Foreign Currency Debt, Financial Frictions, and the Exchange Rate Pass-Through *

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Abstract

This paper examines the impact of corporate foreign currency debt (FCD) on the exchange rate pass-through (ERPT) to international prices. We use a unique dataset combining firm-level FCD with international trade flows at the firm-product level in Colombia. Our findings show that relatively indebted industries exhibit an ERPT to import prices greater than one. Conversely, ERPT to export prices is incomplete regardless of debt levels. To rationalize these findings, we propose a novel theoretical mechanism incorporating price stickiness, pricing complementarities, and collateral constraints. In this environment, an exchange rate depreciation induces balance-sheet effects through occasionally binding borrowing constraints, raising domestic firms' marginal costs. Due to pricing complementarities, foreign competitors react to the rise in domestic prices by passing on exchange rate movements to a greater extent, implying larger ERPT to import prices. Pricing complementarities also induce domestic firms to absorb balance-sheet effects and exchange rate fluctuations when setting export prices. Our findings suggest that pricing complementarities ultimately determine the ERPT, even when firms set prices in a vehicle currency, such as the US dollar.

Keywords: Exchange rate pass-through, financial frictions, strategic complementarities, balance-sheet channel, dollarization, foreign currency debt, dominant currency paradigm, borrowing constraints, credit constraints.

JEL Classification Codes: F0, F41, F34, F32.

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1 Introduction

The increased financial integration among countries over the past 30 years has led to a surge in foreign currency debt (FCD) issuance by nonfinancial corporations. According to the Bank of International Settlements (BIS), their outstanding international debt rose from \$0.5 trillion in 1990 to \$7.7 trillion at the end of 2020, having reached 6.8% and 2.2% of GDP in advanced and emerging market economies, respectively.[1] Against this backdrop, the prevalence of balance-sheet currency mismatches among nonfinancial corporations has rendered them vulnerable to global shocks and sudden shifts in capital flows, especially in small open economies. Extensive research, dating back to at least Krugman and Taylor (1978), has shown that the adverse impact of currency devaluations on firms' net worth, known as the balance-sheet channel, can counteract conventional expansionary effects on aggregate demand, as predicted by textbook open economy macroeconomic models in the spirit of Mundell–Fleming.

In this paper, we shift attention to a relatively overlooked aspect within this literature: How does FCD affects the responsiveness of import and export prices to exchange rate movements, commonly referred to as the exchange rate pass-through (ERPT) to international prices? We address this question by studying, empirically and theoretically, the effects of exchange rate movements on export and import prices when firms borrow and set prices in US dollars. This approach is supported by the fact that an overwhelming proportion of international trade and financial flows rely on very few vehicle or "dominant" currencies, namely, the US dollar and, to a much lesser extent, the euro. We show that the answer to our question depends on strategic complementarities in price setting across domestic and foreign firms.

To illustrate the economic mechanism, consider a firm with at least partially dollarized liabilities located in Colombia, a small open economy from emerging markets characterized by its heavy reliance on the US dollar for export invoicing and FCD denomination. In the presence of currency mismatches—in which assets and liabilities are denominated in different currencies, a US dollar appreciation will adversely affect the firm's balance sheet, potentially inducing it to raise prices in order to boost current profits and offset the deterioration of its balance sheet. When its decision is representative of a large proportion of domestic firms, and there are strategic complementarities in pricing, foreign competitors exporting to the Colombian market will pass on to a greater extent exchange rate move-

[1] Aldasoro et al. (2021). International debt refers to debt instruments issued outside the local market of the country where the borrower resides and are mostly denominated in foreign currency. These debt instruments are designed to be traded in financial markets.

ments to their prices. Hence, FCD may affect the ERPT to import and export prices through a balance-sheet channel on domestic firms' pricing decisions with indirect impacts on foreign competitors' prices.

Our contribution is twofold. First, we provide empirical evidence on the differential effects of FCD on the ERPT to import and export prices. We merge novel firm-level foreign currency credit information with firm-product-level data on exports and imports in Colombia. Our rich panel dataset, which is based on quarterly frequency data, contains 9,097 exporters, 14,540 importers, and a range of 7,548 products in the manufacturing sector at the 10-digit Harmonized System (HS) classification. Our sample covers the period from 2010 to 2022, when Colombia underwent a series of global shocks arguably exogenous to its economy that significantly affected its exchange rate.

To measure how currency mismatches in balance sheets affect firms' pricing decisions, we use the FCD to exports ratio. Because borrowing in foreign currency and exports are both overwhelmingly quoted in US dollars, the ratio of dollarized debt to exports captures how much of the dollarized debt can be repaid by cash flows invoiced in US dollars. To connect the FCD to exports ratio to borrowing costs faced by firms, we use novel firm-level credit information containing more than 50,000 credit operations. We document that this ratio does proxy for financial frictions in the form of higher borrowing costs, as it correlates with higher interest rate spreads and greater reliance on foreign banks for accessing credit. By using the FCD to exports as a proxy for financial frictions, we can compare the pricing responses of financially constrained and unconstrained firms.

In the empirical analysis, we build on standard specifications used in the ERPT literature (Campa and Goldberg, 2005; Burstein and Gopinath, 2014; Gopinath, 2015; Gopinath et al., 2020). However, instead of using multiple or trade-weighted exchange rates, we focus on the bilateral exchange rate between the Colombian peso and the US dollar as our primary covariate. This approach is based on the fact that almost all of Colombia's international trade is invoiced in US dollars. First, we estimate an elasticity of the ERPT to FCD for import and export prices by employing a specification that interacts the FCD to exports ratio with the bilateral exchange rate. Second, we consider a specification directly yielding ERPT estimates across highly and lowly-indebted groups of firms or industries, where we interact the exchange rate with an indicator variable that takes one whenever a firm's FCD to exports ratio exceeds the median ratio in the panel.

Our findings show that FCD has nonlinear effects on import prices. First, the estimates uncover an economically meaningful elasticity: A one percent increase in the industry-level FCD to exports ratio results in a 0.05 rise in the ERPT to import prices over two years, where industries follow a fairly disaggregated classification. When it comes to export prices, point estimates indicate incomplete ERPT regardless of FCD levels. Second, results indicate that industries with higher levels of debt experience more than one-for-one pass-through to import prices. Specifically, the ERPT to import prices reaches 1.6 over two years in indebted industries. In contrast, we empirically recover the well-documented incomplete ERPT result in the lowly-indebted counterpart, with a point estimate of 0.7 over the same horizon. These results underscore how FCD may render the domestic economy vulnerable to foreign shocks: a 10 percent depreciation of the Colombian peso relative to the US dollar induces a 16 percent increase in import prices in highly-indebted industries compared to 7 percent in the lowly-indebted counterpart. As for export prices, the empirical results again suggest incomplete ERPT and negligible effects induced by FCD. In summary, while FCD held by domestic firms results in higher ERPT to import prices, it does not exert differential impacts on export prices.

To put our results in context, the bulk of the ERPT literature has found incomplete ERPT to prices. One leading explanation for such incomplete pass-through is the complementarity in pricing decisions, prompting firms to adjust their margins according to the local market conditions. Despite our finding of an ERPT greater than one for import prices, we do not regard it as being at odds with prior studies. We likewise rationalize our results by hefty complementarities in pricing decisions, which lead to an ERPT to import prices greater than one in response to the balance-sheet channel on domestic firms triggered by FCD. While Colombian exporters adjust their margins to absorb exchange rate movements when they set prices targeting the foreign destination market, foreign firms exporting to Colombia similarly take into account prices in the local market, resulting in a larger pass-through of exchange rate movements in indebted industries. In tandem, these findings indicate significant pricing-to-market behavior of both Colombian and foreign firms, even though they all set prices in US dollars. The existing class of general equilibrium models in the ERPT literature cannot replicate this fact.

To overcome this limitation, we provide a novel theoretical mechanism inducing differential pass-through within a small-open economy (SOE) general equilibrium model. This model is calibrated to match macroeconomic moments in Colombia, enabling us to perform counterfactual analyses on the effects of FCD on aggregate price levels. Specifically, the model bridges two strands of literature by integrating key elements in the class of models featuring Dominant Currency Pricing (DCP) and sudden stops. Specifically, from the DCP literature, we incorporate dollar-price setting in international trade, nominal price stickiness, and pricing complementarities. From the second literature, we incorporate FCD limited by a collateral constraint, which generates kinks in pricing responses whenever the constraint is binding and leads to differential ERPT responses. Although the model abstracts from certain features present in the data in order to ensure tractability, such as idiosyncratic shocks and heterogeneity in borrowing constraints across firms, it retains the critical features rationalizing the empirical facts. In particular, the model can qualitatively match our findings.

The mechanism works through the adverse effects of borrowing constraints on firms' marginal costs and pricing decisions. Domestic entrepreneurs are subject to collateral constraints when financing working capital and borrowing in foreign currency. Thus, an exchange rate depreciation increases marginal costs whenever firms' collateral constraints bind. Due to strategic complementarities, local firms' pricing decisions also impact foreign competitors' prices. Foreign firms eventually adjust markups in response to both exchange rate fluctuations and balance-sheet effects on domestic firms, indirectly inducing a larger ERPT to import prices. Importantly, our assumption that foreign firms do not face borrowing constraints underscores that the differential ERPT to import prices stems solely from strategic complementarities.

Moreover, since the mechanism relies on real frictions arising from borrowing constraints and complementarities in pricing decisions, it can be applied to currency paradigms other than DCP, such as Producer or Local Currency Pricing (PCP and LCP, respectively).

We conduct two sets of simulations. First, we separately hit the economy with foreign interest rate and productivity shocks, considering differing degrees of borrowing constraints in order to illustrate the mechanism numerically. The quantitative analysis shows that, consistent with the data, balance-sheet effects experienced by domestic firms exert a more pronounced impact on the ERPT to import prices than to export prices. This prediction is explained by the fact that foreign and local firms are concerned about their prices relative to those of competitors in the destination market. Next, to compare model predictions with empirical results, we perform Monte Carlo simulations combining both shocks and run regressions analogous to those in the empirical analysis. We find that the model delivers an elasticity of the ERPT to FCD of 0.02 for import prices, compared to 0.05 in the empirical results. In counterfactual simulations, we document that shutting down either pricing complementarities or borrowing constraints yields nil effects of FCD on the ERPT to import prices, underscoring the importance of both channels for the indirect impact of FCD on the ERPT to import prices.

Since the existing evidence suggests that, at least for emerging markets, exchange rate risk is borne primarily by the nonfinancial corporate sector (Gopinath and Stein, 2021), we interpret the empirical findings as a consequence of the interplay between local firms' foreign currency indebtedness and borrowing constraints, which in turn has repercussions on the pricing decisions of foreign competitors.

We consider our findings to have extensive ramifications. First, the results suggest that the impact of FCD on small open economies potentially encompasses effects on international price dynamics. Second, our results suggest that the ERPT is ultimately determined by pricing complementarities even when firms set prices using a major vehicle currency. The large degree of price complementarities documented in the data is also consistent with considerable price discrimination across borders, indicating notable deviations from the law of one price. All these facts carry implications for appropriate monetary policy responses and suggest that "real rigidities" (Ball and Romer, 1990)—meaning frictions that make firms hesitant to change their prices relative to others—play a crucial role in international price dynamics.

Related literature. This paper is connected to four strands of literature with significant overlaps across each other. First, our work is related to the vast theoretical and empirical literature on endogenous markups and the ERPT (Campa and Goldberg, 2005; Engel, 2006; Atkeson and Burstein, 2007; Gopinath and Itskhoki, 2010; Gopinath et al., 2010). Our main contribution to this topic is to study the impacts of financial frictions and FCD on the ERPT to import and export prices, finding that balance-sheet effects experienced by domestic firms have spillovers on foreign pricing decisions.

Three papers have directly linked credit constraints with the ERPT. Strasser (2013) examines the impact of credit constraints on export prices, while Carranza et al. (2009) and Kim and Lee (2019) study the effects of dollarized liabilities on domestic prices. We distinguish our paper from theirs in two main ways. First, our empirical analysis centers on the balance-sheet channel to international prices, investigating how FCD can result in differential ERPT to import and export prices. Second, we rationalize our findings by means of a small-open economy general equilibrium model with joint predictions for domestic, export, and import prices, where we incorporate price stickiness in addition to collateral constraints into the framework.

Second, the paper also relates to the growing literature on the DCP paradigm. This literature has achieved substantial progress in recent years after the seminal works of Devereux et al. (2007) and Goldberg and Tille (2008, 2009). Our paper is closely related to Gopinath et al. (2020), contributing along two dimensions. First, we incorporate financial frictions into their DCP environment, and second, we empirically investigate the impact of dollarized debt on the ERPT to international prices. Our theoretical framework builds upon Egorov and Mukhin (2023) by including endogenous markups and foreign currency borrowing limited by collateral constraints.

The third strand of literature is related to the financial channel of exchange rates and the effects of the US dollar cycle on global credit conditions and international trade flows (Cespedes et al., 2000; Rey, 2015; Bruno and Shin, 2015; Avdjiev et al., 2018; Alfaro et al., 2019; Gourinchas, 2021; Bruno and Shin, 2023; Obstfeld and Zhou, 2023). Within this strand of literature, Casas et al. (2023) and Ma and Schmidt-Eisenlohr (2023) are two studies closely related to ours. In contrast to their papers, which focus on how dollarized debt impacts international trade flows, we study how it shapes export and import pricing decisions when international trade is invoiced in US dollars.

Finally, a substantial body of literature has studied the interaction between financial frictions and FCD. This literature has focused on how FCD can exacerbate the vulnerabilities of small-open economies to sudden stops (Mendoza, 2010; Bianchi, 2011; Benigno et al., 2013; Coulibaly, 2023), as well as its influence on firms' outcomes during major devaluation episodes (Kalemli-Ozcan et al., 2010; Brown et al., 2011; Kim et al., 2015; Kohn et al., 2020). It has also explored the connection between financial frictions and debt currency choice (Salomao and Varela, 2021; Gopinath and Stein, 2021; Eren and Malamud, 2022). We contribute to this literature by introducing a general equilibrium model in which international trade and financial flows are denominated in US dollars. We find that collateral constraints combined with strategic complementarities in pricing are crucial for explaining our empirical findings.

The remainder of this paper is structured as follows. Section 2 discusses the firm-level data we use, focusing on the corporate FCD dataset. Sections 3 and 4 detail the empirical analysis and main findings. Section 5 outlines the model, discussing the proposed theoretical mechanism. It also presents a quantitative analysis and a comparison with the empirical results. Section 6 concludes the paper with a summary of the main results and a discussion of their implications for future research.

2 Data

We utilize granular data in the empirical analysis by merging confidential firm-level foreign currency debt (FCD) data from the *Banco de la República* (Banrep) to international trade flows at the firm-product level, which is publicly available at the *Departamento Administrativo Nacional de Estadística* (DANE). According to information provided by the Banrep, the real sector in Colombia borrows in foreign currency from domestic financial institutions and foreign lenders primarily to finance working capital and foreign trade operations, with the manufacturing and retail sectors concentrating most of the corporate outstanding FCD. The empirical analysis in the following section focuses on the manufacturing sector in which product differentiation plays a prominent role. The industries follow the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4.

The merged dataset comprises 9,097 exporters and 14,540 importers, with a range of 7,548 products in the 10-digit harmonized system (HS). Unit values are the ratio of imports (exports) in Colombian pesos (US dollars) per net kilograms. [2] We keep export prices in dollars because this is the price purchasers in the destination country actually face. Since unit values are proxies of actual prices, we follow Gopinath et al. (2020) to account for potential mismeasurement and exclude all firm-product level unit values whose standard deviation is above a threshold. While we set this threshold to the fourth quartile in the empirical distribution, we consider alternative cutoffs as robustness checks. Since we consider quarterly logarithmic changes in unit values, one advantage of this approach is to avoid dropping observations due to seasonal variation in unit values.

The sample period ranges from the first quarter of 2010 to the fourth quarter of 2022. During those years, there was a combination of considerable growth in the outstanding FCD among nonfinancial corporations in tandem with more stable inflationary dynamics in Colombia after the country's central bank adopted an inflation-targeting regime in 1999. As shown in Figure 1, there was also substantial fluctuation in the exchange rate during those years, which is crucial to empirically identifying the exchange rate pass-through (ERPT) to import and export prices. The Colombian currency devaluations in 2015, 2020, and 2022 were due to global shocks arguably exogenous to Colombia, a commodity-exporter small-open economy.[3]

Tables 1 and 2 provide information on the characteristics underlying the corporate FCD in Colombia. Roughly 79% of the firms' debt stock is indexed to fluctuating international interest rates, such as the Libor, with more than 80% of the total debt having a maturity shorter than one year. There is significant variability in the amount of indebtedness, ranging from zero to more than 800 million dollars. Although most of these credit operations are undertaken through the domestic financial system, roughly one-fourth of the total credit is

[2]Both imports and exports are measured under the "free-on-board" (FOB) concept, excluding expenses to the buyer for packing, potage, cartage, etc.

[3]In particular, the economy was affected by the global decline in oil prices in 2015, while in 2020 and subsequent years, the exchange rate depreciated as a result of the COVID-19 pandemic and the ensuing global surge in inflation.

provided by foreign financial institutions.

2.1 Corporate foreign currency debt (FCD) dataset

In the subsequent sections, we exploit firm-level variation in FCD to indirectly identify financially constrained firms and gauge potential differential effects on international prices. The corporate FCD statistics consider the face value of the principal that has yet to be paid by a firm. Since credit constraints firms are exposed to are not directly observable in the data, we used the ratio of FCD to exports to proxy for this form of financial frictions. Our choice for this particular indicator derives primarily from limitations in the dataset, as we do not observe firms' full balance sheets. This precludes us from using standard measures of financial frictions in the literature, such as debt over total assets or total sales. Still, the ratio we consider summarizes the proportion of FCD that can be repaid by foreign currency revenues, capturing potential balance-sheet currency mismatches.

Generating foreign currency revenues is especially important for Colombian firms as the FCD maturity is mostly short-term, averaging 17 months. As seen in table 1, an additional characteristic of the dataset is the overwhelming predominance of US dollar currency denomination in Colombia's corporate FCD, representing 98% of the total fraction, with the remainder being denominated in euros. Combined with nearly all Colombian exports and imports being invoiced in US dollars, the ratio we consider avoids issues associated with compositional effects induced by different currencies in the numerator and denominator. Specifically, we consider the FCD over exports at the firm and industry levels as follows:

$$\mathcal{D}_{i,t} = \frac{\text{Debt}_{i,t}}{\Sigma_{j\in\mathcal{J}_i}\Sigma_{k\in\mathcal{K}}\text{Exports}_{ijk,t}}, \qquad \text{(firm level)} \qquad (1)$$

$$\mathcal{D}_{\mathcal{I},t} = \frac{\Sigma_{i\in\mathcal{I}}\text{Debt}_{i,t}}{\Sigma_{i\in\mathcal{I}}\Sigma_{j\in\mathcal{J}_i}\Sigma_{k\in\mathcal{K}}\text{Exports}_{ijk,t}}, \qquad \text{(industry level)} \qquad (2)$$

for firm i in sector $\mathcal{I}$, which we set to the 4-digit ISIC level, a fairly disaggregated benchmark, product j in the basket of exported products $\mathcal{J}_i$, and country k in the set of destination countries $\mathcal{K}$. $\text{Debt}_{i,t}$ is firm i's FCD, $\text{Exports}_{ijk,t}$ is firm i's exports of product $j \in \mathcal{J}_i$ to country $k \in \mathcal{K}$. Figures 2a and 2b present the histograms of the inverse of the hyperbolic sine transformation of $\mathcal{D}_{i,t}$ and $\mathcal{D}_{\mathcal{I},t}$, which we denote by $d_{i,t}$ and $d_{\mathcal{I},t}$, respectively.

As the histogram shows, although the observations contain many zero values, some firms display massive ratios, which may expose them to balance-sheet currency mismatches and credit constraints to the extent that their dollarized debt disproportionately outweighs their dollarized revenues. To account for possible mismeasurement of our proxy due to, for instance, large firms mainly serving the Colombian market, we drop outliers in the firm-level distribution as a robustness check. For comparison, Figures 2c and 2d portray the histograms of the inverse of the hyperbolic sine transformation of FCD and exports, respectively. We transformed variables to account for zeros in the dataset and shrink the range of the empirical distribution since some firms are large borrowers or exporters. In contrast, others have minimal debt burdens or export revenues.

To argue that our proposed proxy is indeed connected to financial frictions, we regress the firm-level foreign currency loan indexed by o (thus, accounting for the loan ID) to total exports in a given year-quarter t, $\mathcal{D}_{io,t}$, on selected characteristics, taken as covariates. In particular, we include as covariates the loan's spread, maturity, and lender's residence. The spread measures the charged interest rate relative to a benchmark. To separately account for the influence of the other variables, we use indicator variables, equaling to one if the credit operation is long-term (i.e., more than 12 months), if the creditor's residence is foreign, and if the charged interest rate is indexed to a foreign interest rate.

Results summarized in Table 3 provide strong evidence that FCD over exports does proxy for a firm's financial frictions in the form of higher borrowing costs. While larger ratios positively correlate with longer maturity, the metric displays positive loadings on the interest rate spread and the creditor's foreign residence. Nonetheless, we do not find significant evidence that firms with higher ratios are more exposed to interest rates indexed to foreign rates. Overall, the findings suggest that firms with higher FCD-to-export ratios face larger borrowing costs through higher spreads and greater reliance on foreign credit institutions, thus arguably more exposed to foreign shocks disrupting international financial conditions.

3 Empirical strategy

To estimate ERPT coefficients, we ran a distributed lag panel regression at the firm-product level by pooling all observations in the merged dataset. Since almost all imports and exports in Colombia are invoiced in US dollars, we use the bilateral exchange rate between the Colombian peso and the US dollar (COP/USD) in place of multiple bilateral or trade-weighted exchange rates. As underscored by Burstein and Gopinath (2014), the identification strategy relies on the exchange rate "disconnect" from macroeconomic variables since exchange rate changes follow a seemingly white noise process uncorrelated with economic conditions.[4] We consider one specification for the "unconditional" ERPT, which builds upon

[4] A Portmanteau (Q) test for white noise does not reject the null hypothesis that logarithmic changes in the bilateral COP/USD exchange rate follow a white noise process.

a vast ERPT empirical literature (Campa and Goldberg, 2005; Burstein and Gopinath, 2014; Gopinath, 2015; Gopinath et al., 2020), and two alternative specifications for the differential ERPT as follows:

$$\Delta p_{ijk,t} = \alpha_{\mathcal{I}} + \alpha_{\mathcal{T}} + \alpha_k + \sum_{\ell=0}^{7} \beta_\ell \Delta e_{\$,t-\ell} + \theta' \mathbf{X}_{t-1} + \epsilon_{ijk,t}, \tag{3}$$

$$\Delta p_{ijk,t} = \alpha_{\mathcal{I}} + \alpha_{\mathcal{T}} + \alpha_k + \sum_{\ell=0}^{7} \beta_\ell \Delta e^{\$}_{t-\ell} + \sum_{\ell=0}^{7} \beta_{d\ell} \Delta e^{\$}_{t-\ell} \times d_{s,t-1-\ell} + \theta' \mathbf{X}_{t-1} + \epsilon_{ijk,t}, \tag{4}$$

$$\begin{aligned}\Delta p_{ijk,t} = \alpha_{\mathcal{I}} + \alpha_{\mathcal{T}} + \alpha_k + \sum_{\ell=0}^{7} \mathbb{1}_{\left\{d_{i,t-1-\ell} > med\left(d_{s,t}\right)\right\}} \beta_{h\ell} \Delta e_{\$,t-\ell} + \\ + \sum_{\ell=0}^{7} \left(1 - \mathbb{1}_{\left\{d_{i,t-1-\ell} > med\left(d_{s,t}\right)\right\}}\right) \beta_{l\ell} \Delta e_{\$,t-\ell} + \theta' \mathbf{X}_{t-1} + \epsilon_{ijk,t}, \end{aligned} \tag{5}$$

for firm $i \in \mathcal{I}$, product j, and country k, where $\Delta p_{ijk,t}$ is the quarterly logarithmic change in the unit value of either exports or imports, $\Delta e_{\$,t}$ is the logarithmic change of the quarterly average COP/USD bilateral exchange rate, and $s \in \{i, \mathcal{I}\}$ in equations (4) and (5). We consider imports in Colombian pesos and exports in US dollars. This approach of using different currencies for imports and exports is adopted to reflect the actual prices faced by importers in Colombia and by the destination countries for Colombian exports. $\mathbf{X}_t$ denotes a vector of controls, which includes the logarithmic change of the aggregate Colombian PPI and quarterly seasonal dummies. $\alpha_{\mathcal{I}}$, $\alpha_{\mathcal{T}}$, and α_k are four-digit industry-level, year, and country-fixed effects, respectively, and $\epsilon_{ijk,t}$ in each equation stands for the error term.[5] For imports (exports), index k refers to the origin (destination) country. Standard errors are clustered at the firm level.

In the ensuing results, we set the FCD to exports ratio at the firm level ($s = i$) for exports and the industry level ($s = \mathcal{I}$) for imports. We adopt this distinction because it is the individual balance-sheet effect on domestic firms that may influence their markup decisions on exports. In contrast, foreign firms may indirectly respond to the balance-sheet channel on domestic firms via pricing complementarities. Thus, any impact of FCD on the ERPT to import prices should arise from the financial frictions experienced by a sector. We will formalize this argument in the model.

In equation (4)—our baseline specification, which we later compare to model predictions, we interact the proxy for financial frictions with the COP/USD bilateral exchange rate. Conversely, equation (5) employs an indicator variable $\mathbb{1}_{\left\{d_{i,t} > med\left(d_{s,t}\right)\right\}}$ taking one if the FCD to exports ratio in year-quarter t is above the cross sectional median for $s \in \{i, \mathcal{I}\}$. Since equation (5) uses the whole set of observations when estimating each set of coefficients, $\left\{\beta_{h\ell}\right\}_{\ell=0}^{7}$

[5] We do not add year-quarter fixed effects as these would absorb the dollar exchange rate.

and $\{\beta_{l\ell}\}_{\ell=0}^{7}$, it allows for a direct test of whether the ERPT coefficients are equal to each other across groups: $\sum_{\ell=0}^{t} \beta_{h\ell} = \sum_{\ell=0}^{t} \beta_{l\ell}$, for $t = 0, \ldots, 7$.

Therefore, while specification (4) yields an estimate for the elasticity of the ERPT to FCD, equation (5) directly yields ERPT estimates depending on a threshold level, which we set to the median of the FCD to exports ratio at the firm or industry levels in the panel.

For each specification, the ERPT is the sum of coefficients from $t = 0, \ldots, 7$ as follows:

$$\Sigma_{\ell=0}^{t}\beta_{\ell}, \tag{6}$$

$$\Sigma_{\ell=0}^{t}\beta_{\ell} + \beta_{d\ell}d_{s,\text{perc}}, \tag{7}$$

$$\Sigma_{\ell=0}^{t}\beta_{h\ell},\ \Sigma_{\ell=0}^{t}\beta_{l\ell}, \tag{8}$$

for some percentile $d_{s,\text{perc}}$ in the firm-level ($s = i$) or industry-level ($s = \mathcal{I}$) empirical distributions. The coefficient associated with $t = 0$ gives the ERPT on impact, and the sum from $t = 1, \ldots, 7$ portrays the cumulative ERPT up to a horizon of eight quarters. Summary statistics of all variables used in specifications (3)-(5) can be found in table A1 in appendix A.1.

4 Results

We begin by showing estimates for the unconditional ERPT following specification (3) in Figures 3a and 3b. Consistent with Dominant Currency Pricing (DCP), the ERPT to import prices is close to one on impact and roughly flat over the eight-quarter horizon, as prices are sticky in US dollars. This suggests that an exchange rate depreciation translates into an almost one-for-one import price increase when measured in Colombian pesos. Shaded regions portray confidence intervals at the 90$^{\text{th}}$ percent level, which widen as the horizon increases, suggesting heterogeneous effects we want to explore. As for exports, a one percent depreciation of the Colombian peso translates into a negligible response on impact as Colombian firms' prices are also sticky in US dollars. As quarters increase, Colombian firms reduce markups to absorb the exchange rate depreciation, reaching a statistically significant price decrease (in US dollars) of nearly half a percent (-0.47 percent).

With the benchmark provided by the unconditional estimates, we proceed to results in Table 4, which presents empirical results for specification (4) interacting the FCD over exports with the COP/USD bilateral exchange rate. As seen in the third column, the coefficient associated with the interaction term is significant at the five percent level after four and eight quarters, and is quantitatively meaningful. Specifically, the elasticity of the ERPT to industry-level FCD reaches 0.05 at the end of the eight-quarter horizon, indicating a 0.05 increase in the ERPT to import prices in response to a one percent rise in the FCD to exports ratio. In contrast, point estimates for export prices are negative and not statistically significant, suggesting that Colombian firms fully absorb exchange rate movements when exporting to destination countries. To dynamically illustrate the ERPT responses, we selected the 90^{th} and 10^{th} percentiles in the empirical distribution of the FCD to exports ratio at the industry and firm levels for import and export prices, respectively. The curves are depicted in figures 4a and 4b.[6]

Lastly, we move to results using the indicator variable in specification (5). Among highly-indebted industries, the ERPT to import prices in Figure 5a is above one on impact and increases to 1.6 after three quarters, hovering around 1.5 through the end of the eight-quarter horizon. In the same figure, the ERPT point estimate in the lowly-indebted group is consistently below one, yet confidence intervals do not preclude complete pass-through. On impact, the coefficient is 0.9, decreasing to 0.7 after three quarters, stabilizing at this level through the remaining periods. The results portraying cumulative point estimates after four and eight quarters are summarized in Table 5. Since confidence intervals overlap, we perform a hypothesis test to check whether these coefficients are statistically equal to each other. We reject the null at the one-percent significance level, indicating that relatively high FCD levels induce larger ERPT to import prices. We also test the statistical difference between estimates for each quarter individually, rejecting the null at least at the 90% level. Results are reported in Figures A1a and A1b.

When it comes to export prices, we do not find quantitative or statistically significant differences across highly and lowly-indebted firms. However, point estimates are slightly higher among the lowly-indebted group, contrary to the expected response based on balance-sheet effects experienced by Colombian firms. Nevertheless, the lack of significance in empirical results is consistent with pricing complementarities in the destination market. It suggests that highly and lowly-indebted firms absorb movements in the exchange rate when pricing-to-market regardless of the individual financial frictions they face, with empirical dynamics similar to the unconditional responses previously reported.

[6] As a robustness check, we instrument the exchange rate and the interaction term in specification (4) for logarithmic changes in the VIX and Brent crude oil prices. Results are virtually unchanged compared to those in Table 4 and are available upon request. The assumption is that the US dollar bilateral exchange rates correlate with the VIX, and Colombia is a price taker in the oil market. Meanwhile, fluctuations in these instruments are exogenous to the Colombian economy.

4.1 Robustness checks

In this section, we conduct several robustness checks. In particular, we (i) consider alternative approaches to account for unit value bias, (ii) assess the sensitivity of our results to dropping outliers from the corporate FCD empirical distribution, (iii) control for the market share of importers and exporters, and (iv) control for dollarized import origins and dollarized export destinations.

Alternative cutoffs for unit values. Since there is no clear-cut theoretical guidance as to how one should account for unit value bias, we rerun specifications (3)-(5) considering two alternative cutoffs to remove noise from unit value observations. We first adopt a looser approach, dropping observations for which the unit value standard deviation at the firm-product level is at the top decile in the empirical distribution. We also utilize a stricter approach, eliminating observations with quarterly variation in unit values greater than 100 percent. Since there is strong seasonality in unit values at the quarterly frequency, this particular cutoff can be considered demanding as we risk discarding informative data variation rather than noise. Results are reported in Appendix A.2.1.

Reassuringly, the main findings hold regardless of the approach considered. First, point estimates of specification (4) are very similar to each other across alternative cutoffs and similar to the baseline results. In particular, the elasticity of the ERPT to corporate FCD reaches 0.04 and 0.05 for import prices after eight quarters, according to the looser and stricter unit value cutoffs, respectively. These results are reported in Tables A2 and A4 and are significant at the five and one percent levels, respectively. Despite still encountering negative point estimates for export prices, we again do not find statistical significance, as underscored in the baseline results.

If we consider specification (5), import prices in relatively more indebted industries also present a higher ERPT in response to exchange rate movements, and we reject at the one percent level that the ERPT coefficients are equal to each other across highly and lowly-indebted groups of firms. These results are shown in Tables A3 and A5. Considering the looser cutoff, the ERPT to import prices after two years is 1.5 in the group of highly-indebted firms, in contrast to 0.7 in the lowly-indebted counterpart. Alternatively, the stricter cutoff produces point estimates of 1.0 and 0.6 in the former and latter groups, respectively. By construction, point estimates will be smaller in the second approach since we discard unit values with large quarterly variations. Again, we do not document economically meaningful or statistically significant differences across highly and lowly-indebted groups for export prices.

Discarding foreign currency debt (FCD) outliers. Next, we assess the robustness of our results when outliers are discarded from the hyperbolic sine of transformation of the firm-level FCD to exports ratio. We conduct this empirical exercise because the massive ratios observed in the data might not reflect financial frictions experienced by Colombian firms but rather large unconstrained firms mainly serving the local market. In particular, we discard observations above the 99.5^{th} percentile in the empirical distribution. Results are documented in Appendix A.2.2.

Again, the main findings hold. Point estimates of specification (4) are virtually unchanged for import and export prices compared to the baseline results. In particular, the elasticity of the ERPT to the FCD over exports after eight quarters is 0.05 for import prices and is significant at the five percent level. Despite still finding negative point estimates for export prices, we again do not find statistical significance. These results are reported in Table A6. On the other hand, discarding outliers strengthens results for import prices under specification (5). The ERPT reaches 1.9 after eight quarters in relatively more indebted industries compared to 0.6 in the lowly-indebted counterpart. The statistical difference between these estimates is again significant at the one percent level. Likewise, we do not document economically meaningful or statistically significant differences in export prices across highly and lowly-indebted groups. These results are summarized in Table A7.

Controlling for market share. Amiti et al. (2014) documented that firms with high import and export market shares exhibit low ERPT to prices using a sample of Belgian firms. To explore whether the market share drives our findings, we modify specification 4 to introduce an additional interaction between exchange rate, debt, and market share, as described by equation (A.1). For import (export) prices, we consider the market share of Colombian importers (exporters) at the firm-product level throughout the sample ranging from 2010q1 to 2022q4. Results are presented in Table A8.

The differential effects on the ERPT linked to FCD remain intact for import prices, with an ERPT elasticity to FCD of 0.05 after eight quarters. We additionally find a semi-elasticity of the ERPT to market share of -0.05, suggesting that foreign firms absorb exchange rate movements more when selling goods to larger Colombian importers. Both estimates are statistically significant at the five percent level. As for export prices, we find negative estimates associated with FCD with stronger significance (at the 10 percent level after eight quarters) and no effects associated with the market share of Colombian exporters.

Controlling for dollarized origin and destination. Our final robustness check examines whether dollarized origins or destinations influence our results. As mentioned, Colombian imports and exports are predominantly invoiced in US dollars, with the United States being its foremost trading partner. Therefore, we adjust specification (4) to include an additional interaction among exchange rate, debt, and an indicator variable equal to one if country k is a dollarized origin of imports or destination for exports, as outlined by equation (A.3). The set of dollarized countries and Table A9 reporting the empirical results are in Appendix A.2.4.

The differential effects on the ERPT associated with FCD persist for import prices, with an ERPT elasticity to FCD of 0.05 over eight quarters. Again, the estimate achieves a five-percent significance level. We find no evidence of the impact of dollarized origins on the ERPT. Regarding export prices, accounting for dollarized destinations brings estimates linked to the FCD closer to zero. On the other hand, we document that Colombian exporters pass on changes in the exchange rate to a lesser extent when exporting to a dollarized destination, with a coefficient of -0.04. This estimate is also statistically significant at the five percent level.

Finally, to underscore how it is crucial to account for pricing complementarities in the financial fragility measure, we present in Appendix A.2.5 the results of flipping the financial fragility indicators for imports and exports in equation (4). This entails assigning the FCD over exports at the firm level ($s = i$) for imports, and at the industry level ($s = \mathcal{I}$) for exports. As argued before, the indirect balance-sheet channel on import prices stems from financial frictions experienced by Colombian firms, which are transmitted to import prices via strategic complementarities in pricing. As for export prices, it is primarily the individual financial friction experienced by a Colombian firm that drives its markup decisions rather than industry-level constraints. While we still find positive coefficients on FCD for imports (0.04 after four or eight quarters), the estimates are no longer statistically significant. As for exports, coefficients move closer to zero (virtually zero and -0.01 after four and eight quarters, respectively).

5 Theoretical model

To the best of our knowledge, the existing classes of general equilibrium models in the ERPT literature are unable to replicate the empirical findings documented above, where FCD affects the dynamics of import prices yet exerts negligible impacts on export prices. Thus, we provide a novel theoretical mechanism inducing differential pass-through within a small-open economy (SOE) general equilibrium model. Specifically, the model incorporates the Dominant Currency Pricing (DCP) paradigm embedded in an SOE from Egorov and Mukhin (2023) and the endogenous markup structure from Gopinath et al. (2020). The credit constraint is based on a substantial body of literature on sudden stops and pecuniary externalities in small open economies, including works by Mendoza (2010), Bianchi (2011), and Coulibaly (2023), among others.

While the following model abstracts away from important features present in the data in order to ensure tractability, such as idiosyncratic shocks and heterogeneity in borrowing constraints across firms, we still relate it to our empirical framework by comparing it to the average panel effects of FCD. Indeed, robustness checks suggest that the main results presented in Section 4 are not driven by firm-level heterogeneity, as implied, for instance, by varying degrees of market power, but rather by the effects of balance-sheet currency mismatches on pricing decisions.

Environment

The model considers an SOE where entrepreneurs produce unique input varieties indexed by $i \in [0,1]$. Perfectly competitive retailers aggregate these inputs into a homogeneous final consumption good Y_t. Retailers import varieties from foreign entrepreneurs in the rest of the world (ROW), who are similarly indexed by i over the same range. Because each input variety is unique, SOE and ROW entrepreneurs operate as monopolists in imperfect competition. Inputs from local entrepreneurs are indexed by H and those from foreign by F. Thus, a variety produced by an entrepreneur i in the SOE is denoted by I_{iHt}, and in the ROW by I_{iFt}.

Final good production

The retailers' transformation technology is described by a Kimball (1995) aggregator of domestic and foreign intermediates. Therefore, their profit maximization problem is:

$$\begin{aligned} \max_{\{Y_t, \{I_{iHt}\}_{i\in[0,1]}, \{I_{iFt}\}_{i\in[0,1]}\}} \quad & P_t Y_t - \int_0^1 P_{iHt} I_{iHt} di - \int_0^1 \mathcal{E}_t P_{iFt} I_{iFt} di \\ \text{s.t.} \quad & \gamma_H \int_0^1 \Upsilon\left(\frac{I_{iHt}}{\gamma_H Y_t}\right) di + \gamma_F \int_0^1 \Upsilon\left(\frac{I_{iFt}}{\gamma_F Y_t}\right) di = 1, \end{aligned} \tag{9}$$

where $\gamma_H + \gamma_F = 1$. $\gamma_H \in [1/2, 1)$ captures the degree of home bias. The Kimball aggregator $\Upsilon(.)$ has the properties $\Upsilon(1) = 1$, $\Upsilon' > 0$, and $\Upsilon'' < 0$, inducing elasticities of demand increasing with the relative price. These properties imply that entrepreneurs aim to avoid setting prices too far from their competitors when supplying inputs to retailers. This behavior leads to incomplete pass-through of changes in marginal costs unto prices. $\mathcal{E}_t$ is the nominal exchange rate, which we define as home currency per unit of foreign currency. Hence, an increase in $\mathcal{E}_t$ indicates a depreciation of the SOE's currency. The following equations describe the residual demand schedule for domestic and foreign intermediate varieties:

$$\frac{I_{iHt}}{Y_t} = \gamma_H \upsilon \left(\mathcal{D}_t \frac{P_{iHt}}{P_t} \right), \quad \frac{I_{iFt}}{Y_t} = \gamma_F \upsilon \left(\mathcal{D}_t \frac{\mathcal{E}_t P_{iFt}}{P_t} \right) Y_t, \tag{10}$$

where $\upsilon \equiv (\Upsilon')^{-1}$, and $\mathcal{D}_t \equiv \int_0^1 \Upsilon' \left(\frac{I_{iHt}}{\gamma_H Y_t} \right) \left(\frac{I_{iHt}}{Y_t} \right) di + \int_0^1 \Upsilon' \left(\frac{I_{iFt}}{\gamma_F Y_t} \right) \left(\frac{I_{iFt}}{Y_t} \right) di$ is a demand shifter determined in general equilibrium. Conversely, we denote quantities demanded by the ROW or prices set in foreign currency with a $*$ superscript.

Shocks

In this environment, we assume that shocks to the foreign interest rate and aggregate total factor productivity (TFP) are the sole source of macroeconomic fluctuations in the SOE. Each period, entrepreneurs make decisions regarding production, consumption, labor supply, and savings after shocks occur. The TFP shock impacts the entrepreneurs' production technology and is represented by the shock ζ_t^A, with TFP following the process: $a_t = \rho_a a_{t-1} + \zeta_t^A$, with $a_t \equiv \log(A_t)$ and steady-state level $A = 1$.

SOE entrepreneurs decide whether to borrow or save using home and foreign currency bonds, denoted as B_{it+1} and B^*_{it+1} respectively. The home currency bond is only traded domestically, pinning down the domestic interest rate R_t. The foreign currency bond is traded internationally to smooth out consumption over time, paying a nominal interest R_t^*, subject to shocks $\zeta_t^{R^*}$. To ensure the stationarity of the problem without producing quantitatively meaningful impacts on the dynamics of other endogenous variables, we introduce a debt-elastic interest rate as in Schmitt-Grohé and Uribe (2003):

$$R_t^* = R^* + \omega \left(\exp\left\{ - \left(\frac{B_t^*}{P_t^*} - \bar{b} \right) \right\} - 1 \right) + \zeta_t^{R^*}, \ \ \omega > 0, \tag{11}$$

where $\zeta_t^{R^*}$ denotes a foreign interest rate shock, and $\bar{b} < 0$ stands for the SOE's FCD level in the steady state.

Credit constraint

Aside from the unique variety they produce and collateral constraints they face, entrepreneurs in the SOE and ROW are identical in preferences and technology. Specifically, they exhibit standard preferences over consumption and hours worked described by a twice–continuously differentiable and concave period utility function, and a technology linear in labor. Consumption in the SOE is defined over the homogeneous final consumption good Y_t.

Every period entrepreneurs must finance a fraction $\phi \in [0,1]$ of working capital in advance of sales. In particular, while foreign entrepreneurs face the natural borrowing limit on debt, home entrepreneurs can borrow in international markets only up to a fraction $\kappa > 0$ of their tradeable income, $P_{Ht}I_{Ht} + \mathcal{E}_t P^*_{Ht} I^*_{Ht}$:

$$- \mathcal{E}_t B^*_{it+1} + \phi W_t R^*_t N_{it} \leq \kappa \left(P_{Ht} I_{Ht} + \mathcal{E}_t P^*_{Ht} I^*_{Ht} \right), \tag{12}$$

where B^*_{it+1} and $W_t R^*_t N_{it}$ denote foreign-bond holdings and intraperiod working capital loans, respectively. $P_{Ht}I_{Ht} + \mathcal{E}_t P^*_{Ht} I^*_{Ht}$ stands for total sales in domestic and foreign markets, with exports being invoiced in foreign currency. Since entrepreneurs are identical from the perspective of foreign lenders, they all face the same collateral constraint and do not internalize the effect of their decisions on the overall economy's credit constraint.[7]

Discussion of the collateral constraint. While the particular form of collateral constraint is not crucial to our proposed mechanism and results, we adopt the above specification, where debt is constrained by a fraction of tradeable income, for a few reasons. First, it simplifies the model by eliminating the need for an additional state variable, which is typically required under stock-based collateral constraints. As is well known, in this class of models, the capital stock or another kind of asset limits firms' credit. Second, by assuming a flow collateral constraint based on the current tradeable income, the model directly speaks to an extensive theoretical literature featuring sudden stops and Fisherian deflation in small open economies. Third, though the existing empirical evidence focuses on the US, the recent literature has documented that covenant contracts among nonfinancial corporations mostly depend on current cash flows (Lian and Ma, 2020; Drechsel, 2023).

Further, we exclude home currency bonds from the collateral constraint for two main reasons. First, by dropping local currency bonds B_{it}, the model generates endogenous deviations from the uncovered interest parity (UIP) condition, which constitute a realistic aspect of the macroeconomy. Second, the small open economy literature has typically modeled only foreign currency debt (FCD) entering the collateral constraint. Indeed, as argued by Caballero and Krishnamurthy (2001), asymmetric borrowing constraints may result from limited enforceability of contracts. Even though we abstract away from explicitly modeling

[7] Even in the absence of collateral constraints, one could argue that FCD raises firms' average costs after an exchange rate depreciation. Under these circumstances, FCD might influence firms' entry or export discreet choices. Nevertheless, insofar as the ERPT is a short-run phenomenon, we abstract away from any potential impacts of FCD on firms' entry or export decisions, focusing solely on its impact on incumbent firms' marginal costs.

the covenant contract, such an asymmetry may arise from frictions in financial markets, costs in transferring resources from one country to another, or differing collateral valuations by foreign and domestic lenders. For instance, foreign and domestic lenders might value domestic (e.g., nontradeables) and international collateral (e.g., export revenues) differently because domestic lenders can costlessly seize each other's income in the event of default. In contrast, foreign lenders might be able to seize only up to a fraction of it under the same circumstances. Consequently, borrowing in local currency may be less constrained than borrowing in foreign currency.

Entrepreneurs' problem

Entrepreneurs also face quadratic price adjustment costs as in Rotemberg (1982), measured in labor units. Thus, the period t SOE entrepreneur i's profit is:

$$\Pi_{it} \equiv P_{Hit} I_{iHt} + \mathcal{E}_t P^*_{iHt} I^*_{iHt} - \left[1 + \phi(R^*_t - 1) + \Psi\left(\frac{P_{iHt}}{P_{iHt-1}}\right) + \Psi\left(\frac{P^*_{iHt}}{P^*_{iHt-1}}\right) \right] W_t N_{it}, \tag{13}$$

with a symmetric problem faced by entrepreneurs in the ROW, where $\Psi(x) \equiv \frac{\psi}{4}(x-1)^2$. $\psi \geq 0$ determines the degree of price adjustment costs. When prices are flexible ($\psi = 0$), entrepreneurs set prices each period to equate marginal revenues to marginal costs. At the other extreme, when prices are fully rigid ($\psi \longrightarrow \infty$), entrepreneurs set prices once and for all to equate an average of current and future expected marginal revenues to an average of current and future expected marginal costs.

Therefore, the entrepreneur i's problem consists of maximizing the discounted stream of utility flow subject to the budget constraint, collateral constraint, the technology of transforming labor into tradeable inputs, and residual demands:

$$\begin{aligned}
&\max_{C_{it}, B_{it+1}, B^*_{it+1}, L_{it}, N_{it}, P_{iHt}, P^*_{iHt}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_{it}, L_{it}) \quad \text{s.t.} \\
&P_t C_{it} + B_{it+1} + \mathcal{E}_t B^*_{it+1} \leq W_t L_{it} + R_{t-1} B_{it} + \mathcal{E}_t R^*_{t-1} B^*_{it} + \Pi_{it}, && (\lambda_t) \\
&-\mathcal{E}_t B^*_{it+1} + \phi W_t R^*_t N_{it} \leq \kappa \left(P_{Ht} I_{Ht} + \mathcal{E}_t P^*_{Ht} I^*_{Ht} \right), && (\lambda_t \times \mu_t) \\
&I_{iHt} + I^*_{iHt} = A_t N_{it}, \\
&I_{iHt} = \gamma_H v \left(\mathcal{D}_t \frac{P_{iHt}}{P_t} \right) Y_t, \\
&I^*_{iHt} = \gamma^*_H v \left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t} \right) Y^*_t, \text{ for } t \geq 0,
\end{aligned} \tag{14}$$

where λ_t is the Lagrange multiplier on the budget constraint, and μ_t is the multiplier (rescaled by λ_t) on the collateral constraint. In a small-open economy environment, P_t^* and Y_t^* are exogenous variables from the perspective of the domestic economy. Parameter γ_H^* is analogous to γ_F and denotes the degree of home-bias in the ROW production of Y_t^*.

First-order conditions imply:

$$-\frac{U_L(C_t, L_t)}{U_C(C_t, L_t)} = \frac{W_t}{P_t}, \tag{15}$$

$$\mathbb{E}_t\left[\beta\frac{U_C(C_{t+1}, L_{t+1})}{U_C(C_t, L_t)}\left(\frac{P_t}{P_{t+1}}\right)\left(R_t - R_t^*\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right)\right] = \mu_t \geq 0, \tag{16}$$

where we dropped i subscripts since entrepreneurs' individual consumption and saving decisions are identical. Equation (16) implies that a binding collateral constraint ($\mu_t > 0$) generates an endogenous deviation from the UIP.

We assume the Klenow and Willis (2016) functional form for the Kimball homothetic aggregator, with a residual demand:

$$I_{iHt} = \gamma_H\left(1 + \xi\log\left(\frac{\theta-1}{\theta}\right) - \xi\log\left(\mathcal{D}_t\frac{P_{iHt}}{P_t}\right)\right)^{\frac{\theta}{\xi}} Y_t.^{8} \tag{17}$$

Parameters $\theta > 1$ and $\xi > 0$ govern the elasticity and superelasticity of substitution, respectively. In the limiting case $\xi \longrightarrow 0$, the residual demand for varieties (17) reduces to a constant elasticity of substitution (CES) demand schedule. Otherwise, $\xi > 0$ implies complementarities in pricing decisions, thus inducing endogenous markups. Specifically, entrepreneurs with higher relative output face a lower elasticity of substitution when $\xi > 0$: $\theta(I_{Kt}/Y_t) = \theta\left(\frac{I_{Kt}}{\gamma_K Y_t}\right)^{-\frac{\xi}{\theta}}$, with $K \in \{H, F\}$. Consequently, these entrepreneurs will charge higher markups. By substituting equation (17) into the firm i's first-order condition (B.5) and imposing symmetry among firms decisions, we get:

$$1-\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}} - \frac{\psi}{2}\pi_{Ht}(1+\pi_{Ht})MC_{Ht}\left(1+\frac{I_{Ht}^*}{I_{Ht}}\right) + \left[1+\phi\left(R_t^*\left(1+\mu_t\right)-1\right)\right]MC_{Ht}\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}} + \ldots$$
$$+\frac{\psi}{2}\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\pi_{Ht+1}(1+\pi_{Ht+1})^2 MC_{Ht+1}\left(\frac{I_{Ht+1}}{I_{Ht}} + \frac{I_{Ht+1}^*}{I_{Ht}}\right)\right\} = 0 \tag{18}$$

where $MC_{Ht} = \frac{W_t}{A_t P_{Ht}}$ is the real marginal cost of labor (measured in units of the tradeable

[8] In particular, Klenow and Willis (2016) set $\Upsilon(x) = 1 + (\sigma-1)\exp\left(\frac{1}{\xi}\right)\xi^{\frac{\sigma}{\xi}-1}\left[\Gamma\left(\frac{\sigma}{\xi}, \frac{1}{\xi}\right) - \Gamma\left(\frac{\sigma}{\xi}, \frac{x^{\xi/\sigma}}{\xi}\right)\right]$, where $\Gamma(s, y) \equiv \int_y^\infty t^{s-1}e^{-t}$ is the incomplete gamma function.

good), and $\pi_{Ht} \equiv \log(P_{Ht}) - \log(P_{Ht-1})$ is the inflation on inputs sold domestically.[9] Because entrepreneurs are net debtors in foreign currency, an exchange rate depreciation may induce the collateral constraint to bind, thus raising the effective marginal cost of production via $\mu_t > 0$. Specifically, $\mu_t > 0$ captures the shadow value of relaxing the constraint. To simplify the following analytical derivations, we consider a period-utility function linear in hours worked: $U(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - L_t$.

Optimal pricing under flexible prices

First, we analyze the balance-sheet channel on export and import prices absent nominal price stickiness (i.e., $\psi = 0$). Since the firm's problem is static in this case, in each period, the entrepreneur chooses prices P_{Ht} and P^*_{Ht}, disregarding intertemporal effects on profits. However, the real rigidity in the form of "kinked" residual demand curves (captured by $\xi > 0$) still makes firms reluctant to charge prices far from those of competitors. As we will see, the balance-sheet channel on domestic and export prices results directly from a binding collateral constraint.

By setting $\psi = 0$ in equation (18) yields:

$$1 - \theta \left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}} + \left[1 + \phi\left(R^*_t\left(1+\mu_t\right) - 1\right)\right] \frac{W_t}{P_{Ht} A_t} \theta \left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}} = 0 \iff$$

$$P_{Ht} = \left(\frac{\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{\frac{\xi}{\theta}}}{\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{\frac{\xi}{\theta}} - 1}\right)\left[1 + \phi\left(R^*_t\left(1+\mu_t\right) - 1\right)\right] \frac{W_t}{A_t}. \tag{19}$$

Log-linearizing equation (19) around the nonstochastic steady-state gives:

$$p_{Ht} - p_t = \left(\frac{\theta - 1}{\theta - 1 + \xi}\right)\left(\frac{\phi R^*}{1 + \phi(R^* - 1)}\right)(\hat{r}^*_t + \mu_t) + \left(\frac{\theta - 1}{\theta - 1 + \xi}\right)(\widehat{w_t - p_t} - a_t), \tag{20}$$

where lowercase variables denote the logarithm of uppercase variables, and hatted variables denote logarithmic deviations from the steady state.[10]

The pricing equation for export prices is analogous:

$$p^*_{Ht} - p^*_t = \left(\frac{\theta - 1}{\theta - 1 + \xi}\right)\left[\widehat{w_t - p_t} - a_t - q_t + \left(\frac{\phi R^*}{1 + \phi(R^* - 1)}\right)(\hat{r}^*_t + \mu_t)\right], \tag{21}$$

[9] See appendix B.1.2 for a complete derivation.

[10] That is, $\hat{x}_t = x_t - x$, where $x_t = \log(X_t)$. Note that, if $X = 1$, $\hat{x}_t = x_t$.

where $q_t = \epsilon_t + p_t^* - p_t$ is the logarithm of the real exchange rate $Q_t \equiv \mathcal{E}_t P_t^*/P_t$. Hence, marginal costs faced by domestic entrepreneurs will move due to fluctuations in TFP (a_t), foreign interest rate (r_t^*), or binding collateral constraints (μ_t), which induces balance-sheet effects on domestic and export prices. This theoretical result supports our empirical approach of using the FCD to exports ratio at the firm level for export prices.

Finally, given that, aside from financial frictions, the foreign entrepreneurs' profit maximization problem is symmetric, the first-order condition with respect to the foreign currency price P_{Ft}^* of imported inputs is:

$$1 - \theta \left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}} + \left[1 + \phi\left(R_t^* - 1\right)\right] \frac{W_t^*}{P_{Ft}^* A_t^*} \theta \left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}} = 0, \tag{22}$$

with a resulting log-linearized equation:

$$p_{Ft}^* - p_t^* = \left(\frac{\theta - 1}{\theta - 1 + \xi}\right)(\widehat{w_t^* - p_t^*} - a_t^*) - \left(\frac{\xi}{\theta - 1 + \xi}\right) q_t. \tag{23}$$

Discussion of the mechanism. It directly follows from equations (20) and (21) that the balance-sheet channel on prices vanishes if $\phi = 0$ since the entrepreneurs' marginal costs are not affected by their borrowing decisions. However, monopolistic competition combined with pricing complementarities ($\xi > 0$) will induce domestic and foreign entrepreneurs to absorb marginal cost fluctuations in markups. Otherwise, if $\xi \longrightarrow 0$ (i.e., entrepreneurs charge a constant markup over their marginal costs) or $\theta \longrightarrow \infty$ (i.e., monopolistic competition collapses to the perfect competition benchmark), changes in marginal costs are fully passed on to prices. Nonetheless, because home entrepreneurs must borrow to produce (i.e., $\phi > 0$), exchange rate movements will induce differential responses of domestic sale and export prices to shocks whenever the collateral constraint binds.

Phillips curves augmented for balance-sheet effects

Next, we impose $\psi > 0$, so the model combines nominal price stickiness with real rigidity. The log-linearized open-economy new Keynesian Phillips curves (NKPC) under Rotemberg pricing for domestic sales, export, and import inflation are the following:

$$\pi_{Ht} = \frac{\theta}{\psi}\left[1 + \phi(R^* - 1)\right]\Bigg(\widehat{w_t - p_{Ht}} - a_t \underbrace{- \frac{\xi}{\theta - 1}(p_{Ht} - p_t)}_{\substack{\text{incomplete} \\ \text{pass-through} \\ \text{term}}}\Bigg) + \underbrace{\frac{\theta\phi R^*}{\psi}\left(\hat{r}_t^* + \mu_t\right)}_{\substack{\text{balance-sheet} \\ \text{effect}}} + \beta \mathbb{E}_t\left[\pi_{Ht+1}\right] \tag{24}$$

$$\pi^*_{Ht} = \frac{\theta}{\psi}\Big[1+\phi(R^*-1)\Big]\Big(\widehat{w_t - p^*_{Ht}} - \epsilon_t - a_t - \frac{\xi}{\theta-1}(p^*_{Ht} - p^*_t)\Big) + \frac{\theta\phi R^*}{\psi}\Big(\hat{r}^*_t + \mu_t\Big) + \beta\mathbb{E}_t\big[\pi^*_{Ht+1}\big], \tag{25}$$

$$\pi^*_{Ft} = \frac{\theta}{\psi}\Big[1+\phi(R^*-1)\Big]\Big(\widehat{w^*_t - p^*_{Ft}} - \frac{\xi}{\theta-1}(p^*_{Ft} + \epsilon_t - p_t)\Big) + \beta\mathbb{E}_t\big[\pi^*_{Ft+1}\big].^{11} \tag{26}$$

The Phillips curves (24), (25), and (26) reduce to standard open-economy NKPC if markups are constant ($\xi = 0$) and entrepreneurs do not finance working capital ($\phi = 0$). The other terms in these equations have standard interpretations in the new Keynesian literature, where an increase in current or expected real marginal costs leads to higher inflation in period t.

Furthermore, it is evident from (26) that, in the presence of strategic complementarities ($\xi > 0$), domestic prices influence foreign entrepreneurs' pricing decisions. Thus, balance-sheet effects on p_{Ht} will indirectly impact the foreign currency price of imports, p^*_{Ft}, through counterfactual higher markups, causing differential transmission of shocks to import prices. Since this mechanism relies upon borrowing constraints, it can be applied to currency paradigms other than DCP, as we consider here, such as Local Currency Pricing (LCP) or Producer Currency Pricing (PCP).[12]

Similar to the previous discussion regarding export prices, the indirect balance-sheet effect on import prices predicted by the model supports using the proxy for financial constraints at the industry level for import prices in order to capture potential pricing complementarities in the data.

Market clearing and monetary policy

After imposing symmetry, market clearing conditions imply:

$$C_t = Y_t,$$

$$L_t = N_t\left(1 + \Psi\left(\frac{P_{Ht}}{P_{Ht-1}}\right) + \Psi\left(\frac{P^*_{Ht}}{P^*_{Ht-1}}\right)\right),$$

$$B_{t+1} = 0,$$

[11] See Appendix B.1.2 for a complete derivation.

[12] See Obstfeld and Rogoff (1995), Devereux and Engel (2003), and Gopinath et al. (2020) for discussions about PCP, LCP, and DCP, respectively.

so home currency bonds are in zero net supply. The evolution of the net foreign asset (NFA) position follows:

$$B^*_{t+1} - R^*_{t-1}B^*_t = P^*_{Ht}I^*_{Ht} - P^*_{Ft}I_{Ft} - \phi(R^*_t - 1)\frac{W_t}{\mathcal{E}_t}N_t, \tag{27}$$

where $P^*_{Ht}I^*_{Ht} - P^*_{Ft}I_{Ft}$ and $\phi(R^*_t - 1)\frac{W_t}{\mathcal{E}_t}L_t$ denote net exports and intraperiod interest payments on working capital loans, respectively. We close the model by assuming a Taylor-type interest rule:

$$\frac{R_t}{R} = \left(\frac{P_t}{P_{t-1}}\right)^{\phi_\pi}, \phi_\pi > 1, \tag{28}$$

where we assume $R = R^*$, thus implying a slack collateral constraint in the nonstochastic zero-inflation steady state.

5.1 Calibration

As mentioned, we assume that the collateral constraint does not bind in the steady state.[13] To numerically illustrate the economic mechanism in the model, we log-linearized equations around the nonstochastic zero-inflation steady state and solved the model by applying a piecewise linear first-order perturbation approach (Guerrieri and Iacoviello, 2015), which allows us to solve for general equilibrium models incorporating occasionally binding constraints. Although models entailing occasionally binding constraints usually require global solution methods to account for second-order effects, we adopted a perturbation approach for its computational convenience and because our focus is on pricing responses rather than welfare analyses in which agents' precautionary behavior plays a key role.

The calibration of most parameters mostly follows standard values adopted in the literature, while others match a few moments of Colombia's economy between 2010-2022. Table 6 summarizes the model parameterization.

In particular, we followed Gopinath et al. (2020) and Gopinath and Itskhoki (2010) and set the steady-state elasticity of substitution across varieties θ and the superelasticity of demand ξ to 2 and 4, respectively.[14] To calibrate the Rotemberg price adjustment costs, we adopted

[13] Assuming the collateral constraint binds in the steady state would imply a permanent deviation from the UIP condition in equation (16). Moreover, by this same equation, it is clear that the Lagrange multiplier μ_t is a function of expected inflation, which, in tandem with expected inflation in the Phillips curves (24) and (25), might violate stability conditions depending on the parameterization.

[14] These values imply a markup elasticity of $\xi/(\theta - 1) = 4$, which is larger than estimates found in Amiti et al. (2019) when looking at ERPT to domestic prices, but still within the range of values considered in prior studies (Smets and Wouters, 2007; Klenow and Willis, 2016). Other mechanisms that do not play a key role in our empirical results, such as roundabout production as in Basu (1995), must be introduced to ensure a minor degree of strategic complementarities while maintaining numerical results that are empirically plausible.

the strategy of Faia and Monacelli (2008) and Egorov and Mukhin (2023), computing the implied adjustment cost necessary to produce the same slope of the new Keynesian Phillips curve in the Calvo-Yun model.[15] The approach yielded a value of $\psi \approx 72$, which is between the range considered by these two references.

To calibrate the fraction of financed working capital, we followed Mendoza (2010) and computed the average credit to the private nonfinancial sector from banks, which corresponds to 45 percent of GDP in our sample. This approach yielded a value of $\phi = 0.85$, which is between the calibrations adopted in Mendoza (2010), Neumeyer and Perri (2005) and Uribe and Yue (2006). The steady-state value of the external debt was calibrated to $\bar{b} = -0.12$ in order to match the international debt to quarterly GDP ratio among nonfinancial corporations of 14 percent.[16] The degree of home bias was set to $\gamma_H = 0.85$ to imply a steady-state export-to-output ratio of 16 percent.[17]

Finally, the parameter governing the debt-elastic interest rate ω was set to 0.005 to ensure the stationarity of the model without meaningfully interfering with the dynamics of the endogenous variables. The Taylor rule assumes a weight on inflation of 1.5, a standard value in the new Keynesian textbook framework.

We separately simulate impulse response functions to a one-standard-deviation transitory increase (decrease) in the foreign interest rate R_t^* (TFP A_t) for varying degrees of collateral constraints. Specifically, we consider $\kappa \in \{0.6, 0.8, 1.0\}$, and the natural borrowing limit, where κ is large enough to ensure the constraint is never binding. The standard deviations of the exogenous processes σ^{R^*} and σ^A were separately calibrated to match the standard deviations of the COP/USD bilateral exchange rate and private consumption in Colombia's national accounts in the unconstrained economy.[18] We set the autocorrelation of shocks to R_t^* and A_t to 0.3 and 0.9, respectively. The time-frequency in simulations is quarterly over a horizon of three years (12 quarters).

[15]The condition reduces to $\psi = \theta[1 + \phi(R^* - 1)]\left(\frac{\delta}{(1-\delta)(1-\beta\delta)}\right)$. We set the probability of price adjustment to $1 - \delta = 0.15$.

[16]Data for the credit to the private nonfinancial sector and the international debt to GDP ratio for nonfinancial corporations are sourced from the Total Credit Statistics and the International Debt Securities Dataset, both from the BIS.

[17]Data on exports of goods and services as a percentage of GDP come from the World Bank national accounts data, and OECD National Accounts data files.

[18]In contrast to the other moments used in the calibration, the standard deviation of consumption increases substantially to 4.0% when the COVID-19 pandemic is included in the sample. Therefore, to consider a volatility of consumption more representative of the Colombian economy, we considered the standard deviation between 2010 and 2019, which is 0.6%.

5.2 Numerical simulations

Figure 6 portrays the dynamic responses of price and nominal exchange rate changes to a one-standard-deviation increase in the foreign interest rate, for varying degrees of credit constraints (i.e., differing levels of κ). It also depicts the responses of foreign bond holdings to the shock and the resulting UIP deviation. Recall that a higher κ relaxes the collateral constraint as it increases the fraction of income that can be pledged to foreign lenders.

As Figure 6 illustrates, a foreign interest rate shock contemporaneously depreciates the exchange rate, shifting the no-arbitrage condition away from domestic currency bonds. Because SOE entrepreneurs are net borrowers from the ROW, the exchange rate depreciation increases their debt burden, leading to a binding credit constraint when $\kappa \leq 1$, and consequently, an endogenous deviation from the UIP condition. SOE entrepreneurs raise their net foreign bond holdings, as depicted by the positive responses of $\hat{B}^*_{t+1} \equiv B^*_{t+1}/P^*_t - \bar{b}$. By doing so, domestic entrepreneurs can relax their borrowing constraints, ameliorating the adverse balance-sheet effect on consumption. In contrast, when measured in the same currency, local and foreign currency bond returns are equalized in the unconstrained economy. As depicted by the green-dashed curves in the same panel, SOE entrepreneurs borrow more from the ROW, as foreign currency bonds are solely used to smooth out consumption.

As portrayed in the first panel of Figure 6, the balance-sheet effect on SOE entrepreneurs triggers inflationary responses in the prices of domestically sold inputs. Meanwhile, foreign entrepreneurs respond to the exchange rate depreciation by lowering markups on imports. As shown in the second panel, this adjustment in markups leads to a decrease in the foreign currency price of imports (i.e., $\pi^*_{Ft} < 0$ in the first two quarters) since foreign entrepreneurs set prices in the dominant currency. Lastly, export prices remain largely unaffected by the exchange rate depreciation or the balance-sheet effect (third panel of Figure 7a) due to strategic complementarities in pricing. Indeed, price complementarities induce SOE entrepreneurs to absorb exchange rate movements when exporting to the ROW.[19] Comparing consumer price inflation responses, denoted by π_t in the fourth panel, shows that the more credit-constrained the economy, the more inflationary the shock on impact. The more prominent inflationary response underscores the potential for corporate FCD to amplify the vulnerability of credit-constrained economies to external shocks.

[19] Recall that prices in the ROW are exogenous to the SOE. Since P^*_t does not change in response to the shock to R^*_t, so barely does P^*_{Ht}, resulting in $\pi^*_{Ht} \approx 0$ throughout the transition dynamics.

Model-based exchange rate pass-through

In Figure 7a, we portray the implied model-based exchange rate pass-through (ERPT) to domestic input, import, and export prices, which follow directly from the impulse responses in Figure 6. We define the model-based ERPT as the general equilibrium comovement between the cumulative change in prices and the exchange rate, according to the following equations:

$$\begin{aligned}
&\text{ERPT to domestic input prices:} && \frac{\Sigma_{h=0}^{t}\pi_{Hh}}{\Sigma_{h=0}^{t}\Delta\epsilon_h}, \\
&\text{ERPT to import prices:} && \frac{\Sigma_{h=0}^{t}\pi_{Fh}}{\Sigma_{h=0}^{t}\Delta\epsilon_h}, \\
&\text{ERPT to export prices:} && \frac{\Sigma_{h=0}^{t}\pi_{Hh}^{*}}{\Sigma_{h=0}^{t}\Delta\epsilon_h},
\end{aligned} \tag{29}$$

for $t = 0, 1, ..., 12$, where import prices are measured in home currency: $\pi_{Ft} = \pi_{Ft}^{*} + \Delta\epsilon_t$.

As portrayed in Figure 7a, the ERPT to domestic input prices is initially negligible, eventually rising more than one-for-one with the exchange rate depreciation. Similarly, because import prices are sticky in the dominant currency, the ERPT starts high and nearly one, then falls as foreign entrepreneurs reduce markups to accommodate the exchange rate fluctuation.

However, as domestic input prices increase in response to the deterioration of entrepreneurs' balance sheets, the ERPT to import prices increases as a result of strategic complementarities. The tighter the credit constraint, the larger the indirect balance-sheet effect on import prices, translating into a more than complete ERPT for economies with stricter constraints. Likewise, due to strategic complementarities, the ERPT to export prices is largely unresponsive to the balance-sheet channel because SOE entrepreneurs absorb the exchange rate depreciation to maintain prices as close as possible to competitors in the ROW.

When we eliminate strategic complementarities by setting $\xi = 0$ in Figure 7b, the ERPT to domestic input prices is virtually the same as in Figure 7a. In contrast, exchange rate movements are fully passed on to import prices, with an ERPT equal to one over the 12 quarters. On the other hand, the absence of pricing complementarities amplifies balance-sheet effects on export prices. Both outcomes arise from home and foreign entrepreneurs setting constant markups over their marginal costs. The impulse responses of the endogenous variables underlying the ERPT responses in Figure 7b can be found in Figure B.4.

In Appendix B.5, we report responses to a one standard deviation exogenous *decrease* in the TFP. A reduction in TFP squeezes firms' collateral, amplifying the recessionary impact of the shock the tighter the value of κ. Consistent with previous results, economies with more strained borrowing constraints exhibit more marked inflationary responses to the shock.

5.3 Comparing model to empirical results

We also compare model predictions with empirical results in Table 4 by running regressions analogous to those in the empirical using 10,000 model-generated observations. The specification using model-generated data follows:

$$y_t = \text{const.} + \sum_{\ell=0}^{7} \beta_\ell \Delta\epsilon_{t-\ell} + \sum_{\ell=0}^{7} \beta_{d\ell} \Delta\epsilon_{t-\ell} \times \tilde{d}_{t-\ell} + \sum_{\ell=0}^{7} \theta_\ell \pi_{Ht} + u_t,$$

where $y_t = \pi_{Ft}, \pi^*_{Ht}$ for import and export prices, respectively, and $\tilde{d}_t \equiv \log\left(-B^*_t / \left(P^*_{Ht-1} I^*_{Ht-1}\right)\right)$ for $B^*_t < 0$.[20] u_t stands for the error term. We conduct three sets of separate simulations in which we shock the SOE with foreign interest rate (R^*_t) and TFP (A_t) shocks following a normal distribution: $\eta^{R^*}_t \sim \mathcal{N}(0, \sigma^{R^*})$, $\eta^A_t \sim \mathcal{N}(0, \sigma^A)$, with $\rho_{\eta^{R^*}_t, \eta^A_t} = 0$. In the fourth column of Table 4, we run simulations under the calibration presented in Table 6, where we set the credit coefficient to $\kappa = 0.62$. This value ensures that the ratio of FCD among nonfinancial corporations to quarterly GDP never surpasses a cap of 20% in the model, which matches the average observed in the data during the devaluations of the Colombian currency in 2015 and 2020-2022.[21] As previously discussed, these devaluations were influenced by the international decline in oil prices, the COVID-19 pandemic and the ensuing global surge in inflation. In the fifth and sixth columns, we conduct counterfactual simulations by separately shutting down pricing complementarities (i.e., by setting $\xi = 0$) or collateral constraints.

The model under the baseline calibration implies qualitatively consistent estimates for import prices compared to those derived from actual data. While unconditional point estimates obtained from model-generated observations are higher, they also decline as the horizon extends, mirroring the pattern observed in the data. Similarly, the elasticity of the ERPT to corporate FCD is positive, reaching 0.02 compared to 0.05 after eight quarters. In contrast, eliminating strategic complementarities produces estimates consistent with complete ERPT and nil balance-sheet effects on import prices. This pattern was numerically illustrated in Figure 7b. Finally, removing borrowing constraints slightly decreases the estimates on the unconditional ERPT compared to those under the baseline calibration while eliminating differential effects caused by FCD.

In tandem, these results underscore that pricing complementarities and borrowing con-

[20] In the model, entrepreneurs can be net borrowers ($B^*_t < 0$) or savers ($B^*_t > 0$) in foreign currency.
[21] The time series for the nonfinancial corporations' FCD over GDP can be found in Figure B13.

straints are both critical in making FCD a predictor of differential ERPT responses for import prices. In Table B11, we show the role played by strategic complementarities in import prices by presenting coefficients associated with domestic price changes (i.e., domestic input price changes in the model, π_H). As seen in the third row of the panel, coefficients on π_H are positive when we allow for pricing complementarities. Otherwise, coefficients become negligible if we set $\xi = 0$, as indicated in the fourth column. In this case, foreign firms entirely pass on exchange rate changes to import prices.

As for export prices, balance-sheet effects play a minor role under the baseline calibration, with positive yet close to zero coefficients (0.01 after four and eight quarters). Although these coefficients are slightly higher than the nonsignificant results observed in the actual data, they still capture strategic complementarities in export pricing. Shutting down pricing complementarities renders coefficients virtually unchanged, similarly reflecting balance-sheet effects on prices. Finally, removing collateral constraints results in coefficients loading on FCD being nil, mirroring the results for import prices.

Overall, the theoretical mechanism generates predictions that qualitatively align with the empirical results, which suggest that the ERPT is ultimately determined by pricing complementarities even when firms set prices using a dominant currency in global trade and finance. The theoretical model predicts that there will be significant differences arising from FCD in the ERPT to import rather than export prices, which is consistent with the empirical findings. As argued in the model, foreign firms adjust their markups in response to the financial frictions experienced by local firms, whereas these firms absorb exchange rate movements when exporting to other countries.

6 Conclusion

This paper investigated empirically and theoretically whether corporate foreign currency debt (FCD) affects import and export price dynamics in response to exchange rate movements, commonly referred to as the exchange rate pass-through (ERPT) to international prices. Relying on rich firm-level data on credit operations, we used the FCD over exports as a proxy for financial frictions to compare the pricing responses of financially constrained and unconstrained firms via ERPT regressions. Specifically, we provided granular empirical evidence on the differential effects of FCD on the ERPT to import and export prices, where we explored the fact that foreign currency borrowing and exports are both overwhelmingly denominated in US dollars.

Our findings suggest that FCD has nonlinear effects on import prices. In particular, relatively indebted industries experience a more than one-for-one pass-through to import prices of 1.6 over two years. In contrast, we empirically recover the well-documented incomplete ERPT result in lowly-indebted industries, finding a coefficient of 0.7 over the same horizon. The estimates also reveal an economically meaningful elasticity: a one percent increase in the FCD to exports ratio results in a 0.05 rise in the ERPT to import prices over the same period. In contrast, ERPT to export prices is incomplete regardless of debt levels. These results are robust to several different data cleaning approaches and specifications.

While most ERPT literature has documented incomplete ERPT to prices, we do not see our findings as conflicting with prior studies. Instead, we view our results as stemming from marked complementarities in pricing decisions. The indirect balance-sheet channel on import prices arises from financial frictions experienced by Colombian firms, which are transmitted to import prices via strategic complementarities. Meanwhile, Colombian exporters adjust their margins to absorb exchange rate movements when they set prices targeting the foreign destination market. In tandem, these findings indicate significant pricing-to-market behavior of both Colombian and foreign firms, even though they all set prices in US dollars.

The existing class of general equilibrium models in the ERPT literature cannot replicate this fact. Thus, we resorted to a new theoretical mechanism inducing differential pass-through within a small-open economy general equilibrium model. Specifically, the model bridges two strands of literature in a novel fashion by integrating key elements in the class of models featuring Dominant Currency Pricing (DCP) and sudden stops. From DCP, we include dollar price setting in exports and imports along with price stickiness and endogenous markups. From the second, we incorporate FCD limited by collateral constraints. The model can qualitatively match the empirical findings in a calibration for Colombia using foreign interest rate and aggregate productivity shocks.

The underlying mechanism leans explicitly on the adverse effects of borrowing constraints on domestic firms' marginal costs and pricing decisions. In the model, because entrepreneurs in the small open economy borrow in foreign currency and finance working capital, a depreciation of the exchange rate increases the effective marginal cost of production whenever the borrowing constraint is binding. Hence, foreign firms will adjust markups not only in response to the exchange rate depreciation but also in consideration of its impact on domestic entrepreneurs' balance sheets, thereby leading to a larger ERPT to import prices. Since the mechanism relies on borrowing constraints, it can be applied to currency paradigms other than DCP, such as Producer or Local Currency Pricing (PCP and LCP, respectively), which were previously studied in the literature.

We consider our findings to have extensive implications. First, our results suggest that the ERPT is ultimately determined by pricing complementarities even when firms set prices using a major vehicle currency. Second, the large degree of complementarities encountered in the data is also consistent with a large body of empirical evidence documenting significant deviations from the law of one price. Overall, the results suggest that the impact of FCD on small open economies may extend beyond the channel of pecuniary externalities, potentially encompassing effects on international price dynamics, with implications for welfare and appropriate monetary policy responses.

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Summary and descriptive statistics

Table 1
Foreign currency debt (FCD) characteristics

Interest rate type		
	Freq.	Percent
Fixed	3,972	5.23
International	60,362	79.47
Other	11,617	15.30
Total	75,951	
Creditor residence classification		
	Freq.	Percent
External	19,906	26.21
Domestic	56,045	73.79
Total	75,951	
Loan term: short, long		
	Freq.	Percent
≤ 12 months	62,997	82.95
> 12 months	12,954	17.05
Total	75,951	
Debt instrument		
	Freq.	Percent
Loans	71,502	94.14
Supplier credit	4,039	5.32
Other	410	0.54
Total	75,951	
Currency: USD, EUR, other		
	Freq.	Percent
USD	74,562	98.17
EUR	1,213	1.60
Other	176	0.23
Total	75,951	

Table 1 shows the frequency of various characteristics of the firm-level corporate FCD in Colombia. The characteristics include details on the interest rate type (fixed rate, international rate indexation, or other), creditor residence (external or domestic), loan term (short or long term), debt instrument (loans, supplier credit, or other), and currency (USD, EUR, or other).

Table 2
Summary statistics of foreign currency debt (FCD)

Debt stock (million US dollars)	**Total**	**USD**	**EUR**	**Other**
N	75,951	74,562	1,213	176
avg.	0.82	0.83	0.53	0.72
std	6.04	6.09	1.88	1.37
min	0	0	0	0
max	876.56	876.56	34.30	10.27

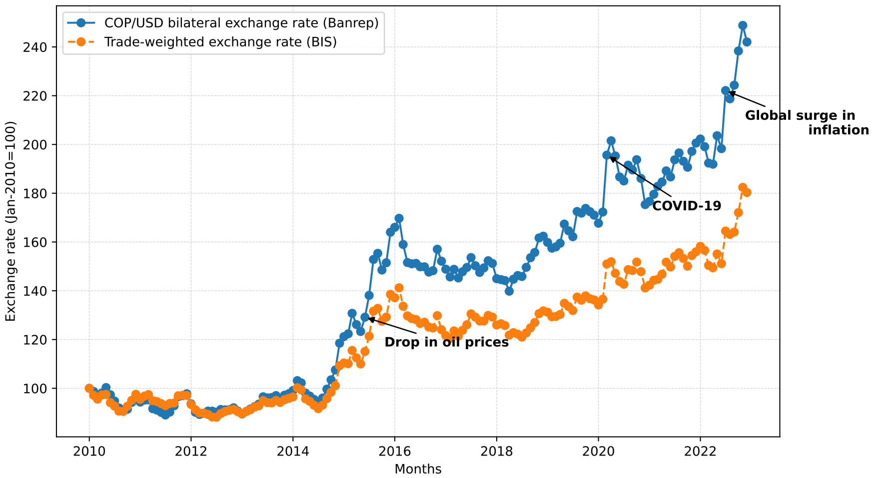
Table 2 presents summary statistics of firm-level corporate FCD for the total stock and its breakdown across distinct currencies (USD, EUR, and others).

Table 3
FCD loadings on selected characteristics

	Debt ID to total exports ratio $\mathcal{D}_{io,t}$ $\mathcal{D}_{io,t} = \text{Debt}_{io,t}/(\Sigma_{j\in\mathcal{J}_i}\text{Exports}_{ij,t})$
$\text{spread}_{io,t}$	0.034
	(0.005)
$\mathbb{1}_{\{\text{maturity} > 12 \text{ months}\}}$	0.098
	(0.023)
$\mathbb{1}_{\{\text{creditor is foreign}\}}$	0.048
	(0.023)
$\mathbb{1}_{\{\text{int. rate is indexed to foreign}\}}$	0.034
	(0.031)
Observations	52,332
R^2	0.132
Industry FE	✓
Year FE	✓

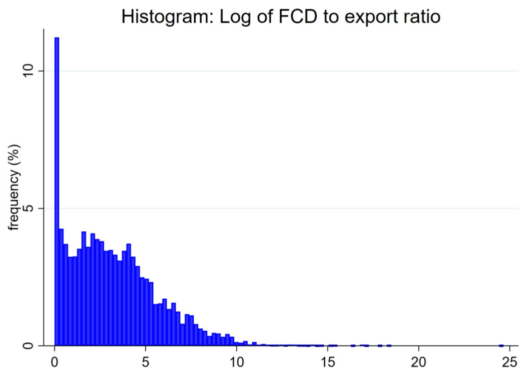
Table 3 regresses the inverse of the hyperbolic sine transformation of firm i's foreign currency loan o over firm i's total exports of products $j \in \mathcal{J}_i$ on selected characteristics of the corporate foreign currency dataset, where $\mathcal{J}_i$ is firm i's exported basket of products. The covariates include loan o's interest rate spread over a benchmark rate, an indicator variable equal to one if loan o is long-term (more than 12 months), an indicator variable equal to one if the lender's residence is foreign, and an indicator variable equal to one if loan o's interest rate is indexed to a foreign interest rate. Standard errors are clustered at the firm level.

Figure 1: Exchange rate dynamics

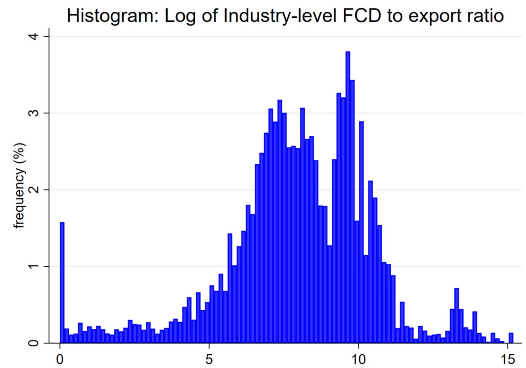


This figure plots the monthly bilateral exchange rate between the Colombian peso and the US dollar along with the trade-weighted nominal effective exchange rate, sourced from the *Banco de la República* (Banrep) and the Bank for International Settlements (BIS), respectively. For comparison purposes, both curves are normalized to 100 for January 2010.

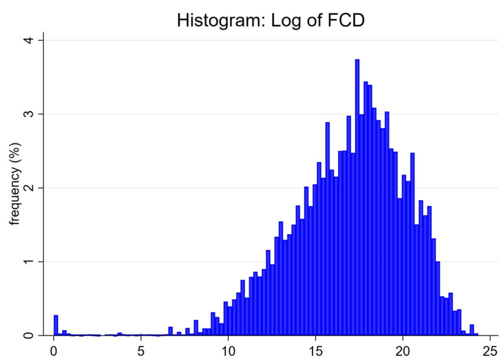
Figure 2: Histograms of selected variables



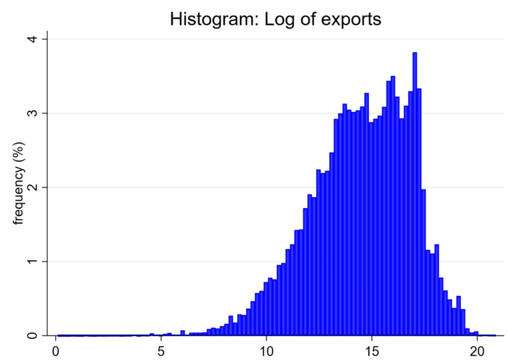
(a) Firm level



(b) Industry level



(c) Foreign currency debt (FCD)

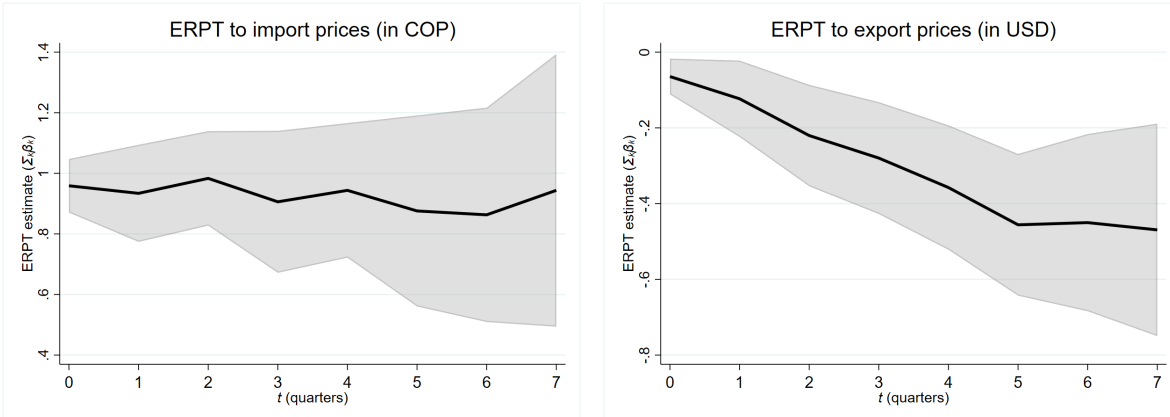


(d) Exports

The figures above show the histograms of the hyperbolic sine transformation, $\log(x + (x^2 + 1)^{1/2})$, of corporate FCD, exports, and the corporate FCD to exports ratio. Panel (2a) shows the corporate FCD to exports ratio at the firm level, $d_{i,t}$. Panel (2b) shows the same variable measured at the industry level, $d_{\mathcal{I},t}$, based on the four-digit International Standard Industrial Classification (ISIC). Panels (2c) and (2d) show the corporate FCD and exports at the firm level, respectively.

Empirical results and numerical simulations

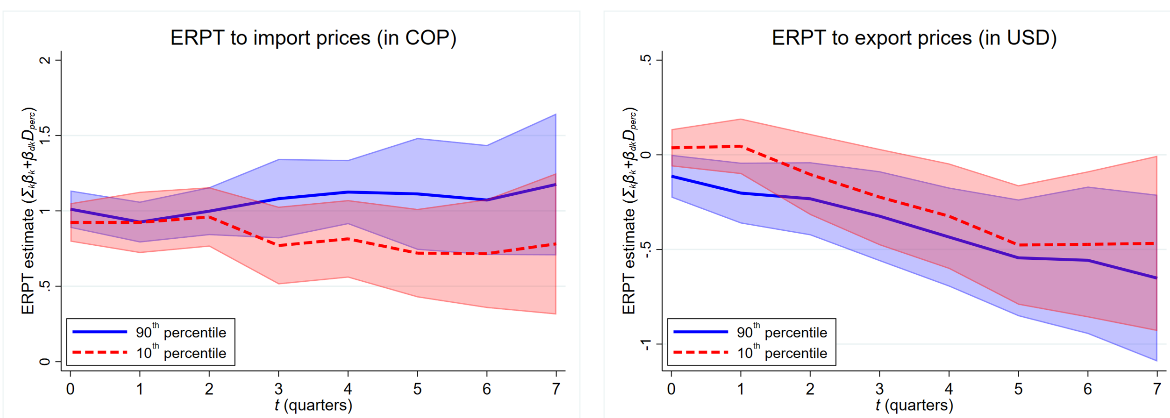
Figure 3: Unconditional exchange rate pass-through (ERPT): Dynamic response



(a) Import prices (b) Export prices

Figures 3a and 3b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (6). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm level in specification (3). The sample ranges from 2010q1-2022q4.

Figure 4: Elasticity of ERPT to FCD: Implied dynamic response



(a) Import prices (b) Export prices

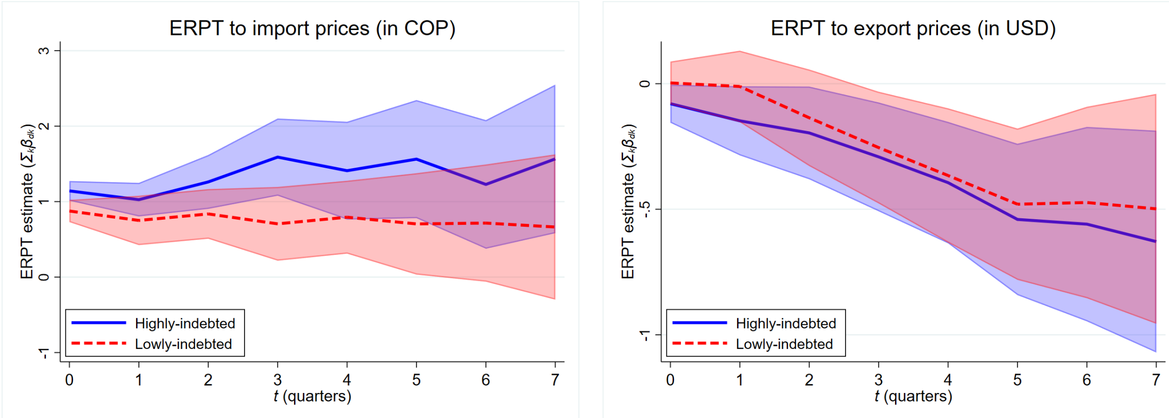
Figures 4a and 4b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (7). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Blue solid (red dashed) curves consider the 90$^{\text{th}}$ (10$^{\text{th}}$) percentile in the empirical distribution of the hyperbolic sine transformation of the corporate FCD over exports. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (4), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table 4
Elasticity of ERPT to FCD: Regression results

	Horizon (quarters)		Actual data	Baseline calibration	No variable markups ($\xi = 0$)	No credit constraints (κ large)
$N = 333,572$ $R^2 = 0.020$			**Import prices**			
$\Delta e_\$$	Four	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	0.55	0.75	1.00	0.73
			(0.22)			
	Eight	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$	0.51	0.70	1.00	0.68
			(0.33)			
$\Delta e_\$ \times d_\mathcal{I}$	Four	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	0.04	0.01	0.00	0.00
			(0.02)			
	Eight	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$	0.05	0.02	0.00	0.00
			(0.02)			
$N = 143,521$ $R^2 = 0.003$			**Export prices**			
$\Delta e_\$$	Four	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	-0.22	-0.04	-0.06	-0.05
			(0.16)			
	Eight	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$	-0.46	-0.05	-0.09	-0.06
			(0.28)			
$\Delta e_\$ \times d_i$	Four	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	-0.02	0.01	0.01	0.00
			(0.03)			
	Eight	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$	-0.03	0.01	0.01	0.00
			(0.02)			

Table 4 presents regression results from specification (4) for import and export prices between 2010q1-2022q4, along with analogous regression results using model-generated data. Import (export) prices are invoiced in Colombian pesos (US dollars). The third column shows the estimates using actual data at the horizons of four and eight quarters, and the fourth to sixth columns present analogous regression results using 10,000 observations of model-generated data. The simulated data originate from Monte Carlo simulations, which assume the economy is subject to productivity and foreign interest rate shocks. The fourth column shows regression results considering the baseline calibration in Table 6. The fifth column shows counterfactual results precluding price complementarities ($\xi = 0$). Finally, the last column presents counterfactual results precluding collateral constraints by setting κ consistent with the natural borrowing limit on debt.

Figure 5: ERPT across highly and lowly-indebted groups: Dynamic response



(a) Import prices

(b) Export prices

Figures 5a and 5b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (8). Import (export) prices are in Colombian pesos (US dollars). ERPT responses are depicted across highly and lowly-indebted groups. The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (5), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table 5

ERPT across highly and lowly-indebted groups: Regression results

$N = 128,663$, $R^2 = 0.022$		**Import prices**	
	Highly-indebted	Lowly-indebted	Test
	$\Sigma_{\ell=0}^{7}\hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7}(\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	1.59	0.71	0.88
	(0.31)	(0.30)	(0.11)
Eight quarters ($t = 7$)	1.57	0.66	0.90
	(0.60)	(0.59)	(0.15)
$N = 143,516$, $R^2 = 0.023$		**Export prices**	
Four quarters ($t = 3$)	-0.29	-0.26	-0.04
	(0.13)	(0.14)	(0.08)
Eight quarters ($t = 7$)	-0.63	-0.50	-0.13
	(0.27)	(0.28)	(0.08)

Table 5 shows the cumulative ERPT estimates from Figures 5a and 5b at the horizons of four ($t = 3$) and eight ($t = 7$) quarters across highly and lowly-indebted groups. The sample ranges from 2010q1-2022q4. The fourth column tests the difference between coefficients across groups. Standard errors are clustered at the firm level.

Table 6
Calibration table

Households & firms		
Discount factor	β	0.99
Coefficient of relative risk aversion	σ	5
Weight of H in Y	γ_H	0.85
Elasticity of substitution btw varieties	θ	2
Superelasticity	ξ	4
Rotemberg price adj. cost	ψ	72
Debt-elastic interest rate parameter	ω	0.005
Fraction of financed working capital	ϕ	0.85
Steady state real foreign bond-holdings	$\bar{b}$	-0.12
Monetary policy	ϕ_π	1.5
Persistence of exogenous shocks		
Shock to F interest rate R^*	ρ^{r^*}	0.3
Standard deviation	σ^{r^*}	0.053
Shock to H productivity	ρ^a	0.9
Standard deviation	σ^a	0.021

The calibration of most parameters mostly follows standard values adopted in the literature, while others match a few moments of Colombia's economy between 2010-2022. The elasticity of substitution between varieties and the superelasticity follow Gopinath et al. (2020) and Gopinath and Itskhoki (2010), respectively. γ_H is set to match the observed average Colombian export-to-GDP ratio of 16%. The steady-state real foreign bond-holdings matches the international debt to quarterly GDP ratio in Colombia of 14%. The standard deviations of foreign interest rate and productivity shocks are set to match the standard deviation of the COP/USD bilateral exchange rate (std($\Delta\epsilon_t$) = 5.0%) and private consumption in Colombia (std(Δc_t) = 0.6%), respectively. The fraction of financed working capital matches an average credit from banks to the private nonfinancial sector as a percent of GDP of 43% in Colombia. Other parameters follow standard values adopted in the literature.

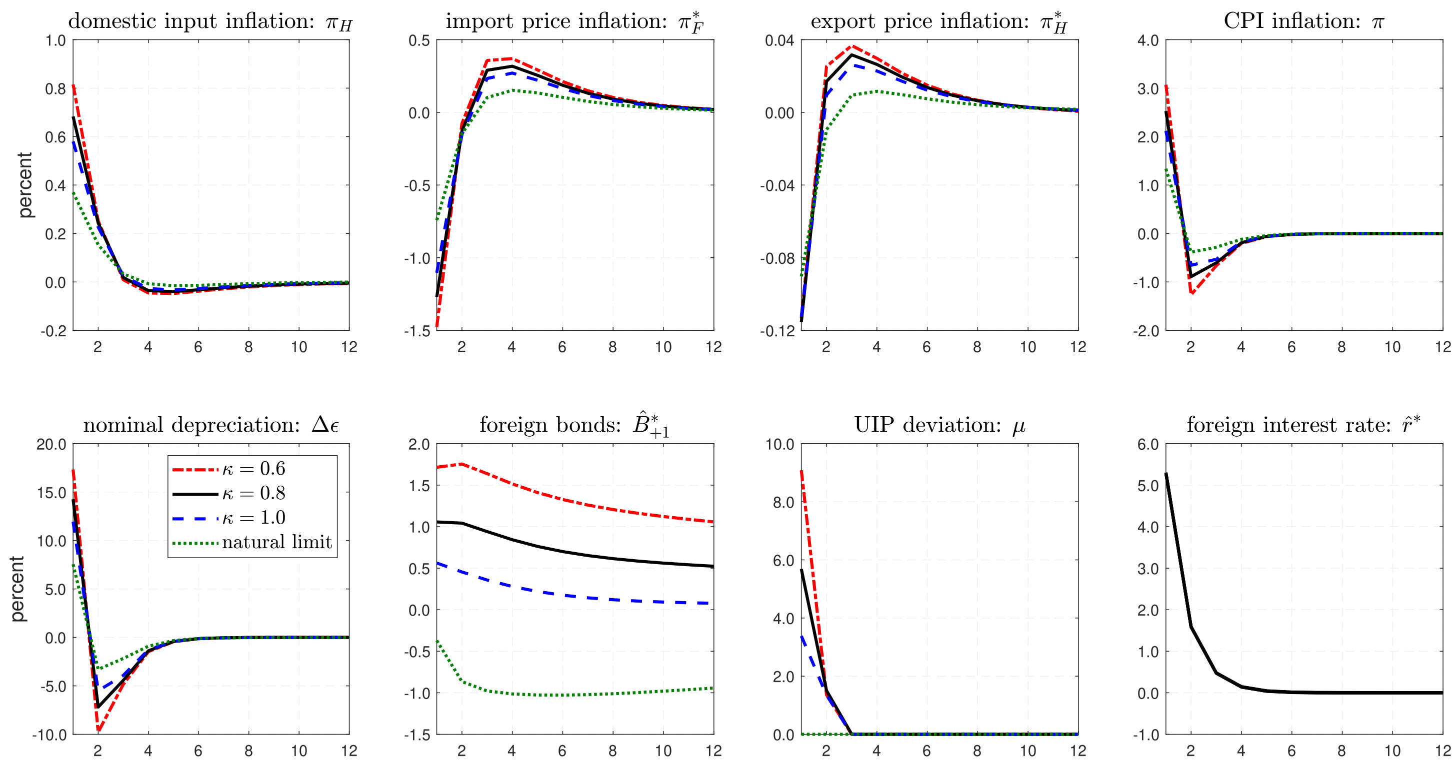
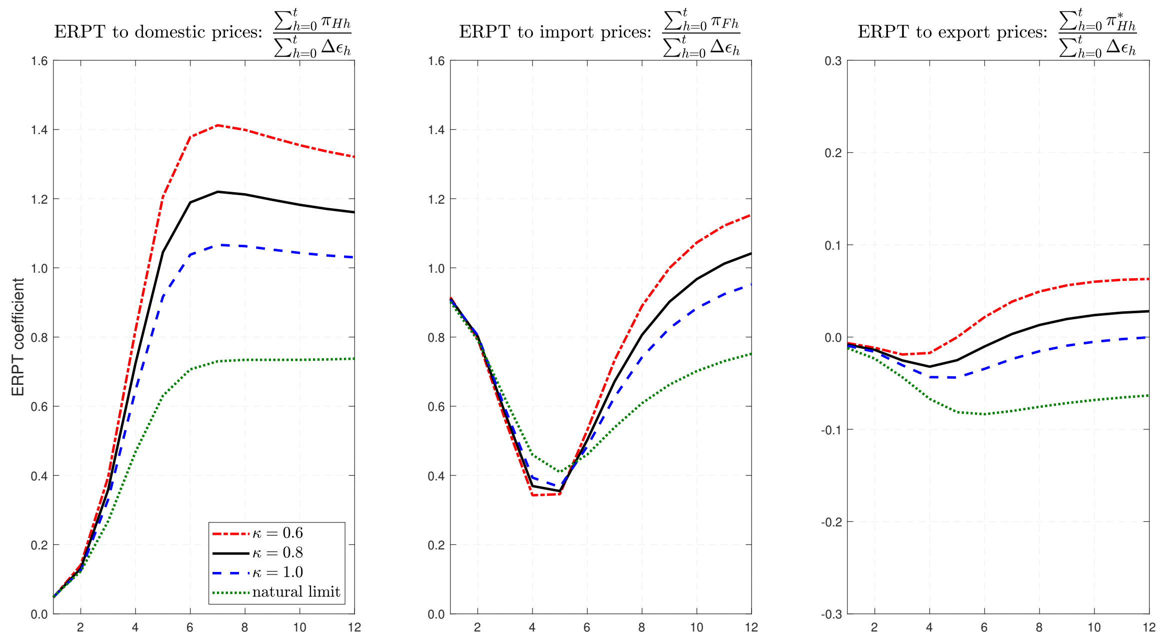
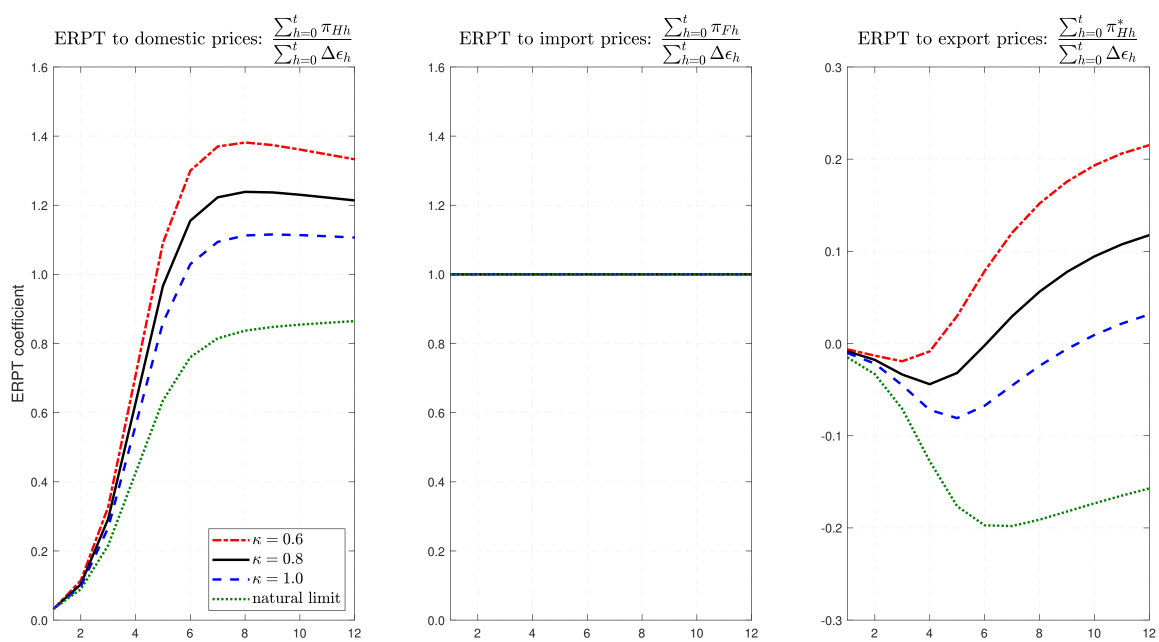


Figure 6: This figure shows the general equilibrium quarterly impulse response functions of the main endogenous variables in the model to an exogenous one standard deviation increase in the logarithm of the foreign interest rate, r^*_t, under the baseline calibration in Table 6. Curves in each panel portray the responses of the same variable for differing degrees of credit constraints, measured by the parameter κ. The dashed green line represents the natural borrowing limit, where κ is so large that the collateral constraint is never binding. Hatted-variables denote deviations from the steady state, where $\hat{r}^*_t \equiv \log(R^*_t) - \log(R^*)$ and $\hat{B}^*_{t+1} \equiv B^*_{t+1}/P^*_t - \bar{b}$.

Figure 7: Cumulative ERPT for varying degrees of credit constraints, κ



(a) Baseline calibration allowing for price complementarities ($\xi > 0$)



(b) Calibration shutting down price complementarities ($\xi = 0$)

Figures 7a and 7b portray the general equilibrium cumulative ERPT to domestic sale, import, and export prices under varying credit constraints characterized by the parameter κ. The shock is a one standard deviation transitory increase in the logarithm of the foreign interest rate, r_t^*. The time-frequency is quarterly. The model-based ERPT is the general equilibrium comovement between the cumulative change in a particular price and the cumulative nominal exchange rate depreciation. The ERPT responses in panel (7a) stem from the impulse responses of prices and exchange rate in figure 6. Panel (7b) presents a counterfactual simulation precluding pricing complementarities ($\xi = 0$).

Appendix A Data appendix

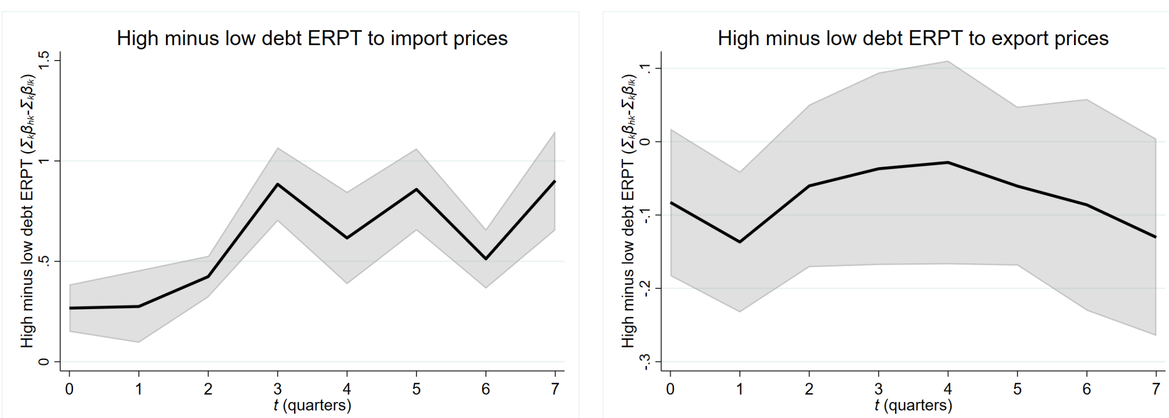
A.1 Summary statistics

Table A1
Summary statistics of dependent variables and covariates

	(2)	(3)	(4)	(5)	(6)	(7)
	Unit values		**FCD over exports**		**COP/USD**	**PPI**
	Imports (COP)	Exports (USD)	Firm-level	Industry-level	**exchange rate**	
	$\Delta p_{ijk,t}$		$d_{i,t}$	$d_{\mathcal{I},t}$	$\Delta e_t^{\$}$	Δppi_t
N	975,479	681,191	2,017,529	4,148,502	2,117,490	2,117,490
avg.	0.022	0.005	3.175	7.960	0.019	0.015
median	0.017	0.000	2.801	8.104	0.009	0.010
std	0.386	0.412	2.465	2.549	0.050	0.029
min	-6.890	-8.961	0.000	0.000	-0.086	-0.039
max	8.434	8.798	24.658	15.189	0.164	0.132

Table A1 presents summary statistics of the dependent variables and covariates used in specifications (3) and (4). We use the logarithmic changes of either export or import unit values (columns two and three) as the dependent variable. Import (export) unit values are in Colombian pesos (US dollars). Columns four and five display the summary statistics of the hyperbolic sine transformation of the corporate FCD to exports ratio at the firm and industry levels, respectively. Columns six and seven show summary statistics of the logarithmic changes in the bilateral exchange rate between the Colombian peso and the US dollar (COP/USD) and the aggregate level producer price index (PPI), respectively.

Figure A1: ERPT across highly and lowly-indebted groups: Test of coefficients



(a) Import prices

(b) Export prices

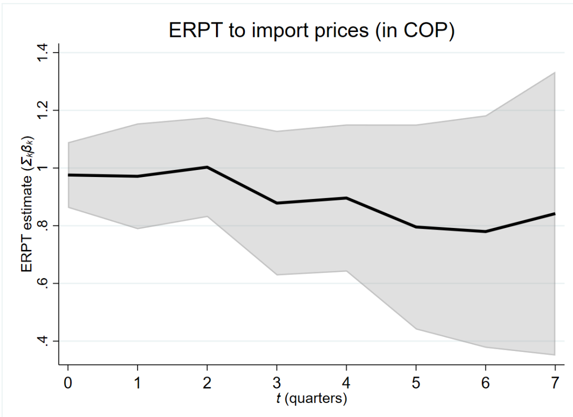
Figures A1a and A1b portray the difference between ERPT coefficients across highly and lowly-indebted groups: $\Sigma_{\ell=0}^{t}\hat{\beta}_{h\ell} - \Sigma_{\ell=0}^{t}\hat{\beta}_{l\ell}$, for $t = 0, 1, ..., 7$. Estimates result from specification (5), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm level.

A.2 Robustness checks

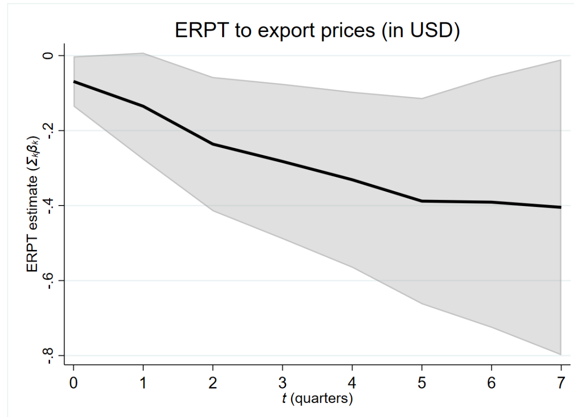
A.2.1 Results using alternative cutoffs for unit values

a) Discarding unit values with a standard deviation above the 90th decile

Figure A2: Unconditional ERPT: Dynamic response



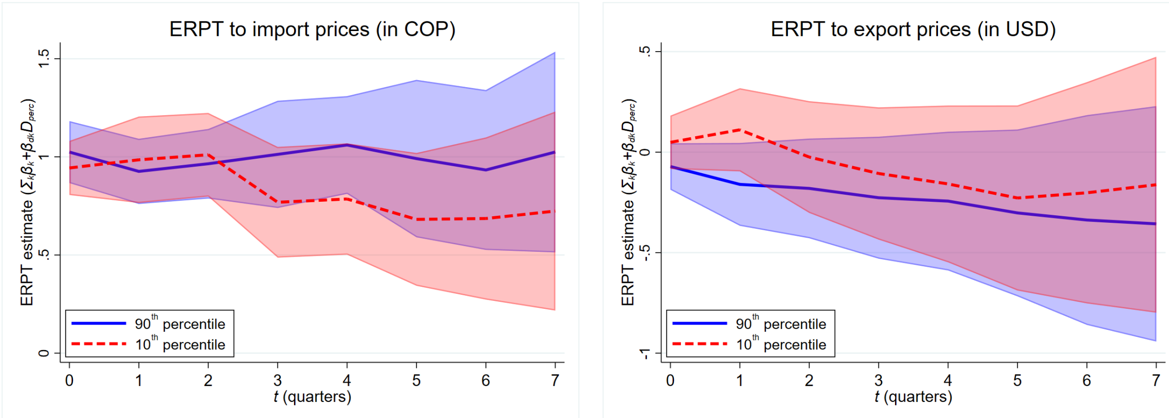
(a) Import prices



(b) Export prices

Figures A2a and A2b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (6). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm level in specification (3). The sample ranges from 2010q1-2022q4.

Figure A3: Elasticity of ERPT to FCD: Implied dynamic response



(a) Import prices

(b) Export prices

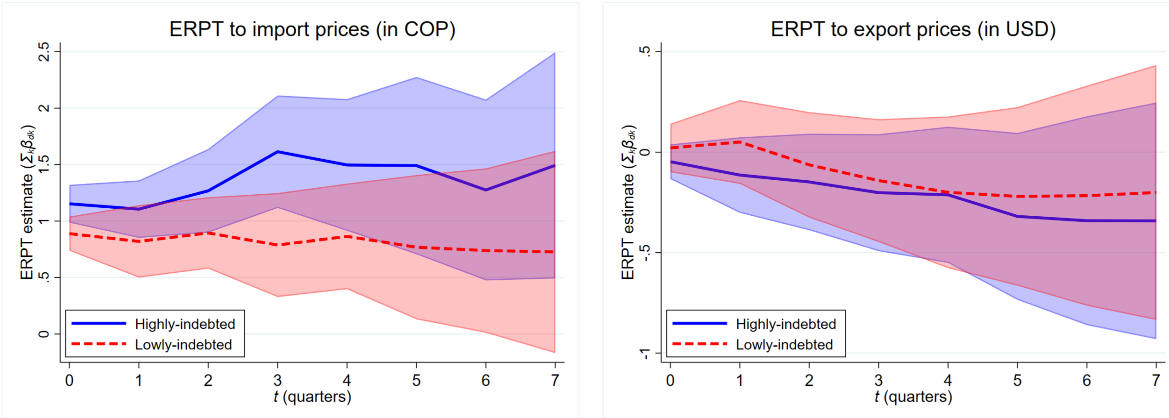
Figures A3a and A3b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (7). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Blue solid (red dashed) curves consider the 90$^{\text{th}}$ (10$^{\text{th}}$) percentile in the empirical distribution of the hyperbolic sine transformation of the corporate FCD over exports. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (4), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A2
Elasticity of ERPT to FCD: Regression results

$N = 384,965, R^2 = 0.012$		**Import prices**		
	Four quarters	Eight quarters	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	0.60	0.52		
	(0.24)	(0.36)		
$\Delta e_{\$} \times d_{\mathcal{I}}$			0.03	0.04
			(0.02)	(0.02)
$N = 152,165, R^2 = 0.002$		**Export prices**		
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	-0.10	-0.16		
	(0.20)	(0.39)		
$\Delta e_{\$} \times d_{i}$			-0.02	-0.03
			(0.03)	(0.02)

Table A2 presents regression results from specification (4) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). The second and third columns display the estimates of the unconditional cumulative ERPT coefficients. The fourth and fifth columns show the cumulative estimates associated with the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

Figure A4: ERPT across highly and lowly-indebted groups: Dynamic response



(a) Import prices (b) Export prices

Figures A4a and A4b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (8). Import (export) prices are in Colombian pesos (US dollars). ERPT responses are depicted across highly and lowly-indebted groups. The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (5), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A3

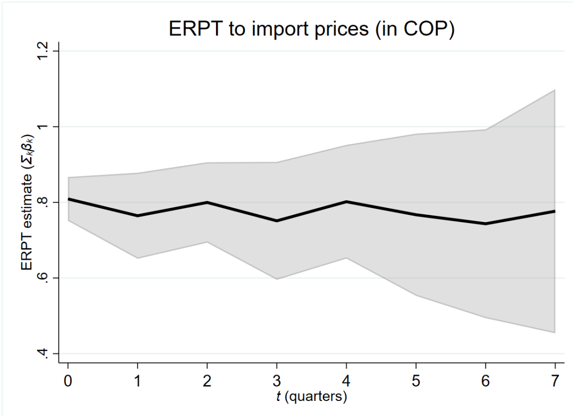
ERPT across highly and lowly-indebted groups: Regression results

$N = 147,975$, $R^2 = 0.013$	**Import prices** ($s = \mathcal{I}$)		
	Highly-indebted	Lowly-indebted	Test
	$\Sigma_{\ell=0}^{7} \hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7} (\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	1.61	0.79	0.83
	(0.30)	(0.28)	(0.16)
Eight quarters ($t = 7$)	1.49	0.73	0.77
	(0.61)	(0.55)	(0.28)
$N = 152,161$, $R^2 = 0.017$	**Export prices** ($s = i$)		
	$\Sigma_{\ell=0}^{7} \hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7} (\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	-0.20	-0.14	-0.06
	(0.18)	(0.19)	(0.09)
Eight quarters ($t = 7$)	-0.34	-0.20	-0.14
	(0.36)	(0.39)	(0.09)

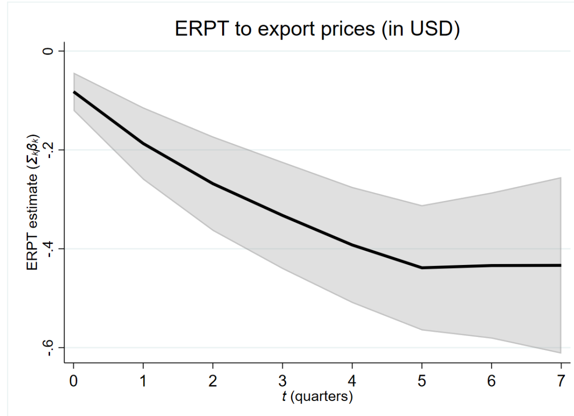
The table A3 shows the cumulative ERPT estimates from Figures A4a and A4b at the horizons of four ($t = 3$) and eight ($t = 7$) quarters across highly and lowly-indebted groups. The sample ranges from 2010q1-2022q4. The fourth column tests the difference between coefficients across highly and lowly-indebted groups. Standard errors are clustered at the firm level.

b) Discarding unit values with quarterly log-change greater than 100%

Figure A5: Unconditional ERPT: Dynamic response



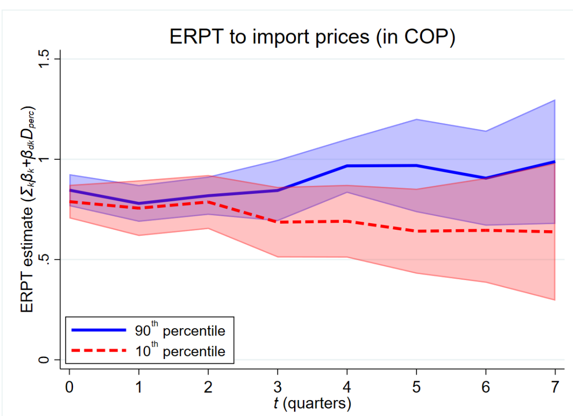
(a) Import prices



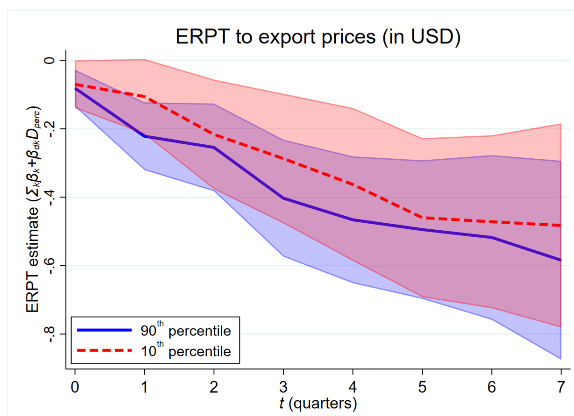
(b) Export prices

Figures A5a and A5b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (6). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm level in specification (3). The sample ranges from 2010q1-2022q4.

Figure A6: Elasticity of ERPT to FCD: Implied dynamic response



(a) Import prices



(b) Export prices

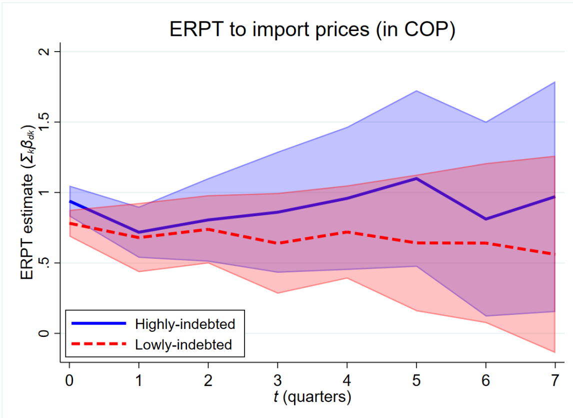
Figures A6a and A6b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (7). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Blue solid (red dashed) curves consider the 90^{th} (10^{th}) percentile in the empirical distribution of the hyperbolic sine transformation of the corporate FCD over exports. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (4), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A4
Elasticity of ERPT to FCD: Regression results

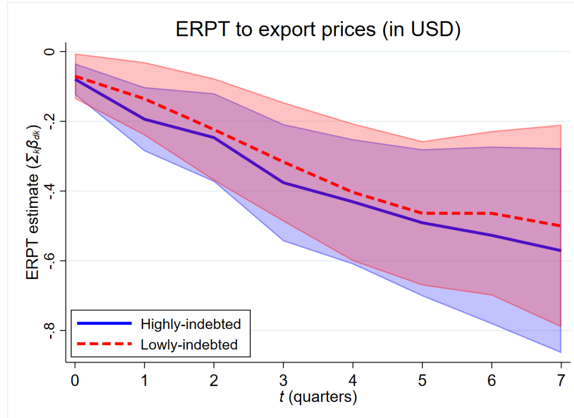
$N = 362, 540, R^2 = 0.034$		**Import prices**		
	Four quarters	Eight quarters	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	0.58	0.40		
	(0.14)	(0.25)		
$\Delta e_{\$} \times d_{\mathcal{I}}$			0.02	0.05
			(0.01)	(0.01)
$N = 145, 275, R^2 = 0.050$		**Export prices**		
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	-0.28	-0.48		
	(0.12)	(0.18)		
$\Delta e_{\$} \times d_{i}$			-0.02	-0.02
			(0.02)	(0.02)

Table A4 presents regression results from specification (4) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). The second and third columns display the estimates of the unconditional cumulative ERPT coefficients. The fourth and fifth columns show the cumulative estimates associated with the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

Figure A7: ERPT across highly and lowly-indebted groups: Dynamic response



(a) Import prices



(b) Export prices

Figures A7a and A7b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (8). Import (export) prices are in Colombian pesos (US dollars). ERPT responses are depicted across highly and lowly-indebted groups. The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (5), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A5

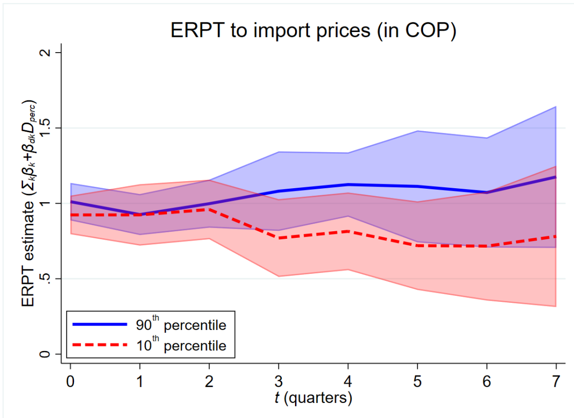
ERPT across highly and lowly-indebted groups: Regression results

$N = 139,309$, $R^2 = 0.035$	**Import prices** ($s = \mathcal{I}$)		
	Highly-indebted	Lowly-indebted	Test
	$\Sigma_{\ell=0}^{7} \hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7} (\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	0.86	0.64	0.22
	(0.26)	(0.22)	(0.10)
Eight quarters ($t = 7$)	0.97	0.56	0.41
	(0.50)	(0.59)	(0.15)
$N = 145,275$, $R^2 = 0.050$	**Export prices** ($s = i$)		
	$\Sigma_{\ell=0}^{7} \hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7} (\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	-0.38	-0.32	-0.06
	(0.10)	(0.10)	(0.06)
Eight quarters ($t = 7$)	-0.57	-0.50	-0.07
	(0.18)	(0.18)	(0.07)

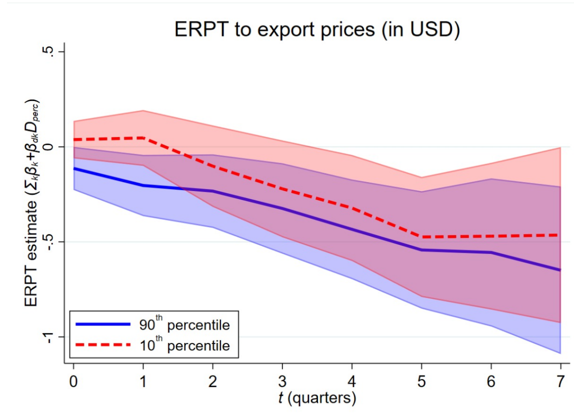
Table A5 shows the cumulative ERPT estimates from Figures A7a and A7b at the horizons of four ($t = 3$) and eight ($t = 7$) quarters across highly and lowly-indebted groups. The sample ranges from 2010q1-2022q4. The fourth column tests the difference between coefficients across highly and lowly-indebted groups. Standard errors are clustered at the firm level.

A.2.2 Results after discarding FCD to exports ratio outliers

Figure A8: Elasticity of ERPT to FCD: Implied dynamic response



(a) Import prices



(b) Export prices

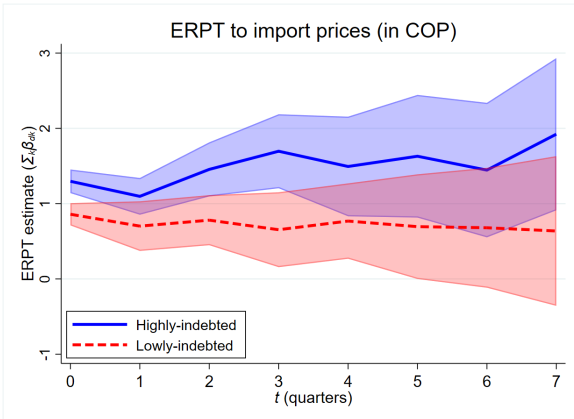
Figures A8a and A8b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (7). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Blue solid (red dashed) curves consider the 90$^{\text{th}}$ (10$^{\text{th}}$) percentile in the empirical distribution of the hyperbolic sine transformation of the corporate FCD over exports. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (4), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A6
Elasticity of ERPT to FCD: Regression results

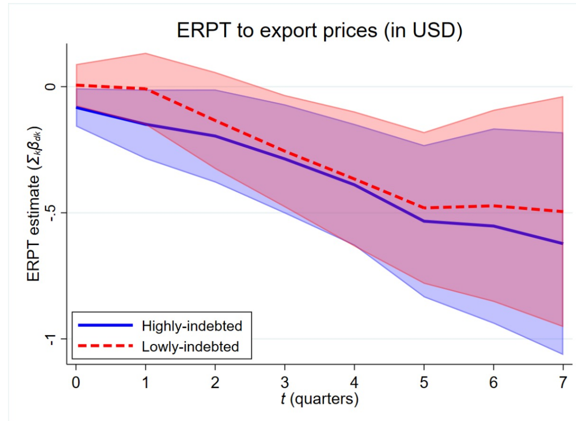
$N = 333,599, R^2 = 0.020$	**Import prices**			
	Four quarters	Eight quarters	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	0.55	0.51		
	(0.22)	(0.33)		
$\Delta e_{\$} \times d_{\mathcal{I}}$			0.04	0.05
			(0.02)	(0.02)
$N = 143,499, R^2 = 0.003$	**Export prices**			
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	-0.22	-0.46		
	(0.16)	(0.28)		
$\Delta e_{\$} \times d_i$			-0.02	-0.03
			(0.03)	(0.02)

Table A6 presents regression results from specification (4) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). The second and third columns display the estimates of the unconditional cumulative ERPT coefficients. The fourth and fifth columns show the cumulative estimates associated with the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

Figure A9: ERPT across highly and lowly-indebted groups: Dynamic response



(a) Import prices



(b) Export prices

Figures A9a and A9b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (8). Import (export) prices are in Colombian pesos (US dollars). ERPT responses are depicted across highly and lowly-indebted groups. The horizon spans from the initial impact ($t = 0$) to eight quarters ($t = 7$). Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (5), where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A7
ERPT across highly and lowly-indebted groups: Regression results

$N = 124,395$, $R^2 = 0.023$	**Import prices** ($s = \mathcal{I}$)		
	Highly-indebted	Lowly-indebted	Test
	$\Sigma_{\ell=0}^{7}\hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7}(\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	1.70	0.65	1.04
	(0.30)	(0.30)	(0.16)
Eight quarters ($t = 7$)	1.92	0.64	1.29
	(0.62)	(0.61)	(0.22)
$N = 143,499$, $R^2 = 0.003$	**Export prices** ($s = i$)		
	$\Sigma_{\ell=0}^{7}\hat{\beta}_{h\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{l\ell}$	$\Sigma_{\ell=0}^{7}(\hat{\beta}_{h\ell} - \hat{\beta}_{l\ell})$
Four quarters ($t = 3$)	-0.29	-0.26	-0.03
	(0.13)	(0.14)	(0.08)
Eight quarters ($t = 7$)	-0.62	-0.50	-0.13
	(0.27)	(0.28)	(0.08)

Table A7 shows the cumulative ERPT estimates from Figures A9a and A9b at the horizons of four ($t = 3$) and eight ($t = 7$) quarters across highly and lowly-indebted groups. The sample ranges from 2010q1-2022q4. The fourth column tests the difference between coefficients across highly and lowly-indebted groups. Standard errors are clustered at the firm level.

A.2.3 Controlling for market share

We modify equation (4) to control for market share by including an additional interaction between the logarithmic change in the exchange rate ($\Delta e_t^{\$}$), the FCD to exports ratio ($d_{s,t-1}$), and firm i's market share for product j over the whole sample (ms_{ij}), as described in the equation below:

$$\Delta p_{ijk,t} = \alpha_{\mathcal{I}} + \alpha_{\mathcal{T}} + \alpha_k + \sum_{\ell=0}^{7} \beta_\ell \Delta e_{t-\ell}^{\$} + \sum_{\ell=0}^{7} \beta_{d\ell} \Delta e_{t-\ell}^{\$} \times d_{s,t-1-\ell} + \sum_{\ell=0}^{7} \beta_{m\ell} \Delta e_{t-\ell}^{\$} \times d_{s,t-1-\ell} \times ms_{ij} + \epsilon_{ijk,t}, \tag{A.1}$$

where we set $s = i$ for exports and $s = \mathcal{I}$ for imports, and $\epsilon_{ijk,t}$ stands for the error term.

Consistent with the prior definition, the ERPT is:

$$\sum_{\ell=0}^{t} \beta_\ell + d_{s,\text{perc}}(\beta_{d\ell} + \beta_{m\ell} ms_{\text{perc}}), t = 0, \ldots, 7, \tag{A.2}$$

for arbitrary percentiles $d_{s,\text{perc}}$ and ms_{perc} in the empirical distributions of the hyperbolic sine transformation of the corporate FCD over exports and firm-product market share.

Table A8
Elasticity of ERPT to FCD: Regression results

$N = 333,599, R^2 = 0.020$	**Import prices**	
	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$
$\Delta e_\$$	0.59	0.54
	(0.21)	(0.33)
$\Delta e_\$ \times d_{\mathcal{I}}$	0.04	0.05
	(0.02)	(0.02)
$\Delta e_\$ \times d_{\mathcal{I}} \times ms_i$	-0.04	-0.05
	(0.02)	(0.02)
$N = 143,521, R^2 = 0.003$	**Export prices**	
	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$
$\Delta e_\$$	-0.24	-0.47
	(0.15)	(0.28)
$\Delta e_\$ \times d_i$	-0.04	-0.04
	(0.04)	(0.02)
$\Delta e_\$ \times d_i \times ms_i$	0.06	0.02
	(0.04)	(0.02)

Table A8 presents regression results from specification (A.1) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). In each panel for import and export prices, we show the estimates for the unconditional cumulative ERPT, the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, and the interaction between the aforementioned variables and the firm-product-level market share, where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

A.2.4 Controlling for dollarized origin or destination

Similar to section A.2.3, we modify equation (4) to control for dollarized origins or destinations of imports and exports, respectively. Specifically, we introduce an additional interaction between the logarithmic change in the exchange rate ($\Delta e_t^{\$}$), the FCD to exports ratio ($d_{s,t-1}$), and an indicator variable taking one if the destination or origin country is dollarized:

$$\Delta p_{ijk,t} = \alpha_{\mathcal{I}}+\alpha_{\mathcal{T}}+\alpha_k+\sum_{\ell=0}^{7} \beta_\ell \Delta e_{t-\ell}^{\$}+\sum_{\ell=0}^{7} \beta_{d\ell} \Delta e_{t-\ell}^{\$}\times d_{s,t-1-\ell}+\sum_{\ell=0}^{7} \beta_{\$\ell} \Delta e_{t-\ell}^{\$}\times d_{s,t-1-\ell}\times \mathbb{1}_{\{k\in\mathcal{S}_{\$}\}}+\epsilon_{ijk,t}, \tag{A.3}$$

where, as before, we set $s = i$ for exports and $s = \mathcal{I}$ for imports, and $\epsilon_{ijk,t}$ stands for the error term.

Consistent with section A.2.3, the ERPT is:

$$\sum_{\ell=0}^{t} \beta_\ell + d_{s,\text{perc}}(\beta_{d\ell} + \beta_{\$\ell}\mathbb{1}_{\{k\in\mathcal{S}_{\$}\}}), t = 0, \ldots, 7 \tag{A.4}$$

for some percentile $d_{s,\text{perc}}$ in the empirical distribution of the hyperbolic sine transformation of the corporate FCD to exports ratio.

We follow the approach in Gopinath et al. (2020) and define the set of dollarized countries as $\mathcal{S}_{\$}$ = {East Timor, Ecuador, El Salvador, Federated States of Micronesia, Marshall Islands, Palau, Panama, United States}. Similarly to that paper, we also drop countries with currencies pegged to the US dollar from the sample: are Argentina, Bahrein, Barbados, Belize, Brunei, China, Cuba, Djibouti, Dominica, Fiji, Granada, Hong Kong, Jordania, Macao, Maldives, Namibia, San Cristobal, Santa Lucia, San Vicente, Venezuela, and Zimbabwe.

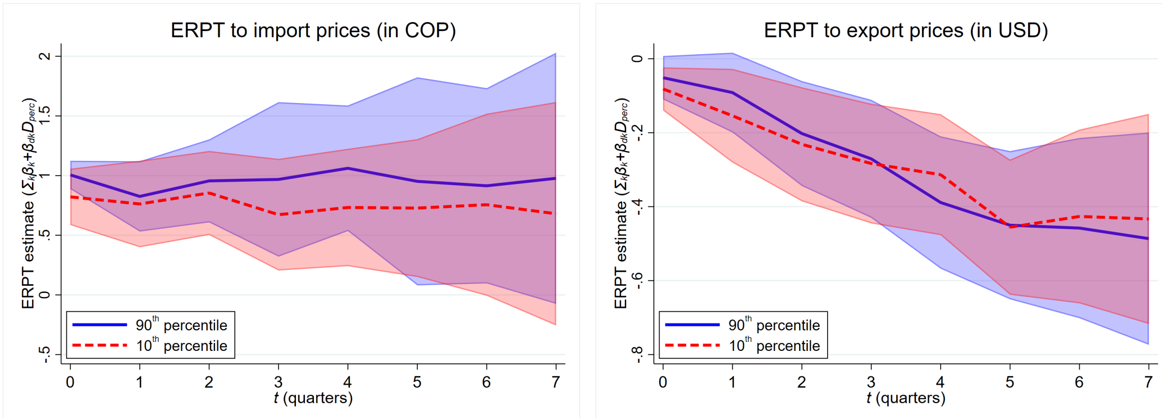
Table A9
Elasticity of ERPT to FCD: Regression results

$N = 266,410, R^2 = 0.020$	**Import prices**	
	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$
$\Delta e_\$$	0.56	0.53
	(0.23)	(0.32)
$\Delta e_\$ \times d_{\mathcal{I}}$	0.04	0.05
	(0.02)	(0.02)
$\Delta e_\$ \times d_{\mathcal{I}} \times \mathbb{1}_{\{k\in\mathcal{S}_\$\}}$	0.00	-0.01
	(0.01)	(0.01)
$N = 135,514, R^2 = 0.003$	**Export prices**	
	$\Sigma_{\ell=0}^{3}\hat{\beta}_\ell$	$\Sigma_{\ell=0}^{7}\hat{\beta}_\ell$
$\Delta e_\$$	-0.22	-0.45
	(0.16)	(0.27)
$\Delta e_\$ \times d_i$	0.00	-0.01
	(0.02)	(0.02)
$\Delta e_\$ \times d_i \times \mathbb{1}_{\{k\in\mathcal{S}_\$\}}$	-0.05	-0.04
	(0.03)	(0.02)

Table A9 presents regression results from specification (A.3) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). In each panel for import and export prices, we show the estimates for the unconditional cumulative ERPT, the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, and the interaction between the aforementioned variables and the firm-product-level market share, where $s = \mathcal{I}$ ($s = i$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

A.2.5 Regression results from flipping financial fragility measure

Figure A10: Elasticity of ERPT to FCD: Implied dynamic response



(a) Import prices (b) Export prices

Figures A10a and A10b portray the dynamic responses of the cumulative ERPT to import and export prices following a one percent depreciation of the Colombian peso against the US dollar, as defined by equation (7). Import (export) prices are in Colombian pesos (US dollars). The horizon spans from the initial impact at $t = 0$ to eight quarters later at $t = 7$. Blue solid (red dashed) curves consider the 90$^{\text{th}}$ (10$^{\text{th}}$) percentile in the empirical distribution of the hyperbolic sine transformation of the corporate FCD over exports. Shaded regions represent 90% confidence intervals associated with standard errors clustered at the firm-level in specification (4), where we flip the aggregation level index, assigning $s = i$ ($s = \mathcal{I}$) for import (export) prices. The sample ranges from 2010q1-2022q4.

Table A10
Elasticity of ERPT to FCD: Regression results

$N = 333,599, R^2 = 0.020$		**Import prices**		
	Four quarters	Eight quarters	Four quarters	Eight quarters
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	0.67	0.68		
	(0.29)	(0.57)		
$\Delta e_{\$} \times d_{\mathcal{I}}$			0.04	0.04
			(0.04)	(0.03)
$N = 143,499, R^2 = 0.003$		**Export prices**		
	$\Sigma_{\ell=0}^{3}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{\ell}$	$\Sigma_{\ell=0}^{3}\hat{\beta}_{d\ell}$	$\Sigma_{\ell=0}^{7}\hat{\beta}_{d\ell}$
$\Delta e_{\$}$	-0.30	-0.38		
	(0.15)	(0.20)		
$\Delta e_{\$} \times d_i$			0.003	-0.01
			(0.016)	(0.015)

Table A10 presents regression results from specification (4) for import and export prices at the horizons of four and eight quarters. Import (export) prices are in Colombian pesos (US dollars). The second and third columns display the estimates of the unconditional cumulative ERPT coefficients. The fourth and fifth columns show the cumulative estimates associated with the interaction between the logarithmic change in the exchange rate and the hyperbolic sine transformation of the corporate FCD over exports, where we flip the aggregation level index, assigning $s = i$ ($s = \mathcal{I}$) for import (export) prices. The sample ranges from 2010q1-2022q4. Standard errors are clustered at the firm level.

Appendix B Model appendix

B.1 Pricing equations

By substituting residual and total labor demand equations into entrepreneur i's profit, the first-order conditions with respect to P_{iHt} and P^*_{iHt} are as follows:

$$
\begin{aligned}
[P_{iHt}] : \gamma_H \upsilon\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right) Y_t + P_{iHt}\gamma_H \upsilon'\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right)\left(\mathcal{D}_t \frac{Y_t}{P_t}\right) - \ldots \\
- \frac{\psi}{2}\left(\frac{P_{iHt}}{P_{iHt-1}} - 1\right)\left(\frac{W_t}{A_t P_{iHt-1}}\right)\left[\gamma_H \upsilon\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right) Y_t + \gamma^*_H \upsilon\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right)\right] - \ldots \\
- \left[1 + \phi(R^*_t - 1) + \frac{\psi}{4}\left(\frac{P_{iHt}}{P_{iHt-1}} - 1\right)^2 + \frac{\psi}{4}\left(\frac{P^*_{iHt}}{P^*_{iHt-1}} - 1\right)^2\right]\left(\frac{W_t}{A_t}\right)\gamma_H \upsilon'\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right)\left(\mathcal{D}_t \frac{Y_t}{P_t}\right) - \ldots \\
- \mu_t \phi R^*_t \left(\frac{W_t}{A_t}\right)\gamma_H \upsilon'\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right)\left(\mathcal{D}_t \frac{Y_t}{P_t}\right) + \ldots \\
+\frac{\psi}{2}\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{P_{iHt+1}}{P_{iHt}} - 1\right)\left(\frac{P_{iHt+1}}{P^2_{iHt}}\right)\left(\frac{W_{t+1}}{A_{t+1}}\right)\left[\gamma_H \upsilon\left(\mathcal{D}_{t+1}\frac{P_{iHt+1}}{P_{t+1}}\right) Y_{t+1} + \gamma^*_H \upsilon\left(\mathcal{D}^*_{t+1}\frac{P^*_{iHt+1}}{P^*_{t+1}}\right) Y^*_{t+1}\right]\right\} = 0,
\end{aligned}
\tag{B.5}
$$

$$
\begin{aligned}
[P^*_{iHt}] : \mathcal{E}_t \gamma^*_H \upsilon\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right) Y^*_t + \mathcal{E}_t P^*_{iHt}\gamma^*_H \upsilon'\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right)\left(\mathcal{D}^*_t \frac{Y^*_t}{P^*_t}\right) - \\
- \frac{\psi}{4}\left(\frac{P^*_{iHt}}{P^*_{iHt-1}} - 1\right)\left(\frac{W_t}{A_t P^*_{iHt-1}}\right)\left[\gamma_H \upsilon\left(\mathcal{D}_t \frac{P_{iHt}}{P_t}\right) Y_t + \gamma^*_H \upsilon\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right)\right] - \\
- \left[1 + \phi(R^*_t - 1) + \frac{\psi}{4}\left(\frac{P_{iHt}}{P_{iHt-1}} - 1\right)^2 + \frac{\psi}{4}\left(\frac{P^*_{iHt}}{P^*_{iHt-1}} - 1\right)^2\right]\left(\frac{W_t}{A_t}\right)\gamma^*_H \upsilon'\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right)\left(\mathcal{D}^*_t \frac{Y^*_t}{P^*_t}\right) - \\
- \mu_t \phi R^*_t \left(\frac{W_t}{A_t}\right)\gamma^*_H \upsilon'\left(\mathcal{D}^*_t \frac{P^*_{iHt}}{P^*_t}\right)\left(\mathcal{D}^*_t \frac{Y^*_t}{P^*_t}\right) + \\
+\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\frac{\psi}{2}\left(\frac{P^*_{iHt+1}}{P^*_{iHt}} - 1\right)\left(\frac{P^*_{iHt+1}}{(P^*_{iHt})^2}\right)\left(\frac{W_{t+1}}{A_{t+1}}\right)\left[\gamma_H \upsilon\left(\mathcal{D}_{t+1}\frac{P_{iHt+1}}{P_{t+1}}\right) Y_{t+1} + \gamma^*_H \upsilon\left(\mathcal{D}^*_{t+1}\frac{P^*_{iHt+1}}{P^*_{t+1}}\right) Y^*_{t+1}\right]\right\} = 0,
\end{aligned}
\tag{B.6}
$$

for an arbitrary function $\Upsilon(.)$ satisfying the properties of the Kimball (1995) aggregator, with $\upsilon \equiv (\Upsilon')^{-1}$. In particular, we assume the Klenow and Willis (2016) specification for $\Upsilon(.)$.

B.1.1 Relative prices equations under flexible prices

By setting $\psi = 0$ in equation (18) gives:

$$1-\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}}+\left[1+\phi\left(R_t^*\left(1+\mu_t\right)-1\right)\right]\frac{W_t}{P_{Ht}A_t}\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}}=0 \iff$$

$$\left(1-\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{\frac{\xi}{\theta}}\right)\frac{P_{Ht}}{P_t}=\left[1+\phi\left(R_t^*\left(1+\mu_t\right)-1\right)\right]\frac{W_t}{P_t A_t}. \tag{B.7}$$

Log-linearizing equation (B.7) yields:

$$1-\frac{1}{\theta}-\frac{\xi}{\theta^2}(\hat{\imath}_{Ht}-\hat{y}_t)+\left(1-\frac{1}{\theta}\right)(p_{Ht}-p_t)=\frac{W}{P}\left[1+\phi(R^*-1)\right]+\frac{W}{P}\left[1+\phi(R^*-1)\right](\widehat{w_t-p_t}-a_t)+\phi R^*\frac{W}{P}\left(\hat{r}_t+\mu_t\right),$$

where we used the steady state equations $I_H = \gamma_H Y$, $P_H = P$, and the normalization $A = 1$. Given $\frac{W}{P}[1+\phi(R-1)] = \frac{\theta-1}{\theta}$ and the approximation $\hat{\imath}_{Ht} - \hat{y}_t = -\theta(p_{Ht} - p_t)$, we can simplify the above equation further:

$$(p_{Ht}-p_t)(\xi+\theta-1)=(\theta-1)(\widehat{w_t-p_t}-a_t)+(\theta-1)\frac{\phi R^*}{1+\phi(R^*-1)}\left(\hat{r}_t^*+\mu_t\right) \iff$$

$$p_{Ht}-p_t=\left(\frac{\theta-1}{\theta-1+\xi}\right)\left(\frac{\phi R}{1+\phi(R-1)}\right)\left(\hat{r}_t^*+\mu_t\right)+\left(\frac{\theta-1}{\theta-1+\xi}\right)(\widehat{w_t-p_t}-a_t). \tag{B.8}$$

Finally, given that, aside from financial frictions, the foreign firms' problem is symmetric, the first-order condition with respect to P_{Ft}^* for the profit maximization problem is:

$$1-\theta\left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}}+\left[1+\phi\left(R_t^*-1\right)\right]MC_{Ft}^*\theta\left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}}=0, \tag{B.9}$$

where $MC_{Ft}^* \equiv \frac{W_t^*}{P_{Ft}^*}$. Since we can approximate

$$\theta\left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}} \approx \theta\left(1-\frac{\xi}{\theta}(\hat{\imath}_{Ft}-\hat{y}_t)\right) = \theta(1+\xi(\epsilon_t+p_{Ft}^*-p_t^*))=\theta(1+\xi(q_t+p_{Ft}^*-p_t^*)),$$

the resulting linearized equation is:

$$p_{Ft}^*-p_t^*=\left(\frac{\theta-1}{\theta-1+\xi}\right)\widehat{w_t^*-p_t^*}-\left(\frac{\xi}{\theta-1+\xi}\right)q_t, \tag{B.10}$$

where $q_t = \epsilon_t + p_t^* - p_t$.

B.1.2 Phillips curves augmented for balance-sheet effects

Using the first-order approximation $\pi_{Ht}^2 \approx 0$ in the optimal pricing decision simplifies equation (18) further to:

$$1-\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}}-\frac{\psi}{2}\pi_{Ht}MC_{Ht}\left(1+\frac{I_{Ht}^*}{I_{Ht}}\right)+\left[1+\phi\left(R_t^*\left(1+\mu_t\right)-1\right)\right]MC_{Ht}\theta\left(\frac{I_{Ht}}{\gamma_H Y_t}\right)^{-\frac{\xi}{\theta}}+\ldots$$
$$+\frac{\psi}{2}\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\pi_{Ht+1}MC_{Ht+1}\left(\frac{I_{Ht+1}}{I_{Ht}}+\frac{I_{Ht+1}^*}{I_{Ht}}\right)\right\}=0 \quad \text{(B.11)}$$

Moreover, first-order approximations around the nonstochastic steady state yield $MC_t \approx MC(1+\hat{mc}_{Ht})$, $\theta(I_{Ht}/Y_t) \approx \theta\left(1-\frac{\xi}{\theta}\left(\hat{\imath}_{Ht}-\hat{y}_t\right)\right)=\theta\big(1+\xi(p_{Ht}-p_t)\big)$. Assuming that the collateral constraint binds implies:

$$\begin{aligned}\mu_t &= 1-\mathbb{E}_t\left[R_t^*\frac{\lambda_{t+1}}{\lambda_t}\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right]\\ &\approx 1-R^*\beta\mathbb{E}_t\left[(1+\hat{r}_t)(1-\pi_{t+1}-\Delta\hat{c}_{t+1})(1+\Delta\epsilon_{t+1})\right]\\ &\approx 1-R^*\beta\mathbb{E}_t\left[1+\hat{r}_t-\pi_{t+1}-\Delta\hat{c}_{t+1}+\Delta\epsilon_{t+1}\right],\\ &\approx \mathbb{E}_t\left[\pi_{t+1}+\Delta\hat{c}_{t+1}-\hat{r}_t-\Delta\epsilon_{t+1}\right]>0\end{aligned} \quad \text{(B.12)}$$

where we use $\beta R^*=1$ in the last equation, and $\Delta\epsilon_t \equiv \log(\mathcal{E}_t)-\log(\mathcal{E}_{t-1})$.

Thus, using the first-order approximations above in the log-linearized equation (B.11) gives:

$$1-\psi\pi_{Ht}MC_H-\ldots$$
$$\left\{1-\left[1+\phi\left(R^*(1+\hat{r}_t)\left(1+\mu_t\right)-1\right)\right]MC_H(1+\hat{mc}_{Ht})\right\}\theta\big(1+\xi(p_{Ht}-p_t)\big)+\ldots$$
$$+\psi\beta\mathbb{E}_t\left[\pi_{Ht+1}MC_H(1-\pi_t-\Delta\hat{c}_t+\hat{mc}_{Ht}+\Delta\hat{\imath}_{Ht+1})\right]=0 \iff$$

$$1-\psi\pi_{Ht}MC_H-\ldots$$
$$-\Big\{\underbrace{1-MC_H[1+\phi(R^*-1)]}_{=1/\theta}-MC_H[1+\phi(R^*-1)]\hat{mc}_{Ht}-\phi R^*MC_H(1+\hat{mc}_{Ht})\mu_t\Big\}\theta\big(1+\xi(p_{Ht}-p_t)\big)+\ldots$$
$$+\psi\beta MC_H\mathbb{E}_t\left[\pi_{Ht+1}\right]=0 \iff$$

$$1-\psi\pi_{Ht}MC_H-\left\{1/\theta-MC_H[1+\phi(R^*-1)]\hat{mc}_{Ht}-MC_H\phi R^*\mu_t\right\}\theta\big(1+\xi(p_{Ht}-p_t)\big)+\dots$$
$$+\psi\beta MC\mathbb{E}_t\left[\pi_{Ht+1}\right]=0\iff$$

$$1-\psi\pi_{Ht}MC_H-\left\{1-\theta MC_H[1+\phi(R^*-1)]\hat{mc}_{Ht}-\theta MC_H\phi R^*\mu_t\right\}\big(1+\xi(p_{Ht}-p_t)\big)+\dots$$
$$+\psi\beta MC_H\mathbb{E}_t\left[\pi_{Ht+1}\right]=0\iff$$

$$-\psi\pi_{Ht}+\theta[1+\phi(R^*-1)]\hat{mc}_{Ht}+\theta\phi R^*\mu_t-\frac{\xi}{MC_H}\big(p_{Ht}-p_t\big)+\psi\beta\mathbb{E}_t\left[\pi_{Ht+1}\right]=0\iff$$

$$-\psi\pi_{Ht}+\theta[1+\phi(R^*-1)]\hat{mc}_{Ht}+\theta\phi R^*\mu_t-\Theta\xi[1+\phi(R^*-1)]\big(p_{Ht}-p_t\big)+\psi\beta\mathbb{E}_t[\pi_{Ht+1}]=0, \tag{B.13}$$

where we impose $I_H=\gamma_H Y$ in steady state, and use the fact $[1+\phi(R-1)]MC=(\theta-1)/\theta$ in the nonstochastic steady state, with the mark-up defined by $\Theta\equiv\theta/(\theta-1)$. Hence, the Phillips curve for domestic input prices is:

$$\pi_{Ht}=\frac{\theta}{\psi}\Big[1+\phi(R^*-1)\Big]\Big(\hat{mc}_{Ht}-\frac{\xi}{\theta-1}\big(p_{Ht}-p_t\big)\Big)+\frac{\theta\phi R^*}{\psi}\Big(\hat{r}_t^*+\mu_t\Big)+\beta\mathbb{E}_t\left[\pi_{Ht+1}\right] \tag{B.14}$$

where $mc_{Ht}=w_t-p_{Ht}-a_t$. In turn, the first-order condition for export prices P^*_{Ht} is:

$$1-\theta\left(\frac{I^*_{Ht}}{\gamma^*_H Y^*_t}\right)^{-\frac{\xi}{\theta}}-\psi\pi^*_{Ht}MC^*_{Ht}\left(\frac{I_{Ht}}{I^*_{Ht}}+1\right)+\left[1+\phi\left(R^*_t\left(1+\mu_t\right)-1\right)\right]MC^*_{Ht}\theta\left(\frac{I^*_{Ht}}{\gamma^*_H Y^*_t}\right)^{-\frac{\xi}{\theta}}+\dots$$
$$+\psi\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\pi^*_{Ht+1}MC^*_{Ht+1}\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\left(\frac{I^*_{Ht+1}}{I^*_{Ht}}+\frac{I_{Ht+1}}{I^*_{Ht}}\right)\right\}=0, \tag{B.15}$$

where $MC^*_{Ht}\equiv\dfrac{W_t}{A_t\mathcal{E}_tP^*_{Ht}}$, so, in logarithm, $mc^*_{Ht}=w_t-p^*_{Ht}-\epsilon_t-a_t$. Log-linearizing the equation (B.15) yields:

$$\pi^*_{Ht}=\frac{\theta}{\psi}\Big[1+\phi(R^*-1)\Big]\Big(\hat{mc}^*_{Ht}-\frac{\xi}{\theta-1}(p^*_{Ht}-p^*_t)\Big)+\frac{\theta\phi R^*}{\psi}\Big(\hat{r}_t^*+\mu_t\Big)+\beta\mathbb{E}_t[\pi^*_{Ht+1}]. \tag{B.16}$$

Finally, the problem of foreign firms is symmetric yet not subject to credit constraints. Thus, the profit maximization problem is:

$$\max_{P_{iFt+s}}\sum_{s=0}^{\infty}\mathcal{M}^*_{t,t+s}\left[1+\xi\log\left(\frac{\theta-1}{\theta}\right)-\xi\log\left(\mathcal{D}_{t+s}\frac{\mathcal{E}_{t+s}P_{iFt+s}}{P_{t+s}}\right)\right]^{\frac{\theta}{\xi}}Y_{t+s}\left\{P_{iFt+s}-\left[1+\phi(R^*_t-1)+\frac{\psi}{2}\left(\frac{P_{iFt+s}}{P^I_{iFt+s-1}}-1\right)^2\right]\frac{W^*_{t+s}}{A^*_{t+s}}\right\}, \tag{B.17}$$

where $\mathcal{M}^*_{t,t+s}\equiv\beta^s\dfrac{U_{C^*}(C^*_{t+s},L^*_{t+s})}{U_{C^*}(C^*_t,L^*_t)}$ is the analogous ROW discount factor, with first-order condition:

$$1-\theta\left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}}-\psi\pi^*_{Ft}MC^*_{Ft}+\left[1+\phi\left(R^*_t-1\right)\right]MC^*_{Ft}\theta\left(\frac{I_{Ft}}{\gamma_F Y_t}\right)^{-\frac{\xi}{\theta}}+\psi\mathbb{E}_t\left[\mathcal{M}^*_{t,t+1}\pi_{Ft+1}MC^*_{Ft+1}\frac{I_{Ft+1}}{I_{Ft}}\right]=0.\tag{B.18}$$

[22]

Given the symmetric structure of the foreign firms' problem, the resulting Phillips curve is:

$$\pi^*_{Ft}=\frac{[1+\phi(R^*-1)]}{\psi}\left\{\theta\hat{mc}^*_{Ft}-\Theta\xi\left(\epsilon_t+p^*_{Ft}-p_t\right)\right\}+\beta\mathbb{E}_t\left[\pi_{Ft+1}\right]\iff$$

$$\pi^*_{Ft}=\frac{\theta}{\psi}\left[1+\phi(R^*-1)\right]\left(\hat{mc}^*_{Ft}-\frac{\xi}{\theta-1}\left(p^*_{Ft}+\epsilon_t-p_t\right)\right)+\beta\mathbb{E}_t\left[\pi^*_{Ft+1}\right],\tag{B.19}$$

where $mc^*_{Ft}=w^*_t-p^*_{Ft}$.

[22]Although the entrepreneur's problem in the SOE chooses consumption, hours, and prices jointly as in (14), the problem would have been equivalent if we had written the firm's profit maximization problem separately.

B.2 Equilibrium equations

Finally, by positing an interest rate rule, our log-linearized system reduces to:

$$\hat{c}_t = \widehat{w_t - p_t}, \tag{B.20}$$

$$\mathbb{E}_t[\Delta c_{t+1} + \hat{r}_t - \pi_{t+1}] = 0, \tag{B.21}$$

$$\mathbb{E}_t[\Delta c_{t+1} + \Delta\epsilon_{t+1} + \hat{r}^*_t - \pi_{t+1}] = 0, \tag{B.22}$$

$$\hat{r}^*_t = -\omega\beta\hat{B}^*_t + \zeta^{R^*}_t, \tag{B.23}$$

$$\hat{\imath}_{Ht} - \hat{y}_t = -\theta(p_{Ht} - p_t), \tag{B.24}$$

$$\hat{\imath}^*_{Ht} - \hat{y}^*_t = -\theta(p^*_{Ht} - p^*_t), \tag{B.25}$$

$$\hat{\imath}_{Ht} - \hat{y}_t = -\theta(q_t + p^*_{Ft} - p^*_t), \tag{B.26}$$

$$\pi_{Ht} = \frac{\theta}{\psi}\Big[1 + \phi(R^* - 1)\Big]\Big(\widehat{w_t - p_{Ht}} - a_t - \frac{\xi}{\theta - 1}\big(p_{Ht} - p_t\big)\Big) + \frac{\theta\phi R^*}{\psi}\Big(\hat{r}^*_t + \mu_t\Big) + \beta\mathbb{E}_t\big[\pi_{Ht+1}\big], \tag{B.27}$$

$$\pi^*_{Ht} = \frac{\theta}{\psi}\Big[1 + \phi(R^* - 1)\Big]\Big(\widehat{w_t - p^*_{Ht}} - \epsilon_t - a_t - \frac{\xi}{\theta - 1}\big(p^*_{Ht} - p^*_t\big)\Big) + \frac{\theta\phi R^*}{\psi}\Big(\hat{r}^*_t + \mu_t\Big) + \beta\mathbb{E}_t\big[\pi^*_{Ht+1}\big], \tag{B.28}$$

$$\pi^*_{Ft} = \frac{\theta}{\psi}\Big[1 + \phi(R^* - 1)\Big]\Big(\widehat{w^*_t - p^*_{Ft}} - \frac{\xi}{\theta - 1}\big(p^*_{Ft} + \epsilon_t - p_t\big)\Big) + \beta\mathbb{E}_t\big[\pi^*_{Ft+1}\big], \tag{B.29}$$

$$\hat{B}^*_t - R^*\hat{B}^*_{t-1} = I^*_H(p^*_{Ht} - p^*_t + \hat{\imath}^*_{Ht}) - \gamma_F Y(p^*_{Ft} - p^*_t + \hat{\imath}_{Ft}) - \phi\frac{W}{P}L[(R^* - 1)(\widehat{w_t - p_t} + \ell_t - q_t) + R^*\hat{r}^*_t), \tag{B.30}$$

$$-\hat{B}^*_{t+1} + \phi\frac{W}{P}R^*L(\hat{r}^*_t + \hat{\ell}_t + \widehat{w_t - p_t}) - \kappa[I^*_H(p^*_{Ht} - p^*_t + \hat{\imath}^*_{Ht} + q_t) + \gamma_H Y(p_{Ht} - p_t + \hat{\imath}_{Ht})] \leq \kappa L - \phi\frac{W}{P}R^*L + \bar{b}(1 + q_t), \tag{B.31}$$

$$0 = \gamma_H(\hat{\imath}_{Ht} - \hat{y}_t) + \gamma_F(\hat{\imath}_{Ft} - \hat{y}_t), \tag{B.32}$$

$$\ell_t = \frac{I_H}{L}\hat{\imath}_{Ht} + \frac{I^*_H}{L}\hat{\imath}^*_{Ht}, \tag{B.33}$$

$$\hat{r}_t = \phi_\pi\pi_t, \tag{B.34}$$

the following identities:

$$\pi_{Ht} = (p_{Ht} - p_t) - (p_{Ht-1} - p_{t-1}) + \pi_t, \tag{B.35}$$

$$\pi^*_{Ht} = (p^*_{Ht} - p^*_t) - (p^*_{Ht-1} - p^*_{t-1}) + \pi^*_t, \tag{B.36}$$

$$\pi^*_{Ft} = (p^*_{Ft} - p^*_t) - (p^*_{Ft-1} - p^*_{t-1}) + \pi^*_t, \tag{B.37}$$

$$q_t = q_{t-1} + \Delta\epsilon_t + \pi^*_t - \pi_t. \tag{B.38}$$

and shocks to the foreign interest rate and aggregate TFP:

$$\zeta_t^{R^*} = \rho^{R^*}\zeta_{t-1}^{R^*} + \eta_t^{R^*}, \eta_t^{R^*} \sim \mathcal{N}(0, \sigma^{R^*}) \tag{B.39}$$

$$\zeta_t^{a} = \rho^{a}\zeta_{t-1}^{a} + \eta_t^{A}, \eta_t^{A} \sim \mathcal{N}(0, \sigma^{A}), \tag{B.40}$$

with $\rho_{\eta_t^{R^*}\eta_t^A} = 0$.

B.3 Steady state

We assume that κ is large anough so that the collateral constraint does not bind in steady state. Therefore, consumption is

$$C = Y = \frac{W}{P} = \frac{\theta - 1}{\theta}[1 + \phi(R^* - 1)]^{-1},$$

so $I_H = \gamma_H \left\{\frac{\theta-1}{\theta}[1+\phi(R^*-1)]^{-1}\right\}^{\frac{1}{\theta}}$ and $I_F = \gamma_F \left\{\frac{\theta-1}{\theta}[1+\phi(R^*-1)]^{-1}\right\}^{\frac{1}{\theta}}$. The steady state NFA is

$$\bar{b} - R^*\bar{b} = I_H^* - I_F - \phi(R^* - 1)\frac{W}{P}(I_H + I_H^*),$$

thus implying

$$I_H^* = \left\{1 - \phi(R^*-1)[1+\phi(R^*-1)]^{-1}\left(\frac{\theta-1}{\theta}\right)\right\}^{-1}\left\{-\bar{b}(R^*-1) + \gamma_F Y + \phi(R^*-1)[1+\phi(R^*-1)]^{-1}\left(\frac{\theta-1}{\theta}\right)\gamma_H Y\right\},$$

where we impose $P_H/P = P_F/P^* = Q = 1$ in a symmetric equilibrium. Therefore, total hours is $L = I_H + I_H^*$ in steady state.

B.4 IRFs to a foreign interest rate shock, shutting down price complementarities ($\xi = 0$)

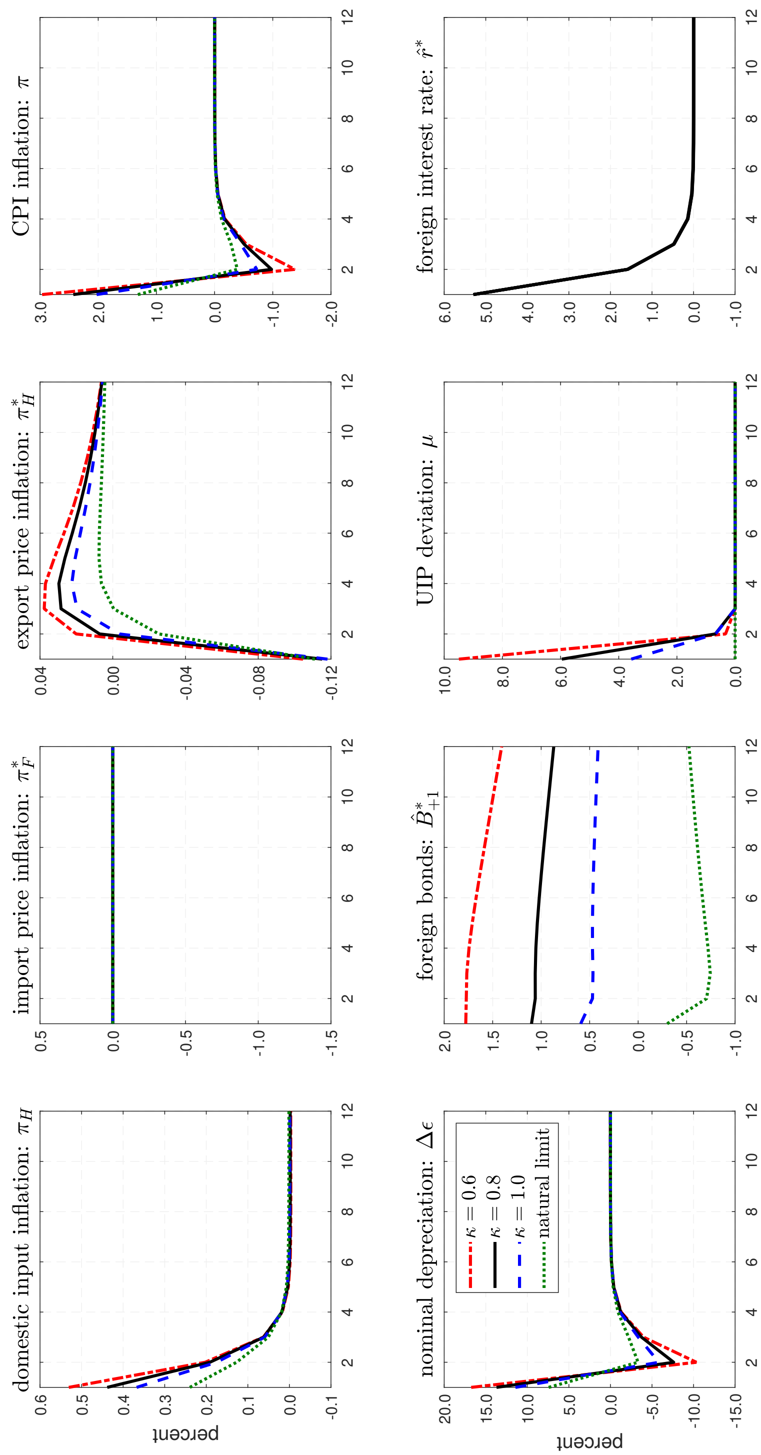


Figure B11: This figure shows the general equilibrium impulse response functions of the main endogenous variables in the model to an exogenous one standard deviation increase in the logarithm of the foreign interest rate, r_t^*, absent pricing complementarities ($\xi = 0$). The time-frequency is quarterly. Curves in each panel portray the responses of the same variable for differing degrees of credit constraints, measured by the parameter κ. The dashed green line represents the natural borrowing limit, where κ is so large that the collateral constraint is never binding. Hatted-variables denote deviation from the steady state, where $\hat{r}_t^* \equiv \log(R_t^*) - \log(R^*)$ and $\hat{B}_{t+1}^* \equiv B_{t+1}^*/P_t^* - \bar{b}$.

B.5 IRFs to a productivity shock under the baseline calibration

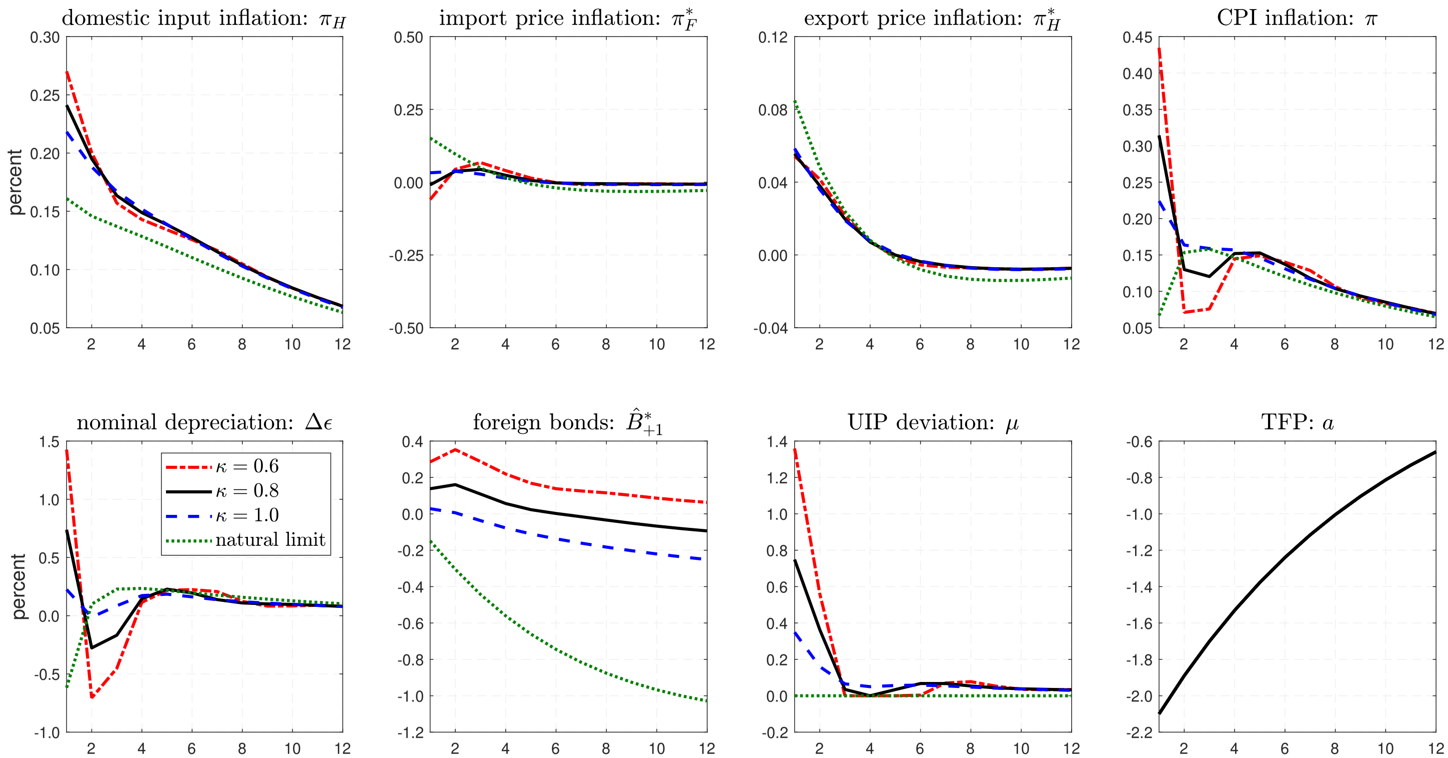


Figure B12: This figure shows the general equilibrium impulse response functions of the main endogenous variables in the model to an exogenous one standard deviation decrease in the logarithm of the aggregate total factor productivity, a_t, under the baseline calibration in Table 6. The time-frequency is quarterly. Curves in each panel portray the responses of the same variable for differing degrees of credit constraints, measured by the parameter κ. The dashed green line represents the natural borrowing limit, where κ is so large that the collateral constraint is never binding. Hatted-variables denote deviation from the steady state, where $\hat{B}_{t+1}^* \equiv B_{t+1}^*/P_t^* - \bar{b}$.

B.6 Model simulations

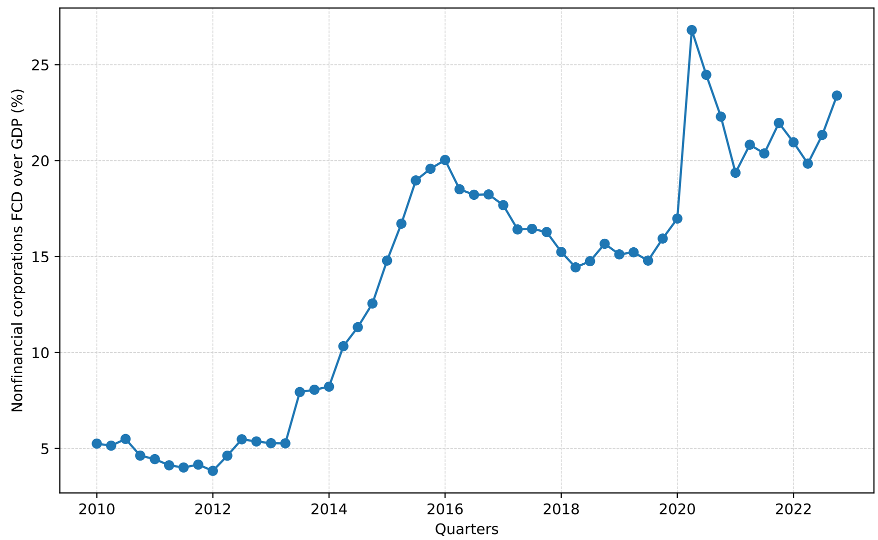


Figure B13: This figure plots the outstanding FCD for nonfinancial corporations (NFC) over quarterly GDP from 2010q1 to 2022q4. The time series combines NFC's outstanding FCD from the Bank for International Settlements (BIS) and quarterly GDP from the International Monetary Fund (IMF). We used the quarterly average bilateral exchange rate from the IMF to convert GDP in Colombian pesos to US dollars.

Table B11
Regression results using model-generated data

	Import prices			
	Horizon (two-years)	Baseline calibration	No variable markups ($\xi = 0$)	No financial frictions (κ large)
$\Delta e_{\$}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{\ell}$	0.70	1.00	0.68
$\Delta e_{\$} \times d_{\mathcal{I}}$	$\Sigma_{\ell=0}^{7} \hat{\beta}_{d\ell}$	0.02	0.00	0.00
π_H	$\sum_{\ell=1}^{7} \hat{\theta}_{\ell}$	0.21	0.00	0.20

Table B11 reproduces the regression results at the horizon of eight quarters using model-generated data in table 4, additionally including estimates on domestic prices omitted in that table. Model-generated import prices load positively on domestic sales inflation (π_H) when the calibration allows for pricing complementarities ($\xi > 0$), as shown in columns three and five. In contrast, column four shows that loadings are negligible when pricing complementarities are absent ($\xi = 0$).