Exchange Rate Pass-Through and Invoicing Currency: Different Patterns at the Border and the Store*

Luis Cabezas† — Central Bank of Chile

Bernardo Candia‡ — UC Berkeley

Youyou Xu§ — UC Berkeley

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Abstract

We use detailed microdata from Chile to analyze the role of currency of invoicing for exchange rate pass-through (ERPT) at the border and the store. At the border, we find a predominant role for the USD for ERPT; however, bilateral exchange rate fluctuations also matter for longer time horizons. Using an instrumental variable approach to estimate ERPT at the store, we show that on impact, exchange rate fluctuations have no effect on retail prices, consistent with sticky prices set in the consumer's currency. For longer time horizons, bilateral and USD exchange rate movements significantly affect store prices.

Keywords: DCP, Exchange Rate Pass-Through, Currency of Invoicing.

JEL: F14, F31.

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†luiscabezas@g.ucla.edu

‡bernardo_candia@berkeley.edu

§williamxyy@berkeley.edu

1 Introduction

Understanding the impact of the exchange rates on consumer inflation is a centerpiece of international economics and of first-order interest for policymakers in open economies. The relationship between exchange rate fluctuations and international prices depends on the currency in which prices are rigid (Gopinath , 2016). In recent years, three competing hypotheses have governed the debate: PCP, LCP, and DCP (Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller , 2020).[1] Given the predominance of the US dollar in international transactions, DCP has gained an enormous interest (Gopinath and Itskhoki , 2022).

The debate around what currency of invoicing governs international prices is associated with import and export prices at the border, and it is independent of the category of goods, which raises some concerns. First, one of the consensus hypotheses is that exchange rate pass-through (ERPT) is larger at the border than at the store (Burstein and Gopinath , 2014; Amiti, Itskhoki, and Konings , 2019). Moreover, store prices are primarily set in local currency (Engel , 2016), so the role of currency of invoicing related to exchange rate shocks at the store should be muted.[2]

Secondly, many internationally traded goods are not final consumer goods; they are intermediate and capital goods used to produce final goods (Engel , 2016). Recent literature shows that ERPT at the border changes across industries (Chen, Chung, and Novy , 2022; Giuliano and Luttini , 2020). However, if capital goods and intermediate inputs are used in the production process, then ERPT will also be impacted by the ERPT and currency of invoicing of intermediate and capital goods.

[1] Under Producer Currency Pricing (PCP), prices are sticky in the currency of the producing country. Local Currency Pricing (LCP) assumes prices are sticky in the currency of the destination market. More recently, the Dominant Currency Paradigm (DCP) questions the validity of the previous hypotheses by stating that firms set export prices in dominant currencies, mainly the US dollar.

[2] One of the exceptions is (Yang , 2023) that studies the role of input-output linkages in determining ERPT in final consumer prices and the role of the currencies of invoicing.

In this paper, we study the relevance of the currency of invoicing for ERPT at the border and at the store. First, we evaluate how prices respond to exchange rate movements at the border in imports. Importantly, we assess the role of currency of invoicing on ERPT by explicitly distinguishing between final consumption goods and non-consumption goods (intermediate goods and capital goods). To study this at the border, we exploit detailed customs of import data for Chile at the transaction level. Then, we evaluate how prices respond to exchange rate movements at the store. We employ disaggregated product-level data used for constructing the Consumer Price Index (CPI). To assess the role of the currency of the invoice, we match import prices to every product, and we develop a new instrumental variable to estimate ERPT that leverages on customs data.

To guide our empirical assessment, we develop an open economy model that extends the one presented in (Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller , 2020) by including a distribution sector that involves all the additional costs in domestic currency, such as distribution services, to make the imported product available at the store. From the model, we obtain a set of testable implications. In the short run, where prices are sticky, exchange rate fluctuations affect prices at the border (under PCP, bilateral is relevant; under DCP, the dollar is relevant) but do not affect prices at the store. In the long run, where prices are flexible, the ERPT at the border corresponds to the impact over marginal costs. This impact is not fully passed to the store price, where the incompleteness's magnitude depends on the distribution sector's share.

We then empirically analyze the role of currency of invoicing for exchange rate pass-through (ERPT) at the border and the store at different time horizons. At the border, consistent with the dominant currency paradigm, we find a predominant role for the USD for ERPT; however, bilateral exchange rate fluctuations also matter for longer time horizons, providing support to PCP. Specifically, for USD-invoiced imports from non-USD countries, the short-run ERPT from a depreciation in the USD exchange rate is high (around 90 percent). It remains relatively high after eight quarters (around 60 percent). On the other hand, the ERPT from a depreciation in the bilateral exchange rate is close to zero on impact for USD invoiced imports but increases, reaching a peak of 28 percent after four quarters. Furthermore, it is higher for consumption goods than non-consumption goods (42 percent vs. 20 percent) and exceptionally high for food (57 percent).

An essential challenge to estimating ERPT at the store is related to endogeneity concerns.[3] To overcome this challenge, we develop a new instrumental variable approach to estimate ERPT at the store by leveraging at-the-border regressions. We use the ERPT results at the border, exogenously estimated due to differences in the invoicing currency, to construct instruments to estimate retail prices. The instrument corresponds to the weighted average across varieties of a product of the predicted value of price changes for imports.

Consistent with sticky prices set in the consumer's currency, we find an ERPT over-impact close to zero at the store. As predicted by our model, for longer time horizons, as nominal rigidities ease, determinants of import prices at the border echo at the store, however, in a lower magnitude. We find an ERPT of around 25 percent after eight quarters. We show that considering only bilateral rates or dollar fluctuations as a determinant of retail prices produces biased estimations, highlighting the relevance of the currency of invoices at the store.

These results carry significant implications for monetary policy. First, at the border, if we distinguish consumption from non-consumption goods, the currency of invoicing is still relevant. What is not trivial is the level of ERPT when we compare them at the border. The relevance of this result is that intermediate inputs won't underestimate or overestimate the role of invoice currency at the store. Second, at the store, the low sensitivity of ERPT in the short term contrasts with the results at the border. This result

[3]The first endogeneity concern is related to double causality for an endogenous monetary policy response to expected inflation, which affects exchange rates through interest rate parity conditions. The second endogeneity concern we show in our empirical analysis at the border is related to omitted variable bias caused by the lack of adequate accounting for different currencies of invoicing that interact at the store.

points out the Engel (2016) idea that all consumer prices are invoiced in local currency. However, as we show empirically and with our model, this result is valid only in the short term due to price rigidities. Invoice currency is relevant at the store in the medium and long term. Finally, those results carry important implications for expenditure switching. In the short run, important effects on quantities derived from exchange shocks are expected at the border, but at the store, they should be more muted.

Related literature. This paper is related to the literature on ERPT and the currency of invoicing. In the presence of market power and price rigidities, exchange rate fluctuations can affect economic activity (Dornbusch , 1987), where a key variable to evaluate the impact of those fluctuations is the ERPT. An abundant amount of literature has estimated ERPT in different periods and countries(Feenstra , 1989; Knetter , 1989; Goldberg and Knetter , 1997). More recent literature estimates different ERPTs according to the currency of invoicing.[4] For example, Gopinath, Itskhoki, and Rigobon (2010) show very low long-run pass-through for dollar-priced goods and complete pass-through for non-dollar-priced goods. Gopinath (2016) finds that ERPT depends on foreign currency invoicing shares, providing evidence of the US dollar as a dominant currency. Developing a modeling framework with dominant currency pricing, pricing complementarities, and imported inputs in production, called the "dominant currency paradigm," Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller (2020) show that changes in the dominant currency should drive the pass-through of import prices. Giuliano and Luttini (2020) and De Gregorio, García, Luttini, and Rojas (2023) closely relate to our work. Using a comprehensive dataset for Chile, the former shows that even though most Chilean imports are invoiced in dollars, bilateral exchange rates to exporter currencies matter in the medium term. At the same time, the latter finds that bilateral exchange rate fluctuations don't affect export prices in the short run, supporting DCP, but do affect export prices in the long run, supporting PCP. We go one step further by studying how prices respond to exchange rate movements at the border in imports, distinguishing between final consumption goods and non-

[4] See Burstein and Gopinath (2014) and Auer, Burstein, and Lein (2021).

consumption goods. Moreover, we decompose final consumption goods into food, transportation, and other manufactured goods. To the best of our knowledge, we are the first to analyze ERPT for different good categories.

The main part of the literature on ERPT and invoicing currency concerns the effect of exchange rate fluctuations on border prices. Burstein, Neves, and Rebelo (2003) find that distribution costs are relevant to explaining exchange rate dynamics, and they impact pass-through at the store. To the best of our knowledge, the only paper connecting invoice currency's role to exchange rate changes and the store is Auer, Burstein, and Lein (2021). Focusing on a natural experiment in Switzerland, they find a lower pass-through to retail than at the border. More recently, Yang (2023) adds to this literature by incorporating a rich input-output network with imported inputs. In the context of an emerging economy like Chile and based on distributed lag regressions, we contribute to this literature by comparing the role of invoicing currency for imports, distinguishing between consumption and non-consumption goods. We also provide a new instrumental variable to estimate the role of invoicing currency on ERPT at the store and develop a simple model to explain the mechanisms based on sticky prices and distribution costs.

The paper is organized as follows. Section 2 develops an open economy model incorporating distribution costs to the DCP model, providing a theoretical framework to benchmark our empirical results. Section 3 provides our empirical methodology to test the implications derived in Section 2. Section 4 explains the main features of the dataset and provides descriptive statistics. Section 5 presents the empirical results of the paper. Section 6 concludes.

2 Theoretical Framework and Testable Implications

We build a simple model to describe the evolution of prices at the border and the store depending on nominal rigidities and invoicing currency. Consider a small economy j that trades goods and assets with the rest of the world. Consistent with the evidence for Chile,[5] we assume that the dominant currency is the dollar. Households consume a bundle of imported and exported final goods and have access to foreign currency-denominated bonds. Producer firms adjust prices infrequently a la Calvo. Moreover, the producer sector uses imported intermediate inputs, and their prices are affected by exchange rate fluctuations. The main departure of this model in comparison with Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller (2020) is the inclusion of a distribution sector that involves all the additional costs in domestic currency, such as transportation services, to make the imported product available at the store. Firms in the distribution sector also adjust prices infrequently a la Calvo.[6]

Producer-level import price inflation in country j for goods produced in country i is[7]

$$\Delta p_{ij} = \theta^i_{ij} \underbrace{(\Delta p^i_{ij} + \Delta e_{ij})}_{\text{PCP}} + \theta^j_{ij} \underbrace{(\Delta p^j_{ij} + \Delta e_{jj})}_{\text{LCP}} + \theta^\$_{ij} \underbrace{(\Delta p^\$_{ij} + \Delta e_{\$j})}_{\text{DCP}},$$

where we assume there are three potential invoicing currencies, producer-priced (PCP), locally-priced (LCP), or dominant currency-priced (DCP), with the fraction of each invoicing currency k given by θ^k_{ij} and $\theta^i_{i,j} + \theta^j_{i,j} + \theta^\$_{i,j} = 1$.

Under Calvo pricing $\Delta p^k_{ij,t} = (1 - \delta_p)(\bar{p}^k_{ij} - p^k_{ij,t-1})$.[8] $1 - \delta_p$ firms randomly reset prices every period. Then, import price changes are as follows[9]

$$\Delta p_{ij} = \theta^i_{ij} \Delta e_{ij} + \theta^\$_{ij} \Delta e_{\$j} + (1 - \delta_p) \sum_{k \in \{i,j,\$\}} \theta^k_{ij} (\bar{p}^k_{ij,t} - p^k_{ij,t-1})$$

Assuming fully rigid prices ($\delta_p \to 1$), then, under PCP $\Delta p_{ij} = \Delta e_{ij}$ and import prices are directly affected by bilateral exchange rates. Under LCP, $\Delta p_{ij} = 0$, and im-

[5]Section 4 provides evidence of the US dollar as a dominant currency.

[6]Details of the model are in Appendix A.

[7]Log-level variables are denoted with lower case such that $p \equiv \log P$.

[8]The optimal reset price $\bar{p}^k_{ij,t}$ comes from the producer problem (see Appendix A.3). The presence of a distribution sector modifies the optimal reset price. For instance, assuming flexible prices $\bar{P}_{ji} = \frac{(1-\gamma)\sigma}{(1-\gamma)\sigma - 1} MC_j$, where $1 - \gamma$ corresponds to the share of imported consumption goods used by the retail firm.

[9]Note that we assume the convention $\mathcal{E}_{jj} = 1$.

port prices are not sensitive to bilateral exchange rate fluctuations. Finally, under DCP $\Delta p_{ij} = \Delta e_{\$j}$ and import prices are directly affected by the dollar.

We also evaluate how prices evolve at the store. Retail-level price inflation is

$$\Delta p_j^r = \theta^j(\Delta p_j + \Delta e_{jj})$$

where $\theta^j = 1$, and $\mathcal{E}_{jj} = 1$ implies that $\Delta p_j^r = \Delta p_j$. Then, retail prices are not directly affected by the exchange rate and are only impacted through import prices on marginal costs. As shown in Appendix A, retail prices are in local currency and subject to price rigidities. Under Calvo pricing assumption in the distribution sector, retail price changes can be expressed as

$$\Delta p_j^r = (1 - \delta_r)(\bar{p}_j^r - p_{j,t-1}^r).$$

Assuming fully rigid prices ($\delta_r \to 1$), the exchange rate does not affect retail prices. This result contrasts with border prices, where the exchange rate plays a first-order role in determining prices. In the long run, price rigidities ease. The exchange rate fluctuations are fully passed through marginal costs at the border (see Appendix A.3). However, the ERPT at the store is incomplete, even under fully flexible prices. Under the assumption of a Cobb-Douglas production function in the distribution sector, the incompleteness depends on the share of the distribution sector determined by $\gamma \in (0, 1)$.

In our empirical section, we test the following implications derived from the previous analysis: in the short run (rigid prices), exchange rate fluctuations affect prices at the border (under PCP, bilateral is relevant; under DCP, the dollar is relevant), but does not affect prices at the store. In the long run (flexible prices), the ERPT at the border corresponds to the impact over marginal costs, while the ERPT at the store is lower than at the border in magnitude $1 - \gamma$.

3 Empirical Strategy

3.1 Exchange Rate Pass-Through at the Border

We adopt dynamic-lag regressions of the type surveyed by Burstein and Gopinath (2014) to estimate exchange rate pass-through at the border. Pass-through regressions estimate the sensitivity of import or export prices to exchange rates.[10] We evaluate the relevance of the currency of the invoice across consumption and non-consumption goods (intermediate and capital goods). Due to its preponderance in the household consumption bundle, food, transportation, and manufactured goods are examined in our analysis. As discussed in the next section, the currency of invoice share in dollars and trade partner changes across good categories, so we expect a differential impact across goods. We use the same models to compare goods categories.

We study short and long-run ERPT for import prices. As we discussed in Section 2, in the short run, given nominal price rigidities, the ERPT from USD depreciation to import prices for goods shipped from non-USD origins invoiced in USD should be higher than the ERPT from the bilateral exchange rate. In the long run, the ERPT for the USD should moderate as nominal rigidities ease, but it should be more relevant for the exporter currency. For the cumulative USD ERPT, our hypothesis anticipates a decreasing magnitude over time, and for the cumulative bilateral ERPT, we anticipate an increasing pattern as prices freely adjust.

The relevant variable we evaluate is log changes in import prices of a variety v, invoiced in currency k, imported from country i denoted by ΔP_{vkit}. The empirical model considers changes in contemporaneous and 8-period ($L = 8$) lagged bilateral exchange

[10]Our empirical models closely follow recent literature of ERPT for the Chilean case (De Gregorio, García, Luttini, and Rojas , 2023; Giuliano and Luttini , 2020).

rates $\mathcal{E}_{CL,i}$, between Chilean pesos and the exporter country's currency[11]

$$\Delta P_{vkit} = \sum_{s=0}^{L} \beta_s \Delta \mathcal{E}_{CL,i,t-s} + \gamma \mathbf{z}_{it} + \alpha_{vki} + \lambda_t + \epsilon_{vkit}, \tag{1}$$

where z is a set of control variables, including the exporter country's inflation. α is a set of fixed effects at variety-currency-country level, and λ is a time fixed effect. Δ is the first difference quarterly operator. $\Sigma_{s=0}^{L}\beta_s$ captures the L-periods cumulative ERPT of an exchange rate movement at time 0.

We then gauge the degree of imports ERPT according to invoice currency. As discussed in the previous section, with nominal price stickiness, the currency of invoices in international trade transactions is a key determinant of the degree of ERPT and monetary policy transmission in the short and medium term. An important assumption is that the currency in which prices of goods are set is given, which is the relevant case for a small open economy. We measure the degree of ERPT of transactions invoiced in the exporter country's currency and those invoiced in USD. We do this by interacting the invoice currency with the associated exchange rate and measuring the ERPT for each currency of the invoice:

$$\begin{aligned} \Delta P_{vkit} = & \sum_{s=0}^{L} \beta_s^B \Delta \mathcal{E}_{CL,i,t-s} D_{\text{invoice}=i} + \sum_{s=0}^{L} \beta_s^\$ \Delta \mathcal{E}_{CL,\$,t-s} D_{\text{invoice}=\$} \\ & + \gamma \mathbf{z}_i + \alpha_{vki} + \lambda_t + \epsilon_{vkit}, \end{aligned} \tag{2}$$

where $D_{\text{invoice}=i}$ indexes transactions invoiced in the exporter country's currency, and $D_{\text{invoice}=\$}$ indexes transactions invoiced in USD.[12] Cumulative ERPT of transactions invoiced in the currency of country i is $\Sigma_{s=0}^{L}\beta_s^B$ and $\Sigma_{s=0}^{L}\beta_s^\$$ for transactions invoiced in USD.

The model in Equation (2) allows us to evaluate the relative relevance between bi-

[11] As we defined in the previous section an increase in the bilateral exchange rate $\mathcal{E}_{CL,i}$ corresponds to a depreciation of the Chilean peso.

[12] For dollarized countries such as the U.S. or Ecuador, we assume that if they invoice in USD, it corresponds to exporter country's currency.

lateral and USD but does not consider the potential impact of the bilateral exchange rate when the currency of the invoice is in the USD. Then, we quantify the role of the exporter currency's exchange rate from non-dollar origins for those transactions invoiced in USD, which comprise the bulk of Chilean imports. To measure the interaction, we add a third term to the previous specification between transactions invoiced in USD and the bilateral exchange rate

$$\begin{aligned}\Delta P_{vkit} = &\sum_{s=0}^{L} \beta_s^{B;B} \Delta \mathcal{E}_{CL,i,t-s} D_{\text{invoice}=i} + \sum_{s=0}^{L} \beta_s^{\$;\$} \Delta \mathcal{E}_{CL,\$,t-s} D_{\text{invoice}=\$} \\ &+ \sum_{s=0}^{L} \beta_s^{B;\$} \Delta \mathcal{E}_{CL,i,t-s} D_{\text{invoice}=\$} + \gamma \mathbf{z}_{it} + \alpha_{vki} + \lambda_t + \epsilon_{vkit}\end{aligned} \tag{3}$$

where $\Sigma_{s=0}^{L} \beta_s^{B;\$}$ is the cumulative ERPT for the exporter bilateral currency for transactions invoiced in USD.

3.2 Exchange Rate Pass-Through at the store

We aim to make a consistent estimation of ERPT at the store. One estimation approach uses bilateral or multilateral exchange rates as a regressor over product-level retail prices. However, using only bilateral or multilateral rates presents an omitted variable bias.[13] Our unique dataset used for estimations at the border allows us to go a step further by using the information from at-the-border regressions to produce a new instrumental variable for consistent estimations.[14]

By assuming the exogenous currency of invoice decisions, our regressions at the border produced a consistent identification of ERPT due to differential changes in invoicing currency vis-a-vis bilateral rates for import prices. Therefore, we use these

[13] Official multilateral exchange rates are estimated as a weighted exchange rate where the weight on each trading partner's bilateral exchange rate is given by the trade share for that country. This indicator is problematic because the currency of the invoice does not always coincide with the trading partner's currency. Moreover, consumption goods correspond to 34% of total imports, which is another reason why trading partner weights in trade do not necessarily coincide with trading partners' weights in consumption.

[14] An additional identification challenge in this literature is the double causality bias. Given the consistency of the first stage, we will evaluate this bias under our proposed instrument.

regression results as a first stage for every retail product in our dataset.[15] Our instrumental variable z_{gt} for every product g and time t is obtained as follows

$$z_{gt} = \sum_{v(g),k,i} \omega_{vkit} \Delta \hat{p}_{vkit}, \tag{4}$$

where $\Delta \hat{p}_{vkit}$ is estimated from border regressions, and weights ω_{vkit} is computed as

$$\omega_{vkit} = \frac{V_{vkit}}{\sum_{v(g),k,i} V_{vkit}},$$

where V_{vkit} is the total value of imports for variety v invoice in currency k with origin country i. Then, we use this instrumental variable to estimate ERPT at the store,

$$\Delta p_{gt} = \sum_{i=0}^{L} \beta_i^s z_{gt-i} + \alpha_g + \eta \chi_t + \varepsilon_{gt}, \tag{5}$$

where p_{gt} corresponds to log change retail prices of product g, α_g is fixed effects per product g, and χ_t is a domestic control variable that, in this case, is seasonally adjusted domestic Chilean output. The number of lags considered again is eight lags.

One concern related to the performance of our instrumental variable is how the performance is compared to a multilateral exchange rate estimated with the bilateral rates weighted by relevant trade partners at the product level. Then, to tackle this concern, we develop a new variable called nominal effective exchange rate at the product level (NEER product level). NEER product level $NEER_{gt}$ for every product g and time t is obtained as follows

$$NEER_{gt} = \sum_{v(g),k,i} \omega_{vkit} \Delta e_{it}, \tag{6}$$

where ω_{vkit} is the same weight as for the instrument. Then, we estimate ERPT in Equation (5) by using as control this new variable $NEER_{gt}$ instead of z_{gt}.[16]

[15]Section 4 describes the merging procedure we followed to connect import and export prices at the transaction level for every product in the consumption basket. It implies that per every product, estimations for different varieties within a product are an instrument for each one of them.

[16]We have different alternatives to construct NEER product level using only import or export

4 Data

4.1 Data Sources

We use four different data sources that inform us about import prices, bilateral exchange rates, retail prices, and domestic household expenditure bundles in Chile.

The first two datasets are the most important ones and contain customs data at the transaction level for imports. Those datasets contain total values and quantities to calculate unit values used as our import prices. A key characteristic of this dataset is that it incorporates the currency of the invoice of every transaction. We aggregate it quarterly and focus on the 2009-2020 period. This transaction level data is coded at the firm, HS 8-digit level.[17] A novel procedure we developed is splitting import datasets at BEC codes to classify them as consumption, intermediate, or capital goods. Then, for consumption goods, we match every HS 8-digit variety with CCIF product categories used for CPI construction.

The third dataset contains monthly retail prices at the product level from 2009 to 2020. The Chilean Statistics Agency uses this data to construct the CPI. We match this data with import unit values. Note that import varieties have a higher level of disaggregation, so different varieties will serve as an instrument to estimate ERPT at the store. We aggregate them by using total value shares.

The fourth dataset contains bilateral exchange rates we use for pass-through regressions. We adopt quarterly-level data collected in a period-average fashion. Other variables are domestic Chilean output and foreign inflation for the counterpart country.

4.2 Data Description

We use quarterly average bilateral exchange rates that are invoiced twofold: at the origin country and trade. First, we briefly describe the currency of the invoice for Chilean international trade. We observe that Chilean imports are mainly invoiced in USD re-

weights or both of them. Given the high concentration of exports in food, we evaluate both cases.

[17] Each pair of price and value records is based on a unique exporting firm ID, the original country where the firm is established, and the invoiced currency at trade.

gardless of country of origin, except for countries in the Eurozone.

Table 1 displays the import share distribution by currency for each major origin for 2009-2020. Panel A of Table 1 decomposes imports across consumption, non-consumption, capital, and intermediate goods. The USD is the most important invoicing currency: 93.8% of consumption goods are invoiced in USD. Panel B of Table 1 displays import share distribution by currency but focuses on consumption goods only. Again, the USD is the most critical invoicing currency among the three categories defined by the first digit of CCIF encoding.

Table 1: Share of Import Value by Invoicing Currency (2009-2020)

Classification / Share (%)	Dollar	Euro	Yen	Pound	Others	Share
Panel A. BEC						
Total Imports	88.66	8.44	0.60	0.21	2.08	
Consumption	93.80	3.75	0.15	0.23	2.08	34.17
Non-consumption	86.50	8.69	2.43	0.18	2.20	65.83
Capital	77.47	16.78	1.96	0.31	3.48	20.95
Intermediate	91.22	7.37	0.22	0.14	1.05	44.88
Panel B. CCIF						
Total	95.56	3.18	0.22	0.22	0.82	
Food (1-2)	92.98	5.12	0.00	0.35	1.55	36.89
Manufactured (3-4-5-6-8-9)	94.99	3.62	0.18	0.31	0.89	33.83
Transportation (7)	98.69	0.79	0.49	0.01	0.02	29.29

Notes: The table shows the import share distribution by currency for each major origin/destination. Panel A decomposes imports across consumption, non-consumption, capital, and intermediate goods. Panel B decomposes imports across three categories defined by the first digit from 1 to 9 of CCIF encoding: food (codes 1 and 2), transportation (code 7), and manufactured (all other digits combined). Column share is the ratio of each category over all of them. The shares are computed using nominal values and correspond to the annual average for 2009-2020.

Table 2 displays the import share distribution by trading partner origin. The US (38.26%) and China (27.84%) are important trading partners at origin for consumption goods, LATAM (31.67%) is important for non-consumption goods, and Europe (29.98%) for capital goods. When we focus on consumption goods only (Panel B of Table 2), LATAM (70.99%) is the most relevant trading partner at origin for food, Asia without China (70.76%) is important for manufactured goods, and the US (85.73%) for transportation.

Consistent with previous studies for emerging economies (Goldberg and Tille, 2008; Gopinath, 2016), we have documented that most Chilean international trade is conducted in US dollars. Around 90 percent of Chilean imports are invoiced in USD, even though only 23 percent come from the US. This predominance of the US dollar remains across good types, with some differences in the magnitudes. Finally, there is a significant heterogeneity in the import share distribution by origin across good types.

Table 2: Share of Import Value by Origin and Share of Export Value by Destination

Classification / Share (%)	U.S.	China	Asia (w/o China)	Europe	America (w/o U.S.)	Others	Africa
Panel A. BEC							
Total Imports	23.02	15.57	12.83	16.52	31.07	0.86	0.13
Consumption	38.26	27.84	6.54	8.25	18.98	0.07	0.07
Non-consumption	18.21	12.17	16.13	20.73	31.67	0.92	0.16
Capital	22.83	12.07	12.43	29.98	21.93	0.63	0.13
Intermediate	18.22	13.79	9.08	16.51	40.90	1.27	0.22
Panel B. CCIF							
Total Imports	34.13	0.57	28.63	5.94	29.93	0.73	0.06
Food (1-2)	11.94	1.44	5.28	8.14	70.99	2.13	0.07
Manufactured (3-4-5-6-8-9)	4.73	0.24	70.76	7.31	16.79	0.07	0.10
Transportation (7)	85.73	0.03	9.83	2.39	2.01	0.01	0.00

Notes: The table shows the import share distribution by trading partner origin. Panel A decomposes imports across consumption, non-consumption, capital, and intermediate goods. Panel B decomposes imports across three categories defined by the first digit from 1 to 9 of CCIF encoding: food (codes 1 and 2), transportation (code 7) and manufactured (all other digits combined). The shares are computed using nominal values and correspond to the annual average for 2009-2020.

5 Regression Results

5.1 Results at the border

This section presents our regression results at the border for import prices at different horizons.[18] We evaluate the hypothesis described in the previous section for different invoice currencies among goods categories. We first compare those hypotheses for consumption goods with non-consumption goods (intermediate and capital goods). Then, we open up consumption goods in the most relevant consumption divisions for the Chilean case.

Figure 1 reports regression results of ERPT to import prices for all product imported categories.[19] Panel (a) of Figure 1 shows results from a panel regression of import prices on bilateral exchange rates (see Equation 1).[20] Consistent with Giuliano and Luttini (2020), the ERPT from a depreciation in the bilateral exchange rate is 44 percent on impact and then increases slightly in the medium (54 percent) and long run (50 percent). When imported goods are decomposed into consumption and non-consumption goods (see Figure 2), the ERPT is higher in the first quarter for consumption goods (53 percent vs. 38 percent). Moreover, the ERPT increases in the medium run for consumption goods, while the ERPT remains relatively stable for non-consumption goods for longer horizons.[21]

Consumption goods are products ready for sale, so ERPT impacts CPI more than non-consumption goods that support production. Then, we dig deeper into consumption goods by decomposing them into three categories: food, manufacturing, and transportation. Figure 3 reports regression results of ERPT to consumption goods. The

[18] $\sum_{i=0}^{Q} \beta_i$ is the cumulative ERPT for the Q-periods. For the exposition, the short run refers to $Q = 0$, the medium run refers to $Q = 4$, and the long run refers to $Q = 8$.

[19] To understand the role of invoice currency in the ERPT, we follow Giuliano and Luttini (2020).

[20] For additional regression result details, see Appendix C Table A.1.

[21] Table A.3 in Appendix C shows ERPT to border results decomposing non-consumption goods into intermediate and capital goods according to BEC classification. When we decompose non-consumption goods into intermediate and capital goods, the ERPT is higher for intermediate goods (52 percent vs. 41 percent).

three categories follow an increasing bilateral ERPT over time, although it is lower for transportation goods on impact and steeper in the medium run (39 percent vs. 55-56 percent).

The above results have two shortcomings:[22] (1) the coefficient on the bilateral exchange rate could be capturing movements in the CLP-USD parity, and (2) the coefficient on the bilateral exchange rate is an average of potentially heterogeneous ERPT to import prices, which depend on the currency of the invoice. We then measure the degree of ERPT of transactions invoiced in the exporter country's currency and those invoiced in USD. Panel (b) of Figure 1 shows results for ERPT regression distinguishing among transactions invoiced in the exporter country's currency *vis a vis* those that invoice in USD (see Equation 2). The ERPT has a similar impact on both types of exporters (around 75 percent). However, the ERPT from exporters that invoice their products in their country's currency is higher in the medium (86 percent vs 53 percent) and long run (78 percent vs 43 percent).

When we decompose import goods into consumption and non-consumption goods, for both types of exporters, there are no significant differences in the ERPT to import prices on the impact between good categories; however, in the long run, we find different patterns across currency of invoice (see Figure 4). After eight quarters, the ERPT from exporters invoiced in their domestic currency is higher for consumption goods than non-consumption goods (107 percent vs. 61 percent) and closer across good categories for exporters invoiced in USD (51 vs. 37 percent). We find noticeable differences across good categories when decomposing final consumption goods into food, manufactures, and transportation (see Figure 5). For food and manufacturers, the ERPT has a high impact (around 90 percent); it increases for exporters that invoice in their country's currency and decreases for exporters that invoice in USD. In contrast, for transportation, the ERPT is relatively lower (59 percent bilateral and 52 percent USD) and increases over time for exporters that invoice in USD.

[22] Those shortcomings have been previously stated by ERPT and currency of invoice literature. See Giuliano and Luttini (2020).

The previous analysis allowed us to evaluate the ERPT depending on the currency of the invoice. Still, it did not consider the potential impact of the bilateral exchange rate when the currency of the invoice is in the USD, which is the corresponding case for mainly all the Chilean imports originating outside the US.[23] To understand the role of bilateral exchange rates to non-USD countries that invoice their exports in USD, we add an interaction term between transaction invoice in USD and the CLP-X exchange rate (see Equation 3). Over impact, the ERPT from a depreciation in the bilateral exchange rate is close to zero on impact for USD invoiced imports but increases, reaching a peak of 28 percent after four quarters. For USD invoiced imports, the short-run ERPT from a depreciation in the USD exchange rate is high (76 percent). In the medium and long run, the ERPT decreases but remains relatively high (around 40 percent).

We explore the difference between consumption and non-consumption goods in Figure 6. There are no quantitatively large differences across good categories in the short run. In contrast, in the medium run, it is higher for consumption goods than non-consumption goods (45 percent vs. 16 percent). Finally, for the three categories of final consumption goods, the ERPT from a depreciation in the USD exchange rate is high on impact (around 80 percent) and decreases over time but remains relatively high (see Figure 6 in Appendix B). Instead, the ERPT in the bilateral exchange rate for USD invoiced imports is not significantly different from zero on impact for every consumption good category. However, it is high in the medium run for manufactured goods (54 percent).

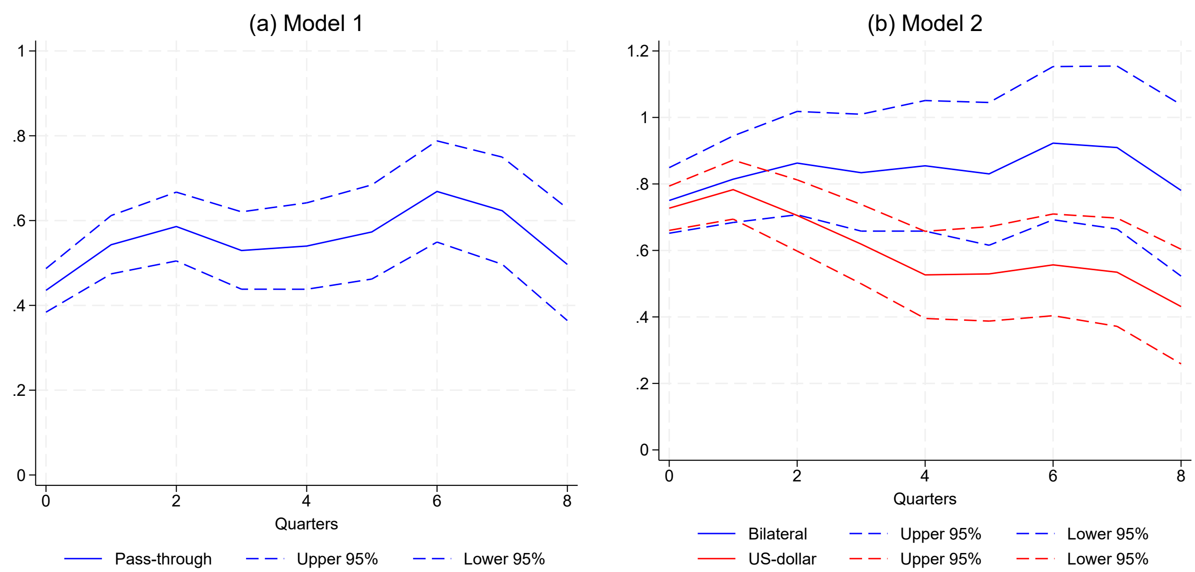
When comparing imported good categories in our previous analysis, we followed a pragmatic approach by directly comparing the ERPT accumulated level in figures. Still, a formal evaluation is required to compare those broad good categories. Table 3 evaluates this difference by extending Equations 1, 2, and 3 to account for a potential divergence in coefficient levels, and we compare this net effect considering consumption goods with our baseline estimations. In this case, the Equation 1 turns to be

[23] As we showed in Section 4.2 almost 90 percent of Chilean imports are invoiced in the US dollar, even though only 23 percent of imports come from the US.

$\Delta P_{vkit} = \sum_{s=0}^{L} \beta_s^{B;B} \Delta \mathcal{E}_{CL,i,t-s} + \sum_{s=0}^{L} \delta_s^{B;B} \Delta \mathcal{E}_{CL,i,t-s} D_{cons} + \gamma \mathbf{z}_{it} + \alpha_{vki} + \lambda_t + \epsilon_{vkit}$ where D_{cons} is a dummy variable equal to 1 if an imported good is classified as a consumption good according to the BEC classification. The results in column (1) reveal that when considering consumption goods, bilateral ERPT is higher in both the short and long run (43.5 vs. 47.8 percent and 49.7 vs. 51.3 percent). As previously explained, the USD exchange rate is essential for Chilean imports. Over impact, ERPT for the USD exchange rate increases from 72.7 to 76.8 percent and from 78.1 to 82.9 percent in the long run. Then, we conduct the same exercise by considering the potential impact of the bilateral exchange rate when the currency of the invoice is in the USD. The results still exhibit higher ERPT for bilateral and USD exchange rates in the short and long run, although the ERPT is higher for consumption in the medium run (26.7 vs. 29 percent). Previous results are maintained when directly comparing consumption with intermediate goods, i.e., excluding capital goods (see columns (2), (4), and (6)).

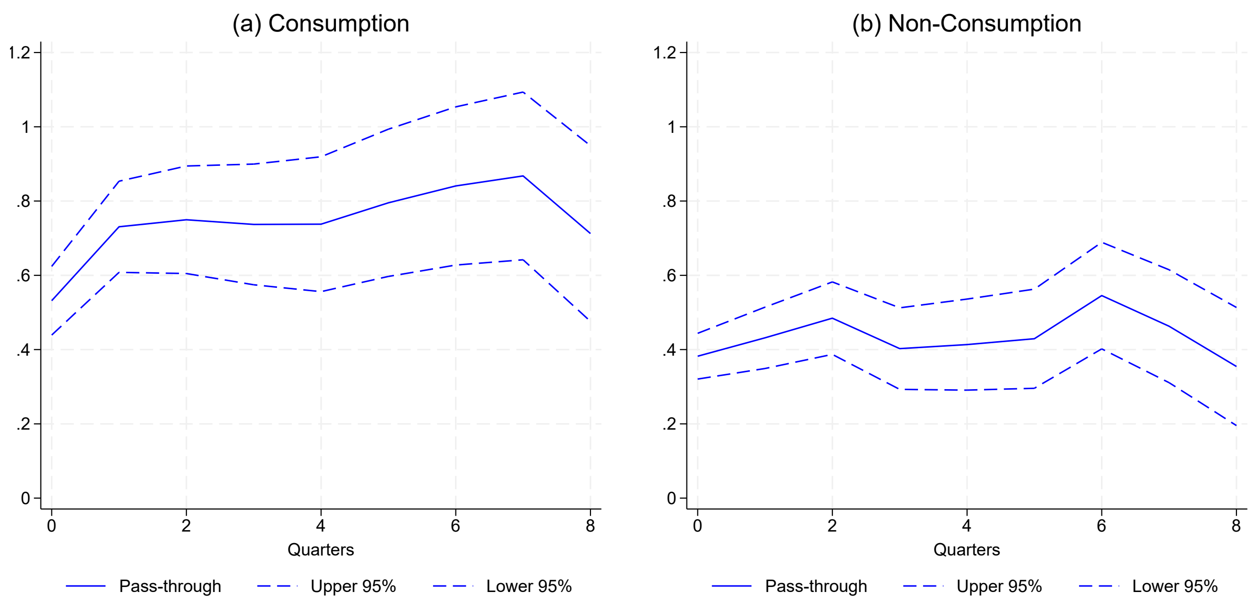
The previous results support the dominant currency paradigm in imports in the short run. However, bilateral exchange rate fluctuations also matter for longer time horizons, supporting PCP. Although consumption and non-consumption goods exhibit similar currency of invoicing patterns, imported consumption goods experience a higher ERPT mainly in the long run and for both dominant currency and PCP. These new results are meaningful for the expected ERPT at the store. They are a new argument to support that ERPT at the border is an upper bound for ERPT at the store.

Figure 1: ERPT to import prices for all imported goods



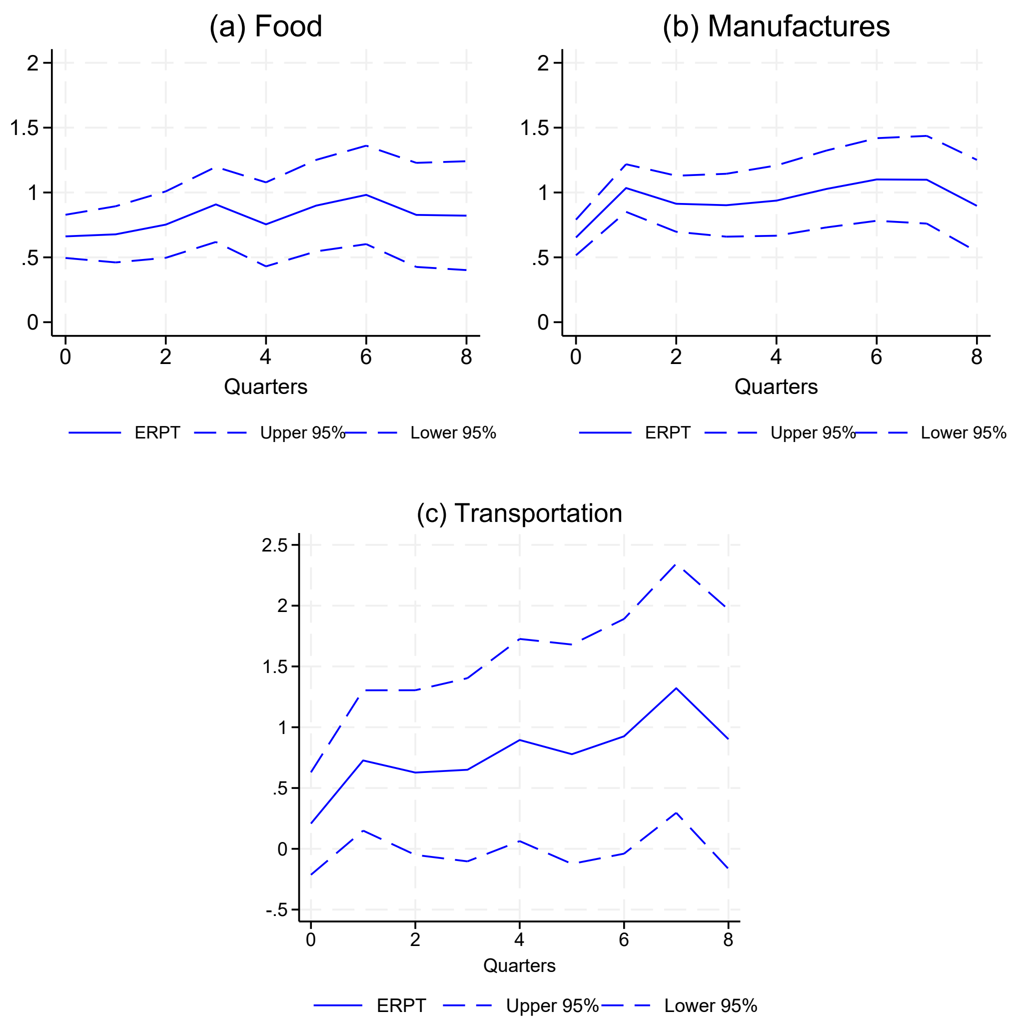
Note: The figure shows cumulative bilateral and CLP-USD ERPT to import price regressions for all imported goods. Panel (a) shows the regression results for Equation (1), and Panel (b) for Equation (2). The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid red line captures the L-quarters cumulative ERPT of the USD-CLP exchange rate at time 0. Dashed red lines indicate 95% confidence bands of cumulative ERPT of USD-CLP. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure 2: EPRT to import prices by consumption and non-consumption goods



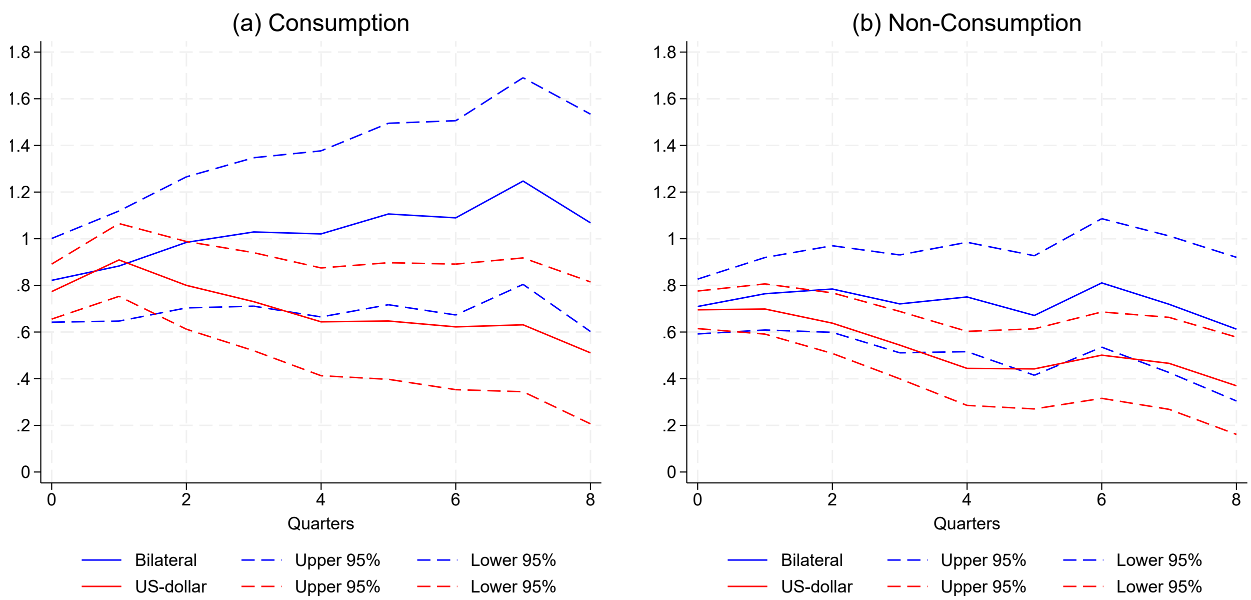
Notes: The figure shows cumulative bilateral ERPT to import price regressions. It reports the results of Equation (1). Panel (a) shows the results for consumption goods, and Panel (b) for non-consumption goods (intermediate and capital goods) according to BEC classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure 3: EPRT to import prices by consumption goods



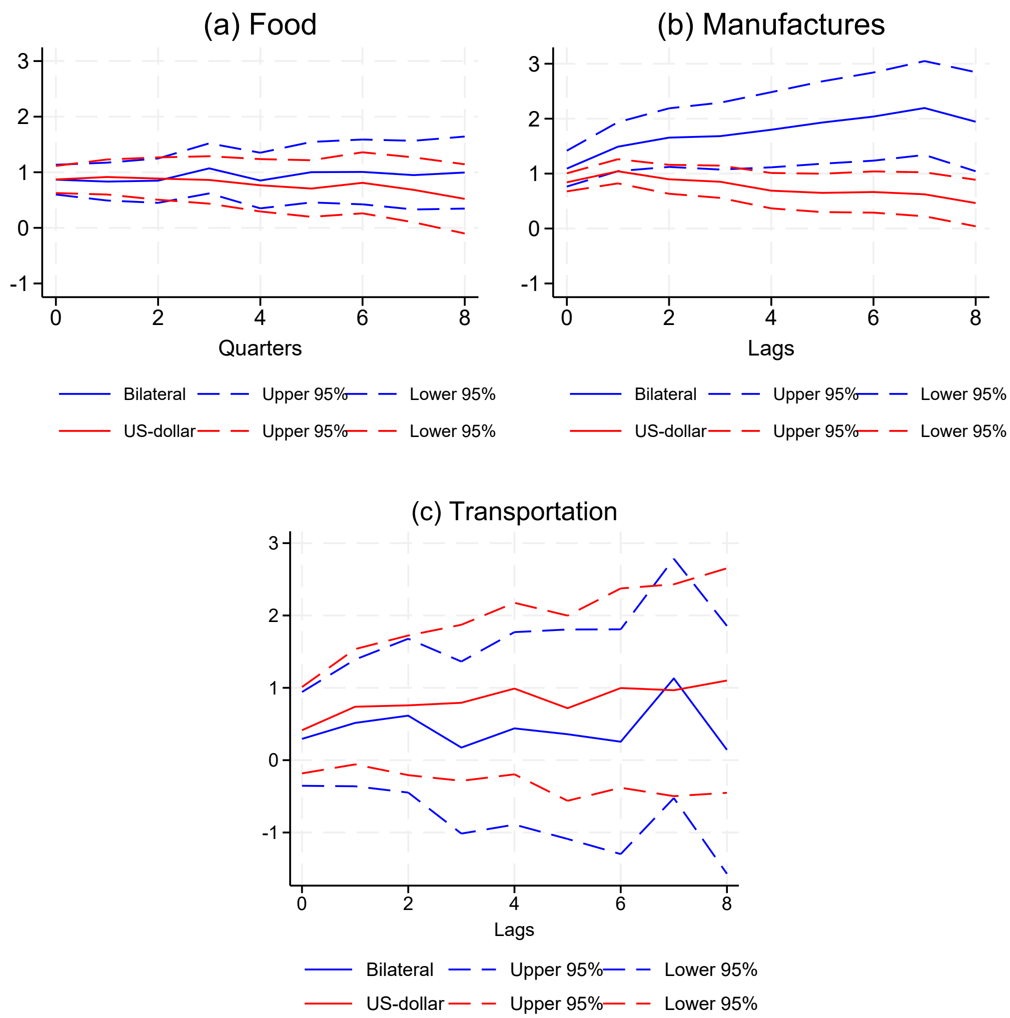
Notes: The figure shows cumulative bilateral ERPT to import price consumption good regressions. It reports the results of regression (1). Panel A shows the results for consumption goods related to food, Panel B for consumption goods related to manufactures, and Panel C for consumption goods related to transportation according to COICOP classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure 4: EPRT by Invoice Exporter Currency and Invoice USD



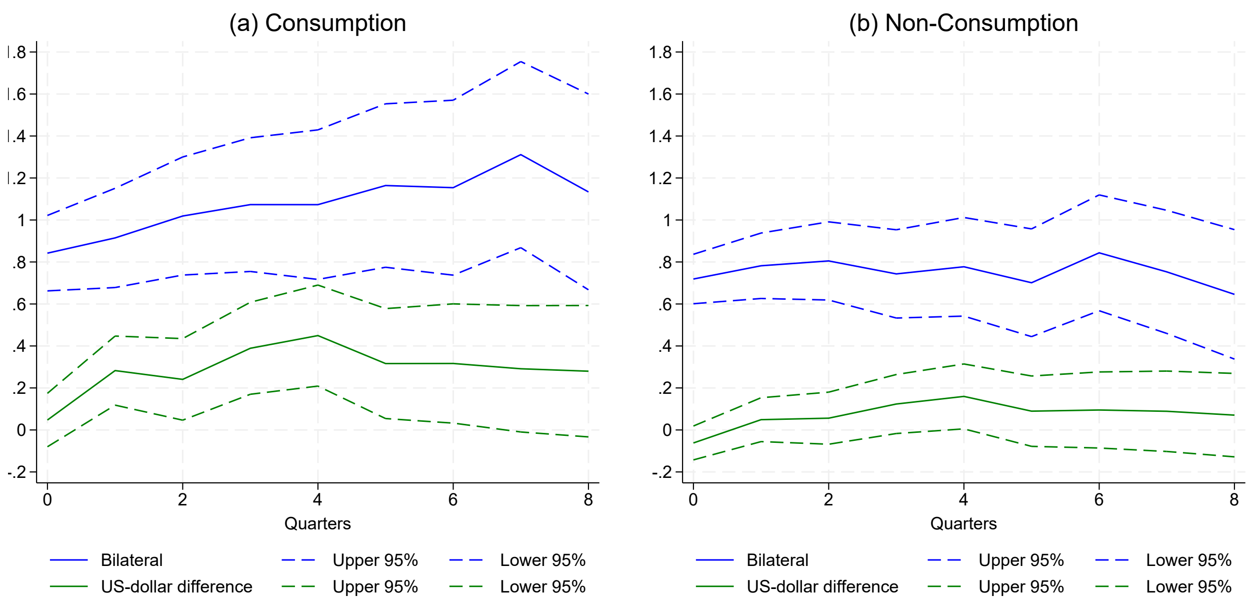
Note: The figure shows cumulative bilateral and CLP-USD ERPT to import price regressions. It reports the results of regression (2). Panel (a) shows the results for consumption goods, and Panel (b) for non-consumption goods (intermediate and capital goods) according to BEC classification. The solid blue line captures the *L*-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid red line captures the *L*-quarters cumulative ERPT of the USD-CLP exchange rate at time 0. Dashed red lines indicate 95% confidence bands of cumulative ERPT of USD-CLP. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure 5: Disaggregate EPRT by Invoice Exporter Currency and Invoice USD



Note: The figure shows cumulative bilateral and CLP-USD ERPT to import price consumption good regressions. It reports the results of regression (2). Panel A shows the results for consumption goods related to food, Panel B for consumption goods related to manufactures, and Panel C for consumption goods related to transportation according to COICOP classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid red line captures the L-quarters cumulative ERPT of the USD-CLP exchange rate at time 0. Dashed red lines indicate 95% confidence bands of cumulative ERPT of USD-CLP. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure 6: Difference in ERPT by Invoice Exporter Currency and Invoice USD



Note: The figure shows cumulative bilateral ERPT and its differences regarding CLP-USD ERPT to import price regressions. It reports the results for regression (3). Panel A shows the results for consumption goods and Panel B for non-consumption goods (intermediate and capital goods) according to the BEC classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid green line captures the L-quarters cumulative ERPT of bilateral exchange rate interacted with USD currency invoice $\sum_{s=0}^{L} \beta_s^{B\,\$}$. Dashed green lines indicate 95% confidence bands of cumulative ERPT of $\sum_{s=0}^{L} \beta_s^{B\,\$}$. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Table 3: Invoice Currency and Bilateral ERPT: Net effect of consumption

	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_0^{B;B} + \delta_0^{B;B}$	0.478***	0.479***	0.713***	0.718***	0.726***	0.732***
$\sum_{s=0}^{4}(\beta_s^{B;B} + \delta_s^{B;B})$	0.575***	0.592***	0.844***	0.862***	0.881***	0.900***
$\sum_{s=0}^{8}(\beta_s^{B;B} + \delta_s^{B;B})$	0.513***	0.535***	0.829***	0.858***	0.877***	0.907***
$\beta_0^{\$;\$} + \delta_0^{\$;\$}$			0.768***	0.769***	0.798***	0.797***
$\sum_{s=0}^{4}(\beta_s^{\$;\$} + \delta_s^{\$;\$})$			0.611***	0.615***	0.505***	0.495***
$\sum_{s=0}^{8}(\beta_s^{\$;\$} + \delta_s^{\$;\$})$			0.475***	0.478***	0.515***	0.503***
$\beta_0^{B;\$} + \delta_0^{B;\$}$					-0.00494	-0.00326
$\sum_{s=0}^{4}(\beta_s^{B;\$} + \delta_s^{B;\$})$					0.290**	0.312**
$\sum_{s=0}^{8}(\beta_s^{B;\$} + \delta_s^{B;\$})$					0.0932	0.122
Obs.	86,708	72,485	86,708	72,485	86,708	72,485
R2	0.069	0.067	0.075	0.074	0.076	0.075
Adj. R2	-0.0279	-0.0309	-0.0207	-0.0235	-0.0204	-0.0231

Notes: The table shows the results of the consumption net effect of ERPT on import price regressions. Columns (1) and (2) show the results of regression (1) adding the interaction of bilateral exchange rate with consumption category captured by $\delta_s^{B;B}$. For instance, column (1) shows the net result of regression (1), $\Delta P_{vkit} = \sum_{s=0}^{L} \beta_s^{B;B} \Delta\mathcal{E}_{CL,i,t-s} + \sum_{s=0}^{L} \delta_s^{B;B} \Delta\mathcal{E}_{CL,i,t-s} D_{cons} + \gamma \mathbf{z}_{it} + \alpha_{vki} + \lambda_t + \epsilon_{vkit}$, where D_{cons} is a dummy variable equal to 1 if imported goods are classified as a consumption good according to BEC classification. Columns (3) and (4) show the results of regression (2) adding the interactions of bilateral exchange rate and USD exchange rate with consumption category captured by $\delta_s^{B;B}$ and $\delta_s^{\$;\$}$. Columns (5) and (6) show the results of regression (3) adding the interactions of bilateral exchange rate and USD exchange rate with consumption category captured by $\delta_s^{B;B}$, $\delta_s^{\$;\$}$, and, $\delta_s^{B;\$}$. Columns (1), (3), and (5) report estimates for all import products. Columns (2), (4), (6) report estimates only for consumption goods and intermediate goods according to BEC classification (i.e., it excludes capital goods). ***, **, * denote statistical significance at 1, 5, and 10 percent levels.

5.2 Results at the store

This section presents our regression results at the store's product level. We evaluate how ERPT depends on the currency of invoicing associated with imported goods. As a benchmark, we first estimate ERPT for consumption goods with the traditionally used nominal effective exchange rates (NEER) and bilateral dollar rates. Then, we estimate ERPT with the new NEER weighted at the product level described in Section 3.2. Finally, we compare those previous results with our new instrumental variable approach.

Table 4 reports ERPT regression results for the store's NEER and bilateral dollar rates. We find that the official NEER has a higher ERPT than the bilateral dollar (see columns (1)-(3)).[24] This result is valid in the short and medium term, and in both cases, ERPT increases with the time horizon.

The official NEER is an aggregate index calculated using almost all traded goods. As discussed in previous sections, goods are traded with different countries, so assuming the same weight for all goods is misleading. Then, to tackle this concern, we develop a new variable called nominal effective exchange rate at the product level (NEER product level), where bilateral rates are weighted by relevant trade partners at the product level. Column (4) in Table 4 reports the results. ERPT decreases and is closer to the bilateral USD rate. Even when we use a non-weighted average of the specific bilateral rates associated with imports, ERPT decreases (see column 5).[25]

Three important results emerge from the previous analysis. First, independently of the exchange rate variable considered in-store regressions, ERPT is significantly lower at the store than at the border for imports. This finding is consistent with our model and with a long body of literature that found a lower ERPT at the store than at the border (Burstein and Gopinath , 2014). Second, independently of the exchange rate variable considered in-store regression, ERPT over impact is close to zero and increases

[24] NEER official considers the bilateral exchange rate of all trading partners. In comparison, NEER-5 considers bilateral rates of only the five main trading partners: the U.S., Japan, the UK, Canada, and the Euro Zone.

[25] It implies that there is a country composition and a magnitude composition effects interacting. Future research will disentangle both effects.

over time. This result is directly related to our theoretical results; in the short run, price rigidities play a determinant role, and as those rigidities ease, then exchange rate fluctuations become relevant. This result is similar to LCP but at lower levels of ERPT. Third, when we move to a more suitable exchange rate, such as the bilateral dollar (90% of consumption imports are invoiced in dollars) or NEER product-level (heterogeneous bilateral rates across products), ERPT at the store decreases. So, this is indicative of an upward bias when using NEER to measure ERPT at the store.

Table 4: Tradable CPI at the Product Level. ERPT with Observed Exchange Rates for Imports

	(1) NEER Official	(2) NEER-5 Official	(3) USD	(4) NEER Product-level (weighted avg.)	(5) NEER Product-level (simple avg.)
β_0^s	0.061***	0.071***	0.015***	0.007	0.013
$\sum_{i=0}^{4} \beta_i^s$	0.323***	0.305***	0.217	0.198***	0.197***
$\sum_{i=0}^{8} \beta_i^s$	0.466***	0.435***	0.254***	0.317***	0.356***
Observations	2,840	2,840	2,840	2,840	2,840
R-squared	0.196	0.192	0.194	0.188	0.184
Adj. R-squared	0.156	0.151	0.154	0.147	0.142

Notes: The table shows the results of ERPT to the store regression (5) controlling for different exchange rates. Column (1) controls for the official nominal effective exchange rate (NEER). Column (2) controls for the official NEER-5 (the US, Japan, the UK, Canada, and the Euro Zone). Column (3) controls for CLP-USD. Column (4) controls for NEER product level defined in Equation (6). Column (5) controls for a non-weighted NEER product level. ***, **, * denote statistical significance at 1, 5, and 10 percent levels.

Next, we move to the instrumental variable approach described in Section 3.2. Panel (a) in Figure 7 shows results when we use Equation (1) as a first stage. We find a lower ERPT at the store compared to the results obtained in Columns (1) and (2) in Table 4, even though our instrument does not include dollar variation.[26] Specifically,

[26]Note that in Panel (a) we construct our instrument using bilateral rates only. As we discussed, the instrument in this case has an omitted relevant variable bias due to the dollar's relevance at the border, and so on; the results are more similar to those in the official NEER.

compared to our benchmark results (columns 1 and 2 in Table 4), we find a lower ERPT for both the short and long run.[27] This lower pass-through implies an upward bias in official NEER when calculating ERPT at the store. An important result is that over-impact ERPT is lower and closer to zero, consistent with our model. When we include dollar variation in our instrument (Equation 2) we find a lower ERPT in the short (0 percent) and long run (24 percent). Finally, in Panel (c), we include bilateral rates for dollar invoices in our instrument (Equation 3). ERPT reduces slightly in the long run to 29 percent.

Contrasting the instrumental variables with and without bilateral dollars is important to account for the relevance of the currency of the invoice (i.e., Panel (a) vs. Panel (b) and (c)). The level of ERPT is significantly lower when present, which points out that bilateral rates are not the only determinant.[28] Moreover, as both bilateral and dollar are relevant at the border, our econometric model would be misspecified without considering the dollar variation. The implication is that the currency of invoicing matters at the border and the store.[29]

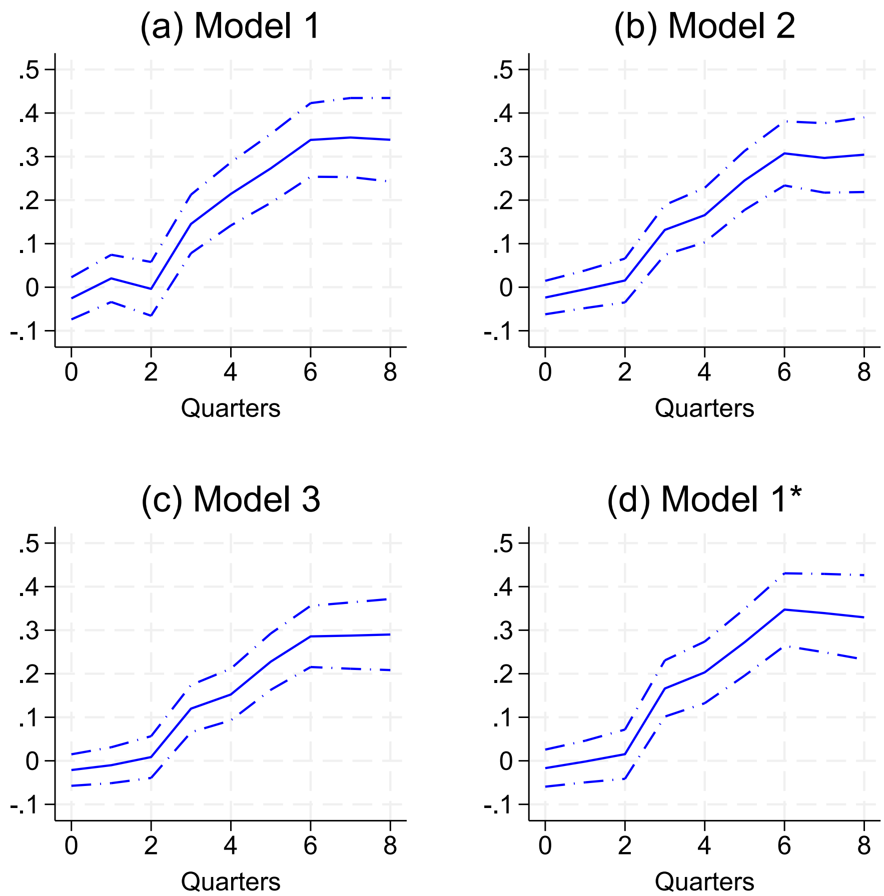
The previous results provide three key insights. First, over impact, ERPT is almost zero. This result was also present without considering instrumental variable analysis and is consistent with our theoretical model. Second, considering only bilateral rates or dollars as a determinant of retail prices is misleading and can produce biased estimations. Third, determinants of import prices at the border echo at the store, mainly in the medium and long term. We showed in Chile at the border for consumption goods, the currency of the invoice is an important determinant of ERPT on top of bilateral rates. Therefore, our second and third insights highlight the relevance of the currency of invoices at the border and the store.

[27] For additional details see Table A.4 in Appendix C.

[28] Table A.5 in Appendix A.5 shows ERPT to store results when we consider at the border and the store food and alcoholic beverages only.

[29] A caveat for our results is that at the border, we find a similar impact for imports for a dollar and bilateral exchange rates, so huge differences at the store should not be observed. In Panel (d) Figure 7, we consider only dollar variation, finding almost identical results to Panel (a).

Figure 7: Aggregate ERPT at Store



Note: The figure shows cumulative ERPT at store regressions. It reports the results of regression (5) where the dependent variable is the difference of log retail price of product g at time t. Panel (a) considers the instrumental variable of the model in Equation (1). Panel (b) considers the instrumental variable of the model in Equation (2). Panel (c) considers the instrumental variable of the model in Equation (3). Finally, Panel (d) uses the same model as Panel (a) but replaces the bilateral exchange rate with the CLP-USD exchange rate. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT. *Sources*: Authors' calculations are based on customs import data, retail prices at the product level used to construct CPI, and exchange rates.

6 Conclusion

This paper uses a comprehensive dataset from Chile to analyze the role of currency in invoicing for ERPT at the border and the store. At the border, consistent with the dominant currency paradigm, we find a predominant role for the USD for ERPT; however, bilateral exchange fluctuations display an important role in the medium and long run, providing support to PCP. Moreover, we find differences in the magnitude of ERPT when we distinguish between final consumption goods and non-consumption goods and when we decompose final consumption goods into food, transportation, and manufacturing.

Using a new instrumental variable approach that leverages at-the-border regressions, we find that exchange rate fluctuations do not affect retail prices on impact, consistent with sticky prices set in the consumer's currency. For longer time horizons, as nominal rigidities ease, determinants of import prices at the border echo at the store, however, in a lower magnitude. We show that considering only bilateral rates or dollar fluctuations as a determinant of retail prices produces biased estimations, highlighting the relevance of the currency of invoices at the store.

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A Model

A.1 Households

We consider an economy populated by a continuum of symmetric households of measure 1. In country j, a representative household h consumes a bundle of traded goods C_{jt}.[30] Households own firms in this economy, and to simplify, we assume labor is inelastically supplied. Then, per period utility function is

$$U_t = \frac{1}{1-\sigma} C_{jt}^{1-\sigma} \tag{7}$$

where the coefficient of relative risk aversion is $\sigma > 0$. The consumption aggregator is defined by the homothetic CES[31]

$$C_{jt} = (w_x^{\frac{\eta-1}{\eta}} (C_t^x)^{\frac{\eta-1}{\eta}} + w_m^{\frac{\eta-1}{\eta}} (C_t^m)^{\frac{\eta-1}{\eta}})^{\frac{\eta}{\eta-1}} \tag{8}$$

where η is the relative preference parameter for exports to imports.

The following function describes households preferences,

$$\mathbb{E}_t \sum_t \beta^t U(C_t) \tag{9}$$

where U is a standard CRRA function with parameter σ. β is a subjective discount factor within the interval $(0, 1)$.

It is assumed that the consumer divides expenditures between imported C^m and exported C^x consumption of final goods and has access to an internationally traded one-period, state non-contingent bond B_t denominated in foreign currency. Then, con-

[30]The notation closely follows the one in Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller (2020).

[31]Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Moller (2020) assumes Kimball homothetic demand aggregator. In our case, we omit this assumption to gain more economic intuition in the role of distribution costs.

sumer budget constraint is,

$$P_t^m C_t^m + P_t^x C_t^x + \mathcal{E}_{jt}(1 + i_{jt-1})B_{jt} = W_t N_t + \Pi_t + \mathcal{E}_{jt} B_{jt+1} \tag{10}$$

where P_t^m is the price of imported goods, P_t^x is the price of exported goods. Households receive income from labor, where W_t is the nominal wage and N_t hours worked that are supplied inelastically.

A.2 Domestic retailer

As we previously discussed, an essential part of our analysis is related to retailers selling imported or domestically produced products to export combined with domestic distribution services. We assume the existence of a competitive retail sector. This sector combines tradable goods (imports and exported goods) with non-tradable distribution services ready to buy for final consumers. Production technology is[32]

$$f(Y_j^k, Y_d^k) = Y^r = \frac{1}{(1-\gamma)^{1-\gamma}(\gamma)^\gamma}(Y_j^k)^{1-\gamma}(Y_d^k)^\gamma \tag{11}$$

where Y_j^k is a bundle of consumption goods consumed in country j invoiced in currency k composed by imported goods Y_{ij}^k in country j of goods produced in country i, and domestically produced goods that can also be exported Y_{ji}^k produced in country j and potentially exported to country i.[33] Y_d^k is a distribution service denominated in currency k in the country j.

The cost minimization problem determines consumers' final retail price in product g invoiced in currency k. To simplify, we assume retailers sell in local currency $k = j$. The retail price index of good g is:

$$P_{gj}^r = (P_{gj})^{1-\gamma}(P_d^k)^\gamma \tag{12}$$

[32]Leontief technology is a stylized assumption used in the literature that captures all the relevant elements for our analysis (Burstein, Neves, and Rebelo , 2003).

[33]To simplify notation we skip subindex t. We only include it when it is necessary to avoid confusion.

where producer price P_{gj} for product g in country j invoiced in currency local currency is obtained by aggregating import and export prices as:

$$P_{gj} = (w_m^{\eta-1}(P_{ij})^{1-\eta} + w_x^{\eta-1}(P_{ji})^{1-\eta})^{\frac{1}{1-\eta}} \tag{13}$$

where w_x is home bias parameter and η elasticity of substitution.

The per-period nominal profits of the firm in the distribution sector is

$$\Pi_j(\omega) = P_j^r(\omega)C_j(\omega) - MC_j^r Y^r(\omega) \tag{14}$$

Reset price in the firm in the distribution sector satisfies the optimality condition

$$\mathbb{E}\sum_{s=t}^{\infty} \delta_d^{s-t}\Theta_{js}Y_j\left(\bar{P}_j^r(1-\sigma) + \sigma MC_{js}^r\right) = 0 \tag{15}$$

In the case of fully flexible prices $\delta_d = 0$, the problem in Equation 15 collapses to the one-period firm problem. Distribution prices under flexible price is

$$\bar{P}_j^r = \frac{\sigma}{\sigma-1}MC_j^r \tag{16}$$

A.3 Producers

Firms produce using imported intermediate inputs and labor with a Cobb-Douglas production function

$$Y_j = A_j L_j^{1-\alpha} X_j^{\alpha} \tag{17}$$

The minimization problem of the firm determines nominal marginal costs as

$$MC_j = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}\frac{W_j^{1-\alpha}P_j^{\alpha}}{A_j} \tag{18}$$

The per-period nominal profits of the domestic firm producing is

$$\Pi_j(\omega) = \sum_{i,k} \mathcal{E}_{kj} P^k_{ji}(\omega)\big(C^k_{ji}(\omega) + X^k_{ji}(\omega)\big) - MC_j Y_j(\omega) \tag{19}$$

where a firm's output can be used as a consumption or intermediate good. Moreover, the convention is that $\mathcal{E}_{jj} = 1$. Producer price from country j invoiced in currency k sold in country i is P^k_{ji}.

The firm chooses prices to sell in the country j or i. As in previous literature, we consider a Calvo pricing where firms randomly reset prices with probability $1 - \delta_p$, such that price dynamic is given by

$$\Delta p^k_{ij,t} = (1 - \delta_p)(\bar{p}^k_{ij} - p^c_{ij,t-1}) \tag{20}$$

The demand schedule for this economy assumes a CES aggregator such that[34]

$$C_j(\omega) = \left(\frac{P^r_{gj}}{P_j}\right)^{-\sigma} C_t \tag{21}$$

The firm reset price satisfies the optimality condition

$$\mathbb{E} \sum_{s=t}^{\infty} \delta_p^{s-t} \Theta_{js} Y^k_{ji} \Big(\mathcal{E}_{kjs} \bar{P}^k_{ji} (1 - (1-\gamma)\sigma) + (1-\gamma)\sigma MC_{js} \Big) = 0 \tag{22}$$

In the case of fully flexible prices $\delta_p = 0$, the problem in Equation 22 collapses to the one-period firm problem. Produce prices under flexible prices is

$$\mathcal{E}_{kjs} \bar{P}^k_{ji} = \bar{P}_{ji} = \frac{(1-\gamma)\sigma}{(1-\gamma)\sigma - 1} MC_j \tag{23}$$

[34]This assumption produces constant markups. A potential extension to raise this assumption is defining a consumption aggregator C_j implicitly defined by a Kimball (1995) homothetic demand aggregator.

We can use the producer price in 23 to produce the retail price P^r

$$P^r_g = \left(\frac{(1-\gamma)\sigma}{(1-\gamma)\sigma - 1}\right)^{1-\gamma} (MC_j)^{1-\gamma}(P_d)^{\gamma} \tag{24}$$

Then, we calculate the pass-through of costs to producer prices and retail prices, respectively:

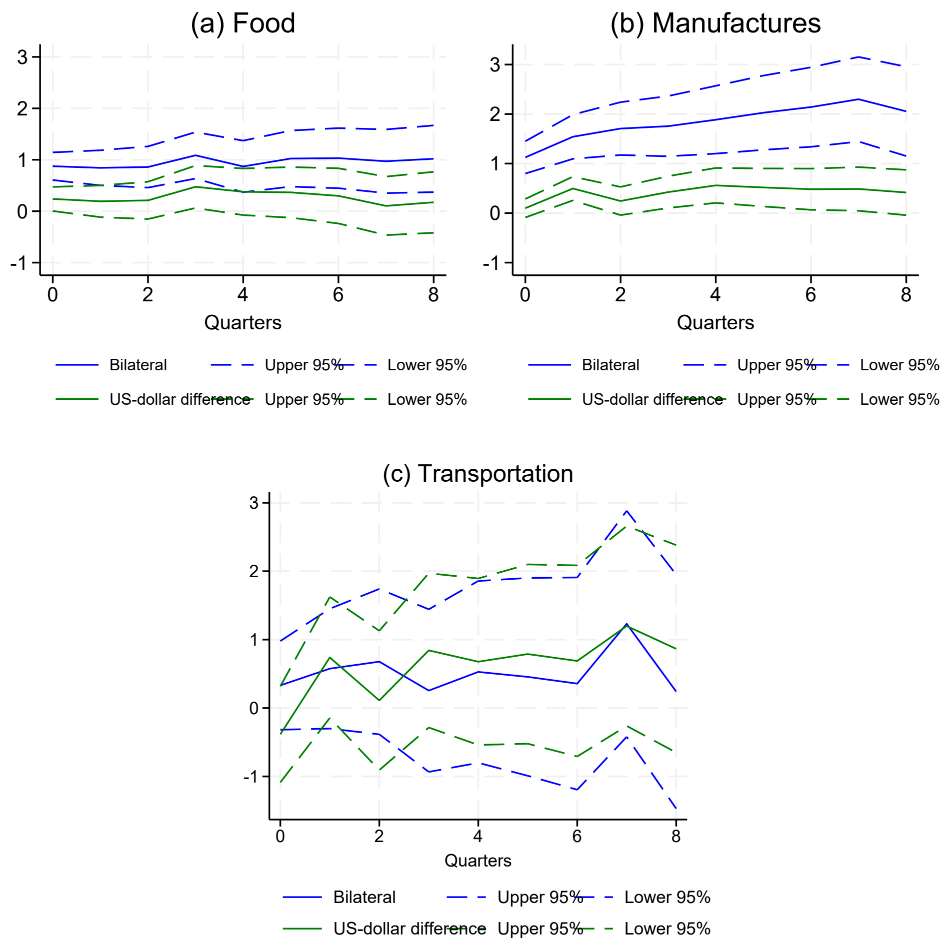
$$\frac{d\log \bar{P}_{ji}}{d\log MC_j} = 1 \tag{25}$$

$$\frac{d\log P^r_g}{d\log MC_j} = 1-\gamma \tag{26}$$

Pass-through shows why it is different at the border and the store. Imported intermediate input prices are affected by ERPT, and then, in the long term, with flexible prices, ERPT at the border is higher than at the store since $\gamma \in (0,1)$.

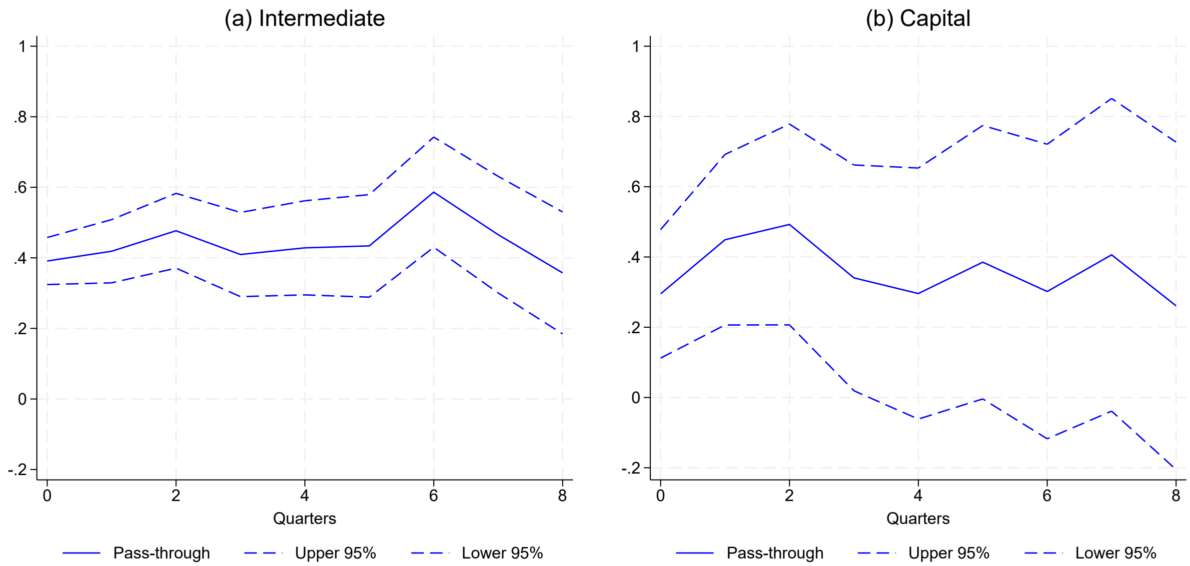
B Additional figures

Figure A.1: Difference in Disaggregate ERPT by Invoice Exporter Currency and USD



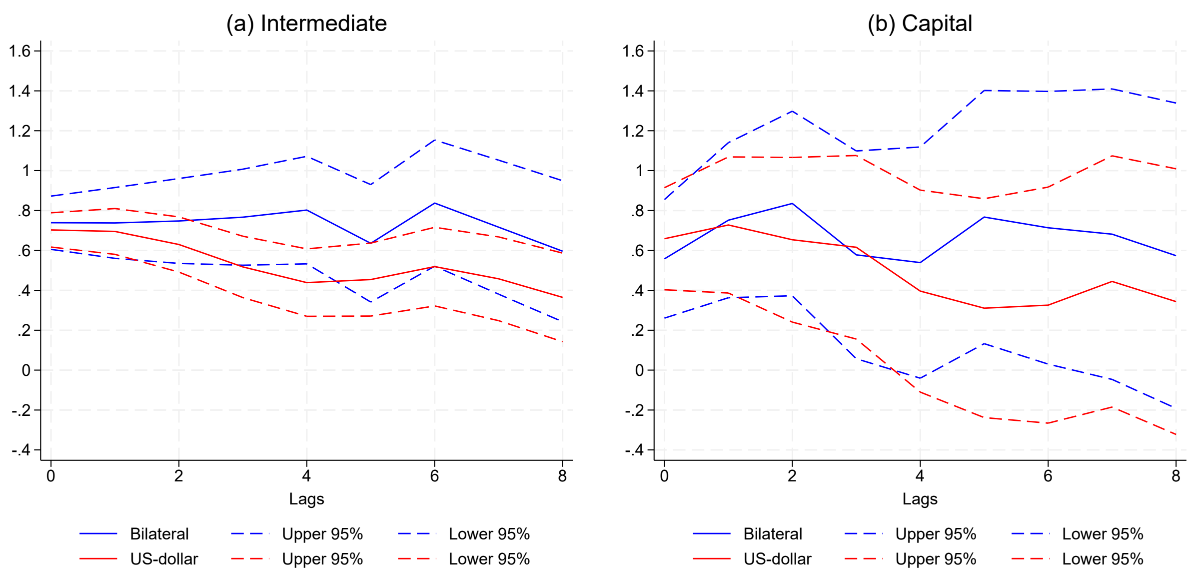
Note: The figure shows cumulative bilateral ERPT and its differences regarding CLP-USD ERPT to import price consumption good regressions. It reports the results for regression (3). Panel A shows the results for consumption goods related to food, Panel B for consumption goods related to manufactures, and Panel C for consumption goods related to transportation according to COICOP classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid green line captures the L-quarters cumulative ERPT of bilateral exchange rate interacted with USD currency invoice $\sum_{s=0}^{L} \beta_s^{B\,\$}$. Dashed green lines indicate 95% confidence bands of cumulative ERPT of $\sum_{s=0}^{L} \beta_s^{B\,\$}$. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure A.2: ERPT by Intermediate and Capital Goods



Notes: This figure shows cumulative bilateral ERPT to import price regressions. It reports the results of Equation (1). Panel (a) shows the results for intermediate goods and Panel (b) for capital goods (intermediate and capital goods) according to BEC classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. *Sources*: Authors' calculations are based on customs import data and exchange rates.

Figure A.3: EPRT by Invoice Exporter Currency and Invoice USD



Note: The figure shows cumulative bilateral and CLP-USD ERPT to import price regressions. It reports the results of regression (2). Panel (a) shows the results for intermediate goods, and Panel (b) for capital goods according to BEC classification. The solid blue line captures the L-quarters cumulative ERPT of a bilateral exchange rate at time 0. Dashed blue lines indicate 95% confidence bands of cumulative ERPT of a bilateral exchange rate. The solid red line captures the L-quarters cumulative ERPT of the USD-CLP exchange rate at time 0. Dashed red lines indicate 95% confidence bands of cumulative ERPT of USD-CLP. *Sources*: Authors' calculations are based on customs import data and exchange rates.

C Additional tables

Table A.1: Invoice Currency and Bilateral ERPT to Import Prices

		BEC		COICOP		
	All	Consumption	Non-consump.	Food	Transportation	Manufactures
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ERPT Bilateral						
β_0	0.435***	0.532***	0.382***	0.549***	0.386**	0.562***
$\sum_{s=0}^{4} \beta_s$	0.540***	0.738***	0.413***	0.669***	0.904	0.781***
$\sum_{s=0}^{8} \beta_s$	0.497***	0.713***	0.354***	0.749***	0.765*	0.731***
R2	0.069	0.068	0.070	0.085	0.059	0.065
Panel B. ERPT by invoice currency						
β_0^B	0.750***	0.822***	0.710***	0.823***	0.591*	0.892***
$\sum_{s=0}^{4} \beta_s^B$	0.855***	1.021***	0.750***	0.808***	0.581	1.276***
$\sum_{s=0}^{8} \beta_s^B$	0.781***	1.068***	0.612***	1.031***	0.141	1.316**
$\beta_0^{\$}$	0.727***	0.773***	0.695***	0.807***	0.523*	0.774***
$\sum_{s=0}^{4} \beta_s^{\$}$	0.526***	0.644***	0.444***	0.665***	0.776	0.607***
$\sum_{s=0}^{8} \beta_s^{\$}$	0.431***	0.511***	0.370***	0.457*	0.859	0.478***
R2	0.075	0.074	0.077	0.094	0.068	0.070
Panel C. Invoice currency and bilateral ERPT.						
$\beta_0^{B;B}$	0.764***	0.842***	0.719***	0.837***	0.630**	0.921***
$\sum_{s=0}^{4} \beta_s^{B;B}$	0.892***	1.073***	0.777***	0.843***	0.674	1.350***
$\sum_{s=0}^{8} \beta_s^{B;B}$	0.826***	1.134***	0.646***	1.075***	0.249	1.411***
$\beta_0^{\$;\$}$	0.761***	0.778***	0.740***	0.823***	0.719*	0.758***
$\sum_{s=0}^{4} \beta_s^{\$;\$}$	0.432***	0.468***	0.392***	0.617**	0.273	0.378*
$\sum_{s=0}^{8} \beta_s^{\$;\$}$	0.427***	0.484***	0.381***	0.523*	0.442	0.415*
$\beta_0^{B;\$}$	-0.0266	0.0473	-0.0619	0.094	-0.241	0.095
$\sum_{s=0}^{4} \beta_s^{B;\$}$	0.267***	0.450***	0.160*	0.369	0.866	0.535***
$\sum_{s=0}^{8} \beta_s^{B;\$}$	0.153	0.280	0.0706	0.172	0.980	0.369
R2	0.076	0.075	0.077	0.095	0.077	0.071
Obs.	86,708	30,570	56,138	7,292	1,151	18,291

Notes: The table shows the results of ERPT to import price regressions. Panel A shows the results of regression (1), Panel B of regression (2), and Panel C of regression (3). Column (1) reports estimates for all import products. Columns (2) and (3) report estimates for consumption goods and non-consumption goods (intermediate and capital goods) according to BEC classification. Columns (4)-(6) report estimates decomposing final consumption goods into food, transportation, and manufacturing according to COICOP classification. ***, **, * denote statistical significance at 1, 5 and 10 percent levels.

Table A.2: Invoice Currency and Bilateral ERPT: Interactions with consumption

	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_0^{B;B}$	0.418***	0.409***	0.770***	0.768***	0.784***	0.783***
$\sum_{s=0}^{4} \beta_s^{B;B}$	0.526***	0.518***	0.861***	0.890***	0.898***	0.929***
$\sum_{s=0}^{8} \beta_s^{B;B}$	0.493***	0.471***	0.765***	0.715***	0.809***	0.762***
$\delta_0^{B;B}$	0.0595	0.0702	-0.0568	-0.0501	-0.0573	-0.0510
$\sum_{s=0}^{4} \delta_s^{B;B}$	0.0492	0.0739	-0.0172	-0.0285	-0.0170	-0.0296
$\sum_{s=0}^{8} \delta_s^{B;B}$	0.0198	0.0636	0.0648	0.143	0.0685	0.145
$\delta_0^{\$;\$}$			0.707***	0.720***	0.738***	0.751***
$\sum_{s=0}^{4} \delta_s^{\$;\$}$			0.483***	0.486***	0.392***	0.384***
$\sum_{s=0}^{8} \delta_s^{\$;\$}$			0.407***	0.409***	0.387***	0.374***
$\delta_0^{\$;\$}$			0.0609	0.0486	0.0601	0.0466
$\sum_{s=0}^{4} \delta_s^{\$;\$}$			0.128	0.129	0.113	0.111
$\sum_{s=0}^{8} \delta_s^{\$;\$}$			0.0671	0.0688	0.128	0.130
$\beta_0^{B;\$}$					-0.0324	-0.0334
$\sum_{s=0}^{4} \beta_s^{B;\$}$					0.259***	0.261**
$\sum_{s=0}^{8} \beta_s^{B;\$}$					0.181	0.200
$\delta_0^{B;\$}$					0.0274	0.0302
$\sum_{s=0}^{4} \delta_s^{B;\$}$					0.0311	0.0508
$\sum_{s=0}^{8} \delta_s^{B;\$}$					-0.0878	-0.0780
Observations	86,708	72,485	86,708	72,485	86,708	72,485
R-squared	0.069	0.067	0.075	0.074	0.076	0.075

Notes: The table shows the ERPT results for import price regressions. Columns (1) and (2) show the results of regression (1) adding the interaction of bilateral exchange rate with consumption captured by $\delta_s^{B;B}$. For instance, regression (1) is now $\Delta P_{vkit} = \sum_{s=0}^{L} \beta_s^{B;B} \Delta \mathcal{E}_{CL,i,t-s} + \sum_{s=0}^{L} \delta_s^{B;B} \Delta \mathcal{E}_{CL,i,t-s} C_{cons} + \gamma \mathbf{z}_{it} + \alpha_{vki} + \lambda_t + \epsilon_{vkit}$, where C_{cons} is a dummy variable equal to 1 if the import is classified as a consumption good according to BEC classification. Columns (3) and (4) show the results of regression (2) adding the interactions of bilateral exchange rate and USD exchange rate with consumption category captured by $\delta_s^{B;B}$ and $\delta_s^{\$;\$}$. Columns (5) and (6) show the results of regression (3) adding the interactions of bilateral exchange rate and USD exchange rate with consumption category captured by $\delta_s^{B;B}$, $\delta_s^{\$;\$}$, and, $\delta_s^{B;\$}$. Columns (1), (3), and (5) report estimates for all import products. Columns (2), (4), (6) report estimates only for consumption goods and intermediate goods according to BEC classification (i.e., it excludes capital goods). ***, **, * denote statistical significance at 1, 5, and 10 percent levels.

Table A.3: Invoice Currency and Bilateral ERPT for non-consumption goods

	Intermediate (1)	Capital (2)
Panel A. ERPT Bilateral		
β_0	0.517***	0.407***
$\sum_{s=0}^{4} \beta_s$	0.586***	1.114**
$\sum_{s=0}^{8} \beta_s$	0.550***	0.490*
R-squared	0.067	0.072
Panel B. ERPT by invoice currency		
β_0^B	0.882***	0.839***
$\sum_{s=0}^{4} \beta_s^B$	1.029***	1.028***
$\sum_{s=0}^{8} \beta_s^B$	0.751***	1.096**
$\beta_0^\$$	0.877***	0.808***
$\sum_{s=0}^{4} \beta_s^\$$	0.601***	0.797***
$\sum_{s=0}^{8} \beta_s^\$$	0.562***	0.596*
R-squared	0.076	0.079
Panel C. Invoice currency and bilateral ERPT		
$\beta_0^{B;B}$	0.895***	0.841***
$\sum_{s=0}^{4} \beta_s^{B;B}$	1.064***	1.035***
$\sum_{s=0}^{8} \beta_s^{B;B}$	0.793***	1.105**
$\beta_0^{\$;\$}$	0.906***	0.908***
$\sum_{s=0}^{4} \beta_s^{\$;\$}$	0.512***	0.940***
$\sum_{s=0}^{8} \beta_s^{\$;\$}$	0.534***	0.775**
$\beta_0^{B;\$}$	-0.009	-0.214
$\sum_{s=0}^{4} \beta_s^{B;\$}$	0.252**	-0.175
$\sum_{s=0}^{8} \beta_s^{B;\$}$	0.207	-0.340
R-squared	0.076	0.079
Observations	47,074	9,762

Notes: The table shows the results of ERPT to import price regressions for components of non-consumption goods. Panel A shows the results of regression (1), Panel B shows the results of regression (2), and Panel C shows the results of regression (3). Column (1) reports estimates for intermediate goods, and column (2) for capital goods. ***, **, * denote statistical significance at 1, 5, and 10 percent levels.

Table A.4: Tradable CPI at a product level. Instrumental variables associated with imports prices

	(1) IV Model 1	(2) IV Model 2	(3) IV Model 3	(4) IV Model 1*
β_0^s	-0.0255	-0.0237	-0.0212	-0.0168
$\sum_{i=0}^{4} \beta_i^s$	0.214***	0.166***	0.152***	0.203***
$\sum_{i=0}^{8} \beta_i^s$	0.339***	0.304***	0.290***	0.329***
Obs.	2,840	2,840	2,840	2,840
R2	0.189	0.192	0.193	0.195
Adj. R2	0.148	0.152	0.152	0.155

Notes: The table shows the results of ERPT to the store regression (5) controlling for different instrumental variables. Each panel shows the sum of ERPT regression coefficients of no lags, lags 0 to 4, and lags 0 to 8. Column (1) considers the instrumental variable of the model in Equation (1). Column (2) considers the instrumental variable of the model in Equation (2). Column (3) considers the instrumental variable of the model in Equation (3). Finally, Column 4 considers the same model as in Column 1 but replaces the bilateral exchange rate with the CLP-USD exchange rate. ***, **, * denote statistical significance at 1, 5, and 10 percent levels.

Table A.5: Tradable CPI related to food and alcoholic beverages. Instrumental variables associated with import prices

	(1) IV Model 1	(2) IV Model 2	(3) IV Model 3
β_0^s	0.0217**	0.0772*	0.0406***
$\sum_{i=0}^{4} \beta_i^s$	0.272***	0.257***	0.225***
$\sum_{i=0}^{8} \beta_i^s$	0.342	0.342***	0.277
Obs.	1,216	1,216	1,216
R2	0.038	0.036	0.035
Adj. R2	-0.0173	-0.0191	-0.0201

Notes: The table shows the results of ERPT to the store regression (5) controlling for different exchange rates. This table considers only divisions 1 and 2 of consumption related to food and alcoholic beverages Each panel shows the sum of ERPT regression coefficients of no lags, lags 0 to 4, and lags 0 to 8. Column (1) considers the instrumental variable of the model in Equation (1). Column (2) considers the instrumental variable of the model in Equation (2). Column (3) considers the instrumental variable of the model in Equation (3). ***, **, * denote statistical significance at 1, 5, and 10 percent levels.