in terms of destinations as well as products (three and two times respectively for the median firm). We separately identify exports to different destinations invoiced in different currencies, and we estimate how the previous correlations change when exports are invoiced in the currency of destination instead of the USD. Following up on our simple two destination-one good example, we are able to estimate the correlation of the export price of wine to the UK in GBP, when exports are invoiced in USD versus when they are invoiced in GBP. We find that, for exports invoiced in local currency, neither a bilateral nor a USD depreciation has a significant effect in the short-run on the local price of exports. Over time, the bilateral depreciation leads to changes in the local currency price of exports. This suggests that in the short-run, for exports invoiced not in USD but in the local currency, pricing is sticky in the short-run in the invoicing currency, but eventually moves closer to what appears a PCP paradigm.

As the motivation for studying pricing of exports is a concern about the impact of exchange rate movements on the external adjustment of economies, we then estimate the effects of, exchange rates on the quantities, and not the prices, exported. We find that quantities are fairly inelastic in the short run to both bilateral and USD exchange rate movements, but over time the effect adds up and ends resulting in a substantial change of export volumes after eight quarters. Given that the point estimate of the effect of a bilateral depreciation on prices is 0.82 and the point estimate of the quantity effect is -1.36, this produces an implicit trade elasticity of 1.65, which is economically significant. The quantity responses to USD exchange rate movements are significantly more muted at all horizons, although a slight 'U' shaped response is not very precisely obtained. The joint estimated effects of exchange rates fluctuations on prices and quantities movements are suggestive and consistent with a gradual build-up over several quarters of a Mundell-

Fleming-type of macroeconomic adjustement to bilateral exchange rate movements. This, notwithstanding the fact that in the very short-run, export prices are indeed sticky in the currency of invoicing.

The rest of the paper is organized as follows. Section 2 provides a discussion to benchmark the results of our empirical exercise. Section 3 describes the data used in the analysis and present descriptive statistics about the currency of invoice in Chile. Section 4 discusses the methodology of our empirical exercises. Section 5 presents the empirical results about the impact of different exchange rates changes on firms' export prices and quantities. Section 6 concludes.

Related literature. Our paper is related to three strands in the literature. First, there is a vast amount of papers computing the exchange rate pass-through into export and import prices using microeconomic data. Burstein and Gopinath (2014) and Gopinath and Itskhoki (2022) review the state of the art. We add to this literature by studying a developing country and focusing not only on prices, but also on quantities.

TBD

2 Exports Pricing and ERPT

In this Section we provide the conceptual framework for the empirical approach below. We first describe the problem the firm faces and what its optimal price es. Then, we focus on six different cases that depend on the different currencies of invoicing and pricing strategies.

2.1 Pricing in international markets

Consider the case in which the exporter wants to set the optimal price maximizing the domestic currency profits. We denote the optimal log price of firm f, expressed in the Chilean pesos (CLP),[3] exported to country j, at time t as $\tilde{p}_{f,j,CLP,t}$. This price solves the following problem:

$$\tilde{p}_{f,j,CLP,t}\left(\Omega_t\right) = \max_{p_{f,j,CLP,t}} \Pi\left(p_{f,j,CLP,t} \middle| \Omega_t\right),$$

where Ω_t represents all the states of the world. This can be called the "optimal PCP price."

[3] Alternatively, it can can also be expressed in an arbitrary currency c.

We denote by $\mathcal{E}_{i,j,t}$ the price of currency j in terms of currency i at time t. We also define $e_{i,j,t} = \log \mathcal{E}_{i,j,t}$. Ignoring the t subindex we have that when $e_{i,j}$ increases, currency i depreciates with respect to j, that is, the price of currency j increases with respect to currency i (an increase in e is a depreciation of the currency represented by the first subindex). For most of the discussion we will have the following three exchange rates:

- $e_{CLP,USD}$ is the value of the USD in Chilean peso units, and an increase represents a CLP depreciation with respect to the USD.
- $e_{USD,j}$ is the log of the value of currency j in terms of USD units. Country j will be, in most of the discussion, the country of destination of Chilean exports. An increase in this exchange rate is a depreciation of the USD with respect to currency j.
- $e_{CLP,j}$ is the bilateral exchange rate of currency j with respect to the Chilean peso, and an increase is a depreciation of the Chilean peso with respect to currency j.

In absence of strategic complementarities, and when firms face an isoelastic demand function, the desired flexible price of the firm is:

$$\tilde{p}_{f,j,CLP,t}\left(\Omega_t\right) = \mu + (1-\alpha)w_t + \alpha\left(m_t + e_{CLP,USD,t}\right) - a_{ft}, \tag{1}$$

where μ is a markup, a_f is productivity of the firm, w are wages, $m + e$ the value of imported inputs in exporter's currency, and α the share of imported inputs in total costs. This is a general set-up, but we will leave imported inputs aside for the initial exercise, retaking them in following sections. Note that in this setup we exclude the effect of imported inputs, which we consider in following sections.

In what follows we propose some simple cases which distinguish the currency under which prices are sticky, and the currency in which optimal prices are calculated when firms can reset them. We will consider 6 cases, as the combination of two assumptions for price rigidity, in local currency or USD, and three optimal prices, DCP, LCP and PCP. After that we discuss some extensions to the basic analysis.

2.2 Fixed prices vs. optimal prices

In the following discussion we will analyze different pricing strategies for exports to destination j, and to simplify notation we will ignore the index for destinations since it is always to cuountry j. Thus, $p_{f,c,t}$ represents price of exports from firm f expressed in currency c at time t.

(A) PRICE STICKINESS IN THE DOMINANT CURRENCY AND PCP

We consider the case in which exports are invoiced in USD. The local price, in its domestic currency, of good produced by firm f at time t is:

$$p_{f,j,t} = \tilde{p}_{f,CLP,t} + e_{CLP,USD,t} + e_{USD,j,t},$$

where $e_{CLP,USD,t}$ transforms the price of exports in CLP to USD, the currency of invoicing and in which prices are sticky. On the other hand, $e_{USD,j,t}$ transforms the price in USD to local currency. This is equivalent to transforming the price from pesos to local currency at a bilateral exchange rate $e_{CLP,j,t}$. That is, $p_{ft} = \tilde{p}_{ft} + e_{USD,j,t}$, since $e_{CLP,USD,t} + e_{USD,j,t} = e_{CLP,j,t}$.

Consider that in the short run prices are sticky in USD, the currency of invoicing. Denoting the price of goods of firm f at destination in dollars as $p_{f,USD,t}$, we have that $p_{f,USD,t} = p_{f,j,t} - e_{USD,j,t}$ is fixed.

We can assume that over a time span k a fraction $\theta(k)$ of firms, which we index by f' do not change prices in USD, and thus local prices in local currency will change according to the changes in the value of local currency j with respect to the USD:

$$p_{f',j,t+k} - p_{f',j,t} = e_{USD,j,t+k} - e_{USD,j,t}. \tag{2}$$

As expected, a depreciation of the local currency with respect to the USD will lead to a 1 to 1 increase in prices in the local currency.

Over the same time span of k, the remaining $(1 - \theta(k))$ share of firms, indexed by f'', reset their prices to their optimal PCP price, in which case, absent other shocks, they return to $\tilde{p}_{f'',CLP,t+k} = p_{f'',j,t+k} - e_{CLP,j,t+k}$, and therefore:

$$p_{f'',j,t+k} - p_{f'',j,t} = e_{CLP,j,t+k} - e_{CLP,j,t}$$

Over time the evolution of the local price in local currency of all firms f will be given by:

$$p_{f,j,t+k} - p_{f,j,t} = \theta(k)(e_{USD,j,t+k} - e_{USD,j,t}) + (1 - \theta(k))(e_{CLP,j,t+k} - e_{CLP,j,t}). \tag{3}$$

Given that $\theta(0) = 1$, $\lim_{k\to\infty} \theta(k) = 0$, and $\theta'(k) < 0$, we have that in the short run the ERPT of the USD exchange rate is one. As time passes by its impact vanishes to zero, whereas the ERPT of the bilateral exchange rate goes to one.

(B) PRICE STICKINESS IN THE DOMINANT CURRENCY AND LCP

In this case the sticky price is in USD. This implies that for the fraction of firms that do not adjust prices they will have a 1 to 1 ERPT from a depreciation with respect to the USD, and changes in the bilateral exchange rate will have no effects at all. For these firms $p_{f,j,t+k} - p_{f,j,t} = e_{USD,j,t+k} - e_{USD,j,t}$, just as equation (2). Since firms want to keep their prices constant in the local currency, firms that change their price will 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 during a k lapse of time, we have that:

$$p_{f,j,t+k} - p_{f,j,t} = \theta(k)(e_{USD,j,t+k} - e_{USD,j,t}). \tag{4}$$

Since all firms start with fixed price ($\theta = 1$) we have that the ERPT is 1 in short run and declines to zero over time. Although this assumption sounds unrealistic, we treat it for completeness.

(C) PRICE STICKINESS IN THE DOMINANT CURRENCY AND DCP

This case is simple to analyze, in the short run prices will absorb completely a change in the USD exchange rate, and since it is also the currency to set the optimal price, the optimal is to let this adjustment to take place and remain there. The bilateral exchange rate has no effect on prices. Hence:

$$p_{f,j,t+k} - p_{f,j,t} = e_{USD,j,t+k} - e_{USD,j,t}. \tag{5}$$

(D) PRICE STICKINESS IN LOCAL CURRENCY AND PCP

At $t+k$ a fraction $\theta(k)$ of firms will have $p_{f,j,t+k} = p_{f,j,t}$, while firms that are changing prices will make it to keep $\tilde{p}_{f,CLP,t} = p_{ft} - e_{CLP,j,t}$ constant, and hence they reset 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 will be,

$$p_{f,j,t+k} - p_{f,j,t} = (1 - \theta(k))(e_{CLP,j,t+k} - e_{CLP,j,t}). \tag{6}$$

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

(E) PRICE STICKINESS IN LOCAL CURRENCY AND DCP

This case is analogous to the previous one, but instead of the bilateral exchange rate, the USD exchange rate of the destination country is the relevant one. In this case the ERPT

for the USD starts from zero and converges to 1:

$$p_{f,j,t+k} - p_{f,j,t} = (1 - \theta(k))(e_{USD,j,t+k} - e_{USD,j,t}). \tag{7}$$

(F) PRICE STICKINESS IN LOCAL CURRENCY AND LCP

In this case, the optimal price as well as short-run fixed prices are denominated in local currency and therefore the bilateral together with the USD ERPT are zero in the short- and long-run.

Finally, in all the cases discussed above, all increases in local prices will lead to a decline in demand for Chilean exports. And for a given price elasticity, the larger the increase in prices the larger the fall in exports.

3 Data and Descriptive Statistics

In this Section we describe the data sources we employ, and present descriptive statistics that characterize our data. They replicate the overwhelming presence of invoicing in USD for Chilean exports as it has been reported extensively in the literature.

3.1 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[4] of Chilean non-mining[5] exports at item-level. From the Customs Export Declaration we use information on FOB value, quantity, exporting firm, good product code, invoicing currency, and destination country. Our study focuses on the 2010-2019 period. The database classifies goods according to an 8-digit Harmonized System (HS8) classification system, equivalent to the U.S. 10-digit Harmonized System (HS10).

We add employment characteristics of the exporting firms using data from the Unemployment Insurance Administrator (AFC).[6] We obtain the economic sector of firms using

[4]Sample of considerate countries are the top 30 trading partners excluding those without macro data, ending with 24 countries. This represents on average 81% and 73% of the value and transactions respectively of the universe of non-mining exports.

[5]We do not cover mining data because of reverse causality bias. For example, a change in Chinese copper demand affects copper price and exchange rate at the same time.

[6]AFC data consider full-time or part-time employees with permanent or fixed contract who work in the

data from the Internal Revenue Service of Chile.

A common limitation of customs declarations is that they do not contain information on prices. Our dataset is not an exception. To solve this we collapse for firm f, product g, invoiced in currency j, to destination country c, and in period t using Amiti et al. (2022) price. Thus, for each tuple (f, g, j, c) the price in the period t is the unit value across all the relevant transactions i,

$$P_{fgjct} = \frac{\sum_i \text{FOB}_{ifgjct}}{\sum_i Q_{ifgjct}}.$$

We exclude items exported by firms that have less than 5 employees. We also drop items that contain obvious errors such as missing values in quantities or values, and remove items exported by firms that do not reported economic sector. Our final sample covers 4,992 Chilean exporting firms, 4,931 distinct goods, 18 distinct invoiced currencies, and 24 different destinations. Finally, our regressions below consider tuples observed for at least 8 quarters to be able to distinguish and identify tuples for minimum 2 years.

The source of data for the aggregate controls are dual. Chilean Producer Price Index (PPI) data is from National Statistics Institute of Chile. Trade partnerships Consumer Price Index (CPI) and Gross Domestic Product (GDP) are from International Monetary Fund.

3.2 Descriptive Statistics

Table 1 displays the main descriptive statistics in our sample at annual level. The first two columns shows that the average firm has around 300 employees, while the median has 72. The same happens for the number of destinations, products and total exports, where this last one is the more acute. This is consistent with the right skewness observed for exporters, and firms in general.

In the next two set of columns we separate firms depending on whether they invoice in USD or not.[7] We can observe that Non USD firms are on average larger than USD firms, whether we measure that by the number of employees or total exports. Similarly, Non USD firms export to more destinations and more products. Finally, Table 1 also shows that around 91% of exporters heavily invoice in USD.

private sector. We exclude home contracts as employees.

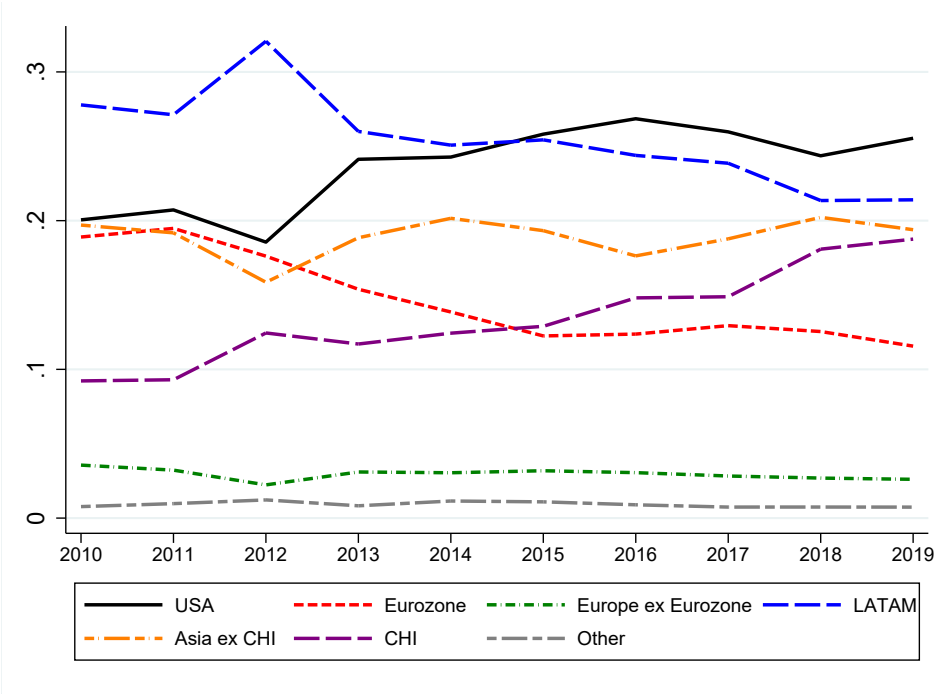
[7] Firms that export at least 95% invoiced in USD are labeled as "USD" in Table 1. If not, they are labelled as "Non USD".

Table 1: Descriptive statistics

	All		USD		Non USD	
	Mean	*Median*	*Mean*	*Median*	*Mean*	*Median*
# employees	290.9	71.6	274.9	66.8	455.4	150.9
# destinations	2.7	1.8	2.6	1	3.5	3.2
# products	4.5	2	4.4	2	5.0	3.9
Total exports (USD million)	6.819	0.403	6.637	0.334	8.747	1.635
# firms	2,236		2,034		202	

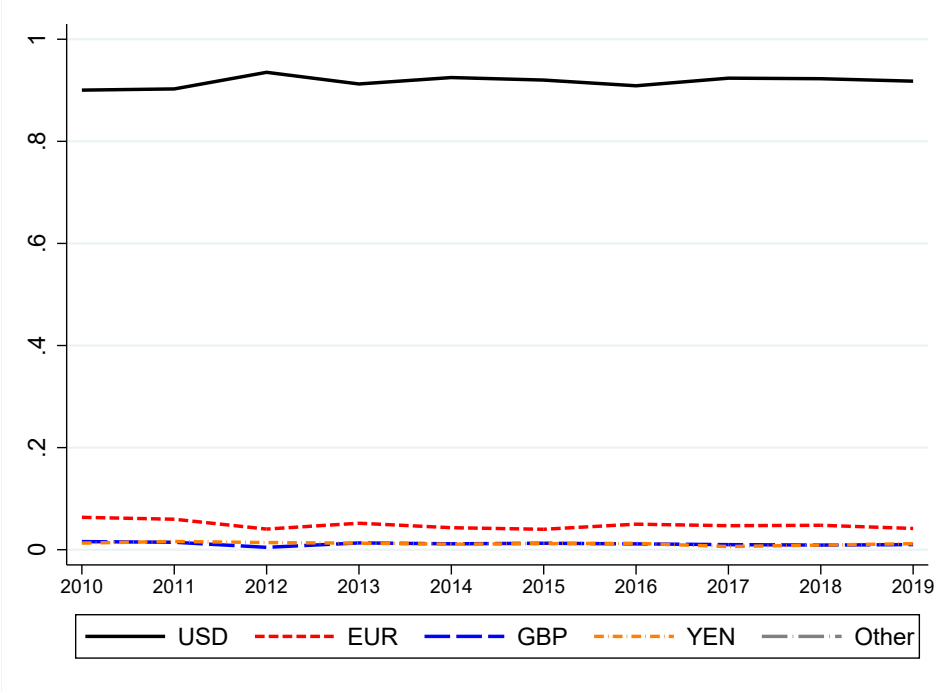
Figure 1 shows the export share of our sample by destination. Exports to the US and Latin America (LatAm) represent about a quarter of total exports separately in our sample. Export share to China doubles between 2010 and 2019, whereas the share to the Eurozone almost halved in the same period. Despite this, Figure 2 shows that the invoicing currency composition share is around 90 percent given by the USD, which is more than three times its corresponding share of exports going to the US. The currency composition share in Euro is a mere 5 percent, which is considerably less than the share to the Eurozone, which almost double. The Chilean Peso (CLP) is contained in the "Other" category. These facts are at odds with theories where international trade is either invoiced in the currency of the origin country or the destination country, and lends support to the dominant currency paradigm.

Figure 1: Exports Share by Destination



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

Figure 2: Exports Share by Currency



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

To complement the description of the data, Table 2 displays the export share distribution by currency for each major destination. In Asia, the Yen plays a small role, compared to the overwhelming use of the USD for currency invoicing. In the Eurozone, the Euro plays a greater, but only is used to invoice about a quarter of exports to that zone, while the dollar is again the most important currency of invoicing. A similar pattern emerges for other destinations. In the case of LatAm, as no country has a currency used massively in international trade, most exports are invoiced in dollars. This evidence, though scant, portrays a picture similar to that already observed in papers like Boz et al. (2022) for Colombia where exports invoiced in the USD are even more prevalent.

Table 2: Currency Distribution by Destination

Destination	Currency	Exports (%)	Transactions (%)
Asia ex China	USD	93.56	92.48
	YEN	6.12	6.74
	EUR	0.32	0.76
	CLP	0.00	0.00
	Other	0.00	0.01
China	USD	99.03	98.6
	RMB	0.60	0.73
	EUR	0.33	0.60
	YEN	0.03	0.05
	CLP	0.00	0.00
	Other	0.00	0.01
Europe no Eurozone	USD	48.05	39.99
	GBP	38.52	51.58
	EUR	11.31	6.10
	CLP	0.00	0.01
	Other	2.12	2.32
Eurozone	USD	70.12	55.07
	EUR	29.16	44.25
	CLP	0.68	0.45
	GBP	0.02	0.12
	Other	0.02	0.12
LATAM	USD	95.89	92.65
	EUR	0.69	1.57
	CLP	0.53	0.33
	Other	2.90	5.45
USA	USD	99.66	99.91
	CLP	0.28	0.04
	EUR	0.05	0.04
	Other	0.00	0.00
Other	USD	98.83	98.46
	EUR	0.90	1.20
	CLP	0.00	0.00
	Other	0.26	0.33

Notes: Exports value (%) is the FOB value percentage of the exports. Transactions (%) is the percentage of the number of observations at item level. Observations are after data cleaning procedure explained in Data Section. *Source*: Author´s own calculations are based on Chile´s National Customs Service.

4 Empirical Strategy

In this section we first report basic evidence on the ERPT from the bilateral exchange rate into prices denominated in the importer's currency (indistinctly called "local" or "destination"). Hence we can estimate the response of prices in local currency to a depreciation with respect to the exporter's currency (indistinctly called "origin" or "producer"), which in our case is the Chilean peso.

Then we extend the analysis to distinguish the ERPT from two exchange rates: the bilateral exchange rate and the exchange rate of the importer's currency with respect to the USD.

4.1 Bilateral ERPT

The conventional wisdom until the 2000's came from Mundell-Flemming. In that model, exporters set their prices in their domestic currency (Chilean pesos), and for this reason is called "producer currency pricing" (PCP). This was incorporated in general equilibrium model of a small open economic in the seminal paper by Galí and Monacelli (2005). Given PCP, a depreciation of the destination's currency with respect to the producer currency should increase import prices in terms of the local currency, with an ensuing decline in demand for exports.

To examine the impact of the bilateral exchange rate on local prices in local currency, we run the following regression:

$$\Delta p_{fgjct} = \lambda_{fgjc} + \sum_{k=0}^{8} \beta_k^P \Delta e_{CLP,j,t-k} + \theta' X_{jt} + \varepsilon_{fgjct}, \tag{8}$$

where p_{fgjct} is the log of is the price of product g, from Chilean exporter f, to destination j, invoiced in currency c, at time t, and $e_{i,j,t} = \log \mathcal{E}_{i,j,t}$ is the price of currency i in terms of currency j, and hence an increase in $e_{i,j,t}$ is a depreciation of j with respect to i. As discussed above, the price is computed by,

$$p_{fgjct} = \log\left(\text{FOB}_{fgjct}\mathcal{E}_{USD,j,t}/Q_{fgjct}\right)$$

and

$$\Delta p_{fgjct} = p_{fgjct} - p_{fgjct-1}.$$

In the rest of the paper, the price at the LHS will be always expressed in terms of local currency. X_{jt}, in turn, controls for demand and supply of Chilean exports, by using GDP variations at destination j and variations in Chilean Producer Price Index, respectively.

The prediction of the PCP framework in Mundell-Flemming is that $\beta_0^P = 1$. This happens mechanically because prices are fixed in the currency of the exporter (PCP), and hence a bilateral depreciation of the local currency with respect to the Chilean peso will increase prices 1 to 1.

What should we expect in the long-run? In the basic setup where all costs are domestic wages, there is no strategic complementarities, and there are no other sources of rigidity, the bilateral exchange rate variation does not affect anything else other than changes in the optimal price chosen by the firms. Therefore, in the long run it should also be that $\sum_k \beta_k^P = 1$.

The increase in prices will reduce demand for exports, and to this end we run the following regression for quantities:

$$\Delta q_{fgjct} = \lambda_{fgjc} + \sum_{k=0}^{8} \beta_k^Q \Delta e_{CLP,j,t-k} + \theta' X_{jt} + \varepsilon_{fgjct}, \tag{9}$$

where $q_{fgjct} = \log(\sum_i Q_{ifgjct})$. By assuming a CES demand with an elasticity of substitution across origins of σ, then we should expect $\beta_0^Q = -\sigma$ in the short-run and $\sum_k \beta_k^Q = -\sigma$ in the long-run. These implications are usually referred to as coming from the producer currency pricing (PCP).

The change in prices with the consequent change in quantities is central to the adjustment mechanism induced by exchange rates in small open economies.

The first deviation from PCP came form the observation of the low observed ERPT from exchange rates to inflation. The presumption was that prices where set in the importer's currency, this is local currency pricing (LCP). Indeed papers such as Betts and Devereux (2000) or Chari et al. (2002) advanced the idea that exporters set their prices in the importer's (local or destination) currency and therefore exchange rate variations should have *zero* effect on prices. This means, we should expect both parameters and sets of parameters to be equal to zero at all horizons. This is referred to as the local currency pricing (LCP). This gave rise the exchange rate pessimism, in terms of its ability to induce current account adjustment.

4.2 Baseline Analysis

The work done by Gopinath and Rigobon (2008), Goldberg and Tille (2008), Gopinath et al. (2020), and others show that international trade was actually priced in a vehicle currency. That is, the currency used is neither the origin's nor the destination's. In this context, the USD appeared to be the *dominant* currency in such trades. Thus, it is referred to as the dollar or dominant currency paradigm (DCP).

To test jointly the different pricing mechanisms we expand specifications (8) and (9) to include the USD exchange rate, and assess how the parameters change to the exchange rate with respect to the producr's currency and the US dollar:

$$\Delta p_{fgjct} = \lambda_{fgjc} + \sum_{k=0}^{8} \beta_k^{P,USD} \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \beta_k^{P,BER} \Delta e_{CLP,j,t-k} + \theta' X_{jt} + \varepsilon_{fgjct}, \quad (10)$$

$$\Delta q_{fgjct} = \lambda_{fgjc} + \sum_{k=0}^{8} \beta_k^{Q,USD} \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \beta_k^{Q,BER} \Delta e_{CLP,j,t-k} + \theta' X_{jt} + \varepsilon_{fgjct}. \quad (11)$$

In this equation we have two pass-through coefficients; one from bilateral exchange rate movements and another one from USD exchange rate movements. We label them with superindices BER and USD.

As discussed in section2.2, if firms have local prices fixed in the short run in USD, and not in the local or producer currency, we should expect $\sum_k \beta_k^{P,BER}$ in (10) to play a significantly less important role than $\sum_k \beta_k^P$ in (8). In addition if their optimal prices in DCP we should expect $\beta_0^{P,USD} = 1$ in the short-run. This happens mechanically given that prices are fixed in USD. If prices are set and fixed in local currency, we should have that both $\beta^{P,USD}$ and $\beta^{P,BER}$ should equal zero.

What should expect in the long-run? The answer to this depends on the currency choice for the optimal prices, and what are the effects of exchange rate movements on the optimal price chosen by the firm. In general, this depends on the structure of the economy as a whole, type of competition, cost structure, among others. For instance, if there is no strategic complementarities and all costs are in USD, then the pass-through in the long-run should be equal to the one in the short-run. If some costs are domestic, then the long-run pass-through should be smaller. Table 3 summarizes the implications of the discussion in section 2.2 in the context of the regressions we estimate in next section.

Table 3: ERPT Predictions Non-imported Materials

	Prices sticky in local currency		Prices sticky in dominant currency	
	Short-run	Long-run	Short-run	Long-run
PCP	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$	$\beta_0^{BER} = 1, \beta_0^{USD} = 0$	$\beta_0^{BER} = 0, \beta_0^{USD} = 1$	$\beta_0^{BER} = 1, \beta_0^{USD} = 0$
LCP	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$	$\beta_0^{BER} = 0, \beta_0^{USD} = 1$	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$
DCP	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$	$\beta_0^{BER} = 0, \beta_0^{USD} = 1$	$\beta_0^{BER} = 0, \beta_0^{USD} = 0$	$\beta_0^{BER} = 1, \beta_0^{USD} = 0$

Notes: Predictions based on discussion in section 2.2

5 Results

5.1 Bilateral Exchange Rate Pass-through

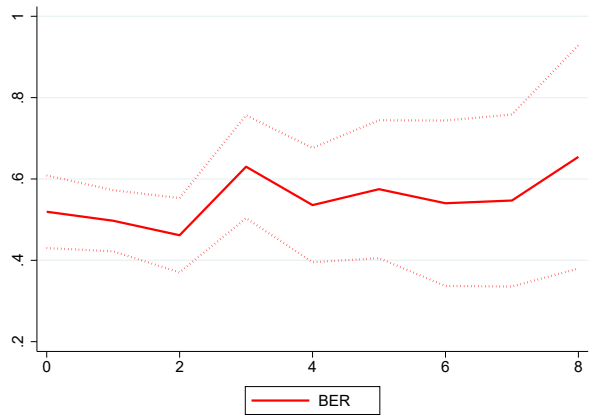
We begin our analysis by considering standard ERPT regressions at firm-product-destination-currency level as in equation (8). Figure 3 plots the cumulative sum of β_k^P. We present results for the three samples that are used in the article. Panel 3a employs information from all invoicing currencies (index c) to all destinations (index j). Panel 3b considers only transactions invoiced in USD to non-dollarized destinations. Finally, panel 3c presents all exports, regardless currency of invoicing, to non-dollarized destinations.[8]

Short-run ERPT 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.[9]

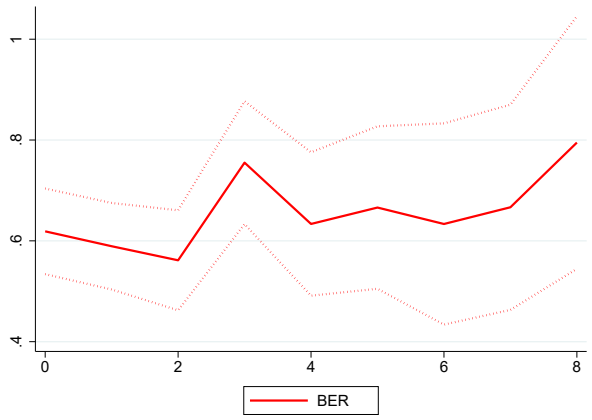
[8] As shown in Table 8, the USA is the only dollarized country of the 24 we use in our data. It represents 23.63% of total export value in our sample.

[9] See Boz et al. (2022) for the case of Colombia, Berman et al. (2012) for France, Chatterjee et al. (2013) for Brazil, or Amiti et al. (2022) for Belgium.

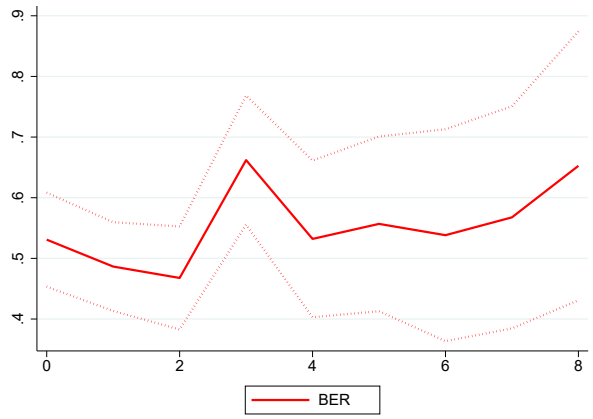
Figure 3: Bilateral Exchange Rate Pass-through



(a) All currencies, all destinations



(b) USD, non-dollarized destinations

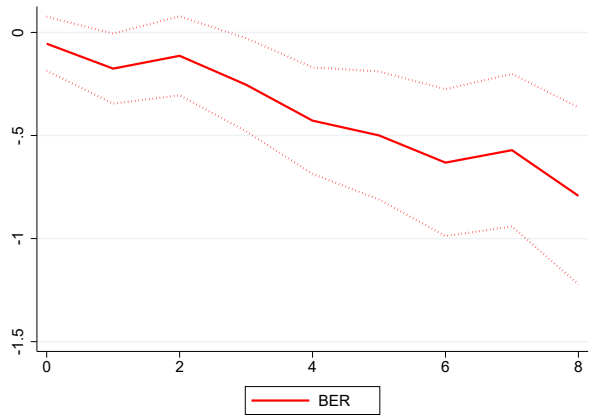


(c) All currencies, non-dollarized destinations

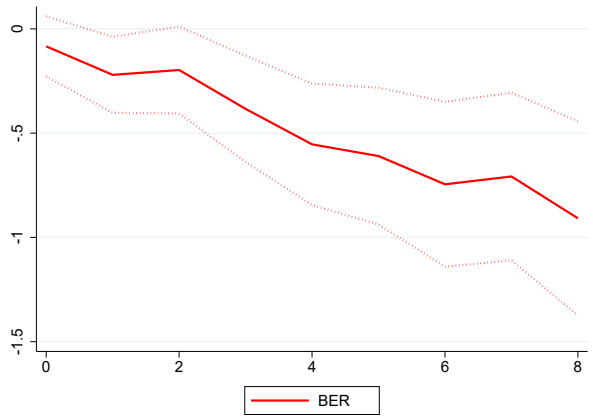
Notes: Results for estimation (8) using non-mining sector. Figure plots the sum of β_k^P.

As for the effects on quantities, we find that movements in the bilateral exchange rates have real effects. Figure 4 plots the cumulative sum of β_k^Q from estimating equation (9). 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 imported quantities, i.e., decline in Chilean exports' demand. The effect of a nominal depreciation takes time to have allocating 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 close to 1.

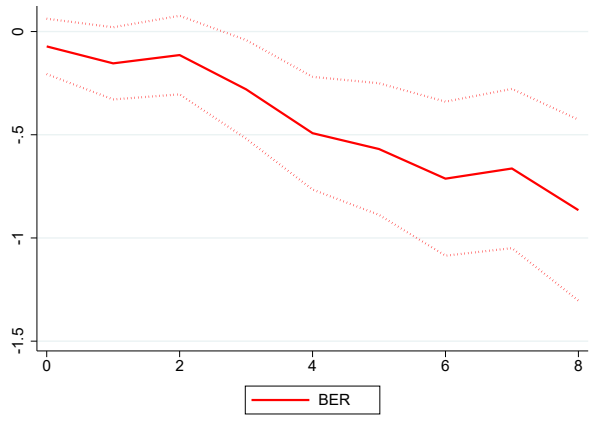
Figure 4: Bilateral Exchange Rates and Quantites Correlation



(a) All currencies, all destinations



(b) USD, non-dollarized destinations



(c) All currencies, non-dollarized destinations

Notes: Results for estimation (9) using non-mining sector. Figure plots the sum of β_k^Q.

5.2 Bilateral and USD Exchange Rate Pass-through

As suggested in previous sections, the separate identification of the pass-through to local prices at destination from both bilateral exchange rates and USD exchange rates can shed light on the pricing behavior of firms. We therefore shift our attention to ERPT regressions for the USD and the bilateral exchange rate, and also analyze its effects on quantities. In particular, we focus on transactions invoiced in USD to non-dollarized destinations in order to not confound the effect of currency of invoicing with those of the exchange rate movements.

Our goal is assessing the short-run and long-run importance of the USD, the main

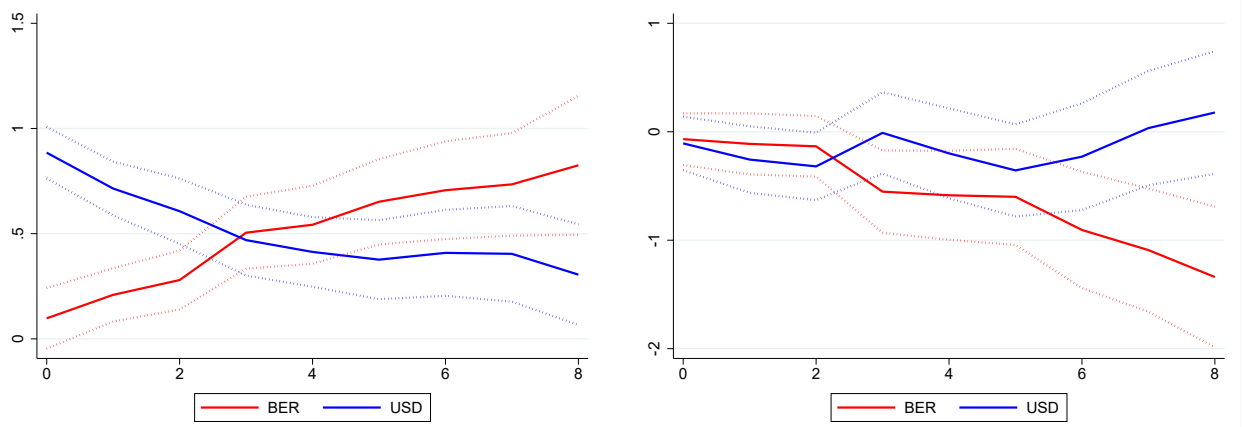
currency of invoice of Chile's international trade (DCP), and the bilateral exchange rates, thus looking at producer's pricing (PCP) implicit in the Mundell-Fleming model.[10] If local currency pricing prevails we should not observe relevant ERPT from bilateral or USD exchange rates. This scheme also allows to test LCP, as a null effect of the bilateral exchange rate would support that pricing strategy.

The main results are shown in Figure 5 and Table 4. Short-run ERPT of USD to border prices is almost complete and nil for the bilateral exchange rate. However, the results show a relevant reversion as time progresses. Figure 5a plots the cumulative sum of $\beta_k^{P,USD}$ and $\beta_k^{P,BER}$ from estimating equation (10). Once the USD is taken into account in the regression, the short-run bilateral ERPT is quantitatively small and does not statistically differ from zero. This pass-through is significantly smaller than without conditioning for the currency of invoicing. Indeed, when USD was not included the bilateral ERPT was about 0.55, as reported in the previous subsection. Despite this, long-run bilateral ERPT is of the same order as in Figure 3, this is about 0.8. In contrast, the short-run USD ERPT is almost complete, close to 0.8, but after four quarters falls to approximately 0.4.

This result shows that in the short-run DCP is a good approximation, but in the long-run PCP dominates. This is one of the main findings of this paper that we examine further and provide robustness checks below.

[10]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 Figure 9 and 10 respectively.

Figure 5: Bilateral and USD ERPT and Quantities



(a) Price (b) Quantity

Notes: Results for estimation (10) in Panel A and (11) in Panel B, using non-mining sector and considerating USD to 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 $\beta_k^{Q,USD}$.

We turn now to analyze the implications of the currency of invoice for quantities. Figure 5b plots the cumulative sum of estimates of $\beta_k^{Q,USD}$ and $\beta_k^{Q,BER}$ from estimating equation (11). We estimate a U-shaped pattern of a local appreciation of the USD on quantities. Quantities react more slowly to changes in the bilateral exchange rate so as to initially fall behind the effect of the USD exchange. Similar to the prices equation, quantities end up having a higher sensitivity to the bilateral exchange rate than to the USD exchange rate. The effects on quantities are consistent with results on pricing for the bilateral exchange rate. In the short-run demand is fairly inelastic to prices, but over time, as the price of exports increases with a depreciation of the bilateral exchange rate, demand falls as predicted in the Mundell-Fleming model.

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: 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 (k) respectively. BER is for bilateral exchange rate effect between currency j and CLP. USD is for exchange rate effect between CLP and US dollar. Fixed effects at firm-product-currency-destination level. 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.

The results of this section underscore the importance of the USD to determine prices and quantities, especially over short horizons. This takes particular relevance in episodes of global changes in the value of the USD, where it has nominal and allocating implications, even if the economy is in equilibrium. Yet, the relevance of the bilateral exchange for the macroeconomic adjustment process proves to still be present, especially over longer periods.

5.3 Bilateral ERPT when Prices are Invoiced in Local Currency

We extend the analysis to transactions invoiced in local currency. We compare their adjustment of prices and quantities with changes in both exchange rates to the adjustments when transactions are invoiced in USD. To do that, we modify our baseline specification to include transactions that are invoiced in local currency. We consider the following regression model:

$$\Delta p_{fgjct} = \sum_{k=0}^{8} \left(\beta_k^{USD} + \gamma_k^{USD} D_{fgjct}^{LC}\right) \Delta e_{USD,j,t-k} + \sum_{k=0}^{8} \left(\beta_k^{BER} + \gamma_k^{BER} D_{fgjct}^{LC}\right) \Delta e_{CLP,j,t-k} + \alpha D_{fgjct}^{LC} + \theta' X_{jt} + \lambda_{fg} + \varepsilon_{fgjct}, \tag{12}$$

where D_{fgjct}^{LC} is 1 if the export is invoiced in local currency and 0 if in USD. This means that we exclude exports in CLP and in other vehicle currencies different to the USD (e.g., to the Republic of Ireland in British Pounds). Parameters β_k^{USD} and β_k^{BER} have the same interpretation as above when invoiced in USD. Parameters γ_k^{USD} and γ_k^{BER} denote the differential pass-through from USD and bilateral exchange rate movements, respectively, of an export invoiced in local currency. Therefore, β^{USD} (β^{BER}), represents the ERPT of the USD (bilateral) exchange rate to local prices of exports when they are invoiced in USD. In contrast, $\beta^{USD} + \gamma^{USD}$ ($\beta^{BER} + \gamma^{BER}$), represents the ERPT of the USD (bilateral) exchange rate to local prices of exports when they are invoiced in local currency.

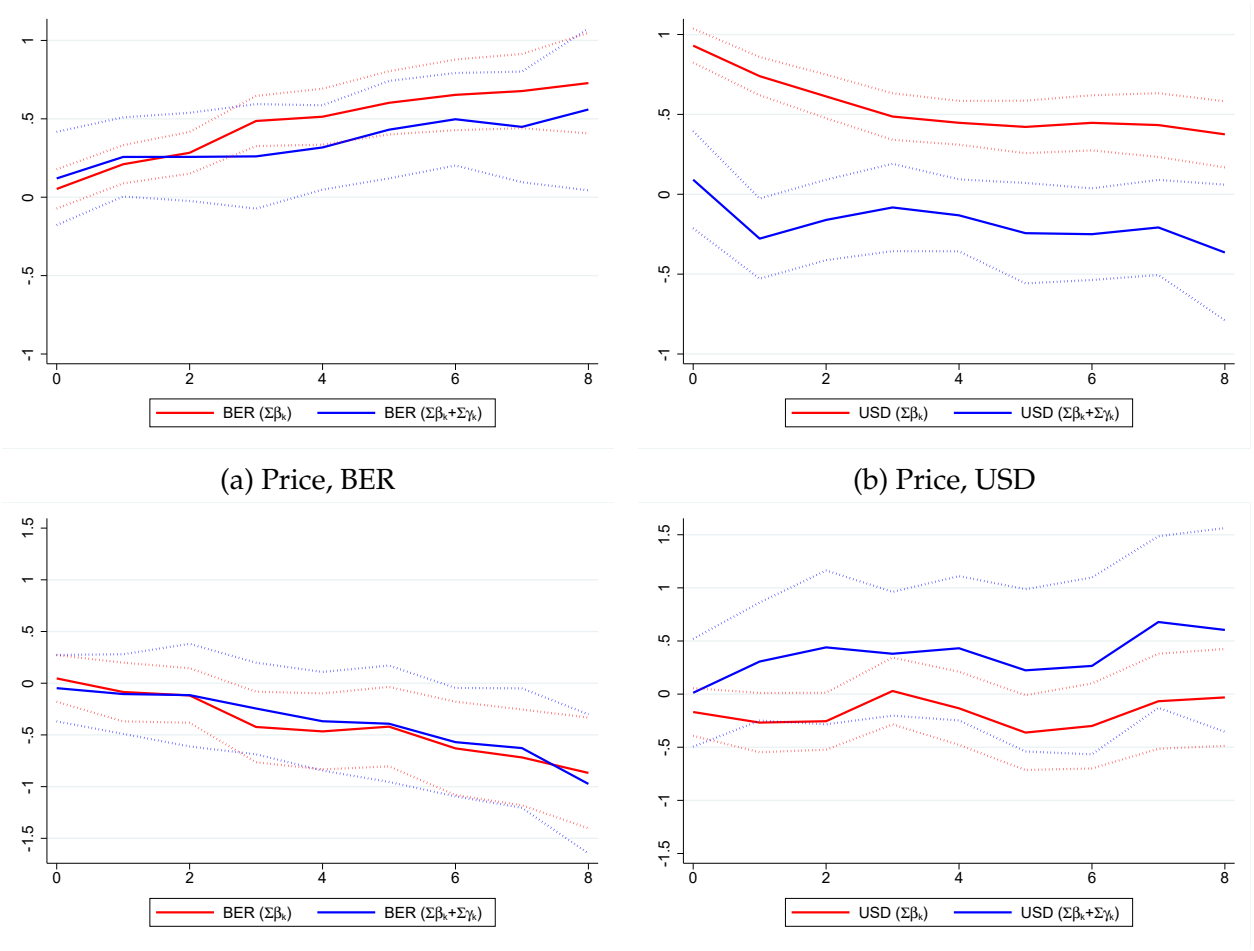
This setup implies that if $\gamma_k^{USD} < 0$, the pass-through into local prices from a depreciation of the local currency with respect to the USD is smaller when invoiced in local currency vis-à-vis when invoiced in USD. Similarly, if $\gamma_k^{BER} > 0$, the pass-through into local prices from a depreciation of the local currency with respect to the CLP is larger when invoiced in local currency vis-à-vis when invoiced in USD.

The results are presented in Figure 6 and Table 5. As Figure 6a shows, for the case of transactions invoiced in local currency, the dynamics of the bilateral ERPT into prices and quantities are similar to the results presented in Section 5.2. The bilateral ERPT to border prices is close to zero in the short run, but becomes quantitatively important after two quarters. *Hence, the dynamics of the bilateral ERPT to border prices is similar regardless of the currency of invoice.*

Figure 6c displays the dynamics of the USD ERPT for both types of invoicing. When exports are invoiced in the local currency, the pass-through into prices is not statistically different from zero at any horizon, which is very different from then exports are invoiced

in USD. The pass-through into quantities is similar for both and is zero as in Section 5.2. *Hence, the dynamics of the USD ERPT to border prices differ with the currency of invoice.*

Figure 6: Local Currency vs Vehicle Currency Invoicing



(a) Price, BER

(b) Price, USD

(c) Quantity, BER

(d) Quantity, USD

Notes: Results for estimation (12). 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).

Table 5: Dominant and Local Currency Invoicing

	DCP vs LCP		Non-USD: DCP vs LCP		USD as DCP and LCP	
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: 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 (k) respectively. γ^0 is the differential effect at the instant, $\sum_{k=0}^{4} \gamma_k$ and $\sum_{k=0}^{8} \gamma_k$ is the sum of the coefficient at the 4 and 8 quarters (k) respectively. In DCP vs LCP, total and Non-USD, γ is the differential effect for exports invoiced in local currency, and in USD as LCP and DCP, γ is the differential effects for exports to USA. BER is for bilateral exchange rate effect between currency j and CLP. USD is for exchange rate effect between CLP and US dollar. Fixed effects at firm-product level. 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.

We perform two final exercises to assess the robustness of our findings. First, we re-

peat (12) but exclude dollarized destinations. The results for this are in columns 3 and 4 in Table 5 and in Figure 7. They show that the dynamics of prices for a depreciation of the bilateral exchange rate is independent of the currency of invoicing (panel (a)). For example, for exports to the Eurozone, a depreciation of the Euro with respect to the Chilean peso does not change prices on impact, regardless the currency of invoicing. For exports invoiced in Euro the price is sticky. For exports invoiced in USD the price in Euro also does not change since we are simulating a depreciation of the Euro with respect to the peso maintaining the rest constant, the USD among other things. As time goes on, the price in Euro adjust gradually to its depreciation, and quantities respond as expected, with a gradual decline, and this result holds independent the currency of invoicing.

For exports invoiced in dollars the ERP of the USD is close to 1 in the short run, while it is close to zero for exports non-USD invoiced (panel (b)). All these results show that that prices are sticky in the currency of invoicing. This is the same result we obtained for the full sample in Figure 6. It shows that the ERPT is almost 1 for exports invoiced in dollars (red line in panel (b)) and small, close but statistically not zero, for exports invoiced in other currencies. Since the USD is not a currency of the countries trading, in the long run a depreciation of the USD has declining effects on prices and quantities.

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

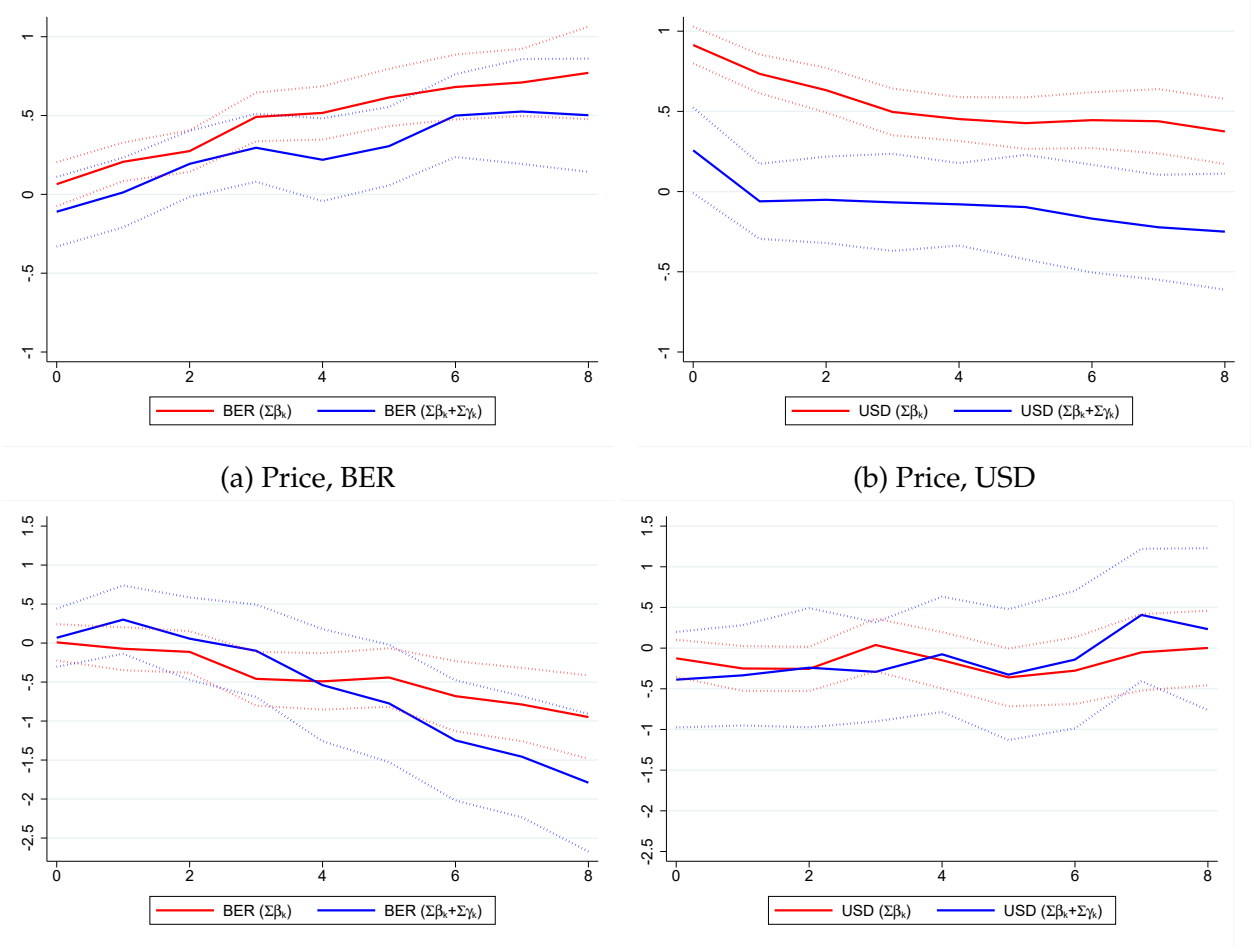
$$\begin{aligned}\Delta p_{fgjt} =& \lambda_{fg} + \sum_{k=0}^{8} \left(\beta_k^{BER} + \gamma_k^{BER} D_{fgjt}^{US}\right) \Delta e_{CLP,j,t-k} + \sum_{k=0}^{8} \beta_k^{USD} \Delta e_{USD,j,t-k} \\ &+ \alpha D_{fgjt}^{US} + \theta' X_{jt} + \varepsilon_{fgjt},\end{aligned} \tag{13}$$

where D_{fgjt}^{US} is 1 if the destination is the US, the only dollarized country in opur sample, and 0 otherwise.

The results for this are in columns 5 and 6 in Table 5 and in Figure 8. In this case the dummy takes the value of 1 when the destination is the US. The results show that prices are sticky in dollars regardless the currency of destination, and then they adjust to the higher value of the Chilean peso over time, regardless the destination country's currency is the USD (panels (a) and (c)). Panels (b) and (d) consider a depreciation of the local currency respect to the dollar, excluding obviously the US. 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, these last two exercises show that the results remain virtually the same, which confirms that the adjustment of prices and quantities to the bilateral exchange rate is almost independent of the currency of invoice.

Figure 7: Non US sample: Local Currency vs USD Invoicing



(a) Price, BER

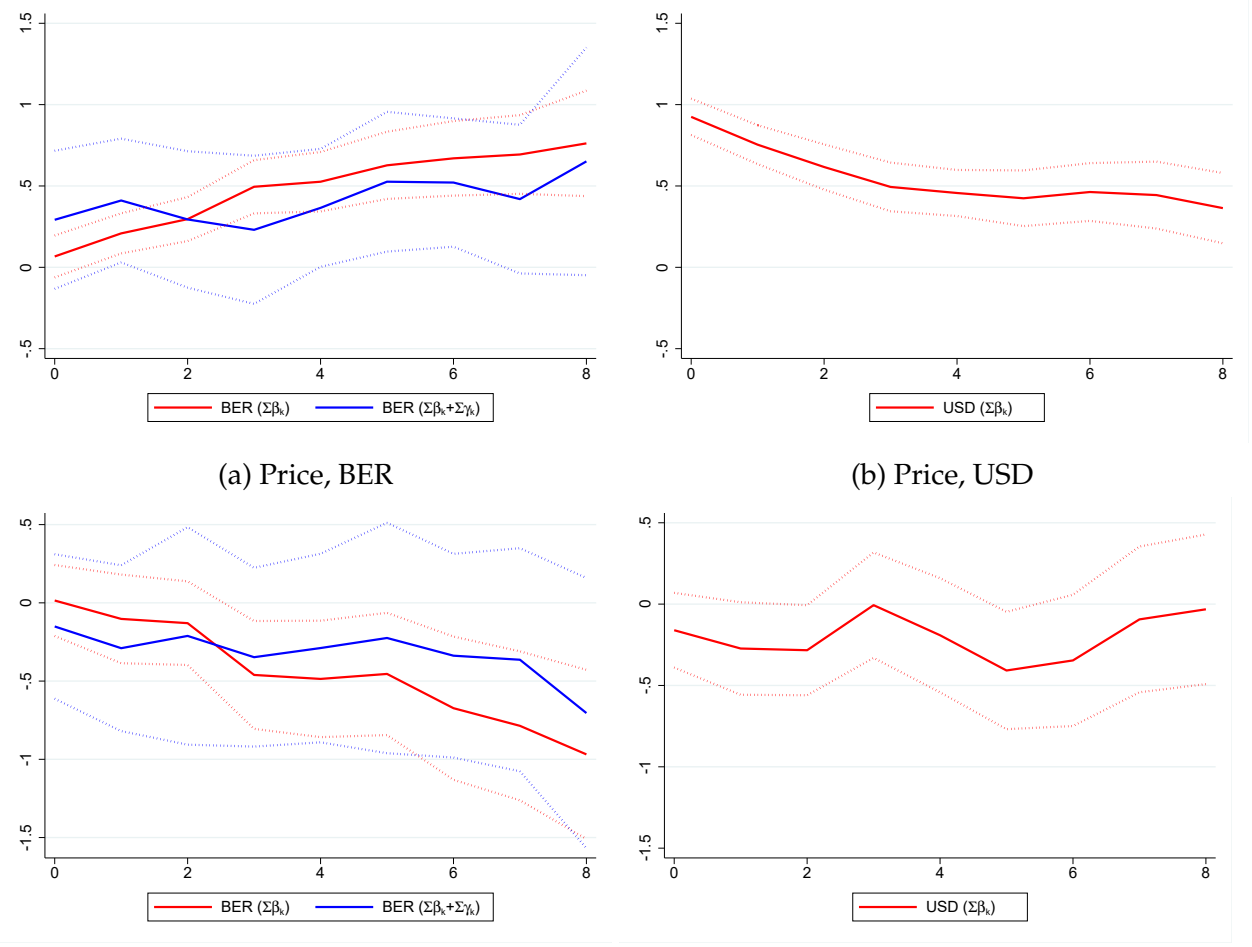
(b) Price, USD

(c) Quantity, BER

(d) Quantity, USD

Notes: Results for estimation (12) 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).

Figure 8: Exports Invoiced in USD



(a) Price, BER

(b) Price, USD

(c) Quantity, BER

(d) Quantity, USD

Notes: Results for estimation (13) 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 US and blue line is the total effect for exports invoiced in USD to US.

5.4 Robustness exercises

To make sure our results are not driven by a particular specification, we extend the analysis carried out in (10) and (11) for different samples, data cleaning or variables definition. To start, we focus on the manufacturing sector and present results by subsectors therein. We do this to understand whether our results might be explained by specific sectors driving the results.

Table 6 and Table 7 present such results. We can see that for most sectors, the estimates

are in line with the aggregate results. For prices in the short-run, there is small or zero ERPT for bilateral exchange rate, which then increases in the medium- to long-term to levels of around 0.60-0.70. The ERPT of the USD instead is very high, above 0.8, for most industries, and then falling over the medium term. Regarding quantities, we only obtain significant results for bilateral exchange rates pass-through, which is consistent with certain degree of medium-term PCP. The only two subsectors that have somewhat different results are "Fishing industry" and "Other beverages and tobacco products". In the former case, the bilateral ERPT starts high in the short term, even larger than the USD ERPT. Regarding quantities, exports are quite insensitive to exchange rates. In latter case, the short-term bilateral ERPT is about 0.3 and declining in the long run. Quantities are sensitive to the bilateral exchange rate, although not with a precise estimate. Overall, these results support our baseline estimates, although quantity estimates lack significance in most cases.

In addition, we perform other robustness exercises. First, we consider a different definition of prices, which instead of being the unit values as computed in Section 4, they are Laspeyres price indexes. Second, we use standard errors clustered at the time-destination level instead of firm level, which is the clusterization used in Amiti et al. (2022). Third, we change the control variables. We omit either destination's GDP, destination's CPI, Chile's PPI, or a combination of those. Fourth, we improve the definition of a product by combining the HS8 together with the units of measure of the export.[11] Finally, we proceed to clean the data in a less strict way to allow for more observations to be included in our regression. For all the cases mentioned above, the results do not change substantially and are available upon request.

[11] These can be meters, square meters, litres, metric ton, carat, dozen, hundred, among others.

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}	$\sum_{k=0}^{4}\beta_k^{USD}$	$\sum_{k=0}^{8}\beta_k^{USD}$
Pulp, paper and printing prod.	0.322	0.7061***	0.6148*	0.803***	0.4156	0.5528*
	(0.3201)	(0.3008)	(0.3582)	(0.1572)	(0.3447)	(0.2842)
Chemical industries	0.0148	0.5947**	1.0795***	0.7731***	0.4718***	0.1561
	(0.1125)	(0.2664)	(0.4252)	(0.1361)	(0.1852)	(0.2003)
Fishing industry	0.5699***	0.6255***	0.6543***	0.2236***	0.3154***	0.3793**
	(0.0757)	(0.1254)	(0.1787)	(0.0931)	(0.1264)	(0.1823)
Wood and furniture manufacture	-0.0398	0.3426***	0.2789	0.8646***	0.1149	0.0865
	(0.1398)	(0.0986)	(0.1987)	(0.1123)	(0.1852)	(0.245)
Rest of the food industry	0.0593	0.3971*	0.7431*	0.8809***	0.4693***	0.3264**
	(0.0988)	(0.2372)	(0.392)	(0.0667)	(0.1057)	(0.1536)
Wine elaboration	-0.0292	0.2715***	0.4449***	0.8655***	0.3852***	0.3021*
	(0.0639)	(0.1106)	(0.1814)	(0.0732)	(0.1258)	(0.1785)
Basic metal industry	0.122	0.2237	0.1209	0.3886*	0.2143	0.3178
	(0.2322)	(0.3318)	(0.4903)	(0.2103)	(0.3592)	(0.3644)
Metal prod., machinery and equip.	0.2334	0.9968***	1.7343***	0.8903***	0.2993	-0.1339
	(0.2971)	(0.3611)	(0.5604)	(0.2565)	(0.3523)	(0.4765)
Rubber and plastic production	-0.2222	0.0284	0.4441	1.3327***	0.8392***	0.6196**
	(0.2528)	(0.2784)	(0.4722)	(0.1781)	(0.2895)	(0.2842)
Other industries	0.1566	0.469	0.3624	0.908***	0.2299	0.3696
	(0.2781)	(0.3138)	(0.6195)	(0.2235)	(0.3608)	(0.4402)
Other beverages and tobacco prod.	0.3198**	0.4509***	-0.2476	1.2407***	0.5044	1.3477
	(0.1541)	(0.1902)	(0.4466)	(0.2917)	(0.4819)	(0.8275)
Median	0.1220	0.4509	0.4449	0.8655	0.3852	0.3264
Mean	0.1370	0.4642	0.5663	0.8337	0.3872	0.3931
Transaction-weighted median	0.0148	0.3971	0.4449	0.8655	0.3852	0.3021
Transaction-weighted mean	0.1108	0.4427	0.6375	0.8135	0.3905	0.3033
Value-weighted median	0.1220	0.5947	0.6148	0.8030	0.4156	0.3264
Value-weighted mean	0.1829	0.5346	0.6636	0.7381	0.3752	0.3359

Notes: Price baseline regression interacting with each relevant sector. A sector is relevant if Exports value (%) > 0.01 according to Table 9, 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.

Table 7: Bilateral and USD Quanities 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}	$\sum_{k=0}^{4}\beta_k^{USD}$	$\sum_{k=0}^{8}\beta_k^{USD}$
Pulp, paper and printing prod.	-0.5557	0.0362	0.1266	0.2933	-0.2365	-0.0625
	(0.5485)	(0.3918)	(0.6943)	(0.4409)	(0.4285)	(0.6218)
Chemical industries	0.0536	-0.4985	-1.2272**	-0.0658	-0.1061	0.3003
	(0.2653)	(0.4236)	(0.6012)	(0.2896)	(0.2824)	(0.3682)
Fishing industry	-0.1911	-0.5043	-0.8385	0.2328	0.2731	0.7885
	(0.3112)	(0.3897)	(0.5473)	(0.3162)	(0.4131)	(0.5788)
Wood and furniture manufacture	0.0791	-0.4425	-1.0389	0.1301	-0.7209**	-0.0863
	(0.2917)	(0.4224)	(0.6583)	(0.2795)	(0.3317)	(0.4697)
Rest of the food industry	-0.105	-0.4418	-1.4904***	-0.3495*	-0.4451	-0.0988
	(0.1576)	(0.3031)	(0.4513)	(0.1866)	(0.3018)	(0.3525)
Wine elaboration	-0.0289	-0.758***	-1.7171***	-0.0965	0.3682	0.8939**
	(0.1386)	(0.2706)	(0.4325)	(0.1744)	(0.2954)	(0.4224)
Basic metal industry	-0.7803	-0.5362	-1.0413	0.3412	-0.8941	-1.3899
	(0.4851)	(0.7198)	(1.1069)	(0.6107)	(0.6596)	(1.05)
Metal prod., machinery and equip.	-0.0227	-0.9855	-1.6291**	-0.0589	0.4507	0.743
	(0.3823)	(0.6001)	(0.8301)	(0.3536)	(0.5182)	(0.6043)
Rubber and plastic production	0.4532	-0.2888	-0.8612	-0.7134**	-0.55	-0.4682
	(0.3857)	(0.5064)	(0.8445)	(0.3405)	(0.4214)	(0.6137)
Other industries	0.3271	-0.5852	-0.5019	-0.7045*	0.4006	0.6238
	(0.3723)	(0.5444)	(0.8506)	(0.3923)	(0.6318)	(0.7839)
Other beverages and tobacco prod.	-0.712	0.4628	2.1904*	0.6513	1.4036	1.3176
	(0.6155)	(0.9893)	(1.3102)	(1.0022)	(1.3426)	(1.3166)
Median	-0.0289	-0.4985	-1.0389	-0.0589	-0.1061	0.3003
Mean	-0.1348	-0.4129	-0.7299	-0.0309	-0.0051	0.2329
Transaction-weighted median	-0.0289	-0.4985	-1.0389	-0.0658	0.2731	0.6238
Transaction-weighted mean	-0.0071	-0.5181	-1.0987	-0.0928	-0.0538	0.3383
Value-weighted median	-0.1050	-0.4425	-1.0389	0.1301	-0.2365	-0.0625
Value-weighted mean	-0.1781	-0.3739	-0.7968	0.0563	-0.1509	0.1801

Notes: Quantity baseline regression interacting with each relevant sector. A sector is relevant if Exports value (%) > 0.01 according to Table 9, 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.

6 Conclusions

In this paper we presented evidence consistent with an important role of the USD over short horizons, but with the bilateral exchange rates having the role assigned by the traditional Mundell-Fleming workhorse at longer ones. By using a comprehensive dataset for Chile, we documented the overwhelming presence of the USD to invoice exports. We considered several ERPT regressions to gauge the role played by the USD and bilateral exchange rates. The DCP paradigm seems a good characterization in the short-run, while the PCP paradigm becomes a better description over the medium-term. Finally, we showed that the dynamics of the bilateral ERPT and its allocative implications are independent of the currency of invoicing.

To fully understand the role of the different exchange rates, an analysis about the role of imported inputs is called for. This topic appears as the next step in our research agenda.

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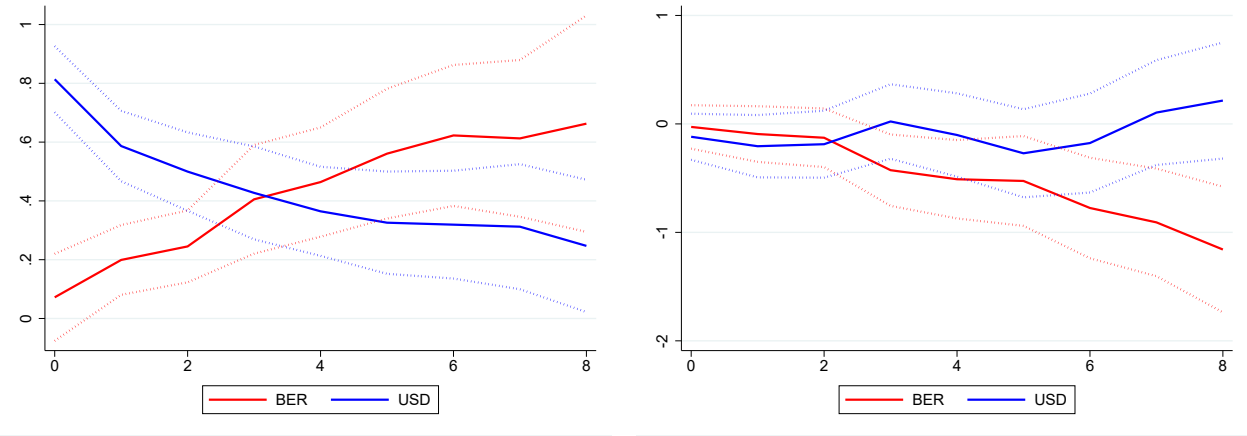
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A Additional Tables and Figures

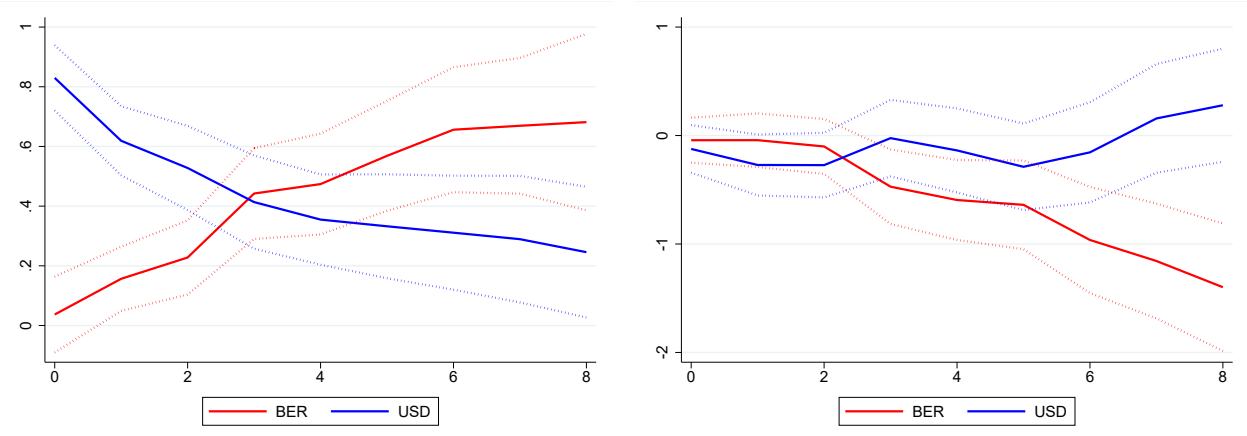
Figure 9: All currencies, all destinations



(a) Price (b) Quantity

Notes: Results for estimation (10) in Panel A and (11) 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 10: All currencies, non-dollarized destinations



(a) Price (b) Quantity

Notes: Results for estimation (10) in Panel A and (11) 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 8: Export Value and Transaction per Destination

Destination	Exports (%)	Transactions (%)
USA	23.63	35.43
China	13.45	6.25
Japan	10.80	5.68
Brazil	8.73	7.20
Peru	5.53	11.85
Netherlands	5.31	3.60
Mexico	4.97	4.26
South Korea	4.17	2.37
Colombia	3.33	5.17
United Kingdom	2.52	3.97
Italy	2.19	0.84
Russia	2.18	1.96
Spain	2.14	1.87
Belgium	1.87	0.57
Germany	1.81	1.24
Canada	1.80	2.99
France	1.37	0.84
Costa Rica	1.10	1.47
Australia	0.92	0.98
India	0.76	0.36
Thailand	0.72	0.43
Sweden	0.33	0.42
Turkey	0.29	0.14
Switzerland	0.11	0.12

Notes: Sample of considerate destinations are the top 30 trading partners excluding those without macro data, ending with 24 countries. This represents on average 81% and 73% of the value and transactions respectively of the universe of non-mining exports. Exports value (%) is the FOB value percentage of the exports. Transactions (%) is the percentage of the number of observations at item level. Destinations in descending order by Exports value.

Table 9: Export Value and Transaction per Sector

Sector	Macrosector	Exports (%)	Transactions (%)
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 7. Sectors in descending order by Exports value.