Trade Shocks in Distorted Economies:

Evidence from Firm-level Import Data*

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Abstract

Using a dataset of firm-level imports for 57 countries, we measure importer firm concentration and its impact on the aggregate and distributional effects of tariff changes. Our model links importer concentration to the domestic market power of importer firms, as summarized by the firm-level elasticity of imports to tariff changes. In our data, this elasticity decreases monotonically with a firm's import share of a given good, implying that a firm's markup increases with its import share. Given these estimates, welfare responses to tariff changes depend on the covariance between import responses and initial markups across firms. Among trade liberalization episodes in our sample, we find that importer concentration induces changes in allocative efficiency comparable in magnitude to welfare changes predicted by neoclassical mechanisms. The higher and more dispersed concentration in import markets of poorer and smaller countries amplifies the effect of tariff changes on allocative efficiency.

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1 Introduction

Consider a small open economy that undergoes a trade liberalization. Suppose, in addition, that the tariff reduction is uneven: tariffs fall for some products and trading partners, but not for others. Such a trade liberalization will induce a reallocation of resources across products and firms that use imported inputs. When the marginal product is similar across all firms, this reallocation has no aggregate welfare effect. However, when marginal products differ, the reallocation potentially has first-order effects on allocative efficiency. If trade costs fall more for products and firms with a high marginal product, allocative efficiency rises. Conversely, if trade costs fall primarily for products and firms with low marginal product, then allocative efficiency declines.

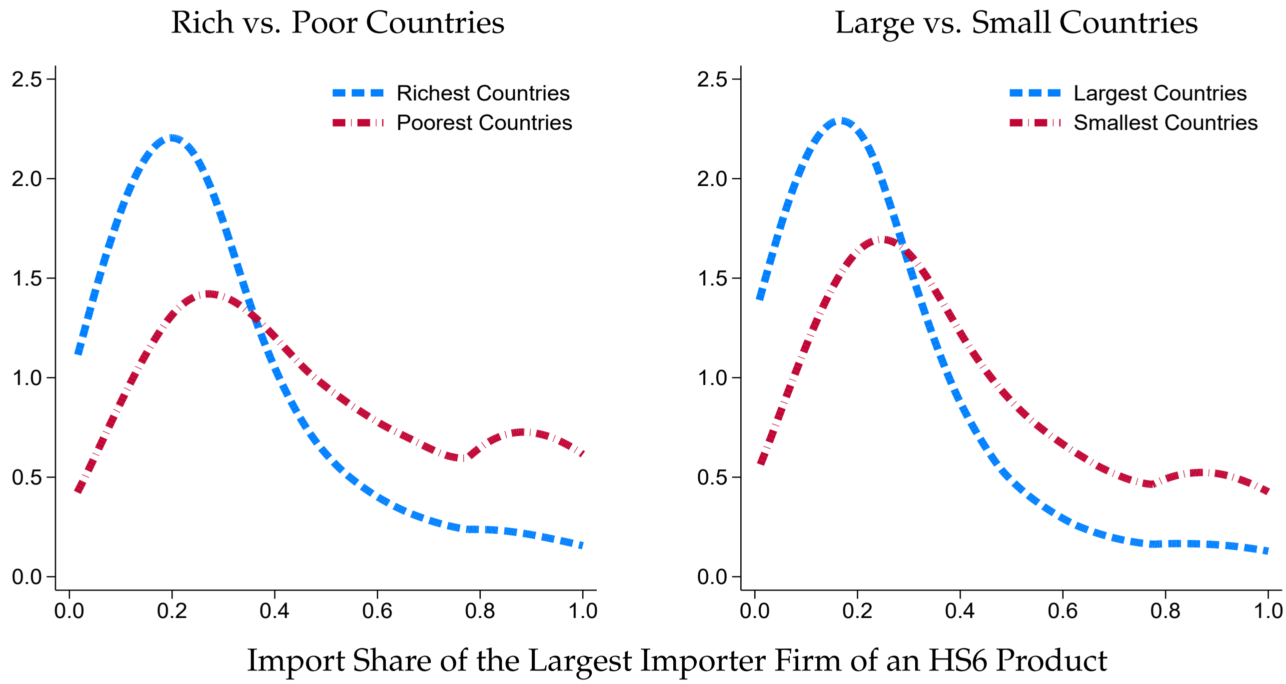
This paper measures the effect of trade shocks on allocative efficiency through the reallocation of resources between firms with different marginal products. We focus on marginal product dispersion arising from the domestic market power of importer firms, driven by import concentration within countries. Our analysis begins with two key facts, documented using a dataset we compile from administrative firm-level import records for 57 countries spanning the period from 1997 to 2021.

First, trade liberalization episodes generate dispersion in import cost changes across goods and firms. For the countries in our sample, the correlation between the average tariff change and the between-good dispersion in tariff changes is -0.66. Trade liberalization episodes also have heterogeneous effects on the tariff costs of firms importing the same good from different origins: the correlation between a country's average tariff change and the within-good dispersion of changes in firm-specific tariff costs is -0.77.

Our second fact is the dispersion of firm import shares within countries in our sample. Figure 1 displays the distribution of the import share of the largest importer firm of each product for the five richest and poorest countries (left panel) and the five largest and smallest countries (right panel). The figure highlights the between-good dispersion in the import share of the largest importer firm. It also shows that the level and dispersion of importer concentration is higher in poorer and smaller countries.

The dispersion of importer concentration in Figure 1 is only suggestive evidence of marginal product heterogeneity across importers. To formalize the link between firm import shares and domestic market power, 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. Each importer's perceived elasticity of domestic demand is a function of its share of the domestic market among importers supplying varieties of the same good, similar to Atkeson and Burstein (2008) and Amiti et al. (2019a). In this model, the firm's share of

Figure 1: Distribution of the Import Share of the Largest Importer Firm in an HS6 Product



Notes: Figure shows distribution of the import share of the largest importer firm in each product-country-year for the five richest and poorest countries (left panel) and the five largest and smallest countries (right panel) in our sample of 57 countries. Product definition is the 6-digit Harmonized Schedule (HS6). Poorest countries are Burundi, Guinea-Bissau, Madagascar, Malawi, and Rwanda; Richest countries are Chile, Croatia, Mexico, Romania, and Uruguay. Smallest countries are Comoros, Cape Verde, Sao Tome and Principe, Montenegro, and Mauritius; Largest countries are Bangladesh, India, Mexico, Indonesia, and Pakistan. Mean (standard deviation) of the import share of largest importer firm are 0.30 (0.22) for richest, 0.49 (0.29) for poorest, 0.25 (0.22) for largest, and 0.42 (0.28) for smallest countries. Kernel density estimates use a bandwidth of 0.1. Observations weighted by share of HS6 product in each country's imports.

domestic sales among competitors, and thus its markup, is monotonically related to its import share among competitors.

The effect of a trade liberalization on allocative efficiency is then summarized by the covariance between initial markup distortions and import responses to tariff costs, both across goods and across importers within goods. This statistic formalizes the intuition that allocative efficiency improves when tariff costs fall for firms and goods with higher initial markups, which is equivalent to higher importer concentration in our model.

The key moment linking the distribution of firm import shares to the distribution of markups is the elasticity of the firm's imports to its average tariff cost, and how this elasticity varies with the firm's import share among its domestic competitors. 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. If the firm's import elasticity does not vary with its import share, then domestic markups also do not vary with import shares. In this case, dispersion in firm import shares conveys no information about marginal product heterogeneity.

However, we find clear evidence that a firm's import elasticity does, in fact, vary with its import share of a good. For firms with low import shares, an increase of 1 log-point in tariff costs induces a decline in their imports of 3.4 log-points. In contrast, the same shock induces only a 0.8 log-point reduction in imports for firms that account for more than 50% of the country's imports of a given good.[1] These estimates imply that domestic markups range from 1.4 for small importers to 2.8 for larger ones.

Armed with our estimates of firm import elasticities, we infer the domestic markup of each importer firm in our sample of 57 countries based on the firm's import share of a good. In line with Figure 1, we show that the dispersion of markups—both across products and between firms importing the same product—is greater in poorer and smaller countries than in richer and larger ones. We then use the firm-level estimates of domestic markups and import elasticities to quantify the incidence of tariff changes across firms and products with different marginal products, and the resulting changes in allocative efficiency from resource reallocation.

We report four main findings.

First, trade liberalization episodes in our sample of countries lead to changes in allocative efficiency whose magnitude is similar to the contribution of the neoclassical channel of reductions in tariff distortions. Across all episodes, the median change in allocative efficiency due to markup distortions (relative to that of tariff distortions) is –0.41, with the 10th and 90th percentiles at –1.74 and 1.22, respectively.

Second, for the majority of the trade liberalization episodes in our sample, allocative efficiency *falls* because reductions in trade costs are typically stronger for firms and goods with lower markups; that is, those with lower importer concentration. The decline in allocative efficiency thus offsets the neoclassical gains generated by reductions in tariff distortions. In fact, the losses created by markup distortions more than offset neoclassical gains in 21% of the episodes.

Third, the change in allocative efficiency is almost entirely driven by importer profits. In fact, in the majority of our episodes, welfare changes for owners of importer firms exceed the aggregate welfare change associated with markup dispersion. This implies that even when allocative efficiency falls, welfare increases for domestic workers and owners of non-importer firms.

Fourth, because the dispersion in importer concentration is larger in poorer and smaller

[1] These responses stem entirely from changes in import quantity: the unit import value paid to foreign suppliers does not respond to tariff changes at any level of the firm's import share.

countries, the effect of tariff changes on allocative efficiency is also larger in these countries. Going from the markup distribution of the richest and largest country in our sample (Mexico) to the poorest and smallest country (Comoros) can amplify the effect of tariffs on allocative efficiency by about 60%.

Our paper builds on the large literature studying the aggregate effect of distortions. Atkin and Donaldson (2022) present suggestive evidence that distortions are likely to be more prevalent in low-income countries and to matter for the welfare effect of trade openness. We focus on a single source of distortions, domestic market power created by importer concentration, and measure its implications for the effect of trade shocks. Our mechanism generates heterogeneity in the levels and responses of markups to tariff changes across firms depending on their market share, as in Edmond et al. (2015) and Amiti et al. (2019a). We build on the insights in Baqaee and Farhi (2020; 2024), Atkin and Donaldson (2022), and Adão et al. (2023) to show that importer concentration matters for tariff incidence only through the covariance between tariff-induced changes in imports and initial relative markups across both goods (between-good reallocation) and importers with varieties of the same good (within-good reallocation).

To measure the sufficient statistics in our formulas, we use a panel dataset of firm-level imports in 57 developing countries. It allows us to estimate how the firm's elasticity of imports to average tariff costs varies with its share of the country's imports of a good. This is closely related to the evidence in Amiti et al. (2019a) of 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 heterogeneity in import responses to the heterogeneity in markups within and between goods, which we then use to show that distortions generated by importer concentration are an important determinant of tariff incidence, with an even greater importance for smaller and poorer countries.

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 decisions of importer firms and their implications for welfare responses to trade shocks.

Our analysis uses administrative customs records to recover how domestic markups of importer firms vary with the firm's import share in 57 countries. Our paper comple-

[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.

ments the literature that builds on Hall (1986) to estimate the markup distribution across firms using detailed plant-level data on inputs, output, and prices.[3] While our approach relies on stronger assumptions regarding technology, demand, and market structure, it only requires customs records, which we harmonize across a large set of countries. The payoff is a set of estimates for the component of markups associated with a firm's market share among *all* importer firms in 57 countries. Our estimates suggest that distortions associated with markup dispersion on imports are larger in poorer and smaller countries.[4]

We focus on the domestic markups and import responses of firms using foreign inputs. We are silent on the pricing decisions of domestic substitutes of imported products as well as those of foreign producers. Going back to Krugman (1979), an extensive literature studies the pro-competitive effect of imports on the markups of domestic substitutes of imported products. Edmond et al. (2015) and Arkolakis et al. (2019) focus on how markups of foreign producers respond to trade costs, and how this affects pricing decisions of their domestic competitors. In contrast, we assume that prices of foreign producers are exogenous to policy choices of importer countries. We find that, consistent with this assumption, prices of foreign products do not change with trade costs in our dataset, in line with recent evidence in Fajgelbaum et al. (2019) and Amiti et al. (2019b).[5]

Our paper is organized as follows. Section 2 presents our model linking importer concentration to the pricing decisions of importers and its implications for the incidence of tariff changes. Section 3 documents patterns of importer concentration in our sample of countries. Section 4 provides estimates of how the firm-level elasticity of imports to tariff costs varies with the firm's import share of a good. In Section 5, we quantify the role of importer concentration for the aggregate and distributional effects of tariff changes. Section 6 concludes.

2 A Model of Oligopolistic Importer Firms

This section presents a model that links domestic prices charged by importers to the concentration of imports across firms. We show that importer concentration shapes both the aggregate and distributional effects of tariff changes through the covariance, across im-

[3]Examples include De Loecker and Warzynski (2012), De Loecker et al. (2016) and, for a review, see De Loecker and Goldberg (2014).

[4]The welfare cost from dispersion in marginal products (some of which is 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 markup dispersion with comparable data for a large number of countries.

[5]We also abstract from other mechanisms via which importer firms may matter for tariff incidence. For example, Alviarez et al. (2023) focus on bilateral bargaining between exporters and importers, and Blaum et al. (2018, 2019) show how importer firms affect domestic prices through their input sourcing choices.

porter firms, between initial domestic markups and import responses. Measuring this covariance within our framework requires firm-level customs data and estimates of the elasticity of a firm's imports with respect to its average tariff cost. In our model, the extent to which this elasticity declines with the importer's share of total imports among its competitors summarizes its domestic market power and, consequently, its markup. Accordingly, the variation of this elasticity regulates the mapping from the distribution of firm import shares to the distribution of domestic markups across importers.

To highlight the core mechanisms, we derive our main results in the context of a small open economy with a simplified structure of preferences and production. We later discuss generalizations to more complex environments.

2.1 Environment

We consider a small open economy populated by workers who supply $\bar{L}^D$ units of domestic labor and owners who operate an exogenous set of firms, where each firm f produces a variety of a good g.[6] There are three types of goods: (i) those sold in the domestic market produced using only labor of domestic workers; (ii) those sold in the domestic market produced using only foreign inputs; and (iii) those sold in export markets produced using only the owner's firm-specific labor endowment (denoted by $\bar{L}^X_{gf}$). We refer to these three types as domestic, imported, and exported, respectively.

Preferences. Workers and owners have identical homothetic preferences given by

$$C = \left[\sum_g (C_g)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad \text{with} \quad C_g = \left[\sum_f (q_{gf})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}},$$

where q_{gf} denotes the consumption of the variety of (imported or domestic) good g supplied by firm f, and σ and η represent the elasticities of substitution across firms within a good and across goods, respectively. We assume that domestic and importer firms are bundled in different demand nests as we observe only firm-level imports. This nesting structure enables us to estimate the model while accommodating a flexible substitution

[6] To simplify our analysis, we abstract from firm entry decisions and focus on the allocative effects associated with markup heterogeneity across incumbent importers. As a result, import cost shocks have distributional effects through changes in importer profits. Alternatively, with endogenous firm entry under monopolistic competition, aggregate importer profits are zero, and markup heterogeneity affects welfare through the consumer surplus generated by new varieties, as in Baqaee et al. (2024).

pattern between firms.[7]

Given prices p_{gf}, the domestic demand of firm f is

$$q_{gf} = (p_{gf})^{-\sigma}(P_g)^{\sigma-\eta}Q \quad \text{with} \quad (P_g)^{1-\sigma} = \sum_f (p_{gf})^{1-\sigma},$$

where Q is a demand shifter given by

$$Q = P^{\eta-1}E \quad \text{and} \quad P^{1-\eta} = \sum_g (P_g)^{1-\eta},$$

with g denoting imported and domestic goods, and E denoting aggregate expenditure.

Technology. For importer firms, production combines foreign varieties:

$$Y_{gf} = \left[\sum_v (a_{vgf})^{\frac{1}{\theta}}(q_{vgf})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}},$$

where q_{vgf} are imports by firm f of foreign variety v, $a_{vgf} \geq 0$ is a variety-firm productivity shifter, and θ is the elasticity of substitution across foreign varieties.

The production function of domestic ($h = D$) and exporter ($h = X$) firms is linear in labor: $Y_{gf} = a_{gf}L^h_{gf}$, where a_{gf} is an exogenous productivity shifter, and L^h_{gf} is the specific type of labor used by the firm, $h \in \{D, X\}$.

Our choice of the production technology greatly simplifies exposition, since it entails segmented factor markets for the three types of goods. This implies that changes in import costs do not directly affect the cost of producing domestic or exported varieties.[8]

Foreign Offer Curve. All firms face exogenous world prices, p^W_v.[9]

Government. The government imposes an ad-valorem import tax of τ_v on foreign variety v. This implies that the import cost of foreign varieties is $p_v = (1 + \tau_v)p^W_v$. The tariff

[7] Due to data availability, Fajgelbaum et al. (2020) and Adão et al. (2023) impose similar nesting structures of preferences. To simplify exposition, our baseline model has a single sector and the same elasticity of substitution between all goods. We later show how to extend our analysis to allow for generic homothetic preferences between goods in the upper nest and homothetic single aggregator preferences across firms in the lower nest. We also allow domestic and importer firms to be in the same demand nest.

[8] We show below that our key insights remain the same if we allow production of all firms to use the same type of domestic labor. We also allow firms to use intermediate goods, provided that production follows a nesting structure identical to that of final demand–a common restriction in quantitative trade models (Costinot and Rodríguez-Clare, 2014).

[9] We consider below an extension with endogenous world prices.

revenue is rebated to workers and owners with a lump-sum transfer:

$$T = \sum_g \sum_f \sum_v \tau_v p_v^W q_{vgf}.$$

Market Structure. Each firm acknowledges the impact of its pricing decision on its domestic demand while taking as given prices of other firms and the demand shifter Q, as in Atkeson and Burstein (2008). Our nested structure of demand implies that pricing decisions of firms in other nests only affect a firm's demand through the common shifter Q. This is the key assumption that allows us to measure tariff incidence using firm-level customs data and import elasticities, without any information about domestic firms.

The elasticity of substitution between goods, η, summarizes the domestic competition of other goods. It determines how the pricing decision of an importer depends on its size (relative to firms in the same demand nest). We assume $1 < \eta \leq \sigma \leq \eta^2$, which guarantees that a firm's markup increases with its revenue and cost.

We further assume that firms are price takers in the world good market and in the domestic labor market. That is, each firm takes as given world prices and domestic wages.

Market Clearing. Labor supply must be equal to labor demand. For every exporter firm, this requires $L_{gf}^X = \bar{L}_{gf}^X$. For domestic firms, this implies $\bar{L}^D = \sum_g \sum_f L_{gf}^D$.

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

$$E = w\bar{L}^D + \sum_g \sum_f \Pi_{gf} + T,$$

where w is the wage rate and Π_{gf} is the profit of firm f with a variety of good g.[10]

Equilibrium. Conditional on world prices and import tariffs, Appendix A.1 outlines the economy's equilibrium, in which (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.

[10]Since the consumers' budget constraint requires $E = \sum_g \sum_f p_{gf} q_{gf}$, the market clearing conditions above imply trade balance.

2.2 Firm-Level Markups and Imports in Equilibrium

Appendix A.2 shows that firm f sets its domestic price according to

$$p_{gf} = \mu_{gf} c_{gf} \quad \text{such that} \quad \mu_{gf} = \frac{\varepsilon_{gf}}{\varepsilon_{gf} - 1} \quad \text{and} \quad \varepsilon_{gf} = \sigma - (\sigma - \eta) e_{gf},$$

where c_{gf} is the firm's marginal cost and $e_{gf} \equiv p_{gf} q_{gf} / P_g C_g$ is its share of the domestic expenditure on all firms supplying varieties of good g.

The optimal price entails a markup over marginal cost of μ_{gf}, which is decreasing in the firm's perceived elasticity of domestic demand with respect to its own price, ε_{gf}. Our model's oligopolistic market structure implies that the perceived elasticity of domestic demand is endogenous. As a consequence of the nesting structure of preferences, it only depends on the price of other producers of the same good g through the firm's share of domestic expenditure in its demand nest, e_{gf}.

In equilibrium, firms differ in their markups μ_{gf} and imports q_{gf}.[11] Formally, holding constant good-level variables,

$$\beta^{\mu}_{gf} \equiv -\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} = \frac{\rho_{gf}}{1 + \rho_{gf}} \quad \text{and} \quad \beta^{q}_{gf} \equiv -\frac{\partial \log q_{gf}}{\partial \log c_{gf}} = \frac{\sigma}{1 + \rho_{gf}}$$

where $\rho_{gf} \equiv (\sigma - \varepsilon_{gf})(\sigma - 1)/\varepsilon_{gf}(\varepsilon_{gf} - 1)$. Note that $\varepsilon_{gf} \in [\eta, \sigma]$ implies that $\rho_{gf} \geq 0$.

Firms with high marginal cost and negligible market share, $e_{gf} \approx 0$, behave as in monopolistic competition by setting a constant markup of $\sigma/(\sigma - 1)$. For firms with lower marginal costs, the perceived elasticity of demand is lower. As a result, these firms charge higher markups but have lower prices and higher imports, $\beta^{\mu}_{gf} \in [0, 1)$ and $\beta^{q}_{gf} \in (0, \sigma]$. This stems from the fact that the between-good elasticity, which is lower than the between-firm elasticity, becomes a more important determinant of the perceived demand elasticity as the firm's market share increases. Consequently, the average markup is higher for goods with higher concentration of market share across firms.

Accordingly, firm f's domestic markup is intrinsically related to its import elasticity:

$$\mu_{gf} = \mathcal{M}(\beta^{q}_{gf}),$$

with $\mathcal{M}(.)$ strictly decreasing. Intuitively, the import elasticity, β^{q}_{gf}, summarizes strategic pricing behavior created by both the level and the sensitivity of the firm's perceived demand elasticity. The function $\mathcal{M}(.)$ simply links back the firm's perceived demand

[11] For importers, c_{gf} and q_{gf} are the import cost and quantity indices, respectively. Thus, in the rest of the paper, we refer to q_{gf} as the firm's imports.

elasticity ε_{gf} to its import elasticity β^q_{gf}. We leverage the mapping $\mathcal{M}(.)$ to identify the distribution of domestic markups among importer firms, μ_{gf}, from the sensitivity of each firm's imports to its import cost, β^q_{gf}, which we can estimate using firm-level customs data (and without firm-level data on domestic prices and sales). Across importer firms, since $\mathcal{M}(.)$ strictly decreasing, higher dispersion in import elasticities translates into higher dispersion in markups.

For any given firm, the partial-equilibrium elasticities of import quantity and (tariff-inclusive) import expenditure are intrinsically related, since firm f's import expenditure is $M_{gf} = c_{gf} q_{gf}$ and, thus, $-\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \beta^q_{gf} - 1 > 0$.[12] Accordingly, an importer with a higher share of imports among all firms in its demand nest, $m_{gf} \equiv M_{gf} / \sum_{f'} M_{gf'}$, will also have a higher share of the domestic expenditure in its demand nest, e_{gf}; in other words, there is a one-to-one mapping between m_{gf} and e_{gf}. Below, we use this property to show that m_{gf} is a sufficient statistic for the firm's response to changes in import costs.

2.3 The Impact of Import Cost Changes

We now analyze how the economy responds to exogenous changes in import tariffs.[13]

2.3.1 Firm-level Responses

Changes in import costs affect firms through their marginal costs. For importer firms, this is the import-weighted average of changes in import costs:

$$d \log c_{gf} = \sum_v m_{vgf} d \log(1 + \tau_v), \tag{1}$$

where m_{vgf} is the share of foreign variety v in firm f's imports, defined as $m_{vgf} \equiv M_{vgf} / M_{gf}$ and $M_{vgf} \equiv p_v q_{vgf}$.

In response to marginal cost changes, importer firms adjust imports and markups:

$$d \log q_{gf} = -\beta^q_{gf} (d \log c_{gf} - d \log c_g) - \eta d \log c_g + d \log Q \tag{2}$$
$$d \log \mu_{gf} = -\beta^\mu_{gf} (d \log c_{gf} - d \log c_g) \tag{3}$$

[12]This holds because of the assumption that $\sigma \in (\eta, \eta^2)$, which guarantees that the perceived demand is sufficiently elastic to induce more productive firms to have higher import expenditure. Intuitively, a sufficiently elastic demand limits the extent to which more productive firms want to cut output in order to increase their markups and profits. In line with this intuition, $\sigma > 1$ implies that $\beta^q_{gf} > 1$ for firms with e_{gf} sufficiently low, since their demand is already sufficiently elastic. The condition $\sigma < \eta^2$ imposes that the demand elasticity is also high enough for firms with high market shares.

[13]We consider the first-order approximation of equilibrium outcomes, as derived in Appendix A.3.

where $d\log c_g \equiv \sum_f \omega_{gf} d\log c_{gf}$ is a weighted average of cost changes among importers within g, with $\omega_{gf} \equiv \mu_{gf} m^q_{gf} / \sum_{f'} \mu_{gf'} m^q_{gf'}$ and $m^q_{gf} \equiv M_{gf}\beta^q_{gf} / \sum_{f'} M_{gf'}\beta^q_{gf'}$. The endogenous shifter, $d\log Q$, summarizes the general-equilibrium demand response, which is common to all firms.

Responses in markups and imports depend on the change in the average import cost of firm f relative to all importers with varieties of the same good. In fact, the firm-specific elasticities β^μ_{gf} and β^q_{gf} summarize strategic considerations in domestic price setting. Since sales and imports decrease with the firm's marginal cost, these elasticities are a function of the firm's import share among all competitors in its demand nest, m_{gf}:

$$\beta^q_{gf} = \beta^q(m_{gf}) \quad \text{and} \quad \beta^\mu_{gf} = 1 - \beta^q(m_{gf})/\sigma \tag{4}$$

with

$$\frac{\partial \beta^q(m)}{\partial m} < 0 \quad \text{and} \quad \beta^q(0) = \sigma.$$

The slope of $\beta^q(m)$ summarizes how domestic competition varies with the firm's relative size in its group. In the limit, small firms with $m_{gf} \approx 0$ behave as in monopolistic competition: they choose to completely adjust prices in response to cost shocks (i.e., $\beta^\mu(0) = 0$), which causes imports to decline by σ (i.e., $\beta^q(0) = \sigma$). Given the same relative increase in average import cost, firms with a larger import share, m_{gf}, reduce more their domestic markups and, consequently, less their imports. When $\sigma - \eta$ is larger, the firm's perceived demand elasticity declines more with its relative size, the slope of $\beta^q(m)$ is steeper and, consequently, markups are less sensitive to import shares (as $\mu_{gf} = \mathcal{M}(\beta^q(m_{gf}))$).[14]

For all domestic firms, the change in the marginal cost is equal to the change in the domestic wage, $d\log c_{gf} = d\log w$. Due to our model's market structure, the identical marginal cost change for all domestic firms implies that their markups remain unchanged, $d\log \mu_{gf} = 0$, and that their output change by the same amount, $d\log q_{gf} = d\log q^D$. Since domestic labor is employed exclusively by domestic firms, the labor market clearing condition ensures that the output of domestic firms remain constant, $d\log q^D = 0$. Intuitively, because of the segmentation in domestic demand and factor markets, the economy's resource constraint insulates domestic firms from changes in import costs.[15]

[14]As discussed below, this intuition carries to our extensions with an arbitrary elasticity structure between goods and with domestic and importer firms in the same demand nest. In both cases, the demand elasticity of importers is $\varepsilon_{gf} = \sigma - \kappa_g e_{Mgf}$, where e_{Mgf} is the revenue share of importer f among all importers within g, which is strictly increasing with f's import share within g, m_{gf}. The parameter κ_g is higher for goods that (i) are less substitutable with other goods, and (ii) have a higher share of imports in domestic expenditure. Intuitively, κ_g summarizes domestic competitive pressures faced by importers. When κ_g is higher, import responses and domestic markups are more sensitive to m_{gf}.

[15]Our model thus implies that import cost changes do not induce reallocation of resources across domes-

2.3.2 Aggregate and Distributional Welfare Responses

We consider next welfare responses to tariff changes. To focus on the implication of distortions generated by the domestic market power of importers, we analyze a tariff increase around an initial equilibrium without tariffs.

Aggregate Effect. We start with the shock's aggregate welfare effect defined as the sum of the equivalent variation across workers and owners, which is given by[16]

$$dC = \sum_g \sum_f (p_{gf} - c_{gf}) dq_{gf}. \tag{5}$$

The effect of tariff changes on aggregate welfare corresponds to the change in allocative efficiency due to domestic market power. This arises from the reallocation of resources across firms with distinct marginal products – e.g., Baqaee and Farhi (2020; 2024), Atkin and Donaldson (2022), and Adão et al. (2023). Expression (5) is the sum of the shock's first-order impact on the Harberger triangles associated with the deadweight losses in the domestic sales of all firms, calculated as the initial markup distortion $(p_{gf} - c_{gf})$ multiplied by the change in production (dq_{gf}). It indicates that welfare gains are larger for shocks that help to correct initial distortions by reallocating resources towards goods and firms with inefficiently low supply in the initial equilibrium due to a high markup relative other goods and firms.

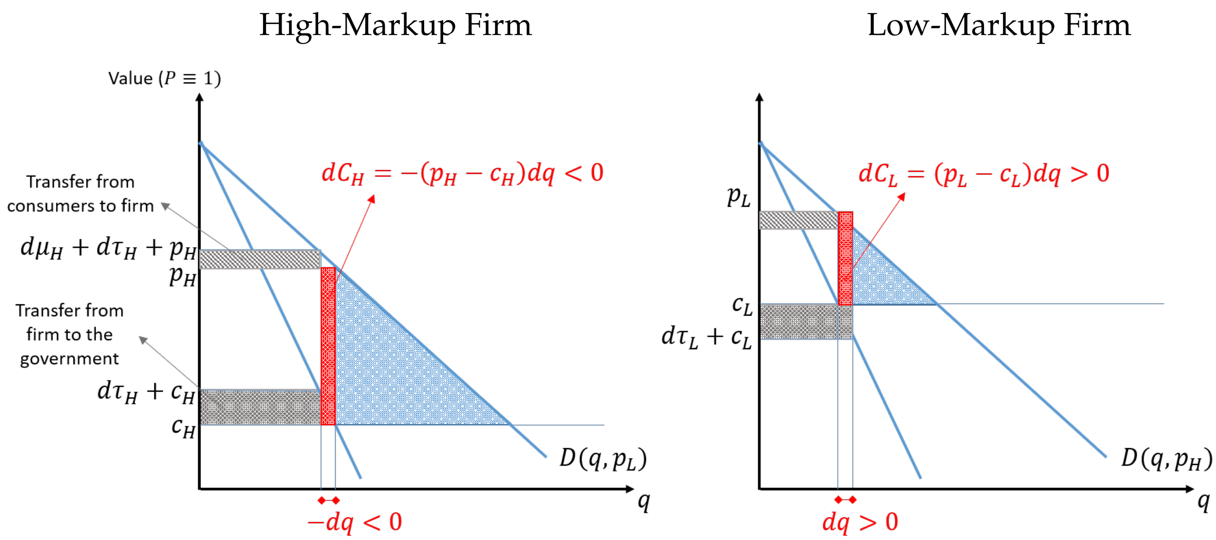
Figure 2 illustrates the intuition behind expression (5). It represents the equilibrium of an economy with two importer firms supplying varieties of the same good: the high-markup (low-cost) firm on the left panel and the low-markup (high-cost) firm on the right panel. In the initial equilibrium, the economy's deadweight loss is the sum of the Harberger triangles in blue. Consider a tariff change that induces sales of the high-markup (low-markup) firm to contract (expand) by dq. The first-order impact on welfare is denoted by the two red rectangles whose areas are given by the product of the initial markup and the change in production. Because the policy reallocated production from the high-markup to the low-markup firm, aggregate welfare falls as the deadweight loss increase for the high-markup firm is larger than the decrease for the low-markup firm.

Note that neither changes in tariffs nor markups themselves have a direct impact on aggregate welfare. Conditional on changes in production, tariff and markup adjustments

tic and importer firms, which shuts down potential margins of adjustment in the economy. As we discuss below, away from this limiting case, richer structures of demand or technology imply that sales of domestic firms respond to import cost changes.

[16]This is the measure of aggregate welfare implied by a utilitarian social welfare function.

Figure 2: First-Order Impact of Tariff Changes on Aggregate Welfare



Notes: Figure illustrates impact of tariff changes that induce symmetric changes in dq for the high-markup firm (left panel) and the low-markup firm (right panel). The numeraire is the ideal price index, $P \equiv 1$. The blue triangles represent the deadweight loss in the initial equilibrium. The red rectangles represent the first-order change in the deadweight loss of each firm, whose sum is negative due to the contraction of the high-markup firm. The gray rectangles represent the changes in consumer welfare (diagonal lines) and government revenue (dotted area). The combination of the red and gray rectangles determines the shock's impact on owners of importer firms.

simply represent transfers from firms to the government and consumers, as illustrated by the two gray rectangles in Figure 2. The overall impact on the owners of importer firms combines the direct impact on sales given the initial markup (the red rectangles) and the net effect of the changes in markups and marginal costs (the gray rectangles).

Using the firm-level responses in Section 2.3.1, we can re-write expression (5) in terms of variables in the initial equilibrium and import cost changes:

$$\frac{dC}{M} = -Cov_g\left[(\bar{\mu}_g - \bar{\mu})\eta, d\log c_g\right] - \mathbb{E}_g\left[\frac{\bar{\mu}}{\bar{\mu}_g^q} Cov_{f|g}\left[(\mu_{gf} - \bar{\mu}_g^q)\beta_{gf}^q, d\log c_{gf}\right]\right] \tag{6}$$

such that $M = \sum_g \sum_f M_{gf}$ is the country's initial imports, and $Cov_s[.,.]$ and $\mathbb{E}_s[.]$ are the import-weighted covariance and average across goods ($s = g$) or importers within a good ($s = f|g$). The terms $\bar{\mu}_g \equiv \mathbb{E}_{f|g}[\mu_{gf}]$ and $\bar{\mu}_g^q \equiv \mathbb{E}_{f|g}[\mu_{gf}\beta_{gf}^q]/\mathbb{E}_{f|g}[\beta_{gf}^q]$ are import-weighted averages of markups across importers f within good g, and $\bar{\mu} \equiv \mathbb{E}_g[\bar{\mu}_g]$ is the import-weighted average of markups across all importers.

Expression (6) links allocative efficiency to reallocation along two margins: across goods supplied by importers (first term) and across importers within a good (second term). Each margin corresponds to an import-weighted covariance that quantifies the extent to which the import cost shock leads to the expansion of imports for more distorted goods and firms, as captured by the product of the initial relative markup and the import elasticity. For the between-good component in the first term, this is the covariance between the good's relative average markup and its average cost shock. For the between-firm component in the second term, the aggregate effect is the sum over goods of the covariance of the reallocation and distortion across importers with varieties of the same good, weighted by the inverse of the good's relative average markup.

As a corollary, importer concentration only matters for the aggregate incidence of tariffs when the initial level of markups and the change in import costs vary across firms and goods. Figure 2 again illustrates the intuition. If both firms experience the same import cost change, relative prices and imports remain the same.[17] Alternatively, if both firms have the same initial markup, the deadweight loss reduction for one firm exactly compensates the increase for the other firm.

Lastly, expression (6) outlines the sufficient statistics for measuring aggregate tariff incidence. Given any import cost change, measurement requires (i) the mapping from each firm f to a demand nest g; (ii) firm-level custom records, $\{M_{vgf}\}$, (iii) the firm-level import elasticity function, $\beta^q(m)$, and (iv) the elasticity of substitution across goods, η. This approach leverages the insight that a firm's markup can be inferred from the elasticity of its imports with respect to its average import cost, $\mu_{gf} = \mathcal{M}(\beta^q(m_{gf}))$. Importantly, beyond firm-level customs records, one does not need any additional data on domestic prices or sales of importer firms. Instead, these domestic adjustments are implicitly captured through the extent to which firms adjust their imports in response to cost changes.

Distributional Effects. We now turn to how tariff changes affect owners of importer firms. Our notion of the change in the average markup on imports is the change in importer profits divided by initial imports, $d\Pi^M/M \equiv \sum_g \sum_f d\Pi_{gf}/M$ with summation defined over importers. This corresponds to

$$\frac{d\Pi^M}{M} = \frac{dC}{M} + \mathbb{E}_g\left[(\bar{\mu}_g - 1) d\log c_g\right] + \mathbb{E}_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}_g^q}\frac{\beta_{gf}^q}{\bar{\beta}_g^q}, d\log c_{gf}\right]\right]. \tag{7}$$

The first determinant of the impact of tariffs on importer profits is the production reallocation across importers given their initial markups, which is simply the change in the

[17] Note that, because $d\log q^D = 0$, uniform tariff changes do not affect welfare. This follows from the assumptions of segmented factor markets and nested domestic demand, which help us highlight that domestic market power of importers generates aggregate implications through resource reallocation across importers. As we discuss below, relaxing either assumption would result in the average tariff change having a distinct impact on aggregate welfare through reallocation across domestic and importer firms.

economy's allocative efficiency discussed above, $dC \equiv \sum_g \sum_f (p_{gf} - c_{gf}) dq_{gf}$. It implies that importer profits tend to increase for shocks that reallocate resources towards firms and goods with higher initial markups. The other terms in (7) measure the average change in profit margins given initial imports, $\sum_g \sum_f (dp_{gf} - dc_{gf}) q_{gf}$, which combines responses in costs and markups. Its impact on profits is higher when the shock lowers costs for firms with more elastic markups (i.e., those with low $\mu_{gf}\beta^q_{gf}$ in their group).

The impact on the welfare of owners of importer firms must also account for consumption cost changes. It is given by

$$\frac{dC^M}{M} = (1-\lambda)\frac{dC}{M} + Cov_g\left[\frac{\bar{\mu}_g}{\bar{\mu}}, d\log c_g\right] + \mathbb{E}_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}^q_g}\frac{\beta^q_{gf}}{\bar{\beta}^q_g}, d\log c_{gf}\right]\right] \tag{8}$$

with $\lambda \equiv (\bar{\mu}-1)(1-\bar{\mu}m)/\eta\bar{\mu}$ and $m \equiv M/E$. The first term in this expression indicates that importers only appropriate a fraction $(1-\lambda)$ of aggregate gains. This is because their income depends on profits generated from all imports, but only a fraction of their consumption costs depends on imports. In fact, $\lambda = 0$ whenever the share of domestic goods in consumption is zero. Again, the other terms measure the net impact on the real profits of importers created by changes in their markups and costs. Note that measurement of dC^M/M relies on the same information required to compute dC/M, in addition to the economy's import-to-expenditure ratio, m.[18]

2.4 Extensions

We now discuss extensions of our main results. In Appendix A.3.3, we present derivations for the general case of changes in both tariffs and world prices starting from any initial equilibrium. As equation (A.36) shows, world price changes and initial tariffs introduce two additional components into dC: changes in allocative efficiency due to initial distortions caused by import tariffs and improvements in the economy's terms of trade. These two terms are present in any neoclassical economy in which import tariffs are the only source of distortions – e.g., Fajgelbaum et al. (2020) and Adão et al. (2024).

Appendix B presents extensions of our baseline model. In all cases, versions of equations (5) and (7) remain valid, attesting to the robustness of our main insight regarding the implications of importer concentration for tariff incidence. However, each additional mechanism affects import and markup responses, $d\log\mu_{gf}$ and $d\log q_{gf}$.

We first extend our model to incorporate an integrated labor market for all firms and

[18] Appendix A.3.4 also shows the break down of the gains for the rest of the economy into the equivalent variation for domestic workers, domestic firms, exporter firms, and government revenue.

endogenous world prices. In this case, the average tariff change triggers responses in aggregate imports and domestic wages that lead to a uniform production increase among domestic firms, which impacts welfare through the difference in the average markup between importer and domestic firms. Additionally, tariff changes influence the neoclassical component of welfare associated with terms of trade.[19] Measurement in this case also requires the labor cost of exports, the elasticity parameters of the export demand and import supply curves, and the average markup of domestic firms.[20]

In our second extension, we consider a multi-sector model in which domestic firms use varieties supplied by both domestic and importer firms as intermediate inputs. Since (5) remains valid, intermediate production affects aggregate welfare only through production reallocation across firms. In this case, changes in imported input costs induce changes in marginal costs for domestic firms, which drive reallocation between domestic and importer firms within and across sectors. This effect is captured by a sector-specific average tariff change, which summarizes the role of input-output linkages.

Our third extension allows for a flexible substitution structure across goods while maintaining the assumption of CES demand across firms. This framework captures the idea that imported goods are not equally substitutable for all domestic goods. Firm-level markups and elasticities remain governed by the relationships in Section 2.2. However, in general equilibrium, we must account for reallocation between domestic and imported goods due to demand substitution. This requires employment data for domestic firms and estimates of the between-good elasticity matrix.

Our fourth extension assumes homothetic single-aggregator preferences across firms, as in Matsuyama (2023). In our oligopolistic setting, this implies that identification of markups for importer firms requires estimates of firm-level import and price elasticities. Given these elasticities, our analysis proceeds as above.[21]

Our final extension allows domestic and importer firms to be in the same demand nest. The expressions in Section 2.2 still apply for markups and elasticities of importers. In this case, the import elasticity function, $\beta^q_g(m)$, is steeper with a higher share of importers

[19] It is straightforward to allow importers to use labor, as in Appendix B.2. While this extension alters the multiplier on the average tariff change, it does not affect other terms given marginal cost changes. We can use the share of imports in each firm's total cost, α_{gf}, to measure its marginal cost change and its import elasticity as a function of an adjusted measure of the firm's import share within a group, $\tilde{m}_{gf} = M_{gf}\alpha_{gf}^{-1} / \sum_{f'} M_{gf}\alpha_{gf'}^{-1}$ (which is to m_{gf} if all importers in a group have the same import cost share, $\alpha_{gf} = \alpha_g$).

[20] We also show that, conditional on the average markup of importer firms, one can infer the average markup of domestic firms from aggregate expenditure and labor payments in the national accounts.

[21] We note that either prices or imports would suffice if importers operate in monopolistic competition, as in Baqaee et al. (2024). The reason is that, in this case, there is no distinction between the firm's perceived demand elasticity and its demand elasticity given the single aggregator.

in the good's domestic sales. In fact, given η, the slope of $\beta_g^q(m)$ identifies the domestic market share of importers, which we can use to compute markups of domestic firms given their employment shares within goods and, thus, welfare responses to tariff changes.

3 Importer Firm Concentration Across Countries

We established above that tariff incidence depends on the variation of import cost changes across firms with heterogeneous markup levels and import elasticities. In our model, this heterogeneity is intrinsically related to the distribution of firm import shares. Accordingly, we now use firm-level imports to measure importer concentration for 57 countries.

3.1 Data

The main import database used in the paper pools individual countries' transaction-level import records for 57 countries, provided in most cases by local customs agencies.[22] For each country, the data cover the universe of import transactions across all sectors and firms. The database spans the period from 1997 to 2021, though the exact time period available for each country varies depending on the data provided by the customs agency. Appendix Table C.1 presents the list of countries in our database along with their respective sample periods.

Our firm-level import database harmonizes import records across countries for key variables of interest: firm identifier, origin country, product code, import value, and import quantity.[23] First, we construct a unique firm identifier using the firm's name, tax identification number, or an artificial unique code provided by the data source.[24] Second, we harmonize origin countries to a consistent set of origins by consolidating name changes over time and aggregating territories that split during the sample period. Third, we concord each country's product classification to a list of consolidated six-digit products in the Harmonized System (HS). This is the most disaggregated level that is interna-

[22]The data are provided to the World Bank by customs agencies under conditions of strict confidentiality. For India, Indonesia, Mexico, Sri Lanka, and Vietnam, the import data are obtained from S&P Global Market Intelligence's Panjiva data platform (under a paid subscription). The collection of these import datasets is part of the expansion of the Exporter Dynamics Database (Fernandes et al., 2016).

[23]The procedure adapts to import records the method used for export records in Fernandes et al. (2016).

[24]For countries with data from the S&P Global Market Intelligence's Panjiva data platform, firm identifiers are constructed based on firm names following the approach described in Ghose et al. (2023) for Sri Lanka. In some countries, there are breaks in firm identifiers, resulting in separate sub-panels of data when a country's identifier code system changes during the sample period or when data are provided in different batches, each with a distinct artificial identifier. Such countries will not be used in our estimation of import responses to tariff changes as discussed later in Section 4.1.

tionally comparable within our sample period. Our consolidated product classification accounts for the seven HS revisions that occurred during our sample period, as well as the specific HS revision adopted by each country in a given year.[25] Fourth, we convert import values to US dollars and import quantities to kilograms.[26] Lastly, to focus on imports for domestic consumption in a given year, we aggregate transactions by origin-product-firm-year, excluding those classified as re-imports, temporary imports, or warehouse import regimes. We also exclude observations for 6-digit HS products in the oil sector (HS chapter 27) due to poor coverage in customs data. Across countries and years in our sample, the database captures on average 90% of aggregate imports reported in UN COMTRADE/WITS (excluding HS 27).

The final database is a panel of 158,121,069 origin-product-firm-destination-year observations with information on the value and quantity of imports. We compute unit values as the import value divided by the import quantity. Additionally, we merge our data with the database from Teti (2020) that includes ad-valorem import tariffs applied by each country to different origins and 6-digit HS products between 2001 and 2017.[27]

3.2 Import Firm Shares: Descriptive Statistics

We begin by measuring importer firm concentration. Guided by our model, we build the distribution of each firm's share of imports relative to its competitors within a destination country. This requires defining groups of importer firms that supply similar varieties of the same good in the domestic market—that is, the mapping from each firm f to a demand nest g.

Our baseline definition assumes that each importer firm supplies a distinct variety of a good that is produced with origin-specific inputs corresponding to each six-digit HS product (HS6). Accordingly, a firm f is represented by a unique importer-product pair, and the demand nest of similar varieties g comprises all importer-product pairs associated with the same HS6 product. Throughout the rest of the paper, we refer to each good g simply as an HS6 product.[28]

[25] The use of a consolidated HS classification is essential for measurement. In several countries, the new HS revision is not adopted in the year of its introduction and, even after adoption, customs records may still include older 6-digit HS codes. The consolidation principle is to identify HS codes that are related (e.g., codes that were split or merged) across revisions and to replace them with a single code for the entire period. See Forero (2025) for details on the HS consolidation procedure.

[26] Import values include cost, freight, and insurance, but exclude import duties. Exchange rates from the International Monetary Fund are used to convert imports in local currency to US dollars. The datasets for Chile, India, Indonesia, Mexico, and Vietnam do not include information on quantity.

[27] The same consolidation of HS 6-digit codes is applied to the database from Teti (2020).

[28] Our choice of HS6 products to define groups of importers competing in the domestic market (i.e., the

In a destination country d and year t, we measure each firm f's import share within a good g, denoted $m_{gf,dt}$, as the value of the firm's imports of HS6 product g, $M_{gf,dt}$, divided by its total import value of product g, $M_{g,dt}$.

Figure 3 presents the distribution of firm import shares in our sample. The left panel reports the histogram of firm import shares across all firm-good-origin-destination-year observations in our sample. 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 3 illustrates the distribution of a country's total imports associated with firms holding different levels of the share of a good's imports in their country. Despite the large number of small importer firms, the right-skewness of the distribution in the right panel 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 the import share of that good.

In Appendix C.1.1, we provide additional summary statistics on importer concentration. Appendix Figure C.1 presents the distribution of Herfindahl-Hirschman Index (HHI) for firm import shares, as well as the import share of the largest importer across good-destination-year observations. The figure shows that both the level and the dispersion of importer concentration are substantial. Appendix Figure C.2 reports the average importer concentration by HS section. Concentration is highest in sectors such as mineral products and arms, and lowest in sectors like footwear, apparel, and plastic products.

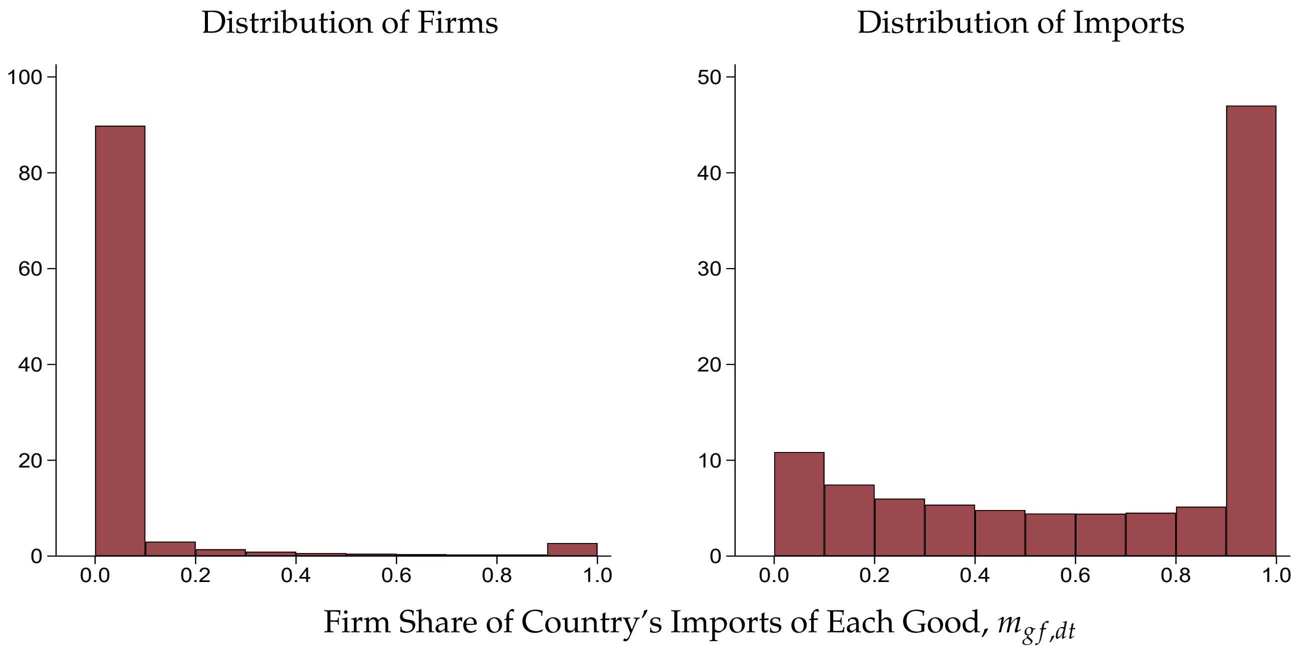
3.3 Within-Good Dispersion in Importer Concentration

We now turn to the dispersion of import shares across firms within each good. In our model, this reflects within-good dispersion in elasticity-adjusted markups across importer firms, which appear in the covariance term of the second component of (6). Specifically, we first calculate the standard deviation of import shares across firms for each good-destination-year. Then, for each country-year, the import-weighted average of this statistic across goods is our measure of within-good dispersion in importer concentration.

Figure 4 shows the cross-country scatter plot of within-good dispersion in import firm concentration against GDP per capita (left panel) and population (right panel), where

demand nest g) reflects the lack of firm-level information beyond customs records, which do not include data on domestic activities. To address concerns about mismeasuring the relevant market scope, we report that our conclusions are qualitatively robust to alternative definitions based on more aggregate HS classifications (e.g., 4- or 2-digit HS codes) or on the firm's sector, inferred from the composition of its imports.

Figure 3: Distribution of Firms and Imports by Firm Import Share



Notes: Sample of 158,121,069 firm-good-destination-year observations. Left panel reports the fraction of observations by bracket of the firm's import share of a good (i.e., the imports of the firm-good-destination-year divided by imports of the good-destination-year), where the weight of all firms of each good-destination-year is the good-destination-year's share of the destination-year's total imports divided by the good-destination-year's share of the number of firms in the database. The right panel reports the share of a destination's total imports associated with firms in different brackets of the firm's good import share. It is a histogram of firm-good-destination-year observations where the weight of each observation is its share of the imports of the destination-year divided by the good-destination-year's share of the number of firms in the database.

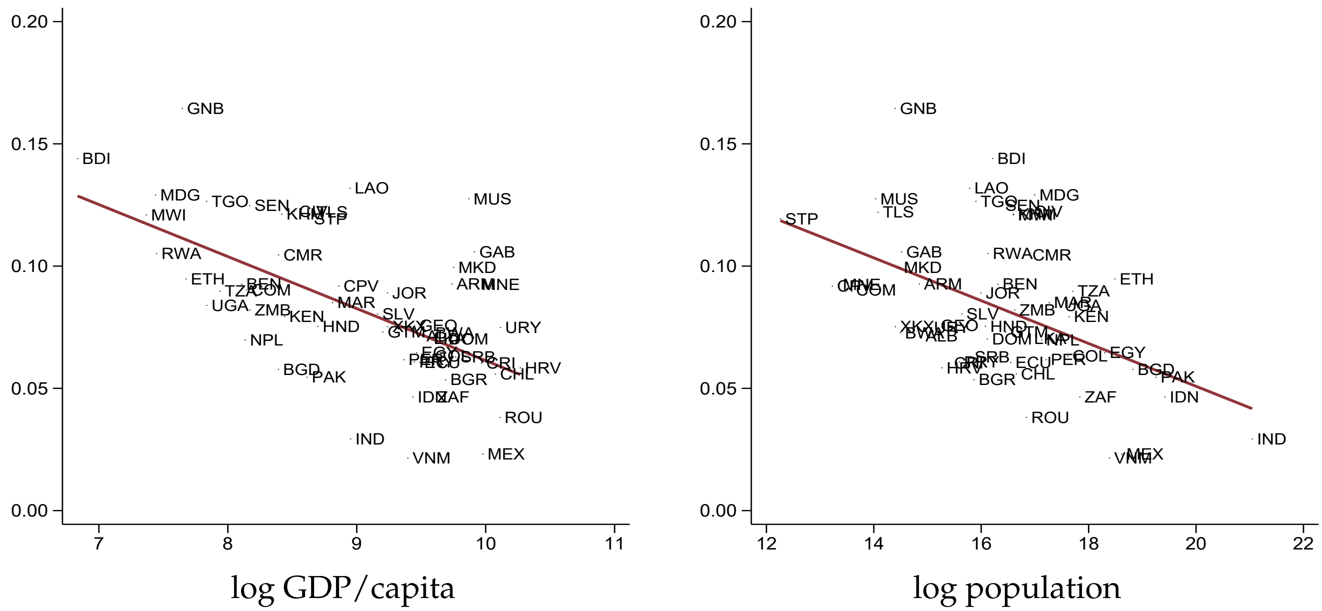
each value is the variable's simple average across years in our sample. It indicates that there is substantial dispersion in firm import shares within a product, with a median of 7.9 p.p. in our sample of countries. It also shows that within-good dispersion in import firm concentration is higher in poorer and smaller countries. This evidence suggests that tariff changes that have a differential impact across firms importing the same product will have a larger aggregate effect in poorer and smaller countries.[29]

3.4 Between-Good Dispersion in Importer Concentration

We next examine the dispersion of import firm concentration across goods. In our model, differences in the HHI of firm import shares across goods are intrinsically linked to differences in average markups, which appear in the covariance term of the first compo-

[29] Appendix Table C.2 examines the robustness of the relationships in Figure 4 when we control for good-year fixed effects, import market size, number of importers, and destination-good fixed effects.

Figure 4: Within-Good Dispersion in Importer Concentration Across Countries



Note: Figure shows within-good dispersion in importer concentration against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each country, within-good dispersion in importer concentration is the simple average across years of the import-weighted average across goods of the standard deviation of firm import shares within a good-destination-year.

nent of (6).[30] Accordingly, we measure the HHI of each imported good in a destination-year as the sum of the squared import shares across importers of that good, $\text{HHI}_{g,dt} \equiv \sum_f (m_{gf,dt})^2$. For each destination, our measure of between-good dispersion in importer concentration is the import-weighted standard deviation of the $\text{HHI}_{g,dt}$ across goods.[31]

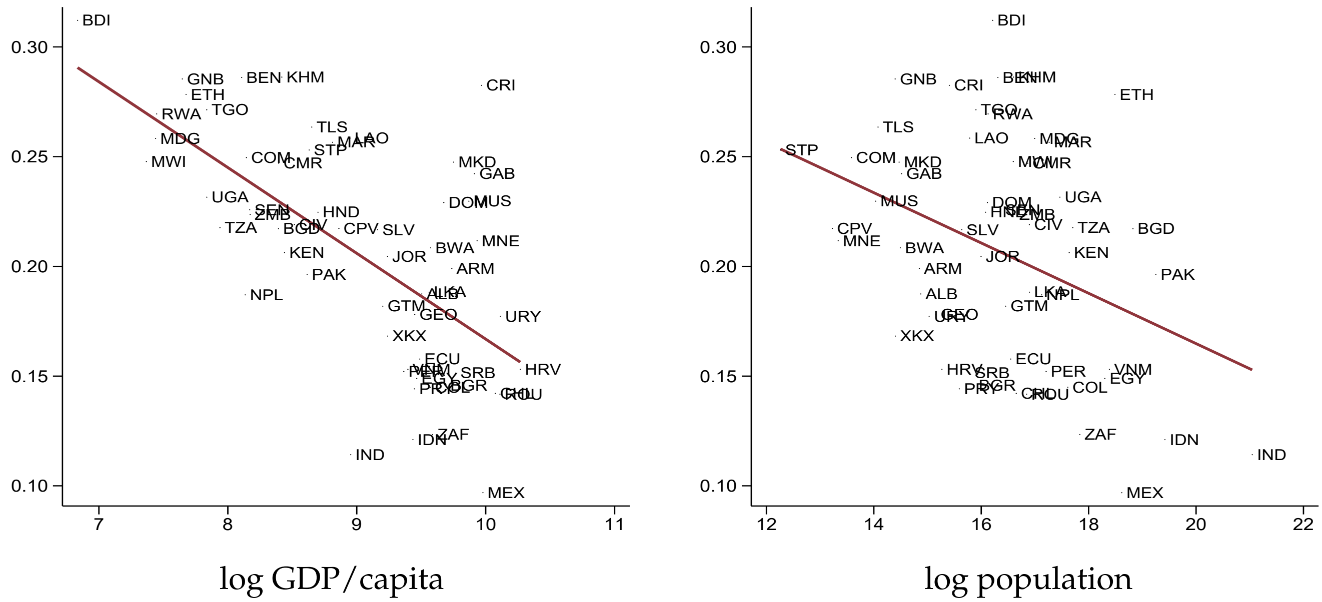
Figure 5 presents a scatter plot of each country's between-good dispersion in importer concentration against log GDP per capita (left panel) and log population (right panel), where we again report values averaged across years in our sample. The figure reveals that dispersion in HHI across products is high in our sample and even more pronounced in poorer and smaller countries. This finding suggests greater heterogeneity in average markups across goods in these countries.[32]

[30] To see this, consider a first-order approximation of a firm's markup around that of a firm with a negligible import share ($m \approx 0$): $\mu_{gf} = \sigma/(\sigma-1) + \kappa m_{gf}$ with $\kappa > 0$. In this case, $\bar{\mu}_g \equiv \sigma/(\sigma-1) + \kappa \text{HHI}_g$, where $\text{HHI}_g \equiv \sum_f (m_{gf})^2$ is the HHI of import shares across importers of good g.

[31] To prevent differences being driven by variation in the composition of imported goods across countries and years, we only consider the subset of 1,749 HS6 products that all destinations import in all years. Appendix Figure C.3 shows that our conclusions are qualitatively similar when we consider all goods imported by each destination-year.

[32] Appendix Table C.3 shows the robustness of the relationships in Figure 5 when we control for year and country fixed effects, as well as import market size.

Figure 5: Between-Good Dispersion in Importer Concentration Across Countries



Note: Figure shows between-good dispersion in importer concentration against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each destination, between-good dispersion in importer concentration is the simple average across years of the import-weighted standard deviation across HS6 goods of their HHI of firm import shares.

In summary, we find significant heterogeneity in importer concentration both within and between goods in our customs data from 57 countries. Furthermore, the magnitude of both dispersion dimensions is greater in poorer and smaller countries.[33] Through the lens of our model, these findings suggest that, due to changes in allocative efficiency, trade shocks have the potential to generate substantial aggregate and distributional effects, which are larger in poorer and smaller countries.

4 Estimates of Import Responses to Tariff Changes

In this section, we estimate how firms adjust their import decisions in response to tariff changes in countries with trade liberalization episodes. Our estimation strategy proceeds in three steps, moving from the lower to the upper nest of our model.

[33] In addition, Appendix C.1.3 shows that the average concentration across all imported goods is greater in poorer and smaller countries.

4.1 Estimation Sample

We consider the subsample of countries in our data that have time-consistent firm identifiers and complete information on the value and quantity of imports up to 2017, the sample period for which tariffs also are available.[34] We then select countries that experience trade liberalization episodes, defined as destination-year pairs that meet two requirements. First, at least 10% of origin-good pairs must experience a tariff decline of more than 1 percentage point. Second, the country's average tariff, weighted by initial imports, must decline by at least 0.1 percentage point.

Appendix Table C.5 reports the countries with at least one liberalization episode. Our estimation sample includes 16 countries and 17.1 million firm-good-destination-year observations with positive imports in two consecutive years. This sample ensures that the main source of variation identifying the model's parameters comes from firms responding to tariff changes during the 73 liberalization episodes in our dataset. These episodes involve broad tariff reductions affecting a sizeable fraction of imports across origins and goods, generating meaningful variation in import costs across firms. This variation is essential for precisely estimating how firms respond to tariff changes. The episodes are typically triggered by unilateral reductions in MFN tariffs (as in Morocco between 2003 and 2011) or by major trade agreements (such as Romania and Bulgaria joining the EU in 2007 or the Dominican Republic joining CAFTA-DR in 2006).

In these episodes, individual firms are unlikely to influence the final tariff rates applied to specific origin-good pairs. Indeed, Appendix C.2.2 reports estimates of a regression of tariff changes on the initial tariff across origin-good pairs affected by liberalization episodes. The estimated coefficient is -0.44 (s.e.= 0.04) with an R-squared of 0.49. Appendix Figure C.5 shows the associated bin scatter plot. These estimates indicate that initial tariffs explain a sizeable fraction of the tariff reductions in our sample of liberalization episodes. This negative relationship is robust to the inclusion of origin fixed effects, weighting by imports, and holds for all countries. It is consistent with the argument in Topalova (2010) that the magnitude of tariff reductions in liberalization events is largely determined by the level of the initial tariff. Since these tariffs were set years before the liberalization, they are unlikely to reflect contemporaneous shocks to firm-level imports.

[34] We exclude Montenegro and Serbia due to changes in their territorial status during the sample period.

4.2 Between-Origin Elasticity of Firm Imports to Tariff Changes

We start by estimating how firms adjust the origin of their imports of a good in response to tariff changes. For each horizon h, we consider the following specification:

$$\Delta^h \log Y_{ogf,dt} = \theta^h \Delta^0 \log(1 + \tau_{og,dt}) + \delta^h_{og,t} + \phi^h_{gf,dt} + \epsilon^h_{ogf,dt} \quad (9)$$

where $\Delta^h \log Y_{ogf,dt}$ denotes the log-change in outcome Y from $t-1$ to $t+h$ for years after t (i.e., $h \geq 0$) and from $t+h-1$ to $t+h$ for years before t (i.e., $h < 0$). Our specification includes fixed effects for each origin-good-year ($\delta^h_{og,t}$) and good-firm-destination-year ($\phi^h_{gf,dt}$). To obtain estimates that are comparable to those based on bilateral trade flows in the literature, we weight observations for each firm by its lagged share of imports from origin o of good g in destination d.

Given the fixed effects in (9), our main identification assumption is that changes in the tariffs that the destinations in our sample apply to origin-good pairs are not related to firm-specific shocks in the demand for the imports from those origin-good pairs. Under this assumption, the OLS estimate of (9) is the between-origin elasticity over horizon h of firm-level import outcomes in response to tariff changes, θ^h. When the dependent variable is the import value, the estimate of θ^h is the between-origin elasticity of substitution within each firm, since world prices are exogenous in our model.

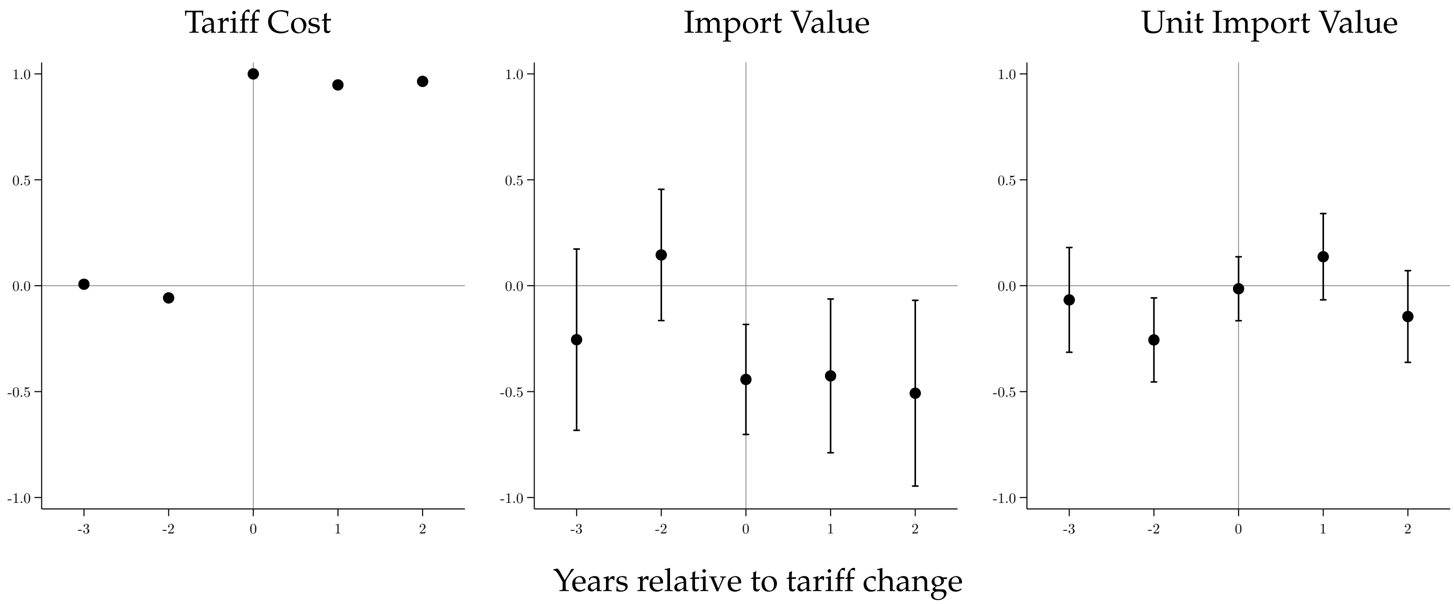
Figure 6 presents the estimates of (9) in our sample of 19,509,926 origin-good-firm-destination-year observations. The left panel reports estimates with the dependent variable defined as the change in tariffs over different horizons. In our sample, tariff changes resemble one-time shocks. In the pre-shock years, we estimate only a minor change from $t-2$ to $t-1$ whose magnitude is equivalent to -10% of the change from $t-1$ to t. At year t, the coefficient is equal to one by construction. Afterwards, our estimates suggest a weak mean reversal of less than 10% of the tariff change from $t-1$ to t.

The middle panel of Figure 6 reports estimates with the dependent variable defined as the change in tariff-exclusive import value. Estimates indicate that tariff changes induce firms to substitute across origins, with an elasticity of 0.45-0.50. In the year prior to the tariff changes, estimates are smaller in magnitude and not statistically significant.

Finally, the right panel of Figure 6 indicates that the unit import value does not respond to tariff changes. These findings are consistent with the assumption in our model of exogenous world prices of foreign varieties, at least within our sample, which is predominantly composed of developing countries.[35]

[35]Our findings are also consistent with those in Fajgelbaum et al. (2019) and Amiti et al. (2019b). They find that import prices of the United States and China did not respond to the tariff changes during the

Figure 6: Between-Origin Elasticity of Firm Imports to Tariff Changes



Note: Figure shows estimates and 95% confidence intervals of θ^h in equation (9) in a sample of 19,509,926 origin-good-firm-destination-year observations. The dependent variables are the log-change in tariff cost ($\Delta^h \log(1+\tau_{og,dt})$), tariff-exclusive import value ($\Delta^h \log V_{ogf,dt}$), and unit import value ($\Delta^h \log p^W_{ogf,dt}$) in the left, middle, and right panels, respectively. All regressions weight observations for each firm by its lagged share of imports from origin o of good g in country d. Confidence intervals clustered by origin-good and destination-good.

In terms of magnitude, our estimates closely align with those reported in Boehm et al. (2023) over the same horizons. Since tariffs do not vary across firms, they are directly comparable to Boehm et al. (2023)'s estimates based on good-level trade flows when controlling for fixed effects for good-destination-year instead of firm-good-destination-year. Indeed, Appendix Figure C.6 shows that estimates obtained with good-destination-year fixed effects (red triangles) are similar to our baseline estimates (black circles).

4.3 Between-Firm Elasticity of Imports to Tariff Changes

We now turn to the response in each firm's imports to changes in its average tariff cost. Given exogenous world import prices, equations (1)-(2) imply that

$$\Delta \log V_{gf,dt} = \beta^q(m_{gf,dt-1})(\Delta \log c_{gf,dt} - \zeta_{g,dt}) + \delta_{gd,t} + \phi_{f,dt} + \epsilon_{gf,dt} \tag{10}$$

such that

$$\Delta \log c_{gf,dt} \equiv \sum_o m_{ogf,dt-1} \Delta \log(1+\tau_{og,dt})$$

US-China trade war in 2018-2019.

with Δ denoting changes from $t-1$ to t, and $V_{gf,dt}$ denoting firm f's tariff-exclusive import value of good g. In line with our model, (10) includes good-destination-year fixed effects, $(\zeta_{g,dt}, \delta_{g,dt})$, that account for drivers of import and price changes that are common to all importers of good g in destination d. We also include firm-destination-year fixed effects $\phi_{fd,t}$ to absorb firm-level shocks that are common to all goods imported by the firm, like shocks to the firm's export or domestic demand.

Given the set of fixed-effects in (10), the residual $\epsilon_{gf,dt}$ can be interpreted as unobserved idiosyncratic shocks to the imports of good g by firm f; for example, shocks to the productivity shifters that are specific to the variety of firm f based on imports of good g. Accordingly, 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, which generate variation in $\Delta \log c_{gf,dt}$ across importers of the same good.

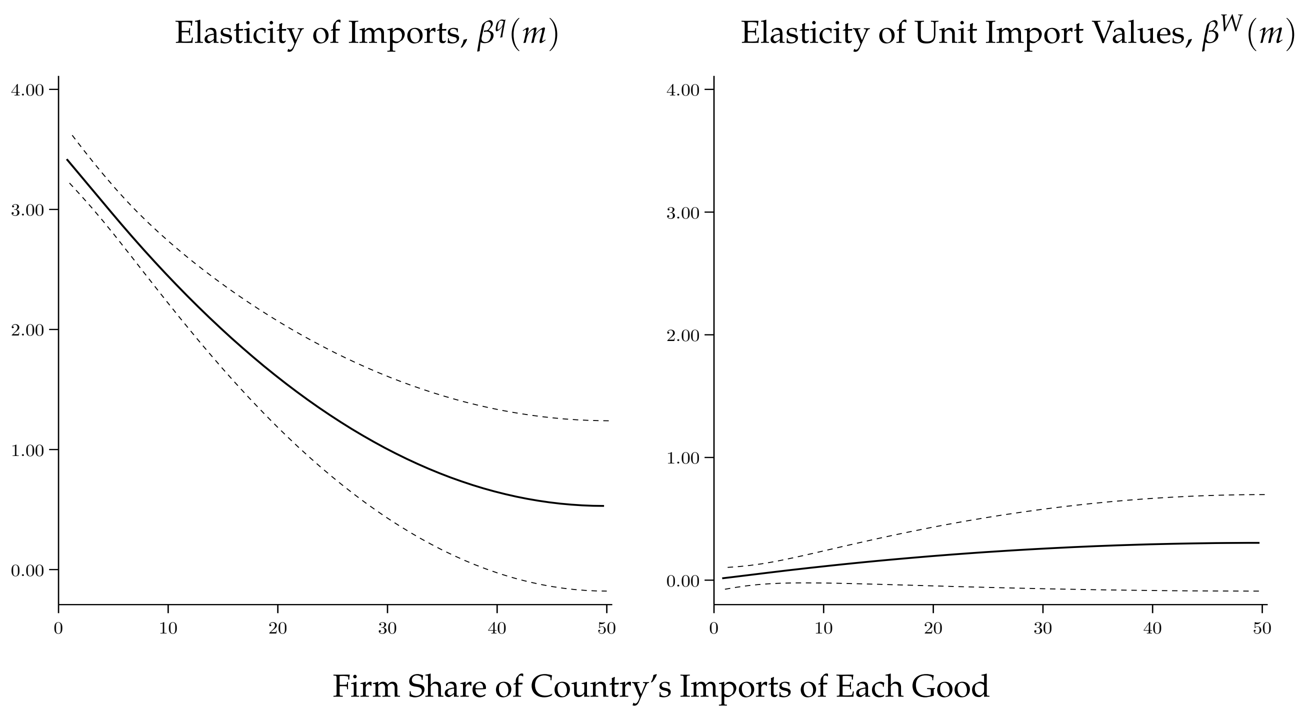
Change in average tariff cost across firms. Our estimation strategy exploits the fact that, since tariffs vary across origin-good pairs, firms that import the same good from different origins may face different changes in their average tariff costs. Accordingly, Appendix Figure C.7 shows the frequency of $\Delta \log c_{gf,dt}$ across good-firm-destination-year observations in our sample, residualized from good-destination-year fixed effects. There would be no variation across firms in their residualized change in 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. However, the left panel of 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 also requires changes in average tariff costs across firms that differ in terms of their share of the imports of a good, $m_{gf,dt}$. Section 3 documented that more than 93% of the firms in our database account for less than 10% of their country's imports of a good. We now evaluate the frequency of observations in our sample with sizeable changes in residualized average tariff costs that correspond to large importers of a good. The right panel of Appendix Figure C.7 shows the frequency distribution of the residualized $\Delta \log c_{gf,dt}$ across firm-good-destination-year observations with $m_{gfd,t-1} \geq 10\%$ 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 guides our functional form choices for estimation.[36]

[36] Appendix C.2.1 describes the parametrization of $\beta^q(m)$. We use a piece-wise spline that guarantees smooth estimates that are constant beyond a threshold, which we pick to be 50% due to the low number of

Baseline estimates. The left panel of Figure 7 presents the baseline estimates of (10). The figure shows that firms with a lower import share of a good have a larger elasticity of imports to tariffs, whereas the elasticity of imports is smaller among firms with greater import share of a good. For firms with negligible import shares ($m \approx 0$), an increase of 1 log-point in their tariff cost induces a decline in imports of 3.4 log-points. In contrast, the same shock induces only a reduction of roughly 0.8 log-point in the imports of goods for which a firm accounts for more than 50% of the destination's imports. Our estimates suggest that import firm concentration shapes how firms respond to tariff changes. They are consistent with the mechanism in our model: larger importers of a good respond less to tariff changes through import changes, but more through domestic markup changes.

Figure 7: Firm's Elasticity of Imports and Unit Values to Tariff Changes



Note: Sample of 18,626,944 good-firm-destination-year observations. Solid line in the right panel is the estimate of $\beta^q(m)$ obtained from (10), along with dashed lines illustrating the 95% confidence intervals implied by standard errors (two-way) clustered by good-firm-destination and good-destination-year. The left panel reports the elasticity function obtained from a specification analogous to (10) where the dependent variable is instead the log-change in the unit import value of the firm's imports of the good.

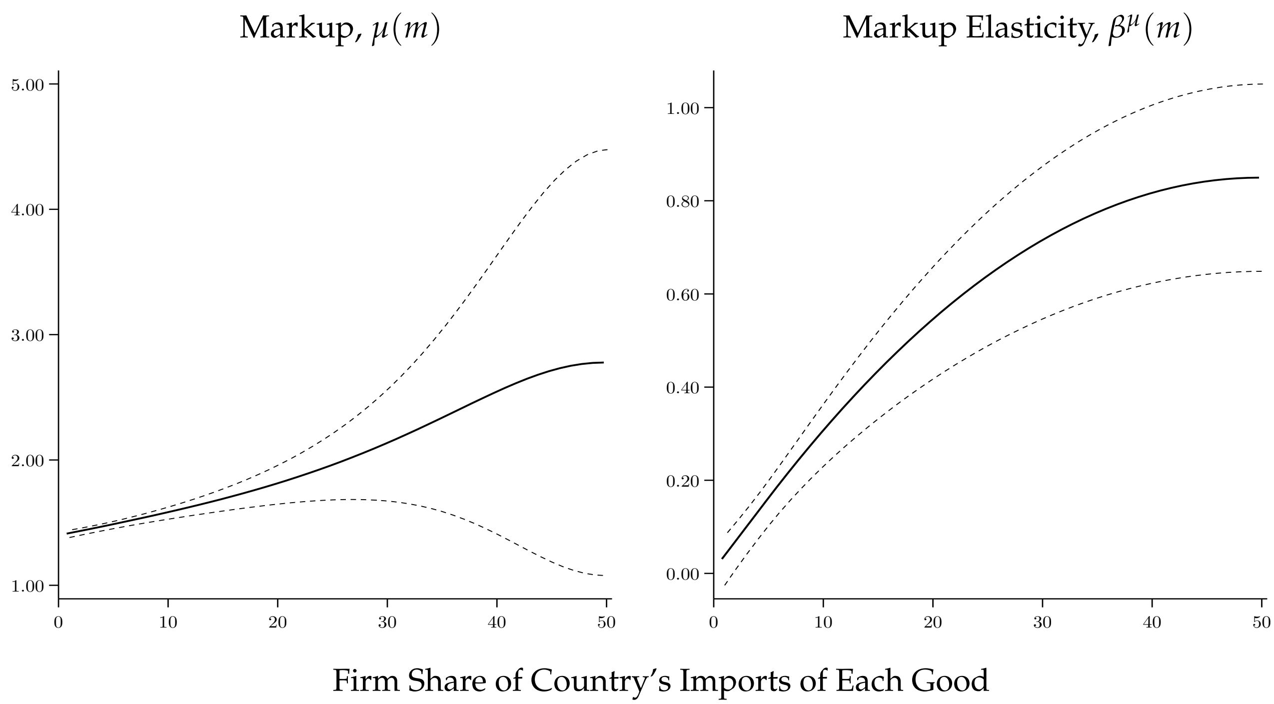
The right panel of Figure 7 examines whether the observed pattern of import responses arises from systematic differences across firms in the prices paid to foreign suppliers. To explore this, we estimate a specification analogous to (10), replacing the dependent variable with the log-change in the unit import value of the firm's imports of

firms that have both high differential changes in average tariff cost and high import shares of a good.

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.

Through the lens of our model, the estimates of $\beta^q(m)$ identify the level and the sensitivity of the domestic markup of importer firms, since $\mu(m) = \mathcal{M}(\beta^q(m))$ and $\beta^\mu(m) = 1 - \beta^q(m)/\beta^q(0)$. Figure 8 presents our estimates of the domestic markup of importer firms (left panel) and its sensitivity to the firm's import costs (right 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 close to 2.8, with an elasticity of -0.8.[37]

Figure 8: Domestic Markup of Importer Firms



Note: Figure shows point estimates (solid lines) and 95% confidence intervals (dashed lines) of the domestic markup of importer firms (left panel) and the sensitivity of the domestic markup to the firm's average tariff cost (right panel) as a function of the firm's share of its country's imports of a good. Estimates obtained using the elasticity of imports to average tariff costs in the left panel of Figure 7.

[37]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 1 (and thus a markup elasticity near zero), whereas the average pass-through among large firms is 0.5 (and thus a markup elasticity near -0.5).

4.4 Between-Good Elasticity of Imports to Tariff Changes

Next we estimate the elasticity of substitution across imported goods η. Using the estimates above, we obtain an expression linking a measure of domestic expenditure on good g to the tariff-induced change in the price index of good g. Formally, we define the following weighted averages of changes in firm-level imports and tariffs: $\Delta \log V_{g,dt} \equiv \sum_f m_{gf,dt-1}(\mu_{gf,dt-1}/\bar{\mu}_{g,dt-1})\Delta \log V_{gf,dt}$ and $\Delta \log c_{g,dt} \equiv \sum_f \omega_{gf,dt-1}\Delta \log c_{gf,dt}$. Assuming that world prices are exogenous, the aggregation of equation (2) across firms yields

$$\Delta \log V_{g,dt} = -\eta \Delta \log c_{g,dt} + \zeta_{dt} + \epsilon_{g,dt}, \tag{11}$$

where ζ_{dt} is a destination-year fixed effect. To compute $\Delta \log V_{g,dt}$ and $\Delta \log c_{g,dt}$, we use the estimates in Section 4.3 to set $\beta^q_{gf,dt-1} = \beta^q(m_{gf,dt-1})$ and $\mu_{gf,dt-1} = \mu(m_{gf,dt-1})$.

Appendix Table C.8 presents estimates of equation (11). Our baseline estimate of η is 1.86 (s.e.=0.38), which is slightly higher than the estimate of 1.53 that Fajgelbaum et al. (2019) obtain for the United States. When we estimate the elasticity across narrower sets of goods, we get η =2.05 (s.e.=0.35) within 2-digit HS goods and η =2.12 (s.e.=0.37) within 4-digit HS goods.

4.5 Robustness: Firm-level Import Elasticity

We now assess the robustness of the key moment disciplining the domestic market power of importer firms in our model: the response of firm-level imports to changes in average tariff costs as a function of the firm's import share in its group. To do so, we estimate equation (10) with a simplified step-function parametrization of the firm import elasticity: $\beta^q(m) \equiv \beta_L + (\beta_H - \beta_L)D_H(m)$, where $D_H = \mathbf{1}[m > \bar{c}]$ is an indicator variable equal to one for firms with import shares above the cutoff $\bar{c}$.

Figure 9 reports our estimates across various alternative specifications. The left panel shows estimates of the intercept parameter β_L, which captures the import elasticity of firms with low import shares. The right panel presents estimates of $\beta_H - \beta_L$, which corresponds to the differential import elasticity for firms with high import shares.

We first consider import responses over longer horizons. The second panel indicates that small firms have slightly smaller responses over extended periods, with a point estimate of roughly 2.4 (instead of 2.9 over one year). Estimates of the differential response for larger firms are slightly stronger over longer horizons, though they are not statistically different from our baseline estimates. These estimates suggest that our conclusions are similar for import responses over different time horizons.

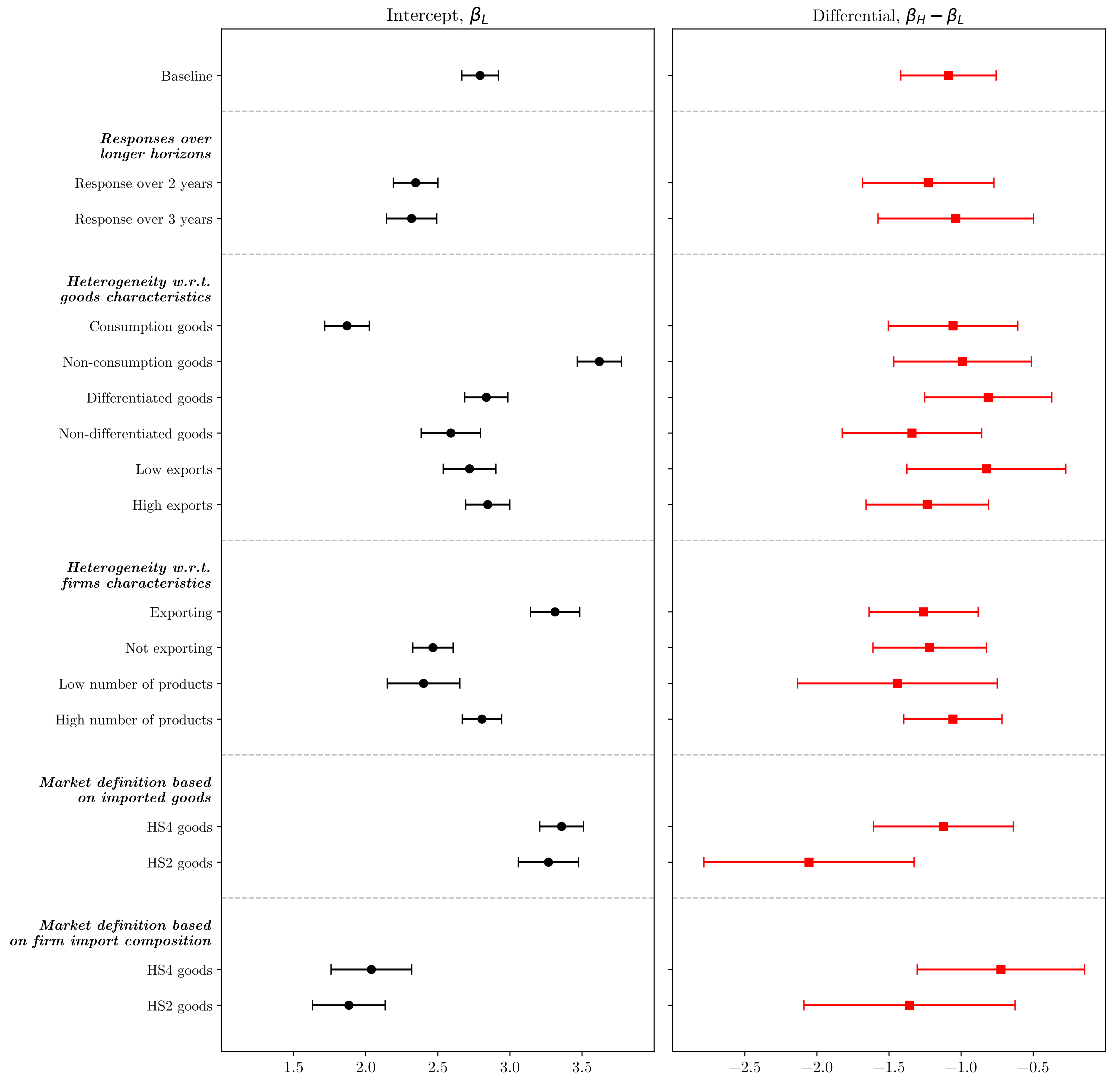
The next panels evaluate how firm-level import responses vary with characteristics of the good. For consumption goods, the definition of a firm's relevant domestic market is more likely to align with HS6 codes, since these are finished products sold to consumers. Reassuringly, while import responses for small firms are weaker, the differential response of larger importers remains similar. These estimates suggest that, as a fraction of the overall import response, importer concentration is an even more important determinant of the firm's import response to tariff changes for consumption goods. We also show that estimates are similar when we split products according to the Rauch (1999) index, distinguishing between differentiated and non-differentiated products for which the elasticity of substitution across varieties my differ. The last specification in this panel considers estimates for low- and high-export products in each country.[38] Intuitively, if the country has low exports of a product, it is more likely that the domestic production of that good is lower. We obtain estimates for both sets of products that are not statistically different from our baseline estimates.

The third panel investigates heterogeneity in import responses with respect to firm characteristics. We first show that estimates are similar for importers with a high and low number of imported goods, with groups defined by the median number of imported goods per firm in a country-year. This assesses whether firms with many imported goods respond differently because of within-firm cannibalization concerns or complementarity between different inputs. The second set of estimates investigates whether importer-exporter firms respond differently. In both cases, we find that are not statistically different from our baseline estimates.

The fourth panel explores the robustness of our findings to alternative definitions of the domestic goods market. We consider more aggregated classifications in which g is defined either by the product's 4-digit or 2-digit HS code. These definitions allow firm-specific varieties to combine inputs from multiple HS6 products within the same broader category. For example, under the HS2 classification, firms importing vehicles and vehicle parts are allowed to produce their own firm-specific varieties and compete in the same domestic market. We find that import responses for smaller firms are stronger under these alternative definitions. For larger firms, the differential elasticity is similar to the baseline estimate under the HS4 classification but becomes stronger under the coarser HS2 classification. These estimates indicate that our conclusions are robust to broader definitions of demand nests.

[38] We use the BACI dataset to compute the ratio between the product's share in the country's total exports and in the world's total exports. For each country-year, low-export products are those for which this ratio is below the median across all goods.

Figure 9: Alternative Specifications of Between-Firm Import Elasticity



Note: Figure shows estimates of β_L (left panel) and $\beta_H - \beta_L$ (right panel) obtained from (10) with $\beta(m) \equiv \beta_L + (\beta_H - \beta_L)D_H(m)$, where $D_H = \mathbf{1}[m > \bar{c}]$ with $\bar{c} = 0.1$ for all specifications except HS2 goods where $\bar{c} = 0.05$. Baseline refers to our main specification from equation (10). Response over 2 years and 3 years use cumulative changes in imports over 2 and 3 years, respectively. Consumption/non-consumption goods split the sample based on the UN BEC classification. Differentiated/non-differentiated goods split the sample based on the Rauch (1999) classification. Low-export (high-export) products defined as those whose ratio between its share in the total exports of the country and the world is below (above) the median of this ratio across all goods for each country-year. Firms with low (high) number of products defined as those with number of imported products below (above) the median number of imported products per firm in the country-year. Market definition based on imported goods defines g to be either HS4 or HS2 codes (instead of HS6 codes). Market definition based on firm import composition groups firms with most of their imports in the same HS4 or HS2 codes. Horizontal bars denote 90% confidence intervals with standard errors clustered by firm-good-destination and good-destination-year.

The last panel explores an alternative definition of the firm's domestic market based on the composition of its imports. We define group g as the set of importer firms whose imports are primarily concentrated in the same 4-digit or 2-digit HS code. Intuitively, this definition assumes that firms with similar import product composition supply firm-specific varieties that are closer substitutes.[39] Since all firms now belong to a single group, we estimate (10) without firm-year fixed effects. Our estimates suggest that this alternative definition yields lower elasticity of substitution for small firms, with an elasticity around 2. However, larger firms still have a significantly lower import elasticity.

Lastly, Appendix Figure C.8 presents estimates with different cutoffs $\bar{c}$ for both the baseline sample (in black) and the sample restricted to years with liberalization episodes (in red), as described in Section 4.1. This figure highlights two findings. First, the right panel highlights the main driver of the pattern shown in Figure 7: firms with high import shares respond less than those with low import shares. Moreover, this difference is more pronounced as we increase the cutoff defining the set of firms with a high import share. Second, the estimates in red illustrate that variation indeed comes from liberalization episodes, as the same patterns emerge when we restrict the sample to liberalization years.

5 Markup Dispersion and Tariff Incidence

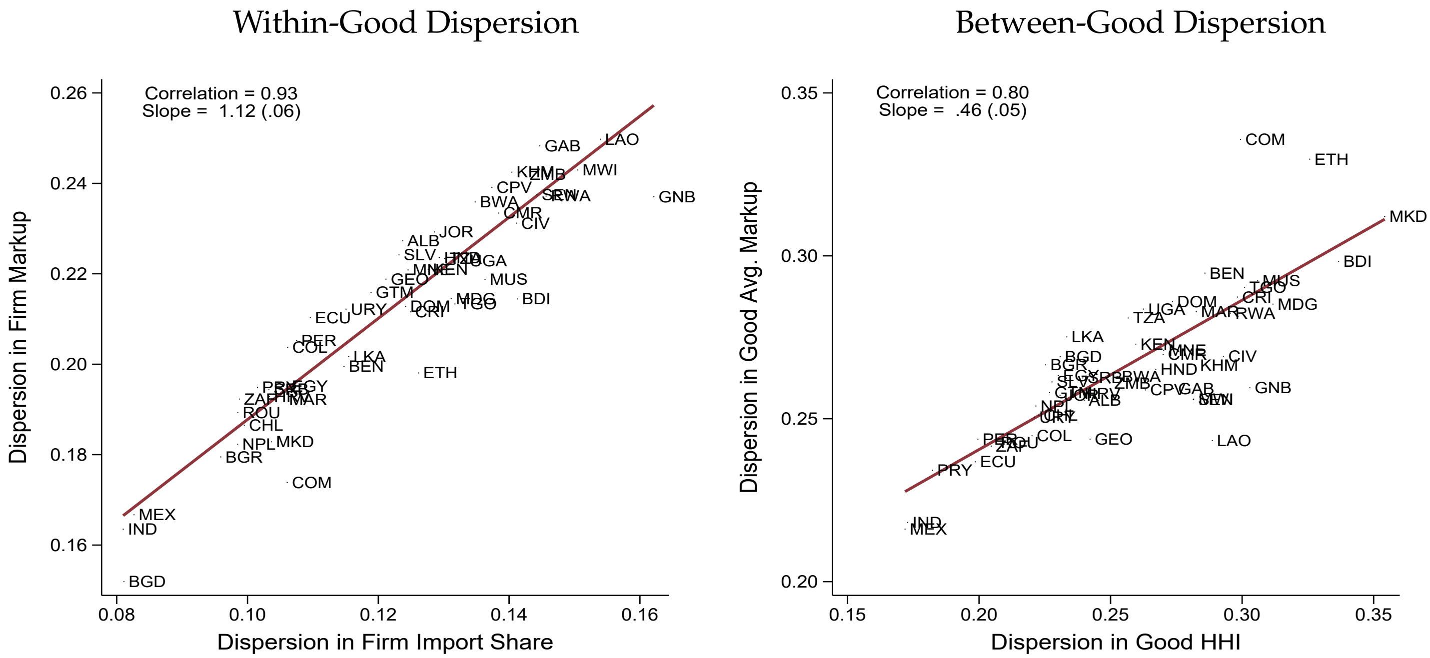
In this section, we quantify how markup distortions generated by importer concentration affect the aggregate and distributional effects of tariff changes. We first combine the distribution of firm import shares reported in Section 3 and the estimated import elasticities reported in Section 4 to obtain the markup distortions across goods and firms for each destination country. For a given trade liberalization episode, we then calculate the dispersion of import cost changes across goods and firms, and their correlation with initial markup distortions. Finally, we put all these ingredients into the tariff incidence formulas in Section 2 to measure welfare responses to tariff changes.

5.1 Dispersion in Markups

We start by showing the magnitude of the within- and between-good heterogeneity in markups in our sample. We use the estimated markup function in Figure 8, along with the data on firm import shares, to impute the domestic markup of each importer. We then measure within-good markup dispersion as the average standard deviation of markups

[39] The share of a firm's imports accounted for by its largest HS2 category is 0.48, 0.68, and 0.98 at the 10th, 25th, and 50th percentiles of the empirical distribution across firms in our sample.

Figure 10: Dispersion in Markups vs. Dispersion in Importer Concentration

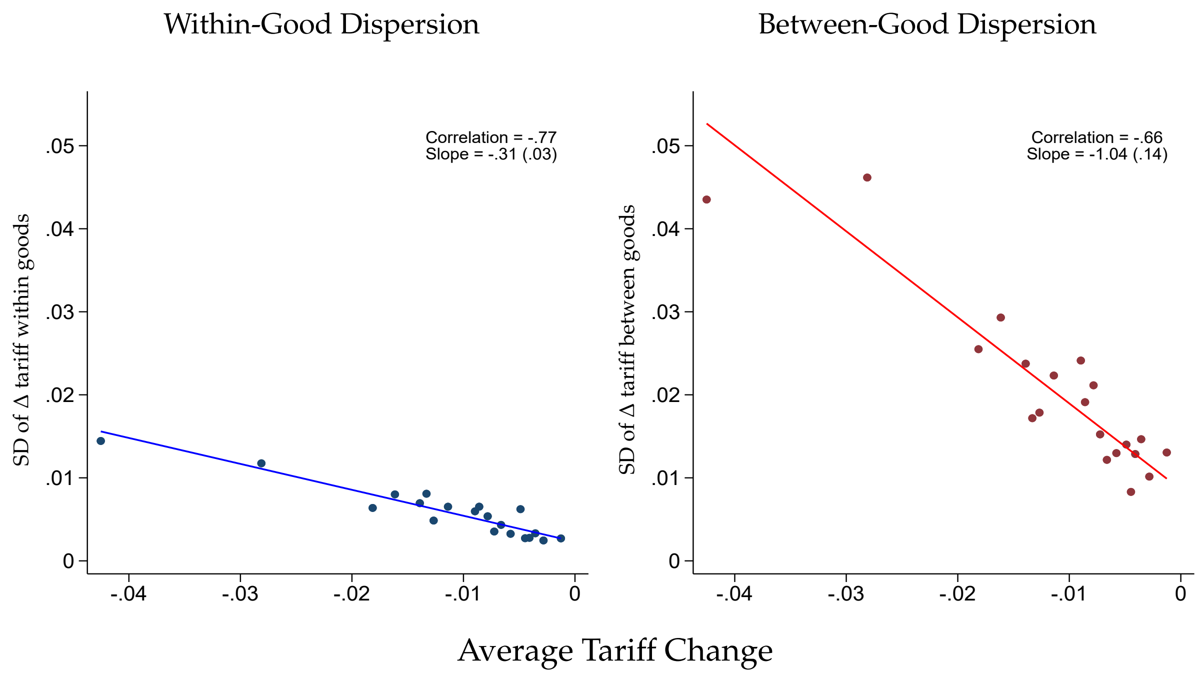


Note: Sample of 57 countries with import data between 1997 and 2021. Left panel compares the within-good standard deviation of import shares among importers of each good (x-axis) with the within-good standard deviation of firm markups among importers of each good (y-axis). Both measures are aggregated to country-level using import-weighted averages across goods in a given year, and simple averages across years. Right panel compares the import-weighted standard deviation across goods of their HHI of firm import shares (x-axis) with the import-weighted standard deviation across goods of their import-weighted average of firm markups (y-axis). Both measures are aggregated to country-level using simple averages across years.

among importers of each good, and the between-good markup dispersion as the standard deviation of the average markup across goods. All statistics are import-weighted, in line with expression (6).

Figure 10 shows the dispersion in markups within goods (left panel) and between goods (right panel) on the y-axis and the dispersion in the measures of importer concentration introduced in Section 3 (within and between goods) on the x-axis. The y-axis indicates substantial markup dispersion in our sample: across countries, the median is 0.21 within goods and 0.27 between goods. The figure also shows the positive relationship between the dispersions in markups and importer concentration: the cross-country correlation of these measures is 0.93 within goods and 0.80 between goods. This tight relationship simply reflects the fact that, through the estimates in Figure 8, import share dispersion fully determines markup dispersion.

Figure 11: Dispersion in Import Cost Changes vs. Average Tariff Changes



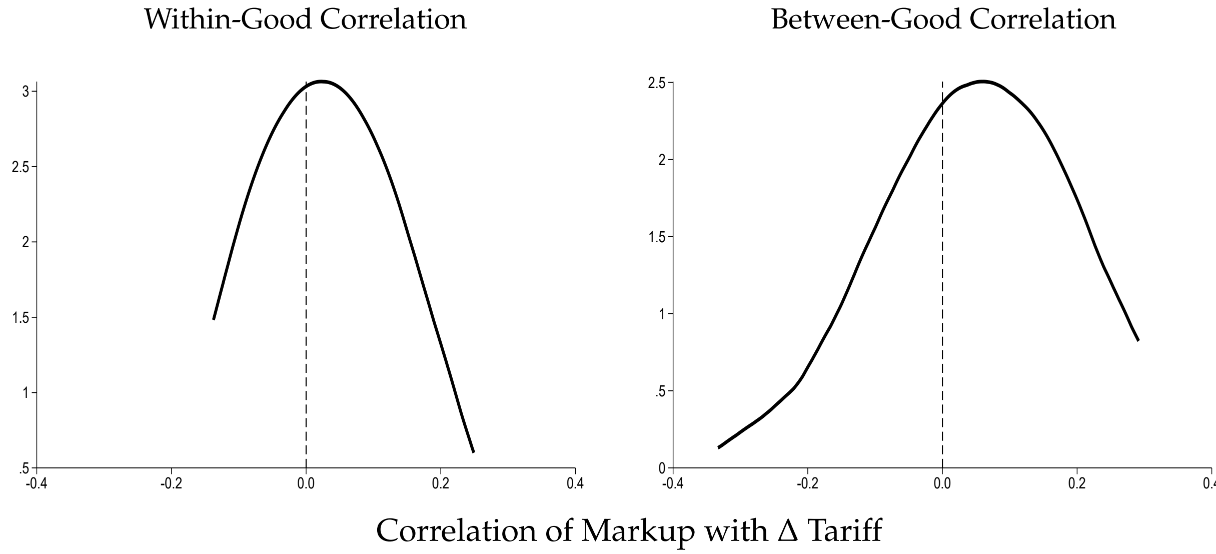
Note: Binscatter plot in sample of 73 country-year pairs defined as trade liberalization episodes. Left panel compares the within-good standard deviation of changes in import tariff costs among importers of the same good, $\Delta \ln c_{gf,dt}$, (y-axis) with the average of changes in the log of one plus the tariff across origins and goods (x-axis). Within-good dispersion is aggregated to country-level using the import-weighted average across goods in a given year. Right panel compares the import-weighted standard deviation across goods of changes in import tariff costs, $\Delta \ln c_{g,dt}$, (y-axis) with the import-weighted average of changes in the log of one plus the tariff across origins and goods (x-axis).

5.2 Dispersion in Import Cost Changes

We now turn to the dispersion of import cost changes. Figure 11 shows that trade liberalization episodes that reduce a country's average import tariff also tend to create dispersion in import cost changes across goods and firms. It displays a binscatter plot of the average tariff change against the within- and between-good dispersion in the model-consistent measures of import cost changes. Specifically, the left panel shows the average of the within-good standard deviation in $\Delta \ln c_{gf,dt}$, while the right panel shows the between-good standard deviation in $\Delta c_{g,dt}$, both weighted by initial imports.

The figure reveals a strong negative correlation between the average tariff change and the two measures of dispersion in import cost changes: –0.77 within goods and –0.66 between goods. Moreover, across episodes, between-good dispersion tends to be roughly four times greater than within-good dispersion in import cost changes, as demonstrated by the steeper slope in the right panel. Combined with the larger between-good markup

Figure 12: Correlation of Markups and Import Cost Changes



Note: Sample of 73 country-year pairs defined as liberalization episodes. The left panel reports the density across episodes of the average across goods of the within-good correlation between elasticity-adjusted markup and import cost change (corresponding to the second term in (6) with $Corr_{f|g}[.,.]$ instead of $Cov_{f|g}[.,.]$). The right panel shows the density across episodes of the between-good correlation between the average markup and the import cost change (corresponding to the first term of (6) computed with $Corr_g[.,.]$ instead of $Cov_g[.,.]$).

dispersion documented above, this pattern implies that markup distortions should affect welfare responses primarily through reallocation across goods.

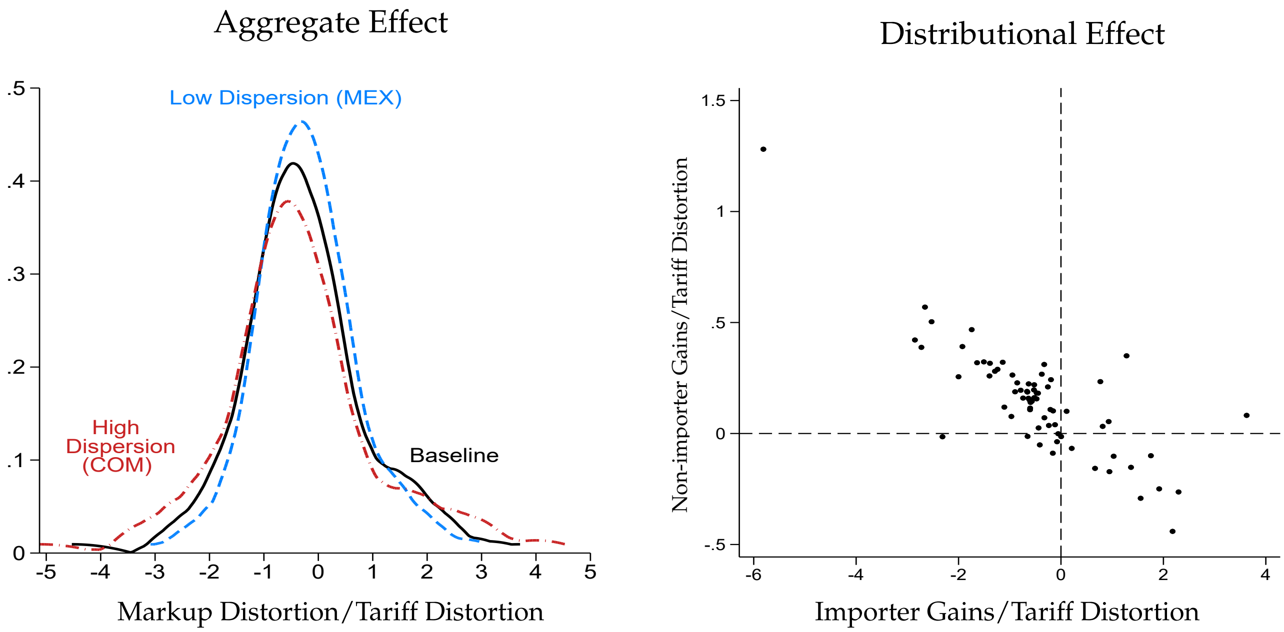
5.3 Correlation of Markup Distortions and Import Cost Changes

We documented above the dispersion of import cost changes and markup distortions in our sample. We now analyze the remaining component of allocative efficiency gains in equation (6): the within- and between-good correlation between import cost changes and markup distortions in each trade liberalization episode. Figure 12 presents the distribution across episodes of these correlations, with the left panel showing the between-good correlation and the right panel showing the within-good correlation across importers.

The right panel indicates that, across episodes, the within-good correlation is centered slightly above zero. In other words, the number of episodes in which import cost changes across firms importing the same good are positively correlated with their elasticity-adjusted markups is roughly equal to the number of episodes in which this correlation is negative.

In contrast, the between-good correlation is right-skewed. This suggests that in most episodes, tariff changes are more likely to be positively correlated with average markups

Figure 13: Welfare Gains from Allocative Efficiency



Note: Sample of 73 country-year pairs defined as liberalization episodes (excluding two episodes for which relative markup distortion is greater than 5). In the left panel, the black solid line is the density across episodes of the component of aggregate welfare changes associated with markup distortions (computed with (A.39)) normalized by the component associated with initial tariff distortions (computed with (A.40)). The blue dashed curve and the red dash-dotted curves denote the counterfactual densities that obtain by adjusting welfare effects by the ratio of the elasticity-adjusted markup dispersion of the episode's initial year and that of Mexico (low-dispersion) and Comoros (high-dispersion), respectively. The right panel is a scatter plot of the welfare gains for non-importers (y-axis) and importers (x-axis) associated with markup distortions, normalized by the component of the aggregate welfare change associated with tariff distortions.

across goods. That is, tariff reductions tend to be smaller for high-markup goods—those more distorted due to higher importer concentration. As a result, allocative efficiency tends to *worsen* in these episodes. Across all episodes, the median between-good correlation is 0.06, with the 10th and 90th percentiles at -0.11 and 0.20, respectively.

5.4 Effect of Tariff Changes on Allocative Efficiency

Finally, we combine the components above to measure how importer concentration affects welfare responses to tariff changes, as summarized by the expressions in Section 2.3.2. Specifically, the black solid line in the left panel of Figure 13 shows the distribution across episodes of the contribution of importer concentration to the welfare effect of tariff changes. We define this contribution as the component of aggregate welfare changes associated with markup distortions (computed using the version of (6) in (A.39)) normalized by the component associated with initial tariff distortions (computed using (A.40)).[40]

The density plot reveals that 77% of episodes experienced a deterioration in allocative efficiency due to importer concentration. This largely reflects the fact that, as discussed above, most episodes were characterized by smaller tariff reductions for goods with higher markups.[41]

Moreover, importer concentration makes a sizable contribution to the welfare effects of tariff changes. It exceeds the welfare gains from reductions in tariff distortions (in absolute value) in 34% of episodes and fully offsets those gains in 21% of episodes. Across all episodes, the median contribution of importer concentration (relative to that of tariff distortions) is –0.41, with the 10th and 90th percentiles at –2.02 and 1.22, respectively.

The left panel also displays two additional densities that illustrate how the size and income of a country affect the role of markup distortions in shaping welfare responses to tariff changes. For each country, we compute a counterfactual welfare response assuming it had the initial dispersion in markup distortions of either a richer, larger country (blue dashed curve, based on Mexico) or a poorer, smaller one (red dash-dotted curve, based on Comoros).[42] Under these counterfactual scenarios, the 10th and 90th percentiles of the welfare responses are –1.55 and 0.98 for the distribution based on the richer, larger country, and –2.71 and 1.50 for that based on the poorer, smaller country. These results highlight the quantitative importance of country size and income in determining the magnitude of markup distortions and, in turn, the welfare impact of tariff changes.

The right panel of Figure 13 further investigates the distributional effects of tariff changes arising from importer concentration. It presents a scatterplot of the welfare gains of importer owners (x-axis) against the contribution of importer concentration to the combined welfare of workers and non-importer owners (y-axis). Observations to the right of the dashed vertical line correspond to episodes in which importer owners experienced positive gains, while those above the dashed horizontal line represent episodes in which other agents benefited from reductions in markup distortions.

The figure reveals an efficiency-equity trade-off. Importer concentration generates

[40] Appendix Figure C.10 reports the relative contribution of importer concentration to the welfare effects of tariff changes for each country that experienced a trade liberalization episode. For each country, we consider the period between the initial and final years across all of its liberalization episodes.

[41] Appendix Figure C.9 shows that the between-good component of the aggregate welfare response is substantially larger than the within-good component (as defined by the two terms in (6)). This follows from three observations based on Figures 10–12: the dispersion and correlation of initial markup distortions and import cost changes are stronger between goods than within goods.

[42] Specifically, for each episode, we multiply each covariance term in the welfare response from (6) by an adjustment factor reflecting the ratio between the alternative country's dispersion in elasticity-adjusted markups and that of the country undergoing liberalization. Appendix Figure C.11 reports these adjustment factors separately for the within- and between-good components in (6).

welfare gains from tariff changes that mostly accrue to owners of importing firms, since their average domestic markup increases when import costs fall more for firms and goods with higher importer concentration. In fact, in most episodes, gains to importer firms were negative, as the majority of observations lie to the left of the vertical dashed line. In contrast, gains to other agents were predominantly positive, with most observations appearing above the horizontal dashed line. The key implication is that even when overall allocative efficiency declined, most of the losses were absorbed by owners of importing firms, while other agents gained.

Aggregate Import Responses. Appendix Figure C.12 evaluates the robustness of our findings when we allow for aggregate import responses generated by the extended model with an integrated labor market in a large economy.[43] Due to reallocation between domestic and importer firms, measurement requires taking a stance on the difference in their average markups. We report results under three assumptions: the average markup of domestic firms is equal to (i) the average markup of importers in their country, (ii) the minimum average importer markup in our sample, and (iii) the maximum average importer markup in our sample. Under the equal-markup assumption, the markup distortion contribution remains unchanged, but the neoclassical gains increase in proportion to the initial average tariff. This adjustment has only a modest effect on the importance of markup distortions, with the median distortion falling from –0.41 to –0.36. Under the two extreme assumptions, the median is –0.46 and –0.08, respectively.

Case Study: Romania vs Dominican Republic. Appendix C.3.2 illustrates the main mechanisms discussed above through two episodes: the Dominican Republic (DOM) joining CAFTA-DR in 2005 and Romania (ROU) joining the European Union in 2007. While both episodes yielded similar gains from reductions in tariff distortions, they differed markedly in terms of welfare responses associated with markup distortions: DOM experienced a gain of 1.4% of imports, whereas ROU saw a loss of 0.1%. Two factors explain this divergence. First, had ROU the same negative correlation between import cost changes and markup distortions as DOM, its allocative efficiency gain would have reached 1.1%. Second, as a larger and richer economy, ROU had lower importer concentration than DOM. If ROU also had DOM's dispersion in markup distortions, its allocative efficiency gain would have increased to 1.7%.

[43]Specifically, we implement the formulas in Appendix B.1.6, setting the elasticity of foreign export supply to zero—consistent with the lack of unit import value responses documented in Section 4—and the elasticity of foreign import demand to σ, consistent with the assumption of monopolistic exporter firms in the world market.

6 Conclusion

This paper studied the incidence of tariff changes in the presence of distortions created by the domestic market power of importing firms. We propose a model in which oligopolistic importing firms make strategic domestic pricing decisions based on their import shares. We show that a firm's strategic considerations are summarized by the elasticity of its imports to tariff changes, which depends on the firm's share of the country's imports among its competitors. Given firm-level pricing decisions, the incidence of tariff changes depends on both the between- and within-good covariance between import responses and initial markups.

To measure the contribution of importer concentration to the incidence of tariff changes, we assembled a dataset of firm-level imports from 57 countries. This dataset reveals that importer concentration is higher and more dispersed in poorer and smaller countries. Furthermore, we show that, relative to smaller importers of a given good, larger importers respond less to tariff cost changes and, through the lens of our model, conclude that they have higher domestic markups. By combining our estimates of initial markups and import responses, we decompose welfare responses to tariff changes into components associated with markup and tariff distortions. We find that both components are similar in magnitude, but markup distortions are more important in poorer and smaller countries due to their higher dispersion in importer concentration.

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A Theoretical Appendix

A.1 Equilibrium

Notation. Let $\mathcal{G}^D$, $\mathcal{G}^M$, and $\mathcal{G}^X$ denote the sets of domestic, importer, and exporter firm groups, respectively. Let $\mathcal{F}_g$ be the set of firms producing a variety of good g. The set of foreign varieties is denoted by $\mathcal{V}$.

Domestic Demand. Given preferences, utility maximization implies that domestic demand is given by

$$q_{gf} = (p_{gf})^{-\sigma}(P_g)^{\sigma-\eta}Q \quad \text{with} \quad (P_g)^{1-\sigma} = \sum_{f\in\mathcal{F}_g}(p_{gf})^{1-\sigma}, \tag{A.1}$$

$$Q = P^{\eta-1}E \quad \text{and} \quad P^{1-\eta} = \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}(P_g)^{1-\eta}. \tag{A.2}$$

Cost Minimization Problem. For domestic firms, the cost minimization problem implies that the marginal cost is

$$c_{gf} = w/a_{gf}. \tag{A.3}$$

For importer firms, the cost minimization problem under their production function,

$$Y_{gf} = \left[\sum_{v\in\mathcal{V}}(a_{vgf})^{\frac{1}{\theta}}(q_{vgf})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{A.4}$$

implies that the marginal cost is given by

$$c_{gf} \equiv \left[\sum_{v\in\mathcal{V}}(a_{vgf})(p_v)^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{A.5}$$

Firm f's imports of foreign variety v are given by

$$q_{vgf} = (a_{vgf})(p_v/c_{gf})^{-\theta}q_{gf}. \tag{A.6}$$

Profit Maximization of Domestic Sales. Conditional on its marginal cost c_{gf}, firm f sets its price optimally given the perceived domestic demand:

$$\Pi_{gf} \equiv \max_{p_{gf},q_{gf}}(p_{gf}-c_{gf})q_{gf} \quad \text{subject to (A.1)} \tag{A.7}$$

The first-order condition of (A.7) is

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

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

$$p_{gf} = \mu_{gf} c_{gf} \quad \text{such that} \quad \mu_{gf} = \frac{\varepsilon_{gf}}{\varepsilon_{gf} - 1} \tag{A.8}$$

where

$$\varepsilon_{gf} = \sigma - (\sigma - \eta) e_{gf} \quad \text{and} \quad e_{gf} = \frac{a_{gf}(p_{gf})^{1-\sigma}}{\sum_{f' \in \mathcal{F}_g} a_{gf'}(p_{gf'})^{1-\sigma}}, \tag{A.9}$$

Note that $\varepsilon_{gf} > 1$ because $\sigma \geq \eta > 1$. This guarantees that the second-order condition of the maximization problem holds.

We denote the firm's revenue and cost in equilibrium by $E_{gf} \equiv p_{gf} q_{gf}$ and $M_{gf} \equiv c_{gf} q_{gf}$, respectively.

Profit Maximization of Export Sales. Given world prices, exporters of variety v find it optimal to supply their endowment and receive profits of

$$\Pi_{gf} = p_v^W x_{gf} \quad \text{and} \quad x_{gf} = a_{gf} \bar{L}_{gf}^X \quad \text{for all} \quad g \in \mathcal{G}^X. \tag{A.10}$$

Budget Balance. The lump-sum transfer to workers and owners is

$$T = \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} \tau_v p_v^W q_{vgf}. \tag{A.11}$$

Labor Market Clearing. For each exporter firm, $L_{gf}^X = \bar{L}_{gf}^X$. For domestic firms,

$$\bar{L}^D = \sum_{g \in \mathcal{G}^D} \sum_{f \in \mathcal{F}_g} L_{gf}^D \tag{A.12}$$

Aggregate Expenditure. Expenditure is equal to income:

$$E = w\bar{L}^D + \sum_{g \in \mathcal{G}^M \cup \mathcal{G}^D \cup \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} \Pi_{gf} + T. \tag{A.13}$$

Equilibrium. Given tariffs and world prices $\{\tau_v, p_v^W\}_{v \in \mathcal{V}}$, the equilibrium is $\{p_{gf}, q_{gf}, c_{gf}\}_{f \in \mathcal{F}_g, g \in \mathcal{G}^D \cup \mathcal{G}^M}$ and $\{w, E\}$ such that:

(i) Consumers maximize their utility, as in (A.1)–(A.2);

(ii) Firms minimize their costs, as in (A.3)-(A.6);

(iii) Firms maximize their profits in domestic markets, as in (A.7)–(A.9);

(iv) Firms maximize their profits in export markets, as in (A.10);

(v) The government balances its budget, as in (A.11);

(vi) Domestic markets for labor and goods clear, as in (A.12)–(A.13).

A.2 Proofs of Section 2.2

Cross-firm variation in prices, markups, and sales. Holding constant the price index P_g, equation (A.8) implies that

$$\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = 1 + \frac{\partial \log \mu_{gf}}{\partial \log c_{gf}}$$

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

$$\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} = (\sigma - \varepsilon_{gf})(\sigma - 1)$$

Thus,

$$\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = 1 - \rho_{gf} \frac{\partial \log p_{gf}}{\partial \log c_{gf}} \implies \frac{\partial \log p_{gf}}{\partial \log c_{gf}} = \frac{1}{1+\rho_{gf}}$$

with

$$\rho_{gf} = \frac{(\sigma - \varepsilon_{gf})(\sigma - 1)}{\varepsilon_{gf}(\varepsilon_{gf}-1)}.$$

This implies that

$$\frac{\partial \log q_{gf}}{\partial \log c_{gf}} = -\sigma \frac{\partial \log p_{gf}}{\partial \log c_{gf}} = -\frac{\sigma}{1+\rho_{gf}}$$

$$\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} = \frac{\partial \log p_{gf}}{\partial \log c_{gf}} - 1 = -\frac{\rho_{gf}}{1+\rho_{gf}}$$

$$\frac{\partial \log E_{gf}}{\partial \log c_{gf}} = \frac{\partial \log p_{gf} q_{gf}}{\partial \log c_{gf}} = \frac{1-\sigma}{1+\rho_{gf}}$$

$$\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \frac{\partial \log c_{gf} q_{gf}}{\partial \log c_{gf}} = 1 - \frac{\sigma}{1+\rho_{gf}}$$

Note that $\sigma \geq \eta > 1$ implies that $\sigma \geq \varepsilon_{gf}$, $\rho_{gf} \geq 0$, $\frac{\partial \log p_{gf}}{\partial \log c_{gf}} \in (0,1]$, $\frac{\partial \log \mu_{gf}}{\partial \log c_{gf}} \in (-1,0]$, $\frac{\partial \log q_{gf}}{\partial \log c_{gf}} \in [-\sigma, 0)$, and $\frac{\partial \log E_{gf}}{\partial \log c_{gf}} \in [1-\sigma, 0)$. Finally, we note that

$$\frac{\partial \log M_{gf}}{\partial \log c_{gf}} = \frac{1-\sigma+\rho_{gf}}{1+\rho_{gf}} = \frac{\sigma-1}{1+\rho_{gf}} \left(\frac{(\sigma - \varepsilon_{gf})}{\varepsilon_{gf}(\varepsilon_{gf}-1)} - 1 \right) = \frac{\sigma-1}{1+\rho_{gf}} \frac{\sigma - (\varepsilon_{gf})^2}{\varepsilon_{gf}(\varepsilon_{gf}-1)},$$

which implies that $\frac{\partial \log M_{gf}}{\partial \log c_{gf}} < 0 \Leftrightarrow (\varepsilon_{gf})^2 > \sigma$. Since $\varepsilon_{gf} \in [\eta, \sigma]$, this condition is satisfied if $\eta < \sigma < \eta^2$.

Mapping from β^q_{gf} to μ_{gf}. To simplify notation, we drop subscripts for goods. The definition of β^q_f in Section 2.2 implies that

$$\beta^q_f = \frac{\sigma}{1 + \frac{(\sigma-\varepsilon_f)(\sigma-1)}{\varepsilon_f(\varepsilon_f-1)}},$$

which yields the following quadratic equation:

$$(\sigma - \beta^q_f)(\varepsilon_f)^2 - (1 - \beta^q_f)\sigma\varepsilon_f - \beta^q_f(\sigma - 1)\sigma = 0.$$

Since $\beta^q_f \in (0, \sigma]$, the positive real root is

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

If $\varepsilon_f > 1$, we can then compute $\mu_f = \varepsilon_f/(\varepsilon_f - 1)$. Thus, $\mu_f = \mathcal{M}(\beta^q_f)$ such that

$$\mathcal{M}(\beta) \equiv \frac{\varepsilon(\beta)}{\varepsilon(\beta) - 1} \tag{A.14}$$

where

$$\varepsilon(\beta) \equiv \frac{(1 - \beta)\sigma + \sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma}}{2(\sigma - \beta)}. \tag{A.15}$$

It only remains to show that $\varepsilon_f > 1$. Indeed, since $\beta \in (0, \sigma]$, $\varepsilon > 1$ is equivalent to

$$\begin{aligned}
2(\sigma - \beta) &< (1 - \beta)\sigma + \sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma} \\
2(\sigma - \beta) + (\beta - 1)\sigma &< \sqrt{((1 - \beta)\sigma)^2 + 4(\sigma - \beta)\beta(\sigma - 1)\sigma} \\
4(\sigma - \beta)\beta(\sigma - 1)\sigma &> ((\beta - 1)\sigma)^2 + 4(\beta - 1)\sigma(\sigma - \beta) + 4(\sigma - \beta)^2 - ((1 - \beta)\sigma)^2 \\
(\sigma - \beta)\beta(\sigma - 1)\sigma &> (\beta - 1)\sigma(\sigma - \beta) + (\sigma - \beta)^2 \\
\beta(\sigma - 1)\sigma &> (\beta - 1)\sigma + (\sigma - \beta) \\
\beta(\sigma - 1)\sigma &> \beta(\sigma - 1) \\
\sigma &> 1
\end{aligned}$$

A.3 Proofs of Section 2.3

We now derive the first-order approximation for the economy's response to an arbitrary change in tariffs τ_v and world import prices p^W_v.

A.3.1 Firm-level Responses

Let us write the price of each firm as an implicit function, $p_{gf} = \mathcal{P}_g(c_{gf}, P_g)$, characterized by the solution of

$$p_{gf} = \frac{\sigma - (\sigma - \eta)\left(\frac{p_{gf}}{P_g}\right)^{1-\sigma}}{\sigma - 1 - (\sigma - \eta)\left(\frac{p_{gf}}{P_g}\right)^{1-\sigma}} c_{gf}.$$

Thus, the total differentiation of this system implies that

$$\begin{aligned} d\log p_{gf} &= \tfrac{\partial \log p_{gf}}{\partial \log c_{gf}} d\log c_{gf} + \tfrac{\partial \log p_{gf}}{\partial \log P_g} d\log P_g \\ &= \tfrac{1}{1+\rho_{gf}} d\log c_{gf} + \tfrac{\partial \log p_{gf}}{\partial \log P_g} d\log P_g \end{aligned}$$

where we use the fact that $\frac{\partial \log p_{gf}}{\partial \log c_{gf}} = \frac{1}{1+\rho_{gf}}$.

To derive an expression for $\frac{\partial \log p_{gf}}{\partial \log P_g}$, we first note that

$$\begin{aligned} \frac{\partial \log p_{gf}}{\partial \log P_g} &= \frac{\partial \log \mu_{gf}}{\partial \log p_{gf}} \frac{\partial \log p_{gf}}{\partial \log P_g} + \frac{\partial \log \mu_{gf}}{\partial \log P_g} \\ &= -\frac{1}{\varepsilon_{gf}(\varepsilon_{gf} - 1)} \left(\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} \frac{\partial \log p_{gf}}{\partial \log P_g} + \frac{\partial \varepsilon_{gf}}{\partial \log P_g} \right) \\ &= -\frac{(\sigma - \varepsilon_{gf})(\sigma - 1)}{\varepsilon_{gf}(\varepsilon_{gf} - 1)} \left(\frac{\partial \log p_{gf}}{\partial \log P_g} - 1 \right) \\ &= -\rho_{gf} \left(\frac{\partial \log p_{gf}}{\partial \log P_g} - 1 \right) \\ &= \frac{\rho_{gf}}{1 + \rho_{gf}} = 1 - \frac{1}{1 + \rho_{gf}} \end{aligned}$$

where the third row uses the expression derived above, $\frac{\partial \varepsilon_{gf}}{\partial \log p_{gf}} = -\frac{\partial \varepsilon_{gf}}{\partial \log P_g} = (\sigma - \varepsilon_{gf})(\sigma - 1)$; and the fourth row uses the definition of ρ_{gf}.

This implies that

$$d\log p_{gf} = \beta^p_{gf} d\log c_{gf} + (1 - \beta^p_{gf}) d\log P_g$$

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

Thus,

$$\begin{aligned} d\log P_g &= \textstyle\sum_{f \in \mathcal{F}_g} e_{gf} d\log p_{gf} \\ &= \textstyle\sum_{f \in \mathcal{F}_g} e_{gf} \beta^p_{gf} d\log c_{gf} + \sum_{f \in \mathcal{F}_g} e_{gf} (1 - \beta^p_{gf}) d\log P_g \\ &= \textstyle\sum_{f \in \mathcal{F}_g} \omega_{gf} d\log c_{gf} \end{aligned}$$

which implies that

$$d\log P_g = d\log c_g \equiv \sum_{f \in \mathcal{F}_g} \omega_{gf} d\log c_{gf} \quad \text{and} \quad \omega_{gf} \equiv \frac{e_{gf} \beta^p_{gf}}{\sum_{f' \in \mathcal{F}_g} e_{gf'} \beta^p_{gf'}}. \tag{A.16}$$

We also have that

$$\begin{aligned} d\log\mu_{gf} &= d\log p_{gf} - d\log c_{gf} \\ &= (\beta^{p}_{gf} - 1)\left(d\log c_{gf} - d\log P_g\right) \end{aligned}$$

Thus,

$$d\log\mu_{gf} = -\beta^{\mu}_{gf}\left(d\log c_{gf} - d\log c_g\right) \tag{A.17}$$

where we use the fact that $\beta^{\mu}_{gf} = (1-\beta^{p}_{gf})$.

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

$$\begin{aligned} d\log q_{gf} &= -\sigma d\log p_{gf} + (\sigma-\eta) d\log P_g + d\log Q \\ &= \left(-\sigma\tfrac{1}{1+\rho_{gf}}\right) d\log c_{fg} - \sigma\left(1 - \tfrac{1}{1+\rho_{gf}}\right) d\log P_g + (\sigma-\eta) d\log P_g + d\log Q \\ &= \left(-\sigma\tfrac{1}{1+\rho_{gf}}\right)\left(d\log c_{gf} - d\log P_g\right) - \eta d\log P_g + d\log Q \end{aligned}$$

Thus,

$$d\log q_{gf} = -\beta^{q}_{gf}(d\log c_{gf} - d\log c_g) - \eta d\log c_g + d\log Q \tag{A.18}$$

where $\beta^{q}_{gf} = \sigma\beta^{p}_{gf}$.

Note that we can write

$$\omega_{gf} \equiv \frac{e_{gf}\beta^{p}_{gf}}{\sum_{f'\in\mathcal{F}_g} e_{gf'}\beta^{p}_{gf'}} = \frac{M_{gf}\mu_{gf}\beta^{q}_{gf}}{\sum_{f'\in\mathcal{F}_g} M_{gf'}\mu_{gf'}\beta^{q}_{gf'}} \tag{A.19}$$

where we use $e_{gf} = E_{gf}/E_g = \mu_{gf}M_{gf}/E_g$.

Domestic Firms. For all $g \in \mathcal{G}^D$, (A.3) implies that $d\log c_{gf} = d\log w$ and, thus, $d\log P_g = d\log p_{gf} = d\log w$. Using (A.18), we have that

$$d\log q_{gf} = d\log q^D \equiv -\eta d\log w + d\log Q \quad \text{for all} \quad g \in \mathcal{G}^D. \tag{A.20}$$

Importer Firms. For all $g \in \mathcal{G}^M$, (A.5) implies that

$$d\log c_{gf} = \sum_{v\in\mathcal{V}} m_{vgf} d\log p_v \tag{A.21}$$

with $m_{vgf} \equiv p_v q_{vgf}/M_{gf}$ defined as the share of firm f's imports of variety v, and

$$d\log p_v = d\log(1+\tau_v) + d\log p^W_v.$$

Equation (A.6) implies that

$$d\log q_{vgf} = -\theta(d\log p_v - d\log c_{gf}) + d\log q_{gf}. \tag{A.22}$$

Equation (A.18) implies that

$$d\log q_{gf} = -\beta^{q}_{gf}(d\log c_{gf} - d\log c_{g}) - \eta d\log c_{g} + d\log Q. \tag{A.23}$$

A.3.2 Aggregate Responses

The price index is given by

$$d\log P \quad = \quad (1-e^{M})d\log w + e^{M}d\log c^{M} \tag{A.24}$$

where $e^{M} \equiv E^{M}/E$, $E^{M} \equiv \sum_{g\in\mathcal{G}^{M}} E_{g}$, $E_{g} \equiv M_{g}\bar{\mu}_{g}$, $\bar{\mu}_{g} \equiv \sum_{f\in\mathcal{F}_{g}} M_{gf}\mu_{gf}/M_{g}$, $M_{g} \equiv \sum_{f\in\mathcal{F}_{g}} M_{gf}$, and

$$d\log c^{M} \equiv \sum_{g\in\mathcal{G}^{M}} \frac{M_{g}\bar{\mu}_{g}}{\sum_{g'\in\mathcal{G}^{M}} M_{g'}\bar{\mu}_{g'}} d\log c_{g}. \tag{A.25}$$

We now solve for aggregate variable in terms of the change in the economy's aggregate real spending, $C = E/P$. Note that

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta(1-e^{M})d\log w + \eta e^{M}d\log c^{M} + d\log C \end{aligned}$$

Equations (A.20) and (A.23) imply that

$$d\log q^{D} = -\eta e^{M}(d\log w - d\log c^{M}) + d\log C \tag{A.26}$$

$$d\log q_{gf} = -\beta^{q}_{gf}(d\log c_{gf} - d\log c_{g}) - \eta(d\log c_{g} - d\log c^{M}) + \eta(1-e^{M})\left(d\log w - d\log c^{M}\right) + d\log C \tag{A.27}$$

We now use the labor market clearing condition to solve for $d\log w$ as a function of $d\log C$. From the labor market clearing condition in (A.12),

$$0 \quad = \quad \sum_{g\in\mathcal{G}^{D}} \sum_{f\in\mathcal{F}_{g}} L^{D}_{gf} d\log q_{gf} = d\log q^{D},$$

which combined with (A.26) implies that

$$d\log w = d\log c^{M} + \frac{1}{\eta e^{M}} d\log C \tag{A.28}$$

Also, we can plug (A.28) into (A.27) to get that

$$d\log q_{gf} = -\beta^{q}_{gf}(d\log c_{gf} - d\log c_{g}) - \eta(d\log c_{g} - d\log c^{M}) + \frac{1}{e^{M}} d\log C. \tag{A.29}$$

A.3.3 Aggregate Welfare Effect

Price index. Let us write the change in the price index as

$$d\log P = \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{p_{gf}q_{gf}}{E}(d\log\mu_{gf}+d\log c_{gf}). \tag{A.30}$$

Profits. For every firm, we can write:

$$d\Pi_{gf} = q_{gf}(dp_{gf}-dc_{gf})+(p_{gf}-c_{gf})dq_{gf},$$

which implies that

$$d\Pi_{gf} = p_{gf}q_{gf}\left(d\log\mu_{gf}+(1-1/\mu_{gf})(d\log c_{gf}+d\log q_{gf})\right). \tag{A.31}$$

For importer firms, using $p_{gf}q_{gf}=\mu_{gf}M_{gf}$, (A.31) implies that

$$d\Pi^M \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}d\Pi_{gf} = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}M_{gf}\left(\mu_{gf}d\log\mu_{gf}+(\mu_{gf}-1)(d\log c_{gf}+d\log q_{gf})\right). \tag{A.32}$$

For domestic firms, $d\log\mu_{gf}=d\log q_{gf}=0$ for all $g\in\mathcal{G}^D$, so (A.31) implies that

$$d\Pi^D = \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}d\Pi_{fg} = \Pi^D d\log w \tag{A.33}$$

with $\Pi^D \equiv \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}$.

For exporter firms, profits do not change as world prices and endowments remain constant:

$$d\Pi^X = \sum_{g\in\mathcal{G}^X}\sum_{f\in\mathcal{F}_g}d\Pi_{gf} = 0. \tag{A.34}$$

Tariff revenue. The expression for tariff revenue in (A.11) implies that

$$dT = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}}\left(\tau_v p_v^W dq_{vgf}+q_{vgf}d(\tau_v p_v^W)\right). \tag{A.35}$$

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

$$dC \equiv Ed\log C = dE - Ed\log P = dw\bar{L}^D + d\Pi^M + d\Pi^D + d\Pi^X + dT - Ed\log P.$$

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

$$\begin{array}{rcc} dC & = & d\log w\left(\sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} c_{gf}q_{gf}\right) \\ & + & \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} q_{gf}p_{gf}\left(d\log\mu_{gf}+(1-1/\mu_{gf})(d\log c_{gf}+d\log q_{gf})\right) \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}}\left(\tau_{vg}p_v^W dq_{vgf}+q_{vgf}d(\tau_v p_v^W)\right) \\ & - & \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(p_{gf}q_{gf})\left(d\log\mu_{gf}+d\log c_{gf}\right) \end{array}$$

where we use expressions (A.12) for $\bar{L}^D$, (A.31) for $d\Pi^M$ and $d\Pi^D$, (A.34) for $d\Pi^X$, (A.35) for dT, and (A.30) for dP.

Manipulating this expression, we get that

$$\begin{array}{rcc} dC & = & \sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}}\tau_v p_v^W q_{vgf}d\log q_{vgf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}d\log c_{gf} \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} q_{vgf}d(\tau_v p_v^W) \end{array}$$

Using the expression in (A.21) to substitute for $d\log c_{gf}$ of importer firms in any $g\in\mathcal{G}^M$, the expression above becomes

$$\begin{array}{rcc} dC & = & \sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}}\tau_v p_v^W q_{vgf}d\log q_{vgf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} q_{vgf}\left(d(\tau_v p_v^W)-dp_v\right) \end{array}$$

Since $dp_v = d((1+\tau_v)p_v^W) = dp_v^W + d(\tau_v p_v^W)$, this expression is equivalent to

$$\begin{array}{rcc} dC & = & \sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}}\tau_v p_v^W q_{vgf}d\log q_{vgf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} p_v^W q_{vgf}d\log p_v^W \end{array}$$

Note that, by definition, $\Pi_{gf} = q_{gf}(p_{gf}-c_{gf}) = q_{gf}c_{gf}(\mu_{gf}-1)$, $T_{vgf} = \tau_v p_v^W q_{vgf}$, and $V_{vgf} \equiv p_v^W q_{vgf}$. Thus,

$$\begin{array}{rcc} dC & = & \sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf} \\ & + & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{c\in\mathcal{V}} T_{vgf}d\log q_{vgf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} V_{vgf}d\log p_v^W \end{array} \tag{A.36}$$

We now obtain another expression for real spending in terms of shocks. By plugging $d\log q_{gf} = 0$ for all $g\in\mathcal{G}^D$ and $d\log q_{vgf}$ in (A.22) into (A.36):

$$\begin{array}{rcc} dC & = & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})d\log q_{gf} \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} T_{vgf}\theta(d\log p_v - d\log c_{gf}) \\ & - & \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} V_{vgf}d\log p_v^W \end{array} \tag{A.37}$$

with $T_{gf} \equiv \sum_{v \in \mathcal{V}} T_{vgf}$.

Using (A.29), this expression becomes

$$\begin{aligned} dC &= \tfrac{\Pi^M + T}{E^M} E d\log C \\ &- \sum_{g \in \mathcal{G}^M} (\Pi_g + T_g) \eta (d\log c_g - d\log c^M) \\ &- \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} (\Pi_{gf} + T_{gf}) \beta^q_{gf} (d\log c_{gf} - d\log c_g) \\ &- \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} T_{vgf} \theta (d\log p_v - d\log c_{gf}) \\ &- \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} V_{vgf} d\log p^W_v \end{aligned}$$

with $\Pi_g = \sum_{f \in \mathcal{F}_g} \Pi_{gf}$, $T_g = \sum_{f \in \mathcal{F}_g} T_{gf}$, $\Pi^M \equiv \sum_{g \in \mathcal{G}^M} \Pi_g$ and $T = \sum_{g \in \mathcal{G}^M} T_g$.

Note that

$$\left(1 - \frac{\Pi^M + T}{E^M}\right) = \left(E^M - \Pi^M - T\right) \frac{1}{E^M} = \frac{V}{E^M} = \frac{1}{E^M/M} \frac{1}{M/V}$$

where we use the fact that $\Pi^M = E^M - M$, $M \equiv \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} p_v q_{vgf}$, $V \equiv \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} p^W_v q_{vgf}$, and $M = V + T$.

Thus,

$$\begin{aligned} dC = &-\chi \sum_{g \in \mathcal{G}^M} (\Pi_g + T_g) \eta (d\log c_g - d\log c^M) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} (\Pi_{gf} + T_{gf}) \beta^q_{gf} (d\log c_{gf} - d\log c_g) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} T_{vgf} \theta (d\log p_v - d\log c_{gf}) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} V_{vgf} d\log p^W_v \end{aligned} \tag{A.38}$$

where $\chi \equiv \bar{\mu}(1 + \bar{\tau})$, with $\bar{\mu} \equiv E^M/M = \sum_{g \in \mathcal{G}^M} M_g \bar{\mu}_g / M$ and $\bar{\tau} \equiv T/V$.

We now split this equation into three parts. The first is the component associated with markup distortions (MD):

$$\begin{aligned} dC^{\text{MD}} = &-\chi \sum_{g \in \mathcal{G}^M} \Pi_g \eta (d\log c_g - d\log c^M) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \Pi_{gf} \beta^q_{gf} (d\log c_{gf} - d\log c_g). \end{aligned} \tag{A.39}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} dC^{\text{TD}} = &-\chi \sum_{g \in \mathcal{G}^M} T_g \eta (d\log c_g - d\log c^M) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} T_{gf} \beta^q_{gf} (d\log c_{gf} - d\log c_g) \\ &-\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} T_{vgf} \theta (d\log p_v - d\log c_{gf}) \end{aligned} \tag{A.40}$$

The last term is the change in terms of trade associated with the change in world prices:

$$dC^{\text{ToT}} = -\chi \sum_{g \in \mathcal{G}^M} \sum_{f \in \mathcal{F}_g} \sum_{v \in \mathcal{V}} V_{vgf} d\log p^W_v \ . \tag{A.41}$$

Note that, by construction,

$$dC = dC^{\text{MD}} + dC^{\text{TD}} + dC^{\text{ToT}}.$$

We now re-write dC^{MD} in terms of markup dispersion. Given the definitions in (A.19) and (A.25), $\sum_{g\in\mathcal{G}^M} M_g\mu_g(d\log c_g - d\log c^M) = \sum_{f\in\mathcal{F}_g} M_{gf}\mu_{gf}\beta^q_{gf}(d\log c_{gf} - d\log c_g) = 0$. Thus, (A.39) becomes

$$\begin{aligned} dC^{\text{MD}} &= \chi \textstyle\sum_{g\in\mathcal{G}^M} M_g\eta(d\log c_g - d\log c^M) \\ &+ \chi \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}(d\log c_{gf} - d\log c_g). \end{aligned}$$

Substituting for the definitions of $d\log c^M$ and $d\log c_g$, we get that

$$\begin{aligned} dC^{\text{MD}} &= \chi\left[\textstyle\sum_{g\in\mathcal{G}^M} M_g\eta d\log c_g - \sum_{g\in\mathcal{G}^M}\frac{M_g\mu_g}{\sum_{g'\in\mathcal{G}^M} M_{g'}\mu_{g'}/\sum_{g'\in\mathcal{G}^M} M_{g'}}\eta d\log c_g\right] \\ &+ \chi\textstyle\sum_{g\in\mathcal{G}^M}\left[\sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf} d\log c_{gf} - \sum_{f\in\mathcal{F}_g}\frac{M_{gf}\beta^q_{gf}\mu_{gf}}{\sum_{f'\in\mathcal{F}_g} M_{gf'}\beta^q_{gf'}\mu_{gf'}/\sum_{f'\in\mathcal{F}_g} M_{gf'}\beta^q_{gf'}} d\log c_{gf}\right]. \end{aligned}$$

By defining $\bar{\mu}^q_g \equiv \sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}\mu_{gf}/\sum_{f\in\mathcal{F}_g} M_{gf}\beta^q_{gf}$, the expression above becomes

$$\begin{aligned} dC^{\text{MD}} &= \chi\textstyle\sum_{g\in\mathcal{G}^M}\left(1 - \frac{\bar{\mu}_g}{\bar{\mu}}\right) M_g\eta d\log c_g \\ &+ \chi\textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(1 - \frac{\mu_{gf}}{\bar{\mu}^q_g}\right) M_{gf}\beta^q_{gf} d\log c_{gf}. \end{aligned}$$

Given that $\chi = \bar{\mu}(1+\bar{\tau})$, $m_g = M_g/M$ and $m_{gf} = M_{gf}/M_g$, this expression is equivalent to

$$\begin{aligned} dC^{\text{MD}}/M = &- (1+\bar{\tau})\textstyle\sum_{g\in\mathcal{G}^M} m_g\left(\bar{\mu}_g - \bar{\mu}\right)\eta d\log c_g \\ &- (1+\bar{\tau})\textstyle\sum_{g\in\mathcal{G}^M} m_g\frac{\bar{\mu}}{\bar{\mu}^q_g}\sum_{f\in\mathcal{F}_g} m_{gf}\left(\mu_{gf} - \bar{\mu}^q_g\right)\beta^q_{gf} d\log c_{gf}. \end{aligned}$$

For any variable z, we define $E_g[z_g] = \sum_{g\in\mathcal{G}^M} m_g z_g$ and $\mathbb{E}_{f|g}[z_{gf}] = \sum_{f\in\mathcal{F}_g} m_{gf}z_{gf}$. Thus,

$$\begin{aligned} dC^{\text{MD}}/M = &- (1+\bar{\tau})E_g\left[\left(\bar{\mu}_g - \bar{\mu}\right)\eta d\log c_g\right] \\ &- (1+\bar{\tau})E_g\left[\frac{\bar{\mu}}{\bar{\mu}^q_g}\mathbb{E}_{f|g}\left[\left(\mu_{gf} - \bar{\mu}^q_g\right)\beta^q_{gf} d\log c_{gf}\right]\right]. \end{aligned}$$

Note that, by definition, $\mathbb{E}_g[\bar{\mu}_g - \bar{\mu}] = \sum_{g\in\mathcal{G}^M} m_g\left(\bar{\mu}_g - \bar{\mu}\right) = 0$ and $\mathbb{E}_{f|g}[\left(\mu_{gf} - \bar{\mu}^q_g\right)\beta^q_{gf}] = \sum_{f\in\mathcal{F}_g} m_{gf}\left(\mu_{gf} - \bar{\mu}^q_g\right)\beta^q_{gf} = 0$. For any variables z and x, we define $Cov_g[z_g, x_g] = E_g[z_g x_g] - E_g[z_g]E_g[x_g]$ and $Cov_{f|g}[z_{gf}, x_{gf}] = \mathbb{E}_{f|g}[z_{gf}x_{gf}] - \mathbb{E}_{f|g}[z_{gf}]\mathbb{E}_{f|g}[x_{gf}]$. Thus,

$$\begin{aligned} dC^{\text{MD}}/M = &- (1+\bar{\tau})Cov_g\left[\left(\bar{\mu}_g - \bar{\mu}\right)\eta,\ d\log c_g\right] \\ &- (1+\bar{\tau})E_g\left[\frac{\bar{\mu}}{\bar{\mu}^q_g}Cov_{f|g}\left[\left(\mu_{gf} - \bar{\mu}^q_g\right)\beta^q_{gf},\ d\log c_{gf}\right]\right]. \end{aligned} \tag{A.42}$$

This expression is equivalent to (6) when we consider tariff changes in an economy for which initial tariffs are equal to zero, so that $\bar{\tau} = 0$ and $dC^{\text{MD}}/M = dC/M$.

A.3.4 Distributional Welfare Effect

Given that $\Pi^M = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf} = \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} q_{gf}(p_{gf}-c_{gf})$, the change in import profits is

$$\begin{aligned}
\frac{d\Pi^M}{M} &= \frac{1}{M}\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(p_{gf}-c_{gf})dq_{gf} + \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{q_{gf}}{M}(dp_{gf}-dc_{gf}) \\
&= \frac{dC^{\mathrm{MD}}}{M} + \sum_{g\in\mathcal{G}^M} m_g \sum_{f\in\mathcal{F}_g} m_{gf}(d\mu_{gf} + (\mu_{gf}-1)d\log c_{gf}) \\
&= \frac{dC^{\mathrm{MD}}}{M} + E_g\left[E_{f|g}\left[d\mu_{gf}\right]\right] + E_g\left[E_{f|g}\left[(\mu_{gf}-1)d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} - E_g\left[E_{f|g}\left[\mu_{gf}\beta^{\mu}_{gf}(d\log c_{gf} - d\log c_g)\right]\right] + E_g\left[E_{f|g}\left[(\mu_{gf}-1)d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} - E_g\left[E_{f|g}\left[\mu_{gf}(1-\beta^{q}_{gf}/\sigma)(d\log c_{gf} - d\log c_g)\right]\right] + E_g\left[E_{f|g}\left[(\mu_{gf}-1)d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} - E_g\left[E_{f|g}\left[\mu_{gf}(d\log c_{gf} - d\log c_g)\right]\right] + E_g\left[E_{f|g}\left[(\mu_{gf}-1)d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} - E_g\left[E_{f|g}\left[d\log c_{gf}\right] - \bar{\mu}_g d\log c_g\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} + E_g\left[(\bar{\mu}_g-1)d\log c_g\right] + E_g\left[d\ln c_g - E_{f|g}\left[d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} + E_g\left[(\bar{\mu}_g-1)d\log c_g\right] + E_g\left[\frac{E_{f|g}[\mu_{gf}\beta^q_{gf}d\log c_{gf}] - E_{f|g}\left[d\log c_{gf}\right]E_{f|g}[\mu_{gf}\beta^q_{gf}]}{E_{f|g}[\mu_{gf}\beta^q_{gf}]}\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} + E_g\left[(\bar{\mu}_g-1)d\log c_g\right] + E_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}^q_g}\frac{\beta^q_{gf}}{\bar{\beta}^q_g}, d\log c_{gf}\right]\right]
\end{aligned}$$

where the second row uses the definitions of dC^{MD}, $p_{gf} = \mu_{gf}c_{gf}$ and $M_{gf} = c_{gf}q_{gf}$, the third row uses the definitions of $E_g[.]$ and $E_{f|g}[.]$, the fourth row uses the expression for markup changes in (3), the fifth row uses the definition of β^{μ}_{gf} in (4), the sixth row uses the fact that $d\log c_g = E_{f|g}[\mu_{gf}\beta^q_{gf}d\log c_{gf}]/E_{f|g}[\mu_{gf}\beta^q_{gf}]$, the seventh row uses the definition of $\bar{\mu}_g = E_{f|g}[\mu_{gf}]$, the remaining row use the definitions of $d\ln c_g$, $\bar{\mu}^q_g$, and $\bar{\beta}^q_g$.

The change in the equivalent variation of owners of importer firms is $dC^M = d\Pi^M - \Pi^M d\log P$. So,

$$\begin{aligned}
\frac{dC^M}{M} &= \frac{d\Pi^M}{M} - \frac{\Pi^M}{M}\left(d\log c^M + \frac{1-e^M}{\eta e^M}d\log C\right) \\
&= \frac{d\Pi^M}{M} - (\bar{\mu}-1)\left(\sum_g \frac{\bar{\mu}_g M_g}{\bar{\mu}M}d\log c_g + \frac{1-\bar{\mu}m}{\eta\bar{\mu}}\frac{E}{M}d\log C\right) \\
&= \frac{d\Pi^M}{M} - \left(1-\frac{1}{\bar{\mu}}\right)E_g[\bar{\mu}_g d\log c_g] - \lambda\frac{dC}{M} \\
&= \frac{dC^{\mathrm{MD}}}{M} - \lambda\frac{dC}{M} + E_g\left[\left(\frac{\bar{\mu}_g}{\bar{\mu}}-1\right)d\log c_g\right] + \mathbb{E}_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}^q_g}\frac{\beta^q_{gf}}{\bar{\beta}^q_g}, d\log c_{gf}\right]\right] \\
&= \frac{dC^{\mathrm{MD}}}{M} - \lambda\frac{dC}{M} + Cov_g\left[\frac{\bar{\mu}_g}{\bar{\mu}}, d\log c_g\right] + \mathbb{E}_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}^q_g}\frac{\beta^q_{gf}}{\bar{\beta}^q_g}, d\log c_{gf}\right]\right]
\end{aligned}$$

where the first equality uses the expression for $d\log P$ implied by (A.24) and (A.28), the second row uses the definitions of $\Pi^M = (\bar{\mu}-1)M$, $m = M/E$, and $d\log c^M$ in (A.25), the third row uses the definition $\lambda \equiv (\bar{\mu}-1)(1-\bar{\mu}m)/\eta\bar{\mu} \in (0,1)$, and the fourth row uses the expression for $d\Pi^M/M$ above, and the last row uses the fact that $\bar{\mu} = E_g[\bar{\mu}_g]$.

Thus,

$$\frac{dC^M}{M} = \frac{dC^{\mathrm{MD}}}{M} - \lambda\frac{dC}{M} + Cov_g\left[\frac{\bar{\mu}_g}{\bar{\mu}}, d\log c_g\right] + \mathbb{E}_g\left[Cov_{f|g}\left[\frac{\mu_{gf}}{\bar{\mu}^q_g}\frac{\beta^q_{gf}}{\bar{\beta}^q_g}, d\log c_{gf}\right]\right] \tag{A.43}$$

Note that, starting from the equilibrium with no tariffs, $\frac{dC^{\text{MD}}}{M} = \frac{dC}{M}$ and the expression above yields the expression for $\frac{dC^M}{M}$ in (8).

For completeness, we now derive the equivalent variation for other agents. Consider first the change in the real wage of domestic workers:

$$\begin{aligned} d\log w\bar{L}^D/P &= d\log w - d\log P \\ &= e^M(d\log w - d\log c^M) \\ &= \tfrac{1}{\eta} d\log C. \end{aligned}$$

which implies that $dC^L \equiv dw\bar{L}^D - w\bar{L}d\log P$ is given by

$$\frac{dC^L}{M} = \frac{w\bar{L}^D}{E}\frac{1}{\eta}\frac{dC}{M}.$$

Note also that (A.33) and $d\log\mu_{gf} = d\log q_{gf} = 0$ implies that $d\log\Pi^D = d\log w$. Thus, $dC^D \equiv d\Pi^D - \Pi^D d\log P$ is given by

$$\frac{dC^D}{M} = \frac{\Pi^D}{E}\frac{1}{\eta}\frac{dC}{M}.$$

Together, these expressions imply that

$$\frac{dC^L + dC^D}{M} = \frac{e^D}{\eta}\frac{dC}{M} = \frac{1-\bar{\mu}m}{\eta}\frac{dC}{M}.$$

Note that profits of importer firms remain constant, so that $dC^X = d\Pi^X - \Pi^X d\log P$ is

$$\begin{aligned} \tfrac{dC^X}{M} &= -\tfrac{\Pi^X}{M}\left(d\log c^M + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \\ &= -\tfrac{V}{M}\left(\mathbb{E}_g\left[\tfrac{\bar{\mu}_g}{\bar{\mu}}d\log c_g\right] + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right). \\ &= -\tfrac{1}{1+\bar{\tau}}\left(\mathbb{E}_g\left[\tfrac{\bar{\mu}_g}{\bar{\mu}}d\log c_g\right] + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \end{aligned}$$

where the second row uses trade balance ($\Pi^X = X = V$) and the definition of $d\log c^M$ in (A.25), and the third row uses the definition of $\bar{\tau}$.

The change in government transfers is $dC^T/M = dT/M - (T/M)d\log P$. Thus,

$$\begin{aligned} \tfrac{dC^T}{M} &= \tfrac{dT}{M} - \tfrac{T}{M}\left(d\log c^M + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \\ &= \tfrac{1}{M}\sum_g\sum_f\sum_{v\in\mathcal{V}}(q_{vgf}d\tau_v + dq_{vgf}\tau_v) - \tfrac{M-V}{M}\left(\mathbb{E}_g\left[\tfrac{\bar{\mu}_g}{\bar{\mu}}d\log c_g\right] + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \\ &= \tfrac{dC^{TD}}{M} + \tfrac{1}{M}\sum_g\sum_f q_{gf}dc_{gf} - \tfrac{M-V}{M}\left(\mathbb{E}_g\left[\tfrac{\bar{\mu}_g}{\bar{\mu}}d\log c_g\right] + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \\ &= \tfrac{dC^{TD}}{M} + \mathbb{E}_g\left[\mathbb{E}_{f|g}\left[d\log c_{gf}\right]\right] - \tfrac{\bar{\tau}}{1+\bar{\tau}}\left(\mathbb{E}_g\left[\tfrac{\bar{\mu}_g}{\bar{\mu}}d\log c_g\right] + \tfrac{1-\bar{\mu}m}{\eta\bar{\mu}}\tfrac{dC}{M}\right) \end{aligned}$$

where the second row uses the definitions of government revenue T in (A.11) and $d\log c^M$ in

(A.25), the third row uses the definition of $\frac{dC^{TD}}{M}$ and the fact that change in costs of importer firms, $q_{gf}dc_{gf} = \sum_{v\in\mathcal{V}} q_{vgf}dp_v = \sum_{v\in\mathcal{V}} q_{vgf}d\tau_v$, and the last row uses the definitions of $\mathbb{E}_g[.]$, $\mathbb{E}_{f|g}[.]$ and $\bar{\tau}$.

A.3.5 Measurement

For any given set of shocks $d\log p_v$ and $d\log p_v^W$, we can compute dC in (A.38) and its three components in (A.39), (A.40), and (A.41) with the following variables: (i) mapping of firms to groups; (ii) firm-level custom data, $\{M_{vgf}, T_{vgf}\}$; (iii) the elasticity parameters $\{\eta, \theta\}$; and (iv) the elasticity function, $\beta^q(m)$.

First, note that $\sigma = \beta^q(0)$ and $\beta^q_{gf} = \beta^q(m_{gf})$, with $m_{gf} = M_{gf}/M_g$, $M_{gf} = \sum_{v\in\mathcal{V}} M_{vgf}$ and $M_g = \sum_{f\in\mathcal{F}_g} M_{gf}$. We can then use the mapping in (A.14) to compute μ_{gf} as a function of β^q_{gf} and σ. This allows us to compute firm-level variables: profits, $\Pi_{gf} = (\mu_{gf}-1)M_{gf}$, domestic expenditure, $E_{gf} = \mu_{gf}M_{gf}$, and taxes, $T_{gf} = \sum_{v\in\mathcal{V}} T_{vgf}$. Similarly, we can aggregate firm-level variables to compute their good-level and aggregate counterparts: $\Pi_g = \sum_{f\in\mathcal{F}_g}\Pi_{gf}$, $T_g = \sum_{f\in\mathcal{F}_g} T_{gf}$, $\mathbb{E}_g \equiv \sum_{f\in\mathcal{F}_g} E_{gf}$, $M \equiv \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_{v\in\mathcal{V}} M_{vgf}$, $E^M \equiv \sum_{g\in\mathcal{G}^M}\mathbb{E}_g$, $T = \sum_{g\in\mathcal{G}^M} T_g$, $V = M - T$, $\bar{\mu} \equiv E^M/M$ and $\bar{\tau} \equiv T/V$.

We can compute $d\log c_{gf}$ using (A.21) with $m_{vgf} = M_{vgf}/M_{gf}$, $d\log c_g$ using (A.16) with $\omega_{gf} \equiv \mu_{gf}m^q_{gf}/\sum_{f'\in\mathcal{F}_g}\mu_{gf'}m^q_{gf'}$ and $m^q_{gf} \equiv M_{gf}\beta_{gf}/\sum_{f'\in\mathcal{F}_g} M_{gf'}\beta_{gf'}$, and $d\log c^M$ using (A.25).

Finally, note that knowledge of the import-to-expenditure ratio, $m = M/E$, implies that we can also compute dC^M/M, dC^T/M, dC^X/M, and $(dC^L + dC^D)/M$.

B Extensions

B.1 Large Economy with Integrated Labor Market

B.1.1 Environment

We maintain the same structure of preferences and production of the baseline model, but we now consider two extensions.

Foreign Offer Curve. We assume that firms in the country face log-linear foreign demand and supply curves, similar to the specifications in Broda et al. (2008) and Fajgelbaum et al. (2020). Given a price of p_{gf}, the demand for exported variety v of good $g \in \mathcal{G}^X$ supplied by firm f is given by

$$q_{vgf} = a^W_{vgf}(p_{vgf})^{-\sigma^W} \tag{B.1}$$

where a^W_{gf} is a demand shifter, and $\sigma^W > 0$ is the export demand elasticity.

We also assume that, given imports of q^W_{vgf}, the inverse supply curve faced by variety v of good g is

$$p^W_{vgf} = a^W_{vgf}(q^W_{vgf})^{\omega^W} \tag{B.2}$$

where a^W_{vgf} is a demand shifter, and $\omega^W > 0$ is the import supply elasticity.

Market Clearing. We assume that exporter and importer firms use the same type of labor. Thus, the labor market clearing condition is

$$\bar{L} = \sum_{g \in \mathcal{G}^D \cup \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} L_{gf}, \tag{B.3}$$

with $\bar{L} \equiv \bar{L}^D + \sum_{g \in \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} \bar{L}^X_{gf}$.

Market Structure. Domestic and Importer firms behave as in the baseline model. In addition, we assume that exporters also make pricing decisions given the their demand in each destination, as specified in (B.1). For simplicity, we maintain the assumption that all firms take as given the foreign import prices and the domestic wage rate.

Equilibrium. The equilibrium is similar to that of the baseline model, with three modifications.

First, the world price of imported products must satisfy the foreign supply curve in (B.2)

Second, given their marginal cost $c_{gf} = w$, exporter firm f solve the following problem:

$$\Pi_{gf} \equiv \sum_v \max_{p_{vgf}, q_{vgf}} (p_{vgf} - c_{gf}) q_{vgf} \quad \text{subject to } q_{vgf} \text{ given by (B.1)} \tag{B.4}$$

which yields

$$p_{vgf} = \frac{\sigma^W}{\sigma^W - 1} w, \quad E_{gf} = (w)^{1-\sigma^W} \delta^W_{gf}, \quad w L_{gf} = \frac{1}{\sigma^W} E_{gf}, \quad \Pi_{gf} = \left(1 - \frac{1}{\sigma^W}\right) E_{gf}, \tag{B.5}$$

with $\delta^W_{gf} \equiv (\frac{\sigma^W}{\sigma^W - 1})^{1-\sigma^W} \sum_v a^W_{vgf}$.

Third, the labor market clearing condition is given by (B.3).

B.1.2 Firm-level Responses

Expressions (A.21)–(A.23) remain valid given changes in import prices, import tariffs, and aggregate demand shifter. We now solve for the endogenous changes in import prices in order to write quantity changes in terms of changes in import tariffs and aggregate shifter.

We start by re-writing the quantity change for importer firms as

$$d \log q^M_{vgf} = -\theta(d \log p^W_{vgf} - d \log p^W_{gf}) - \theta(d \log(1 + \tau_{vg}) - d \log c^\tau_{gf}) + d \log q_{gf} \tag{B.6}$$

and

$$d\log q_{gf} = d\log q^W_{gf} + d\log q^\tau_{gf} + d\log Q \tag{B.7}$$

where

$$d\log q^\tau_{gf} = -\beta^q_{gf}(d\log c_{gf} - d\log c^\tau_g) - \eta d\log c^\tau_g$$
$$d\log q^W_{gf} = -\beta^q_{gf}(d\log p^W_{gf} - d\log p^W_g) - \eta d\log p^W_g$$

with $d\log p^W_{gf} \equiv \sum_v m_{vgf} d\log p^W_{vgf}$, $d\log c_{gf} \equiv \sum_v m_{vgf} d\log(1+\tau_{vg})$, $d\log p^W_g \equiv \sum_{f\in\mathcal{F}_g}\omega_{gf} d\log p^W_{gf}$, and $d\log c^\tau_g \equiv \sum_{f\in\mathcal{F}_g}\omega_{gf} d\log c_{gf}$.

The combination of the import supply curve in (B.2) and the import change in (B.6) implies that

$$d\log p^W_{vgf} = -\omega^W\theta(d\log p^W_{vgf} - d\log p^W_{gf}) - \omega^W\theta(d\log(1+\tau_{vg}) - d\log c^M_{gf}) + \omega^W d\log q_{gf},$$

and, by aggregating across origins for the same firm with m_{vgf}, $d\log p^W_{gf} = \omega^W d\log q_{gf}$. Thus,

$$d\log p^W_{vgf} - d\log p^W_{gf} = -\frac{\omega^W\theta}{1+\omega^W\theta}(d\log(1+\tau_{vg}) - d\log c_{gf}), \tag{B.8}$$

$$d\log q_{vgf} = -\frac{\theta}{1+\omega^W\theta}(d\log(1+\tau_{vg}) - d\log c_{gf}) + d\log q_{gf}. \tag{B.9}$$

Using (B.7),

$$\begin{aligned} d\log p^W_{gf} &= \omega^W d\log q_{gf} \\ &= \omega^W(-\beta^q_{gf} d\log p^W_{gf} + (\beta^q_{gf} - \eta)d\log p^W_g) + \omega^W(d\log q^\tau_{gf} + d\log Q) \\ &= \omega^W((\beta^q_{gf} - \eta)d\log p^W_g + d\log q^\tau_{gf} + d\log Q)/(1+\omega^W\beta^q_{gf}) \end{aligned}$$

which, aggregating across firms for the same good with ω_{gf},

$$\begin{aligned} d\log p^W_g &= \left(\sum_f \omega_{gf}\tfrac{\omega^W(\beta^q_{gf}-\eta)}{1+\omega^W\beta^q_{gf}}\right)d\log p^W_g + \omega^W\sum_f \tfrac{\omega_{gf}}{1+\omega^W\beta^q_{gf}} d\log q^\tau_{gf} + \omega^W\sum_f \tfrac{\omega_{gf}}{1+\omega^W\beta^q_{gf}} d\log Q \\ &= \omega^\tau\left(\sum_{f\in\mathcal{F}_g}\omega^W_{gf} d\log q^\tau_{gf} + d\log Q\right) \\ &= \omega^\tau\left(-d\log p^\tau_g + d\log Q\right) \end{aligned}$$

with $\omega^W_{gf} \equiv \frac{\omega_{gf}/(1+\omega^W\beta^q_{gf})}{\sum_{f'\in\mathcal{F}_g}\omega_{gf'}/(1+\omega^W\beta^q_{gf'})}$, $\omega^\tau \equiv \frac{\omega^W}{1+\omega^W\eta}$, and

$$d\log p^\tau_g \equiv \sum_{f\in\mathcal{F}_g}\omega^W_{gf}\beta^q_{gf}(d\log c_{gf} - d\log c^\tau_g) + \eta d\log c^\tau_g.$$

Using the expressions above for $d\log p_{gf}^W$ and $d\log p_g^W$, (B.7) implies that

$$d\log q_{gf} = \frac{-\beta_{gf}^q}{1+\omega^W\beta_{gf}^q}\left(d\log c_{gf} - d\log c_g\right) - \frac{\eta}{1+\omega^W\beta_{gf}^q}d\log c_g + \frac{1}{1+\omega^W\eta}d\log Q. \qquad \text{(B.10)}$$

$$d\log P_g = d\log c_g^\tau + d\log p_g^W = d\log c_g + \omega^\tau d\log Q \qquad \text{(B.11)}$$

with $d\log c_g \equiv d\log c_g^\tau - \omega^\tau d\log p_g^\tau$.

B.1.3 Aggregate Responses

Using (B.11), the change in the import price index is

$$d\log P^M = \sum_{g\in\mathcal{G}^M} \mathbb{E}_g^M d\log P_g = d\log c^M + \omega^\tau d\log Q$$

with $d\log c^M \equiv \sum_{g\in\mathcal{G}^M} \mathbb{E}_g^M d\log c_g$ and, as in the baseline model, $\mathbb{E}_g^M \equiv \bar{\mu}_g^M M_g / \sum_{g'\in\mathcal{G}^M} \bar{\mu}_{g'}^M M_{g'}$. Thus,

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta(1-e^M)d\log w + \eta e^M d\log c^M + \eta e^M\omega^\tau d\log Q + d\log C \\ &= \tfrac{\eta(1-e^M)d\log w + \eta e^M d\log c^M + d\log C}{1-\eta e^M\omega^\tau} \end{aligned}$$

We now solve for the wage change using the labor market clearing condition in (B.3), quantity changes for exporters in (B.5) and domestic firms in (A.20), and the aggregate shifter above:

$$\begin{aligned} 0 &= \ell^X d\log q^X + \ell^D d\log q^D \\ 0 &= -\ell^X\sigma^W d\log w + \ell^D(-\eta d\log w + d\log Q) \\ d\log w &= \beta^w(d\log c^M + d\log C/\eta e^M) \end{aligned}$$

where $W^D \equiv \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g} w\ell_{gf}$, $\ell^D \equiv W^D/wL$, $\ell^X = 1-\ell^D$, and $\beta^w \equiv \ell^D\eta e^M/((1-\eta e^M\omega^\tau)(\ell^X\sigma^W + \ell^D\eta) - \ell^D\eta(1-e^M))$.

From quantity changes for exporters in (B.5), domestic firms in (A.20), and importer firms in (B.7),

$$d\log q^X = -\sigma^W\beta^w(d\log c^M + \frac{1}{\eta e^M}d\log C) \qquad \text{(B.12)}$$

$$d\log q^D = \beta^D(\eta e^M d\log c^M + d\log C) \qquad \text{(B.13)}$$

$$
\begin{aligned}
\log q_{gf} = & - & \frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\
& - & \frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\
& - & \left(\frac{1/e^M}{1+\omega^W\beta^q_{gf}} - \beta^M\right)\eta e^M d\log c^M \\
& + & \beta^M d\log C
\end{aligned}
\tag{B.14}
$$

where

$$
\beta^D \equiv \frac{1-(1-\eta\omega^\tau)\,\beta^w}{1-\eta e^M\omega^\tau} \quad \text{and} \quad \beta^M \equiv \frac{1+\beta^w e^D/e^M}{1+\omega^W\eta e^D}.
$$

B.1.4 Aggregate Welfare

The same steps in Section A.3.3 implies that

$$
\begin{aligned}
dC = & \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}(\mu_{gf}-1)d\log q_{gf} \\
+ & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}d\log q_{vgf} \\
+ & \textstyle\sum_{g\in\mathcal{G}^X}\sum_{f\in\mathcal{F}_g} q_{gf}c_{gf}\mu_{gf}d\log p^W_{vgf} \\
- & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf}\log p^W_{vgf}
\end{aligned}
$$

Note that, because of the log-linear foreign demand, the price and allocation terms for exporters cancel out:

$$
\begin{aligned}
(\mu_{gf}-1)d\log q_{gf} + \mu_{gf}d\log p^W_{vgf} & = \left(-(\mu_{gf}-1)\sigma^W + \mu_{gf}\right)d\log c_{gf} \\
& = \left(-(\sigma^W - \sigma^W + 1)\sigma^W + \sigma^W\right)\tfrac{1}{\sigma^W-1}d\log c_{gf} \\
& = 0
\end{aligned}
$$

Thus,

$$
\begin{aligned}
dC = & \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf} \\
+ & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}d\log q_{vgf} \\
- & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf}d\log p^W_{vgf}
\end{aligned}
$$

Using the foreign supply curve in (B.2), the expression for $d\log q_{vgf}$ in (B.9) and the fact that $d\log q_{gf} = d\log q^D$ for all $g\in\mathcal{G}^D$, this expression becomes

$$
\begin{aligned}
dC = & \Pi^D d\log q^D \\
+ & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf} + T_{vgf} + \omega^W v_{vgf}\right)d\log q_{gf} \\
- & \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\left(T_{vgf} + \omega^W v_{vgf}\right)\frac{\theta}{1+\omega^W\theta}\left(d\log(1+\tau_{vg}) - d\log c_{gf}\right)
\end{aligned}
$$

with $\Pi^D \equiv \sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf} = E - E^M - W^D$.

Using expressions (B.13) and (B.14),

$$\begin{aligned} dC = & -\chi \left(\left(\chi^{-1}-1\right)\bar{\mu}^M M + \chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g} \frac{\Pi_{gf}+T_{gf}+\omega^W v_{gf}}{1+\omega^W\beta^q_{gf}} \right)\eta d\log c^M \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf}+T_{gf}+\omega^W v_{gf}\right)\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\Pi_{gf}+T_{gf}+\omega^W v_{gf}\right)\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\left(T_{vgf}+\omega^W v_{gf}\right)\frac{\theta}{1+\omega^W\theta}\left(d\log(1+\tau_{vg}) - d\log c_{gf}\right) \end{aligned} \tag{B.15}$$

where

$$\chi^{-1} \equiv 1 - \frac{\beta^D\Pi^D + \beta^M\left(\Pi^M + T + \omega^W V\right)}{E}$$

Again, we split this equation into three parts. The first is the component associated with markup distortions (MD):

$$\begin{aligned} dC^{\text{MD}} = & +\chi \left(\left(\frac{\beta^D\Pi^D+\beta^M\Pi^M}{E}\right)\bar{\mu}^M M - \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{\Pi_{gf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \end{aligned} . \tag{B.16}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} dC^{\text{TD}} = & -\chi \left(-\beta^M\frac{T}{E}\bar{\mu}^M M + \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{T_{gf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}T_{gf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}T_{gf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ & -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}\frac{\theta}{1+\omega^W\theta}\left(d\log(1+\tau_{vg}) - d\log c_{gf}\right) \end{aligned} . \tag{B.17}$$

The last term is the change in terms of trade associated with the change in world prices (ToT):

$$\begin{aligned} dC^{\text{ToT}} = & -\chi\omega^W \left(-\beta^M\frac{V}{E}\bar{\mu}^M M + \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{v_{vgf}}{1+\omega^W\beta^q_{gf}}\right)\eta d\log c^M \\ & -\chi\omega^W \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\omega^W v_{vgf}\frac{\eta}{1+\omega^W\beta^q_{gf}}\left(d\log c_g - d\log c^M\right) \\ & -\chi\omega^W \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}v_{vgf}\frac{\beta^q_{gf}}{1+\omega^W\beta^q_{gf}}\left(d\log c_{gf} - d\log c_g\right) \\ & -\chi\omega^W \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf}\frac{\theta}{1+\omega^W\theta}\left(d\log(1+\tau_{vg}) - d\log c_{gf}\right) \end{aligned} . \tag{B.18}$$

B.1.5 Measurement

To compute dC in (B.15), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to: (i) the elasticity parameters of the foreign export demand and import supply curves, $\{\sigma^W, \omega^W\}$; (ii) labor payments in domestic and exporter firms, $\{W^D, W^X\}$; and (iii) aggregate expenditure, E.

B.1.6 Special Case with Exogenous Import Prices

We now consider a special case in which the world price of imported varieties is exogenous, $\omega^W = 0$. This implies that $\omega^\tau = 0$. It also implies that $d\log q_{gf}$ and $d\log P_g$ in (B.10)–(B.11) are equivalent to their analogous expressions in the baseline model. In addition, we have that

$$\beta^D \equiv 1-\beta^w, \quad \beta^M \equiv 1+\beta^w e^D/e^M, \quad \beta^w = \frac{1}{1+\frac{\sigma^W}{\eta}\frac{\ell^X}{\ell^D}\frac{1}{e^M}},$$

and

$$\begin{aligned}
\chi^{-1} &= 1-\left(\beta^D\frac{\Pi^D}{E}+\frac{M}{E}\beta^M\left(\frac{\Pi^M}{M}+\frac{T}{M}\right)\right)\\
&= 1-\left(\beta^D\frac{\Pi^D}{W^D}\frac{W^D}{E}+\frac{M}{E}\beta^M\left(\bar{\mu}^M-1+\frac{\bar{\tau}}{1+\bar{\tau}}\right)\right)\\
&= 1-\left((1-\beta^w)(\bar{\mu}^D-1)\ell^D\ell+\frac{M}{E}\frac{1}{e^M}(e^M+\beta^w e^D)\left(\bar{\mu}^M-\frac{1}{1+\bar{\tau}}\right)\right)\\
&= 1-\left((1-\beta^w)(\bar{\mu}^D-1)\ell^D\ell+(e^M+\beta^w e^D)\left(1-\frac{1}{\bar{\mu}^M}\frac{1}{1+\bar{\tau}}\right)\right)
\end{aligned}$$

with $\ell \equiv W/E$ defined as the share of labor in aggregate spending.

We now derive the components of aggregate welfare. Equation (B.18) implies that $dC^{\text{ToT}} = 0$.

Equation (B.16) implies that

$$\begin{aligned}
\frac{dC^{\text{MD}}}{M} = &+\chi \quad \beta^{MD}\eta d\log c^M\\
&-\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{\Pi_{gf}}{M}\eta\left(d\log c_g-d\log c^M\right)\\
&-\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{\Pi_{gf}}{M}\beta^q_{gf}\left(d\log c_{gf}-d\log c_g\right)
\end{aligned}$$

where

$$\begin{aligned}
\beta^{MD} &= \left(\frac{\beta^D\Pi^D+\beta^M\Pi^M}{M}\right)\bar{\mu}^M\frac{M}{E}-\frac{\Pi^M}{M}\\
&= \left(\beta^D\frac{\Pi^D}{M}+\beta^M(\bar{\mu}^M-1)\right)e^M-(\bar{\mu}^M-1)\\
&= (1-\beta^w)\frac{\Pi^D}{M}e^M+(e^M\beta^M-1)(\bar{\mu}^M-1)\\
&= (1-\beta^w)\frac{\Pi^D}{M}e^M+(e^M+\beta^w e^D-1)(\bar{\mu}^M-1)\\
&= (1-\beta^w)\left(\frac{\Pi^D}{M}e^M-e^D(\bar{\mu}^M-1)\right)\\
&= (1-\beta^w)\frac{W^D}{E}\left((\bar{\mu}^D-1)\bar{\mu}^M-\bar{\mu}^D(\bar{\mu}^M-1)\right)\\
&= (1-\beta^w)\ell^D\ell(\bar{\mu}^D-\bar{\mu}^M)
\end{aligned}$$

Equation (B.17) implies that

$$\begin{aligned}
dC^{\text{TD}} = &-\chi \quad \beta^{TD}\eta d\log c^M\\
&-\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{T_{gf}}{M}\eta\left(d\log c_g-d\log c^M\right)\\
&-\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\frac{T_{gf}}{M}\beta^q_{gf}\left(d\log c_{gf}-d\log c_g\right)\\
&-\chi \quad \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\frac{T_{vgf}}{M}\theta(d\log(1+\tau_{vg})-d\log c_{gf})
\end{aligned}$$

where

$$\begin{aligned}\beta^{TD} &= \left(1-\beta^M \frac{\bar{\mu}^M M}{E}\right)\frac{T}{M} \\ &= \left(1-\beta^M e^M\right)\frac{\bar{\tau}}{1+\bar{\tau}} \\ &= (1-\beta^w)(1-e^M)\frac{\bar{\tau}}{1+\bar{\tau}}.\end{aligned}$$

Compared to the baseline model with $\frac{dC^{\text{MD}}}{M}|^{\text{baseline}}$ in (A.39) and $\frac{dC^{\text{TD}}}{M}|^{\text{baseline}}$ in (A.40), the expressions above imply that

$$\frac{dC^{\text{MD}}}{M} = \tilde{\chi}\frac{dC^{\text{MD}}}{M}|^{\text{baseline}} + \chi\beta^{MD}\eta d\log c^M \tag{B.19}$$

$$\frac{dC^{\text{TD}}}{M} = \tilde{\chi}\frac{dC^{\text{TD}}}{M}|^{\text{baseline}} - \chi\beta^{TD}\eta d\log c^M \tag{B.20}$$

with $\tilde{\chi} \equiv \chi/\bar{\mu}^M(1+\bar{\tau})$, $(\beta^w)^{-1} = 1 + \frac{\sigma^W}{\eta}\frac{\ell^X}{\ell^D}\frac{1}{e^M}$,

$$\chi^{-1} \equiv 1 - \left((1-\beta^w)(\bar{\mu}^D - 1)\ell^D\ell + (e^M + \beta^w e^D)\left(1 - \frac{1}{\bar{\mu}^M}\frac{1}{1+\bar{\tau}}\right)\right),$$

$$\beta^{MD} \equiv (1-\beta^w)\ell^D\ell(\bar{\mu}^D - \bar{\mu}^M),$$

$$\beta^{TD} \equiv (1-\beta^w)(1-e^M)\bar{\tau}/(1+\bar{\tau}).$$

B.2 Intermediate Production

B.2.1 Environment

We consider an environment similar to that of our baseline model, but we now classify goods into sectors $k \in \mathcal{K}$. Let $\mathcal{G}_k^h$ be the set of goods in sector k with $h \in \{D, M, X\}$, and $\mathcal{G}^h \equiv \cup_{k\in\mathcal{K}}\mathcal{G}_k^h$.

Preferences. Workers and owners have identical homothetic preferences given by

$$C = \Pi_{k\in\mathcal{K}}(C_k)^{\gamma_k} \tag{B.21}$$

$$C_k = \left[\sum_{g\in\mathcal{G}_k^D\cup\mathcal{G}_k^M}(a_g)^{\frac{1}{\eta_k}}(C_g)^{\frac{\eta_k-1}{\eta_k}}\right]^{\frac{\eta_k}{\eta_k-1}}, \tag{B.22}$$

$$C_g = \left[\sum_{f\in\mathcal{F}_g}(a_{gf})^{\frac{1}{\sigma_k}}(C_{gf})^{\frac{\sigma_k-1}{\sigma_k}}\right]^{\frac{\sigma_k}{\sigma_k-1}}, \tag{B.23}$$

with $\sum_{k\in\mathcal{K}}\gamma_k = \sum_{g\in\mathcal{G}_k^D\cup\mathcal{G}_k^M} a_g = \sum_{f\in\mathcal{F}_g} a_{gf} = 1$.

Technology. We maintain the same technology for importer and exporter firms. However, we now allow domestic firms to use intermediate inputs. For all firms $f \in \mathcal{F}_g$ producing good $g \in \mathcal{G}_k^D$,

$$y_{gf} = z_{gf}(L_{gf})^{\alpha_k^L}(I_{gf})^{\alpha_k^I}, \quad \alpha_k^L + \alpha_k^I = 1.$$

Following the standard in quantitative trade models (Costinot and Rodríguez-Clare, 2014), we assume that production follows a nesting structure identical to that of final demand. For all firms in sector k,

$$I_{gf} = \Pi_{k \in \mathcal{K}}(q_{k',gf}^I)^{\phi_{k'k}} \tag{B.24}$$

where $\sum_{k' \in \mathcal{K}} \phi_{k'k} = 1$ and

$$q_{k',gf}^I = \left[\sum_{g' \in \mathcal{G}_k^D \cup \mathcal{G}_k^M} (a_{g'})^{\frac{1}{\eta_k}} (q_{g',gf}^I)^{\frac{\eta_k - 1}{\eta_k}} \right]^{\frac{\eta_k}{\eta_k - 1}}, \tag{B.25}$$

$$q_{g',gf}^I = \left[\sum_{f' \in \mathcal{F}_{g'}} (a_{g'f'})^{\frac{1}{\sigma_k}} (q_{g'f',gf}^I)^{\frac{\sigma_k - 1}{\sigma_k}} \right]^{\frac{\sigma_k}{\sigma_k - 1}}. \tag{B.26}$$

Note that, except for Cobb-Douglas parameters, all the shifters and elasticities are the same for final and intermediate consumption.

Market Structure. We maintain the same market structure as in the baseline model, and assume that the parameter condition holds for all sectors and goods, $1 < \eta_k \leq \sigma_k \leq \eta_k^2$ for all $g \in \mathcal{G}_k^D \cup \mathcal{G}_k^M$.

Market Clearing. Labor supply must be equal to the labor demand of domestic firms:

$$\bar{L}^D = \sum_{g \in \mathcal{G}^D} \sum_{f \in \mathcal{F}_g} \ell_{gf}. \tag{B.27}$$

For domestic good market to clear, we must have that

$$q_{gf} = \sum_{g' \in \mathcal{G}^D} \sum_{f' \in \mathcal{F}_g} q_{gf,g'f'}^I + C_{gf}. \quad \forall g \in \mathcal{G}^D \cup \mathcal{G}^M \tag{B.28}$$

From the budget constraint, aggregate domestic spending must be equal to the income from labor, profits and tariff revenue:

$$F = w\bar{L}^D + \sum_{g \in \mathcal{G}^D \cup \mathcal{G}^M \cup \mathcal{G}^X} \sum_{f \in \mathcal{F}_g} \Pi_{gf} + T. \tag{B.29}$$

Equilibrium. The equilibrium is similar to that of baseline model. There are two main differences that we now discuss.

First, cost minimization implies that the marginal cost of domestic firms f producing a variety of good $g \in \mathcal{G}_k^D$ is

$$c_{gf} = (1/z_{gf})(w/\alpha_k^L)^{\alpha_k^L}(P_k^I/\alpha_k^I)^{\alpha_k^I}, \tag{B.30}$$

with $P_k^I \equiv \Pi_{k'}(P_{k'})^{\phi_{k'k}}$. Given total quantity sold by firm f of q_{gf}, labor spending is $w\ell_{gf} = \alpha_k^L c_{gf} q_{gf}$, and intermediate spending on sector k' is $I_{k,gf} \equiv P_k q_{k,gf}^I = \alpha_g^I c_{gf} q_{gf}$.

Second, in each sector, domestic demand takes the form in (A.1) with the demand shifter given by

$$Q_k = (P_k)^{\eta_k - 1} E_k \quad \text{and} \quad (P_k)^{1-\eta_k} = \sum_{g \in \mathcal{G}_k^D \cup \mathcal{G}_k^M} (a_g)(P_g)^{1-\eta_k}, \tag{B.31}$$

where E_k is the country's aggregate expenditure in sector k,

$$E_k = \gamma_k F + \sum_{k' \in \mathcal{K}} \phi_{kk'} \alpha_{k'}^I \sum_{g \in \mathcal{G}_{k'}^D} \sum_{f \in \mathcal{F}_g} c_{gf} q_{gf}. \tag{B.32}$$

B.2.2 Firm-level Responses

Importer Firms. Given their sector's demand shifter, importer firms behave as in our baseline model. Given the demand shifter $d \log Q_k$, imports of firm f producing variety v of good $g \in \mathcal{G}_k^M$ are given by $d \log q_{vgf}$ and $d \log q_{gf}$ in (A.22)–(A.23), with $d \log c_g$ and $d \log c_{gf}$ defined in (A.16) and (A.21), respectively.

Domestic Firms. For all $g \in \mathcal{G}^D$, (B.30) implies that $d \log c_{gf} = d \log c_k^D$ and, thus, $d \log P_g = d \log p_{gf} = d \log c_k^D$. For all firms producing $g \in \mathcal{G}_k^D$, (A.18) implies that

$$d \log q_{gf} = d \log q_k^D = -\eta d \log c_k^D + d \log Q_k, \tag{B.33}$$

where

$$d \log c_k^D = \alpha_k^L d \log w + \alpha_k^I \sum_{k'} \phi_{k'k} d \log P_{k'}. \tag{B.34}$$

B.2.3 Aggregate Responses

In sector k, the change in the price index is

$$d \log P_k = e_k^D d \log c_k^D + e_k^M d \log c_k^M$$

with $d \log c_k^M \equiv \sum_{g \in \mathcal{G}_k^M} \mathbb{E}_g^M d \log c_g$, $\mathbb{E}_g^M \equiv \bar{\mu}_g^M M_g / \sum_{g' \in \mathcal{G}_k^M} \bar{\mu}_{g'}^M M_{g'}$. Thus,

$$d \log P_k - e_k^D \alpha_k^I \sum_{k'} \phi_{k'k} d \log P_{k'} = e_k^D \alpha_k^L d \log w + e_k^M d \log c_k^M$$

which implies that

$$d\log P_k = \alpha_k^{Pw} d\log w + \sum_{k'} \alpha_{kk'}^{PM} e_{k'}^M d\log c_{k'}^M \tag{B.35}$$

with $[\alpha_{kk'}^{PM}] \equiv (I - [e_k^D \alpha_k^I \phi_{k'k}])^{-1}$ and $\alpha_k^{Pw} \equiv \sum_{k'} \alpha_{kk'}^{PM} e_{k'}^D \alpha_{k'}^L$.

This implies that

$$d\log c_k^D = \alpha_k^{Dw} d\log w + \sum_{k'} \alpha_{kk'}^{DM} d\log c_{k'}^M$$

with $\alpha_{kk'}^{DM} \equiv \alpha_k^I \sum_{k'} \phi_{kk'} \alpha_{sk'}^{PM} e_{k'}^M$ and $\alpha_k^{Dw} \equiv \alpha_k^L + \sum_{k'} \phi_{k'k} \alpha_{k'}^{Pw}$.

From (B.32),

$$d\log E_k = b_k d\log F + \sum_{k' \in \mathcal{K}} b_{kk'} (d\log c_{k'}^D + d\log q_{k'}^D)$$

where $b_k \equiv \gamma_k F / E_k$ and $b_{kk'} \equiv \phi_{kk'} \frac{\alpha_{k'}^I}{\alpha_{k'}^L} \frac{wL_k}{E_k}$, with $L_k \equiv \sum_{g \in \mathcal{G}_{k'}^D} \sum_{f \in \mathcal{F}_g} L_{gf}$.

By denoting $d\log \tilde{E}_k = d\log E_k - d\log P$, we can write

$$\begin{aligned} d\log \tilde{E}_k &= b_k d\log C + \textstyle\sum_{k' \in \mathcal{K}} b_{kk'} ((1-\eta_{k'})(d\log c_{k'}^D - d\log P_{k'}) + d\log \tilde{E}_{k'}) \\ &= b_k d\log C + \textstyle\sum_{k' \in \mathcal{K}} b_{kk'} ((1-\eta_{k'}) e_{k'}^M (d\log c_{k'}^D - d\log c_k^M) + d\log \tilde{E}_{k'}) \end{aligned}$$

and, thus,

$$d\log \tilde{E}_k \equiv \beta_k^E d\log C + \sum_{k' \in \mathcal{K}} \beta_{kk'}^E (1-\eta_{k'}) e_{k'}^M (d\log c_{k'}^D - d\log c_{k'}^M)$$

with $[\beta_{kk'}^E] \equiv (I - [b_{kk'}])^{-1}$ and $\beta_k^E \equiv \sum_{k'} \beta_{kk'}^E b_{k'}$.

The labor market clearing condition is

$$d\log w = \sum_k w\ell_k ((1-\eta_k) e_{k'}^M (d\log c_{k'}^D - d\log c_{k'}^M) + d\log \tilde{E}_{k'})$$

which implies that

$$d\log w = \beta^{wC} d\log C + \sum_k \beta_k^{wM} d\log c_k^M \tag{B.36}$$

with $\beta^w \equiv (1 - [w\ell_k]'(I + \beta^E) diag((1-\eta_k) e_{k'}^M)[\alpha_k^{Dw}])^{-1}$, $\beta^{wC} = \beta^w \sum_k w\ell_k \beta_k^E$ and $\beta^{wM} \equiv \beta^w [w\ell_k]'(I + \beta^E) diag((1-\eta_k) e_{k'}^M)(\alpha^{DM} - I)$.

Thus,

$$d\log c_k^D - d\log c_k^M = \tilde{\beta}_k^{DC} d\log C + \sum_{k'} \tilde{\beta}_{kk'}^{DM} d\log c_{k'}^M$$

$$d\log \tilde{E}_k = \tilde{\beta}_k^{EC} d\log C + \sum_{k'} \tilde{\beta}_{kk'}^{EM} d\log c_{k'}^M$$

with $\tilde{\beta}_k^{DC} \equiv \alpha_k^{Dw} \beta^{wC}$, $\tilde{\beta}_{kk'}^{DM} \equiv (\alpha_k^{Dw} \beta_{k'}^{wM} + \alpha_{kk'}^{DM} - \mathbb{I}_{k=k'})$, $\tilde{\beta}_k^{EC} \equiv \beta_k^E - \sum_{k' \in \mathcal{K}} \beta_{kk'}^E (1-\eta_{k'}) e_{k'}^M \beta_{k'}^{DC}$, and $\tilde{\beta}_{kk'}^{EM} \equiv \sum_{k''} \beta_{kk''}^E (1-\eta_{k''}) e_{k''}^M \beta_{k''k'}^{DM}$.

We can then solve for the change in quantity for domestic firms using (B.33):

$$\begin{aligned} d\log q_k^D &= -\eta_k e_k^M (d\log c_k^D - d\log c_k^M) + d\log \tilde{E}_k \\ &= \beta_k^{DC} d\log C + \textstyle\sum_{k'} \beta_{kk'}^{DM} d\log c_{k'}^M \end{aligned} \tag{B.37}$$

with $\beta_k^{DC} \equiv -\eta_k e_k^M \tilde{\beta}_k^{DC} + \tilde{\beta}_k^{EC}$ and $\beta_{kk'}^{DM} \equiv -\eta_k e_k^M \tilde{\beta}_{kk'}^{DM} + \tilde{\beta}_{kk'}^{EM}$.

We can also solve for the demand shifter:

$$\begin{aligned} d\log Q_k &= \eta_k d\log c_k^M + \eta_k e_k^D \left(d\log c_k^D - d\log c_k^M\right) + d\log \tilde{E}_k \\ &= \eta_k d\log c_k^M + \beta_k^{MC} d\log C + \textstyle\sum_{k'} \beta_{kk'}^{MM} d\log c_{k'}^M \end{aligned}$$

with $\beta_k^{MC} \equiv \eta_k e_k^D \tilde{\beta}_k^{DC} + \tilde{\beta}_k^{EC}$ and $\beta_{kk'}^{MM} \equiv \eta_k e_k^D \tilde{\beta}_{kk'}^{DM} + \tilde{\beta}_{kk'}^{EM}$.

Together with (A.23), this implies that, for all $g \in \mathcal{G}_k^M$,

$$\begin{aligned} d\log q_{gf} = & - \beta_{gf}^q (d\log c_{gf} - d\log c_g) \\ & - \eta_k (d\log c_g - d\log c_k^M) \\ & + \textstyle\sum_{k'} \beta_{kk'}^{MM} d\log c_{k'}^M + \beta_k^{MC} d\log C. \end{aligned} \tag{B.38}$$

B.2.4 Aggregate Welfare

Consumption Price index. Let us write the change in the price index as

$$d\log P^C = \sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \frac{p_{gf} C_{gf}}{F} d\log p_{gf}, \tag{B.39}$$

with C_{gf} the final consumption of firm f producing good g.

Firms. For every firm, we can write the change in profits as

$$d\Pi_{gf} = q_{gf}(dp_{gf} - dc_{gf}) + (p_{gf} - c_{gf}) dq_{gf} \tag{B.40}$$

From the cost minimization problem, the Envelope theorem implies that

$$q_{gf} dc_{gf} = L_{gf} dw + \sum_{g'\in\mathcal{G}^D\cup\mathcal{G}^M} \sum_{f'\in\mathcal{F}_g} q_{g'f',gf}^I dp_{g'f'} + \sum_v q_{vgf}^M (dp_{vg}^W + d(p_{vg}^W \tau_{vg})). \tag{B.41}$$

Tariff revenue. The expression for tariff revenue in (A.11) implies that

$$dT = \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \sum_v \left(\tau_{vg} p_{vg}^W dq_{vgf} + q_{vgf} d(\tau_{vg} p_{vg}^W)\right). \tag{B.42}$$

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

$$dC \equiv Fd\log C = dF - Fd\log P = dw\bar{L} + d\Pi^M + d\Pi^D + d\Pi^X + dT - Fd\log P^C.$$

Using the expressions for the changes in the price index in (B.39), profits in (B.40) and tariff revenue in (B.42), we obtain

$$\begin{aligned} dC &= dw\bar{L}^D \\ &+ \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(q_{gf}(dp_{gf}-dc_{gf})+(p_{gf}-c_{gf})dq_{gf}\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\left(\tau_{vg}p^W_{vg}dq_{vgf}+q_{vgf}d(\tau_{vg}p^W_{vg})\right) \\ &- \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}C_{gf}dp_{gf} \end{aligned}$$

Substituting for the market clearing conditions in (B.27)–(B.28) and the change in costs in (B.41), this expression becomes:

$$\begin{aligned} dC &= dw\left(\textstyle\sum_{g\in\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\ell_{gf}\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(p_{gf}-c_{gf})dq_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(\sum_{g'\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f'\in\mathcal{F}_g}q^I_{gf,g'f'}+C_{gf}\right)dp_{gf} \\ &- \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\left(L_{gf}dw+\sum_{g'\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f'\in\mathcal{F}_g}q^I_{g'f',gf}dp_{g'f'}+\sum_v q_{vgf}(dp^W_{vg}+d(p^W_{vg}\tau_{vg}))\right) \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\left(\tau_{vg}p^W_{vg}dq_{vgf}+q_{vgf}d(\tau_{vg}p^W_{vg})\right) \\ &- \textstyle\sum_{g\in\mathcal{G}^D\cup\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}C_{gf}dp_{gf} \end{aligned}$$

Rearranging this expression, we obtain the change in aggregate welfare:

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(p_{gf}-c_{gf})dq_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v\tau_{vg}p^W_{vg}dq^M_{vgf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v q^M_{vgf}dp^W_{vg} \end{aligned}$$

which implies that

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}^M\cup\mathcal{G}^D}\sum_{f\in\mathcal{F}_g}\Pi_{gf}d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}d\log q_{vgf} \\ &- \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf}d\log p^W_{vg} \end{aligned} \tag{B.43}$$

with $\Pi_{gf} \equiv c_{gf}q_{gf}(\mu_{gf}-1)$, $T_{vgf} \equiv \tau_{vg}v_{vgf}$ and $v_{vgf} \equiv p^W_{vg}q_{vgf}$. We can then use these three terms to define the three components of welfare changes: markup distortions (first row), tariff distortions (second row), and terms of trade changes (last row).

By plugging (B.37)–(B.38) into (B.43),

$$
\begin{aligned}
dC = \quad & +\chi && \textstyle\sum_k \chi_k d\log c_k^M \\
& -\chi && \textstyle\sum_{g\in\mathcal{G}^M}(\Pi_g + T_g)\eta_k(d\log c_g - d\log c_k^M) \\
& -\chi && \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf} + T_{gf})\beta_{gf}^q(d\log c_{gf} - d\log c_g) \\
& -\chi && \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}\theta(d\log p_{vg} - d\log c_{gf}) \\
& -\chi && \textstyle\sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf} d\log p_{vg}^W
\end{aligned}
\tag{B.44}
$$

with $\chi \equiv 1 - \sum_k \frac{\Pi_k^M + T_k}{F}\beta_k^{MC} + \sum_k \frac{\Pi_k^D}{F}\beta_k^{DC}$ and $\chi_k \equiv \sum_{k'}(\Pi_{k'}^M + T_{k'})\beta_{k'k}^{MM} + \Pi_{k'}^D\beta_{k'k}^{DM}$.

B.2.5 Measurement

To compute dC in (B.44), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to the following variables in national accounts: for each sector, final spending, intermediate spending and labor payments, $\{I_{k'k}, W_k, F_k\}$.

To see this, note that we can compute technology parameters for domestic firms as $\phi_{k'k} = I_{k'k}/\sum_{k'} I_{k'k}$ and $\alpha_k^L = W_k/(W_k + \sum_{k'} I_{k'k})$. Since only domestic firms use inputs, we can use the model identities to compute domestic profits: $\Pi_k^D = F_k + \sum_{k'} I_{kk'} - M_k\bar{\mu}_k^M - W_k - \sum_{k'} I_{k'k}$.

B.3 Homothetic Preferences Across Goods

B.3.1 Environment

Everything remains as in our baseline model, but we now assume that domestic demand is such that

$$q_{gf} = a_{gf}(p_{gf})^{-\sigma}(P_g)^{\sigma-1}\mathbb{E}_g(\mathcal{P})E$$

with $\mathcal{P} \equiv \{P_g\}_{g\in\mathcal{G}^M\cup\mathcal{G}^D}$ and P_g the CES price index for good g. The function $\mathbb{E}_g(\mathcal{P})$ is a general demand that determines the share of aggregate spending on good g. It is useful to define the following elasticity matrices:

$$\eta_{gg'} \equiv \frac{\partial \log \mathbb{E}_g(\mathcal{P})}{\partial \log P_{g'}} \quad \text{and} \quad \gamma_{gg'} \equiv \frac{1}{\sigma-1}\frac{\eta_{gg}}{\sigma-1+\eta_{gg}}\frac{\partial^2 \log \mathbb{E}_g(\mathcal{P})}{\partial \log P_g \partial \log P_{g'}}.$$

The equilibrium remains the same as in our baseline model, but the firm's perceived elasticity of demand is now given by

$$\varepsilon_{gf} = \sigma - (\sigma - 1 + \eta_{gg})e_{gf}.$$

B.3.2 Firm-level Responses

We start by totally differentiating the price system as a function of the firm's marginal costs:

$$d\log p_{gf} = d\log c_{gf} - \frac{1}{\varepsilon_{gf}(\varepsilon_{gf}-1)} d\varepsilon_{gf}$$

with

$$d\varepsilon_{gf} = (\sigma-1)(\sigma-1+\eta_{gg})e_{gf}\left(d\log p_{gf} - d\log P_g - \sum_{g'} \gamma_{gg'} d\log P_{g'}\right).$$

Thus,

$$d\log p_{gf} = \beta^p_{gf} d\log c_{gf} + (1-\beta^p_{gf})\left(d\log P_g + \sum_{g'} \gamma_{gg'} d\log P_{g'}\right) \tag{B.45}$$

where, as before, $\rho_{gf} \equiv (\sigma-\varepsilon_{gf})(\sigma-1)/\varepsilon_{gf}(\varepsilon_{gf}-1)$ and $\beta^p_{gf} \equiv 1/(1+\rho_{gf})$.

By aggregating across firms, we can then solve for the change in the price index. Since $d\log P_g = \sum_{f\in\mathcal{F}_g} e_{gf} d\log p_{gf}$,

$$d\log P_g = \sum_{f\in\mathcal{F}_g} \omega_{gf} d\log c_{gf} + \sum_{g'} \tilde{\gamma}_{gg'} d\log P_{g'}$$

where $\omega_{gf} \equiv e_{gf}\beta^p_{gf} / \sum_{f\in\mathcal{F}_g} e_{gf}\beta^p_{gf}$ and $\tilde{\gamma}_{gg'} \equiv \frac{1-\sum_f e_{gf}\beta^p_{gf}}{\sum_f e_{gf}\beta^p_{gf}}\gamma_{gg'}$. By defining $\beta^P \equiv (I-\tilde{\gamma})^{-1}$,

$$d\log P_g = \sum_{g'} \beta^P_{gg'} \sum_{f\in\mathcal{F}_{g'}} \omega_{g'f} d\log c_{g'f}. \tag{B.46}$$

For domestic firms $g \in \mathcal{G}^D$, $d\log c_{gf} = d\log w$ and, thus,

$$d\log P_g = \beta^{Pw}_g d\log w + d\log c^P_g,$$

with $\beta^{Pw}_g \equiv \sum_{g'\in\mathcal{G}^D} \beta^P_{gg'}$ and $d\log c^P_g \equiv \sum_{g'\in\mathcal{G}^M} \beta^P_{gg'} \sum_{f\in\mathcal{F}_{g'}} \omega_{g'f} d\log c^M_{g'f}$.

In addition, we can define:

$$d\log P_g + \sum_{g'} \gamma_{gg'} d\log P_{g'} = \beta^w_g d\log w + d\log c^q_g$$

with $\beta^w_g \equiv \beta^{Pw}_g + \sum_{g'} \gamma_{gg'}\beta^{Pw}_{g'}$ and $d\log c^q_g \equiv d\log c^P_g + \sum_{g'} \gamma_{gg'} d\log c^P_{g'}$.

We can then solve for firm-level outcomes as a function of exogenous changes in import costs and endogenous changes in wages and aggregate consumption:

$$d\log \mu_{gf} = -\beta^\mu_{gf}\left(d\log c_{gf} - \beta^w_g d\log w - d\log c^q_g\right)$$

with $\beta^\mu_{gf} \equiv (1-\beta^p_{gf}) \in (0,1)$.

We can then solve for quantity as a function of wages and aggregate consumption:

$$d\log q_{gf} = -\beta^{q}_{gf}\left(d\log c_{gf} - (\beta^{w}_{g} d\log w + d\log c^{q}_{g})\right) + \sum_{g'} \beta^{q}_{gg'}\left(\beta^{Pw}_{g'} d\log w + d\log c^{P}_{g'}\right) + d\log C \tag{B.47}$$

where $\beta^{q}_{gf} \equiv \sigma\beta^{p}_{gf}$ and $\beta^{q}_{gg'} \equiv \eta_{gg'} + e_{g'} - \sigma\gamma_{gg'} - \mathbb{I}_{g=g'}$.

B.3.3 Aggregate Responses

We now turn to the responses in aggregate variables. We only need to solve for the change in wages. Note that, because of the general preferences across goods, domestic firms producing different goods react deferentially to changes in the import costs. For all domestic firms producing a variety of good $g \in \mathcal{G}^{D}$,

$$d\log q_{gf} = -\beta^{q}_{gf}\left((1-\beta^{w}_{g}) d\log w - d\log c^{q}_{g}\right) + \sum_{g'} \beta^{q}_{gg'}\left(\beta^{Pw}_{g'} d\log w + d\log c^{P}_{g'}\right) + d\log C.$$

Together with the labor market clearing condition, this implies that

$$d\log w = \beta^{w}(d\log c^{w} + d\log C) \tag{B.48}$$

where

$$d\log c^{w} \equiv \sum_{g\in\mathcal{G}^{D}} \ell_{g}\left[-(\sum_{f\in\mathcal{F}_{g}} \ell_{gf}\beta^{q}_{gf}) d\log c^{q}_{g} + \sum_{g'} \beta^{q}_{gg'} d\log c^{P}_{g'}\right],$$

$$(\beta^{w})^{-1} \equiv \sum_{g\in\mathcal{G}^{D}} \ell_{g}\left[(\sum_{f\in\mathcal{F}_{g}} \ell_{gf}\beta^{q}_{gf})(1-\beta^{w}_{g}) - \sum_{g'} \beta^{q}_{gg'}\beta^{Pw}_{g'}\right],$$

with $\ell_{gf} = L_{gf}/L_{g}$ and $L_{g} = \sum_{f\in\mathcal{F}_{g}} L_{gf}$.

Thus, (B.47) and (B.48) imply that

$$\begin{aligned} d\log q_{gf} &= -\beta^{q}_{gf}\left(\mathbb{I}_{g\in\mathcal{G}^{M}} d\log c_{gf} - d\log c^{q}_{g}\right) + \textstyle\sum_{g'} \beta^{q}_{gg'} d\log c^{P}_{g'} \\ &+ \beta^{qw}_{gf}\beta^{w} d\log c^{w} + (1+\beta^{qw}_{gf}\beta^{w}) d\log C \end{aligned} \tag{B.49}$$

where $\beta^{qw}_{gf} \equiv \beta^{q}_{gf}(\beta^{w}_{g} - \mathbb{I}_{g\in\mathcal{G}^{D}}) + \sum_{g'} \beta^{q}_{gg'}\beta^{Pw}_{g'}$.

B.3.4 Aggregate Welfare

We note that the same steps used in Section (A.3.3) yields the following analog of expression (A.37):

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_{g}} (\Pi_{gf} + T_{gf}) d\log q_{gf} \\ &- \textstyle\sum_{g\in\mathcal{G}^{M}} \sum_{f\in\mathcal{F}_{g}} \sum_{v\in\mathcal{V}} T_{vgf}\theta(d\log p_{vg} - d\log c_{gf}) \\ &- \textstyle\sum_{g\in\mathcal{G}^{M}} \sum_{f\in\mathcal{F}_{g}} \sum_{v\in\mathcal{V}} v_{vgf} d\log p^{W}_{vg} \end{aligned} \tag{B.50}$$

where $T_{gf} = 0$ for all $g \in \mathcal{G}^D$ and $\mathcal{G} \equiv \mathcal{G}^D \cup \mathcal{G}^M$.

By plugging (B.49) into (B.50), we get that

$$\begin{aligned} dC = \; & +\chi \left(\sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} \left(\Pi_{gf} + T_{gf}\right) \beta^{qw}_{gf} \beta^{w}\right) d\log c^{w} \\ & -\chi \sum_{g\in\mathcal{G}} (\Pi_g + T_g) \sum_{g'} \beta^{q}_{gg'} d\log c^{P}_{g'} \\ & -\chi \sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} (\Pi_{gf} + T_{gf}) \beta^{q}_{gf} \left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^{q}_{g}\right) \\ & -\chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \sum_{v\in\mathcal{V}} T_{vgf} \theta (d\log p_{vg} - d\log c_{gf}) \\ & -\chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \sum_{v\in\mathcal{V}} v_{vgf} d\log p^{W}_{vg} \end{aligned} \tag{B.51}$$

where

$$\chi^{-1} \equiv 1 - \frac{M}{E} \sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} \frac{(\Pi_{gf} + T_{gf})}{M} (1 + \beta^{qw}_{gf} \beta^{w}).$$

Again, we split this equation into three parts. The component associated with change in terms of trade is still given by (A.41). The component associated with markup distortions (MD):

$$\begin{aligned} dC^{\mathrm{MD}} = \; & +\chi (\sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} \Pi_{gf} \beta^{qw}_{gf} \beta^{w}) d\log c^{w} \\ & -\chi \sum_{g\in\mathcal{G}} \Pi_g \sum_{g'} \beta^{q}_{gg'} d\log c^{P}_{g'} \\ & -\chi \sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} \Pi_{gf} \beta^{q}_{gf} \left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^{q}_{g}\right) \end{aligned} . \tag{B.52}$$

The second is the component associated with distortions created by the initial tariffs (TD):

$$\begin{aligned} dC^{\mathrm{TD}} = \; & -\chi (\sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} T_{gf} \beta^{qw}_{gf} \beta^{w}) d\log c^{w} \\ & -\chi \sum_{g\in\mathcal{G}} T_g \sum_{g'} \beta^{q}_{gg'} d\log c^{P}_{g'} \\ & -\chi \sum_{g\in\mathcal{G}} \sum_{f\in\mathcal{F}_g} T_{gf} \beta^{q}_{gf} \left(\mathbb{I}_{g\in\mathcal{G}^M} d\log c_{gf} - d\log c^{q}_{g}\right) \\ & -\chi \sum_{g\in\mathcal{G}^M} \sum_{f\in\mathcal{F}_g} \sum_{v\in\mathcal{V}} T_{vgf} \theta (d\log p_{vg} - d\log c_{gf}) \end{aligned} . \tag{B.53}$$

B.3.5 Measurement

To compute dC in (B.53), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to: (i) firm-level employment data, $\{L_{gf}\}$; and (ii) the good-level demand function, $\mathbb{E}_g(\mathcal{P})$.

To see this, note that the definition of β^{q}_{gf} is identical to that of our baseline model, so that $\mu_{gf} = \mathcal{M}(\beta^{q}_{gf})$ with $\mathcal{M}(.)$ defined in (A.15). We can then use $\mathbb{E}_g(\mathcal{P})$ to compute $\eta_{gg'}$ and $\gamma_{gg'}$, which yields $\beta^{P}_{gg'}$, $\beta^{q}_{gg'}$, β^{w}_{g}, and β^{qw}_{gf}. Finally, we can combine firm-level markups with firm-level imports and employment to compute firm-level profits Π_{gf} and the aggregate multipliers β^{w}, χ and χ^{w}.

B.4 Homothetic Single Aggregator Across Firms

B.4.1 Environment

Everything remains as in our baseline model, but we now assume that demand takes the form of a nested extension of the homothetic single-aggregator demand in Matsuyama (2023). To simplify exposition, we maintain CES preferences across good with an elasticity of η. For firm $f \in \mathcal{F}_g$ producing a variety of good $g \in \mathcal{G}^M \cup \mathcal{G}^D$, domestic demand is

$$p_{gf}q_{gf} = \bar{e}_g(z_{gf})a_g \left(P_g/P\right)^{1-\eta} E \quad \text{such that} \quad z_{gf} \equiv a_{gf}p_{gf}/A_g, \tag{B.54}$$

where $\bar{e}_g(z)$ is a strictly decreasing function with elasticity $\sigma_g(z) \equiv -\partial \log \bar{e}_g(z)/\partial \log z$, and A_g is an endogenous demand aggregator, which is implicitly defined as

$$\sum_{f\in\mathcal{F}_g} \bar{e}_g(a_{gf}p_{fg}/A_g)) = 1. \tag{B.55}$$

Firm f's optimal price satisfies (2.2) with perceived demand elasticity given by

$$\varepsilon_{gf} = \varepsilon_g(z_{gf}, \bar{\sigma}_g) \equiv 1 + \sigma_g(z_{gf}) - \mathbb{I}_O \left(\sigma_g(z_{gf})\frac{\sigma_g(z_{gf})}{\bar{\sigma}_g} - (\eta+1)\right)\bar{e}(z_{gf}) \tag{B.56}$$

where $\bar{\sigma}_g \equiv \sum_{f\in\mathcal{F}_g} \bar{e}(z_{gf})\sigma_g(z_{gf})$ and $\mathbb{I}_O$ is a dummy that equals one for our baseline oligopolistic market structure and zero for monopolistic competition. Note that this extended specification covers our baseline specification with $A_g = P_g$ and $\varepsilon(z) = \sigma - (\sigma-\eta)e(z)$, but it also allows for variable markups under monopolitic competition.

In what follows, it will be useful to work with the transformation in terms of market share,

$$\varepsilon_{gf} = \varepsilon_g^e(e_{gf}, \bar{\sigma}_g) \equiv \varepsilon_g(\bar{e}_g^{-1}(z_{gf}), \bar{\sigma}_g) \quad \text{and} \quad \sigma_{gf} = \sigma_g^e(e_{gf}) \equiv \sigma(\bar{e}_g^{-1}(z_{gf})).$$

B.4.2 Firm-level Responses

We start by characterizing changes in firm-level outcomes as a function of exogenous changes in marginal costs.

As in our baseline model, all domestic firms have the same marginal cost change, so it is still true that, for all $g \in \mathcal{G}^D$,

$$d\log p_{gf} = d\log P^M + \frac{1}{\eta e^M} d\log C \quad \text{and} \quad d\log q_{gf} = 0. \tag{B.57}$$

Turning to importer firms, (2.2) and (B.56) imply that

$$d\log p_{gf} - d\log A_g = \beta_{gf}^p \left(d\log c_{gf} - d\log A_g + \beta_{gf}^{\bar{\sigma}} d\log\bar{\sigma}_g\right) \tag{B.58}$$

such that $\beta^p_{gf} = \beta^p_g(e_{gf})$ and $\beta^{\bar{\sigma}}_{gf} \equiv \beta^{\bar{\sigma}}_g(e_{gf})$, with

$$\beta^p_g(e) \equiv \frac{1}{1 - \frac{\sigma^e_g(e)}{\varepsilon^e_g(e,\bar{\sigma}_g)-1}\frac{\partial \log \varepsilon^e_g(e,\bar{\sigma}_g)}{\partial \log e}} \quad \text{and} \quad \beta^{\bar{\sigma}}_g(e) \equiv \frac{\mathbb{I}_O}{\varepsilon^e_g(e,\bar{\sigma}_g)(\varepsilon^e_g(e,\bar{\sigma}_g)-1)}\frac{(\sigma_g(e))^2 e}{\bar{\sigma}_g}.$$

The definitions of A_g and $\bar{\sigma}_g$ in (B.55) imply that

$$d\log A_g = \sum_{f\in\mathcal{F}_g} \varphi^A_{gf} d\log p_{gf} \quad \text{such that} \quad \varphi^A_{gf} \equiv \frac{e_{gf}\sigma_{gf}}{\sum_{f'\in\mathcal{F}_g} e_{gf'}\sigma_{gf}} \tag{B.59}$$

and

$$d\log \bar{\sigma}_g = -\sum_{f\in\mathcal{F}_g} \varphi^{\bar{\sigma}}_{gf}\left(d\log p_{gf} - d\log A_g\right) \quad \text{such that} \quad \varphi^{\bar{\sigma}}_{gf} \equiv \omega^A_{gf}\sigma_{gf}\left(1 + \frac{\partial \log \sigma^e(e_{gf})}{\partial \log e}\right). \tag{B.60}$$

For each good $g \in \mathcal{G}^M$, the system (B.58)–(B.60) determines $\{d\log p_{gf}\}_{f\in\mathcal{F}_g}$ as a function of marginal cost changes $\{d\log c_{gf}\}_{f\in\mathcal{F}_g}$:

$$d\log p_{gf} = \sum_{f'\in\mathcal{F}_g} \beta^{pc}_{gf,gf'} d\log c_{gf'}$$

with $\beta^{pc} \equiv (I + [(1-\beta^p_{gf})\varphi^A_{gf'} + \beta^p_{gf}\beta^{\bar{\sigma}}_{gf}\varphi^{\bar{\sigma}}_{gf}])^{-1}$.

Thus,

$$d\log A_g = d\log c^A_g \equiv \sum_{f\in\mathcal{F}_g} \omega^A_{gf} d\log c_{gf} \tag{B.61}$$

$$d\log P_g = d\log c^M_g \equiv \sum_{f\in\mathcal{F}_g} \omega^P_{gf} d\log c_{gf} \tag{B.62}$$

with $\omega^A_{gf} \equiv \sum_{f'\in\mathcal{F}_g} \varphi^A_{gf'}\beta^{pc}_{gf',gf}$ and $\omega^P_{gf} \equiv \sum_{f'\in\mathcal{F}_g} e_{gf'}\beta^{pc}_{gf',gf}$.

Note that $\sum_{f'\in\mathcal{F}_g} \beta^{pc}_{gf,gf'} = 1$ for all $f \in \mathcal{F}_g$, since the system determining prices is homogeneous of degree one. This implies that $\sum_{f\in\mathcal{F}_g} \omega^A_{gf} = \sum_{f\in\mathcal{F}_g} \omega^P_{gf} = 1$. Together with (B.60), this implies that

$$d\log \bar{\sigma}_g = \sum_{f\in\mathcal{F}_g} \omega^{\bar{\sigma}}_{gf}\left(d\log c_{gf} - d\log A_g\right) \tag{B.63}$$

with $\omega^{\bar{\sigma}}_{gf} \equiv -\sum_{f'\in\mathcal{F}_g} \varphi^{\bar{\sigma}}_{gf'}\beta^{pc}_{gf',gf}$.

Note that (B.58) implies the following relationship:

$$d\log P_g - d\log A_g = \sum_{f\in\mathcal{F}_g} e_{gf}\beta^p_{gf}(d\log c_{gf} - d\log A_g) + \beta^{\bar{\sigma}}_g d\log \bar{\sigma}_g \tag{B.64}$$

with $\beta^{\bar{\sigma}}_g \equiv \sum_{f\in\mathcal{F}_g} e_{gf}\beta^{\bar{\sigma}}_{gf}$.

Finally, (B.54)–(B.58) implies that the change in imports is

$$d\log q_{gf} \quad = \quad -\beta^q_{gf}(d\log c_{gf} - d\log A_g + \beta^\sigma_{gf} d\log\bar{\sigma}_g) + (1-\eta) d\log P_g - d\log A_g + d\log Q \ , \tag{B.65}$$

such that $\beta^q_{gf} = \beta^q_g(e_{gf})$ with

$$\beta^q_g(e) \equiv (1 + \sigma_g(e))\beta^p_g(e).$$

B.4.3 Aggregate Responses

We can then immediately solve for the import price index using $d\log P_g$ in (B.62):

$$d\log P^M = d\log c^M \equiv \sum_{g\in\mathcal{G}^M} \mathbb{E}^M_g d\log c^M_g$$

and, thus, the demand shifter change is

$$\begin{aligned} d\log Q &= \eta d\log P + d\log C \\ &= \eta\left(e^D d\log w + e^M d\log P^M\right) + d\log C \\ &= \eta d\log c^M + \tfrac{1}{e^M} d\log C. \end{aligned}$$

Thus, we can characterize firm-level import changes in terms of fundamentals and $d\log C$. Equation (B.65) implies that

$$\begin{aligned} d\log q_{gf} &= -\beta^q_{gf}(d\log c_{gf} - d\log A_g) - \beta^q_{gf}\beta^\sigma_{gf} d\log\bar{\sigma}_g \\ &+ (d\log P_g - d\log A_g) - \eta(d\log P_g - d\log c^M) + \tfrac{1}{e^M} d\log C \end{aligned} .$$

Together with (B.61)–(B.64), this expression implies that

$$\begin{aligned} d\log q_{gf} = &- \beta^q_{gf}(d\log c_{gf} - d\log c^A_g) \\ &- \textstyle\sum_{f'\in\mathcal{F}_g}((\beta^q_{gf}\beta^\sigma_{gf} - \beta^q_g)\omega^{\bar{\sigma}}_{gf'} - e_{gf'}\beta^p_{gf'})(d\log c_{gf'} - d\log c^A_g) \\ &- \eta(d\log c^P_g - d\log c^M) \\ &+ \tfrac{1}{e^M} d\log C. \end{aligned} \tag{B.66}$$

with $\beta^A_{gf,gf'} \equiv -(\beta^q_g - \beta^q_{gf}\beta^\sigma_{gf})\omega^{\bar{\sigma}}_{gf'} - e_{gf'}\beta^p_{gf'}$

B.4.4 Aggregate Welfare

In this model, (A.37) remains valid. We now plug (B.66) into (A.37) to obtain the following expression for welfare

$$
\begin{aligned}
dC = \quad & -\chi \sum_{g\in\mathcal{G}^M}(\Pi_g + T_g)\eta(d\log c_g^P - d\log c^M) \\
& -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})(\beta_{gf}^q + \beta_{gf}^A)(d\log c_{gf} - d\log c_g^A) \\
& -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v T_{vgf}\theta(d\log p_{vg} - d\log c_{gf}) \\
& -\chi \sum_{g\in\mathcal{G}^M}\sum_{f\in\mathcal{F}_g}\sum_v v_{vgf} d\log p_{vg}^W
\end{aligned}
\tag{B.67}
$$

with $\beta_{gf}^A \equiv \sum_{f'\in\mathcal{F}_g}(\Pi_{gf'}+T_{gf'})((\beta_{gf'}^q\beta_{gf'}^\sigma - \beta_g^q)\omega_{gf}^{\bar{\sigma}} - e_{gf}\beta_{gf}^p)/(\Pi_{gf}+T_{gf})$.

B.4.5 Measurement

To compute dC in (B.67), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to the firm-level price elasticity function, $\beta_g^p(e)$.

To see this, note that the definition of $\beta_g^p(e)$ in (B.58) implies that

$$
\beta_g^p(e) - 1 = \frac{\beta_g^p(e)\sigma_g^e(e)}{\varepsilon_g^e(e,\bar{\sigma}_g) - 1}\frac{\partial \log \varepsilon_g^e(e,\bar{\sigma}_g)}{\partial \log e}
$$

which, combined with the definition of $\beta_g^q(e)$ in (B.65) , yields

$$
(\beta_g^q(e) - \beta_g^p(e))\frac{\partial \log \varepsilon_g^e(e,\bar{\sigma}_g)}{\partial \log e} - (\beta_g^p(e) - 1)(\varepsilon_g^e(e,\bar{\sigma}_g) - 1) = 0 \tag{B.68}
$$

with $\varepsilon_g^e(0,\bar{\sigma}_g) = \beta_g^q(0)/\beta_g^p(0)$. The solution of this differential equation yields $\varepsilon_g^e(e,\bar{\sigma}_g)$.

We can then compute firm-level markups and elasticities. First, we obtain $\varepsilon_{gf} = \varepsilon_g^e(e_{gf},\bar{\sigma}_g)$ and $\mu_{gf} = \varepsilon_{gf}/(\varepsilon_{gf}-1)$. Second, since $\sigma_g^e(e) = \beta_g^q(e)/\beta_g^p(e)$, we also obtain $\bar{\sigma}_g = \sum_{f\in\mathcal{F}_g} e_{gf}\sigma_g^e(e_{gf})$, $\beta_{gf}^{\bar{\sigma}} = \beta_g^{\bar{\sigma}}(e_{gf})$, φ_{gf}^A, $\varphi_{gf}^{\bar{\sigma}}$, and β^{pc}. Finally, these elasticities we obtain the shares: ω_{gf}^A, ω_{gf}^P, and β_{gf}^A.

B.5 Demand Nests with Domestic and Importer Firms

B.5.1 Environment

Consider the same environment of our baseline model, but instead assume that each demand nest g includes both domestic and importer firms. A firm's type defines whether it produces with domestic labor or imported inputs within g. Let $\mathcal{F}_{Dg}$ and $\mathcal{F}_{Mg}$ denote the set of domestic and importer firms within g, respectively.

B.5.2 Firm-Level Responses

Equation (A.23) still holds for every firm f supplying good g,

$$
d\log q_{gf} = -\beta_{gf}^q(d\log c_{gf} - d\log c_g) - \eta d\log c_g + d\log Q.
$$

where $d\log Q = (\eta-1)d\log P + d\log C$ and $d\log P = \sum_g e_g d\log c_g$ (with $e_g = E_g/E$).

As in the baseline model,

$$\beta^q_{gf} = \frac{\sigma}{1+\rho_{gf}}, \quad \rho_{gf} = \frac{(\sigma-\varepsilon_{gf})(\sigma-1)}{\varepsilon_{gf}(\varepsilon_{gf}-1)}, \quad \varepsilon_{gf} \equiv \sigma - (\sigma-\eta)e_{gf}.$$

For importers ($h = D$) and domestic firms ($h = D$) within good g, the demand elasticity is

$$\varepsilon_{gf} \equiv \sigma - \kappa_{hg} e_{hgf} \quad \text{where} \quad e_{hgf} \equiv \frac{e_{gf}}{\sum_{f' \in \mathcal{F}_{hg}} e_{gf'}}$$

with $\kappa_{hg} \equiv (\sigma-\eta)e_{hg}$ and $e_{hg} \equiv \sum_{f' \in \mathcal{F}_{hg}} e_{gf'}$. Note that $\kappa_{Dg} + \kappa_{Mg} = \sigma - \eta$.

Recall that cost and revenue are decreasing with marginal cost across firms within the same group. Thus, the expressions above imply that

$$\beta^q_{gf} = \beta^q(u_{hgf}, \kappa_{hg})$$

where $u_{hgf} \equiv U_{gf} / \sum_{f \in \mathcal{F}_{hg}} U_{gf'}$ is firm f's share of total cost among firms of its type within good g, with $U_{gf} \equiv c_{gf} q_{gf}$.

As in the baseline model, firms with a lower demand elasticity respond to shocks by adjusting more their markups and less their quantities. In this case, lower demand elasticity is associated with higher within-type cost share (i.e., higher u_{hgf}) or between-type cost share (i.e., higher κ_{hg}). Thus,

$$\beta^q(0,\kappa) = \sigma, \quad \frac{\partial \beta^q(u,\kappa)}{\partial u} < 0, \quad \text{and} \quad \frac{\partial \beta^q(u,\kappa)}{\partial \kappa} < 0.$$

This suggests that, given the elasticity intercept $\beta^q(0,\kappa) = \sigma$, a steeper slope of the import elasticity function is associated with stronger competition among importers (i.e., higher κ_{Mg}) and, thus, a higher share of importer firms in domestic spending (i.e., higher e^M_g and lower e^D_g).

B.5.3 Aggregate Responses

Changes in good-level price indices are given by

$$d\log c_g = \omega^D_g d\log w + (1-\omega^D_g) d\log c^M_g$$

where

$$d\log c^M_g \equiv \sum_{f \in \mathcal{F}_{Mg}} \frac{M_{gf}\mu_{gf}\beta^q_{gf}}{\sum_{f' \in \mathcal{F}_{Mg}} M_{gf'}\mu_{gf'}\beta^q_{gf'}} d\log c_{gf}$$

$$\omega^D_g \equiv \frac{\sum_{f \in \mathcal{F}_{Dg}} W_{gf}\mu_{gf}\beta^q_{gf}}{\sum_{f \in \mathcal{F}_g} U_{gf}\mu_{gf}}.$$

Thus,

$$d\log P = \sum_g e_g \omega^D_g d\log w + \sum_g e_g (1-\omega^D_g) d\log c^M_g$$

with $e_g \equiv \sum_{f\in\mathcal{F}_g} U_{gf}\mu_{gf}/E$.

For domestic firms, we have that

$$\begin{aligned} d\log q_{gf} = & + \left[-\beta^q_{gf}(1-\omega^D_g) - \eta\omega^D_g + (\eta-1)\textstyle\sum_{g'} e_{g'}\omega^D_{g'}\right] d\log w \\ & + \left[(\beta^q_{gf}-\eta)(1-\omega^D_g)d\log c^M_g + (\eta-1)\textstyle\sum_{g'} e_{g'}(1-\omega^D_{g'})d\log c^M_{g'}\right] \\ & + d\log C \end{aligned}$$

Labor market clearing requires $0 = \sum_g \ell_g \sum_{f\in\mathcal{F}^D_g} \ell_{gf} d\log q_{gf}$. This implies that

$$d\log w = \beta^w(d\log C + d\log c^w)$$

where

$$(\beta_w)^{-1} \equiv \sum_g \ell_g \sum_{f\in\mathcal{F}^D_g} \ell_{gf}\left[\beta^q_{gf}(1-\omega^D_g) + \eta\omega^D_g\right] - (\eta-1)\sum_g e_g\omega^D_g$$

$$d\log c^w \equiv \sum_g (1-\omega^D_g)\left(\ell_g \sum_{f\in\mathcal{F}^D_g} \ell_{gf}(\beta^q_{gf}-\eta) + (\eta-1)e_g\right) d\log c^M_g$$

Thus,

$$d\log c_g = \omega^D_g\beta^w(d\log C + d\log c^w) + (1-\omega^D_g)d\log c^M_g$$

$$d\log Q = (1+\beta^w(\eta-1)\omega^D)d\log C + \beta^w(\eta-1)\omega^D d\log c^w + (\eta-1)d\log c^M$$

with $\omega^D \equiv \sum_g e_g\omega^D_g$ and $d\log c^M \equiv \sum_g e_g(1-\omega^D_g)d\log c^M_g$.

Finally, by substituting all these expressions into (A.23),

$$\begin{aligned} d\log q_{gf} &= -\beta^q_{gf}(d\log c_{gf} - (1-\omega^D_g)d\log c^M_g) \\ &- \eta\left((1-\omega^D_g)d\log c^M_g - d\log c^M\right) \\ &+ \beta^{qw}d\log c^w - d\log c^M + \beta^{qC}d\log C \end{aligned} \quad \text{(B.69)}$$

with

$$\beta^{qC} \equiv (1+\beta^w(\eta-1)\omega^D) - \eta\omega^D_g\beta^w - \beta^q_{gf}\omega^D_g\beta^w$$

$$\beta^{qw} \equiv \beta^w(\eta-1)\omega^D - \eta\omega^D_g\beta^w - \beta^q_{gf}\omega^D_g\beta^w$$

B.5.4 Aggregate Welfare

Following the same steps of the derivation of equations (A.37), we obtain

$$\begin{aligned} dC &= \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}^D_g} \Pi_{gf} d\log q_{gf} \\ &+ \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}^M_g} (\Pi_{gf} + T_{gf}) d\log q_{gf} \\ &- \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}^M_g}\sum_{v\in\mathcal{V}} T_{vgf}\theta(d\log p_v - d\log c_{gf}) \\ &- \textstyle\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}^M_g}\sum_{v\in\mathcal{V}} V_{vgf} d\log p^W_v \end{aligned}$$

In combination with (B.69), this expression implies that

$$
\begin{aligned}
dC &= \chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^D}\Pi_{gf}\beta^q_{gf}(1-\omega^D_g)d\log c^M_g \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}(\Pi_{gf}+T_{gf})\beta^q_{gf}(d\log c_{gf}-(1-\omega^D_g)d\log c^M_g) \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}(\Pi_{gf}+T_{gf})\eta\left((1-\omega^D_g)d\log c^M_g - d\log c^M\right) \\
&+\chi \left[\chi^w d\log c^w - (\Pi^M+\Pi^D+T)d\log c^M\right] \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}\sum_{v\in\mathcal{V}}T_{vgf}\theta(d\log p_v - d\log c_{gf}) \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}\sum_{v\in\mathcal{V}}V_{vgf}d\log p^W_v
\end{aligned}
\tag{B.70}
$$

where

$$
(\chi)^{-1} \equiv 1 - \frac{\Pi^M+\Pi^D+T}{E}\beta^{qC} + \beta^w \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^D}\frac{\Pi_{gf}\beta^q_{gf}}{E}
$$

$$
\chi^w \equiv (\Pi^M+\Pi^D+T)\beta^{qw} - \beta^w \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^D}\Pi_{gf}\beta^q_{gf}
$$

This yields the same components of welfare changes. The component of markup distortions is

$$
\begin{aligned}
dC^{MD} &= \chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^D}\Pi_{gf}\beta^q_{gf}(1-\omega^D_g)d\log c^M_g \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}\Pi_{gf}\beta^q_{gf}(d\log c_{gf}-(1-\omega^D_g)d\log c^M_g) \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}\Pi_{gf}\eta\left((1-\omega^D_g)d\log c^M_g - d\log c^M\right) \\
&+\chi \left((\Pi^M+\Pi^D)\beta^{qw} - \beta^w\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^D}\Pi_{gf}\beta^q_{gf}\right)d\log c^w - \chi(\Pi^M+\Pi^D)d\log c^M
\end{aligned}
$$

The component of tariff distortions is

$$
\begin{aligned}
dC^{TD} = &-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}T_{gf}\beta^q_{gf}(d\log c_{gf}-(1-\omega^D_g)d\log c^M_g) \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g}T_{gf}\eta\left((1-\omega^D_g)d\log c^M_g - d\log c^M\right) \\
&+\chi\, T\left[\beta^{qw}d\log c^w - d\log c^M\right] \\
&-\chi \sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}\sum_{v\in\mathcal{V}}T_{vgf}\theta(d\log p_v - d\log c_{gf})
\end{aligned}
$$

The component of terms of trade changes is

$$
dC^{ToT} \equiv -\chi\sum_{g\in\mathcal{G}}\sum_{f\in\mathcal{F}_g^M}\sum_{v\in\mathcal{V}}V_{vgf}d\log p^W_v .
$$

B.5.5 Measurement

To compute dC in (B.70), we need the same requirements of the baseline model (as described in Section A.3.5) in addition to: (i) good-specific import elasticity functions, $\beta^q_{Mg}(m)$; and (ii) payroll of domestic firms, W_{gf}.

To see this, consider the firm-level import elasticity for each good g, $\beta^q_{Mg}(m) \equiv \beta^q(m,\kappa^M_g)$. Since the same mappings in (A.14)–(A.15) hold, we have that $\mu_{gf} = \mathcal{M}(\beta_{gf})$ and $\varepsilon_{gf} = \varepsilon(\beta_{gf})$.

This immediately yields the markup of every importer firm: $\mu_{gf} = \mathcal{M}(\beta^q_{Mg}(m))$ for $f \in \mathcal{F}_{Mg}$.

To obtain markups and elasticities for domestic firms, note that $\kappa_{Mg} = \sigma - \varepsilon(\beta^q_M(1, \kappa_{Mg}))$, which implies that $e_{Mg} = \kappa_{Mg}/(\sigma - \eta)$ and $\kappa_{Dg} = \varepsilon(\beta^q_M(1, \kappa_{Mg})) - \eta$. We set $\beta_{gf} = \beta^q(u_{Dgf}, \kappa^D_g)$ and $\mu_{gf} = \mathcal{M}(\beta_{gf})$ for all $f \in \mathcal{F}_{Dg}$, where $\beta^q(.,.)$ is the function implied by $\beta^q_{Mg}(m)$ given the recovered κ^M_g.

We can then proceed as in the baseline model to compute all the terms in (B.70). In particular, we compute each firm's cost as $U_{gf} = W_{gf}$ for $f \in \mathcal{F}_{Dg}$ and $U_{gf} = M_{gf}$ for $f \in \mathcal{F}_{Mg}$. For each firm, this yields profits ($\Pi_{gf} = (\mu_{gf} - 1)U_{gf}$), sales ($E_{gf} = \mu_{gf} U_{gf}$) and pass-through weights ($\omega_{gf} = U_{gf}\mu_{gf}\beta^q_{gf} / \sum_{f \in \mathcal{F}_g} U_{gf'}\mu_{gf'}\beta^q_{gf'}$).

C Empirical Appendix

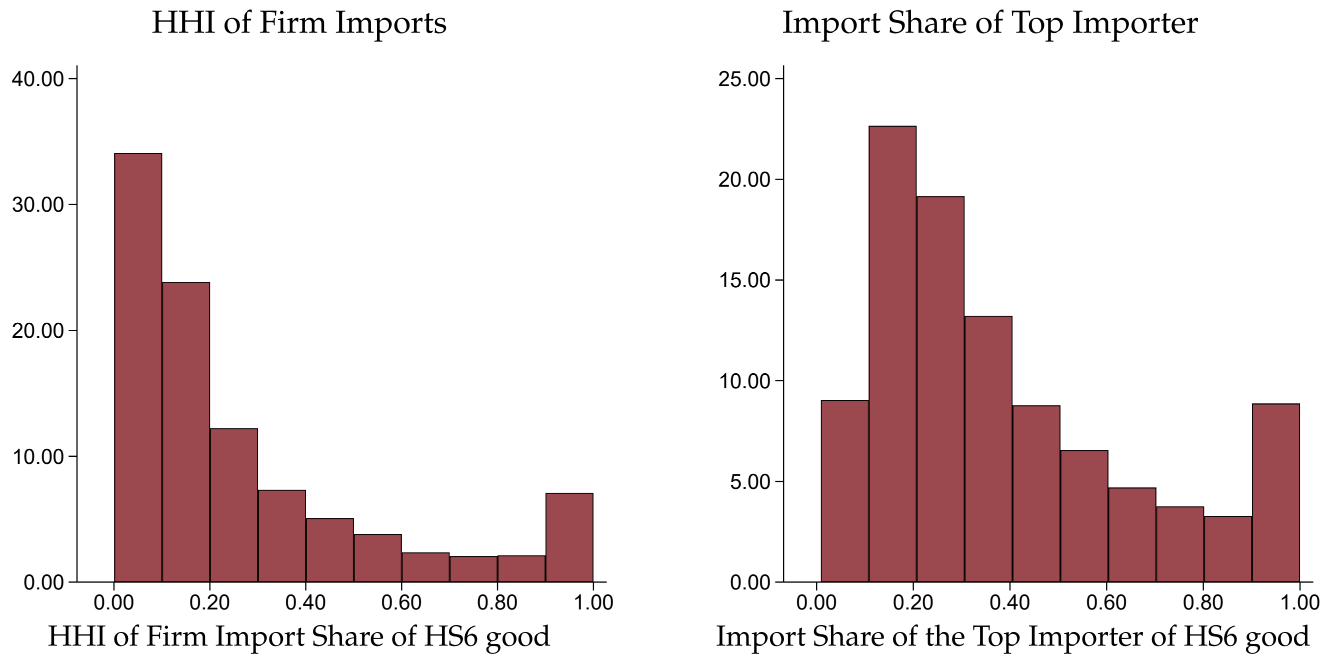
C.1 Importer Firm Concentration Across Countries

C.1.1 Summary Statistics

Table C.1: Countries and Years in Importer Database

Country	Years	Country	Years
Albania[44]	2007 - 2022	Lao PDR	2015 - 2022
Burundi	2010 - 2022	Sri Lanka	2016 - 2022
Benin	2016 - 2021	Morocco	2002 - 2013
Bangladesh	2005 - 2016	Madagascar	2007 - 2021
Bulgaria	2001 - 2006	Mexico	2011 - 2022
Botswana	2004 - 2010	Macedonia	2008 - 2018
Chile	1997 - 2022	Montenegro	2004 - 2020
Cote d'Ivoire[44]	2000 - 2021	Mauritius[44]	2000 - 2022
Cameroon[44]	2007 - 2017	Malawi	2005 - 2021
Colombia	1997 - 2022	Nepal	2011 - 2014
Comoros	2016 - 2022	Pakistan	2019 - 2022
Cabo Verde	2010 - 2021	Peru	2000 - 2021
Costa Rica	2010 - 2021	Paraguay	2000 - 2022
Dominican Republic	2002 - 2021	Romania	2005 - 2011
Ecuador	2002 - 2021	Rwanda[44]	2002 - 2016
Egypt	2005 - 2016	Senegal	2000 - 2020
Ethiopia[44]	2012 - 2021	El Salvador	2006 - 2021
Gabon	2009 - 2021	Serbia	2006 - 2019
Georgia	2000 - 2022	Sao Tome and Principe	2017 - 2019
Guinea Bissau	2012 - 2018	Togo	2015 - 2021
Guatemala	2005 - 2013	Timor-Leste	2018 - 2022
Honduras	2012 - 2022	Tanzania[44]	2003 - 2021
Croatia	2007 - 2015	Uganda	2011 - 2020
Indonesia	2020 - 2020	Uruguay	2001 - 2022
India	2016 - 2022	Viet Nam	2018 - 2022
Jordan	2008 - 2021	Kosovo	2013 - 2019
Kenya	2006 - 2022	South Africa	2010 - 2021
Cambodia	2016 - 2022	Zambia	2010 - 2021
Armenia	2018 - 2022		

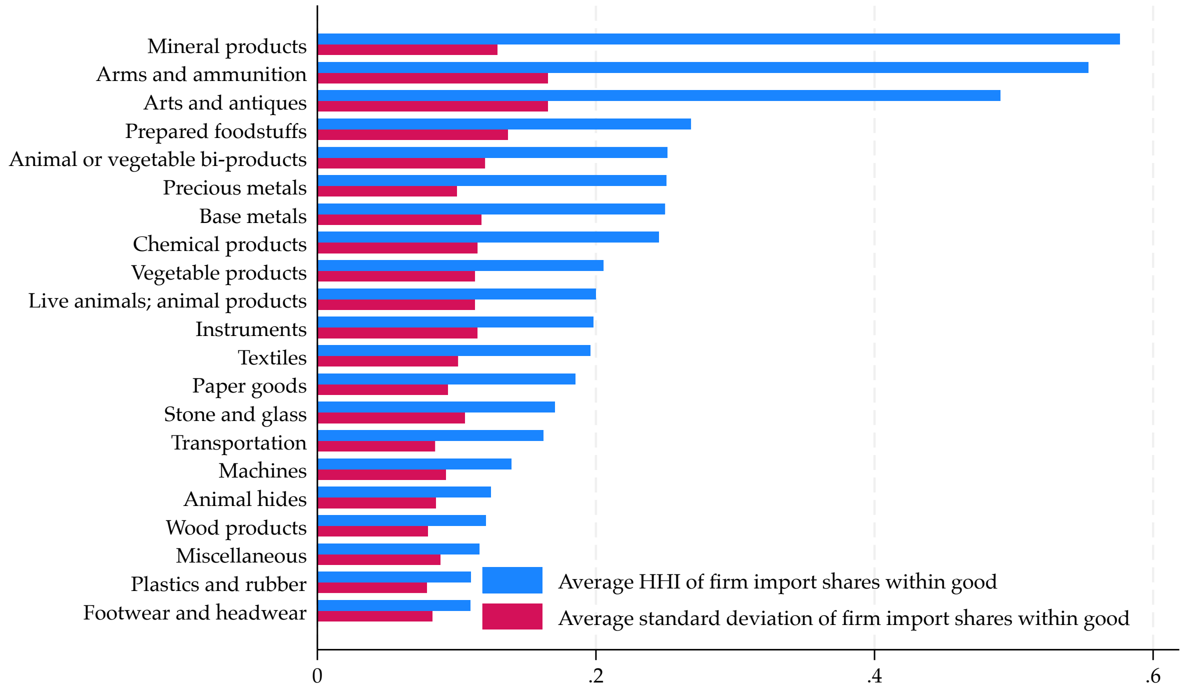
Figure C.1: Between-Good Dispersion in Importer Concentration Across Countries



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.

[44]Sample excludes the years 2016 for Albania, 2007–2009 for Cote d'Ivoire, 2012 for Cameroon, 2016 for Ethiopia, 2009 for Mauritius, 2008 for Rwanda, and 2011 and 2013 for Tanzania. These gaps in the sample arise due to either unavailable data or changes in firm identifiers across years.

Figure C.2: Average Importer Concentration by HS Section



Note: Figure reports the import-weighted average of the measure of importer concentration across good-destination-year observations for which the HS6 product belongs to the HS section in the row.

C.1.2 Additional Results

This section presents additional results that complement those presented in Section 3.

Table C.2 examines the robustness of the univariate relationships in Figure 4. The first column reports coefficient estimates from a regression of the standard deviation of firm import shares in a good-country-year on the two variables of interest after controlling for good-year fixed effects to account for the composition of imported goods in each country-year. We obtain estimated coefficients on log GDP per capita and log population that are negative and precise.

The second column shows that these relationships are not fully explained by the size of the import market, measured as the log imports in the good-country-year. The third column shows that within-good dispersion declines with the number of importers and multi-product importers. However, even accounting for number of firms, we obtain similar negative coefficients for the country's income and size. Lastly, the fourth and fifth columns also control for good-country fixed effects, so that we only exploit variation over time for the same country and good. This leads to point estimates that are even more negative albeit less precisely estimated.

Table C.2: Within-Good Dispersion of Importer Concentration vs. GDP/capita and Population

	St. dev. of firm import shares				
log GDP/capita	-0.015***	-0.014***	-0.010***	-0.045***	-0.065***
	(0.001)	(0.002)	(0.002)	(0.011)	(0.016)
log Population	-0.008***	-0.008***	-0.005***	-0.032**	-0.048**
	(0.001)	(0.001)	(0.001)	(0.015)	(0.019)
log Imports		-0.001	0.004***	0.018***	0.015***
		(0.001)	(0.001)	(0.001)	(0.001)
log Importers			-0.007	-0.015	
			(0.006)	(0.011)	
log Multi-good Importers			-0.013**	-0.004	
			(0.006)	(0.011)	
R-squared	0.334	0.334	0.364	0.716	0.712
Fixed Effects:					
HS6-Destination	No	No	No	Yes	Yes
HS6-Year	Yes	Yes	Yes	Yes	Yes

Note: Table reports regressions of the standard deviation of firm import shares in each good-destination-year for a sample of 1,757,466 good-destination-year observations on the variables listed in the rows. Observations are weighted by their share of the destination's imports in a given year. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

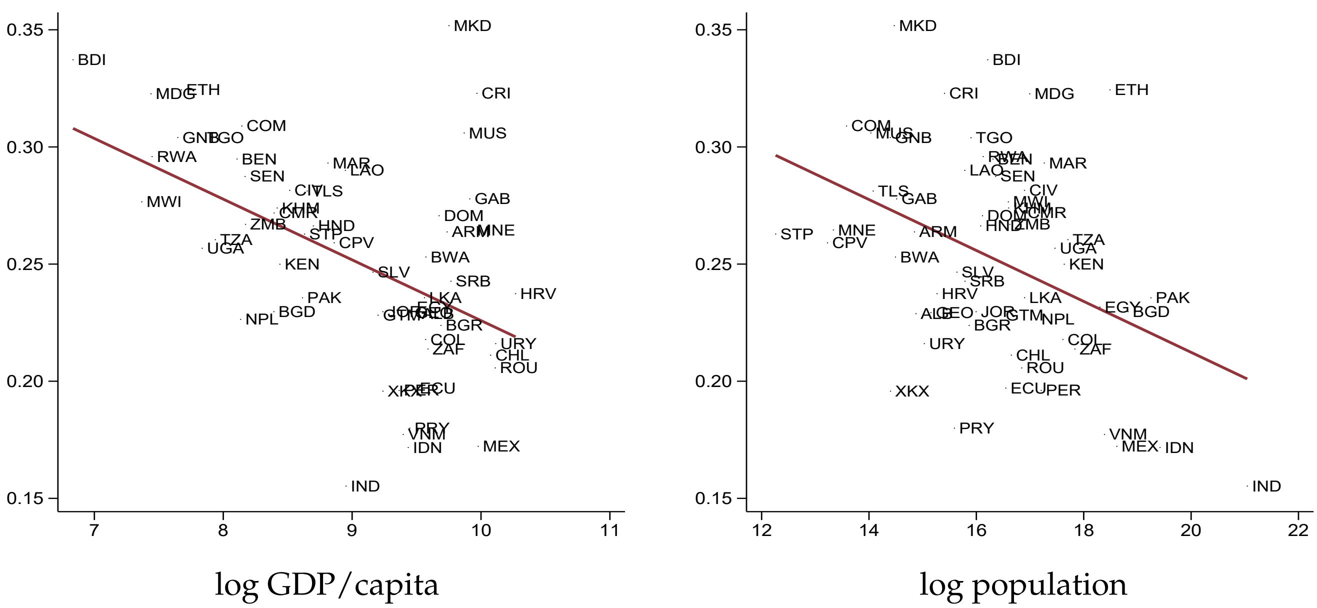
Next, Table C.3 probes the robustness of the relationship reported in Figure 5. The first column introduces log GDP per capita and log population in the same regression, and shows that the negative relationships in Figure 5 hold for both variables simultaneously. The second column shows that these findings hold conditional on the country's trade openness. The last column shows that, when controlling for country fixed effects, coefficients are again larger in magnitude, but less precise. Lastly, Figure C.3 shows similar results when using all HS6 goods instead of the common subset used in Figure 5.

Table C.3: Between-Good Dispersion in Import Concentration vs. GDP/capita and Population

	St. dev. of HHI across goods		
log GDP/capita	-0.043***	-0.046***	-0.102**
	(0.004)	(0.010)	(0.048)
log Population	-0.016***	-0.018**	-0.119*
	(0.003)	(0.008)	(0.067)
log Imports		0.002	0.029
		(0.008)	(0.021)
R^2	0.472	0.472	0.754
Fixed Effects:			
Destination	No	No	Yes
Year	Yes	Yes	Yes

Note: Table reports regressions of the import-weighted standard deviation of HHI of a HS6 good across the subset of common HS6 goods for each destination-year for a sample of 704 destination-year observations on the variables listed in the rows. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

Figure C.3: Between-Good Dispersion in Importer Concentration Across Countries



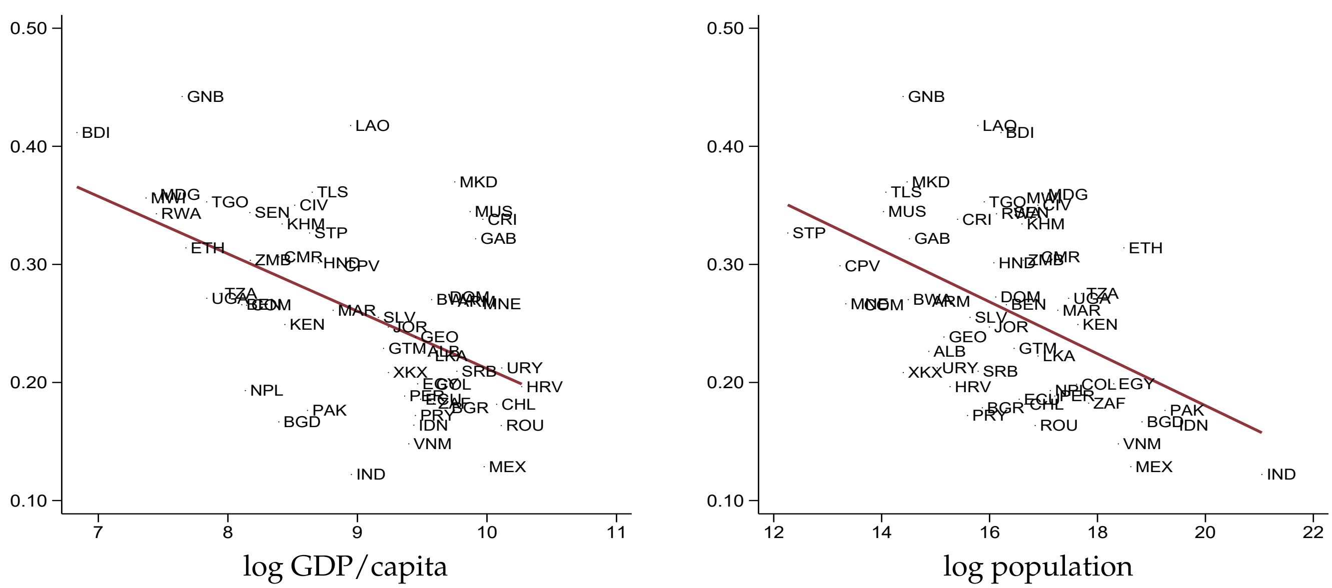
Note: Figure shows between-good dispersion in importer concentration against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each destination, between-good dispersion in importer concentration is the simple average across years of the import-weighted standard deviation across HS6 goods of their HHI of firm import shares.

C.1.3 Average Importer Concentration

The average markup of imported goods increases with the average HHI of firm import shares across goods.[45] Thus, we measure a country's average importer concentration as the import-weighted average of the HHI of firm import shares across goods.

Figure C.4 reports a scatter plot of each country's average import firm concentration against log GDP per capita (left panel) and log population (right panel), with values averaged over years in our sample. The figure shows that not only is the dispersion of concentration (both between and within goods) higher in poorer and smaller countries, but average import firm concentration is also higher in these countries. Table C.4 shows that our findings are robust to controlling for good-year fixed effects (column 1), the size of the import market (column 2), the number of importers and multi-product importers (column 3), and destination-good fixed effects (columns 4 and 5).

Figure C.4: Average Importer Concentration Across Countries



Note: Figure shows average import firm concentration in the country against log GDP per capita (left panel) or log population (right panel) in our sample of 57 countries. For each country, average import firm concentration is the simple average across years of the import-weighted average across goods of their HHI of firm import shares.

[45]Using the same first-order approximation of a firm's markup around that of a firm with a negligible import share ($m \approx 0$), we obtain $\bar{\mu} = E_g[\bar{\mu}_g] \approx \sigma/(\sigma-1) + \kappa E_g[\text{HHI}_g]$, with $E_g[.]$ denoting the import-weighted average across goods.

Table C.4: **Average Importer Concentration vs. GDP/capita and Population**

	HHI of firm import shares				
log GDP/capita	-0.062***	-0.068***	-0.043***	-0.074***	-0.215***
	(0.004)	(0.005)	(0.005)	(0.021)	(0.044)
log Population	-0.038***	-0.043***	-0.026***	-0.104***	-0.217***
	(0.004)	(0.004)	(0.004)	(0.034)	(0.051)
log Imports		0.006**	0.037***	0.080***	0.056***
		(0.003)	(0.004)	(0.004)	(0.004)
lop Importers			-0.026	-0.040***	
			(0.023)	(0.013)	
log Multigood Importers			-0.095***	-0.096***	
			(0.024)	(0.012)	
R-squared	0.334	0.334	0.364	0.716	0.712
Fixed Effects:					
HS6-Destination	No	No	No	Yes	Yes
HS6-Year	Yes	Yes	Yes	Yes	Yes

Note: Sample of 1,757,466 good-destination-year observations. Table shows coefficients from regressions of HHI of firm import shares in each good-destination-year on the variables listed on the rows. All regressions include good-year and year fixed effects. Observations weighted by its share of the destination's imports in a given year. Standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1

C.2 Estimates of Import Responses to Tariff Changes

C.2.1 Estimation: Functional Basis for $\beta(m)$

This appendix details the estimation of the function $\beta(m)$. The empirical pattern in the data suggests a concave relationship that eventually flattens at high market shares. To capture this pattern, we adopt a piecewise function that combines linear and quadratic segments, following the spline regression approach described in Harrell (2015). This approach allows us to estimate a flexible, nonlinear relationship while maintaining both computational simplicity and the ability to impose economic structure through our choice of thresholds and functional form.

Given that m ranges between 0 and 1, we set threshold points at $m_1 = 0.05$ and $m_2 = 0.5$. The choice of $m_2 = 0.5$ reflects the sparsity of observations at high market shares (less than 5% of the sample has $m > 0.5$). We specify:

$$\beta(m) = \begin{cases} a_0 + a_1\, m & \text{if } m \leq m_1 \\ a_2 + a_3\, m + a_4\, m^2 & \text{if } m \in [m_1, m_2] \\ a_5 & \text{if } S \geq m_2 \end{cases} \tag{C.1}$$

To ensure the function is well-behaved at the threshold points, we impose continuity and differentiability at m_1 and m_2. The continuity conditions ensure the function has no jumps, while the differentiability conditions (also known as smooth pasting conditions) ensure there are no kinks.

Our goal is to transform this piecewise function into a form that facilitates straightforward estimation. Specifically,

$$\beta(m) = a_0 + a_1 H(m) \tag{C.2}$$

where $H(m)$ depends only on the threshold parameters m_1 and m_2. This transformation allows us to estimate $\beta(m)$ using a simple linear regression once we construct $H(m)$ from the data.

To derive $H(m)$, we first solve for the parameters a_2 through a_5 in terms of a_0 and a_1. Starting with the smooth pasting condition at m_2 and working backwards through the continuity conditions, we obtain expressions for all parameters. After substitution and rearrangement, we can write $H(m)$ in terms of three auxiliary functions:

$$\begin{aligned} \tilde{m}_1(m) &= \min\{m, m_1\} \\ \tilde{m}_2(m) &= \min\{m, m_2\} \\ \tilde{m}(m) &= \max\{\tilde{m}_2(m) - m_1, 0\} \end{aligned} \tag{C.3}$$

These auxiliary functions allow us to write:

$$H(m) = \tilde{m}_1(m) + \tilde{m}(m)\frac{2m_2 - (\tilde{m}_2(m) + m_1)}{2(m_2 - m_1)} \tag{C.4}$$

Given our chosen values of $m_1 = 0.05$ and $m_2 = 0.5$, we can construct $H(m)$ directly from the data. The estimation of $\beta(m)$ then reduces to a linear regression of the observed import elasticities on a constant and $H(m)$, where the estimated coefficients correspond to a_0 and a_1 respectively.

C.2.2 Trade Liberalization Episodes

In this section, we describe the trade liberalization episodes in our sample. Table C.5 reports the set of countries with at least one year that satisfies the criteria described in Section 4.1 to define a liberalization episode. The table also reports the initial and final years of the panel of importer firms in each country, along with the number of continuing firms with imports in two consecutive years in the sample.

We next turn to the determinants of tariff changes in the sample of liberalization episodes. Specifically, we estimate the following specification:

$$\ln(1+\tau_{og,dt_f}) - \ln(1+\tau_{og,dt_0}) = \alpha \ln(1+\tau_{og,dt_0}) + \delta_d + \epsilon_{og,dt} \quad \text{(C.5)}$$

where t_0 and t_f are the initial and final years across liberalization episodes for destination d, and δ_d is a destination fixed-effect. For each destination, the coefficient α captures the tariff change across all episodes that is explained by its initial level.

Table C.6 presents the estimates of (C.5) for the pooled sample of all countries with a liberalization episode. The negative coefficient in column (1) indicates that origin-good pairs with higher initial tariffs experienced larger tariff reductions during liberalization episodes. The R-squared indicates that initial tariffs explain more than 45% of the variation in tariff changes in our sample. Columns (2) and (3) show that this negative relationship is robust to the inclusion of origin-episode fixed effects and to weighting origin-good pairs by their initial import values. Column (4) reports estimates of (C.5) using origin-good-destination-year observations with non-zero tariff changes for all years in which liberalization episodes occurred in a given destination. In this specification, the coefficient is smaller, reflecting the fact that tariff changes may have been implemented gradually over multiple years. Finally, column (5) further shows that the relationship is even stronger—and accounts for a larger share of variation in tariff changes—when we restrict the sample to origin-good pairs with non-zero tariff changes; that is, those directly affected by the liberalization episodes. In this subsample, initial tariffs explain 49% of the variation in tariff changes.

Table C.7 also reports estimates of (C.5) separately for each country, that is, we estimate α_d for each destination in the sample. All countries with a liberalization episode display a negative relationship between initial tariffs and tariff changes across origin-good pairs.

Table C.5: Estimation Sample

Country	Initial year	Final year	N. of continuing importers
BGR	2001	2007	570,586
COL	2001	2017	2,209,592
DOM	2002	2017	1,622,880
EGY	2005	2017	1,122,080
GEO	2001	2017	837,572
HRV	2007	2016	1,514,991
JOR	2008	2017	287,486
MAR	2002	2014	1,319,384
MDG	2007	2017	203,182
MKD	2008	2017	644,284
MWI	2005	2017	199,698
PER	2001	2017	2,145,866
PRY	2001	2017	709,240
ROU	2005	2012	1,686,512
SLV	2006	2017	952,836
URY	2001	2017	1,112,741
Total			17,138,930

Note: We define continuing importers as firms with positive imports in two consecutive years.

Table C.6: Liberalization Episodes - Initial Tariffs vs. Tariff Changes Across Origin-Good Pairs

	(1)	(2)	(3)	(4)	(5)
	Dep. Var.: $\ln(1+\tau_{og,dt_f}) - \ln(1+\tau_{og,dt_0})$				
$\ln(1+\tau_{og,dt_0})$	-0.367***	-0.398***	-0.312***	-0.157***	-0.439***
	(0.026)	(0.032)	(0.028)	(0.010)	(0.042)
R-squared	0.457	0.506	0.441	0.372	0.494
Observations	840,351	840,344	730,464	729,124	432,047

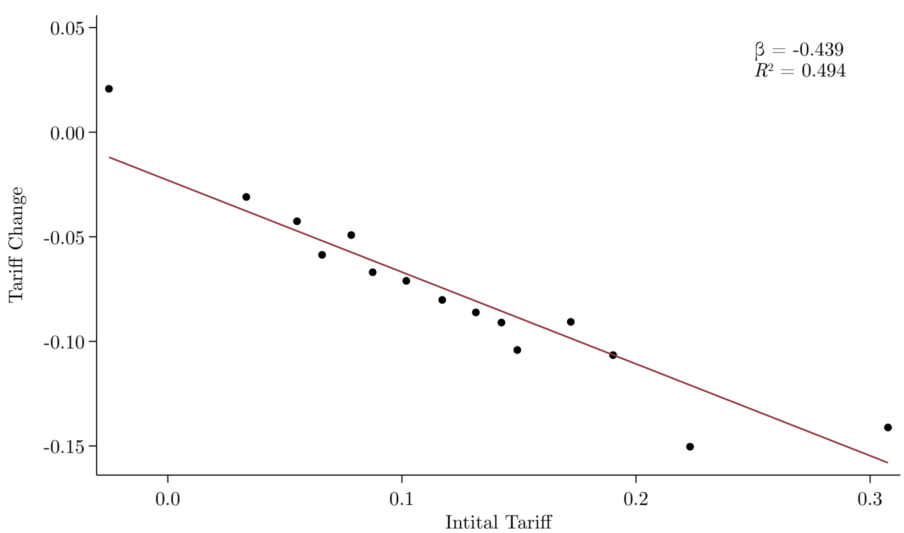
Note: Column (1) reports estimates of (C.5) for the pooled sample of origin-good-destination observations for all countries with a liberalization episode. Column (2) further controls for origin-destination fixed effects. Column (3) reports estimates of (C.5) weighted by initial imports. Column (4) reports estimates of (C.5) in the sample of origin-good-destination-year observations associated with trade liberalization episodes and non-zero tariff changes. Column (5) restricts estimation to the subset of origin-good-destination observations with non-zero tariff changes. Standard errors in parenthesis clustered by good-destination. ***p-value < 0.001

Table C.7: Liberalization Episodes - Country Specific α_d

	(1) α_d	(2) SE	(3) Correlation
BGR	-0.155	0.006	-0.321
COL	-0.486	0.009	-0.590
DOM	-0.123	0.006	-0.204
EGY	-0.151	0.040	-0.361
GEO	-0.716	0.066	-0.806
HRV	-0.695	0.011	-0.779
JOR	-0.177	0.017	-0.339
MAR	-0.616	0.007	-0.771
MKD	-0.161	0.006	-0.410
MWI	-0.083	0.008	-0.156
PER	-0.604	0.006	-0.691
PRY	-0.101	0.005	-0.199
ROU	-0.826	0.006	-0.937
SLV	-0.213	0.008	-0.637
URY	-0.082	0.003	-0.176

Note: Column (1) presents estimates of α_d obtained with (C.5) for each country with at least one liberalization episode. Column (2) reports the associated standard errors clustered by good-destination. Column (3) reports the correlation between the initial tariff and the tariff change across origin-good pairs.

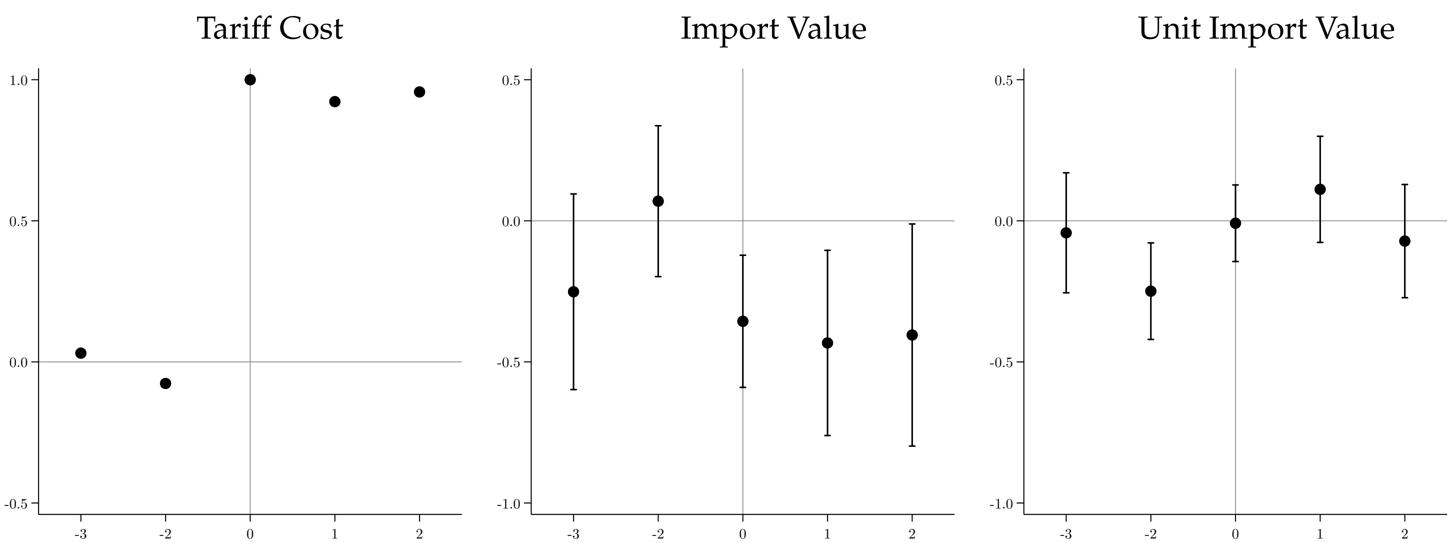
Figure C.5: Initial Tariffs and Tariff Changes



Note: Sample of 473,535 of origin-good-destination observations for which there was a tariff change over the period covering the destination's liberalization episodes. Variables residualized from destination fixed-effects. Bin scatter based on estimates from the sample of pooled countries in column (4) of Table C.6.

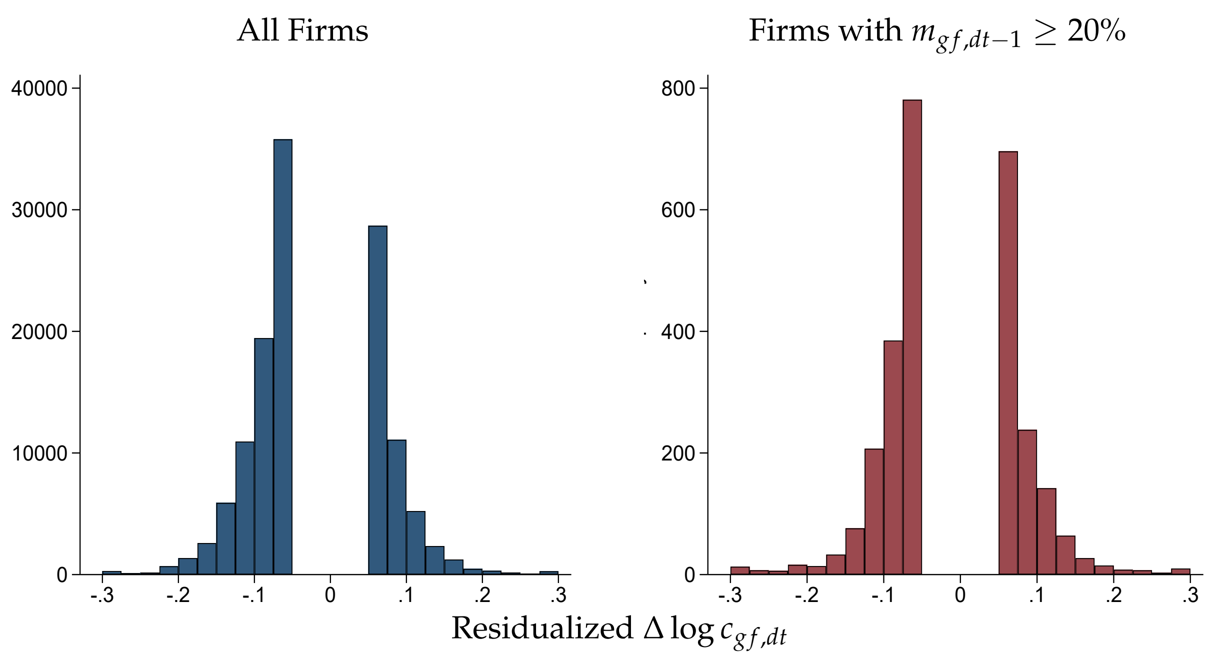
C.2.3 Additional Results

Figure C.6: Between-Origin Elasticity of Firm Imports to Tariff Changes – Alternative Fixed Effects



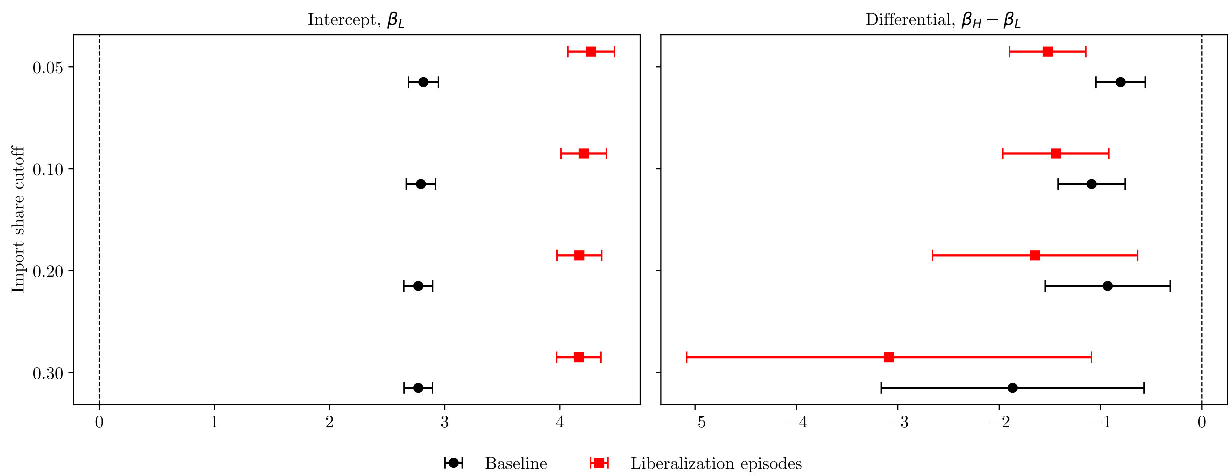
Note: Sample of 19,509,926 origin-good-firm-destination-year observations. Black circles are estimates of θ^h obtained from (9), along with 95% confidence intervals implied by standard errors (two-way) clustered by good-destination and good-origin. Red triangles are estimates controlling for destination-good-year fixed effect, instead of firm-destination-good-year fixed effects. The dependent variable is the log-change in tariff cost in the left panel ($\Delta^h \log(1+\tau_{ogd,t})$), in (tariff-exclusive) import value in the middle panel ($\Delta^h \log v_{ogfd,t}$), and in unit import value in the right panel ($\Delta^h \log p^W_{ogfd,t}$). In all regressions, we weight observations for each firm by its lagged share of imports from origin o of good g in country d.

Figure C.7: Frequency Distribution of Changes in Average Tariff Costs, $\Delta \log c_{gf,dt}$



Note: Figure shows the frequency distribution of $\Delta \log c_{gf,dt}$ residualized from good-destination-year fixed effects among firm-good-destination-year observations whose value of the residualized $\Delta \log c_{gf,dt}$ 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, $m_{gf,dt-1}$, exceeds 20%. Bin at 0.3 is $\geq .3$; bin at $-.3$ is $\leq -.3$

Figure C.8: Robustness: Alternative import shares cutoff $\bar{c}$ and estimation sample



Note: Figure shows estimates of β_L (left panel) and $\beta_H - \beta_L$ (right panel) obtained from equation (10) using the step function $\beta(m) = \beta_L + (\beta_H - \beta_L) \cdot D_H$, where $D_H = \mathbf{1}[m_{gf} > \bar{c}]$, for different import shares cutoff $\bar{c}$ as indicated in the vertical axis. Black dots are estimates obtained from the baseline sample, while red dots are obtained restricting the sample to country-year pairs in which a liberalization episode occurs as described in Section 4.1. Bars are 90% confidence with standard error clustered by firm-good-destination and good-destination-year.

Table C.8: Estimates of Elasticity of Substitution Across HS6 Goods

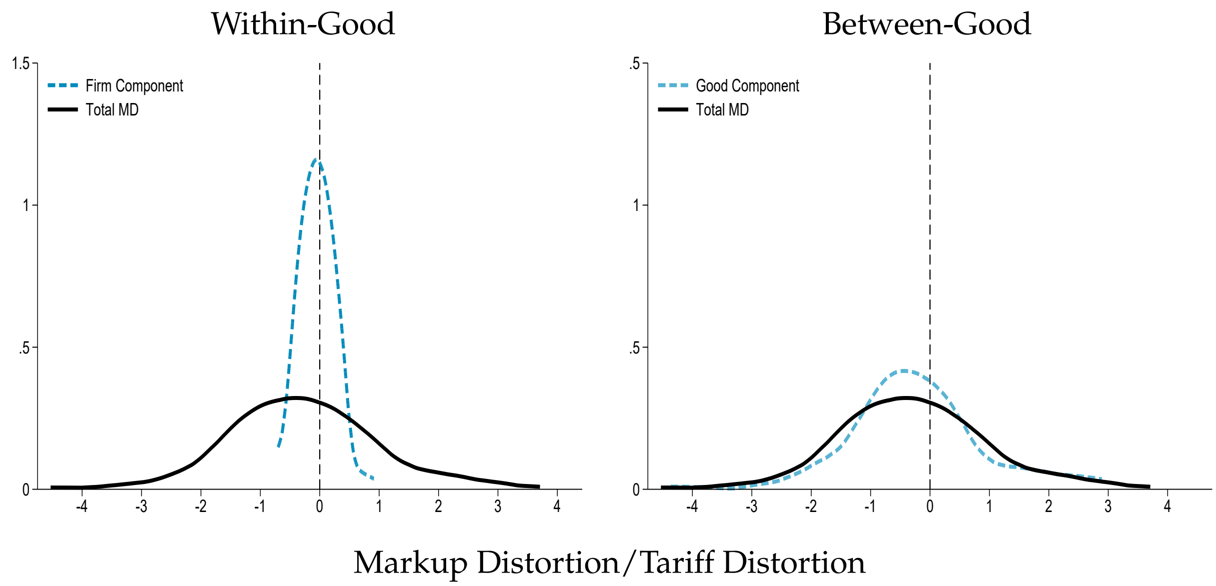
	(1)	(2)	(3)
	1.855	2.052	2.119
	(0.379)	(0.349)	(0.371)
R^2	0.038	0.061	0.092
Fixed Effects:			
Country-Year	Yes	No	No
Country-Year-HS2	No	Yes	No
Country-Year-HS4	No	No	Yes

Note: Table reports estimates of elasticity of substitution across HS6 products, η, from equations (11) with country-year fixed effects (column 1) and (11) with fixed effects for country-year-HS2 (column 2) and country-year-HS4 (column 3) from sample of 787,750 good-destination-year observations. Standard errors in parenthesis clustered by good-destination.

C.3 Counterfactual Analysis

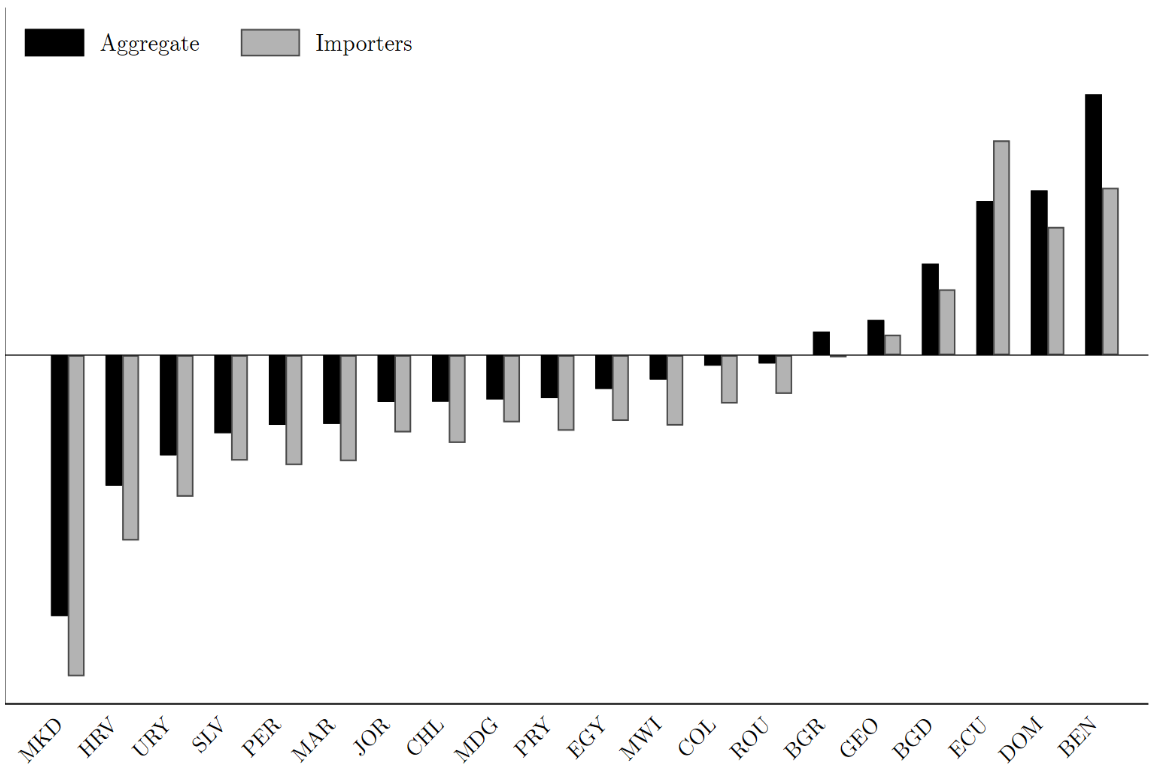
C.3.1 Additional Results

Figure C.9: Distribution of Components of Welfare Responses due to Markup Distortions



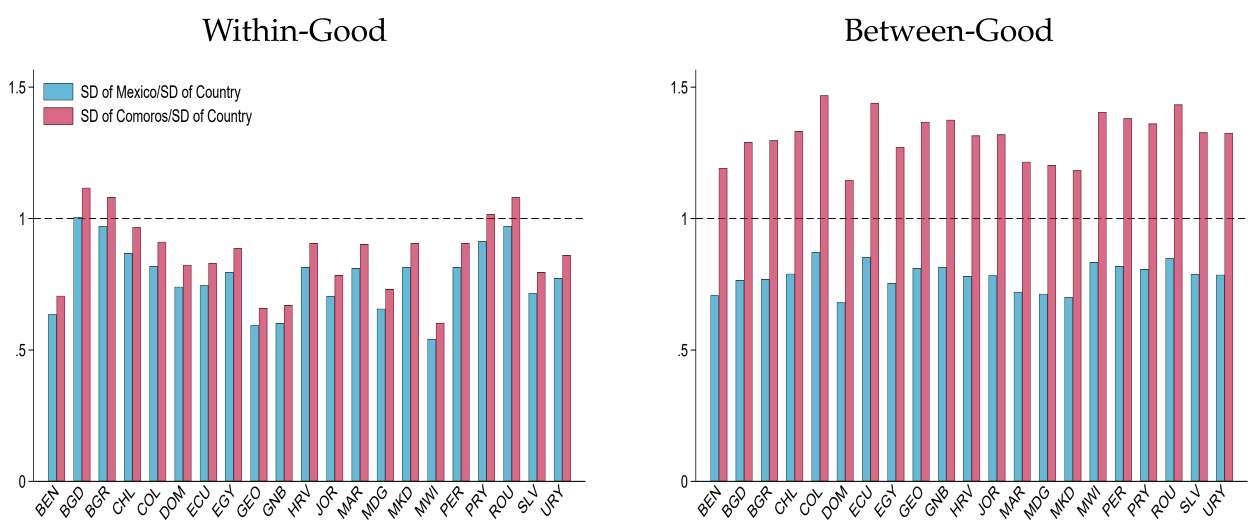
Note: Sample of 73 country-year pairs defined as liberalization episodes (excluding two episodes for which relative markup distortion is greater than 5). In both panels, black solid curve is the density across episodes of the component of aggregate welfare changes associated with markup distortions (computed with (A.39)) normalized by the component associated with initial tariff distortions (computed with (A.40)). The blue dashed curves display the firm (left panel) and good (right panel) components of welfare changes associated with markup distortions, normalized by the component of the aggregate welfare change associated with tariff distortions.

Figure C.10: Welfare Responses with Markup Distortions – Aggregate vs Importer



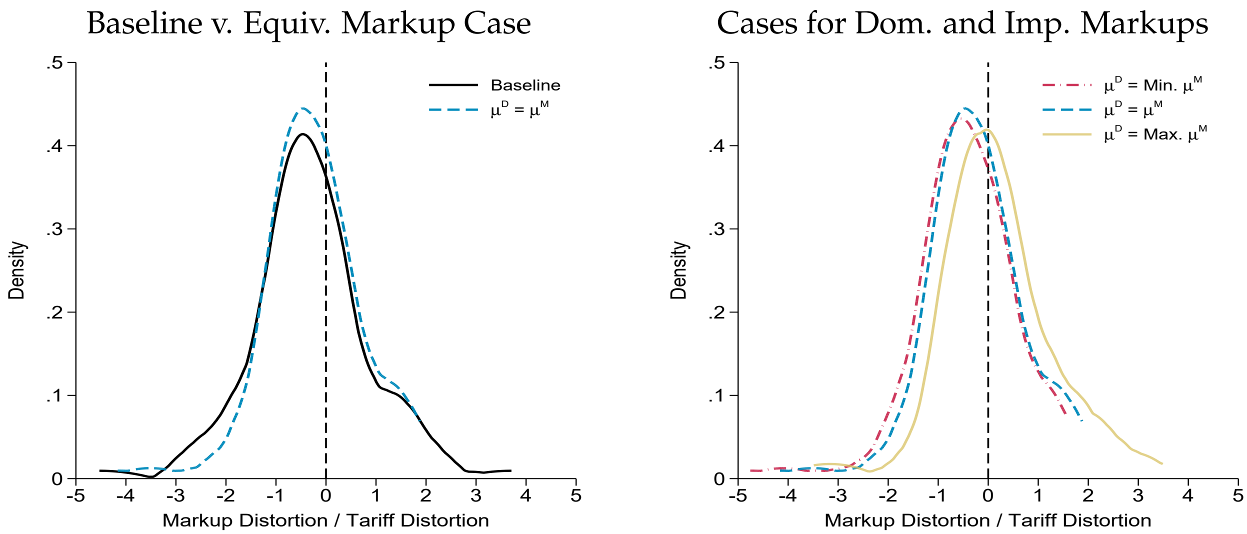
Note: Bar chart of 21 countries with at least one year defined as a trade liberalization episode. Black bars display the component of aggregate welfare changes associated with markup distortions (computed with (A.39)) normalized by the component associated with initial tariff distortions (computed with (A.40)). Gray bars display the welfare gains for importers, normalized by the component of the aggregate welfare change associated with tariff distortions. For each country, we consider welfare responses for the entire period between the initial and final years across all of its liberalization episodes.

Figure C.11: Ratio of Markup Distortion Dispersions Across Countries



Note: Bar chart of 21 countries with at least one year defined as a trade liberalization episode. The blue and the red bars display the ratio of the elasticity-adjusted markup dispersion of the episode's initial year and that of Mexico (low-dispersion) and Comoros (high-dispersion), respectively. Left and right panels display the two ratios for the within-good and between-good dispersion in elasticity-adjusted markups, respectively.

Figure C.12: Markup Distortion with Importer and Domestic Firm Reallocation (Extension B.1)



Note: Sample of 73 country-year pairs defined as liberalization episodes (excluding two episodes for which relative markup distortion is greater than 5). In both panels, blue dashed curve is the density across episodes of the component of aggregate welfare changes associated with markup distortions (computed with (B.19)) normalized by the component associated with initial tariff distortions (computed with (B.20)) for the case where the aggregate importer and domestic markups ($\bar{\mu}^M = \bar{\mu}^D$) are set equal for each episode. The left panel overlays these density estimates with the baseline results from Figure 13 (solid black curve). Right panel shows the same density under two alternative assumptions: one where aggregate domestic markup is set equal to the minimum importer markup across episodes (dot-dashed red curve), and another where aggregate domestic markup is set equal to the maximum importer markup (solid yellow curve) across episodes.

C.3.2 Case Study: Dominican Republic vs. Romania

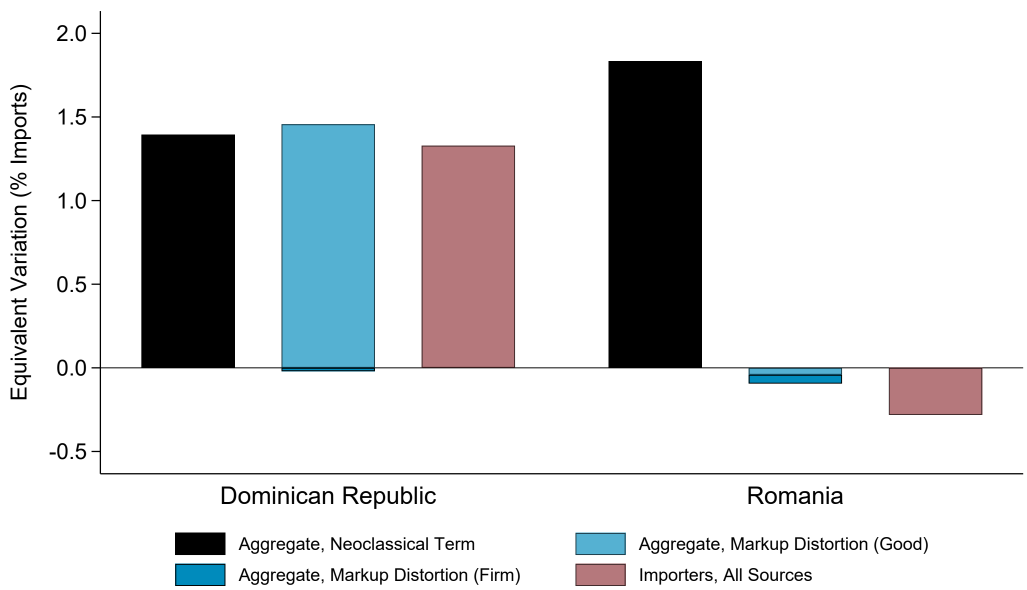
In this section, we compare two trade liberalization episodes from the mid-2000s: the Dominican Republic (DOM) joining CAFTA-DR in 2005 and Romania (ROU) joining the European Union in 2007. Appendix Figures C.13 reports the welfare responses caused by tariff changes for each country. Both episodes created similar aggregate welfare gains from reductions in tariff distortions—1.4% of initial imports in DOM and 1.8% in ROU. However, markup distortions produced markedly different aggregate welfare effects, particularly through reallocation across goods. While importer concentration caused a welfare gain of 1.4% of imports in DOM, it resulted in a welfare loss of 0.1% in ROU.

To understand why Romania's allocative gains were lower, Appendix Figure C.14 uses expression (6) to conduct a counterfactual decomposition of the sources of these welfare differences. We begin by evaluating the role of the correlation between import cost changes and initial importer concentration. Specifically, we calculate the allocative efficiency gains ROU would have realized if it had exhibited the same correlation between import cost changes and elasticity-adjusted markups as observed in DOM. This counterfactual yields allocative gains of 1.1% for ROU, largely because DOM's between-good correlation was 30 times larger—and of the opposite sign—than ROU's.

We then examine the role of differences in importer concentration between the two episodes. As a larger and richer economy prior to the shock, Romania exhibited substantially lower markup dispersion among importers than DOM, particularly across goods (see Appendix Figure C.15). To assess the impact of this difference, we simulate ROU's welfare gains under the assumption that its dispersion of elasticity-adjusted markups matched that of DOM. Under this scenario, ROU's allocative efficiency gain would have reached 1.7% of imports—surpassing DOM's actual gain of 1.4%.[46] This suggests that, had Romania exhibited the higher importer concentration observed in the Dominican Republic, its allocative gains would have been approximately 50% larger.

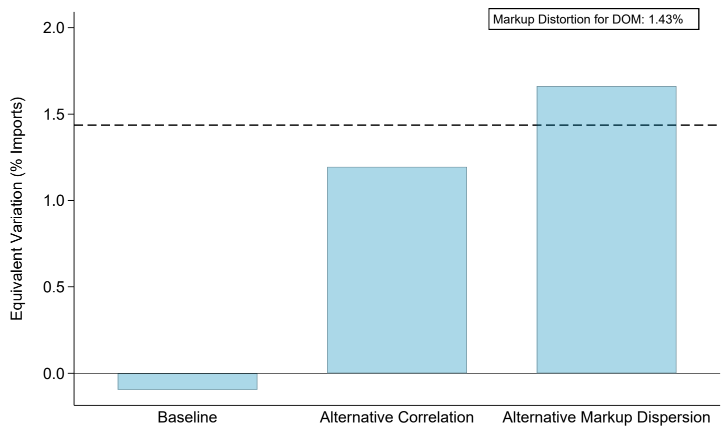
[46]ROU's larger allocative gains in this counterfactual scenario reflect the fact that, compared to DOM, it experienced greater dispersion in import cost changes—by 127% within goods and 143% between goods.

Figure C.13: Welfare Responses to Tariff Changes



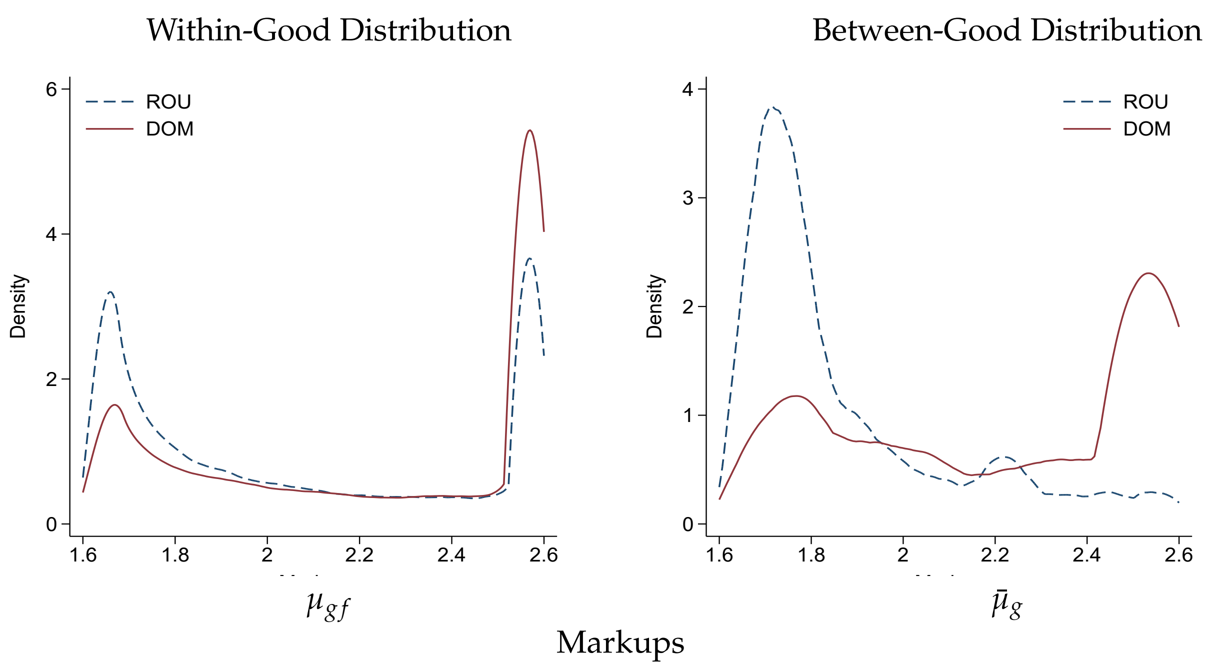
Note: The bar denotes the equivalent variation as a share of initial imports implied by different channels for two liberalization episodes (Dominican Republic in 2005-2007 and Romania in 2007-2008). The black bars are the neoclassical component associated with tariff distortions (equation (A.40)). The blue bars are the good and firm components of the aggregate effect of markup distortions (equation (A.39)). The red bars are the the gains of owners of importer firms (equation (A.43)).

Figure C.14: What if Romania had the Dominican Republic's Dispersion and Correlation of Import Cost Changes and Initial Importer Concentration?



Note: This figure decomposes the allocative efficiency effects of markup distortions for Romania in 2007-2008. The bar denotes the equivalent variation as a share of initial imports under different scenarios. The first column is the actual impact that we estimate for Romania in 2007-2008. The middle bar multiplies the markup distortion component of welfare by the ratio of the correlation between import cost changes and initial elasticity-adjusted markups in DOU and ROU, as defined by the covariances in equation (6). The third column further multiplies the second column by the ratio of the standard deviation of elasticity-adjusted markups in DOU and ROU, as defined by the covariances in equation (6).

Figure C.15: Dispersion in Markups: Dominican Republic vs. Romania



Note: The figures report the densities of estimated markups across firms within a good (left) and across goods (right). Estimated markups obtained from the markup function in Figure 8 and the distribution of firm import shares, $m_{gf,dt}$, for the Dominican Republic in 2005 and for Romania in 2007.