Impact of Import Relationships on Inflation Dynamics

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Abstract

I study the effect of import relationships on the transmission of exchange rate fluctuations into aggregate domestic prices (CPI). Using transaction-level Chilean import data, I document that i) the pass-through of exchange rate fluctuations into import prices decreases as relationships grow older, and ii) older relationships have larger import shares. To quantify the role of these concurring facts, I formalize the channels for exchange rate transmission into CPI in a simple model that accounts for the role of import relationships and includes realistic heterogeneity in other leading frictions that influence the transmission. I find that the presence of older import relationship reduces CPI sensitivity to exchange rate by 20% and insulates domestic prices by reducing inflation by 10% during the "Estallido Social" shock. I also show that the increase in the age of the average import relationship explains a substantial part of the decline in CPI sensitivity to exchange rates from 2009 to 2019. Finally, all frictions considered contribute substantially in reducing CPI sensitivity and their heterogeneity determines which sectors are the most important contributors to the transmission of exchange rate fluctuations.

Keywords: Exchange Rates, Pass-Through, Trade Relationship, Import Exposure, Input-Output Linkages.
JEL: F14, F31, D57, E31, L10, F40.

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1 Introduction

The relationship between domestic prices and exchange rates is a central question in international economics.[1] The link between domestic prices and exchange rates depends crucially on the exchange rate pass-through, the domestic exposure to imported products and their interaction. Exchange rate pass-through quantifies the sensitivity of international prices (e.g. import prices) to exchange rate fluctuations. Import exposure captures the channels through which fluctuations in international prices and exchange rates feed into domestic prices. Extensive evidence show that domestic prices only weakly respond to exchange rate fluctuations and several frictions, like real and nominal rigidities, have been proposed to account for it.[2]

In this paper, I focus on the role that importing tenure has on the relationship between domestic prices and exchange rates, where I define importing tenure as the period of time a firm has engaged in importing activities. Importing tenure is related to firms' participation in international markets and a growing literature has documented how exchange rate pass-through and prolonged participation to international markets are negatively correlated, influencing the sensitivity of domestic prices to exchange rate fluctuations (Campa and Goldberg, 2005; Camatte et al., 2021; Georgiadis et al., 2020). Moreover, the concept of importing tenure as used in this paper can be mapped to several models used to explain incomplete pass-through and pricing-to-market behaviors. Models of market share accumulation (Atkeson and Burstein, 2008), customer search and accumulation (Paciello et al., 2019; Drozd and Nosal, 2012), and relationship capital accumulation or learning-by-doing (Dasgupta and Stiglitz, 1988; Heise, 2019) can, subject to modifications or extensions, micro-found the empirical patterns about importing tenure documented in this paper.[3]

I start by documenting a set of novel empirical facts suggesting that importing tenure plays a substantial role in explaining the low sensitivity of domestic prices. Using the universe of import transactions for Chile from 2009 to 2019, I first show that firms importing the same product for longer periods of time face a lower pass-through rate of exchange rate fluctuations. Specifically, a 10-year experienced importer has a pass-through rate of exchange rate shocks 50% lower compared to a new importer. Second, I show that importing tenure is positively associated to import share. That is, experienced importers tend to import larger amounts and this relation is robust over time, within and across products. These findings together suggest that the importers that are more

[1] Understanding this relation and the factors influencing it has broad implications for the transmission of international shocks and international business cycle comovements (Corsetti et al., 2008; Backus and Smith, 1993), external imbalances and the effectiveness of monetary and exchange rate policies (Mishkin, 2008; Benigno and Benigno, 2003; Corsetti et al., 2010) and domestic redistribution dynamics (Cravino and Levchenko, 2017a; Jaravel, 2021).

[2] See Campa and Goldberg (2005), Gopinath (2015) and Burstein and Gopinath (2014) for a survey.

[3] However, there is little work investigating the aggregate effects of importing tenure and international relationships on the dynamics of aggregate domestic prices and its quantitative performance against other commonly studied frictions, such as distribution costs and nominal rigidities.

relevant in determining import exposure are also those facing lower sensitivity to exchange rate fluctuations because of their longer importing tenure.

I formalize the channels for the transmission of exchange rate fluctuations into aggregate domestic prices (CPI) to quantify the role that importing tenure has for the sensitivity of aggregate prices. I use a static, partial equilibrium framework that connects exchange rate fluctuations to the dynamics of final consumption goods prices, deriving an expression for the aggregate exchange rare pass-through in the spirit of Goldberg and Campa (2010). I account for import exposure, considering direct (imported final consumption) and indirect (imported intermediate products and domestic input-output linkages) exposure as both channels feed exchange rate fluctuations into domestic prices (Goldberg and Campa, 2010). The model includes several leading frictions that influence the transmission of exchange rate fluctuations and cost shocks in general to properly account for the role of importing tenure. Specifically, I consider distribution costs (Burstein et al., 2003; Corsetti and Dedola, 2005), variable markups (Atkeson and Burstein, 2008) and Calvo-style nominal rigidities (Gopinath and Itskhoki, 2011). Finally, I account for the main channel of interest, the effect of importing tenure, in reduced form. Given that multiple mechanisms are consistent with a broad interpretation of importing tenure and its effect on exchange rate pass-through, I directly calibrate its effect on the pass-through rate into import prices, abstracting away from any micro-foundation. The rich and flexible structure of the model is carefully disciplined by using highly disaggregated data, allowing for an accurate quantitative analysis of each component.

One of the goals and contributions of this paper lies in a detailed calibration of the Chilean economy. I leverage several data sources and their disaggregated nature in order to discipline and quantify the scale of each component considered in the model. I construct a granular (180x180) input-output table for the Chilean economy, allowing me to capture the sparsity of the domestic network and account for direct and indirect exposure to imports. I use import transaction data to calibrate the main reduced-form channel of interest, the effect of importing tenure, at the product level. I calibrate domestic frictions at the most disaggregated level possible to quantify the effects of friction heterogeneity on the transmission of exchange rate shocks. Specifically, I compute distribution costs at the product level from the input-output tables, distinguishing between domestic and intermediate products, and between imported and domestic products. I calibrate markup elasticity (variable markups) at the sectoral level using firm-level data from Chile and state-of-the-art production function techniques to estimate markups. Finally, I calibrate nominal rigidities using micro-level estimates of price adjustment frequencies from Chile. The calibrated model closely matches the estimated sensitivity of domestic price to exchange rate fluctuations, providing a benchmark for future empirical studies on CPI sensitivity to exchange rates.

I find that importing tenure is quantitatively relevant for the dynamics of domestic prices and their sensitivity to exchange rate fluctuations. I show that abstracting away from importing tenure increases domestic price sensitivity to exchange rates by 20%. Importing tenure plays a quantitatively important role in explaining the low sensitivity of domestic prices to exchange rate fluctuations because it reduces the pass-through of exchange rate fluctuations for large imported products. I also apply the calibrated model to so-called "Estallido social" event. I use the social outburst in Chile in late 2019 and the consequent sharp depreciation of the Chilean peso as an event study to quantify the role of importing tenure for inflation dynamics. I show that the presence of experienced importers insulated domestic prices from the depreciation shock, reducing domestic inflation by 10% (0.1 p.p. at quarterly level).

Using back-of-the-envelope calculations based on my estimates, I find that the rise in the aggregate importing tenure from 2009 to 2019 can account for a substantial part of the declining trend in CPI sensitivity to exchange rate fluctuations. This result is in line with the growing literature linking prolonged participation to international markets to exchange rate sensitivity and inflation dynamics (Campa and Goldberg, 2005; Camatte et al., 2021; Georgiadis et al., 2020).

The rich structure of the model allows to quantify the role of direct and indirect import exposure, the quantitative performance of each friction and their interaction. I find that each individual friction substantially contributes to the overall insensitivity of domestic prices. Interestingly, frictions located in the domestic economy are relatively more important than incomplete pass-through into import prices. Moreover, I show that domestic spillover effects and indirect import exposure play a negligible role for the sensitivity of aggregate domestic prices. The reason is that products that are relatively more import intensive are also those associated with higher frictions, dampening their contribution to the transmission of exchange rate fluctuations.

Prior Work: This paper is related to several strands of literature. First, I show that importing tenure influences the pass-through rate of exchange rate fluctuations into import prices, pointing at a new source of heterogeneity in exchange rate pass-through at the firm level. This complements prior work focusing on firm size (Berman et al., 2012), imported inputs (Amiti et al., 2014), strategic complementarities (Amiti et al., 2019) and product quality (Chen and Juvenal, 2016).[4] Closely related to my analysis is Heise (2019), that uses US import transaction data to show that as cross-border firm-to-firm relationships grow older, the exchange rate pass-through increases. In contrast to this work, I show that pass-through in fact decreases in importing tenure. The conflicting results suggest that the level of disaggregation and the specific countries considered might influence the

[4] Other related papers are Neiman (2010), which focuses on the effect of intra-firm and arm-length relationships, and Gopinath et al. (2010) and Chen et al. (2022), that study the effect of invoicing choices on pass-through rates.

relation between tenure/relationship age and pass-through into import prices.[5] [6]

My paper is related to the extensive literature studying the relationship between exchange rate fluctuations, pass-through and domestic prices. This literature has explored several mechanisms and frictions to explain the low sensitivity of import and domestic prices to exchange rate fluctuations, including real frictions generating pricing-to-market (PTM) behavior and nominal rigidities.[7] The broad concept of importing tenure used in this paper can be mapped into several leading mechanisms generating PTM which are consistent with my findings on exchange rate pass-through (Dasgupta and Stiglitz, 1988; Atkeson and Burstein, 2008; Drozd and Nosal, 2012). The analysis carried out in this paper can be considered as a quantification of the main reduced-form channel, common across all micro-founded mechanisms, connecting the response of import prices to exchange rate fluctuations. In addition to the specific focus on importing tenure, I complement the existing literature in quantifying the role of other leading frictions against each other.[8] My findings show that all frictions considered are quantitatively relevant in explaining the low sensitivity of domestic prices, suggesting that competing mechanisms should be jointly considered in future analysis.[9]

My paper contributes to the recent literature documenting a long-run decline in domestic price sensitivity to exchange rate fluctuations. Several papers focus on the potential growing role of global determinants, like the rising participation in global value chains, (Campa and Goldberg, 2005; Camatte et al., 2021; Georgiadis et al., 2020). My work is complementary to this literature as I examine the role of importing tenure, which also captures prolonged participation in international markets. My findings show that pass-through decreases as importers gain experience, which is not

[5] It is important to stress that the results in Heise (2019) are not directly comparable for two main reasons. On one hand, the data used in his empirical analysis allow to identify both the buyer and the seller, while the Chilean data are less disaggregated and identify only the buyer (importer). Therefore, his definition of firm-to-firm relationship is more granular than the definition of importing tenure used here. The aggregation level might influence the effects of exchange rate shocks. Similarly, Campa and Goldberg (2005) and Goldberg and Campa (2010), among others, show that exchange rate pass-through is highly heterogeneous across countries and sectors. The fact that I consider an emerging economy (Chile) can make the comparison to Heise (2019) not straightforward given his focus on an advanced economy (US). Extending the analysis to other advanced and emerging economies is an important way to deepen our understanding of the phenomenon.

[6] Another related paper in international trade is Alviarez et al. (2021), that focuses on how bargaining power in firm-to-firm relationships shapes the pass-through of cost shocks like tariffs changes.

[7] See Burstein and Gopinath (2014) and Goldberg and Hellerstein (2008) for recent surveys. Importantly, Gopinath and Itskhoki (2011) show that both nominal and real rigidities are necessary to quantitatively account for the response of prices to exchange rate.

[8] Recently, Ruane and Peter (2022) Peter and Ruane (2018) quantify the welfare consequences of distribution costs and their distortions in closed economy.

[9] A related paper is Drozd and Nosal (2022), which also focuses on the quantitative performance of state-of-the-art frictions in generating PTM and incomplete pass-through. However, differently from the work here, they contrast the performance of each friction against a frictionless benchmark, and not against each other. Moreover, their analysis is carried at business cycle frequencies and looks also at the response of prices and quantities to different types of shocks.

usually observable in standard aggregate global value chain data.[10]

Finally, my paper is related to the growing literature that focuses on production networks, heterogeneity in frictions and propagation of shocks.[11] Rubbo (2020) and Pasten et al. (2020) show in closed economy that heterogeneity in price rigidity is key for the transmission of monetary shocks. The open-economy literature emphasizes that international and domestic input-output linkages are relevant for the propagation of exchange rate shocks and inflation synchronization across countries (Di Giovanni and Levchenko, 2010; Auer et al., 2019; Georgiadis et al., 2020).[12] [13] However, while the former abstracts away from international forces and shocks, the latter generally falls short in accurately describing the domestic economy and its frictions, potentially over- or under-estimating relevant channels. I empirically contribute to this literature by examining the impact of exchange rate shocks on consumer prices using a detailed representation of the domestic economy and disaggregated data to accurately calibrate heterogeneous frictions and domestic exposure to exchange rate shocks.[14]

The rest of the paper is structured as follow. Section 2 documents novel facts relating importing tenure to exchange rate pass-through and import exposure. I also discuss how several existing models map into a broad concept of importing tenure and imply qualitative predictions in line with the empirical evidence documented in here. In Section 3, I present my modelling approach, beginning with a price aggregator and then presenting the model of pass-through, with particular attention to the role of importing tenure and other leading frictions. Section 4 discusses the calibration strategy of the model in detail and Section 5 presents the main results on the effects of importing tenure on the sensitivity of domestic prices to exchange rates. Section 6 concludes.

[10] My finding on the role of importing tenure for price response is of relevance also for the missing inflation puzzle. Heise et al. (2022) shows that global factors, like imported products and import competition, account for part of the growing disconnect between domestic inflation and unemployment. Importing tenure, by influencing pass-through and price level, can play a role in explaining the puzzle. This is an exciting avenue for future research.

[11] See Carvalho and Tahbaz-Salehi (2019) for a recent survey.

[12] Another related paper in international trade is Dhyne et al. (2021), that focuses on the propagation of foreign demand shocks in an international firm-to-firm network. Heise (2019) focuses on the impact of international firm-to-firm relationships on exchange rate pass-through without looking at how the domestic network of firms amplifies or attenuates shocks.

[13] A related literature focuses on micro origins of aggregate fluctuations in closed economy (Grassi et al., 2017; Carvalho and Tahbaz-Salehi, 2019; Burstein et al., 2020) and across countries (Di Giovanni et al., 2017; Cravino and Levchenko, 2017b). My work complements this analysis by focusing on the implications of heterogeneous pass-through rates originating from firm-level importing tenure in shaping the response of aggregate domestic prices to exchange rate shocks.

[14] A close paper in this regard is Huneeus (2018), which calibrates an endogenous production network using Chilean domestic firm-to-firm transaction data. However, using input-output table and product level calibration allows me to properly account for several frictions that can influence shock propagation. Moreover, the focus of his work is on network formation and propagation of foreign demand shocks (Great Trade Collapse) through the domestic network.

2 Facts

In this section, I present two important facts about importing tenure using the universe of Chilean customs data. First, the sensitivity of import prices to exchange rate fluctuations decreases with importing tenure. Second, importing tenure is positively correlated with import share. I also discuss how importing tenure can be mapped in a broad sense to multiple models related to relationship capital accumulation, customer base or market share accumulation.

2.1 Data

The empirical analysis that links importing tenure and exchange rate pass-through is based on the universe of import transactions provided by the Chilean Customs Agency (*Aduanas*). For each import transaction, the dataset includes standard information such as the importer's unique identifier (*importer*), the 8-digit HS product code (*product*), the date of the transaction, the country of origin (*origin*), the FOB and CIF values, the quantity shipped, etc. Data are available from 2009 to 2020. I compute prices as unit values by dividing the shipment value by the quantity shipped. To improve the reliability of the data, I trim the dataset by dropping observations whose price changes are above (below) the 99th (1st) percentile.[15] I aggregate all transactions at the importer-origin-product-quarterly level, by summing over values and quantities. Table 1 provides summary statistics of the main variables and Table 8 reports information on industry and origin composition of the data.

I define the tenure of an importer-product-origin triplet as the number of quarters the importer has been consecutively importing the product, the product being defined as a HS8 category - origin pair. Therefore, my definition is very conservative and focuses on import relationships that trade regularly. As a robustness check in Appendix B, I relax this definition of tenure and consider the number of quarters the importer has been importing a given product, dropping the consecutive requirement. I also consider the cumulative imported quantity for each firm-product-origin triplet.

Table 2 provides information on the distribution of importing tenure and the number of observations along different dimensions. As previously documented in the literature for many countries, import flows to Chile are dispersed across firms, products and countries of origin. The median importing firm records four flows per quarter, concentrated in one product or a couple of countries of origin. The second half of the table shows that the sparsity appears also along the time dimension. Importing is not a long-lasting activity as the median importing tenure across firm-product-origin triplets is one quarter. These statistics provide an overview of the prevalence of short import flows, and this is true using both definitions of tenure.

[15] Additional data cleaning entails the removal of all transactions with missing information, e.g. quantity, value, etc.

Table 1: Description of the Data - Customs

	Whole Sample				
	Mean	Median	StD	p5	p95
Importers	41,186	.	.	.	.
Products	7,518	.	.	.	.
Origin Countries	168	.	.	.	.
Products per importer	10.66	3	27.28	1	43
Origins per importer	2.227	1	2.931	1	7
Unit value (USD/quantity)	1,732.7	21.35	76,930.6	0.934	1,569.2
% Δ log unit value	0.446	0.417	0.690	-116.6	118.1
Transaction value (USD)	130,817.5	7,214.3	2,659,917.9	239.5	286,991.7
Observations (N)	3,044,931	.	.	.	.

The table reports summary statistics of the cleaned universe of import transactions from the Chilean Customs, 2009-2019. Transaction values and unit values are defined in USD.

2.2 Fact I: Responsiveness of Import Prices

I examine the relationship between the pass-through of exchange rate shocks and importing tenure. Let f index an importing firm, p an HS8 product category, o the country of origin, and t the quarter. My baseline specification is:

$$\Delta \log p_{fpot} = \beta_1 \Delta \log e_{ot} + \beta_2 \log \text{Tenure}_{fpot} \times \Delta \log e_{ot} + \beta_3 X_{fpot} + \eta_{fop} + \nu_t + \varepsilon_{fpot}, \qquad (1)$$

where $\Delta \log p_{fpot}$ is the price change of product po imported by firm f between quarter t and $t-1$, and $\Delta \log e_{ot}$ is the change in the Chilean peso-country o exchange rate between quarter t and $t-1$. Tenure_{fpot} is the importing tenure at quarter t, defined as described in the previous section. In the main specification, I use the log of tenure to reduce the impact of the positive skewness in the distribution of tenure.[16] I include time fixed effects and importer-product-origin fixed effects, meaning that the effect of importing tenure on the pass-through of exchange rate fluctuations, β_2, is estimated using the variation within the same import relationship over time.

X_{fpot} is a set of controls that includes the average size of the importer-product-origin triplet and an index of competitor price change. The former is used to control for differences in size and productivity, as larger firms may exhibit lower pass-through rates because of their size or stronger pricing to market behavior, Amiti et al. (2014) and Berman et al. (2012). The latter controls for strategic complementarities across importers. Following Amiti et al. (2019), I construct an index

[16] Table 12 Appendix B reports the main specification estimated using the level. Results are quantitatively similar, with larger discrepancies for higher values of tenure, as expected.

Table 2: Summary Statistics - Importing Tenure

	p5	p25	Median	p75	p95	Mean	N
Observation:							
Importer X Time	1	1	4	11	44	11.8	965,043
Importer X Product X Time	1	1	1	1	2	1.19	9,524,237
Importer X Country X Time	1	1	2	5	18	4.94	2,299,882
Tenure:							
Main	1	1	1	2	6	1.99	2,391,689
Alternative	1	1	1	3	13	3.26	2,391,689

The table reports summary statistics on the distribution of the number of observations along different dimension (importer, time, product and country) from the cleaned universe of import transactions from the Chilean Customs, 2009-2019. The table reports summary statistics on importing tenure, defined as: i) the number of quarters the importer has been consecutively importing a Product X Origin pair (main); ii) the number of quarters the importer has been importing a Product X Origin pair (alternative).

of competitor price change as a weighted average of the price changes of all other importers of the same product p:

$$\Delta \log p_{-ft} = \sum_{j \in F_p} \frac{S_{jt}}{1 - S_{ft}} \Delta \log p_{jt}, \tag{2}$$

where F_p refers to the set of importers purchasing product p from any origin. The shares S_{jt} are defined for each product p across all origins in terms of quantity. Given the potential endogeneity in the change of competitors' prices, I instrument the competitor price changes with movements in the bilateral exchange rates.

As in standard pass-through regression, I control for the inflation rate in the origin country to control for changes in the production cost, Burstein and Gopinath (2014) and Goldberg and Campa (2010).[17]

Table 3 presents the estimates of the key coefficients of interest. Column (1) reports the estimated exchange rate pass-through rate from a standard regression, with no controls except for time fixed effects. The magnitude is comparable to previous estimated in the literature. Using within importer-product-origin variation, Column (3) shows that each additional quarter in importing tenure reduces the responsiveness of import price. The estimated effect implies that an increase in tenure from the bottom quartile (25th percentile) to the top quartile (75th percentile), approximately 3-4 years difference in 2019, reduces the pass-through rate by approximately 5-6%, a substantial drop.[18] Column (4) and (5) introduce additional controls. The qualitative and quantitative effect of importing tenure on pass-through is virtually unaltered. In line with previous

[17] The macroeconomic variables used in the empirical analysis, such as inflation rates and exchange rates, are obtained from additional sources like the IMF, the OECD or the Central Bank of Chile.

[18] See Figure 3 for the distribution of the expenditure-weighted tenure aggregated at the 5-digit product level.

Table 3: Pass-Through Regression

	(1)	(2)	(3)	(4)	(5)
$\Delta \log e$	0.2546	0.2711	0.3376	0.3880	0.3868
	(0.098)	(0.109)	(0.116)	(0.115)	(0.115)
Log Tenure X $\Delta \log e$			-0.0408	-0.0342	-0.0350
			(0.013)	(0.012)	(0.013)
Average Size X $\Delta \log e$				-0.0096	-0.0092
				(0.003)	(0.004)
Strategic $\Delta \log p_{-f}$					0.2718
					(0.313)
Time	Yes	Yes	Yes	Yes	Yes
Importer X Product X Country	No	Yes	Yes	Yes	Yes
Observations	2,568,634	2,368,422	2,368,422	2,368,422	2,365,619

Coefficients for terms in levels (log tenure, average size and inflation of origin country) and left and right censorship dummies are omitted. Standard errors clustered at country level. Tenure is defined as the number of quarters the importer has been consecutively importing a Product x Origin pair. Average size is defined as log average quantity traded at the Importer x Product x Origin level. Strategic is constructed according Equation (2).

results in the literature, own average size reduces pass-through rates, Amiti et al. (2014). Similarly, the index of competitor price change shows the presence of strategic complementarity among importers, Amiti et al. (2019).[19]

In Table 12 Appendix B, I analyze the sensitivity of the results in Table 3. In the first column, I run the baseline specification in Equation (1) using the preferred definition of tenure in levels. I show that results are quantitatively similar, and, as expected, a larger implied pass-through for lower values of tenure. In the second and third columns, I run the baseline specification in Equation (1) using alternative measures of importing tenure. I replace my conservative measure of tenure with the number of quarters since the first time the firm imported a specific HS8 product-country of origin pair. Alternatively, I use the cumulative quantity traded up to that quarter within each importer-product-origin triplet. Both measures have the same qualitative effects on the pass-through of exchange rate shocks. In the fourth column, I identify the effect of tenure on pass-through using the variation coming from different importing experience across different origins, within a firm-product pair. I use a combination of origin-product and firm-product fixed effects to substitute for the firm-product-origin fixed effects. Also in this case, the qualitative effect of importing tenure on pass-through is preserved. The remaining columns examine the sensitivity of my results with respect to the set of controls used in Equation (1). I run the baseline regression using different measures to control for the heterogeneity in firm size. I replace the average quantity of

[19] Amiti et al. (2019) show that strategic complementarities are significant only for larger firms. This could explain why the estimated average effects of strategic complementarities in Table 3 is not significant.

the importer-product-origin triplet and use the size of the importer computed as the total quantity traded across all product-origin pairs throughout the entire dataset or the quantity traded in each given quarter at the importer-product-origin level. Lastly, I construct alternative competitor price indices to control for strategic complementarities. I reconstruct the index in Equation (2) where the shares are computed using the transaction values, rather than quantities. In addition, I use a more conservative definition of competitor and redefine the set of competitors of each importer at the product-origin, F_{po}, which includes all importers purchasing product p from origin o. In all these cases, I find similar results to the baseline specification.

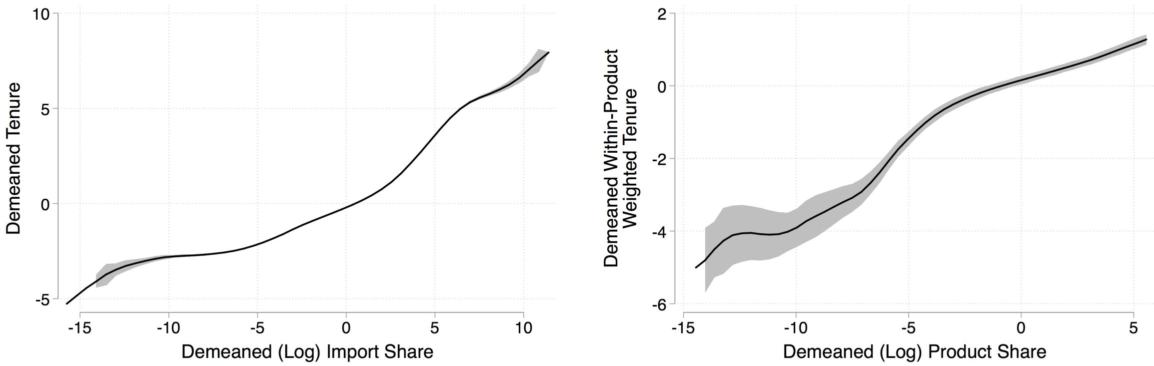
2.3 Fact II: Import Share and Tenure

Figure 1 shows non-parametrically that, at each point in time, products that are imported more intensively are also those where firms have, on average, longer importing tenure. The left panel uses the whole sample, defining tenure and import shares at the firm-product-origin-quarter level. The right panel aggregates the data, defining a product category at the 3-digit SITC level. In this case, for each product, I compute the expenditure-weighted average tenure across all firms importing in that product category. Similarly, import shares now refer to the overall import share of the product category. Independently of the level of aggregation, I demean all variables at the quarter level to avoid the mechanical increase in tenure as time passes and make it comparable over time.[20]

Figures 14 in Appendix B shows that the positive relationship between import shares and tenure is robust to different measures of tenure, variations and subsamples. Panel a) uses the less conservative measure of tenure, which is defined as the number of quarters since the first time the firm imported a specific HS8 product-origin pair. In panel b) and c), I demean the variables at the quarter and quarter-firm-product level, respectively. Finally, panel d) uses only the second half of the sample to avoid possible mechanical increases in average tenure. Similarly, aggregating tenure and import shares at the product level, Figure 15 shows that the relationship is robust to i) the measure of tenure used (panel a); the aggregation weighting (panel b uses simple averages across firm-origin pairs); the subsample considered (panel c uses the second half of the sample only); the aggregation level (panel d aggregates at the 5-digit level). In all these cases, I find similar results to the baseline relationship documented in Figure 1.

[20] When using the whole sample, I demean all variables also at the firm level to control for cross-sectional differences across firms that might influence the relationship between tenure and import share, like size.

Figure 1: Relationship Import Share - Tenure



The left panel plots the non-parametric relationship between the (log) import share and the tenure in the whole sample. Import shares and tenure are defined at the firm-product-origin-quarter level. Products are defined at the 8-digit level. Variables are demeaned at the quarter-firm level. The right panel figure plots the non-parametric relationship between the (log) import share of a product and the expenditure-weighted average tenure across all firms importing that product. Products are defined at the 3-digit SITC level. Share and average tenure are computed at the quarterly level. Variables are demeaned at the quarter level. The panels show the 99% confidence intervals.

2.4 Relation to existing literature

I now briefly review leading micro-founded models that are consistent with the empirical facts just documented. All the mechanisms entail the presence of real rigidities and pricing-to-market behaviors, that make firms reluctant to change their relative price.

A workhorse model in the international economic literature is Atkeson and Burstein (2008), that consider a setup with variable markups originating from strategic complementarities in pricing. Consider an economy with a continuum of sectoral goods aggregated according a CES structure with elasticity of substitution θ. Sectoral goods are, in turn, CES aggregators with elasticity η of sectoral outputs produced by a finite number of firms, with $\eta > \theta$. Assuming that firms engage in Cournot competition, Atkeson and Burstein (2008) show that the profit maximizing price for firm i is:

$$p_i = \frac{\varepsilon(s_i)}{\varepsilon(s_i) - 1}\mathrm{mc}_i(e),$$

where $\varepsilon(s_i)$ is the perceived demand elasticity that depends on the market share of firm, s_i, with $\varepsilon(s_i) = \left[\frac{1}{\eta}(1 - s_i) + \frac{1}{\theta}s_i\right]^{-1}$. The change in a firm's price, Δp_i is given by:

$$\Delta p_i = \frac{1}{1 + (\eta - 1)\Gamma(s_i)}\left[\Delta \mathrm{mc}(e) + \eta\Gamma(s_i)\Delta p\right].$$

This is a weighted average between the change in its cost (due to exchange rate) and the sectoral price index, p. Firms with higher market shares charge higher markups and have higher markup elasticity, $\Gamma(s_i)$. Higher markup elasticity reduces ERPT by decreasing the weight on the exchange rate change and increasing pricing-to-market behavior. As in Heise (2019), suppose that firms have to pay a positive fixed cost and firm's productivity a_i follows an exogenous process, $a_{i,t+1} = a_{i,t} + \zeta_{i,t+1}$ with $\zeta_{i,t+1}$ i.i.d.[21] If productivity becomes too low, firms might choose to shut down and , due to selection, firms that have been participating in the market for longer will have higher market share on average. This simple framework is in line with the empirical facts documented in here when importing tenure is interpreted as firm age: older firms are larger (second fact) and exhibit lower pass-through rates (first fact).

Similar qualitative predictions can be derived in several models that accurately describe customer accumulation process, Gourio and Rudanko (2014) and Paciello et al. (2019). In this class of models, tenure can also be considered as a proxy for firm age. Firms face a downward sloped demand with elasticity θ and current sales depend on the mass of customers a that consumed their good in the previous period. Firms maximizes a forward looking problem subject to the law of motion of the customer base, $a' = (1-\delta)a + f(p)$, where $f(p)$ is the flow of new customers, decreasing in p. The implicit expression for the optimal pricing is:

$$p_i = \frac{\theta}{\theta - 1}\left[\mathrm{mc}(a) - \beta E J_a(a', \mathrm{mc}')\right],$$

where the second term in the brackets is the expected value function with respect to customer base. The producer sets price and markup lower than under static optimization in order to increase future customer bases. The main implication is that markups rise with the customer base, converging to $\frac{\theta}{\theta-1}$. Increasing markups generate stronger pricing-to-market behavior and, thus, decreasing pass-through rates.

In an international context, pricing-to-market behaviors arise in models with customer search (Alessandria, 2009; Drozd and Nosal, 2022) and marketing capital accumulation (Drozd and Nosal, 2012). Variable markups originates from the fact that reaching costumers is a costly activity. The price of the exporter in the importing country is: $p_i = \mathrm{mc} + \gamma\hat{p}$, where γ is the customer search parameter and $\hat{p}$ the price of search effort (in terms of local numeraire). In this case, importing tenure can be considered as lower search costs (following, for instance, investments in distribution and marketing). In the cross-section, firms facing lower search costs have larger market shares and markups, and thus lower pass-through.

Lastly, the full commitment version of the model in Heise (2019) revisits the learning-by-doing framework in Dasgupta and Stiglitz (1988), showing that as relationship-specific capital increases, production costs fall while quantities and markups increase. In this case, the effect of tenure (or firm age) works through relationship capital and production costs rather than customer base

[21] Firms' pricing decision is static given the exogenous productivity process.

accumulation. The customer inflow function in Paciello et al. (2019) is replaced with a build-up of relationship capital $q(p)$, also decreasing in price, so that the law of motion of relationship capital becomes: $a' = (1-\delta) + q(p)$.[22]

3 A Model of Pass-Through into Domestic Price

In this section, I derive an expression for the pass-through of exchange rate fluctuations into aggregate domestic prices (CPI) to quantify the role that importing tenure has for the sensitivity of aggregate prices. I describe a theoretical framework that formalizes the channels and frictions influencing the exchange rate transmission into the CPI, accounting for the effects of importing tenure on border prices. I propose a parsimonious, one-period, partial-equilibrium, multi-product framework that includes several elements that affect the transmission of (exchange rate) shocks previously studied in the literature, such as distribution costs (Burstein et al., 2003; Corsetti and Dedola, 2005), variable markups (Goldberg and Verboven, 2001), imported inputs in the production of domestic products (Goldberg and Campa, 2010) and roundabout production (Basu, 1994), and nominal rigidities (Gopinath et al., 2010). This model allows to outline the key components influencing the sensitivity of aggregate domestic prices to exchange rate fluctuations, linking the behavior or ERPT into border prices to domestic CPI, and perform an accurate calibration exercise to quantitatively assess their individual role.

3.1 Set up

The section i) introduces the assumptions about preferences, production, and frictions; ii) derives an expression for the pass-through rate of exchange rate fluctuations into domestic prices.

Price Aggregator. The preferences of the domestic representative household are given by

$$W(C, L) = U(C) - V(L), \tag{3}$$

where C and L represent the household's final consumption and total labor supply, respectively.[23] I assume domestic households consume N sectoral goods $i \in \{1, \cdot, N\}$.[24] Specifically, the final consumption basket of the household, C, is given by an homogeneous of degree one consumption

22 Dasgupta and Stiglitz (1988) micro-founds the decreasing marginal cost under the assumption of learning-by-doing. Producers gradually become more able to fulfill buyers' requirement at a lower cost as they gain experience, which is captured by the cumulative quantity sold.

23 Typical regularity conditions are imposed on U and V: strictly increasing, twice differentiable, and $U'' < 0$, $V'' > 0$ and the Inada conditions are satisfied.

24 I use i to indicate both the good and the industry that produces the good.

aggregator $\mathcal{C}$ of the individual sectoral goods, $C = \mathcal{C}(c_1, \cdot, c_N)$. The household's utility maximization problem is subject to a standard budget constraint given by:

$$PC \equiv \sum_{i=1}^{N} p_i c_i \leqslant wL + \sum_{i=1}^{n_D} \int_0^1 \pi_{ik} dk, \tag{4}$$

where P is the nominal price index of the final consumption bundle; wL is the labor income; and the last term captures the dividends from owning the domestic firms.

I assume that C takes the form of a Cobb-Douglas aggregator as follows:

$$C(c_1, \cdot, c_N) = \prod_{i=1}^{N} \left(\frac{c_i}{\beta_i}\right)^{\beta_i}, \qquad \text{with } \sum_{i=1}^{N} \beta_i = 1 \tag{5}$$

where c_i is the amount of good i consumed and the constants $\beta_i \geqslant 0$ capture the share of each good in the household's final consumption.

The utility-based final consumption price index, which is the model-implied measure of CPI, is then given by:

$$P(p_1, \cdot, p_n) = \prod_{i=1}^{N} (p_i)^{\beta_i}, \tag{6}$$

where p_i is the price of the good of industry i.

Therefore, the pass-through of exchange rates into CPI (the elasticity of CPI to changes in nominal exchange rates, e), $\eta^{P,e}$, is given by:

$$\eta^{P,e} \equiv \frac{d \log P}{d \log e} = \boldsymbol{\beta} \times \boldsymbol{\eta}^{\mathbf{p},e}, \tag{7}$$

where $\boldsymbol{\beta}$ refers to the $N \times 1$ vector of expenditure shares, $(\beta_1, \cdot, \beta_N)$, and $\boldsymbol{\eta}^{\mathbf{p},e}$ to the $N \times 1$ vector of price elasticities, $(\eta^{p_1,e}, \cdot, \eta^{p_N,e})^T$.

Aggregate pass-through of exchange rate movements into the CPI is a weighted average of pass-through elasticities into the prices of all goods consumed in the domestic economy. Given the Cobb-Douglas specification in Equation (5), the relative weights correspond to the expenditure shares in total consumption, $\beta_i = \frac{p_i c_i}{PC}$.

I assume a subset n_F ($n_D = N - n_F$) of sectoral goods are imported (produced domestically).[25] In this way, I can disentangle the effects of direct import exposure (effect on imported final consumption) and indirect import exposure (effect of imported inputs on the production of domestic

[25] I label a sectoral good $i \in n_F$ ($i \in n_D$) as "imported" ("domestic").

goods). I can rewrite Equation (7) highlighting this decomposition:

$$\eta^{P,e} = \boldsymbol{\beta} \times \boldsymbol{\eta}^{\mathbf{p},e} = \underbrace{\boldsymbol{\beta}^{D} \times \boldsymbol{\eta}^{\mathbf{p}^{D},e}}_{\text{Indirect exposure}} + \underbrace{\boldsymbol{\beta}^{F} \times \boldsymbol{\eta}^{\mathbf{p}^{F},e}}_{\text{Direct exposure}}, \tag{8}$$

where $\eta^{\mathbf{p}^{D},e}$ ($\eta^{\mathbf{p}^{D},e}$) is the vector of price elasticities of a domestically (imported) sectoral goods.

In the following paragraphs, I elaborate further on the features underlying each price elasticity in Equation (8), introducing several element to generate additional realism in the transmission of exchange rate fluctuations. In particular, I consider channels and frictions that can amplify or attenuate the sensitivity of final consumption prices, like the presence of distribution costs, nominal and real rigidities and domestic input-output linkages.

Production and Price Elasticity of Domestic Goods. I assume that each domestic sectoral good, $i \in n_D$, is produced by a local competitive distributor by aggregating a mass of sectoral varieties. In turn, sectoral varieties are produced by a continuum of domestic monopolistically competitive firms, indexed by $k \in [0,1]$.

The competitive distributor of industry $i \in n_D$ aggregates the mass differentiated varieties into an homogeneous sectoral good, y_i, using an homothetic Kimball aggregator, Kimball (1995):

$$\sum_k A_i \mathcal{K}_i \left(\frac{y_{ik}}{y_i} \right) = 1, \tag{9}$$

where y_{ik} is the consumption of variety k in industry i, and A_i is a demand shifter; $\mathcal{K}(\cdot)$ is such that $\mathcal{K}(\cdot) > 0$, $\mathcal{K}'(\cdot) > 0$, $\mathcal{K}''(\cdot) < 0$ and $\mathcal{K}(1) = 1$. In the calibration exercise in Section 4, I adopt the common Klenow and Willis (2016) formulation of the Kimball aggregator.

The distributor sells the homogeneous sectoral good y_i incurring in distribution costs. Distribution costs represent the per-unit service inputs required to bring the homogeneous industry goods to consumers and firms, e.g. transportation, wholesales and retail services, marketing, etc (Burstein et al., 2003; Corsetti and Dedola, 2005). I follow Burstein et al. (2003) and assume that distribution services are combined with one unit of sectoral homogeneous good using a Cobb-Douglas technology and that distribution services are produced using only labor. Thus, the retail price of good i, p_i, is:

$$p_i = \widetilde{p}_i^{\,1-\phi_i} w^{\phi_i} \qquad \text{with } \phi \leqslant 1, \tag{10}$$

where $\widetilde{p}_i$ is the price of the aggregate homogeneous good i and ϕ_i the cost share of distribution services in the retail price of good i. I assume that distribution costs are heterogeneous across industries, as denoted by the i-specific weights in the production technology.

The monopolistically-competitive firms within each domestic industry $i \in n_D$ use a common constant return to scale production function. Domestic and imported sectoral goods can be used as inputs in the production of domestic varieties, together with labor. Indirect exposure arises from both the presence of imported inputs and domestic input-output linkages. The production function of firm k is given by:

$$y_{i,k} = F_i(l_{i,k}, x_{i1,k}, \cdot, x_{iN,k}), \tag{11}$$

where $y_{i,k}$ is firm k's output, $l_{i,k}$ is the labor input and $x_{ij,k}$ is the amount of good j used as input by firm k in sector i. I assume that firms employ the same Cobb-Douglas technology:

$$y_{i,k} = F_i(l_{i,k}, x_{i1,k}, \cdot, x_{iN,k}) = \zeta_i l_{i,k}^{\alpha_{i,l}} \prod_{j=1}^{N} x_{ij,k}^{\alpha_{i,j}} \qquad \text{with } \alpha_{i,l} + \sum_{j=1}^{N} \alpha_{i,j} = 1. \tag{12}$$

I assume that $\alpha_{i,l} > 0$, i.e. that labor is an essential input for the production of all varieties, in the sense that $F_i(0, x_{i1,k}, \cdot, x_{iN,k}) = 0$. $\alpha_{i,j}$ denotes the share of good j in industry i's production technology.[26] ζ_i is a sector-specific normalization constant.

Given the assumption on the distributor's aggregating technology, monopolistically competitive producers charge a (variable) markup over the marginal cost:

$$\widetilde{p_{ik}} = \mu_i mc_i \qquad \text{with } mc_i = w^{\alpha_{i,l}} \prod_{j=1}^{N} p_j^{\alpha_{i,j}}, \tag{13}$$

where $\widetilde{p_{ik}}$ is the price paid by the distributor for variety k, μ_i is the markup charged and the expression for the marginal cost, mc, comes from the specific production function assumed in Equation (12).

I now derive an expression for a change in the price of a domestic sectoral good following a change in exchange rate, which feeds into domestic prices through imported sectoral goods. To introduce additional realism, I assume that monopolistically competitive producers are subject to Calvo-style nominal rigidities: a fraction δ_i of firms in each sector i can adjust prices to changes in sectoral marginal costs $d \log \mathrm{mc}_i$. To simplify the exposition, I limit my analysis to a one-period, partial equilibrium framework.[27] [28]

[26] I assume that $\alpha_{i,j} \geqslant 0$ or, in other words, that industry i may rely on the goods produced by other (domestic or imported) industries as intermediate inputs.

[27] The timing is as follow: before the world begins, firms set prices based on their marginal cost, Equation (13); then the exchange rate change is realized; because of price rigidities, some firms have the possibility to adjust their price after observing the realized change in their marginal cost, while others do not; the world ends after production and consumption take place.

[28] I focus on the direct effect of exchange rate, Burstein and Gopinath (2014). In other words, I consider a partial-equilibrium response of domestic prices, not accounting for changes in the wage rate or the response of firms to changes in sectoral price indices.

A change in the price of domestic goods $i \in n_D$, π_i^D, is:

$$\pi_i^D \equiv d\log p_i^D = \underbrace{(1-\phi_i)}_{\text{Distribution Costs}} \quad \underbrace{\delta_i}_{\text{Nominal rigidities}} \quad \underbrace{\frac{1}{1+\Gamma_i}}_{\text{Variable markups}} \quad d\log mc_i \tag{14}$$

$$\underbrace{d\log mc_i}_{\text{Change in mc}} = \underbrace{\sum_{j=1}^{n_D} \alpha_{i,j}\pi_j^D}_{\substack{\text{Change in Domestic Inputs,}\\ \text{IO linkages}}} + \underbrace{\sum_{j'=1}^{n_F} \alpha_{i,j'}\pi_{j'}^F (d\log e)}_{\text{Change in Foreign Inputs}}. \tag{15}$$

A change in price follows a change in the marginal costs, that, in turn, is due to the change in input prices (last term in Equation (14)). The second summation in Equation (15) captures the change in the price of imported inputs (π^F) while the first summation represents the change the prices of domestically sourced inputs. Crucially, the former depends directly on the (log) exchange rate change, $\Delta \log \varepsilon$, and on the pass-through rate into border prices, which is disciplined later. The latter instead captures the indirect effect that exchange rate changes can have through the domestic production network and the indirect exposure to foreign inputs. Notice that the relevant price for inputs is the retail price set by the distributor, which includes also the distribution services.

A change in marginal cost is not passed completely into the retail price of domestic goods because of the presence of several frictions in the economy. Equation (14) shows that the change in marginal cost is attenuated by the presence of distribution costs, nominal and real rigidities. The presence of nominal rigidities allows only a fraction of firms to change prices. Similarly, real rigidities originated from variable markups in Equation (13) make firms reluctant to change their price relative to other firms' prices.[29] Finally, the presence of distribution costs in Equation (10) reduces the sensitivity of retail prices to changes in the production cost as the latter accounts only for a part of the retail price. By reducing the sensitivity of prices to change in marginal costs, the frictions ultimately dampen the transmission of exchange rate fluctuations.

Because of round-about production and input-output linkage, domestic prices can change because of indirect exposure. Let $\pi^D = (\pi_1, \cdot, \pi_{n_D})^T$ be the $n_D \times 1$ vector of domestic good price changes. Combining Equations (15) and (14) and rearranging, the change in domestic prices becomes:

$$\pi^D = \underbrace{(I - \Phi\Delta\Gamma S_d)^{-1}}_{\substack{\text{Adjusted}\\ \text{Leontief Inverse}}} \underbrace{\Phi}_{\substack{\text{Matrix of}\\ (1-\phi_i)}} \underbrace{\Delta}_{\substack{\text{Matrix of}\\ \delta_i}} \underbrace{\Gamma}_{\substack{\text{Matrix of}\\ \frac{1}{1+\Gamma_i}}} \underbrace{S_m}_{\substack{\text{Imported intermediate}\\ \text{input shares}}} \pi^F. \tag{16}$$

[29] Notice that abstracting from nominal rigidities would make the effect of real rigidities vanish because monopolistically competitive firms are symmetric. If nominal rigidities are absent, the change in price would be identical for all firms, relative prices would not change and real rigidities disappear. Departing from symmetric firms implies that firm-level pass-through depends on the correlation between markup elasticity and the cost shock, Amiti et al. (2019). Calibrating the model in this case without detailed firm level data is prohibitive.

A change in the price of foreign inputs, $\pi^F = (\pi_1, \cdot, \pi_{n_F})^T$, is transmitted to domestic prices through the shares of imported intermediate inputs, captured by the matrix S_m.[30] The change in marginal costs is attenuated by the presence of distribution costs, nominal and real rigidities, captured respectively by the diagonal matrices Φ, Δ and Γ. Finally, the first term represents the so-called Adjusted Leontief Inverse matrix, which captures the amplification arising from domestic round-about production. The Leontief matrix $(I - S_d)^{-1}$, with S_d being the input-output matrix of domestic input shares, captures the total expenditure of sector i on good j.[31] The adjusted matrix accounts for the fact that marginal cost changes are not fully passed into prices, ultimately capturing the effective total elasticity.

It follows immediately that the price elasticity of domestic goods in Equation (8) is:

$$\boldsymbol{\eta}^{\mathbf{p}^D,e} = \underbrace{(I - \Phi\Delta\Gamma S_d)^{-1}\,\Phi\Delta\Gamma S_m}_{\substack{\text{Domestic network} \\ \text{\& frictions}}} \times \underbrace{\boldsymbol{\eta}^{\mathbf{p}^F,e}}_{\substack{\text{Elasticity of} \\ \text{imported inputs}}} \quad , \tag{17}$$

where $\boldsymbol{\eta}^{\mathbf{p}^F,e}$ is the vector of price elasticities of imported goods, which is defined in the following paragraph.

Price Elasticity of Foreign Goods. In Section 2, I find that the exchange rate pass-through into import prices is incomplete and decreasing in importing tenure. I also argued that several micro-founded mechanism are in line with a broad definition of importing tenure and can generate qualitatively consistent patterns in terms of pass-through rates. To simplify the exposition, I take a reduced form approach, without micro-founding any pricing behavior of importers or exporters, but defining directly the exchange rate pass-through.

I assume that imported goods are purchased by a local distributor, which combines imported goods with local distribution services and determines the domestic retail price.[32] As in Equation (10), the retail price of imported goods is given by:

$$p_i = (\widetilde{p}_i(e))^{1-\phi_i}\, w^{\phi_i} \qquad \text{with } \phi \leqslant 1, \tag{18}$$

where $i \in n_F$ and $\widetilde{p}_i$ is the border price of the imported good, which depends on the exchange rate. Following the same reasoning for domestic prices, the change in the retail price of imported goods

[30] In other words, the matrix S_m collects all the input shares $\alpha_{i,j}$ where $j \in n_F$.

[31] Similarly to S_m, S_d captures all the input shares $\alpha_{i,j}$ where i, j are both domestic products.

[32] Notice that, in Section 2, I estimate the exchange rate pass-through into border prices using FOB values. In other words, the price of imported goods does not include local distribution costs that arises after customs are cleared.

following an exchange rate shock is:

$$\pi_i^F = \underbrace{(1-\phi_i)}_{\substack{\text{Distribution}\\ \text{costs}}} \quad \underbrace{\Psi(T_i)}_{\substack{\text{Border PT}\\ \text{Tenure effect}}} \quad d\log e,$$

where $\Psi(T_i)$ captures the incomplete pass-through rate into border prices, $\Psi = \frac{\partial \log \widetilde{p}_i}{\partial \log e}$. Importantly, the pass-through rate into border price depends on importing tenure, T_i, as documented in Section 2.[33]

Finally, it follows immediately that the price elasticity of imported goods appearing in Equations (8) and (17) is:[34]

$$\eta^{p^F,e} = \underbrace{\Phi}_{\substack{\text{Matrix of}\\ (1-\phi_i)}} \quad \underbrace{\Psi(T)}_{\substack{\text{Matrix of}\\ \text{Border PTs}}} \quad . \tag{19}$$

Discussion of Model Assumptions. I close this section with a discussion on the assumptions and caveats made in the description of the domestic economy.

I derive the pass-through of exchange rate into CPI, Equation (7), focusing on the direct effect (Burstein and Gopinath, 2014). In other words, I abstract from the effect of a change in exchange rate on domestic wages, sectoral prices and quantities. While such assumption is a simplification, most of the exchange rate fluctuations at quarterly level are relatively small and changes in aggregate variables like wage are likely to occur in response to larger devaluations or over long horizons.[35] Moreover, general equilibrium dynamics require additional structure in terms of wage determination and taking a stance on the dynamics of exchange rates and sectoral prices for a careful characterization of the dynamics of domestic prices in the presence of Calvo rigidities.

The second key assumption is that production and consumption are Cobb-Douglas. The main implication for the analysis carried out in here is that expenditure switching forces are absent as relative consumption and input shares remain constant. The presence of substitution across

[33] Notice that the structure connecting local distributors and domestic variety producers can be easily applied to imported goods and being consistent with the effects of tenure. If a local distributor aggregates imported varieties into imported sectoral goods, similarly to domestic goods, the incomplete pass-through Ψ arises because of variable markups, in the spirit of Atkeson and Burstein (2008). Importing tenure would be interpreted as market share accumulation, as argued in Section 2. Pursuing this avenue would require calibrating the parameters defining the underlying market structure (market share distribution) in order to match the estimated pass-through.

[34] As previously specified, I assume that sectoral goods are used for both final consumption and as intermediate inputs. The same price elasticity applies to both direct exposure (final consumption) in Equation (8) and indirect exposure (intermediate inputs) in Equation (17). In the empirical quantification, the imported sectoral goods used both as final consumption and intermediate inputs are considered separately, calibrating two different pass-through rates depending on their use.

[35] In this regard, the quantitative exercise on the "Estallido social" and the following depreciation can be interpreted as a short-run, partial-equilibrium approximation.

final consumption goods and inputs would reduce the sensitivity of prices.[36] However, the input-output tables are relatively aggregated compared to standard trade data, making substitution across products relatively low. Moreover, the relevant substitution would be between domestic and imported varieties within the same product, rather than across product categories. This type of expenditure switching forces are likely to occur in response to larger devaluations or over long horizons, and abstracting from them is in line with the direct ERPT and short-run view carried out in the paper.

Lastly, I took a stance on how the leading frictions included are micro-founded. I followed Burstein et al. (2003) in modelling distribution costs. Compared to Corsetti and Dedola (2005), which use additive distribution costs, the qualitative implications on pass-through are the same but the calibration is immediate as I can directly compute the shares ϕ_is from the input-output tables. I also assume that the distribution sector is competitive and distribution services are paid in labor. The former implies that distributors do not charge markups, abstracting from additional real rigidities; the latter implies that the share does not react to exchange rate changes.[37] Similarly, the micro-foundation of nominal and real rigidities follows standard choices in the macro and international economics literature and are compatible with the data available.[38]

4 Calibration

A detailed calibration of the domestic economy is one of the goals and contributions of this paper. Equations (17) and (7) show that different channels and frictions determine the CPI sensitivity to exchange rates. I show how a granular representation of the economy and their frictions is key to accurately gauge the transmission of exchange rate fluctuations into aggregate domestic prices. The strategy and the data I use can provide the basis for other model evaluations or policy analyses.

The main data contribution lies in disciplining the sources of heterogeneity influencing the transmission of exchange rate shocks. I focus on heterogeneous border pass-through rates arising from importing tenure, distributions margins, variable markups and Calvo rates, trade exposure and the granularity of the production network. The key ingredients are: the 2013 "make" and "use" tables from the Central Bank of Chile; data from the survey of manufacturing from 2000

36 In addition to sales reallocation, non-linearities and second-order effects can be relevant in an frictional production network like the one considered here (Hulten, 1978; Baqaee and Farhi, 2020). Exploring these elements in a general equilibrium setting is an important step I leave for future research.

37 Goldberg and Campa (2010) provide a raw estimate of distribution services sensitivity to exchange rate. However, an accurate product level calibration is difficult due to data limitations. The estimated effect of distribution costs can be considered as an lower bound.

38 In Section 4, I show how the markup elasticity of the Klenow and Willis (2016) Kimball specification can be easily calibrated estimating demand elasticity and superelasticity from firm-level data.

to 2007 (ENIA, *Encuesta Nacional Industrial Anual*) compiled by the Chilean National Statistical Agency (INE, *Instituto National de Estadisticas*), the universe of Chilean import transactions from 2009 to 2019 from the Chilean Customs Agency (*Aduanas*).[39] I now discuss in details the data and the strategy I use to calibrate the aggregate pass-through rate; additional information is provided in Appendix A.

Domestic Network: S_m, S_d and β. I construct the input-output matrix for the Chilean economy combining the 2013 "make" and "use" tables provided by the the Central Bank of Chile. The tables consist of two basic national accounting tables: the "make" table shows the production of commodities by industry while the "use" table shows the use of commodities by intermediate and final users. The Central Bank of Chile also provides information on international flow, allowing the construction of international make (for imports) and use (for exports) tables. The tables are very disaggregated and include 180 products and 110 industries.[40]

I combine the make and use tables at basic prices to construct a product-by-product (180x180) input-output matrix that quantifies how much of each product is used in the production of other products. I also use the input-output tables to compute the share of each product in final consumption. This allows me to calibrate the S_m and S_d matrices and the vector $\boldsymbol{\beta}$. Figures 10 in Appendix A.2 show the sparsity of the domestic network and the rich heterogeneity in trade exposure across products. Appendix A.2 provides additional details on the technical assumptions used in the construction of the IO matrices.

Distribution margins: Φ. The distribution margin is computed as the ratio of the value of trade and transport margins to the value of total supply of that product at purchasers' prices:

$$\phi_i \equiv \frac{\text{Retail + wholesale + Transportation costs}}{\text{Value at purchaser prices}} \equiv \frac{\text{Value at purchaser prices - value at basic prices}}{\text{Value at purchaser prices}}. \tag{20}$$

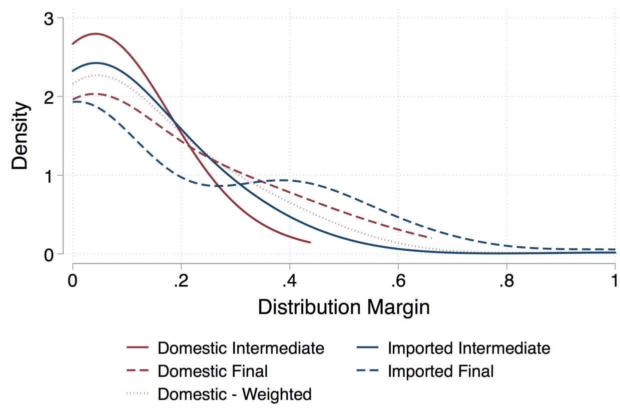
Following Goldberg and Campa (2010), I use the input-output matrices for the Chilean economy to compute the value of trade and transport margins as the difference between the cost of supply (basic price) and the purchaser price.[41] The richness of the data allows me to compute not only heterogeneous margins across products but also across use (final vs intermediate consumption) and

[39] I also use additional macroeconomic variables such as inflation rates, sectoral deflators, GDP growth rates, exchange rates from IMF, OECD or Central Bank of Chile.

[40] As a comparison, commonly used input-output tables as the WIOD or the OECD tables have around 30 to 40 industries. Pasten et al. (2020) shows that the granularity of the input-output table plays a central role in the proper quantification of the real effects of monetary policy.

[41] The Central Bank of Chile provides the make and use tables both at basic and purchaser prices. The latter is defined as the cost of supply plus retail, wholesale, and transportation costs, plus net taxes.

Figure 2: Density of Distribution Margins



The figure plots the density distribution of the distribution margins across products. The distribution margins are computed according to Equation (20). I distinguish products depending: on their use, final vs intermediate use (solid vs dashed lines, respectively); on their origin, imported vs domestically produced (blue vs red lines, respectively). The dotted line shows the density distribution of the expenditure-weighted average of the distribution margin for final and intermediate domestic products.

origin (imported vs domestic).[42]

Figure 2 and Table 9 in Appendix A.2 report the density distribution and the average distribution margin for different class of products (domestic vs imported, intermediate vs final), respectively. It is worth noting that, on one hand, domestically produced products tend to have lower distribution margins, consistently with the fact that internationally sourced goods are subject to larger transportation costs; on the other hand, intermediate goods also tend to have lower distribution margins, suggesting that lower pass-through due to distribution costs potentially arises at the end of the production chain, when products reach final consumers.

Markup elasticity: Γ. I use the Annual National Industrial Survey (ENIA) from 2000 to 2007 to estimate markup elasticities at the 3-digit industry level.[43] The theoretical model in Section 3 assumes a Kimball VES technology. For the main quantitative exercise, I assume that the Kimball aggregator takes the form of a Klenow and Willis (2016) aggregator. I follow Gopinath et al. (2010) and Amiti et al. (2019) and calibrate the steady-state value of the markup elasticity:

$$\Gamma_i = \frac{\epsilon_i}{\sigma_i - 1}, \tag{21}$$

42 In the model in Section 3, the price of domestic goods is the same independently of their use, final consumption vs intermediate input. Therefore, it is not possible to use the corresponding distribution margins. For each domestic product, I calibrate a unique distribution margin as the expenditure-weighted average of the distribution margin for final and intermediate use. The same issue does not arise for imported products.

43 I match the estimated 3-digit industry level parameters with the product classification from the IO tables. It is possible that the same estimated markup elasticity is used for more than one product. For missing products, mostly from the service industry, I use the estimated aggregate markup elasticity.

where the markup elasticity depends on two parameters, the industry-specific elasticity of demand, σ_i, and the super-elasticity of demand, ϵ_i.[44]

For each industry, I calibrate the elasticity of demand to match the revenue-weighted average estimated markup, $\bar{\mu_i}$, $\sigma_i = \frac{\bar{\mu_i}}{\bar{\mu_i}-1}$. ENIA provides information on sales, inputs expenditures, employment and wage bill, investment, industry code (ISIC rev 3), for approximately 5000 plants per year with more than 10 employees. I estimate production functions and firm-level markups using state-of-the-art techniques and best practices, Levinsohn and Petrin (2003), Ackerberg et al. (2015) and De Loecker and Warzynski (2012).

I follow Edmond et al. (2018) in estimating the super-elasticity parameter ϵ using the within-industry relationship between markups and market shares implied by the Klenow and Willis (2016) specification:

$$\frac{1}{\mu_{ik}} + \log\left(1 - \frac{1}{\mu_{ik}}\right) = a_i + b_i \log \texttt{share}_{ik}, \qquad b_i = \frac{\epsilon_i}{\sigma_i}, \tag{22}$$

where $\texttt{share}_{ik}$ is the market share of firm k in industry i. I estimate the slope coefficient b_i for each industry to retrieve the superelasticity, ϵ_i, given the estimated demand elasticity.

Table 4 reports the estimated sectoral parameters (markup elasticity, demand elasticity and superelasticity) and summary statistics of the sectoral markup distributions. Estimated average and median markups are reasonable and in line with previous results from Chile, Levinsohn and Petrin (2003) and Garcia-Marin et al. (2019).[45] Importantly, the steady-state markup elasticities are well between the range of values previously used in the literature and show substantial heterogeneity across sectors.[46] [47]

In Appendix A.3, I provide additional details on the estimation of production function and markups. Moreover, I consider alternative measures of markups as robustness. I estimate markups using different definitions of variable input (cost of good sold vs labor only) and using the simple alternative cost share approach (Autor et al., 2020; De Loecker et al., 2016). Markup distributions and the implied parameters are very similar, independently of the approach or variable input used.

[44] The markup elasticity of variety k in industry i takes the form of $\Gamma_{ik} = \frac{\epsilon_i}{\sigma_i - 1 + \epsilon_i \log\left(\frac{\widetilde{p_{ik}}}{\widetilde{p_i}}\right)}$, with $\widetilde{p_{ik}}$ and $\widetilde{p_i}$ being the price of variety k and the industry price index, respectively. Both Gopinath et al. (2010) and Amiti et al. (2019) calibrate this object under the assumption $\widetilde{p_{ik}} = \widetilde{p_i}$. Under this assumption, the markup elasticity can be interpreted as the steady-state markup elasticity, Gopinath et al. (2010), or the markup elasticity for an average firm, Amiti et al. (2019).

[45] Figure 12 in Appendix A.3 plots the distribution of markups across firms for each industry. I use the median markup to calibrate σ_i for the only industry with an average markup lower than one.

[46] Gopinath et al. (2010) vary the super-elasticity ϵ between $[0, 8]$, implying a Γ varying between $[0, 2]$, given a $\sigma = 5$.

[47] Consistent with the the chosen Kimball specification, the right panel of Figure 13 in Appendix A.3 shows that the positive relationship between average markup and markup elasticity holds also across industries. The left panel of Figure 13 in Appendix A.3 shows that there is no particular relationship between the average markups and the estimated superelasticity across industries.

Table 4: Markup and Markup Elasticity

	Markup				Implied Parameters		
	Mean	Median	StD	Weighted Mean	σ	ϵ	Γ
Food Beverages and Tobacco	1.343	1.302	0.226	1.415	4.098	2.281	0.479
Textile and Apparel	1.274	1.262	0.186	1.301	4.266	1.672	0.498
Wood Paper and Printing	1.289	1.257	0.201	1.377	3.643	1.712	0.646
Petroleoum and Chemical Products	1.392	1.275	0.410	1.420	3.521	1.139	0.434
Plastic Rubber and Construction	1.292	1.262	0.209	1.391	3.930	2.546	0.578
Fabricated Metal	1.165	1.101	0.263	1.295	4.939	0.810	0.226
Machinery and Equipment	1.201	1.177	0.188	1.152	8.122	1.595	0.380
Motor Vehicle	1.088	1.119	0.265	1.047	13.18	7.582	0.486
Forniture	1.244	1.227	0.172	1.275	4.641	2.283	0.627
Aggregate	1.274	1.237	0.247	1.408	3.453	1.093	0.446

The table reports summary statistics of the estimated markups aggregated at the 2-digit sectoral level. Weighted-mean reports the average markup weighted by revenue. Markups are estimated using the survey of manufacturing (ENIA) from 2000 to 2007 and state-of-the-art production function estimation, Ackerberg et al. (2015) and De Loecker and Warzynski (2012). The table reports also the average implied demand elasticity (σ), super-elasticity (ϵ) and markup elasticity (Γ). Demand elasticity is calibrated to match the estimated revenue-weighted average markup. I follow Edmond et al. (2018) to estimate the demand super-elasticity leveraging the within-industry relationship between markups and market shares implied by the Klenow and Willis (2016) specification. Markup elasticity is defined as in Equation (21). Appendix A provides additional information on data and empirical specifications.

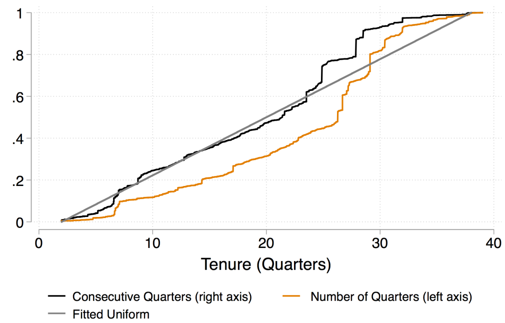
Calvo probability: Δ. Due to lack of disaggregated domestic pricing data, I calibrate a common probability of price adjustment (Calvo parameter), δ, across all products.[48] I set the aggregate average monthly frequency of price adjustment is 30%, according to the micro-level estimates of Aruoba et al. (2022) using confidential daily transaction data from the Chilean Tax Authority.[49] This implies an average quarterly probability of adjustment of 65%, with an average duration of about 2.8 months.

Pass-through and Tenure: $\Psi(T)$. Differently from the other frictions and channels considered, I calibrate directly the incomplete pass-through rate into border prices using the estimates from Section 2. In order to gauge the relevance of importing tenure for domestic prices, I consider two different scenarios: an homogeneous incomplete pass-through across all imported products and tenure-driven heterogeneous pass-through rates. Specifically, the former captures the incomplete

48 As shown in the following section, heterogeneity in frictions is key in determining which products are the most important contributors to the transmission of exchange rate fluctuations. At this stage, the role of price rigidities cannot be fully explored and is left to future research.

49 The frequency of price adjustment is slightly higher compared to the estimated value of $\approx 20\%$ for the US, Nakamura and Steinsson (2008) and Pasten et al. (2020).

Figure 3: Cross-product Distribution of Tenure



The figure plots the cumulative distribution of average import tenure at the product level. I consider 5-digit SITC product categories. The average import tenure for each product is computed as the expenditure-weighted average tenure across all firm-origin pairs. The black (orange) line plots the most preferred (alternative) definition of tenure, as defined in Table 2. The solid gray line represents a uniform distribution over the range of importing tenure. The figure uses data from 2019 only.

pass-through rate abstracting from the role of importing tenure, as if all importers had no importing experience. The latter accounts for the heterogeneous effects of tenure on pass-through and the positive relationship with import shares, providing a reduced-form aggregate quantification of the mechanisms described in Section 2.

I calibrate the homogeneous incomplete pass-through rate to be 0.75, estimated using the Customs data described in Section 2.1 and the regression in Equation (1) after dropping the set of controls and the time fixed effects.[50] The discrepancy with the average pass-through rate in Table 3 is due to the presence of time fixed effects. The presence of time fixed effect is important to properly estimate the effect of importing tenure, Heise (2019). However, removing the time fixed effects is necessary not to soak most of the variation in exchange rate fluctuations and is standard in the literature, Gopinath et al. (2020). Table 11 in Appendix A.4 shows that the value of 0.75 is robust to the set of fixed effects included and in line with previous estimates from the literature (Amiti et al., 2014; Gopinath et al., 2020).[51]

I calibrate heterogeneous pass-through rates combining the estimates on the effect of importing tenure (Table 3) and the positive relationship between import share and tenure (Figure 1). Figure 3 shows that, in 2019, the preferred measure of importing tenure aggregated at the 5-digit product

[50] The pass-through is estimated at quarterly frequencies to be consistent with the Calvo probability Δ, also calibrated at the quarterly level.

[51] The specification used for the estimates in Table 11 in Appendix A.4 controls also for the effect of importing tenure so that the average ERPT can be interpreted as the pass-through faced by a new importer. However, the impact of importing tenure is higher than the one estimated using Equation (1). For this reason, I use the conservative estimates from the main specification when gauging the effect of tenure.

level was ranging from 1 to 40 quarters.[52] [53] Given the estimated effect of tenure, this implies an heterogeneous pass-through ranging between 0.6 and 0.75.[54] Figure 3 shows that the cumulative distribution of importing tenure across 5-digit products closely resembles a uniform distribution. Therefore, I evenly distribute product-level pass-through rates in the rage $[0.6, 0.75]$.[55] Finally, I calibrate the heterogeneous pass-through rates across products leveraging the relationship between import shares and tenure (second fact documented in Section 2). High import shares are associated to higher tenure and, therefore, lower pass-through.[56]

5 Empirical Results

I now study the importance of different forces for the aggregate sensitivity of domestic prices to exchange rate fluctuations, with a particular focus on the role of importing tenure. I find that the heterogeneity in pass-through due to importing tenure documented in Section 2 reduces the sensitivity of aggregate domestic prices by 20%, comparable to the role of the other frictions and channels considered. I use the sharp depreciation episode of the Chilean peso following the 2019 ”Estallido Social” (social outburst) to find that the empirical evidence documented in Section 2 insulated domestic prices and reduced inflation by 10% (0.1 p.p. at quarterly level). Using back-of-the-envelope calculation and my estimates from Section 2, I also show that the increase in aggregate importing tenure from 2009 to 2019 can account for 40% of the recent decline in the aggregate sensitivity of domestic prices to exchange rate fluctuations.

Moreover, I find that most of the CPI sensitivity arises through changes in the price of imported final goods (direct exposure), contrary to previous results in the literature. These results show how a careful modelling of the domestic production network and its frictions is key to precisely unpack the sensitivity of aggregate domestic prices to exchange rate fluctuations.

52 My analysis focuses on the effect of tenure on pass-through across products, not dynamically. I choose the distribution of importing tenure in 2019 interpreting it as the steady state distribution across products. In addition, choosing 2019 makes the quantification of the ”Estallido Social” event study more accurate.

53 I aggregate importing tenure at the 5-digit level computing the expenditure-weighted average tenure across all importer-origin pairs.

54 In order not to underestimate the effects of high levels of importing tenure, I use the estimated coefficient for the effect of tenure in level, column (1) in Table 12, rather than in logs (Table 3). This implies that the lowest pass-through rate is $0.75 - 0.0038 \times 40 \approx 0.75 - 0.15 = 0.6$. Using the coefficients in logs delivers a slightly higher lower bound.

55 The cumulative distribution is very close to a uniform distribution except for very high value of importing tenure. Assuming a uniform distribution would slightly overestimate the relevance of high tenure products. Because of this, the estimated effect of importing tenure on domestic prices can be interpreted as an upper bound.

56 I rely on the relationship between import shares and tenure because matching the HS or SITC classifications used in Customs data to the product classification in the input-output matrices is not possible.

5.1 Decomposing CPI Sensitivity and the Role of Tenure

I now present my first quantitative result: heterogeneity in importing tenure reduces aggregate CPI sensitivity by 20%. This result does not depend on the specific scenario considered, supporting the idea that importing tenure plays a substantial role *per se*. At the same time, I show that alternative forces reducing the sensitivity of domestic prices to exchange rate fluctuations are also quantitative relevant, providing support to previous empirical analysis.

I proceed by quantifying the response of final consumption prices to a one percent depreciation of the exchange rate across different scenarios. I calibrate six different cases. Table 5 lists the different combinations of pass-through into import prices, importing tenure, domestic frictions and input-output linkages I study.[57] The benchmark economy is a frictionless economy (i.e. no distribution costs, markup elasticities and Calvo rigidities) that includes input-output linkages and in which the pass-through rate of exchange rate fluctuations is complete. On the contrary, the full model (Case V) considers a domestic economy that includes all frictions, input-output linkages and in which the pass-through rate of exchange rate fluctuations is incomplete and heterogeneous due to importing tenure.

Table 5: Overview of Calibration Cases

	Pass-through into Import Prices		Domestic Frictions			
	Average	Tenure Heterogeneity	Φ	Γ	Δ	IO Linkages
Benchmark	Complete					✓
Case I	Incomplete					✓
Case II	Incomplete	✓				✓
Case III	Incomplete	✓	✓			✓
Case IV	Incomplete	✓	✓	✓		✓
Case V ("Full")	Incomplete	✓	✓	✓	✓	✓

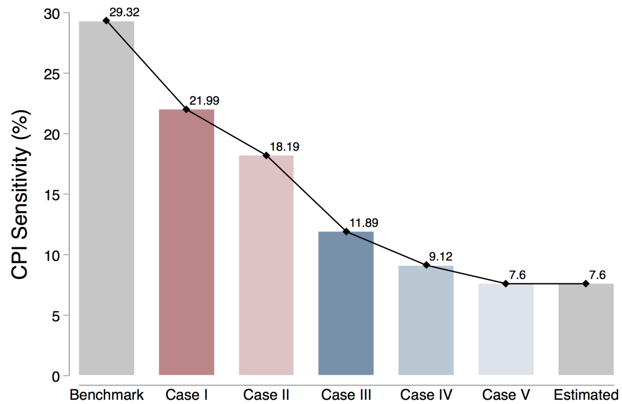
The table details the assumptions on pass-through into import prices, importing tenure, domestic frictions and input-output linkages for the different cases considered in the calibration. Notice that all scenarios use the same input and consumption shares.

Figure 4 shows that the full model (Case V) quantitatively matches the estimated CPI sensitivity for the period from 2009 to 2020. The benchmark economy largely overestimates the sensitivity of domestic prices to exchange rate fluctuations as the implied sensitivity is four times larger than the estimated one.[58] On the contrary, the full model does a great job in matching the estimated

[57] Importantly, in order to make the different cases as comparable as possible, I ignore the possibility that input or consumption shares could be different in the absence of some frictions or input-output linkages.

[58] See Appendix C for more details on the estimation of the average CPI sensitivity over the period 2009-2020.

Figure 4: Decomposition CPI Sensitivity



The figure plots the aggregate CPI sensitivity to a one percent depreciation in the exchange rate for different cases. See Table 5 for a description of the different cases. I scale all the numbers by 100. The last column, "Estimated", reports the estimated CPI sensitivity to exchange rate estimated at the quarterly level from 2009 to 2019 (also scaled by 100). Appendix C provides additional details on the estimation.

sensitivity. This supports the idea that the model presented in Section 3 includes the main channels required in explaining the low sensitivity of domestic prices, and its simplicity is not coming at the expenses of quantitative reality.

Figure 4 helps also shedding lights on the relative importance of each individual channel considered as I add one channel at a time to develop step-wise intuition. Including incomplete but homogeneous exchange rate pass-through rate into import prices reduces the sensitivity of domestic prices by 25% (22/29.3).[59] Case II accounts for the role of importing tenure, ultimately quantifying the impact of the two empirical facts documented in Section 2. Compared to an homogeneous incomplete pass-through (Case I), abstracting from the heterogeneity driven by tenure increases the sensitivity of domestic prices by almost 21% (22/18.2).[60] Applying the same reasoning to the additional domestic frictions considered, distribution costs, markup elasticities and Calvo rigidities reduce domestic price sensitivity by approximately 35%, 25% and 17%, respectively.

All channels considered contribute substantially to the overall aggregate insensitivity of domestic prices, suggesting that future analysis should account for their joint effect. Interestingly, domestic frictions (distribution cost, markup elasticity and Calvo rigidities) are quantitatively more relevant in dampening the sensitivity of CPI than incomplete pass-through to border/import prices. I expand on the sources of this result in Section 5.4, but it already signals the importance

[59] The average incomplete pass-through may arise because exporters have variable markups or they face nominal rigidities, or a combination of the two. As explained in Section A, I calibrate directly the average pass-through into import price without disentangling the potential sources due to lack of data on the exporter side.

[60] Alternatively, including heterogeneous pass-through rates into import prices reduces domestic price sensitivity by approximately 18%, 18.2/22.

Table 6: On the Role of Importing Tenure

	Tenure Heterogeneity	No Tenure Heterogeneity
Frictionless	18.2	22.0
Distribution only	11.9	14.4
Distribution & Markups	9.12	11.0
All Frictions	7.60	9.17

The table compares the aggregate CPI sensitivity computed in the presence of tenure heterogeneity or abstracting from it across different scenarios. In the presence of tenure heterogeneity, the pass-through rate into import price is incomplete and heterogeneous. When abstracting from tenure heterogeneity, the pass-through rate into import price is incomplete but homogeneous. I consider the following scenarios: "Frictionless", referring to a domestic economy with no frictions (i.e. no distribution costs, markup elasticity or Calvo rigidities); "Distribution only" consider a domestic economy with only distribution costs; "Distribution and Markups" refers to an economy including both distribution costs and markup elasticity; "All frictions" considers all domestic frictions together. I consider input-output linkages in all scenarios.

to carefully account for domestic channels.

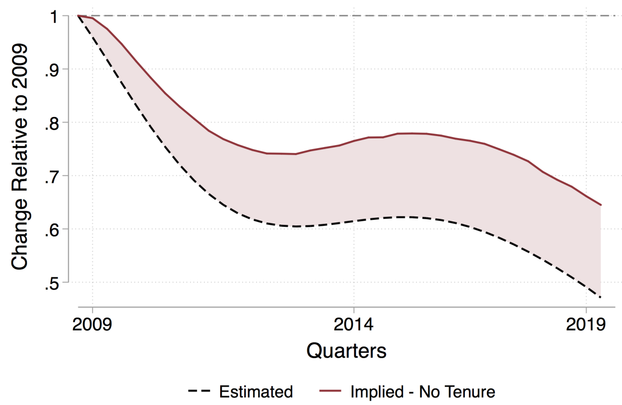
As robustness, Table 6 focuses on the role of importing tenure and shows its contribution is quantitatively similar across other scenarios. In particular, I compare the same scenario including and abstracting from importing tenure. Each scenario is defined in terms of which domestic frictions (distribution cost, markup elasticity and Calvo rigidity) are considered. Independently of the scenario considered, abstracting from the effect of importing tenure on exchange rate pass-through increases the sensitivity of domestic prices by approximately 21%. This suggests that the empirical facts documented in Section 2 play a substantial role *per se* and constitute an important channel in the transmission of exchange rate fluctuations.

Figure 19 in Appendix C shows substantial heterogeneity in the sectoral response to the common exchange rate depreciation shock and how this heterogeneity is affected by the effects of importing tenure. The interaction of different heterogeneities plays a crucial role for the relative contribution of different sectors to the aggregate, Pasten et al. (2020). Figure 19 shows that abstracting from importing tenure not only influences the average sensitivity of domestic prices but also which products contribute relatively more to the overall CPI sensitivity. A deeper investigation on the sources and consequences of sectoral heterogeneities (in domestic frictions, for instance) is postponed to Section 5.4.

5.2 Trend in ERPT and Tenure

I show that the rise in average importing tenure can partially account for the recent declining trend in domestic price sensitivity. Growing evidence document a declining trend in the sensitivity

Figure 5: Trend in ERPT and Contribution of Tenure



The figure plots the estimated trend in CPI sensitivity to exchange rates (dash line) and the counterfactual trend in CPI sensitivity to exchange rates abstracting from the rise in importing tenure. The trend is estimated using a polynomial approximation of the series of estimated exchange rate pass-through rates into CPI. Exchange rate pass-through rates are estimated using a 5-year rolling window from 2007 to 2020 at the quarterly level. Appendix C provides additional details on the estimation. The counterfactual trend is computed subtracting the effect driven by the rise in aggregate importing tenure, documented in Figure 20 in Appendix C. The effect of tenure is computed multiplying tenure by its marginal effect on the pass-through into import prices (Table 1) and scaled by its contribution to domestic price sensitivity (Table 6).

of domestic prices to exchange rate fluctuations across several advanced economies since the late 1980s.[61] Several papers have considered the rise of global value chains and international participation in general as a possible explanation for the decline in exchange rate pass-through (Campa and Goldberg, 2005; Camatte et al., 2021; Georgiadis et al., 2020). The effect of importing tenure on exchange-rate pass-through documented in Section 2 also points in the same direction. I further investigate and document that average importing tenure has increased relative to 2009 and can explain around 30%-40% of the recent declined in CPI sensitivity experienced in Chile.

I document that the sensitivity of domestic prices to exchange rate fluctuations has been decreasing also in Chile, complementing the recent evidence from advanced economies. The dash line in Figure 5 plots the estimated trend from 2007 to 2020 using a 5-year rolling window. I find that the pass-through rate into CPI decreased by 50% in 2019 relative to 2009, in line with previous works (Camatte et al., 2021).[62] [63]

Using back-of-the-envelope calculations based on my estimates, I compute the contribution of

[61] This evidence complements the large empirical literature documenting long-run trends in interest rate, inflation, productivity growth, business dynamism etc.

[62] Figure 18 in Appendix C shows that the recent decline is just part of a long-run declining trend started in the late 70s. CPI sensitivity to exchange rates at the beginning of the sample was around 0.35% and reached a value of about 0.07-0.1% in the last decade.

[63] I estimate a trend because exchange rate pass-through rates at quarterly level can be particularly noisy. Appendix C provides additional details on the estimation.

the rise of importing tenure to the declining trend in CPI sensitivity. Relative to the beginning of 2009, when tenure is normalized to one quarter, Figure 20 in Appendix C shows that the expenditure-weighted average importing tenure increased to 18 quarters. I quantify the change in aggregate CPI sensitivity driven by the increase in tenure using the estimated marginal effect of tenure on import prices (Table 3) and the fact that abstracting from tenure increases CPI sensitivity by 20%.[64] Figure 5 shows that the counterfactual trend in CPI sensitivity (solid line) decreases 40% less relatively to the estimated one.[65] This confirms the importance of participation in international markets, proxied by importing tenure, in explaining the recent trends in domestic price sensitivity to exchange rates.[66]

5.3 The 2019 "*Estallido Social*" in Chile

The "*Estallido Social*" (social outburst) refers to a series of massive and severe riots originated in Chile between October 2019 and March 2020. From the perspective of my analysis, the riots triggered a major devaluation of the Chilean peso against all major currencies and make the event a natural laboratory to study the effects of importing tenure on domestic prices.

The protests started in the capital, Santiago, on October 6 after subway fares were raised by 4%.[67] The riots quickly escalated and spread across the entire country. Figure 6 plots the daily index for the number of Google searches for protests ("protestas" in Spanish) in Chile, showing the timing and the evolution of the shock. Importantly for the following analysis, Figure 6 documents that the riots did not constitute an expected event as the Google search index was zero before the beginning of October. Moreover, the episode was short-lived as the index goes back to the pre-crisis level by the end of 2019.[68]

Figure 6 also shows how, following the social outburst, the Chilean peso sharply depreciated with respect to the a composite index of foreign currencies. Political and social tensions increased uncertainty and risk for international investors, ultimately putting pressure on the value of the

64 A tenure of 18 quarters implies a pass-through rate into import price $\log(18)0.035 \approx 0.10$ lower, given the estimates in Table 3. I then multiply it by 20% to get the effect on domestic prices, which is approximately 0.025%. CPI sensitivity declines from 0.117% to 0.055%. Abstracting from tenure, the end point is 0.0755%, approximately 35% higher.

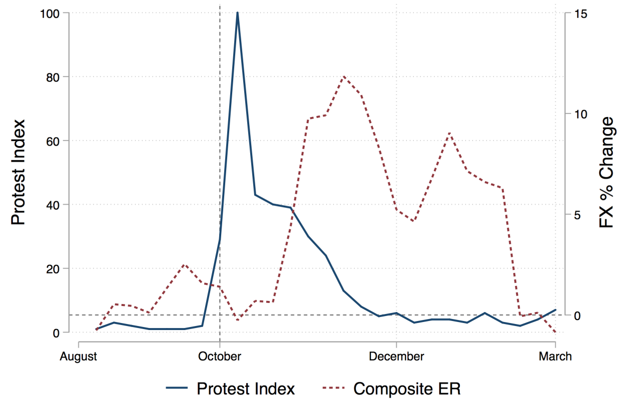
65 As robustness, Figure 21 in Appendix C shows the counterfactual trend using different measures of tenure and different estimates for the marginal effect of tenure on import prices. The counterfactual trend decreases at least 20% less than the estimated one.

66 The rise in average importing tenure and, more generally, international market participation in the period starting from 2009 could be driven by the formation of new international relationship following the Great Trade collapse in 2008, Heise (2019). Expanding the analysis to include the years of the Great Recession with a focus at business-cycle frequency is an interesting avenue for future work.

67 The rise in subway fares was only the trigger of the protests, as high costs of living and socio-economic inequality represented the deeper roots of the social outburst.

68 Aruoba et al. (2022) documents that riots were quite widespread across the entire country, though with different levels of intensity.

Figure 6: Riot Index and Exchange Rate Dynamics



The figure plots, on the left axis, the daily Google search index for protests ("protestas" in Spanish) in Chile. The value is normalized so that the maximum over the time period considered is set equal to 100. On the right axis, I plot the weekly 3-month depreciation rate of the Chilean peso against a composite index of foreign currencies. The composite index of foreign currency is sourced from the Central Bank of Chile and is constructed as a trade-weighted average of bilateral exchange rates.

Chilean peso.[69] The three-month depreciation rate of the Chilean rate peaked at 12% in mid November, right before the Central Bank of Chile started intervening directly on the currency market to stabilize the value of the currency.[70]

I use the theoretical expression of CPI sensitivity to exchange rates derived in Section 3 and the disaggregated calibration from Section 4 to gauge the effect of importing tenure on domestic prices during the 2019 "*Estallido Social*". I consider three different scenarios in measuring the quarterly depreciation rate of the Chilean peso. In the most conservative quantification, I consider the average quarterly depreciation in the last quarter of 2019 with respect to the third quarter of the same year, which is 5.6% ("*Average*"). Alternatively, I consider the peak depreciation rate during the last quarter of 2019, which is about 12% ("*Peak*"). Finally, to account for lagged response of the exchange rate and domestic prices, I consider also the cumulative depreciation of the Chilean peso over the 2019Q4-2020Q1 period with respect to the third quarter of 2019 ("*Cumulative*").

For each scenario, column (1) in Table 7 reports the corresponding depreciation rate. I quantify the implied rise in domestic prices following the depreciation of the Chilean peso using the full model (Case V) in Table 5. Depending on the scenario, imported inflation (column (2)) accounts for 30% to 90% of the actual increase in domestic prices in Chile, which is reported in column (4).[71]

Turning to the role of importing tenure, I compute the implied rise in domestic prices following

69 https://www.bloomberg.com/news/articles/2021-07-06/investors-look-abroad-amid-political-tensions-chile

70 The Central Bank of Chile used around $24bn in open market operations in the period between 2019Q3 and 2020Q1.

71 These numbers are sensible considering that the average quarterly inflation in the previous 4 quarters was 0.5%. Traditional inflationary shocks and additional forces in the economy can explain the remaining part.

Table 7: Tenure and the "*Estallido Social*"

	Depreciation	Imported π		Actual π	Counterfactual		
		Full	w/out Tenure		π	Tenure Contribution	% Increase
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average 2019Q4	5.61	0.43	0.52	1	1.09	0.09	8.98
Peak 2019Q4	11.8	0.90	1.09	1	1.19	0.19	19.0
Cumulative 2019Q4-2020Q1	10.8	0.82	0.99	2.32	2.49	0.17	7.45

The table reports back-of-the-envelope calculations on the effects of tenure on domestic prices during the 2019 "*Estallido Social*" in Chile. Each row corresponds to a different scenario in terms of Chilean peso depreciation rate. Column (1) shows the depreciation rate corresponding to each scenario. Column (2) quantifies the implied rise in domestic prices following the depreciation of the Chilean peso using the full model, Case V in Table 5. Column (3) quantifies the implied rise in domestic prices as in column(2) but dropping the assumption of heterogeneous pass-through rates due to importing tenure. Column (4) reports the actual quarterly inflation rate corresponding to each scenario. Column (5) shows the counterfactual domestic inflation rate under the assumption of no tenure heterogeneity. Column (6) and (7) quantify by how much domestic inflation increases in the counterfactual scenario, in level and in p.p., respectively.

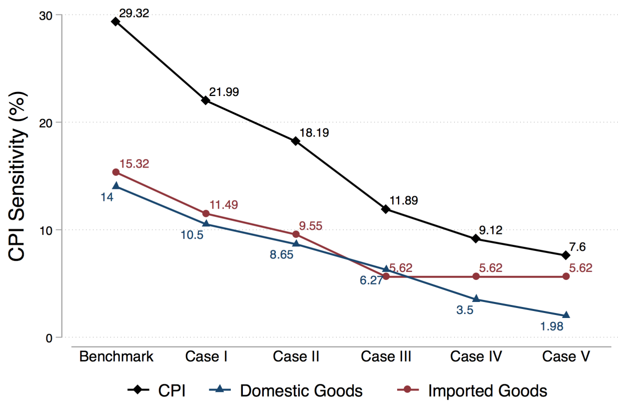
the depreciation shock under the counterfactual assumption that all importing relationships were new, i.e. tenure is equal to zero across all products.[72] As per the results in Table 6, abstracting from tenure heterogeneity increases imported inflation by 20% as the exchange rate pass-through into import price rises. Using back-of-the-envelope calculations, the counterfactual assumption of no importing tenure implies that the domestic inflation rate would be 0.09 to 0.2 p.p. higher depending on the scenario, which is a sizeable increase at the quarterly level. By quantitatively affecting the transmission of exchange rate movements into domestic prices, importing tenure may have implications for optimal monetary and exchange rate policies (Corsetti et al., 2010; Auer et al., 2019).

5.4 Revisiting Other Channels

The exposure of domestic final consumption to imports is a key element to quantify the transmission of exchange rate into domestic prices, Goldberg and Campa (2010). Already accounting for the two empirical facts documented in Section 2 provides new insights on its role, as products with larger import shares are associated to lower pass-through rate due to higher average tenure. However, also input-output linkages and heterogeneous frictions ultimately alter the identity of the most relevant sectors to the transmission of shocks as the recent production network and macroe-

[72] In other words, I consider an economy with all domestic frictions (distribution, markups and Calvo rigidities) and homogeneous incomplete pass-through rate into import prices.

Figure 7: Decomposing Aggregate CPI Sensitivity



The figure plots the aggregate CPI sensitivity to a one percent depreciation in the exchange rate and its decomposition into imported final consumption ("Imported"), i.e. direct exposure, and domestic final consumption ("Domestic"), i.e. indirect exposure, for different cases. See Table 5 for a description of the different cases. I scale all the numbers by 100.

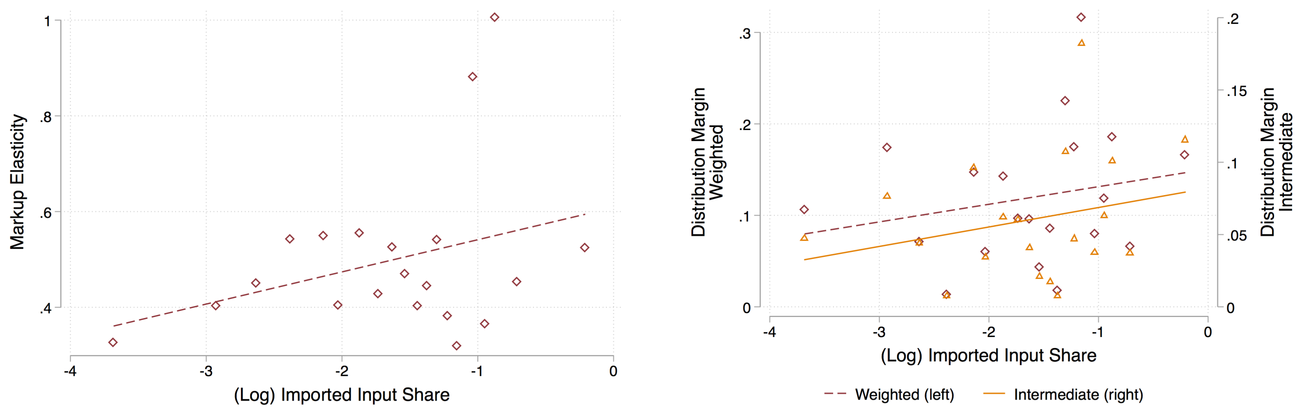
conomic literature pointed out (Pasten et al., 2020; Rubbo, 2020).[73] My framework allows to investigate the role of import exposure in light of the realistic heterogeneities calibrated in Section 4.

Figure 7 shows that, as more frictions are considered, not only CPI become less sensitive to exchange rate fluctuations changes, but the overall sensitivity of CPI is increasingly driven by imported final consumption goods ("direct exposure"). In the full model (Case V), direct exposure accounts for 75% of the overall CPI sensitivity while the import content of domestically produced goods ("indirect exposure") accounts for the remaining part. However, in a frictionless economy ("Benchmark"), direct and indirect import exposure equally contribute to the overall price change. The benchmark case is in line with previous analysis and calibrations that identify imported intermediate inputs as the predominant channel for the aggregate CPI sensitivity (Goldberg and Campa, 2010; Burstein et al., 2003; Gopinath, 2015). I now investigate the conflicting conclusions on the role of direct and indirect exposure and argue that standard practices tend to overestimate the contribution of imported intermediate inputs because they abstract from a careful calibration of (heterogeneous) domestic frictions.

Figure 8 shows that the identity of the most relevant products to overall sensitivity changes when heterogeneous domestic frictions and indirect import exposures interact. Domestic goods produced with relatively more imported inputs are also those associated to larger markup elasticities (left panel) and higher distribution margins (right panel). Both forces reduce the pass-through rate of

[73] A growing literature is studying the role production networks and interacting heterogeneities as key driver in the transmission of monetary policy shocks, Pasten et al. (2020), Rubbo (2020) and La'O and Tahbaz-Salehi (2022).

Figure 8: Import Exposure and Friction Heterogeneity



The left panel plots the relationship between the share of imported inputs in production and the markup elasticity for the set of domestically produced goods. The share of imported inputs is computed as the ratio between the total expenditure on all imported goods used in production and the total costs of production. The right panel plots the relationship between the share of imported inputs in production and the domestic distribution margins for the set of domestically produced goods. Domestic distribution margins are computed for domestic intermediate inputs only or as a weighted average between domestic intermediate inputs and final consumption goods. The dashed lines show linear fit. Table 14 in Appendix C reports the corresponding coefficients. Section 4 and Appendix A provide additional details on how import shares, distribution margins and markup elasticities are computed. Log imported input shares smaller than -10 are dropped.

marginal cost changes into price and, thus, dampen the overall effect of higher import exposure.

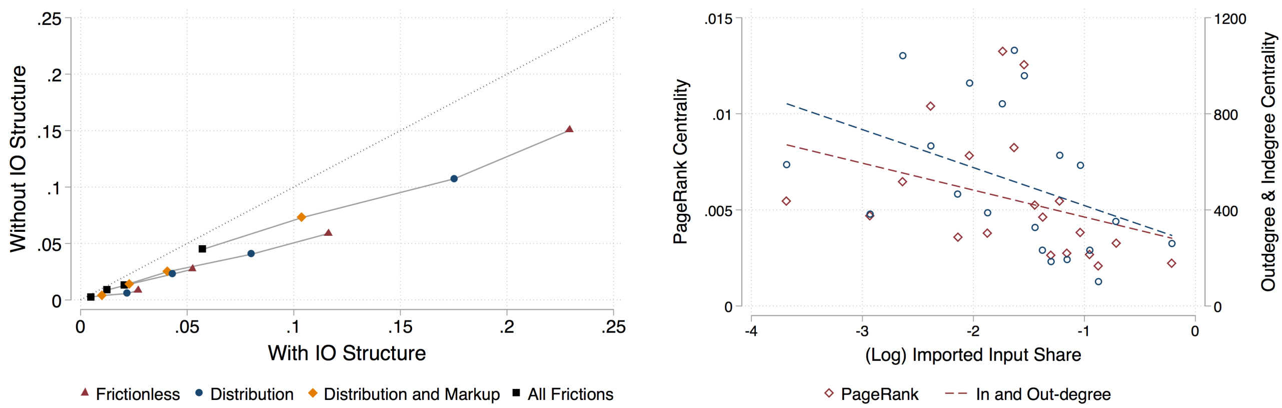
Indirect exposure originates also by the domestic input-output production network. Even though a domestically produced good does not make use of imported intermediate inputs, the domestic inputs used in its production could be produced using imported goods. Figure 9 shows that the contribution of roundabout production is actually modest. The left panel compares the sensitivity of domestic prices in the case of roundabout production (x-axis) and without roundabout production (y-axis) across different scenarios. I show that the median change in domestic prices in each quartile is higher when roundabout production is considered as shocks are amplified through the network, Acemoglu et al. (2016). As more frictions are included in the domestic economy, the amplification generated by the presence of input-output linkages shrinks, Basu (1994) and Pasten et al. (2020). Table 13 in Appendix C shows that, in the full model, abstracting from input-output linkages would reduce CPI sensitivity to exchange rate by only 5%.[74]

Moreover, the right panel of Figure 9 shows that imported inputs are not central in the production network.[75] I measure the centrality of a product in the domestic input-output network

[74] Table 13 in Appendix C reports the CPI sensitivity for all scenarios considered in the presence of and abstracting from input-output linkages. It also reports the decomposition between direct (imported final consumption) and indirect exposure (imported intermediate inputs). Notice that the effect of importing tenure is still quantitatively relevant across all scenarios considered.

[75] Centrality and frictions are complementary elements in the network analysis as frictions can be more relevant

Figure 9: Role of IO network



The left panel compares the evolution of the price of domestic products in an economy that includes input-output linkages (x-axis) to the evolution in an economy that abstracts from input-output linkages (y-axis), as more domestic frictions are considered. Each series plots the median price change in each quartile of the distribution. I consider the following scenarios: "Frictionless" refers to the absence of domestic frictions; "Distribution" includes only distribution margins; "Distribution and markups" includes both distribution and variable markups; "All Frictions" includes distribution, variable markups and Calvo frictions. In all scenario, pass-through into import prices is incomplete and heterogeneous due to the effect of importing tenure. The dotted line shows the 45 degree line. The right panel shows the relationship between the centrality of a product in the domestic production network and the share of imported inputs in its production. I consider the PageRank centrality measure (left axis) and the average of the in-degree and out-degree measures (right axis). Centrality are measured weighting the edges according to the input-output linkages. The share of imported inputs is computed over total costs from the IO tables. The dashed line shows a linear fit. Table 14 in Appendix C reports the corresponding coefficient. Section 4 and Appendix A provide additional details on the IO tables.

using both the PageRank centrality measure and the average between the In-degree and Out-degree measures.[76] Products that are more central rely relatively less on imported inputs, reducing amplification forces.

Figure 23 in Appendix C shows also that ignoring heterogeneous consumption shares identifies the wrong products from which the aggregate sensitivity arises. Products that are consumed relatively more in the domestic basket are also those that are less sensitive to imports and, thus, to exchange rate fluctuations.

depending on where they are located in the network, Grassi et al. (2017). Table 14 in Appendix C shows that centrality and individual frictions (markup elasticity and distribution margin) have comparable correlations with indirect exposure, suggesting that jointly accounting for all these elements is key to accurately quantify CPI sensitivity.

[76] Centrality measures are used to assess the relative importance of the entities in networks. In-degree (out-degree) centrality counts the number of ties directed to (from) the node, quantifying the relevance of a node in the immediate vicinity. As standard practice I take the average of the two. PageRank centrality is a variant of eigenvector centrality, which weights the linked nodes by their centrality. In my sample, the two measures are highly correlated (65%). In both cases, edges are weighted according to the input shares forming the input-output tables (see Appendix A.2). No frictions are considered in the weighting. Figure 22 in Appendix C graphically represents the production network, the centrality and import intensity of each node.

These results suggest that any analysis aiming to quantitatively evaluate the role of import exposure for the transmission of exchange rate fluctuations to domestic prices should carefully evaluate the relative importance of direct and indirect exposures, and incorporate domestic frictions in the analysis. Common practice in calibrating aggregate models is to compute import exposure as the sum of direct and indirect exposure, where the latter is computed from input-output tables (Burstein et al., 2003; Gopinath, 2015). However, abstracting from domestic frictions results in highly overestimating the role of indirect exposure and, ultimately, the magnitude of CPI sensitivity.

5.5 Taking Stock and Policy Implications

Our empirical analysis established a number of important facts. Taken together, these results show that heterogeneity in price sensitivity is key in determining which sectors are the most important contributors to the insensitivity of domestic prices, and importing tenure plays a substantial role in shaping this heterogeneity.

I now elaborate on the broad policy implications of the results presented as domestic price sensitivity to exchange rate is key for the transmission of international shocks and monetary policy. One fundamental aspect for monetary policy trade-offs in open economy is which inflation rate is relevant to policymakers and, specifically, the inflation rate central banks should target crucially depends on the degree of exchange rate pass-through (ERPT) (Corsetti et al., 2010).

On one hand, ERPT is related to inflation stabilization in open economy, exchange rate misalignment and the so-called "fear of floating" (Calvo and Reinhart, 2002). Incomplete ERPT partially insulates domestic prices to exchange rate fluctuations, reducing the cost of floating and volatile exchange rates. On the other hand, ERPT is also related to the transmission and the absorption of shocks and trade imbalances. Incomplete ERPT limits expenditure switching forces, and trade and capital adjustments, reducing the effectiveness of exchange rates as shock absorber and policy instrument.

One of the key implications of the results of this paper is that policymakers should stabilize different components of inflation, not necessarily coinciding with CPI weights. I find that pass-through and domestic prices exposure are highly heterogeneous along the input-output network, due to the role of importing tenure and heterogeneous domestic frictions. Therefore, exchange rate fluctuations are transmitted into different components of CPI, and policymaker should trade-off inflation in different sectors depending on their tenure, frictions and exposure.[77]

[77] This problem is also relevant in closed economy as shown by the long-standing "Inflation Targeting Debate", Bernanke and Woodford (2005), and the recent growing literature on input-output networks and frictions in macroeconomics (Rubbo, 2020; Pasten et al., 2020).

6 Conclusion

In this paper, I have explored the role of importing tenure for the sensitivity of aggregate domestic prices. Using transaction-level trade data, I document that an increase in importing tenure reduces the pass-through of exchange rate fluctuations into import prices and higher importing tenure is associated to larger import shares. These concurring facts together substantially influence the sensitivity of domestic prices to exchange rate fluctuations. Abstracting from the role of importing tenure increases CPI sensitivity by 20%. The presence of high tenure importers insulated domestic prices during the sharp depreciation of the Chilean peso following the 2019 social outburst, reducing inflation by 10%. Moreover, back-of-the-envelope calculations show that the rise in the average importing tenure can account for a substantial part of the recent decline in CPI sensitivity.

I also find that other leading frictions are quantitatively relevant in explaining the low sensitivity of CPI. The quantitative exercise and its accurate product-level calibration show how heterogeneity in frictions is key to understand which products are the most important contributors to the transmission of exchange rate fluctuations and the origins of the low CPI sensitivity in general. I view this findings as useful in guiding future research in developing calibration strategies to quantify the relationship between domestic prices and exchange rates.

The model I use has enough structure to accurately quantify the impact of exchange rate fluctuations on domestic prices but is limited to answer important policy questions. The heterogeneity in exchange rate pass-through driven by importing tenure can play a relevant role for monetary policy and inflation targeting in open economy. However, more structure is required to provide a thorough normal analysis and it is left for future research.

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Appendix

A Data and Calibration

A.1 Chilean Customs Data

Table 8: Summary Statistics - Breakdown by Industry and Origin

	Numbers of Transactions (%)	Import Value (%)
Industry (SITC):		
Food & Animals	3.871	8.238
Beverages, Tobacco	0.291	0.613
Crude Materials	1.589	2.392
Mineral fuels	0.503	24.34
Animal & Vegetable Oils	0.192	0.524
Chemicals	11.55	13.23
Manufactured Goods	18.57	9.466
Machinery	36.52	33.02
Mix Manufacturing	26.91	8.160
Country:		
China	14.02	6.208
USA	25.01	30.00
EU15	25.41	17.41
Other Americas	18.42	25.03
Others	17.14	21.35

The table reports the breakdown by industry (2-digit SITC level) and country of origin of the cleaned universe of import transactions from the Chilean Customs, 2009-2019. The breakdown is computed in terms of i) number of transactions and ii) import values.

A.2 Construction of IO Matrix and Distribution Costs

I construct the input-output matrix for the Chilean economy combining the 2013 "make" and "use" tables provided by the the Central Bank of Chile (*Banco Central de Chile*).[78] I combine the make and use tables at basic prices to construct a product-by-product input-output matrix that quantifies how much of each product is used in the production of other products. I choose to construct a product-by-product matrix, rather than an industry-by-industry, to leverage the larger product dimension of the make and use tables.

[78] The most recent version of the tables provided by the Central Bank of Chile is from 2013. Data are available at the following website: https://si3.bcentral.cl/estadisticas/Principal1/Excel/CCNN/cdr/excel.html.

I follow standard best practice in Mahajan (2018) and Miller and Blair (2009) in constructing the input-output table under the industry technology assumption. Consider the product-by-industry make matrix, V^T, and the product-by-industry use matrices of domestic and imported products U_d and U_m, respectively. Define g^T the row vector of industry output, i.e. the column sum of V^T. I construct the product-mix matrix C,

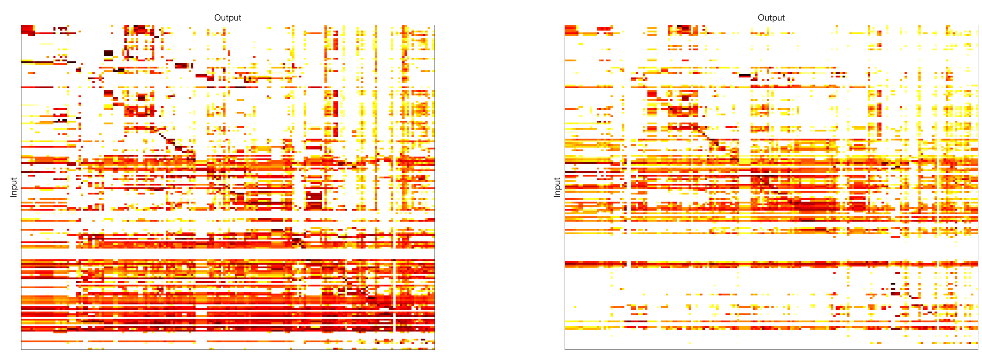
$$C = V^T \left[\texttt{diag}(g^T)\right]^{-1},$$

that collects the share of each product in the output of an industry. Under the industry technology assumption, each industry has its own specific way of production, irrespective of its product mix.[79] I obtain the domestic and international Leontief matrices by multiplying the product-mix matrix C to the use matrices U_d and U_m:

$$S_d = U_d C^T \qquad S_m = U_m C^T,$$

where S_d and S_m represent the domestic and international product-by-product Leontief matrices, respectively. The left (right) panel of Figure 10 plots the domestic (international) Leontief matrix. As expected, the matrices are highly sparse given the granularity of the product classification used.

Figure 10: Domestic and International Leotief Matrices



The left (right) panel plots the domestic (international) input-output matrix of the Chilean economy in 2013. The matrices are computed using the make and use table under the industry technology assumption. Each row (column) represents an input (output). The intensity of the coloring shows how much one product is used as input in the production of other products: the darker (lighter) the color, the higher the input share. Log input shares smaller than -10 are censored.

[79] Compared to the most common alternative assumption (product technology assumption), the key advantage of the industry technology assumption is that negative elements in the input-output table cannot arise.

Table 9: Distribution Margins - Summary Statistics

	Intermediate Goods		Final Goods	
	Domestic	Imported	Domestic	Imported
Farms	0.0701	0.0778	0.258	0.183
Fishing and Forestry	0.0135	0.000166	0.113	0.0224
Oil, Coal and Gas Extraction	0.0000500	0.0236	0	0
Mining	0.000593	0.0216	0	0
Food, Beverages and Tobacco	0.0896	0.207	0.265	0.366
Textile and Apparel	0.128	0.248	0.342	0.529
Wood, Paper and Printing	0.103	0.142	0.181	0.257
Petroleum and Chemical Products	0.150	0.172	0.307	0.386
Plastic Rubber and Construction	0.0580	0.146	0.146	0.401
Fabricated Metal Products	0.0577	0.133	0.0309	0.0809
Machinery and Equipment	0.0918	0.194	0.134	0.336
Motor Vehicles	0.0335	0.0988	0.0744	0.333
Furniture	0.112	0.225	0.312	0.369
Utilities	0.0310	0.000800	0.106	0
Construction	0.00269	0	0	0
Wholesale and Retail Trade	0.00384	0.00180	0.0229	0
Transportation	0.0107	0.00803	0.0183	0
Health Care and Education	0.00190	0	0.0250	0
Accomodation and Recreation	0.0381	0.0216	0.0894	0
Professional Services	0.0208	0.0157	0.0525	0.0226
Communication	0.0451	0.0153	0.149	0
Other Products or Services	0.0908	0.0701	0.0391	0.118

The table reports the average distribution margin for each (2-digit) industry. I distinguish across products depending on their use, final vs intermediate use, and on their origin, imported vs domestically produced.

A.3 Markup Elasticity

In this section, I provide additional information on how markup elasticities are estimated and calibrated. In the main text, I assume that the Kimball aggregator in Equation (9) takes the form of a Klenow and Willis (2016) aggregator. In this case, the firm-level markup elasticity depends on two parameters, the industry-specific elasticity of demand, σ_i, and the super-elasticity of demand, ϵ_i, as follows:

$$\Gamma_{ik} = \frac{\epsilon_i}{\sigma_i - 1 + \epsilon_i \log\left(\frac{\widetilde{p_{ik}}}{\widetilde{p_i}}\right)}. \tag{23}$$

I follow Gopinath et al. (2010) and Amiti et al. (2019) and calibrate the steady-state elasticity of markups, assuming $\widetilde{p_{ik}} = \widetilde{p_i}$.[80] I calibrate the demand elasticity parameter σ to match the

[80] Under the condition $\widetilde{p_{ik}} = \widetilde{p_i}$, Equation (23) can be interpreted also as the markup elasticity for an average

average, steady-state markup. I then follow Edmond et al. (2018) in estimating the superelasticity parameter ϵ using the relationship between markups and market shares implied by the Klenow and Willis (2016) function form of Equation (9).

I now provide details on how I estimate markups and markup elasticities to calibrate the model in Section 3.

ENIA Data: I use the Annual National Industrial Survey (ENIA) from 2000 to 2007, that provides information for approximately 5000 plants per year with more than 10 employees. It reports detailed information on sales, inputs expenditures, employment and wage bill, investment, industry code (ISIC rev 3). I consider the following variables: `REMPAG` as wage bill; `EMPTOT` and `THHANO` as total number of employees and total hours worked, respectively; `VSTK` as capital stock; `FABVAL` as production value; `VBPB` as gross production value and `VA` as value added; the sum of `TCOVAL` and `MTMPVAL` as total material expenditure; `ELECONS` as electricity consumption in MW. Table 10 presents a few basic summary statistics for the leading variables used in the analysis.

Table 10: Description of the Data - ENIA

	Mean	p25	Median	p75
Sales	5,666,147	151,802	407,989	1,607,334
Wage Bill	438,828.1	37,268	88,067	279,700
Material Expenditure	3,067,797	74,545	209,090	866,560
Capital Stock	3,001,394	31,636	130,379	620,612
Electricity Used (MW)	3,520.978	27	77	357
Observations	31,027			

The table reports summary statistics of the cleaned ENIA dataset from 2000 to 2007. All variables but electricity consumption are in millions of Chilean pesos.

I drop firms that have zero or negative employees, wage bill, production, material expenditure or electricity usage, and capital stock. I also drop observations for which i) the gross value of production is lower than the total value added; ii) the wage bill is larger than the total value added. To obtain a real measure of the main nominal variables, I use deflators provided by the Central Bank of Chile or the National Statistical Agency (*INE*). Production value is deflated using industry-specific deflators; the value of capital stock is deflated by the investment good deflator; wage bill is deflated by the domestic CPI and material expenditure by industry-specific producer price indices.

Markup estimation & σ_i: I use production function estimation to estimate markups at the three-digit ISIC industry level following state-of-the-art techniques and best practices, Levinsohn

firm (Amiti et al., 2019) or at the steady-state markup elasticity (Gopinath et al., 2010).

and Petrin (2003), Ackerberg et al. (2015) and De Loecker and Warzynski (2012).

As specified in the theoretical model in Section 3, I estimate a Cobb-Douglas production function of the form:

$$\log y_{ik} = \beta_i^k \log k_{ik} + \beta_i^l \log l_{ik} + \beta_i^x \log x_{ik} + \omega_{ik} + \xi_{ik} \tag{24}$$

where y_{ik}, k_{ik}, l_{ik}, x_{ik}, ω_{ik} and ξ_{ik} represent quantity sold, capital stock, labor, materials, log productivity and the error term, respectively. I follow the control function literature, Levinsohn and Petrin (2003) and Ackerberg et al. (2015), to tackle the endogeneity challenge due to unobserved time-varying firm-level productivity ω_{ik} and consistently estimate the production function in Equation (24).

I treat capital as a dynamic input that faces adjustment costs. I use the consumption of electricity in megawatts as proxy variable. I favor a composite variable of the cost of goods sold as benchmark measure for variable input. I construct this variable summing the total cost of labor (wage bill) to the total expenditure in materials.[81]

Given the estimated output elasticities, markups are constructed following De Loecker and Warzynski (2012); hence, firm-level markups are given by:

$$\mu_{ik} = \widehat{\beta_i^{\texttt{Cost}}} \frac{\texttt{Sales}_{ik}}{\texttt{Cost}_{ik}} \tag{25}$$

where $\texttt{Cost}_{ik}$ is the sum of wage bill and material expenditure and $\beta_i^{\texttt{Cost}}$ is the associated output elasticity estimated from Equation (24). For each industry, I calibrate the industry-specific demand elasticity, using the estimated revenue-weighted average markup $\bar{\mu}_i$, $\sigma_i = \frac{\bar{\mu}_i}{\bar{\mu}_i - 1}$.

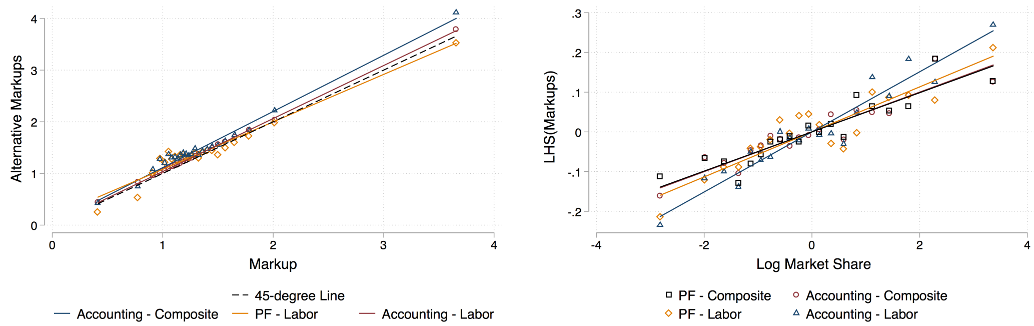
Estimating Kimball Super-elasticity ϵ_i: The Klenow and Willis (2016) functional form of the Kimball aggregator implies the following within-industry relationship between markups and market shares, up to a constant:

$$\frac{1}{\mu_{ik}} + \log\left(1 - \frac{1}{\mu_{ik}}\right) = a_i + b_i \log \texttt{share}_{ik}, \qquad b_i = \frac{\epsilon_i}{\sigma_i},$$

where $\texttt{share}_{ik}$ is the market share of firm k in industry i. I estimate the slope coefficient b_i for each industry introducing firm and year fixed effects. I can then retrieve the sectoral super-elasticities ϵ_i given the estimated demand elasticity σ_i.

81 Using this measure as variable input implicitly imposes an additional assumption in the estimation, as it assumes that labor and materials are perfectly substitutable, De Loecker et al. (2020). As robustness, in the section below, I relax this assumption, treating labor costs and materials separately and using the former to estimate markups. Markups and markup elasticities are highly correlated to the one I obtain from my preferred specification.

Figure 11: Comparison with Alternative Markup Estimates



The left panel plots the relationship between the preferred measure of markups (x-axis) and the alternative measures of markups estimated as robustness (y-axis). The preferred measure of markups is estimated using production function estimation and a composite measure of cost of goods sold as variable input. Alternative measures of markups include: i) estimates using production function estimation and labor as variable input ("PF - Labor"); ii) estimates using the cost share approach and a composite measure of cost of goods sold as variable input ("Accounting - Composite"); iii) estimates using the cost share approach and labor as variable input ("Accounting - Labor"). The right panel shows the relationship between the log market share of a firm and the left-hand-side of Equation (22), $\frac{1}{\mu_{ik}} + \log\left(1 - \frac{1}{\mu_{ik}}\right)$, where μ_{ik} is the firm-level markup. I consider both the preferred measure of markups ("PF - Composite") and the alternative measures estimated as robustness ("PF - Labor", "Accounting - Composite" and "Accounting - Labor"). I use the whole sample and include both year and industry fixed effects.

Robustness: It is well known that standard production data, as those used here, report revenues and expenditures rather than physical units. The standard practise of deflating using sectoral indices can introduce an additional bias due to unobserved firm-specific input price variation, De Loecker et al. (2016).[82] Moreover, recent work by Kaplan and Zoch (2020) shows that it is not possible to consistently estimate output elasticities when only revenue data is available in the presence of variable markups.

To assess the robustness of the estimates from my preferred specification, I compute markups using the simple alternative cost share approach (Autor et al., 2020; De Loecker et al., 2016). Under constant return to scale, the output elasticity of each input is equal to the share of that input in total costs. I assume that the output elasticity is common to all firms within each industry and I calibrate it to the median input share in each industry. I also relax the assumption of a composite variable input used in my preferred specification. I re-estimate markups and markup elasticities treating labor and materials separately using both the production function and the cost share approaches.

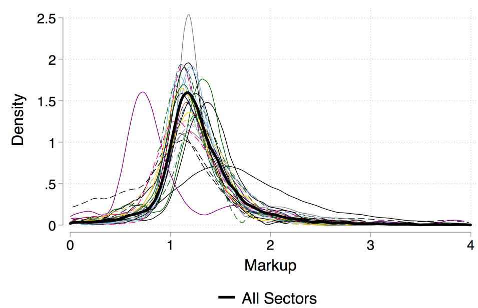
The left panel of Figure 11 plots the alternative estimates of markups against the markups obtained from the preferred specification. The right panel of Figure 11 shows the relationship in Equation (22) between (log) market share and markups, using the whole sample and controlling for

[82] Without more detailed data on output prices and quantities, it is not possible to implement the control function approach proposed by De Loecker et al. (2016) to tackle the input price bias.

year and industry fixed effects. Overall, these robustness estimates show qualitative and quantitative patterns that are similar to the benchmark specification. Markup distributions are very similar, independently of the approach or variable input used. Similarly, the estimated super-elasticities (the slope coefficient on the right panel of Figure 11) are highly comparable.

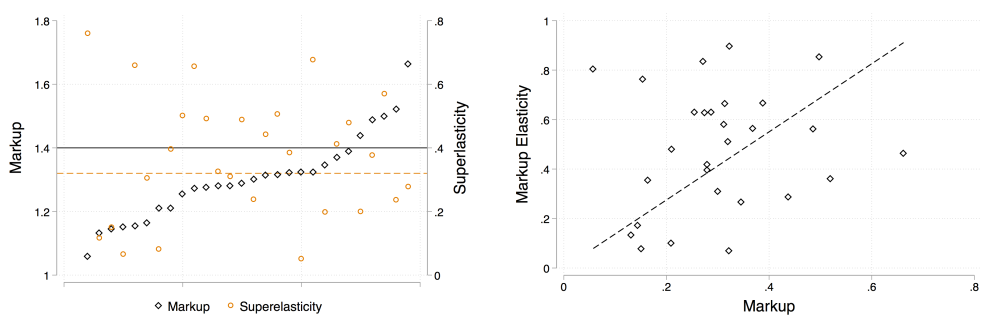
A.3.1 Additional tables and figures

Figure 12: Markup Distributions



The figure plots the distribution of estimated markups for each 3-digit industry. The thick solid black line represents the aggregate distribution pooling all industries together. Markups are estimated using the preferred specification, i.e. production function estimation and a composite measure of cost of goods sold as variable input.

Figure 13: Markup Elasticity and Super-elasticity



In the left panel I rank each 3-digit industry by the estimated revenue-weighted average markup. For each industry I plot the estimated revenue-weighted average markup and the corresponding estimated demand super-elasticity, ϵ_i. The solid horizontal line shows the aggregate revenue-weighted average markup in the whole sample. The right panel shows the relationship between the estimated revenue-weighted average markup (x-axis) and the implied markup elasticity at the 3-digit industry level. The dashed line shows a linear fit through the implied markup elasticities. Markups are estimated using the preferred specification, i.e. production function estimation and a composite measure of cost of goods sold as variable input. Markup elasticity is defined according to Equation (21), where σ_i is calibrated using the revenue-weighted average markup and ϵ_i is estimated using Equation (22).

A.4 Pass-through $\Psi(T)$

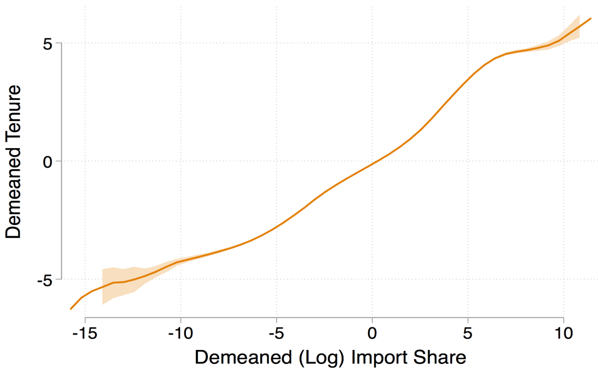
Table 11: Estimated Average Pass-through

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log e$	0.7149	0.8324	0.7759	0.7092	0.8118	0.7641
	(0.107)	(0.105)	(0.103)	(0.111)	(0.107)	(0.105)
Log Tenure X $\Delta \log e$		-0.0816			-0.0727	
		(0.014)			(0.015)	
Tenure X $\Delta \log e$			-0.0109			-0.0100
			(0.002)			(0.002)
Importer X Product X Country	Yes	Yes	Yes			
Importer X Product				Yes	Yes	Yes
Product X Country				Yes	Yes	Yes
Observations	2,368,422	2,368,422	2,368,422	2,413,107	2,413,107	2,413,107

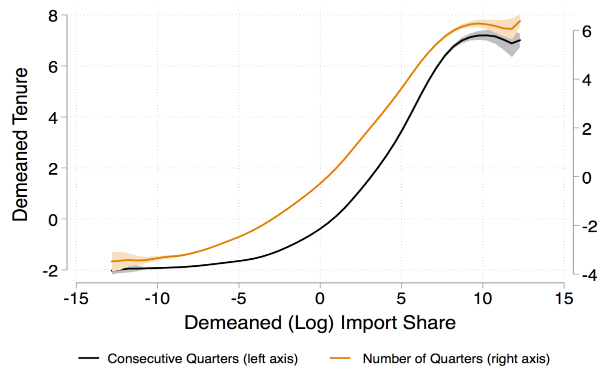
The table reports the estimated coefficients from the specification in Equation (1) without the set of controls included, X, and time fixed effects, ν_t. Columns (1) and (4) do not control for the effect of tenure. Columns (2) and (5) ((3) and (6)) control for the interaction between exchange rate change and the log (level) of tenure. Columns (1), (2) and (3) ((4), (5) and (6)) include Import X Product X Country (Importer X Product and Product X Country) fixed effects. Coefficients for terms in levels (log tenure, tenure and inflation of origin country) and left and right censorship dummies are omitted. Standard errors clustered at country level. Tenure is defined as the number of quarters the importer has been consecutively importing a Product X Origin pair.

B Empirical Analysis: Robustness

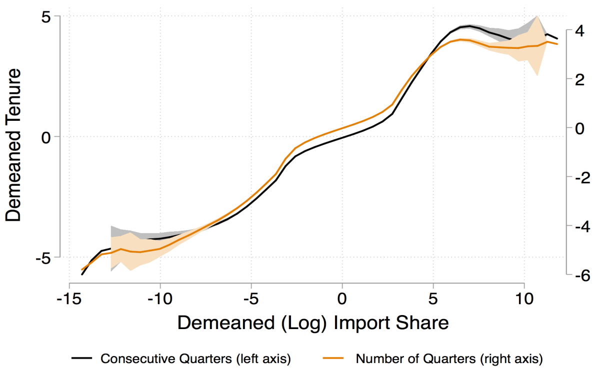
Figure 14: Heterogeneity in Tenure - Robustness



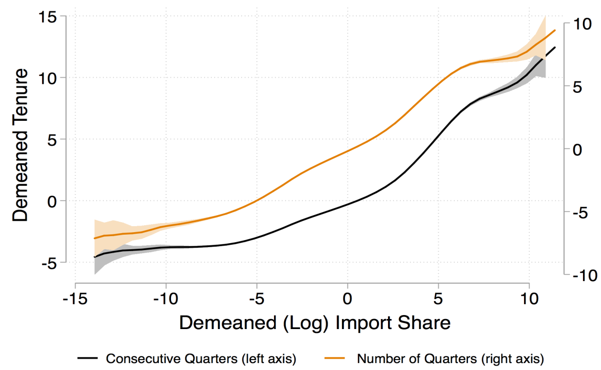
(a) Alternative measure of tenure



(b) Demeaning at quarter level



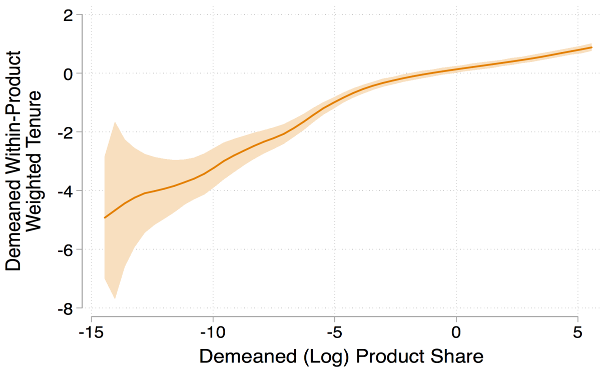
(c) Demeaning at quarter-firm-sector level



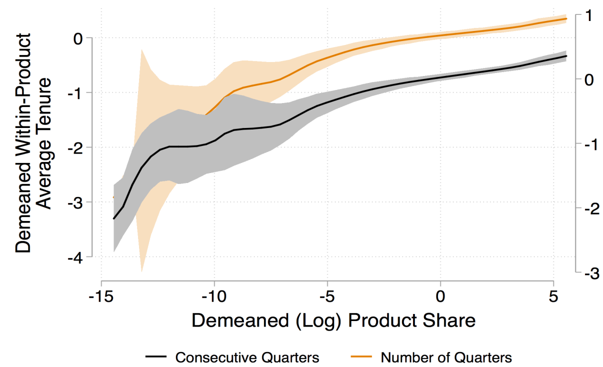
(d) Second half of the sample

All figures plot the non-parametric relationship between the (log) import share and importing tenure in the whole sample. Share and tenure are computed at the quarterly level. Import shares and tenure are defined at the firm-product-origin-quarter level, with product defined at the 8-digit level. Variables are demeaned to avoid mechanical increase in tenure due to time passing and make it comparable over time. Panel a) uses the alternative definition of tenure, the number of quarters a firm is importing the same product-origin pair (dropping the consecutive requirement of the main definition). Panel b) uses both definitions of tenure but demeans variables at the quarterly level only. Similarly, panel c) plots the variables demeaned at the quarterly-firm-sector level, where sector is defined at the 3-digit level. Finally panel d) shows the relationship between the (log) import share and tenure in the second half of the sample, using both definitions of tenure. In all panels, I report the 99% confidence intervals.

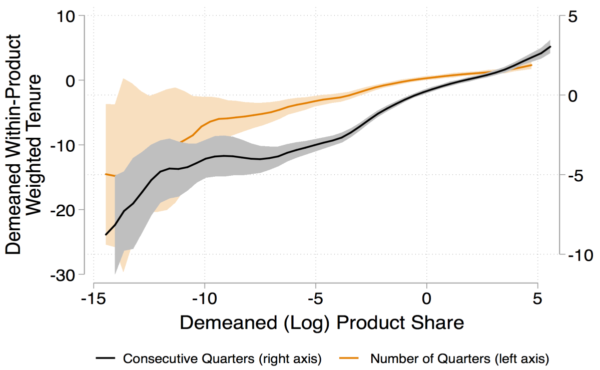
Figure 15: Heterogeneity in Tenure at Product Level - Robustness



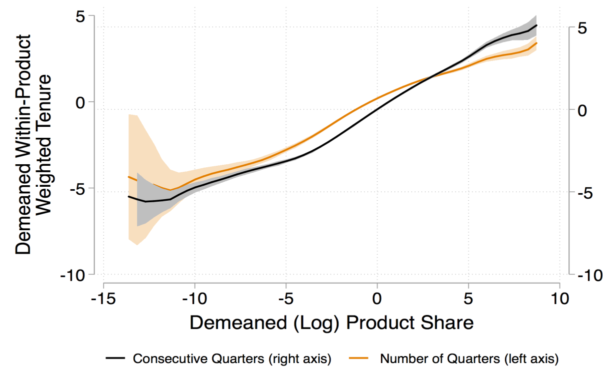
(a) Alternative measure of tenure



(b) Average tenure



(c) Second half of the sample



(d) 5-digit classification

All figures plot the non-parametric, cross-sectional relationship between the (log) import share of a product and the average tenure across all firms importing that product. Share and average tenure are computed at the quarterly level. Variables are demeaned to avoid mechanical increase in tenure due to time passing and make it comparable over time. Panel a) computes the expenditure-weighted tenure using the alternative definition of tenure, the number of quarters a firm is importing the same product-origin pair (dropping the consecutive requirement of the main definition). Panel b) computes the average tenure, considering both the main (left) and the alternative (right) definition of tenure. Panel c) plots the relationship between the (log) import share of a product and the expenditure-weighted average tenure across all firms importing that product using only the second half of the sample. Finally panel d) defines products at the 5-digit level. In all panels, I report the 99% confidence intervals.

Table 12: Pass-through Robustness

	Level	Alternative Tenure		Alternative FEs	Alternative Own Size		Alternative Strategic	
		Cum Quarters	Cum Sales		Trans Value	Importer Size		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \log e$	0.3591	0.4100	0.3359	0.3734	0.3383	0.3906	0.3904	0.4168
	(0.110)	(0.127)	(0.106)	(0.122)	(0.115)	(0.125)	(0.115)	(0.125)
Log Tenure X $\Delta \log e$		-0.0334	-0.0154	-0.0305	-0.0409	-0.0391	-0.0348	-0.0357
		(0.020)	(0.007)	(0.014)	(0.014)	(0.015)	(0.012)	(0.013)
Tenure X $\Delta \log e$	- 0.00375							
	(0.0017)							
Size X $\Delta \log e$	-0.0097	-0.0104	-0.0102	-0.0093	-0.5117	-0.0032	-0.0097	-0.0109
	(0.003)	(0.004)	(0.004)	(0.003)	(0.146)	(0.008)	(0.003)	(0.004)
Strategic Δp_i	0.2664	0.2524	0.2871	0.3001	0.2950	0.3019	-0.0980	-0.3127
	(0.312)	(0.312)	(0.317)	(0.271)	(0.303)	(0.295)	(0.112)	(0.130)
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer X Product X Country	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Importer X Product				Yes				
Product X Country				Yes				
Observations	2,365,619	2,365,619	2,365,619	2,410,260	2,365,619	2,365,619	2,365,619	2,314,387

Coefficients for terms in levels (log tenure, tenure, average size and inflation of origin country) and left and right censorship dummies are omitted. Standard errors clustered at country level. All columns re-runs the baseline specification in Equation (1) using different controls. Column (1) reports the main specification from column (5) in Table 3 using tenure in levels, instead of log. Column (2) is estimated using an alternative definition of tenure, the number of quarters a firm is importing the same product-origin pair (dropping the consecutive requirement of the main definition). Column (3) defines tenure as the cumulative sum of sales at the product-origin pair. Column (4) uses Product X Origin and Product X Importer fixed effects. Column (5) controls for the actual value of the transaction in the quarter, as alternative measure of own-size. Similarly column (6) uses the size of the importer defined as the sum of the all imports across products and origins. Column (7) computes the index of competitor price change using expenditure weights. Finally, column (8) specifies the index of competitor price change at the Product X Origin level.

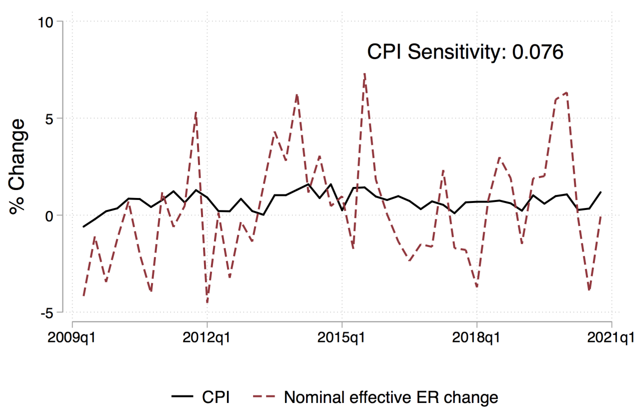
C Additional Figures and Tables

Estimating average CPI sensitivity: I estimate the aggregate CPI sensitivity for the period 2009-2020 at the quarterly level using the following specification:

$$\Delta \log CPI_t = \sum_{\tau=0}^{6} \beta_\tau \Delta \log e_{t-\tau} + \sum_{\tau=0}^{6} \gamma_\tau \pi_{t-\tau} + \varepsilon_t, \tag{26}$$

where CPI is the Chilean consumer price index at the quarterly level; e is the trade-weighted nominal exchange rate between the Chilean peso and the exporting country's currency; π is the trade-weighted inflation rate in the exporting country as proxy for trading partners' costs (Campa and Goldberg, 2005; Burstein and Gopinath, 2014). I include up to 6 lags to control for gradual adjustments and auto-correlation in inflation and exchange rates. Inflation and exchange rate data are sourced from IMF and Datastream, respectively. Figure 16 shows the relationship between the change in domestic prices (CPI) and the trade-weighted measure of nominal exchange rate. The estimated contemporaneous, short-run CPI sensitivity from Equation (26) is 7.6%, in line with estimates from the literature (Goldberg and Campa, 2010). The coefficient is robust to the number of lags included and to the inclusion of lagged domestic CPI as additional control.

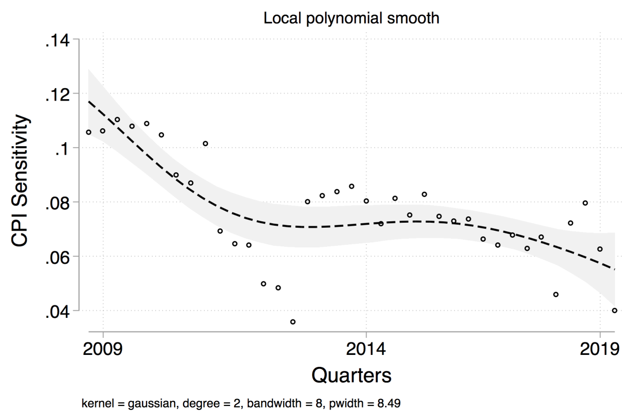
Figure 16: Estimated CPI Sensitivity



The figure plots the relationship between the change in domestic prices (CPI) and the trade-weighted measure of nominal exchange rate. Inflation and exchange rate data are sourced from IMF and Datastream, respectively. Trade shares are computed from the universe of import transactions from 2009 to 2020. The coefficient reported is the contemporaneous CPI sensitivity estimated from Equation (26).

Estimating CPI trends: I estimate the trend in aggregate short-run CPI sensitivity over the period 2009-2020 using the regression in Equation (26) with a rolling time window of five years (20 quarters). I extend the sample to the beginning of 2007 so that the mid-point of the initial window is approximately 2009. Differently from Equation (26), I include lags up to one year as the number of data points in each window is reduced. I then estimate the trend using a polynomial approximation given that the CPI sensitivity is moderately noisy at quarterly level. Figure 17 plots the estimated CPI sensitivities and the corresponding downward trend.

Figure 17: Trend in CPI Sensitivity



The figure plots the estimated trend in short-run CPI sensitivity for Chile over the period from the late 2007 to 2020s. I use a 20-quarter rolling time window and plot the estimated trend at the midpoint of the window. CPI sensitivity is estimated at the quarterly level using regression in Equation (26). Appendix C provides additional details on the data and estimation. The trend is computed using a Gaussian polynomial approximation with bandwidth 8 and degree two. Shaded area plot the 95% confidence intervals.

Figure 18 plots the trend in short-run CPI sensitivity over the period from the late 1970s to 2020 using a rolling time window of ten years (40 quarters). Given the longer horizon considered, I augment the regression in Equation (26) to also control for the growth rate in real GDP of the importing country, Chile, and its lagged values (Campa and Goldberg, 2005):

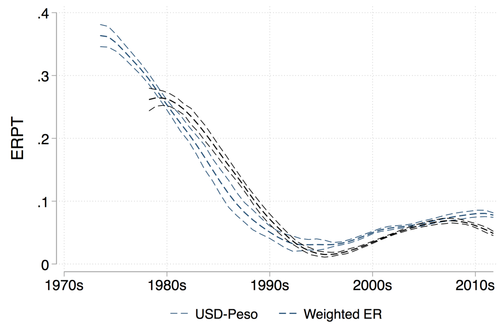
$$\Delta \log CPI_t = \sum_{\tau=0}^{6} \beta_\tau \Delta \log e_{t-\tau} + \sum_{\tau=0}^{6} \gamma_\tau \pi_{t-\tau} + \sum_{\tau=0}^{6} \eta_\tau \Delta \mathrm{GDP}_{t-\tau} + \varepsilon_t. \tag{27}$$

In this case, the trade-weighted nominal exchange rate is downloaded directly from the IMF (series "NEU" from International Financial Statistics). I use the real effective exchange rate in combination to the nominal effective exchange rate from the IMF ("REU" and "NEU" respectively) to compute a trade-weighted measure of exporters' costs.[83] As robustness, I consider the bilateral USD-CLP exchange rate and the US inflation rate as proxy for exporters' costs.[84] I again estimate the trend using a polynomial approximation given that the CPI sensitivity is moderately noisy at quarterly level. Figure 18 shows that sensitivity decreased since the late 1970s and the pattern is

[83] I follow Campa and Goldberg (2005) and construct the proxy for exporters' cost, π, taking advantage of both the real and nominal exchange rate series. I compute $\pi = NEER \times CPI/REER$, where CPI is the measure of domestic prices in Chile.

[84] Using these alternative series allows to extend the period of analysis back to 1975.

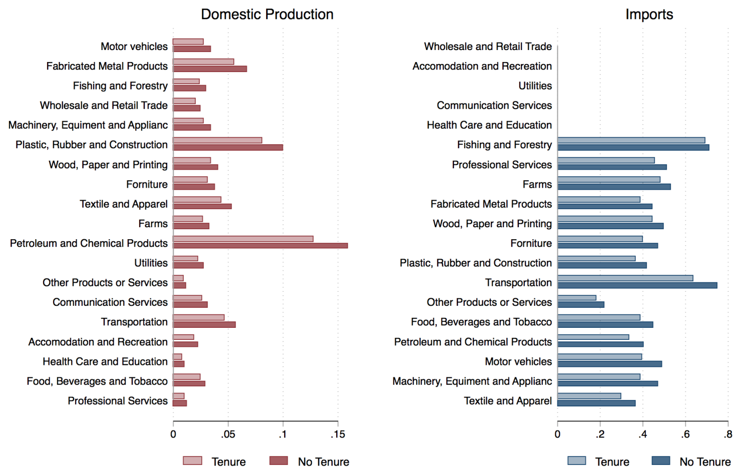
Figure 18: Long-Run Trend in CPI Sensitivity



The figure plots the estimated long-run trend in short-run CPI sensitivity for Chile over the period from the late 1970s to 2020s. I use a 40-quarter rolling time window and plot the estimated trend at the midpoint of the window. CPI sensitivity is estimated at the quarterly level using regression in Equation (27). I use a trade-weighted exchange rate and exporters' costs series from the IMF International Financial Statistics ("Weighted ER"). As robustness, I also consider the bilateral USD-CLP exchange rate and the US inflation rate as cost proxy ("USD-Peso"). The trend is computed using an Epanechnikov polynomial approximation with bandwidth 15 and degree one. Dashed lines plot the 95% confidence intervals.

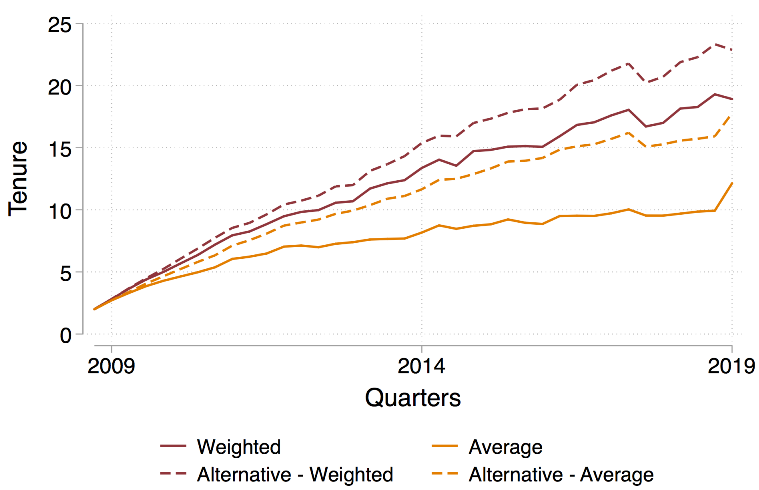
robust to the exchange rate series considered.

Figure 19: Decomposition CPI Sensitivity - Heterogeneity across Sectors



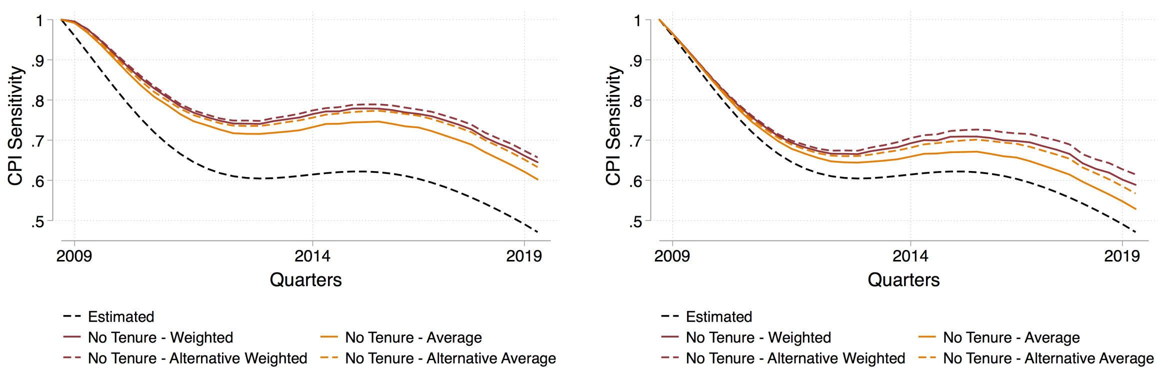
The figure shows the estimated CPI sensitivity at the industry level distinguishing domestic final goods (left panel) and imported final consumption (right panel). For each industry, I report the expenditure weighted price sensitivity across products. Industries are in ascending order according to their consumption share. For each industry, I compare the price sensitivity in the presence of and abstracting from tenure heterogeneity ("Tenure" and "No Tenure", respectively). The price sensitivity in the presence of tenure heterogeneity is computed in the full model scenario, Case V in Table 5. The price sensitivity abstracting from tenure heterogeneity is computed in a model with incomplete but homogeneous pass-through rate into import prices and all frictions in the domestic economy (distribution costs, markup elasticity and Calvo rigidity). Notice that in both cases, I consider input-output linkages.

Figure 20: Trends in Tenure



The figure plots the trend in aggregate tenure from 2009 to 2019 from the universe of import transactions. Solid lines use the main definition of tenure, i.e. the number of consecutive quarters a firm is importing the same product-country pair. Dashed lines ("Alternative") use the less conservative measure of tenure, the number of quarters a firm is importing the same product-country pair (dropping the consecutive requirement of the main definition). Red lines compute aggregate tenure as the expenditure-weighted average tenure across all importer-product-origin triples. Orange lines compute aggregate tenure as a simple average.

Figure 21: Trends in Tenure & CPI Sensitivity



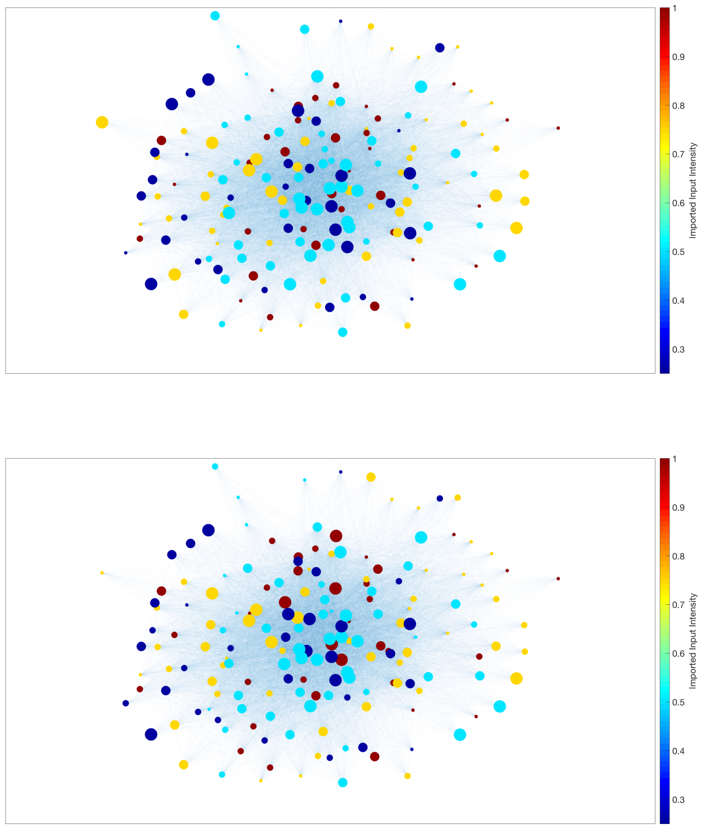
The left panel plots the counterfactual trends in CPI sensitivity using different definitions of aggregate tenure. The measure of aggregate tenure are described in Figure 20. The trends are computed using the estimated marginal effect of tenure from Table 3 (i.e. in logs). The right panel plots the counterfactual trends in CPI sensitivity using the same definitions of aggregate tenure used in the left panel. Differently from the left panel, the trends are computed using the estimated marginal effect of tenure from column (1) in Table 12 (i.e. in levels). In both panels the black, dash line plots the trend in CPI sensitivity to exchange rate estimated as explained in Appendix C.

Table 13: CPI Sensitivity w/out IO linkages

	Tenure Heterogeneity		No Tenure Heterogeneity	
	IO	w/out IO	IO	w/out IO
	(1)	(2)	(3)	(4)
Frictionless:				
Domestic	8.65	4.69	10.5	5.67
Imported	9.55	9.55	11.5	11.5
Total	18.2	14.2	22.0	17.2
Distribution Only:				
Domestic	6.27	3.59	7.63	4.35
Imported	5.62	5.62	6.76	6.76
Total	11.9	9.21	14.4	11.1
Distribution & Markups:				
Domestic	3.50	2.43	4.26	2.95
Imported	5.62	5.62	6.76	6.76
Total	9.12	8.05	11.0	9.71
All Frictions:				
Domestic	1.98	1.58	2.40	1.92
Imported	5.62	5.62	6.76	6.76
Total	7.60	7.20	9.17	8.68

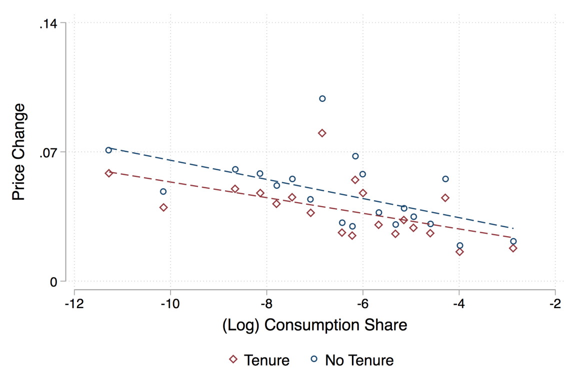
The table reports the implied aggregate CPI sensitivity to exchange rates ("Total") and its decomposition into imported final consumption ("Imported"), i.e. direct exposure, and domestic final consumption ("Domestic"), i.e. indirect exposure. I consider four different scenarios in terms of domestic frictions (distribution margin, markup elasticity, and Calvo rigidity). From top to bottom, I consider a domestic economy with: no frictions; distribution costs only; distribution costs and markup elasticity; all frictions together. In all scenarios, pass-through into import prices is incomplete. Columns (1) and (2) (columns (3) and (4)) include (abstract from) heterogeneous pass-through rate due to importing tenure. Columns (1) and (3) (columns (2) and (4)) include (abstract from) input-output linkages.

Figure 22: Network Centrality and Import Intensity



The figure shows the relationship between import intensity in production and network centrality across domestically produced goods. I plot the domestic production network of the Chilean economy in 2013 as described by the input-output matrix. Each node represents one of the 180 products making part of the economy. The size of each node is proportional to the centrality of the product in the domestic network: the more central the product is, the larger the node. The top panel uses the PageRank centrality measure while the bottom panel uses the average between the in-degree and out-degree centrality measures. Both measures are computed weighting the edges according to the input-output linkages. The coloring of the nodes depends on the import intensity in the production of that good. Import intensity of a product is computed as the share of imported intermediate inputs over total costs. Warmer colors refer to higher import intensity. Appendix A.2 provides additional details on the construction of the domestic input-output matrix.

Figure 23: Consumption Share and Price Change



The figure plots the relationship between the share of each domestic good in the final consumption basket and the change in price due to a depreciation of the exchange rate. The change in price is computed in the full model, Case V in Table 5. The dashed line plots a linear fit. Table 14 in Appendix C reports the corresponding coefficient. Section 4 and Appendix A provide additional details on how consumption shares are computed.

Table 14: Import Exposure and Friction Heterogeneity

	Imported Input Share								Δ Domestic Price
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PageRank Centrality	-3.680				-3.071	-3.253	-0.147	-0.156	
	(1.54)				(1.54)	(1.56)	(0.074)	(0.075)	
Distribution Margin - Intermediate		0.363			0.323		0.150		
		(0.16)			(0.16)		(0.074)		
Distribution Margin - Weighted			0.122			0.0971		0.0846	
			(0.086)			(0.085)		(0.074)	
Markup Elasticity				0.0555	0.0519	0.0507	0.110	0.107	
				(0.035)	(0.035)	(0.035)	(0.073)	(0.074)	
Final Consumption Share									-0.475
									(0.20)
Constant	0.270	0.228	0.235	0.222	0.221	0.231	-6.35e-17	-6.38e-17	0.0424
	(0.016)	(0.016)	(0.017)	(0.022)	(0.026)	(0.026)	(0.073)	(0.073)	(0.0028)
N	180	180	180	180	180	180	180	180	180

Columns (1) to (4) report the correlation coefficients between the share of imported intermediate inputs and product level characteristics in the whole sample of domestically produced goods. The share of imported intermediate inputs is computed as the share of imported intermediate inputs used in production over total costs. I consider the following characteristics: the PageRank centrality of the product in the domestic network, column (1); the distribution margin of the product, computed considering only intermediate inputs or as a weighted average between intermediate and final goods (column (2) and (3), respectively); the markup elasticity of the product, column (4). PageRank centrality is computed weighting the edges according to the input-output linkages. Appendix A provides additional information on how distribution margins and markup elasticities are computed. Column (5) regresses the PageRank centrality measure, the markup elasticity and the distribution margin for intermediate goods all together on the share of imported intermediate inputs. Similarly, column (6) uses the weighted measure of distribution costs. Column (7) and (8) re-run the regressions in column (5) and (6), respectively, after standardizing all the variables. Finally, column (9) reports the correlation coefficient between the change in domestic prices after a depreciation in the exchange rate and the final consumption share in the whole sample of domestically produced goods. The change in domestic prices is computed in the full model, Case V in Table 5.