Import Firm Concentration and Tariff Incidence Across Countries*

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Abstract

How does the market structure among importer firms affect the aggregate and distributional effects of changes in trade costs? We combine a model of domestic pricing decisions of importer firms with administrative firm-level import records from 55 countries to answer this question. We show that imports of a good are highly concentrated among the largest importer firms, with this concentration being more pronounced in smaller and lower income countries. We develop a model in which import firm concentration determines domestic pricing strategies and, consequently, the incidence of tariffs on consumer prices and firm markups. The role of import concentration is captured through the firm-level elasticity of imports to tariff changes, which depends solely on the firm's initial share of the country's imports of a good. We estimate that the negative impact of tariff increases on firm imports is monotonically decreasing with the firm's good import share. Our estimates suggest that, due to higher import concentration, poorer and smaller countries have higher markups on imported goods and a greater incidence of trade cost changes on firm profits than on consumer prices.

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1 Introduction

Importer firms play a crucial role as intermediaries between foreign exporters and domestic consumers. For instance, Fajgelbaum et al. (2019) and Amiti et al. (2019b) show that United States (U.S.) tariffs on Chinese goods in 2018 and 2019 were fully passed through to tariff-inclusive prices paid by U.S. importers. In contrast, Cavallo et al. (2021) find that retail prices paid by U.S. consumers for the same goods moved little, despite the higher costs incurred by U.S. importers. This suggests that importer firms adjusted their markups in response to higher costs, as in De Loecker et al. (2016) and Amiti et al. (2019a). More generally, the market structure among importer firms within a country affects both the level and the responsiveness of domestic markups on imported goods. This raises a key question: how does importer market structure influence the aggregate and distributional consequences of tariff changes across countries?

Our paper addresses this question by combining a model of domestic pricing decisions of importer firms with administrative firm-level import records from 55 countries. We use this data to build a new comprehensive panel dataset on firm-level imports of different goods across countries. This dataset allows us to measure importer firm concentration in each country for detailed goods.

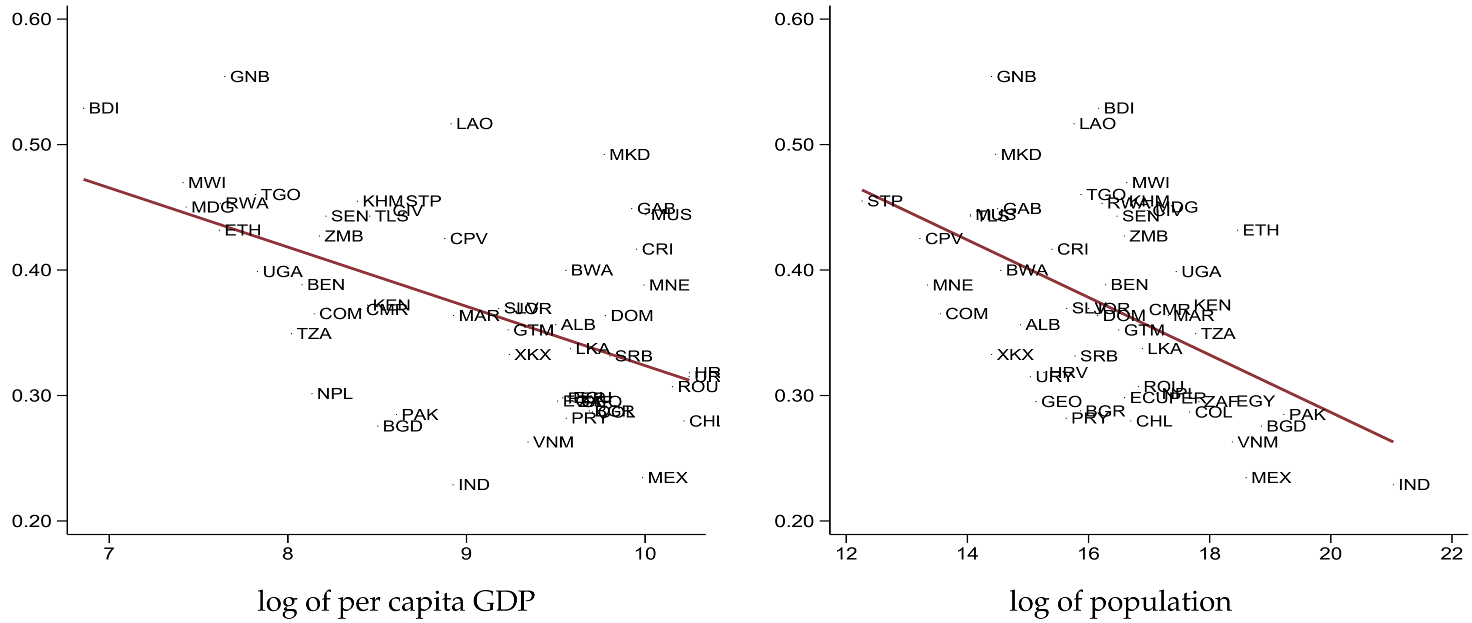
Figure 1 shows how importer firm concentration varies across countries. The figure plots the trade-weighted average of the import share of the largest importer firm in a six-digit HS good in each country against the country's GDP per capita (left panel) and the country's population (right panel). This figure illustrates that imports of a good are highly concentrated among a few large importer firms: the median good import share of the largest importer is 48% across countries, goods and years in our sample. Moreover, the negative slope in the two plots indicates that importer firm concentration is significantly higher in poorer countries compared to richer ones, and in smaller countries compared to larger countries.

Motivated by this evidence, we propose a model that allows the domestic pricing decisions of importer firms to depend on their share of the country's imports of a good. In our model, each firm's perceived elasticity of domestic demand is a function of its share of the domestic market, as in Atkeson and Burstein (2008) and Amiti et al. (2019a). When importer firm concentration matters for pricing decisions, a tariff-induced cost shock causes larger importers of a good to reduce more their domestic markups and, consequently, to reduce less their import spending. This relationship maps directly to how much the firm's perceived elasticity of domestic demand varies with its market share, which in turn determines the importer firm's domestic markup and its sensitivity to tariffs. Building on this

Figure 1: Import Share of Top Importer vs Per capita Income and Population

(a) Top Importer Share and Per capita Income

(b) Top Importer Share and Population



Note: Figure shows scatter-plots of the simple average across years of the country's import-weighted average across 6-digit HS goods (HS6) of the share of the largest importer firm in the country's imports of each HS6 good against log per capita GDP (left panel) and log population (right panel).

insight, we show how to use responses in firm-level imports to measure the aggregate and distributional effects of tariff changes, since such effects are a function of the levels and responses of markups and imports across firms. This links the incidence of tariff changes on prices and profits within a country to measures of importer firm concentration, such as those shown in Figure 1.

We next estimate the model's structural equation for the elasticity of imports to changes in the average tariff cost across firm-good pairs, as a function of the firm's initial share of the country's imports of the good (hereafter, the firm's "good import share"). Our specification accounts for strategic complementarities in firm pricing decisions within a market by including good-country fixed effects interacted with a flexible function of the firm's good import share. We find evidence that concentration in import markets affects firm pricing decisions. Specifically, the magnitude of the firm-level elasticity of imports to average tariff cost decreases monotonically with the firm's good import share. For firms with negligible import shares, an increase of 1 log-point in their tariff cost induces a decline in imports of 2.5 log-points. In contrast, the same shock induces only a reduction of 0.8 log-points in the imports of goods for which a firm has more than 50% of the country's imports.[1] Through the lens of our model, these estimates imply that domestic markups range from 1.4 for small importers to 1.8 for larger ones, with an elasticity to tariff costs near zero for small importers and -0.5 for larger importers.

Finally, we quantify the cross-country variation in markups of importer firms and the tariff incidence on firms and consumers. We obtain two main results that emerge directly from the combination of our estimates of the firm-level elasticity of imports to tariffs and the cross-country variation in import concentration shown in Figure 1. First, domestic markups of importer firms are higher in poorer, smaller countries compared to richer, larger ones. Second, profits of importer firms absorb a significant fraction of firm-specific trade cost changes, with this fraction being larger in poorer, smaller countries. Consequently, the pass-through from import costs to consumer prices is, on average, smaller in poorer, smaller countries.

Our paper suggests that import firm concentration plays an important role in determining the incidence of international shocks on domestic prices and profits through the decisions of importer firms. Our key mechanism is that import firm concentration affects importers' strategic pricing behavior in response to changes in the costs of foreign goods. In this sense, it is most closely related to Amiti et al. (2019a) who also document imperfect pass-through from foreign price shocks to domestic prices, as well as pass-through heterogeneity with respect to firm size. Our contribution is to explicitly link the pass-through magnitude to the market structure of importing firms, and to show how this market structure varies across countries. Combined with our general-equilibrium model, these findings imply that the incidence of trade shocks on consumers increases with country size and income.

More generally, we build upon the theoretical and empirical frameworks used to study how shock transmission across countries depends on the strategic pricing decision of *exporter* firms. In particular, Atkeson and Burstein (2008), Berman et al. (2012), and Amiti et al. (2014) measure how pricing decisions of exporting firms depend on their share of export markets (See Burstein and Gopinath (2013) for a review of this literature).[2] Our focus is not on exporter firms but on the strategic pricing decision of importer firms and its implications for how import firm concentration shapes the impact of trade cost changes on the domestic market.

[1] These responses come entirely from changes in import quantity: the unit import value paid to foreign suppliers does not respond to tariff changes for any level of the firm's good import share. This suggests that monopsony power over foreign suppliers is not the main driver of the weaker import decline for larger importers, at least in our sample that is dominated by developing countries.

[2] Amiti et al. (2014) focus on exporter firms that are also importers and measure the pass-through of changes in exchange rates for such firms.

Our analysis uses administrative custom records to recover the distribution of domestic markups on imported goods across 55 countries. Our paper thus complements the literature that uses the insight of Hall (1986) to estimate the markup distribution across firms using detailed plant-level data on inputs, output, and prices. Some examples are De Loecker and Warzynski (2012) and De Loecker et al. (2016).[3] At the cost of relying on stronger assumptions on technology, demand and market structure, our procedure only requires custom records that we harmonize for a large set of countries. The payoff are estimates of markups for *all* importer firms in 55 countries, albeit restricted only to the importing sector. We use these estimates to measure the aggregate and distributional effects of tariff changes in the presence of endogenous markup *dispersion* caused by import firm concentration.[4]

Finally, there are additional mechanisms via which importer firms may matter that we are silent on. For instance, Alviarez et al. (2023) focus on bilateral bargaining between exporters and importers. Blaum et al. (2018, 2019) show how importer firms affect domestic prices through their input sourcing choices. Going back to Krugman (1979), an extensive literature has studied the pro-competitive effects of international trade defined as the impact of imports on the markups of their domestic substitutes. Some examples of such papers are Edmond et al. (2015), Arkolakis et al. (2019), Jaravel and Sager (2020), and Amiti and Heise (2024).

Our paper is organized as follows. Section 2 documents patterns of import firm concentration across countries. Section 3 presents our model linking import firm concentration to the level and responsiveness of markups and imports across firms. Section 4 provides estimates of how the firm-level elasticity of imports to tariffs varies with the firm's good import share. Section 5 presents the cross-country variation in the domestic markups of importer firms and the incidence of tariffs on firms and consumers. Section 6 concludes.

2 Import Firm Concentration Across Countries

In this section, we build measures of the firm-level concentration of a country's imports of each good. We then use these measures to show that import firm concentration varies with the size and development of countries.

[3]See De Loecker and Goldberg (2014) for a review.

[4]The welfare cost from dispersion in marginal product (some of which are likely due to markup dispersion) is the subject of a large literature, starting with Hsieh and Klenow (2009). We are not aware of cross-country estimates of average and dispersion in markups using comparable data from a large number of countries.

We use a database covering the universe of import transactions for each firm and good across 55 countries from 2000 to 2021. Appendix Table B.1 lists the countries and years in our database.[5] The transaction-level data is generally obtained from countries' customs agencies.[6] We restrict the sample to six-digit goods in the Harmonized System Classification (HS6) that are not in the oil sector.[7] The database has information on the quantity, value (in U.S. dollars), and origin country of each import transaction of HS6 goods and importer firms in a destination country. For a given good-country-year in our sample, we measure each firm's good import share as the value of the firm's imports of an HS6 good divided by the total value of the country's imports of that HS6 good.

The left panel of Figure 2 presents the histogram of firms' good import shares across all firm-good-country-year observations in our database. To ensure equal weighting of observations across goods, countries, and years, we weight each good-country-year by its share of the country-year's total imports, normalized by its share of the total number of firms in the database. The histogram reveals that most firms account for only a small fraction of their country's imports of HS6 goods. Nearly 90% of the firms in our sample hold less than 10% of the import share of a good in their country, while only 2.7% account for more than 90% of their country's imports of a good.

The right panel of Figure 2 illustrates the distribution of a country's total imports associated with firms holding different good import shares. This distribution is calculated by weighting each firm-good-country-year observation by its share of the country-year's imports, normalized by the good-country-year's share of the total number of firms in the dataset. Despite the large number of small importer firms, the right-skewness of the distribution highlights that a few large importer firms account for the majority of the country's imports. Close to 50% of the country's imports correspond to goods imported by firms holding more than 90% of their good import market.

We next construct three measures of import firm concentration for the 2,416,606 good-country-year observations in our sample. For a given HS6 good in a country-year, the measures are: (i) the Herfindahl-Hirschman Index (HHI) defined as the sum of the squared import share across importer firms; (ii) the import share of the largest importer firm; and (iii) the probability that the import share of the largest importer firm is higher than 90%.

Figure 3 plots the distribution of our first two measures of import firm concentration

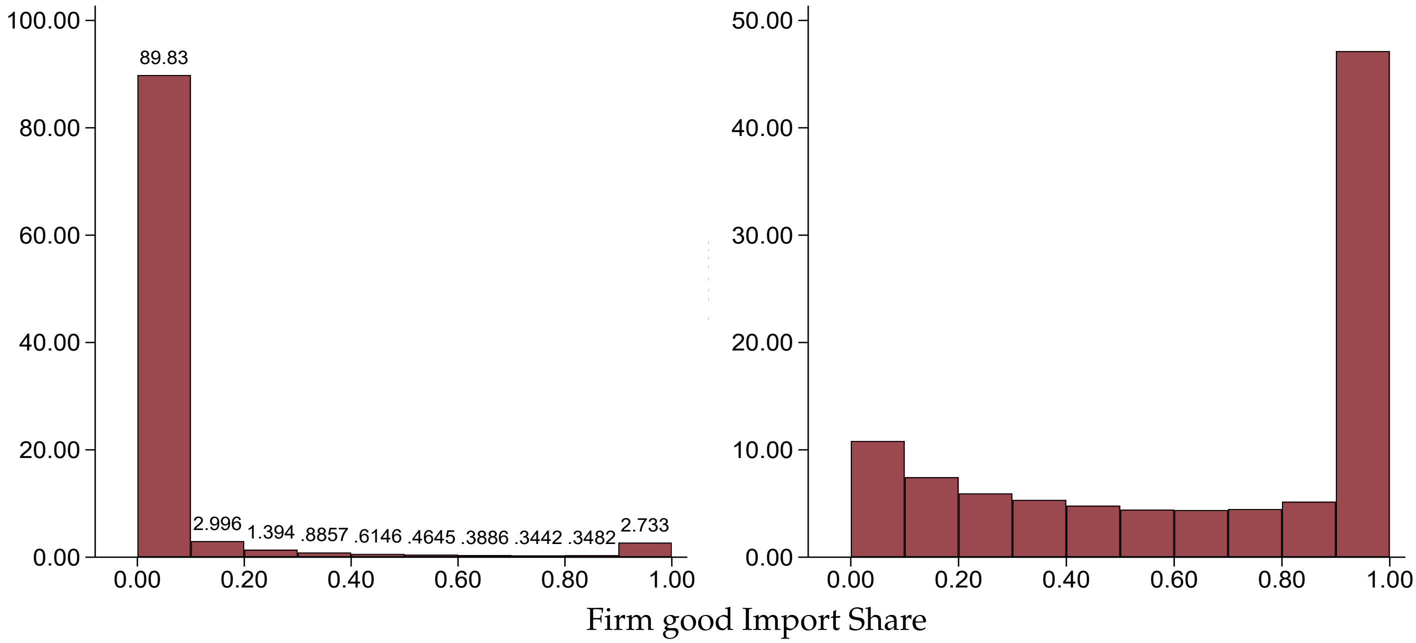
[5] The database has the same source as the World Bank Exporter Dynamics Database described by Fernandes et al. (2016), but it focuses on import transactions.

[6] The main exceptions are India, Mexico, Sri Lanka and Viet Nam for which we use the S&P Global Market Intelligence Panjiva data platform.

[7] We use a time-consistent consolidated classification that concords and harmonizes across several HS revisions in the raw data. We exclude oil goods (HS ch. 27) because they are poorly recorded in customs data. Fernandes et al. (2016) provide a more detailed description of the data construction methodology.

Figure 2: Distribution of Firms and Imports by Firm Import Share

(a) Distribution of Firms **(b)** Distribution of Imports



Notes: Sample of 166,384,728 firm-good-country-year observations. Left panel reports the fraction of observations by bracket of the firm's good import share (i.e., the imports of the firm-good-country-year divided by imports of the good-country-year), where the weight of each good-country-year is its share of the imports of the country-year divided by its share of the number of firms in the database. The right panel reports the share of a country's total imports associated with firms in different brackets of the firm's good import share. It is a histogram of firm-good-country-year observations where the weight of each observation is its share of the imports of the country-year divided by the good-country-year's share of the number of firms in the database.

across good-country-year observations. To account for the size of countries and goods, we weight each observation by its share of the country's imports in a given year divided by the number of good-year observations for each country in the database. The left panel displays the distribution of HHI of firm import shares within each HS6 good. About 35% of the observations have HHI values that exceed 0.25. The right panel shows the distribution of the import share of the largest importer firm of the good in the country. The median of the distribution is 30%, which indicates that the top importer usually accounts for a sizable share of the imports in a given good-country-year. The import share of the top firm exceeds 50% in about 27% of the observations.

We now examine the cross-country variation in import firm concentration. In Figure 1, we observed that poorer and smaller countries exhibit higher average levels of import firm concentration within goods, as measured by the import share of the top importer firm of the good. However, this correlation does not account for other factors that might

Figure 3: Distribution of import firm concentration Across good-Country-Year Triples

Note: Sample of 2,416,606 good-country-year observations. Each panel reports the fraction of good-country-year observations by bracket of the import firm concentration measure. Each observation is weighted by its share of the country's imports in a given year divided by the number of good-year observations for each country in the database. In the left panel, import firm concentration is the Herfindahl-Hirschman Index (HHI) defined as the sum of the squared import share across importer firms. In the right panel, it is the import share of the largest importer firm.

also explain the heterogeneity in import firm concentration across countries, such as good composition or market size.

Table 1 presents regression estimates to evaluate the robustness of this relationship. It shows that the basic pattern in Figure 1 is robust to alternative concentration measures and control variables. The dependent variable in the regressions is either the HHI of firm imports (top panel), the import share of the top importer firm (middle panel), or an indicator variable for whether the import share of the top importer firm exceeds 90% (bottom panel).

In the first column of Table 1, we report the results from a regression of import firm concentration on log per capita GDP, which yields negative and statistically significant coefficients. The second column introduces good-year fixed effects to control for systematic differences in good import composition across countries at varying levels of development. The next two columns report regressions of import firm concentration on log population, both without and with good-year fixed effects. In both cases, the regressions yield precisely estimated negative coefficients.

Table 1: Import Market Concentration by GDP/capita and population

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Panel (a): HHI of Firm Imports			
log GDP/capita	-0.053***	-0.046***			-0.061***	-0.064***	-0.186***
	(0.009)	(0.008)			(0.005)	(0.006)	(0.036)
log Population			-0.020***	-0.027***	-0.037***	-0.039***	-0.165***
			(0.005)	(0.004)	(0.003)	(0.004)	(0.046)
log Imports						0.003	0.055***
						(0.003)	(0.004)
R^2	0.033	0.559	0.014	0.559	0.587	0.587	0.833
				Panel (b): Import Share of Top Importer Firm			
log GDP/capita	-0.053***	-0.047***			-0.062***	-0.063***	-0.188***
	(0.009)	(0.008)			(0.004)	(0.005)	(0.039)
log Population			-0.021***	-0.028***	-0.037***	-0.038***	-0.170***
			(0.006)	(0.004)	(0.003)	(0.004)	(0.050)
log Imports						0.001	0.055***
						(0.003)	(0.004)
R^2	0.034	0.524	0.016	0.523	0.553	0.553	0.857
				Panel (c): Pr(Import Share of Top Importer) $>$ 90%			
log GDP/capita	-0.032***	-0.027***			-0.035***	-0.047***	-0.110***
	(0.007)	(0.006)			(0.004)	(0.005)	(0.023)
log Population			-0.010***	-0.016***	-0.022***	-0.030***	-0.115***
			(0.004)	(0.002)	(0.002)	(0.003)	(0.027)
log Imports						0.010***	0.041***
						(0.002)	(0.004)
R^2	0.012	0.482	0.005	0.483	0.491	0.492	0.786
HS6-Year FE	N	Y	N	Y	Y	Y	Y
HS6-Country FE	N	N	N	N	N	N	Y

Note: Sample of 2,416,606 good-country-year observations. For the import firm concentration measure indicated in each panel's heading, columns report estimates of regressing the concentration measure on the variables listed on the rows. Concentration measures are: (i) the Herfindahl Index of firm imports for each HS6 in panel (a); (ii) the share of the largest importer firm in the country's imports of each HS6 in panel (b); and (iii) a dummy that the import share of the largest importer firm of each HS6 exceeds 90% in panel (c). All regressions are weighted by the share of the good in total imports in that country-year, and include year fixed effects. Columns 2 and 4-7 control for good-year fixed effects; Column 7 also controls for country-good fixed effects. Standard errors clustered by country.

The remaining columns probe the robustness of the negative relationship between market concentration and GDP per capita and population. The regression in column 5 includes log GDP per capita along with log population. The regression in column 6 further adds log imports for the HS-6 product-country-year as a measure of market size. Across these specifications, estimated coefficients on log per capita GDP and log population do not change much, remaining negative and statistically significant.

Finally, in the last column, we include country-good fixed effects, relying solely on within-country variation in per capita GDP and population over time. While the estimated coefficients are larger in magnitude, they are also less precise, reflecting the more limited variation within country-good pairs. Nevertheless, these results reinforce the conclusion that import firm concentration is higher in poorer and smaller countries.

3 A Model of Oligopolistic Importer Firms

In this section, we propose a model that links import firm concentration to the strategic pricing decisions of importer firms in the domestic market. In our model, import firm concentration shapes the aggregate and distributional effects of tariff changes through the level and responsiveness of markups and imports across firms. We further show how to recover markups and their sensitivity to tariff changes from the firm-level elasticity of imports to tariffs as a function of the firm's good import share.

3.1 Environment

We consider a small open economy populated by a unit mass of workers and owners. Workers have an inelastic labor supply of $\bar{L}$. Owners operate an exogenous set of firms. Each firm f produces a differentiated variety of a good. Let $\mathcal{F}_{gk}$ denote the set with the discrete number of firms producing a variety of good g in sector $k \in \mathcal{K}$. We classify goods in each sector into subsets of domestic goods $\mathcal{G}_k^D$, imported goods $\mathcal{G}_k^M$, and exported goods $\mathcal{G}_k^X$. To simplify notation, let $\mathcal{G}_k^C = \mathcal{G}_k^D \cup \mathcal{G}_k^M$ be the set of domestically consumed goods, and $\mathcal{G}_k = \mathcal{G}_k^C \cup \mathcal{G}_k^X$ be the set of all goods.

Preferences. Workers and owners have identical homothetic preferences given by

$$\begin{aligned} C &= \Pi_{k\in\mathcal{K}}(C_k)^{\lambda_k} \\ C_k &= \left[\sum_{g\in\mathcal{G}_k^C}(a_{gk})^{\frac{1}{\eta_k}}(C_{gk})^{\frac{\eta_k-1}{\eta_k}}\right]^{\frac{\eta_k}{\eta_k-1}} \\ C_{gk} &= \left[\sum_{g\in\mathcal{F}_{gk}}(a_{f,gk})^{\frac{1}{\sigma_k}}(q_{f,gk})^{\frac{\sigma_k-1}{\sigma_k}}\right]^{\frac{\sigma_k}{\sigma_k-1}} \end{aligned}$$

where $q_{f,gk}$ denotes the consumption of the variety of good g in sector k supplied by firm f, and σ_k and η_k denote respectively the elasticity of substitution across firm-level varieties of the same good and across goods in the same sector.[8] Note that we separate domestic and imported varieties into different nests within the same sector. We do so because we observe only domestic spending on imported varieties, and the nesting structure enables us to estimate the model while accommodating a flexible substitution pattern across firms, goods, and sectors.[9]

These preferences imply that, given prices $\{p_{f,gk}\}$, domestic demand for the variety of good g supplied by firm f is

$$q_{f,gk} = a_{f,gk}(p_{f,gk})^{-\sigma_k}(P_{gk})^{\sigma_k-\eta_k}a_{gk}D_k \quad \text{with} \quad P_{gk} \equiv \left[\sum_{f\in\mathcal{F}_{gk}} a_{f,gk}(p_{f,gk})^{1-\sigma_k}\right]^{\frac{1}{1-\sigma_k}}, \tag{1}$$

such that D_k is a sector demand shifter,

$$D_k = (P_k)^{\eta_k-1}\lambda_k E \quad \text{and} \quad P_k = \left[\sum_{g\in\mathcal{G}_k^C}(a_{gk})(P_{gk})^{1-\eta_k}\right]^{\frac{1}{1-\eta_k}}, \tag{2}$$

with E denoting the country's aggregate expenditure.

[8] We normalize demand shifters so that $\sum_{k\in\mathcal{K}}\lambda_k = \sum_{g\in\mathcal{G}_k^C} a_{gk} = \sum_{g\in\mathcal{F}_{gk}} a_{f,gk} = 1$.

[9] Fajgelbaum et al. (2020) and Adão et al. (2023, 2024) make similar nesting assumptions.

Technology. Each firm f combines foreign goods and domestic labor to produce its differentiated variety according to

$$y_{f,gk} = \frac{1}{z_{f,gk}} (\ell_{f,gk})^{1-\alpha_g} \left[\sum_o (a^m_{of,gk})^{\frac{1}{\theta_k}} (m_{of,gk})^{\frac{\theta_k - 1}{\theta_k}} \right]^{\alpha_g \frac{\theta_k}{\theta_k - 1}}, \tag{3}$$

where, for a firm f producing a variety of good g, $z_{f,gk}$ is a cost shifter, $\ell_{f,gk}$ is the labor used in production, and $m_{of,gk}$ are imports of foreign good g from origin o. The parameter α_g measures the share of domestic value-added in output.[10] We assume that only labor is used to produce varieties of exported and domestic goods, $\alpha_g = 0$ for all $g \in \mathcal{G}^X_k \cup \mathcal{G}^D_k$. Importer firms also use foreign goods in production, $\alpha_g > 0$ for all $g \in \mathcal{G}^M_k$. Note that all importer firms of a good have the same import cost share, as our dataset based on customs records only entails firm expenditure on imported inputs. For importers of good g in sector k, $\theta_k > 1$ is the elasticity of substitution across foreign origins, and $a^m_{of,gk} \geq 0$ are firm-specific shifters of import demand across origins (with $\sum_o a^m_{of,gk} = 1$).

Foreign Offer Curve. We assume that the country is a small open economy, so that all importer firms face an identical and exogenous price for foreign good g of origin o, $p^F_{o,gk}$.[11] In addition, we assume that, given a price of $p_{f,gk}$, the foreign demand for exported good g of firm f is given by

$$q_{f,gk} = a^X_{f,gk} (p_{f,gk})^{-\sigma_k} \quad \text{for all} \quad g \in \mathcal{G}^X_k, \tag{4}$$

where $a^X_{f,gk}$ is a foreign demand shifter. Our specification of a log-linear foreign demand curve allows us to focus on the equilibrium for each country in our sample, as in Broda et al. (2008) and Fajgelbaum et al. (2020).

Government. The government imposes an ad-valorem import tax of $\tau_{o,gk}$ on foreign good g from origin o. This implies that the cost of foreign goods for importer firms is $p^m_{o,gk} = (1 + \tau_{o,gk}) p^F_{o,gk}$. The tariff revenue is rebated to workers and owners with a lump-

[10] Our analysis below would remain the same if we also allow production to use intermediate goods as long as production entails a similar nesting structure as that of final demand. This is a common restriction in international trade models – for a review, see Costinot and Rodríguez-Clare (2014).

[11] This assumption is consistent with the evidence that import tariffs trigger little changes in the price of foreign goods even for large importer countries like the United States and China – e.g., Fajgelbaum et al. (2020) and Amiti et al. (2019b).

sum transfer:

$$T = \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} \sum_{o} T_{of,gk}, \quad \text{with} \quad T_{of,gk} \equiv \tau_{o,gk} p_{o,gk}^F m_{of,gk}. \tag{5}$$

Market Structure. We assume that each firm acknowledges the impact of its pricing decision on its domestic demand while taking as given prices chosen by other firms, as in Atkeson and Burstein (2008). Specifically, firm f producing a variety of good g perceives (1) to be its domestic demand as a function of its price, given the sector shifter D_k. Our nested structure of demand implies that pricing decisions of firms in other nests only affect a firm's demand through a single demand shifter, which the firm takes as given. This is the key assumption that allows us to link the firm-level import data in Section 2 to the distribution of prices set by importer firms, without data on good-level sales by domestic firms.[12] The elasticity of substitution across goods η_k summarizes domestic competition of other goods, and determines how pricing decisions of importer firms depend on its good import share. We impose that $1 < \eta_k \leq \sigma_k$ in order to guarantee that markups are finite and increasing on firm revenue.

For simplicity, we assume that exporter firms take as given the foreign export demand in (4). As such, they operate in monopolistic competition in the world market. We further assume that firms are price takers on the world good market and the domestic labor market. That is, each firm takes as given both the tariff-inclusive price of imported goods, $p_{o,gk}^m$, and the wage of domestic workers, w.

Equilibrium. Appendix A.1 outlines the equilibrium of our economy given prices and tariffs for foreign goods. The equilibrium guarantees that (i) consumers maximize utility given their budget constraint, (ii) firms maximize profits given their technology and perceived demand, (iii) the government balances its budget, and (iv) markets for goods and labor clear.

[12] Our analysis is simpler under the assumption of CES demand within each group. However, this demand structure is not essential. We can obtain local expressions for small shocks using the general class of single-aggregator demand functions in Amiti et al. (2019a), and global expressions with a nested demand function built with the homothetic single-aggregator demand in Matsuyama (2023).

3.2 Firm-Level Prices and Markups in Equilibrium

We now describe how prices and markups vary across firms in equilibrium, with all derivations contained in Appendix A.2. For domestic and importer firms ($g \in \mathcal{G}_k^C$),

$$p_{f,gk} = \mu_{f,gk} c_{f,gk} \quad \text{such that} \quad \mu_{f,gk} = \frac{\varepsilon_{f,gk}}{\varepsilon_{f,gk} - 1}, \tag{6}$$

where, for firm f producing a variety of good g, $c_{f,gk}$ is the marginal cost, and $\varepsilon_{f,gk} > 1$ is the elasticity of perceived domestic demand as a function of the firm's share of domestic sales of good g, $S_{f,gk}$,

$$\varepsilon_{f,gk} = \sigma_k - \gamma_k S_{f,gk} \quad \text{and} \quad \gamma_k \equiv \sigma_k - \eta_k \geq 0. \tag{7}$$

For each producer f of good g, the optimal price entails a markup over marginal cost of $\mu_{f,gk}$, which is decreasing on the elasticity of the firm's perceived demand with respect to its own price, $\varepsilon_{f,gk}$. Our model's oligopolistic market structure implies that the perceived elasticity of domestic demand is endogenous. As a consequence of the nesting structure of domestic demand, it only depends on the price of other producers of the same good g through the firm's domestic market share $S_{f,gk}$.

In equilibrium, among producers of the same good g, firms with lower marginal costs have higher shares of domestic sales and face lower elasticities of domestic demand. As a result, these firms charge lower prices, but have higher markups. Formally, holding constant good-level variables,

$$\beta^p_{f,gk} \equiv \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = \frac{1}{1 + \rho_{f,gk}} \quad \text{and} \quad \beta^\mu_{f,gk} \equiv \frac{\partial \log \mu_{f,gs}}{\partial \log c_{f,gs}} = \frac{-\rho_{f,gk}}{1 + \rho_{f,gk}} \tag{8}$$

where, because $\sigma_k \geq \varepsilon_{f,gk}$,

$$\rho_{f,gk} \equiv \frac{(\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)}{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)} \geq 0. \tag{9}$$

To gain intuition for these cross-firm patterns, it is useful to consider a linear approximation around the markup of a firm with small domestic sales ($S_{f,gk} \approx 0$):

$$\mu_{f,gk} \approx \frac{\sigma_k}{\sigma_k - 1} + \frac{\gamma_k}{(\sigma_k - 1)^2} S_{f,gk}.$$

Firms with a negligible market share, $S_{f,gk} \approx 0$, behave as in monopolistic competition by setting a constant markup of $\sigma_k/(\sigma_k - 1)$. For firms with a higher market share, the perceived elasticity of demand is lower (i.e., $\varepsilon_{f,gk}$ is decreasing on $S_{f,gk}$). As a result, these firms find it optimal to raise their markups above $\sigma_k/(\sigma_k - 1)$. This stems from the fact that the between-good elasticity, which is lower than the between-firm elasticity by a margin of γ_k, becomes a more important determinant of the perceived demand elasticity of firms with higher market shares. As a result, goods with a higher concentration of market shares tend to have a higher average markup. Using the approximation above, the (revenue-weighted) average markup of good g is increasing on its Herfindahl-Hirschman index of firm market shares, $\mathrm{HHI}_{gk} \equiv \sum_{f\in\mathcal{F}_{gk}} (S_{f,gk})^2$:

$$\bar{\mu}_{gk} \equiv \sum_{f\in\mathcal{F}_{gk}} S_{f,gk}\mu_{f,gk} \approx \frac{\sigma_k}{\sigma_k - 1} + \frac{\gamma_k}{(\sigma_k - 1)^2}\mathrm{HHI}_{gk}.$$

Finally, we turn to imports, which vary across firms in a way that is not proportional to their sales due to differences in markups. Holding good-level variables constant, the relationship between marginal costs and imports across importers of good g is

$$\beta^m_{f,gk} \equiv \frac{\partial \log M_{f,gk}}{\partial \log c_{f,gk}} = 1 - \frac{\sigma_k}{1 + \rho_{f,gk}}. \tag{10}$$

For all firms, $\beta^m_{f,gk} < 1$ since $\gamma_k \geq 0$. However, $\beta^m_{f,gk} < 0$ if, and only if, $\sigma_k < (\varepsilon_{f,gk})^2$, in which case firm f's import share of good g, $S^M_{f,gk} = M_{f,gk}/\sum_{f'\in\mathcal{F}_{gk}} M_{f',gk}$, is decreasing on its marginal cost and increasing on its sales share.[13] As we show below, $\beta_{f,gk} < 0$ is the empirically relevant case.

3.3 The Impact of Tariff Changes

We next analyze how the economy responds to exogenous changes in import tariffs.[14]

3.3.1 Aggregate and Distributional Effects

We start with the incidence of tariff changes on workers and firms. Tariff changes affect firms through changes in their marginal costs. For all domestic and exporter firms, the change in the marginal cost is equal to the change in the domestic wage, which implies

[13]This holds if $\sigma_k - \sqrt{\sigma_k} > \gamma_k$. To see why, consider the monopolistic benchmark with $S_{f,gk} \approx 0$ and $\varepsilon_{f,gk} = \sigma_k > 1$ for all firms where, because of identical markups across firms, higher marginal costs imply higher imports. Away from this benchmark, more goodive firms optimally set higher markups, and thus reduce sales in order to raise profits. Only when the perceived demand elasticity is high enough, more goodive firms reduce their sales by a small enough amount that guarantees higher imports.

[14]Appendix A.3 derives the first-order approximation for responses in equilibrium outcomes.

that $d\log p_{f,gs} = d\log c_{f,gk} = d\log w$. For importer firms, the change in the marginal cost is given by

$$d\log c_{f,gk} = (1-\alpha_g)d\log w + \alpha_g d\log \bar{\tau}_{f,gk} \tag{11}$$

where $d\log \bar{\tau}_{f,gk}$ is the change in firm f's average tariff cost of foreign good g,

$$d\log \bar{\tau}_{f,gk} \equiv \sum_o s^m_{of,gk} d\log(1+\tau_{o,gk}), \tag{12}$$

with $s^m_{of,gk}$ the share of origin o in firm f's imports of good g.

To the extent that changes in average tariff costs vary across importers, responses in domestic prices and markups also differ among importer firms. This variation affects the real earnings of workers, $d\omega^L \equiv dw\bar{L} - dP$, relative to those of importer firm owners, $d\omega^M \equiv d\Pi^M - dP$. After setting the domestic wage as the numeraire, the impact of tariff changes on importers relative to workers is

$$d\omega^M - d\omega^L = \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \frac{M_{f,gk}}{\alpha_g} \left((\mu_{f,gk}-1)d\log M_{f,gk} + \mu_{f,gs} d\log \mu_{f,gs}\right). \tag{13}$$

The relative incidence of tariffs on profits is proportional to the weighted sum of responses in markups and imports (adjusted by initial markups) across importer firms, with weights given by their initial import levels. Intuitively, tariff incidence on importer firms is greater when their profits decrease, on average, in response to a tariff cost increase. Such decreases can arise from declines in both markups and sales. To measure the relative incidence of tariff changes using equation (13), one must observe firm-level responses in imports and markups, as well as their initial imports and markups.

The tariff change also affects aggregate welfare in the economy. For a utilitarian social welfare function, this is the change in real aggregate spending, $d\omega^A = dE - dP$:

$$\begin{aligned} d\omega^A &= \sum_{k\in\mathcal{K}} (\bar{\mu}_k^D - 1) W_k^D d\log D_k \\ &+ \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} M_{f,gk}(\mu_{f,gk}-1)\left(d\log M_{f,gk}/\alpha_g - d\log \bar{\tau}_{f,gk}\right) \\ &+ \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \sum_o T_{of,gk} d\log m_{of,gk}, \end{aligned} \tag{14}$$

where, in sector k, $\bar{\mu}_k^D \equiv \sum_{g\in\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} w\ell_{f,gk}\mu_{f,gk}/W_k^D$ is the average markup of domestic firms, $W_k^D \equiv \sum_{g\in\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} w\ell_{f,gk}$ is the wage bill, and $d\log D_k$ is the log-change in sales of domestic firms.

The aggregate impact of tariff changes is driven entirely by changes in allocative efficiency due to distortions created by markups of domestic firms (first row), markups of importer firms (second row), and tariffs on foreign goods (last row). Importantly, changes in markups themselves do not have a direct aggregate effect, as they primarily represent transfers between firms and consumers. Instead, the aggregate impact crucially depends on the interaction between initial markups and changes in sales across firms.

The first two rows capture the aggregate impact of reallocating resources across domestic and foreign firms, given the distortions caused by their relative market power. For domestic firms, tariff changes uniformly affect the sales of firms within the same sector. Consequently, changes in allocative efficiency are calculated as the weighted sum of spending changes on domestic firms across sectors, with weights determined by the sector's average markup. For importer firms (second row), the aggregate effects of reallocation depend on the covariance across firms between their initial markups and import responses net of the cost shock.

3.3.2 Firm-level Import and Markup Responses

The distributional and aggregate effects of tariff changes depend on how importer firms respond by adjusting their markups and imports. In our model, such responses are

$$d \log \mu_{f,gk} = \beta^{\mu}_{f,gk} \alpha_g (d \log \bar{\tau}_{f,gk} - d \log \bar{\tau}_{gk}) \tag{15}$$

$$d \log M_{f,gk} = \beta^{m}_{f,gk} \alpha_g (d \log \bar{\tau}_{f,gk} - d \log \bar{\tau}_{gk}) + \delta^m_{gk} \tag{16}$$

where $d \log \bar{\tau}_{gk} \equiv \sum_{f \in \mathcal{F}_{gk}} \omega_{f,gk} d \log \bar{\tau}_{f,gk}$ is a weighted average of the tariff cost change among importers of good g, and $\delta^m_{gk} = (1 - \eta_k) \alpha_g d \log \bar{\tau}_{gk} + d \log D_k$ is the change in domestic spending on importers of good g.[15]

Changes in markups and imports of importer firm f of good g depends on the relative change in the average tariff cost of firm f compared to all importers of good g, which measures the change in firm f's marginal cost relative to its competitors. The firm-specific elasticities $\beta^{\mu}_{f,gk}$ and $\beta^{m}_{f,gk}$ summarize strategic considerations in price setting, which depend on the firm's initial marginal cost and, thus, its share of domestic sales:

$$\beta^{\mu}_{f,gk} = \beta^{\mu}_{k}(S_{f,gk}) \quad \text{and} \quad \beta^{m}_{f,gk} \equiv \beta^{m}_{k}(S_{f,gk})$$

such that

$$\frac{\partial \beta^{\mu}_{k}}{\partial S_{f,gk}} < 0 \quad \text{and} \quad \frac{\partial \beta^{m}_{k}}{\partial S_{f,gk}} > 0.$$

[15] The weight of each firm depends on its size adjusted by its pass-through from costs to prices, $\omega_{f,gk} \equiv M_{f,gk} \mu_{f,gk} (1 + \beta^{\mu}_{f,gk}) / \sum_{f' \in \mathcal{F}_{gk}} M_{f',gk} \mu_{f',gk} (1 + \beta^{\mu}_{f',gk})$.

Thus, given the same relative change in average tariff cost, larger importers of good g reduce more their domestic markups and, consequently, less their imports. In the limit, small firms with $S_{fg} \approx 0$ behave as in monopolistic competition: they choose to completely adjust prices after an increase in marginal cost ($\beta^{\mu}_{f,gk} = 0$), which causes imports to decline by $\beta^{m}_{f,gk} = 1 - \sigma_k$. To gain intuition, consider again an approximation around the response of a small firm with $S_{f,gk} \approx 0$: $\beta^{m}_{f,gk} \approx 1 - \sigma_k + \gamma_k S_{f,gk}$ and $\beta^{\mu}_{f,gk} \approx -(\gamma_k/\sigma_k) S_{f,gk}$. As the firm's market share increases, the sensitivity of its import (markup) responses increases (decreases) in proportion to γ_k, since this parameter controls how the firm's perceived demand elasticity declines with its relative size among importers of good g.

Changes in tariffs also change the origin of firm imports, which are given by

$$d \log m_{of,gk} = -\theta_k d \log(1 + \tau_{of,gk}) + (\theta_k - 1) d \log \bar{\tau}_{f,gk} + d \log M_{f,gs}. \tag{17}$$

The parameter θ_k controls how much each firm adjusts its imports of good g from origin o following an origin-specific tariff change of $d \log(1 + \tau_{of,gk})$, conditional on firm-level imports and average tariff costs.

3.3.3 From Firm-level Import Responses to Firm-level Markups

We next show that knowledge of the between-firm elasticity of substitution, σ_k, and the firm-level elasticity of imports to marginal costs, $\beta^{m}_{f,gk}$, are sufficient to recover firm f's domestic markup, $\mu_{f,gk}$.

We first note that the definitions in (9) and (10) imply that

$$(\sigma_k - 1 + \beta^{m}_{f,gk})(\varepsilon_{f,gk})^2 - \sigma_k \beta^{m}_{f,gk} \varepsilon_{f,gk} - (1 - \beta^{m}_{f,gk}) \sigma_k (\sigma_k - 1) = 0.$$

Appendix A.3.3 shows that, since $\beta^{m}_{f,gk} \in (1 - \sigma_g, 1)$, this equation has a unique real solution that is greater than one:

$$\varepsilon_{f,gk} = \frac{\sigma_k \beta^{m}_{f,gk} + \sqrt{\left(\sigma_k \beta^{m}_{f,gk}\right)^2 + 4(\sigma_k - 1 + \beta^{m}_{f,gk})(1 - \beta^{m}_{f,gk}) \sigma_k (\sigma_k - 1)}}{2(\sigma_k - 1 + \beta^{m}_{f,gk})} > 1. \tag{18}$$

Note that, in our model, the elasticity of imports for firms with a negligible good import share identifies the between-firm elasticity: $\sigma_k = 1 - \beta^{m}_{k}(0)$. Thus, knowledge of $\beta^{m}_{f,gk}$ and $\sigma_k = 1 - \beta^{m}_{k}(0)$ identifies firm f's markup: $\mu_{f,gk} = \varepsilon_{fg}/(\varepsilon_{f,gk} - 1)$ with $\varepsilon_{f,gk}$ given by (18). Intuitively, the firm-level import response to cost shocks, $\beta^{m}_{f,gk}$, summarizes firm strategic behavior created by both the level and the sensitivity of the firm's perceived elasticity of demand. The quadratic equation above simply links back the level of ε_{fg} to the import response to shocks, $\beta^m_{f,gk}$, given the between-firm elasticity of substitution, $\sigma_k = 1 - \beta^m_k(0)$.

Equations (16) and (17) form the basis of our empirical strategy below. We use firm-level import responses in (16) to estimate the elasticity function $\beta^m_k(.)$ and thus $\beta^m_{f,gk}$ for every importer firm. We then use these estimates to measure both firm-level markups $\mu_{f,gk}$ using (18) and its sensitivity to trade costs $\beta^\mu_{f,gk}$ using (8) and (10). We use equation (17) to estimate how firms adjust the origin of their imports following tariff changes.

4 Estimates of Firm Import Responses to Tariff Changes

In this section, we estimate how firms adjust their import decisions in response to changes in average tariff costs as a function of their share of the country's imports of a good. From these estimates, we infer the level and sensitivity of domestic markups for importer firms based on their good import shares.

4.1 Change in Average Tariff Costs Across Firms

Our estimation strategy exploits the fact that, since tariffs vary across origin-good-year triplets, firms that import the same good from different origins may face different changes in average tariff costs. Specifically, we use the definition in (12) to measure the change in the average tariff cost between two consecutive years for each firm-good pair in a sample of destinations and years.

We define a good g as a six-digit HS good (HS6). Using the data from Teti (2020), we construct a panel dataset of ad-valorem import tariffs $\tau_{o,gkd,t}$ applied to each origin o and good g by the destination country d in year t.[16] This enables us to calculate annual changes in tariff costs for each origin, good and destination as $d\log(1+\tau_{o,gkd,t}) \equiv \log((1+\tau_{o,gkd,t})/(1+\tau_{o,gkd,t-1}))$. In addition, using the database described in Section 2, we measure the initial share of firm f's imports of good g coming from origin o, denoted as $s^m_{of,gkd,t-1}$. Following the definition in (12), we compute the change in firm f's average tariff cost of good g between $t-1$ and t as $d\log\bar{\tau}_{f,gkd,t} \equiv \sum_o s^m_{of,gkd,t-1} d\log(1+\tau_{o,gkd,t})$.

[16] We obtain tariff data for the following subset of countries in our database: Bulgaria (BGR), Colombia (COL), Costa Rica (CRI), the Dominican Republic (DOM), Ecuador (ECU), Egypt (EGY), Croatia (HRV), Morocco (MAR), Peru (PER), Paraguay (PRY), Romania (ROU), Tanzania (TZA), and Uruguay (URY). For each of these countries, our sample includes the subset of the years listed in Appendix Table B.1 that are between 2001 and 2017.

Figure 4 shows the frequency of $d \log \bar{\tau}_{f,gkd,t}$ across firm-good-destination-year observations in our sample, residualized from good-destination-year fixed effects. Specifically, the left panel of Figure 4 shows the frequency of observations for which the change in average tariff cost is "large" relative to other importers of the same good, defined as an increase in the residualized average tariff cost that is larger than 5% or smaller than −5%. Note that the variation in the plot excludes common effects on the average tariff cost for all importer firms of the same good in a destination. Accordingly, there would be no variation across firms in their residualized average tariff cost if either all firms imported a good from the same origin or if all origins of a good experienced the same tariff change. The figure shows that a large number of firms experience sizeable changes in their average tariff cost relative to other importers of the same good. There are 127,156 observations whose absolute change in residualized average tariff cost is larger than 5%.

Our estimation strategy requires changes in average tariff costs across firms that differ in terms of their share of the imports of a good in a destination, defined as $S^M_{f,gkf,t-1} \equiv M_{f,gkf,t-1} / \sum_{f' \in \mathcal{F}_{gkd,t-1}} M_{f',gkf,t-1}$. Section 2 documented that more than 93% of the firms in our database account for less than 20% of their country's imports of a good. We now evaluate the frequency of observations in our sample with sizeable changes in average tariff costs that correspond to large importers of a good. The right panel of Figure 4 shows the frequency distribution of the residualized $d \log \bar{\tau}_{f,gkd,t}$ across firm-good-destination-year observations with $S^M_{f,gkf,t-1} \geq 20\%$ and absolute residualized tariff change above 5%. Our sample has 2,748 observations that satisfy these restrictions. The limited variation in tariff cost changes for large importers in our sample guides our functional form choices in the estimation strategy below.

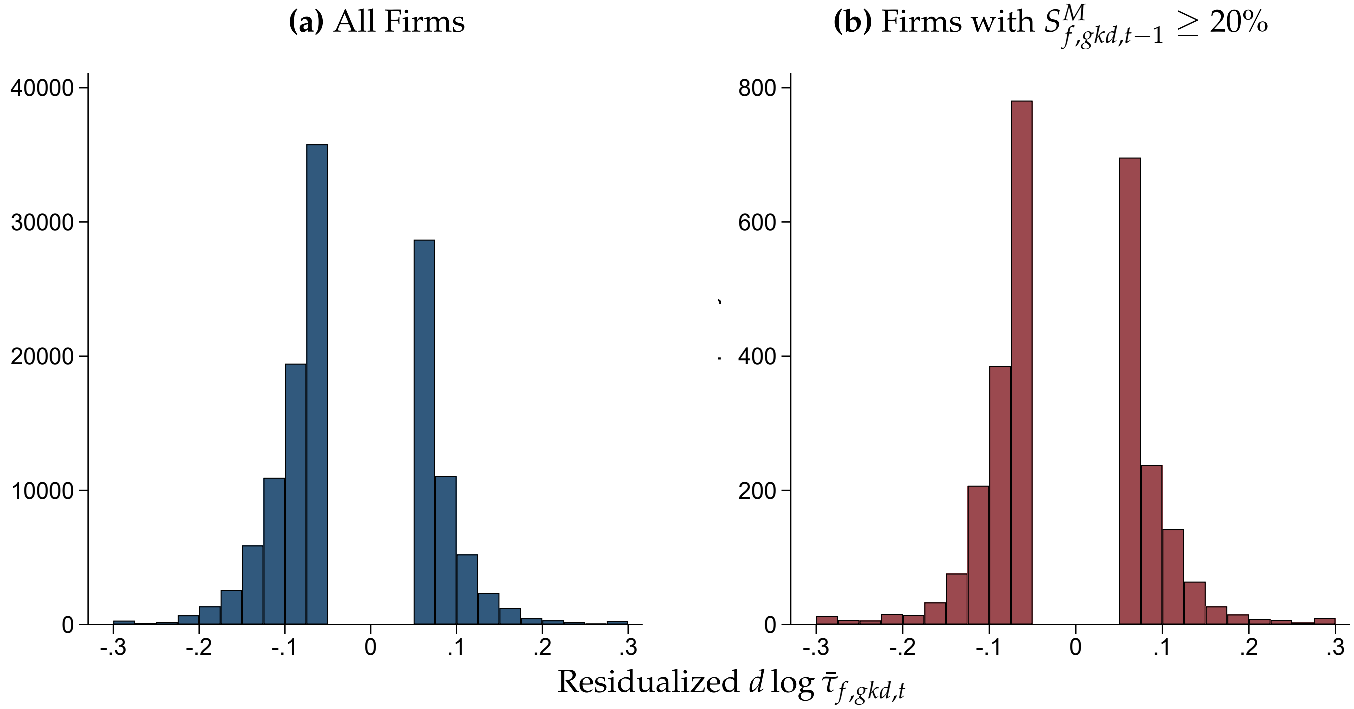
4.2 Estimates

We now estimate the model's expression in (16) for responses of imports to average tariff costs across firms and goods. To derive our estimation strategy, we note that, in our model, the firm-level import elasticity $\beta^m_{f,gkd,t}$ is only a function of the firm's market share, which is increasing with the firm's share of the destination's imports of good g under mild conditions.[17] Under the assumption that $(\sigma_k, \gamma_k, \alpha_g) = (\sigma, \gamma, \alpha)$ for all goods and sectors, our model implies that $\beta^m_{f,gkd,t}\alpha_g = \bar{\beta}(S^M_{f,gkd,t-1})$, so that the firm-level import response in (16) becomes

$$d \log M_{f,gkd,t} = \bar{\beta}(S^m_{f,gkd,t-1})(d \log \bar{\tau}_{f,gkd,t} - \zeta^m_{gkd,t}) + \delta^m_{gkd,t} + \phi_{f,d,t} + \epsilon_{f,gkd,t} \tag{19}$$

[17] We introduced these conditions in Section 3.2. Note that such conditions hold if $\beta^m_{f,gkd,t} < 0$ for all firms, which is true for our estimates below.

Figure 4: Frequency Distribution of Changes in Average Tariff Costs, $d\log\bar{\tau}_{f,gkd,t}$



Note: Figure shows the frequency distribution of $d\log\bar{\tau}_{f,gkd,t}$ residualized from good-destination-year fixed effects among firm-good-destination-year observations whose value of the residualized $d\log\bar{\tau}_{f,gkd,t}$ is greater than 5% or smaller than -5%. The left panel shows the frequency distribution for the 127,156 observations in our sample that satisfy this restriction. The right panel shows an analogous frequency distribution but restricted to the subset of 2,748 observations whose share of the destination's imports of the good, $S^M_{f,gkd,t-1}$, exceeds 20%. Bin at 0.3 is $\geq .3$; bin at $-.3$ is $\leq -.3$

where $d\log M_{f,gkd,t} = \log(M_{f,gkd,t}/M_{f,gkd,t-1})$ is the annual log-change in imports of firm f of good g in destination d at year t, and $(\zeta^m_{gkd,t}, \delta^m_{gkd,t})$ are good-destination-year fixed effects that, in our model, account for drivers of import changes of a good that are common to all firms in the destination. We also include firm-destination-year fixed effects $\phi_{f,d,t}$ to absorb firm-level import demand shocks that are common to all goods, like shocks to the firm's export or domestic demand. Thus, the residual $\epsilon_{f,gkd,t}$ can be interpreted as unobserved idiosyncratic shocks to the imports of good g for firm f; for example, shocks to the cost shifters $z_{f,gkd,t}$ that are specific to the variety of firm f based on the imported good g.

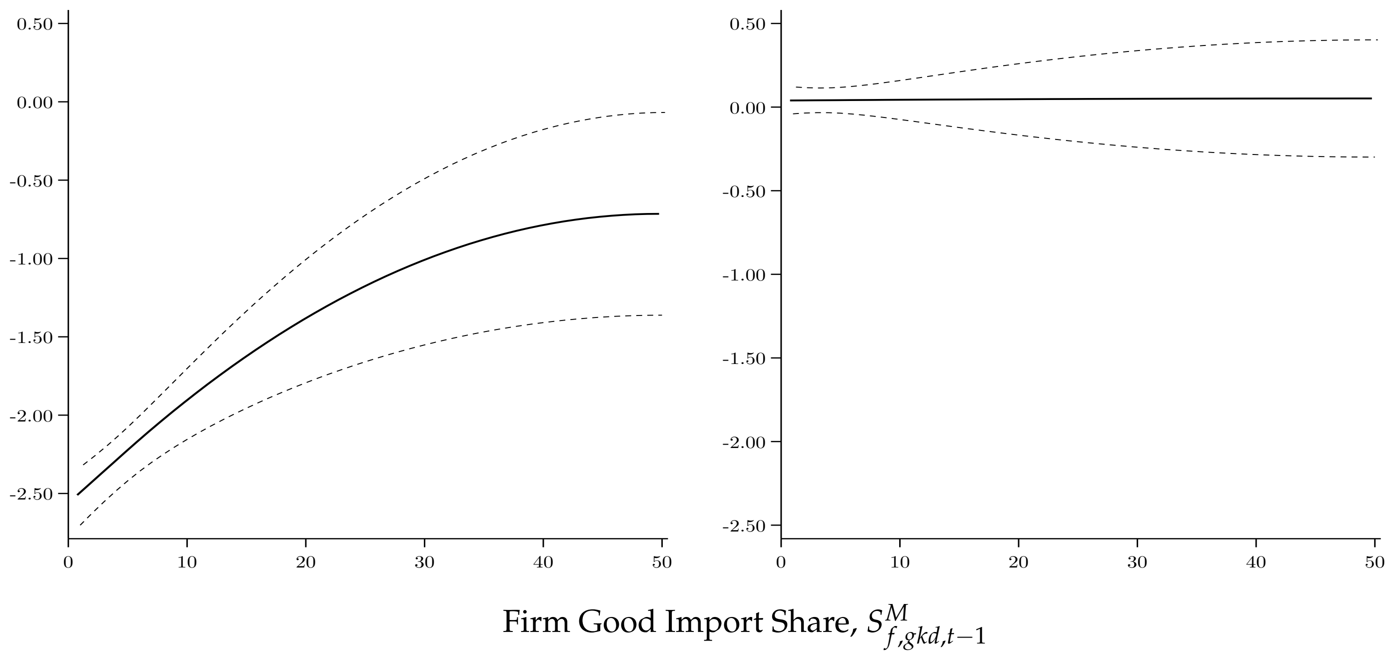
The estimation of (19) relies on the residualized changes in average tariff costs reported in Figure 4. Given good-destination-year and firm-destination-year fixed effects, our identification assumption is that idiosyncratic shocks to imports of a firm-good are orthogonal to changes in tariffs applied to different origins of a good. As described in Appendix B.2, we parametrize $\bar{\beta}(S)$ with a piece-wise spline specification that guarantees smooth estimates that are constant beyond a threshold, which we pick to be 50%

due to the low number of observations that have both tariff cost variation and high good import shares.

Figure 5: Firm's Elasticity of Imports and Unit Values to Tariff Changes

(a) Elasticity of Import Values

(b) Elasticity of Unit Import Value



Note: Sample of 13,623,037 firm-good-destination-year observations. The right panel reports estimates of $\bar{\beta}(S^M)$ obtained from (19), along with 95% confidence intervals implied by standard errors (two-way) clustered by firm-good-destination and good-destination-year. The left panel reports the elasticity function obtained from a specification analogous to (19) where the dependent variable is instead the log-change in the unit import value of the firm's imports of the good.

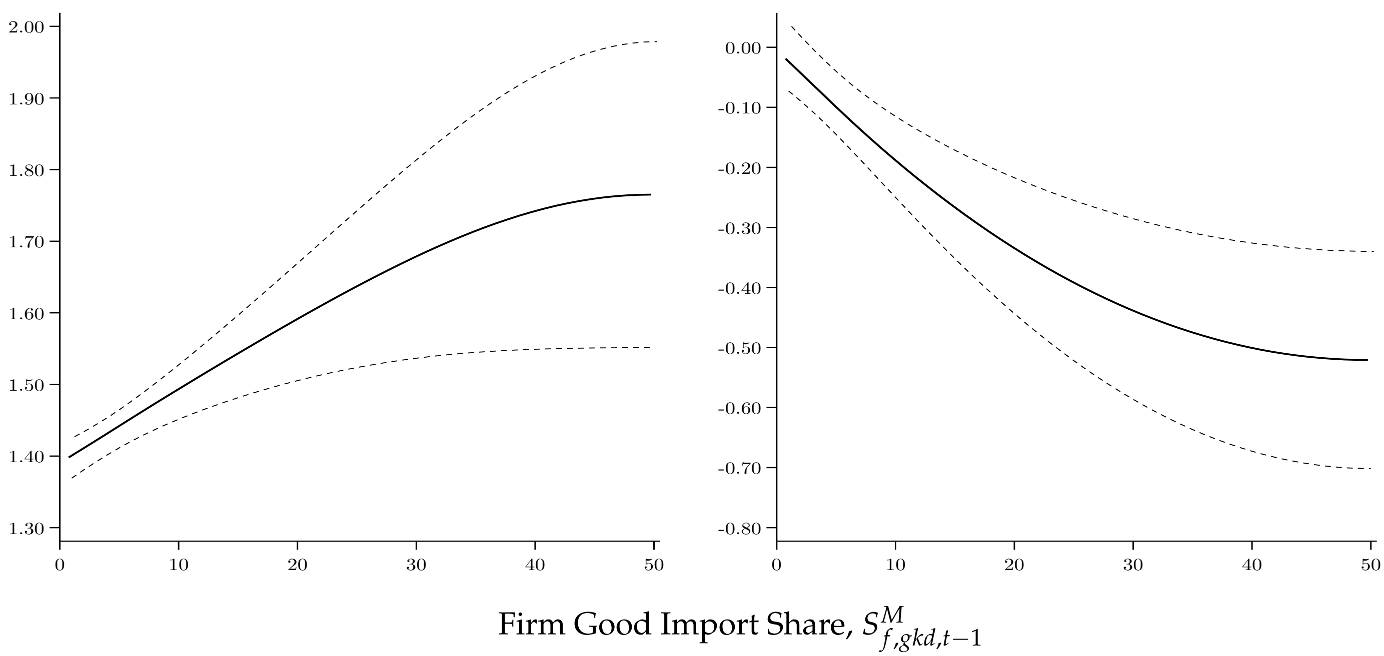
The left panel of Figure 5 presents the baseline estimates of (19). The figure shows that firms with a lower good import shares exhibit a more negative elasticity of imports to tariff costs, whereas the elasticity of imports is weaker among firms with greater good import shares. For firms with negligible import shares, an increase of 1 log-point in their tariff cost induces a decline in imports of 2.5 log-points. In contrast, the same shock induces only a reduction of 0.8 log-points in the imports of goods for which a firm has more than 50% of the destination's imports. Our estimates suggest that import firm concentration shapes how firms respond to changes in trade costs. They are consistent with the mechanism in our model: larger importers of a good respond less to trade cost changes through import changes, but more through domestic markup changes.

The right panel of Figure 5 examines whether the observed pattern of import responses arises from systematic differences across firms in the prices paid to foreign suppliers. To explore this, we estimate a specification analogous to (19), replacing the dependent variable with the log-change in the unit import value of the firm's imports of the good. The results show that the elasticity of unit import values to changes in average tariff costs is close to zero, regardless of the firm's import share of the good. This finding suggests that monopsony power over foreign suppliers is unlikely to be the primary driver of the weaker import decline observed among larger importers, at least within our sample, which is predominantly composed of developing countries.

Our estimates enable us to recover the level and the sensitivity of the domestic markup of importer firms for each good in our sample. We do so by setting $\alpha_g = 1$ for all importer firms, since we do not observe their labor expenditure in our customs data. We then compute $\beta^m_{f,gkd,t} = \bar{\beta}(S^M_{f,gkd,t})$ for each observation, and recover the markup $\mu_{f,gkd,t}$ using (18) with $\sigma = 1 - \bar{\beta}(0) = 3.5$. We further recover the markup sensitivity to trade costs, $\beta^{\mu}_{f,gkd,t}$, using (8) and (10).

Figure 6: Domestic Markup of Importer Firms

(a) Markup **(b)** Markup Elasticity



Note: Figure shows point estimates and 95% confidence intervals of the domestic markup of importer firms (left panel) and the sensitivity of the domestic markup to firm-specific trade costs (right panel) as a function of the firm's good import share. Estimates obtained using the elasticity of import values to average tariff costs in Figure 5.

Figure 6 presents our estimates of the domestic markup of importer firms (left panel) and its sensitivity to the firm's import costs (left panel) as a function of the firm's good import share. We find that the domestic markups of small importers is 1.4, with an elasticity to trade costs close to zero. As the firm's import share increases, it sets higher domestic markups that are also more sensitive to trade costs. For firms that account for more than 50% of the destination's imports of a good, the domestic markup is 1.8, with an elasticity of -0.5.[18]

4.2.1 Robustness

To investigate the robustness of our baseline estimates, we conduct several additional exercises. First, we include a firm-good-destination fixed effect in (19), which captures linear time trends specific to firms and goods while isolating the variation caused by tariff changes. In addition, following Boehm et al. (2023), we instrument the change in average tariff costs using an analog variable that relies only on changes in Most Favored Nation (MFN) tariffs. When a country adjusts its MFN tariff on a good, the change applies to all WTO members without a free trade agreement, including those with no direct influence over the decision. We also consider a second instrument that further excludes tariff variation for the top five origins of each good for the destination country. By focusing on smaller trading partners, this approach minimizes the risk that MFN tariff adjustments are influenced by bilateral lobbying or economic considerations involving major trading partners. Finally, we repeat all three exercises using a piecewise linear spline instead of cubic splines. The results of these robustness checks, presented in Appendix Figure B.1, remain qualitatively consistent with our main findings. While estimates may differ quantitatively, our main conclusion remains unchanged: smaller importers of a good exhibit a more negative elasticity of imports in response to changes in trade costs.

5 Markups on imported goods across countries

[18]These findings align with the estimates of Amiti et al. (2019a), which show that small firms have an average pass-through from marginal costs to consumer prices of 0.972 (and thus a markup elasticity near zero), whereas the average pass-through among large firms is 0.478 (and thus a markup elasticity near -0.5).

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A Theoretical Appendix

A.1 Equilibrium

Marginal Cost. Since firms take as given input prices, the firm's cost minimization problem under the technology in (3) implies that the marginal cost is given by

$$c_{f,gk} = z_{f,gk}(w)^{1-\alpha_g}\left[\sum_o (a^m_{of,gk})(pm_{o,gk})^{1-\theta_k}\right]^{\alpha_g \frac{1}{1-\theta_k}}. \tag{A.1}$$

Domestic and exporter firms in $g \in \mathcal{G}^D_k \cup \mathcal{G}^X_k$ have $\alpha_g = 0$, so that their cost is proportional to the wage, $c_{f,gk} = z_{f,gk}w$. For importer firms, the marginal cost depends on the wage as well as on the average cost of foreign good g across origins, weighted by the firm's demand shifters $a^m_{of,gk}$. Import expenditure is proportional to input expenditure, $M_{f,gk} = \alpha_g C_{fk}$ with $C_{f,gk} = c_{f,gk}q_{f,gk}$. The share of firm f's imports of good g spent on origin o is

$$s^m_{of,gk} = \frac{(a^m_{of,gk})(p^m_{o,gk})^{1-\theta_k}}{\sum_{o'}(a^m_{o'f,gk})(p^m_{o',gk})^{1-\theta_k}}. \tag{A.2}$$

Profit Maximization of Export Sales. For firms producing exported good $g \in \mathcal{G}^X_k$, the profit maximization problem is

$$\Pi_{f,gk} \equiv \max_{p_{f,gk},q_{f,gk}} (p_{f,gk} - c_{f,gk})q_{f,gk} \quad \text{subject to } q_{f,gk} \text{ given by (4)}. \tag{A.3}$$

Thus,

$$p_{f,gk} = \frac{\sigma_k}{\sigma_k - 1} z_{f,gk} w \quad \text{and} \quad q_{f,gk} = \delta_{f,gk}(w)^{-\sigma_k} \tag{A.4}$$

with $\delta_{f,gk} \equiv a^X_{f,gk}(\frac{\sigma_k}{\sigma_k-1}z_{f,gk})^{-\sigma_k}$.

Profit Maximization of Domestic Sales. Conditional on its marginal cost $c_{f,gk}$, firm f sets its price optimally given the perceived domestic demand in (1):

$$\Pi_{f,gk} \equiv \max_{p_{f,gk},q_{f,gk}} (p_{f,gk} - c_{f,gk})q_{f,gk} \quad \text{subject to } q_{f,gk} \text{ given by (1)} \tag{A.5}$$

The first order condition of (A.5) is given by

$$p_{f,gk} - (p_{f,gk} - c_{f,gk})\varepsilon_{f,gk} = 0 \quad \text{where} \quad \varepsilon_{f,gk} \equiv -\frac{\partial \log q_{f,gk}}{\partial \log p_{f,gk}}.$$

Thus, the set of equilibrium prices in the economy satisfies the following system:

$$p_{f,gk} = \mu_{f,gk} c_{f,gk} \quad \text{such that} \quad \mu_{f,gk} = \frac{\varepsilon_{f,gk}}{\varepsilon_{f,gk} - 1}, \tag{A.6}$$

where

$$\varepsilon_{f,gk} = \sigma_k - \gamma_k S_{f,gk}, \quad \gamma_k \equiv \sigma_k - \eta_k, \quad \text{and} \quad S_{f,gk} = \frac{a_{f,gk}(p_{f,gk})^{1-\sigma_k}}{\sum_{f' \in \mathcal{F}_{gk}} a_{f',gk}(p_{f',gk})^{1-\sigma_k}}, \tag{A.7}$$

Note that $\varepsilon_{f,gk} > 1$ because $\sigma_k \geq \eta_k > 1$. This guarantees that the second-order condition of the maximization problem holds.

Market Clearing. In equilibrium, labor income must be equal to labor demand for domestic and export sales:

$$w\bar{L} = \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} (1 - \alpha_g) c_{f,gk} q_{f,gk} + \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^D \cup \mathcal{G}_k^X} \sum_{f \in \mathcal{F}_{gk}} c_{f,gk} q_{f,gk}. \tag{A.8}$$

For goods market to clear, aggregate domestic spending must be equal to the income from labor, profits and tariff revenue:

$$E = w\bar{L} + \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k} \sum_{f \in \mathcal{F}_{gk}} \Pi_{f,gk} + \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} \frac{\tau_{o,gk}}{1 + \tau_{o,gk}} s^m_{of,gk} \alpha_g c_{f,gk} q_{f,gk}. \tag{A.9}$$

Equilibrium. Given $\{\tau_{o,gk}, p^m_{o,gk}\}$, the equilibrium is $\{p_{f,gk}, q_{f,gk}, c_{fg,k}, w, E\}$ such that (i) consumers maximize their utility, as in (1)–(2); (ii) firms minimize their costs, as in (A.1)-(A.2); (iii) firms maximize their profits in export markets, as in (A.3)-(A.4); (iv) firms maximize their profits in domestic markets, as in (A.5)–(A.7); and (v) domestic markets for labor and goods clear, as in (A.8)–(A.9).

A.2 Proofs of Section 3.2

Cross-firm variation in prices, markups and market share. Holding constant all price indices P_{gk}, (A.6) implies that

$$\frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = 1 + \frac{\partial \log \mu_{f,gk}}{\partial \log c_{f,gk}}$$

$$\frac{\partial \log \mu_{f,gk}}{\partial \log c_{f,gk}} = -\frac{1}{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)} \frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}}$$

$$\frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} = (\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)$$

Thus,

$$\frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = 1 - \rho_{f,gk} \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} \implies \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = \frac{1}{1 + \rho_{f,gk}}$$

with

$$\rho_{f,gk} = \frac{(\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)}{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)}.$$

An approximation for the group-level average markup. Note that, in equilibrium, the markup is a function of the firm's market share, $\mu_{f,gk} = \mu_k(S_{f,gk}) = \frac{\sigma_k - \gamma_k S_{f,gk}}{\sigma_k - 1 - \gamma_k S_{f,gk}}$. Thus,

$$\frac{\partial \mu_k(S)}{\partial S} = \frac{-1}{(\varepsilon_{f,gk} - 1)^2} \frac{\partial \varepsilon_{f,gk}}{\partial S_{f,gk}} = \frac{\gamma_k}{(\varepsilon_{f,gk} - 1)^2} > 0.$$

Taking a first-order approximation around the markup of a firm with $S_{f,gk} = 0$, we have that

$$\mu_{f,gk} \approx \frac{\sigma_k}{\sigma_k - 1} + \frac{\gamma_k}{(\sigma_k - 1)^2} S_{f,gk}.$$

Cross-firm variation in input spending. Finally, we note that total cost is

$$\frac{\partial \log C_{f,gk}}{\partial \log c_{f,gk}} = 1 + \frac{-\sigma_k}{1 + \rho_{f,gk}} = \frac{1 - \sigma_k + \rho_{f,gk}}{1 + \rho_{f,gk}} = \frac{\sigma_k - 1}{1 + \rho_{f,gk}} \left(\frac{(\sigma_k - \varepsilon_{f,gk})}{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)} - 1 \right) = \frac{\sigma_k - 1}{1 + \rho_{f,gk}} \frac{\sigma_k - (\varepsilon_{f,gk})^2}{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)}$$

which implies that $\frac{\partial \log C_{f,gk}}{\partial \log c_{f,gk}} < 0 \Leftrightarrow (\varepsilon_{f,gk})^2 > \sigma_k$. Since $\varepsilon_{f,gk} \in (\sigma_k - \gamma_k, \sigma_k)$, this condition is satisfied if $\sqrt{\sigma_k} < \sigma_k - \gamma_k = \eta_k$.

A.3 Proofs of Section 3.3

A.3.1 Proof of Aggregate and Distributional Effects in Section 3.3.1

Price index. From Sheppard's lemma, the change in the price index is given by

$$dP = \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^D \cup \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} p_{f,gs} q_{f,gk} d \log p_{f,gk}. \tag{A.10}$$

Thus,

$$\begin{aligned} \tfrac{dP}{E} &= \textstyle\sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^D \cup \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} \frac{p_{f,gs} q_{f,gk}}{E} d \log p_{f,gk} \\ &= (1 - e^M) d \log w + \textstyle\sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} \frac{c_{f,gs} q_{f,gk}}{E} \mu_{f,gk} d \log p_{f,gk} \\ &= (1 - e^M) d \log w + \textstyle\sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gk}} \frac{M_{f,gk}}{\alpha_g E} \mu_{f,gk} d \log p_{f,gk} \end{aligned}$$

with $e^M \equiv E^M / E$ and $E^M \equiv \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_s^M} \sum_{f \in \mathcal{F}_{gk}} p_{f,gs} q_{f,gk}$. Thus,

$$\frac{dP}{E} = (1 - e^M) d \log w + \sum_{k \in \mathcal{K}} \sum_{g \in \mathcal{G}_k^M} \sum_{f \in \mathcal{F}_{gs}} \frac{M_{f,gk}}{\alpha_g E} \left(\mu_{f,gk} d \log \mu_{f,gs} + \mu_{f,gk} d \log c_{f,gk} \right) \tag{A.11}$$

Workers. The expression for the price index in (A.11)

$$d\log w - d\log P = e^M d\log w - \sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^M}\sum_{f\in\mathcal{F}_{gs}} \frac{M_{f,gk}}{\alpha_g E}\left(\mu_{f,gk} d\log \mu_{f,gs} + \mu_{f,gk} d\log c_{f,gk}\right). \quad \text{(A.12)}$$

Importer Firms. For every firm, we can write:

$$d\Pi_{f,gk} = q_{f,gk}(dp_{f,gk} - dc_{f,gk}) + (p_{f,gsk} - c_{f,gk})dq_{f,gs},$$

which implies that

$$d\Pi_{f,gk} = q_{f,gk}p_{f,gk}\left(d\log\mu_{f,gk} + (1 - 1/\mu_{f,gk})(d\log c_{f,gk} + d\log q_{f,gs})\right). \quad \text{(A.13)}$$

For importer firms, using the fact that $M_{f,gk} = \alpha_g c_{f,gk} q_{f,gs}$, this expression yields change in profits in terms of changes in markups and imports:

$$d\Pi^M \equiv \sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^M}\sum_{f\in\mathcal{F}_{gk}} d\Pi_{f,gk} = \sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^M}\sum_{f\in\mathcal{F}_{gk}} \frac{M_{f,gk}}{\alpha_g}\left(\mu_{f,gk} d\log\mu_{f,gk} + (\mu_{f,gk} - 1) d\log M_{f,gk}\right). \quad \text{(A.14)}$$

Thus, the change in real spending for owners of importer firms is

$$\frac{d\Pi^M - dP}{E} = \sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^M}\sum_{f\in\mathcal{F}_{gk}} \frac{M_{f,gk}}{\alpha_g E}\left((\mu_{f,gk} - 1)d\log M_{f,gk} - \mu_{f,gk} d\log c_{f,gk}\right) - (1 - e^M) d\log w. \quad \text{(A.15)}$$

Exporter Firms. To obtain the change in profits for exporter firms, note that markups do not change. Applying equation (A.4) to (A.13), we get that

$$d\Pi^X \equiv \sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^X}\sum_{f\in\mathcal{F}_{gk}} d\Pi_{f,gk} = -\sum_{k\in\mathcal{K}}\sum_{g\in\mathcal{G}_k^M}\sum_{f\in\mathcal{F}_{gk}} q_{f,gk}c_{f,gk} d\log w \quad \text{for all} \quad g \in \mathcal{G}_k^X. \quad \text{(A.16)}$$

Domestic Firms. For domestic firms, $d\log p_{f,gs} = d\log c_{f,gs} = d\log w$ implies that $d\log P_{gs} = d\log w$ for all $g \in \mathcal{G}_k^D$. Using (1), we have that, for all all domestic firms,

$$\begin{aligned} d\log c_{f,gs} + d\log q_{f,gs} &= (1-\eta_k) d\log w + (\eta_k - 1) d\log P_k + d\log E \\ &= (1-\eta_k) d\log w + d\log D_k. \end{aligned} \quad \text{(A.17)}$$

Since markups do not change for domestic firms, equations (A.17) and (A.13) imply that

$$d\Pi^D = \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} d\Pi_{f,gk} = \sum_{k\in\mathcal{K}} \left[\sum_{g\in\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} w\ell_{f,gk}(\mu_{f,gk}-1) \right] \left[(1-\eta_k)d\log w + d\log D_k\right]. \tag{A.18}$$

Tariff revenue. The expression for tariff revenue in (5) implies that

$$dT = \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \sum_{o} \left(\tau_{o,gk} p^F_{o,gk} dm_{of,gk} + m_{of,gk} d(\tau_{o,gk} p^F_{f,gk}) \right). \tag{A.19}$$

Aggregate Real Spending. By definition, the change in aggregate real spending is:

$$dE - dP = dw\bar{L} + d\Pi^M + d\Pi^D + d\Pi^X + dT - dP.$$

We now use the expressions above to substitute for each term:

$$\begin{aligned} dE - dP \;=\; & d\log w \textstyle\sum_{k\in\mathcal{K}} \left(\sum_{g\in\mathcal{G}_k^X\cup\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} c_{f,gk} q_{f,gk} + \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} (1-\alpha_g) c_{f,gk} q_{f,gk} \right) \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} p_{f,gk} \left(d\log \mu_{f,gk} + (1-1/\mu_{f,gk})(d\log c_{f,gk} + d\log q_{f,gk}) \right) \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} p_{f,gk} (1-1/\mu_{f,gk})(d\log c_{f,gk} + d\log q_{f,gk}) \\ - & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^X} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} c_{f,gk} d\log w \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \sum_o \left(\tau_{o,gk} p^F_{o,gk} dm_{of,gk} + m_{of,gk} d(\tau_{o,gk} p^F_{f,gk}) \right) \\ - & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M\cup\mathcal{G}_k^D} \sum_{f\in\mathcal{F}_{gk}} (p_{f,gs} q_{f,gk}) \left(d\log \mu_{f,gk} + d\log c_{f,gk} \right) \end{aligned}$$

where we use expressions (A.8) for $\bar{L}$, (A.13) for $d\Pi^M$ and $d\Pi^D$, (A.16) for $d\Pi^X$, (A.19) for dT, and (A.10) for dP.

Manipulating this expression, we get that

$$\begin{aligned} dE - dP \;=\; & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} c_{f,gs} q_{f,gs} (1-\alpha_g) d\log w \\ - & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} c_{f,gk} d\log c_{f,gk} \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^D\cup\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} p_{f,gk} (1-1/\mu_{f,gk}) d\log q_{f,gk} \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \sum_o \left(\tau_{o,gk} p^F_{o,gk} dm_{of,gk} + m_{of,gk} d(\tau_{o,gk} p^F_{f,gk}) \right). \end{aligned}$$

Using the expression in (11) to substitute for $d\log c_{f,gk}$ of importer firms in any $g \in \mathcal{G}_k^M$, the expression above becomes

$$\begin{aligned} dE - dP \;=\; & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^D\cup\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} p_{f,gk} (1-1/\mu_{f,gk}) d\log q_{f,gk} \\ - & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \left(\sum_o m_{of,gk} dp^M_{of,gk} \right) \\ + & \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}_k^M} \sum_{f\in\mathcal{F}_{gk}} \sum_o \left(\tau_{o,gk} p^F_{o,gk} dm_{of,gk} + m_{of,gk} d(\tau_{o,gk} p^F_{f,gk}) \right). \end{aligned}$$

Since $dp^M_{of,gk} = d(\tau_{o,gk} p^F_{f,gk}) = p^F_{f,gk} d\tau_{o,gk}$, this expression is equivalent to

$$\begin{aligned} dE - dP &= \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^D_k \cup \mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} q_{f,gk} p_{f,gk} (1 - 1/\mu_{f,gk}) d\log q_{f,gk} \\ &+ \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} \sum_o \left(T_{of,gk} d\log m_{of,gk}\right). \end{aligned}$$

Thus, using the expression for $d\log q_{f,gs}$ in (A.17) and $M_{f,gk} = \alpha_g q_{f,gk} c_{f,gk}$, we get that

$$\begin{aligned} dE - dP &= \textstyle\sum_{k\in\mathcal{K}} \left[\sum_{g\in\mathcal{G}^D_k} \sum_{f\in\mathcal{F}_{gk}} w\ell_{f,gk}(\mu_{f,gk} - 1)\right] (-\eta_k d\log w + d\log D_k) \\ &+ \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} (M_{f,gk}/\alpha_g)(\mu_{f,gk} - 1)\left(d\log M_{f,gs} - d\log c_{f,gs}\right) \\ &+ \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} \sum_o \left(T_{of,gk} d\log m_{of,gk}\right) \end{aligned} \tag{A.20}$$

We now set the domestic wage as the economy's numeraire ($d\log w = 0$). Expressions (A.12) and (A.15) and imply that

$$d\omega^L \equiv dw\bar{L} - dP = -\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gs}} M_{f,gk} \left(\frac{\mu_{f,gk}}{\alpha_g} d\log \mu_{f,gs} + \mu_{f,gk} d\log \bar{\tau}_{f,gk}\right), \tag{A.21}$$

$$d\omega^M \equiv d\Pi^M - dP = \sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} M_{f,gk} \left(\frac{\mu_{f,gk} - 1}{\alpha_g} d\log M_{f,gk} - \mu_{f,gk} d\log \bar{\tau}_{f,gk}\right). \tag{A.22}$$

The difference between these expressions immediately implies the relative incidence in (13). Finally, we obtain the aggregate impact of the shock from (A.20):

$$\begin{aligned} d\omega^A \equiv dE - dP &= \textstyle\sum_{k\in\mathcal{K}} \left[\sum_{g\in\mathcal{G}^D_k} \sum_{f\in\mathcal{F}_{gk}} w\ell_{f,gk}(\mu_{f,gk} - 1)\right] d\log D_k \\ &+ \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} M_{f,gk}(\mu_{f,gk} - 1)\left(d\log M_{f,gs}/\alpha_g - d\log \bar{\tau}_{f,gk}\right) \\ &+ \textstyle\sum_{k\in\mathcal{K}} \sum_{g\in\mathcal{G}^M_k} \sum_{f\in\mathcal{F}_{gk}} \sum_o T_{of,gk} d\log m_{of,gk}. \end{aligned} \tag{A.23}$$

A.3.2 Proofs of Firm-Level Responses in Section 3.3.2

We note that we can write as an implicit function of $p_{f,gk} = \mathcal{P}_g(c_{f,gk}, P_{gk})$ characterized by the solution of

$$p_{f,gk} = \frac{\sigma_k - \gamma_k a_{f,gk} \left(\frac{p_{f,gk}}{P_{gk}}\right)^{1-\sigma_k}}{\sigma_g - 1 - \gamma_k a_{f,gk} \left(\frac{p_{f,gk}}{P_{gk}}\right)^{1-\sigma_k}} c_{f,gk}.$$

Thus,

$$\begin{aligned} d\log p_{f,gk} &= \tfrac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} d\log c_{f,gk} + \tfrac{\partial \log p_{f,gk}}{\partial \log P_{gk}} d\log P_{gk} \\ &= \tfrac{1}{1+\rho_{f,gk}} d\log c_{f,gk} + \tfrac{\partial \log p_{f,gk}}{\partial \log P_{gk}} d\log P_{gk} \end{aligned}$$

where use the fact that $\frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = \frac{1}{1+\rho_{f,gk}}$.

To derive an expression for $\frac{\partial \log p_{f,gk}}{\partial \log P_{gk}}$, we first note that

$$
\begin{aligned}
\frac{\partial \log p_{f,gk}}{\partial \log P_{gk}} &= \frac{\partial \log \mu_{f,gk}}{\partial \log p_{f,gk}} \frac{\partial \log p_{f,gk}}{\partial \log P_{gk}} + \frac{\partial \log \mu_{f,gk}}{\partial \log P_{gk}} \\
&= -\frac{1}{\varepsilon_{f,gk}(\varepsilon_{f,gk}-1)} \left(\frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} \frac{\partial \log p_{f,gk}}{\partial \log P_{gk}} + \frac{\partial \varepsilon_{f,gk}}{\partial \log P_{gk}} \right) \\
&= -\frac{(\sigma_k-\varepsilon_{f,gk})(\sigma_k-1)}{\varepsilon_{f,gk}(\varepsilon_{f,gk}-1)} \left(\frac{\partial \log p_{f,gk}}{\partial \log P_{gk}} - 1 \right) \\
&= -\rho_{f,gk} \left(\frac{\partial \log p_{f,gk}}{\partial \log P_{gk}} - 1 \right) \\
&= \frac{\rho_{f,gk}}{1+\rho_{f,gk}} \\
&= 1 - \frac{1}{1+\rho_{f,gk}}
\end{aligned}
$$

where the third row uses the expression derived above, $\frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} = -\frac{\partial \varepsilon_{f,gk}}{\partial \log P_{gk}} = (\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)$; and the fourth row uses the definition of $\rho_{f,gk}$ in (9).

This implies that

$$
d \log p_{f,gk} = \beta^p_{f,gk} d \log c_{f,gk} + (1 - \beta^p_{f,gk}) d \log P_{gk}
$$

where $\beta^p_{f,gk} \equiv 1/(1 + \rho_{f,gk})$.

Thus,

$$
\begin{aligned}
d \log P_{gk} &= \sum_{f \in \mathcal{F}_{gk}} S_{f,gk} d \log p_{f,gk} \\
&= \sum_{f \in \mathcal{F}_{gk}} S_{f,gk} \beta^p_{f,gk} d \log c_{f,gk} + \sum_{f \in \mathcal{F}_{gk}} S_{f,gk} \left(1 - \beta^p_{f,gk}\right) d \log P_{gk} \\
&= \sum_{f \in \mathcal{F}_{gk}} \omega^p_{f,gk} d \log c_{f,gk} \\
&= (1 - \alpha_g) d \log w + \alpha_g d \log \bar{\tau}_{gk}
\end{aligned}
$$

where

$$
d \log \bar{\tau}_{gk} \equiv \sum_{f' \in \mathcal{F}_{gk}} \omega_{f',gk} d \log \bar{\tau}_{f',gk} \quad \text{and} \quad \omega_{f,gk} \equiv \frac{S_{f,gk} \beta^p_{f,gk}}{\sum_{f' \in \mathcal{F}_{gk}} S_{f',gk} \beta^p_{f',gk}}.
$$

We also have that

$$
\begin{aligned}
d \log \mu_{f,gk} &= d \log p_{f,gk} - d \log c_{f,gk} \\
&= (\beta^p_{f,gk} - 1) \left(d \log c_{f,gk} - d \log P_{gk}\right) \\
&= (\beta^p_{f,gk} - 1) \left(d \log c_{f,gk} - \sum_{f' \in \mathcal{F}_{gk}} \omega_{f',gk} d \log c_{f',gk}\right) \\
&= (\beta^p_{f,gk} - 1) \alpha_g \left(d \log \bar{\tau}_{f,gk} - d \log \bar{\tau}_{gk}\right) \\
&= \beta^\mu_{f,gk} \alpha_g \left(d \log \bar{\tau}_{f,gk} - d \log \bar{\tau}_{gk}\right)
\end{aligned}
$$

where we use the fact that $\beta^\mu_{f,gk} = (\beta^p_{f,gk} - 1)$.

Note that

$$
\omega_{f,gk} \equiv \frac{S_{f,gk} \beta^p_{f,gk}}{\sum_{f' \in \mathcal{F}_{gk}} S_{f',gk} \beta^p_{f,gk}} = \frac{S_{f,gk}(1 + \beta^\mu_{f,gk})}{\sum_{f' \in \mathcal{F}_{gk}} S_{f',gk}(1 + \beta^\mu_{f,gk})} = \frac{M_{f,gk} \mu_{f,gk}(1 + \beta^\mu_{f,gk})}{\sum_{f' \in \mathcal{F}_{gk}} M_{f',gk} \mu_{f',gk}(1 + \beta^\mu_{f,gk})}
$$

We can then substitute this expression into the expression for the change in the firm's cost:

$$\begin{aligned}
d\log C_{f,gk} &= d\log c_{f,gk} + d\log q_{f,gk} \\
&= d\log c_{f,gk} - \sigma_k d\log p_{f,gk} + (\sigma_k - \eta_k) d\log P_{gk} + d\log D_k \\
&= \left(1 - \sigma_k \tfrac{1}{1+\rho_{f,gk}}\right) d\log c_{f,gk} - \sigma_k \left(1 - \tfrac{1}{1+\rho_{f,gk}}\right) d\log P_{gk} + (\sigma_k - \eta_k) d\log P_{gk} + d\log D_k \\
&= \left(1 - \sigma_k \tfrac{1}{1+\rho_{f,gk}}\right) \left(d\log c_{f,gk} - d\log P_{gk}\right) + \left[(1-\eta_k) d\log P_{gk} + d\log D_k\right] \\
&= \left(1 - \sigma_k \tfrac{1}{1+\rho_{f,gk}}\right) \alpha_g \left(d\log c_{f,gk} - d\log P_{gk}\right) + \left[(1-\eta_k) d\log P_{gk} + d\log D_k\right] \\
&= \beta^m_{f,gk} \alpha_g \left(d\log \bar{\tau}_{f,gk} - d\log \bar{\tau}_{gk}\right) + \left[(1-\eta_k) d\log P_{gk} + d\log D_k\right] \\
&= \beta^m_{f,gk} \alpha_g \left(d\log \bar{\tau}_{f,gk} - d\log \bar{\tau}_{gk}\right) + \delta^m_{gk}
\end{aligned}$$

where $\delta^m_{gk} \equiv (1-\eta_k) d\log P_{gk} + d\log D_k$.

Note that price changes are given by:

$$\begin{aligned}
d\log P_k &= (1 - e^M_k) d\log w + \textstyle\sum_{g \in \mathcal{F}_{gk}} e^M_{gk} d\log P_{gk} \\
&= (1 - \alpha_g e^M_k) d\log w + \textstyle\sum_{g \in \mathcal{F}_{gk}} e^M_{gk} d\log \bar{\tau}_{gk}
\end{aligned}$$

Finally, note that (A.2) implies that

$$d\log m_{of,gk} = -\theta_k d\log(1 + \tau_{of,gk}) + (\theta_k - 1) d\log \bar{\tau}_{f,gk} + d\log M_{f,gs}$$

With these expressions, we can also write:

$$\begin{aligned}
d\log D_k &= d\log E + (\eta_k - 1) d\log P_k \\
&= d\log E + (\eta_k - 1)(1 - \alpha_g e^M_k) d\log w + (\eta_k - 1) \textstyle\sum_{g \in \mathcal{G}^M_k} e^M_{gk} d\log \bar{\tau}_{gk}
\end{aligned}$$

Properties of β^μ_{fg} and β^m_{fg}. Comparing firms in the same group, we have that

$$\frac{\partial \beta^\mu_{f,gk}}{\partial \log c_{f,gk}} = -\frac{1}{(1+\rho_{f,gk})^2} \frac{\partial \rho_{f,gk}}{\partial \varepsilon_{f,gk}} \frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = -\frac{(\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)}{(1+\rho_{f,gk})^3} \frac{\partial \rho_{f,gk}}{\partial \varepsilon_{f,gk}}$$

$$\frac{\partial \beta^m_{f,gk}}{\partial \log c_{f,gk}} = \frac{\sigma_k}{(1+\rho_{f,gk})^2} \frac{\partial \rho_{f,gk}}{\partial \varepsilon_{f,gk}} \frac{\partial \varepsilon_{f,gk}}{\partial \log p_{f,gk}} \frac{\partial \log p_{f,gk}}{\partial \log c_{f,gk}} = \frac{\sigma_k(\sigma_k - \varepsilon_{f,gk})(\sigma_k - 1)}{(1+\rho_{f,gk})^3} \frac{\partial \rho_{f,gk}}{\partial \varepsilon_{f,gk}}$$

$$\frac{\partial \rho_{f,gk}}{\partial \varepsilon_{f,gk}} = -(\sigma_k - 1) \frac{\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1) + (\sigma_k - \varepsilon_{f,gk})(2\varepsilon_{f,gk} - 1)}{\left(\varepsilon_{f,gk}(\varepsilon_{f,gk} - 1)\right)^2} < 0$$

Thus, since $\rho_{f,gk} > 0$ and $\sigma_k \geq \varepsilon_{f,gk}$, we have that $\frac{\partial \beta^m_{f,gk}}{\partial c_{f,gk}} < 0$ and $\frac{\partial \beta^\mu_{f,gk}}{\partial c_{f,gk}} > 0$. Note that if $S_{f,gk} = 0$, then $\rho_{f,gk} = 0$, $\beta^m_{f,gk} = 1 - \sigma_k$ and $\beta^\mu_{f,gk} = 0$. Thus, $\beta^m_{f,gk} \geq 1 - \sigma_k$ and $\beta^\mu_{f,gk} < 0$ for all firms.

A.3.3 Proof of Markup Inversion in Section 3.3.3

To simplify notation, we drop subscripts for good and sector. The definitions in (9) and (10) yield

$$\beta_f^m = 1 - \frac{\sigma}{1 + \frac{(\sigma-\varepsilon_f)(\sigma-1)}{\varepsilon_f(\varepsilon_f-1)}}$$

which implies a quadratic equation:

$$(\sigma - 1 + \beta_f^m)(\varepsilon_f)^2 - \sigma\beta_f^m\varepsilon_f - (1-\beta_f^m)\sigma(\sigma-1) = 0$$

Since $\beta_f^m \in (1-\sigma, 1)$, the positive real root is

$$\varepsilon_f = \frac{\sigma\beta_f^m + \sqrt{\left(\sigma\beta_f^m\right)^2 + 4(\sigma-1+\beta_f^m)(1-\beta_f^m)\sigma(\sigma-1)}}{2(\sigma-1+\beta_f^m)}.$$

We note that this condition also guarantees that $\varepsilon_f > 1$: using the expression above, $\varepsilon_f > 1$ is equivalent to

$$\sigma\beta_f^m + \sqrt{\left(\sigma\beta_f^m\right)^2 + 4(\sigma-1+\beta_f^m)(1-\beta_f^m)\sigma(\sigma-1)} > 2(\sigma-1+\beta_f^m)$$

$$\sqrt{\left(\sigma\beta_f^m\right)^2 + 4(\sigma-1+\beta_f^m)(1-\beta_f^m)\sigma(\sigma-1)} > 2(\sigma-1+\beta_f^m) - \sigma\beta_f^m$$

$$\left(\sigma\beta_f^m\right)^2 + 4(\sigma-1+\beta_f^m)(1-\beta_f^m)\sigma(\sigma-1) > \left(\sigma\beta_f^m\right)^2 - 4(\sigma-1+\beta_f^m)\sigma\beta_f^m + 4(\sigma-1+\beta_f^m)^2$$

$$4(\sigma-1+\beta_f^m)(1-\beta_f^m)\sigma(\sigma-1) > -4(\sigma-1+\beta_f^m)\sigma\beta_f^m + 4(\sigma-1+\beta_f^m)^2$$

$$(1-\beta_f^m)\sigma(\sigma-1) > -\sigma\beta_f^m + (\sigma-1+\beta_f^m)$$

$$(1-\beta_f^m)\sigma(\sigma-1) > (\sigma-1)(1-\beta_f^m)$$

$$\sigma > 1$$

B Empirical Appendix

B.1 Data Construction

Table B.1: Countries and Years in Importer Database

Country	Years	Country	Years
Albania	2007 - 2021	Sri Lanka	2016 - 2021
Burundi	2010 - 2022	Morocco	2002 - 2013
Benin	2016 - 2021	Madagascar	2007 - 2021
Bangladesh	2005 - 2016	Mexico	2011 - 2021
Bulgaria	2001 - 2006	Macedonia	2008 - 2018
Botswana	2004 - 2010	Montenegro	2004 - 2020
Chile	1997 - 2021	Mauritius	2000 - 2021
Cote d'Ivoire	2000 - 2021	Malawi	2005 - 2021
Cameroon	2007 - 2017	Nepal	2011 - 2014
Colombia	1997 - 2023	Pakistan	2019 - 2022
Comoros	2016 - 2022	Peru	2000 - 2021
Cabo Verde	2010 - 2021	Paraguay	2000 - 2023
Costa Rica	2010 - 2021	Romania	2005 - 2011
Dominican Republic	2002 - 2021	Rwanda	2002 - 2016
Ecuador	2002 - 2021	Senegal	2000 - 2020
Egypt	2005 - 2016	El Salvador	2006 - 2021
Ethiopia	2012 - 2021	Serbia	2006 - 2019
Gabon	2009 - 2021	Sao Tome and Principe	2017 - 2019
Georgia	2000 - 2022	Togo	2015 - 2021
Guinea Bissau	2012 - 2018	Timor-Leste	2018 - 2023
Guatemala	2005 - 2013	Tanzania	2003 - 2021
Croatia	2007 - 2015	Uganda	2011 - 2020
Indonesia	2020 - 2020	Uruguay	2001 - 2021
India	2016 - 2023	Viet Nam	2018 - 2022
Jordan	2008 - 2021	Kosovo	2013 - 2019
Kenya	2006 - 2022	South Africa	2010 - 2021
Cambodia	2016 - 2022	Zambia	2010 - 2021
Lao PDR	2015 - 2023		

B.2 Estimation: Functional Basis for $\bar{\beta}(S^M)$

We use the baseline statistical regression for cubic splines described by Harrell (2015) and adapt it to our functional form of preference. In particular, we pick the following function:

$$\hat{\beta}(S) = \begin{cases} a_0 + a_1\, S & \text{if } S \leq s_1 \\ a_2 + a_3\, S + a_4\, S^2 & \text{if } S \in [s_1, s_2] \\ a_5 & \text{if } S \geq s_2 \end{cases} \tag{B.1}$$

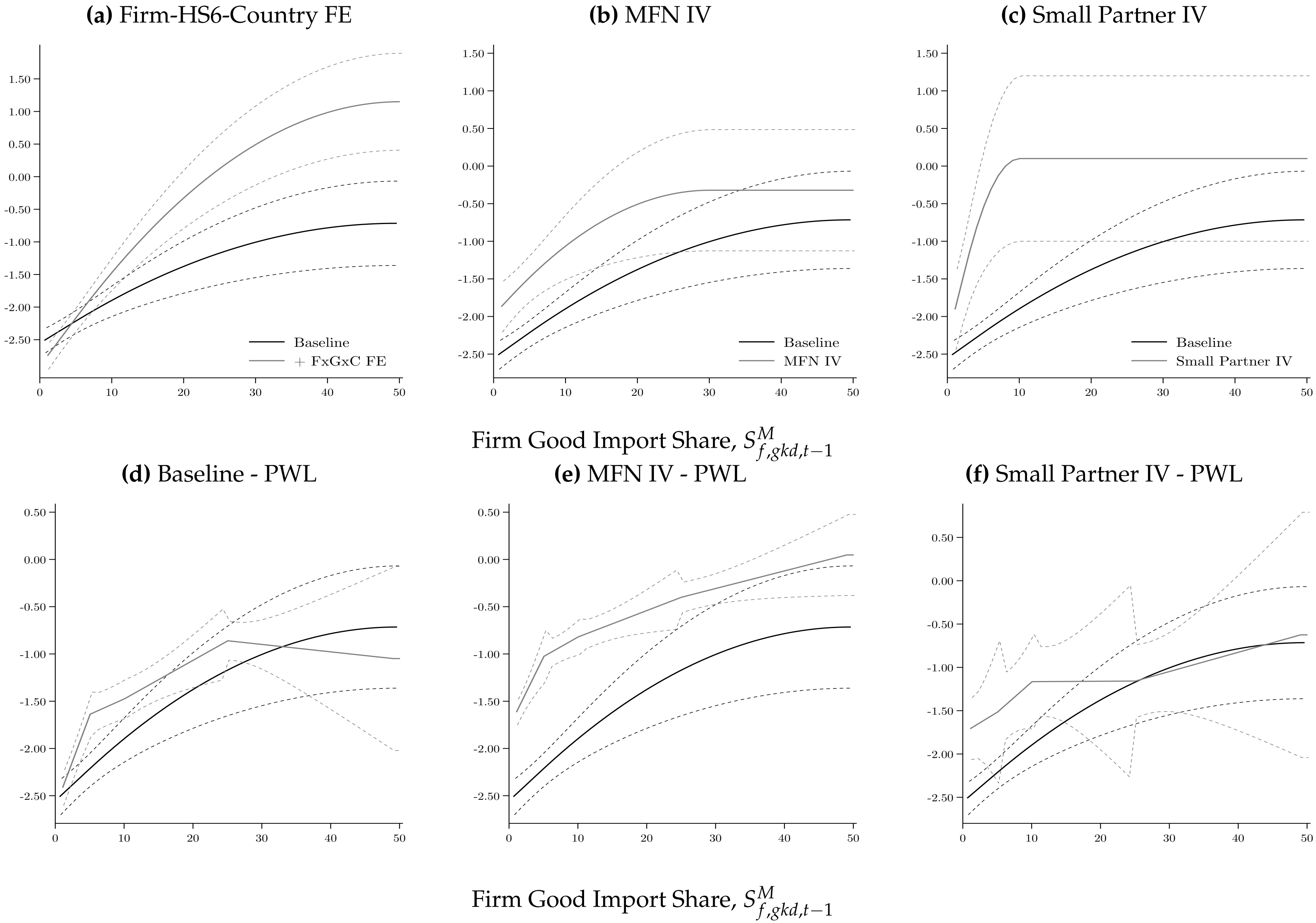
such that we impose continuity and smoothness:

$$\begin{aligned} a_2 + a_3 s_1 + a_4 s_1^2 &= a_0 + a_1 s_1 \\ a_2 + a_3 s_2 + a_4 s_2^2 &= a_5 \end{aligned}$$

$$\begin{aligned} a_1 &= a_3 + 2 a_4 s_1 \\ 0 &= a_3 + 2 a_4 s_2 \end{aligned}$$

B.3 Estimation: Robustness

Figure B.1: Firm's Elasticity of Imports and Unit Values to Tariff Changes



Note: Sample of 13,623,037 firm-good-destination-year observations. Estimtates of $\bar{\beta}(S^M)$ obtained from (19), along with 95% confidence intervals implied by standard errors (two-way) clustered by firm-good-destination and good-destination-year. In all panels, black lines correspond to the baseline estimates reported in Figure 5. Gray lines correspond to estimates obtained with an alternative specification where: panel (a) includes firm-good-country fixed effects; panel (b) instruments $d \log \bar{\tau}_{f,gkd,t}$ with its analog built with only MFN tariff changes; panel (c) instruments $d \log \bar{\tau}_{f,gkd,t}$ with its analog built with MFN tariff changes excluding the top five origins for each good; and panels (d)-(f) implement the baseline and IV specifications using a piecewise linear (PWL) basis for $\bar{\beta}(S^M)$.