The Pro-Competitive Gains and Losses from Trade Around the World*

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Abstract

How do pro-competitive gains from trade vary across countries? We develop a multi-country, multi-sector model featuring rich cross-sector-country heterogeneity in (i) demand elasticities, (ii) the elasticity of import and export markups with respect to the extent of competition, and (iii) productivity, trade costs, market shares, and the number of firms. We find significant cross-country variation in the pro-competitive gains, which crucially depend on import and export shares as well as how elastic demand is for imports compared to exports. The pro-competitive gains from trade are mostly negative, positive for large countries only, and highly sensitive to sectoral tariff variation.

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1 Introduction

One of the classic arguments in favor of international trade is the fostering of competition. Especially in sectors that are dominated by a small number of firms and in which market power is potentially important, proponents of free trade agreements often argue that trade provides great benefits to consumers through reductions in markups and a more efficient allocation of resources. Further, given recent evidence that market power across the world is becoming increasingly more relevant (De Loecker and Eeckhout, 2018; De Loecker, Eeckhout and Unger, 2020), such issues are likely to be of even greater importance today than they were in the past. Surprisingly, however, even in the presence of sizable markups, recent work by Arkolakis et al. (2019) suggests that for a large class of models, such pro-competitive gains are likely to be quite small overall.

Most of the existing literature has determined the pro-competitive gains from trade for a single country, often imposing a large degree of symmetry across countries and sectors. One aspect, however, that has received little attention so far is the extent to which the pro-competitive gains from trade vary across countries and how differences across countries themselves shape these gains. In our view, this is important for at least two reasons. First, markups and the underlying degree of market power are known to vary across countries, for example, due to differences in demand, market concentration, and policy.[1] Therefore, if markups or their elasticity with respect to trade barriers differ systematically across countries, each economy will likely benefit from changes in competition to a different degree as well. Second, tariffs are rarely imposed uniformly but typically vary significantly across sectors. The extent to which countries protect low-markup versus high-markup sectors will therefore matter for the potential pro-competitive gains and provide a way for countries to affect them via policy.

We bridge this gap in the literature and develop a multi-country, multi-sector model of international trade with three key features through which markups vary across markets. First, we employ a nested CES demand structure in which demand within and across sectors is potentially differently elastic, resulting in markups that vary with the extent of competition. Second, we allow demand elasticities to be sector- and country-specific, which implies that export and import markups are potentially different across sectors and countries due to differences in demand and the extent of competition. Lastly, we allow for detailed differences in productivity distributions, trade costs, and tariffs across sectors and countries, which results in a rich degree of variation in terms of firm size distributions, market shares, and how competitive import and export markets are for each sector-country pair. Taken together, we ask to what extent these features can generate sizable differences in the elasticity of markups with respect to the extent of competition across sectors and countries and, ultimately, the pro-competitive gains from trade.

To bring our quantitative model to the data, we first estimate about 3,000 distinct sector- and country-specific import demand elasticities for a sample of 29 countries. This approach allows us to determine not only to what extent countries specialize in high- versus low-markup

[1] We follow Syverson (2019) and define market power as the ability of firms to charge a markup.

goods but also how this specialization varies across markets. Further, for each country, we estimate demand elasticities separately within and across sectors. We show that our estimates are largely consistent with previous findings and expectations and suggest for example that demand is more elastic within than across sectors and that richer economies export and import goods with, on average, lower demand elasticities than poor countries do.

On the supply side, we first follow a non-parametric approach and infer firm-level productivities *relative to* the best firm in each sector-country pair by using information on the empirical relationship between firm rank and size, the number of firms in each sector-country pair, and domestic expenditure shares. We then parameterize bilateral trade costs for each sector based on gravity variables, and employ a Simulated Method of Moments approach to estimate best-firm productivities in each sector-country pair as well as trade cost parameters by matching observed bilateral trade shares in each sector.

Our estimated parameters, including lower- and upper-tier demand elasticities, productivities, and trade costs, jointly determine equilibrium markups in each sector-country pair and, more importantly, the elasticity of markups with respect to market shares. Since markups and their elasticity with respect to market shares are at the heart of our analysis, we use external data sources—not targeted in estimation—to provide supporting evidence for and lend credence to the implied markups and their elasticities in our model. In particular, we show that our model-implied markups are positively correlated with variable profit margins as well as markups in the ORBIS firm-level data for several countries, and are negatively correlated with labor shares. We also show that the elasticity of markups with respect to market shares in the model is largely in line with that in the data.

We employ our estimated model to quantify the role of competition and variable markups in the gains from trade. To this end, we compute the so-called pro-competitive gains from trade, that is, the welfare gains in the presence of variable markups compared to those in a variant of the model with fixed markups (as in, e.g., Arkolakis et al., 2019). Our analysis delivers four main results. First, we document a high degree of dispersion in the pro-competitive gains from trade across countries, with pro-competitive gains from trade that equal between 0.4 and 0.7 percentage points in the U.S. and China and pro-competitive losses of 1.3 to 2.5 percentage points in New Zealand, Mexico, the UK, Austria, Vietnam, and the Netherlands. Interestingly, we find that, broadly consistent with Arkolakis et al. (2019), in about two-thirds of countries, the pro-competitive gains are negative, with main exceptions being larger countries such as the U.S. and China. Therefore, in the majority of cases, we find that increases in import markups in response to trade liberalization have more negative welfare effects than gains from reductions in markup dispersions across domestic firms as well as increases in export markups.

Second, we show both theoretically and quantitatively that cross-country variation in the pro-competitive gains from trade depends primarily on (1) countries' import and export shares, (2) the difference between lower- and upper-tier elasticities on imports, and (3) the difference between lower- and upper-tier elasticities on exports. Specifically, we find that countries with a lower import share and a higher export share experience consistently higher pro-competitive gains from trade, and we determine the quantitative importance of this relationship in a multi-

country environment.[2] Intuitively, while reducing trade costs results in less markup dispersion for domestic firms, it also raises the market share and, therefore, markups of foreign exporters to a country, which creates *negative* pro-competitive gains from trade (Helpman and Krugman, 1989). This channel is especially important when import shares are sizable: larger import shares imply that either a larger fraction of firms serving the domestic market are foreign firms or foreign firms are on average larger (or both). Since these firms increase markups in response to a trade liberalization, having a greater fraction of foreign firms tends to reduce the pro-competitive gains from trade. Moreover, when foreign firms are larger in a market, they increase their markups to a greater extent in response to a reduction in trade costs (Burstein, Carvalho and Grassi, 2020). A similar argument applies to export shares, but in the opposite direction: the pro-competitive gains are increasing in export shares since exporters increase their markups after trade liberalization, especially when they have a larger market share. Consequently, our results show that primarily larger economies with low import shares and high export shares experience pro-competitive gains from trade.

Third, we find that the difference between lower- and upper-tier elasticities (elasticity gap, henceforth) on imports and exports noticeably shapes cross-country heterogeneity in the pro-competitive gains from trade. Specifically, on the import side, we find that countries with *larger* inverse elasticities at the upper tier compared to those at the lower tier experience smaller pro-competitive gains from trade. Intuitively, on the one hand, foreign firms selling to these countries will increase their markups to a larger extent after a trade liberalization because of a larger gap between lower- and upper-tier elasticities, which reduces the pro-competitive gains from trade. On the other hand, the dispersion of markups across domestic producers also declines to a larger extent when there is a larger elasticity gap at home, which increases the pro-competitive gains from trade. In practice, however, we find that the latter force is typically dominated by the former one and consequently, a larger elasticity gap at home translates into smaller pro-competitive gains from trade.

On the export side, countries that face *smaller* gaps between inverse elasticities at the upper and lower tier in their export markets experience smaller pro-competitive gains from trade. Since exporters gain market shares after trade liberalization, they increase their markups, incurring an additional gain. If upper and lower-tier elasticities in export markets are similar, however, this increase in export markups and welfare will be small. Taking imports and exports together, we show a negative relationship between the pro-competitive gains from trade and the difference between upper and lower-tier elasticities on imports versus that for exports. Overall, we find that countries' import and export shares as well as the difference between lower- and upper-tier elasticities on imports and exports jointly explain 60% of cross-country variation in the pro-competitive gains from trade.

Fourth, we show that reducing the extent of cross-country-sector heterogeneity in the elasticity of import and export markups results in small, mostly negative pro-competitive gains from trade, which is consistent with the findings of Arkolakis et al. (2019). Specifically, we show

[2]This paper hence complements Arkolakis et al. (2019), who study these channels in a calibrated economy with two symmetric countries.

that our baseline model implies much larger and more dispersed pro-competitive gains and losses from trade across countries compared to alternative specifications in which we impose certain degrees of symmetry: (i) cross-country homogeneous demand elasticities, (ii) cross-country-sector homogeneous elasticities, and (iii) almost-full symmetry in which all countries share most fundamentals. The main reason behind this result is that there is much less variation in the markup elasticity in these alternative models compared to the baseline model. Hence, given the lack of sizable variation in the elasticity gap on imports versus exports, what mostly matters for the pro-competitive gains in these alternative models are import and export shares. Since import shares tend to be larger than export shares for most countries, responses in import markups are larger than those in export markups—conditional on elasticities—, rendering the pro-competitive gains mostly negative. Hence, negative and small pro-competitive gains in Arkolakis et al. (2019) appear to be robust, at least on average, to using a two-tiered CES framework (Atkeson and Burstein, 2008; Edmond, Midrigan and Xu, 2015) and non-parametric productivity distributions, in the absence of rich cross-country-sector heterogeneity. In our baseline model, however, the larger variation in the elasticity gap on imports versus exports across countries leads to sizable negative pro-competitive gains in some countries and positive pro-competitive gains in others.

In a final counterfactual exercise, we study to what extent policymakers can affect the pro-competitive gains from trade by investigating the relationship between sectoral variation in tariffs and pro-competitive effects. Specifically, we compare the outcomes of two polar counterfactuals in which the U.S. either taxes sectors with low import shares and a low difference between upper- and lower-tier elasticities, or sectors for which both measures are high. We find that the pro-competitive gains are relatively large and equal 0.21 percentage points in the former case, compared to only 0.06 percentage points in the latter scenario. These results, therefore, suggest that countries can affect the pro-competitive effects of trade in a meaningful way by selectively targeting certain sectors with tariffs relative to others.

Lastly, we quantify to what extent the asymmetry between export and import markups shapes the gains from trade. We show that net exporters of high-markup goods benefit from trade disproportionately more than net importers of those products. We show that this result is due to the relocation of profits: Trade essentially allows countries with a comparative advantage in producing high-markup goods to specialize in these products and earn higher profits.[3] Consequently, we document that (i) welfare effects of trade are *positively* related to changes in aggregate markups, and (ii) trade-induced changes in misallocation are *negatively* related to changes in aggregate markups. Interestingly, we find that the U.S. is among a select group of countries that slightly gains from a global tariff war due to the relocation of profits, but experiences sizable pro-competitive gains from trade overall.

[3]In line with a large trade literature (see below), profit relocation refers to the incidence of profits from producing some goods or services shifting from producers in one country to those in another country in response to changes in trade costs.

Related Literature Our paper contributes to an extensive literature on variable markups and the pro-competitive gains from trade (see, e.g., Devarajan and Rodrik, 1991; Atkeson and Burstein, 2008; Melitz and Ottaviano, 2008; Chen, Imbs and Scott, 2009; Behrens and Murata, 2012; Edmond, Midrigan and Xu, 2015; Feenstra and Weinstein, 2017; Melitz, 2018; Arkolakis et al., 2019; Dhyne, Kikkawa and Magerman, 2022; Alviarez et al., 2023; Crowley, Han and Prayer, 2024; Graziano, 2024; Ding, Lashkaripour and Lugovskyy, 2024).[4] Our main contribution to this literature is to determine to what extent asymmetries across countries and sectors in terms of demand and productivity result in heterogeneity in markups and their elasticity with respect to the degree of product market competition, and how this in turn shapes pro-competitive gains from trade across countries. For this purpose, our first and main methodological contribution is to develop and quantify a multi-country, multi-sector model of international trade and variable markups, which allows for detailed sectoral and country-specific differences in demand, productivity, and trade costs. We are unaware of other work that has quantified the pro-competitive gains from trade across a wide range of countries and in the presence of rich heterogeneity, and linked variations in the pro-competitive effects to these underlying fundamentals.

Second, our focus on variation in the pro-competitive gains from trade across countries (as opposed to the work by, e.g., Edmond, Midrigan and Xu (2015), Feenstra and Weinstein (2017), Arkolakis et al. (2019), or Crowley, Han and Prayer (2024)) allows us to document and examine several channels that shape these gains. Specifically, we document that import and export shares are crucial determinants of the pro-competitive effects, while the difference between upper-tier and lower-tier elasticities on imports versus that on exports tends to magnify their importance. Our results thereby also complement Arkolakis et al. (2019) and point to when and why the pro-competitive gains can be small or large. We show that even in a multi-sector setting with rich heterogeneity in productivity and trade costs, the pro-competitive gains from trade are small in most countries. However, we document that the introduction of country-specific demand elasticities can generate meaningful pro-competitive gains from trade, especially in countries with small import shares and moderate differences between upper and lower-tier demand elasticities. Further, broadly consistent with Arkolakis et al. (2019), we find that for about two-thirds of countries in our sample, the pro-competitive gains from trade are in fact negative, and that pro-competitive gains are primarily of importance for larger countries such as the U.S. or China. To the best of our knowledge, this paper is the first to highlight that pro-competitive *gains* appear to be only realistic for larger and less open economies. Further, in contrast to existing work, we show that sectoral variation in tariffs can have very different implications for the pro-competitive gains from trade, hence suggesting a way in which they can be affected by policy.

Lastly, our paper relates to the literature on profit shifting (see, e.g., Spencer and Brander, 1983; Brander and Spencer, 1985; Brander, 1986; Krugman, 1987; Bagwell and Staiger, 2012; Ossa, 2014; Lashkaripour and Lugovskyy, 2023; Firooz and Heins, 2025). Our paper differs from

[4]There is also a growing literature on the pro-competitive effects of trade in the presence of labor market imperfections (e.g., MacKenzie, 2021; Gutiérrez, 2022; Firooz, 2025).

these studies as we allow markups to be variable and thus affected by the degree of competition. The model is, hence, particularly well-suited to understand to what extent the variability of markups mitigates or amplifies the importance of profit shifting in response to tariffs, and we show that these two factors combined result in the U.S. being among a few countries predicted to benefit from a global trade war.[5] Our paper also differs from Edmond, Midrigan and Xu (2015), Epifani and Gancia (2011), and Holmes, Hsu and Lee (2014), who also examine the pro-competitive gains from trade, but restrict profit shifting either by considering symmetric countries or abstracting from rich cross-sector-country heterogeneity in competition as well as import versus export markups.[6]

The paper is organized as follows. Section 2 develops a quantitative multi-country, multi-sector trade model with imperfect product markets and sector- and country-specific demand elasticities. Section 3 develops a simplified, illustrative version of our model to explain the major determinants of the pro-competitive gains from trade in our setting. Section 4 describes the data and the procedure to estimate import demand elasticities, trade costs, and productivity. Section 5 employs external data sources to provide supporting evidence for the implied markups and their elasticities within the structure of our model. Section 6 presents the quantitative results of several counterfactual exercises. Section 7 concludes.

2 The Quantitative Model

2.1 Environment

There are N countries in the world indexed by i and n. Country n is endowed with L_n identical workers/consumers who inelastically supply labor in a perfectly competitive labor market. There are K sectors in each economy indexed by k. Each sector k consists of $J(k)$ sub-sectors indexed by j and l.

2.2 Preferences and Demand Schedules

The representative household in country n has the following Cobb-Douglas utility function

$$Q_n = \Pi_{k=1}^{K} (Q_n^k)^{\alpha_n^k} , \qquad \sum_{k=1}^{K} \alpha_n^k = 1 \quad \forall n \in \{1, ..., N\}, \tag{1}$$

where Q_n^k denotes a composite good in sector k and α_n^k governs its expenditure share. The composite good Q_n^k is a constant elasticity of substitution (CES) aggregate over a large set of

[5] The presence of asymmetric profit shifting also distinguishes the analysis from Arkolakis et al. (2019) and generates noticeably more heterogeneous impacts of tariffs, which matter for pro-competitive effects as well.

[6] Holmes, Hsu and Lee (2014) derive a welfare formula that includes the profit-shifting channel, which they call the "terms of trade effect on markups". However, since the focus of their paper is quite different, they largely focus on a setting with symmetric countries and do for example not quantify the importance of this channel across countries.

sub-sectors

$$Q_n^k = \left(\sum_{j=1}^{J(k)} (q_n^{j(k)})^{\frac{\sigma_n^k - 1}{\sigma_n^k}} \right)^{\frac{\sigma_n^k}{\sigma_n^k - 1}}, \tag{2}$$

where $q_n^{j(k)}$ is a composite good in sub-sector j belonging to sector k in country n. Parameter σ_n^k measures the elasticity of substitution across the sub-sectors of sector k in country n. Note that these elasticities are allowed to differ across sectors and countries.

We assume that each sub-sector $j(k)$ is infinitesimal relative to the entire set of sub-sectors $J(k)$. Given the production technology stated in Equation (2), the cost-minimization problem to produce Q_n^k implies the following demand for the composite good $q_n^{j(k)}$

$$q_n^{j(k)} = \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k} \right)^{-\sigma_n^k} Q_n^k, \tag{3}$$

where $P_n^{j(k)}$ represents the ideal price index for sub-sector $j(k)$ in country n, and $\mathcal{P}_n^k$ denotes the CES price index for sector k in country n

$$\mathcal{P}_n^k = \left[\sum_{j=1}^{J(k)} (P_n^{j(k)})^{1-\sigma_n^k} \right]^{\frac{1}{1-\sigma_n^k}}. \tag{4}$$

Moreover, given the preference structure in (1), consumers in country n face the following price index

$$\mathcal{P}_n = \Pi_{k=1}^K \left(\frac{\mathcal{P}_n^k}{\alpha_n^k} \right)^{\alpha_n^k}. \tag{5}$$

To introduce variable markups into the model, we follow Atkeson and Burstein (2008) and Edmond, Midrigan and Xu (2015) and assume that the composite good $q_n^{j(k)}$ is a CES aggregate over a finite number of varieties from across the world

$$q_n^{j(k)} = \left[\sum_{i=1}^{N} \sum_{f=1}^{F_{in}^{j(k)}} (q_{in,f}^{j(k)})^{\frac{\sigma_n^{j(k)} - 1}{\sigma_n^{j(k)}}} \right]^{\frac{\sigma_n^{j(k)}}{\sigma_n^{j(k)} - 1}}, \tag{6}$$

where $q_{in,f}^{j(k)}$ denotes the demand in country n for varieties produced by firm f from source country i in sub-sector $j(k)$, $F_{in}^{j(k)}$ is the number of firms in sub-sector $j(k)$ from country i selling to n, and the parameter $\sigma_n^{j(k)}$ governs the elasticity of substitution across goods, which is allowed to differ across sub-sectors and countries. For now, to simplify the exposition, we abstract from the extensive margin by assuming that the number of firms in each market is fixed (in contrast to, e.g., Arkolakis et al., 2019).[7] However, in Section 6.4 we relax this assumption,

[7]Specifically, in the baseline specification, we take the number of firms that sell at home and those that

add an extensive margin to the analysis, calibrate destination-sector specific fixed exporting costs, and show that our main results are robust.

Using Equation (6), we can solve for the demand $q_{in,f}^{j(k)}$ as

$$q_{in,f}^{j(k)} = \left(\frac{p_{in,f}^{j(k)}}{P_n^{j(k)}} \right)^{-\sigma_n^{j(k)}} q_n^{j(k)}, \tag{7}$$

where $p_{in,f}^{j(k)}$ denotes the price charged in country n by firm f from country i, and the price index $P_n^{j(k)}$ is given by

$$P_n^{j(k)} = \Big[\sum_{i=1}^{N} \sum_{f=1}^{F_{in}^{j(k)}} (p_{in,f}^{j(k)})^{1-\sigma_n^{j(k)}} \Big]^{\frac{1}{1-\sigma_n^{j(k)}}}. \tag{8}$$

2.3 Production and Trade Frictions

Firm f from country i in sub-sector $j(k)$ produces its unique variety according to the following constant returns to scale (CRS) technology with labor as the sole input, such that

$$q_{i,f}^{j(k)} = A_{i,f}^{j(k)} l_{i,f}, \tag{9}$$

where $A_{i,f}^{j(k)}$ denotes the firm-specific productivity in sector $j(k)$ in country i.

To export a good in sub-sector $j(k)$ from country i to n, producers are subject to an ad valorem tariff $t_{in}^{j(k)}$ and an iceberg cost $d_{in}^{j(k)}$, i.e., to deliver a unit of good $j(k)$ from country i to country n, the producer has to ship $d_{in}^{j(k)} > 1$ units of the good. Total trade frictions can hence be summarized as

$$\tau_{in}^{j(k)} = d_{in}^{j(k)}(1 + t_{in}^{j(k)}),$$

with $\tau_{ii}^{j(k)} = 1$.[8] We assume that firms ship goods only directly from i to n and not via a third country.[9]

export to each of the other countries as exogenously given based on information from the UNIDO Industry Stat 4 database and the World Bank Exporter Dynamics Database (see Section 4). To account for the fact that not all firms export in every single destination, we hence implicitly assume that there is no fixed cost for current exporters and there is a prohibitively large fixed cost for current non-exporters to a given destination, such that firms do not change their exporting decision (on the extensive margin) in the counterfactual equilibrium.

[8] Our formulation implicitly assumes that tariffs are levied on c.i.f. prices. As documented by Feenstra and Romalis (2014), this assumption holds for most countries worldwide.

[9] This assumption is equivalent to assuming that the triangle inequality, $\tau_{ih}^{j(k)} \tau_{hn}^{j(k)} \geq \tau_{in}^{j(k)}$, holds across all country combinations. In practice, this condition may especially affect the impact of trade barriers in so-called entrepôts (see, for instance, Ganapati, Wong and Ziv, 2022) in our sample, such as Egypt or the United Kingdom. Trade barriers in these economies are likely to influence not only domestic outcomes but also trade flows between third countries. Although incorporating such complex trade networks is beyond the scope of this paper, it would be worthwhile for future research to investigate how indirect trade affects the pro-competitive gains from trade across countries.

2.4 Market Structure

We assume that firms in each sub-sector $j(k)$ in country n engage in a Cournot quantity competition. Specifically, firm f from country i chooses the quantity to sell in country n by solving the following profit maximization problem

$$\max_{p_{in,f}^{j(k)}, q_{in,f}^{j(k)}} p_{in,f}^{j(k)} q_{in,f}^{j(k)} - q_{in,f}^{j(k)} [w_i \tau_{in}^{j(k)} / A_{i,f}^{j(k)}], \tag{10}$$

subject to the demand equation (7). The marginal cost of firm f in sub-sector $j(k)$ from country i exporting to country n equals $w_i \tau_{in}^{j(k)} / A_{i,f}^{j(k)}$, where w_i denotes the wage in country i.[10] As Appendix A.1 shows, the first-order condition of this profit maximization problem implies that the price charged by a firm is an endogenous markup over its marginal cost

$$p_{in,f}^{j(k)} = \mu_{in,f}^{j(k)} \left[\frac{w_i \tau_{in}^{j(k)}}{A_{i,f}^{j(k)}} \right], \tag{11}$$

where the firm's optimal markup equals

$$\mu_{in,f}^{j(k)} = \frac{\varepsilon_{in,f}^{j(k)}}{\varepsilon_{in,f}^{j(k)} - 1}, \tag{12}$$

and $\varepsilon_{in,f}^{j(k)}$ is the demand elasticity that firm f from country i faces in sub-sector $j(k)$ in country n

$$\varepsilon_{in,f}^{j(k)} = \left[\frac{1}{\sigma_n^{j(k)}} (1 - s_{in,f}^{j(k)}) + \frac{1}{\sigma_n^k} s_{in,f}^{j(k)} \right]^{-1}, \tag{13}$$

with $s_{in,f}^{j(k)}$ being the firm's sales share in that market

$$s_{in,f}^{j(k)} = \left[\frac{p_{in,f}^{j(k)}}{P_n^{j(k)}} \right]^{1-\sigma_n^{j(k)}}. \tag{14}$$

Using equations (12) and (13), the firm's markup can be expressed as

$$\mu_{in,f}^{j(k)} = \left[\frac{\sigma_n^{j(k)} - 1}{\sigma_n^{j(k)}} - s_{in,f}^{j(k)} \left[\frac{1}{\sigma_n^k} - \frac{1}{\sigma_n^{j(k)}} \right] \right]^{-1}. \tag{15}$$

It is important to note that Equation (13) implies that each firm faces an endogenously determined demand elasticity, which equals a market-share-weighted harmonic average of within

[10] Note that the firm in principle receives the price $p_{in,f}^{j(k)}/(1+t_{in}^{j(k)})$ and the marginal cost of production equals $w_i d_{in}^{j(k)} / A_{i,f}^{j(k)}$. To simplify the exposition, we multiply the firm's objective function by $(1 + t_{in}^{j(k)})$, which does not change the firm's optimal choice.

and across-sector elasticities of substitution. We will estimate these elasticities in Section 4, but for now, it is natural to think that elasticities within sub-sectors are larger than those across sub-sectors, i.e., $\sigma_n^{j(k)} \geq \sigma_n^k$. Firms with small market shares within a sub-sector $j(k)$ mostly compete with other firms within their sub-sector and, therefore, face a larger demand elasticity and charge a lower markup. In contrast, firms with relatively high market shares in sub-sector $j(k)$ face an elasticity that is closer to the upper-tier elasticity σ_n^k and therefore charge a higher markup. When there is a change in trade frictions $\tau_{in}^{j(k)}$, adjustments in the market share of each firm will therefore also affect the distribution of markups, which in turn shape the pro-competitive gains from trade. We discuss this relationship in detail in Section 3.

2.5 Total Expenditure and Welfare

Let I_n denote total expenditure in country n. Given the Cobb-Douglas preferences in (1), consumers in country n spend a fraction α_n^k of their total expenditure on sector k. Thus, country n's expenditure on varieties belonging to sub-sector $j(k)$ is given by

$$X_n^{j(k)} = \alpha_n^k I_n \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k} \right)^{1-\sigma_n^k}. \tag{16}$$

Total income in country n consists of workers' wages, firms' profits Y_n, and tariff revenue R_n. Total expenditure I_n is therefore equal to the sum of these components plus the trade deficit D_n

$$I_n = w_n L_n + Y_n + R_n + D_n. \tag{17}$$

Given the optimal price equation (11), we can write total profits as

$$Y_n = \sum_{k=1}^{K} \sum_{j=1}^{J(k)} \sum_{i=1}^{N} \sum_{f=1}^{F_{ni}^{j(k)}} \frac{1}{\varepsilon_{ni,f}^{j(k)}} \frac{s_{ni,f}^{j(k)} X_i^{j(k)}}{1 + t_{ni}^{j(k)}}. \tag{18}$$

Total tariff revenue earned by country n equals

$$R_n = \sum_{k=1}^{K} \sum_{j=1}^{J(k)} \sum_{i=1}^{N} \sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)}}{1 + t_{in}^{j(k)}} s_{in,f}^{j(k)} X_n^{j(k)}. \tag{19}$$

Trade deficits D_n are defined as total imports minus total exports

$$D_n = \sum_{k=1}^{K} \sum_{j=1}^{J(k)} \sum_{i=1}^{N} \sum_{f=1}^{F_{in}^{j(k)}} \frac{s_{in,f}^{j(k)} X_n^{j(k)}}{1 + t_{in}^{j(k)}} - \sum_{k=1}^{K} \sum_{j=1}^{J(k)} \sum_{i=1}^{N} \sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)} X_i^{j(k)}}{1 + t_{ni}^{j(k)}}. \tag{20}$$

It can then be shown that the trade deficit equation (20) implies labor market clearing. Specifically, summing over all sub-sectors j and all sectors k in Equation (16) and using equations

(17)-(20) allows us to write

$$w_n L_n = \sum_{k=1}^{K} \sum_{j=1}^{J(k)} \sum_{i=1}^{N} \sum_{f=1}^{F_{ni}^{j(k)}} \frac{\varepsilon_{ni,f}^{j(k)} - 1}{\varepsilon_{ni,f}^{j(k)}} \frac{s_{ni,f}^{j(k)} X_i^{j(k)}}{1 + t_{ni}^{j(k)}}, \tag{21}$$

where the right-hand side equals the total revenue of country n's firms across the world net of profits.

Finally, given the utility function (1), welfare of the representative consumer in country n equals real total expenditure

$$Q_n = \frac{I_n}{\mathcal{P}_n}. \tag{22}$$

2.6 Aggregate Productivity, Markup, and Misallocation

To examine the pro-competitive gains from trade, it will prove useful to derive aggregate productivity and aggregate markups. Following Edmond, Midrigan and Xu (2015), we define aggregate productivity in country i denoted by A_i as[11]

$$Q_i = A_i L_i. \tag{23}$$

Appendix A.2 shows that the aggregate productivity can be written as a quantity-weighted harmonic average of firm-level productivities

$$A_i = \left[\sum_{k=1}^{K} \sum_{j=1}^{J(k)} \left(\sum_{f=1}^{F_{ii}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{ii,f}^{j(k)}}{Q_i} + \sum_{n \neq i} d_{in}^{j(k)} \sum_{f=1}^{F_{in}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{in,f}^{j(k)}}{Q_i} \right) \right]^{-1}. \tag{24}$$

To define misallocation, we first solve for the efficient productivity in each country by removing markup heterogeneity within each country (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009; Edmond, Midrigan and Xu, 2015). We denote this efficient productivity in country i by A_i^{eff}. To solve for this efficient productivity, we solve the model by assuming that all firms within a country charge the same markup and then use Equation (24). We define misallocation in each country as the percentage difference between the efficient productivity and aggregate productivity, that is $1 - A_i/A_i^{eff}$.

Two points are worth emphasizing. First, the notion of "efficient" productivity in a multi-country setting is from a global planner's perspective, not necessarily from an individual country's perspective. Indeed, as we show in Section 4.3, this "efficient" productivity in some countries is lower than the productivity in the baseline equilibrium, which is a result of profit shifting across countries. Second, what matters to achieve the efficient allocation (from a global perspective) is to have no markup heterogeneity *within* countries. Specifically, the level

[11] Note that Edmond, Midrigan and Xu (2015) consider labor net of fixed costs in their definition of aggregate productivity. Given the absence of a fixed cost in our setting, we use total labor here.

of markups as well as markup heterogeneity *across* countries does not matter for efficiency. In practice, we compute efficient productivity in each country using the following different assumptions and all yield the exact same result: (i) all firms across the world charge no markup; (ii) all firms across the world charge the same markup $\mu > 1$ in all destinations; (iii) all firms in a subset of countries charge a markup μ_1 in all destinations and all other firms charge a markup $\mu_2 \neq \mu_1$ in all destinations.

We define the aggregate markup in country i as

$$\mu_i = \frac{\mathcal{P}_i}{w_i/A_i}. \tag{25}$$

Appendix A.2 shows that the aggregate markup can be written as a revenue-weighted harmonic average of firm-level markups across the world

$$\mu_i = \left[\sum_{k=1}^{K} \sum_{j=1}^{J(k)} \left(\sum_{f=1}^{F_{ii}^{j(k)}} \frac{1}{\mu_{ii,f}^{j(k)}} \frac{q_{ii,f}^{j(k)} p_{ii,f}^{j(k)}}{\mathcal{P}_i Q_i} + \sum_{n \neq i} \frac{d_{in}^{j(k)}}{\tau_{in}^{j(k)}} \sum_{f=1}^{F_{in}^{j(k)}} \frac{1}{\mu_{in,f}^{j(k)}} \frac{p_{in,f}^{j(k)} q_{in,f}^{j(k)}}{\mathcal{P}_i Q_i} \right) \right]^{-1}. \tag{26}$$

2.7 Equilibrium

Equilibrium Definition. Given productivities $A_{i,f}^{j(k)}$, elasticities of substitution $\sigma_n^{j(k)}$ and σ_n^k, Cobb-Douglas shares α_n^k, labor endowments L_n, trade deficits D_n, iceberg trade costs $d_{in}^{j(k)}$, the number of firms $F_{ni}^{j(k)}$, and ad valorem tariffs $t_{in}^{j(k)}$, an equilibrium is characterized by a vector of wages $\{w_n\}_{n=1}^N \in \mathbf{R}_{++}^N$ that satisfy the equilibrium conditions (4), (8), and (11)-(20).

Solving for the Equilibrium. To solve the model, we follow the approach by Ossa (2014), Caliendo and Parro (2015), Lashkaripour (2020), and Caliendo et al. (2023), among others, and eliminate trade deficits. That is, we first impose trade deficits D_n to be zero and then solve for the equilibrium. We assume that trade deficits remain zero in all counterfactual scenarios.[12] Appendix A.4 explains in detail how we solve for the equilibrium and which steps we follow.

2.8 Extension: Incorporating Multinationals

So far, we have assumed that all production in each country is done by its own firms, and as a result, all profits generated in each country are owned by individuals in that country. Given the rising role of multinational companies across the world, and as a robustness exercise, we have also solved a version of the model that adds multinational companies to explore how they affect the pro-competitive gains from trade. Appendix B.1 describes this specification in detail and how we solve for the equilibrium in this model. As discussed in Section 6.4, the main results are quite similar to those in the baseline case.

[12] While we do not formally prove the uniqueness of equilibrium, to mitigate concerns about multiple equilibria, we start from many initial guesses and we always converge to the same equilibrium.

3 Main Determinants of the Pro-competitive Gains from Trade: An Illustrative Model

To explain the main determinants of the pro-competitive gains from trade in our setting, we rely on an illustrative model in this section before turning to the full quantitative model and results in Section 6. Specifically, we construct an illustrative model with three countries. Each country has two upper-tier sectors k, and each upper-tier sector contains two sub-sectors $j(k)$. We assume symmetry across countries—specifically, all countries have the same iceberg trade costs across all products, equal productivity, identical labor endowments, the same number of domestic and exporting firms, and comparable tariff structures.[13]

We simulate the consequences of a global trade war in which all countries raise tariffs by 50 percentage points. We do so in two different ways, one in which firms adjust markups in response to changing competition (i.e, our baseline model), and one in which firms are assumed to be infinitesimal and therefore always face the lower-tier demand elasticity $\sigma_n^{j(k)}$, in which case their profit-maximizing markup $\sigma_n^{j(k)}/(\sigma_n^{j(k)}-1)$ is constant. We study the pro-competitive gains from trade in our setting via a comparison of the baseline results to those obtained in the fixed-markup variant of the model.

Much of the existing literature discusses the pro-competitive gains from (more) trade, that is, how much larger welfare gains are in the presence of variable markups compared to a fixed-markup variant (see, e.g., Arkolakis et al., 2019). In much of this paper, however, we examine the impact of a tariff war and, hence, of a reduction of trade. To be consistent with the prior literature, we therefore define the pro-competitive gains from trade as welfare changes under variable markups versus those under fixed markups, but with a reversed sign. Note that since we are considering a *tariff war* counterfactual exercise, more *negative* welfare changes under variable markups compared to fixed markups imply larger pro-competitive *gains from trade*. We consider tariff wars instead of tariff liberalizations since tariffs are generally small in our sample (see Section 4) and also given the importance and incidence of tariff wars in the past few years. Nevertheless, we show in Section 6.4 that the model can also be readily used to study reductions in iceberg costs instead, and our results are in fact qualitatively similar in that case.

The pro-competitive gains from trade depend primarily on the elasticity of markups with respect to changes in trade costs τ, which can be written as the product of two elasticities:

$$\frac{d\ln \mu_{in,f}^{j(k)}}{d\ln \tau} = \frac{d\ln \mu_{in,f}^{j(k)}}{d\ln s_{in,f}^{j(k)}} \frac{d\ln s_{in,f}^{j(k)}}{d\ln \tau}. \tag{27}$$

[13] In particular, all three countries exhibit a cross-country iceberg cost of 1.5, and initially impose a 5 percent tariff on imports. Productivity is set to 2 across all country-product pairs, and each country is endowed with one unit of labor. Every sector contains 20 firms following the same productivity distribution, of which 10 percent (i.e., 2 firms) initially export to the other two countries. The upper-tier elasticity in Sector 1 is set to 2.00 and the corresponding lower-tier elasticities to 2.15 and 2.65. For Sector 2, we choose values of 2.40 on the upper tier and lower-tier elasticities of 2.50 and 3.00.

In other words, any changes in trade costs affect firms' market shares in a given market, which in turn translates into changes in markups. Given Equation (15), the elasticity of markups with respect to market share can be written as

$$\frac{d \ln \mu_{in,f}^{j(k)}}{d \ln s_{in,f}^{j(k)}} = \left[\frac{1}{\sigma_n^k} - \frac{1}{\sigma_n^{j(k)}}\right] s_{in,f}^{j(k)} \mu_{in,f}^{j(k)}. \tag{28}$$

Since markups are increasing in market share, Equation (28) implies that in response to the same change in market share, firms with a larger market share in a given market adjust their markup to a larger extent (see also Burstein, Carvalho and Grassi, 2020), especially when there is a larger gap between upper- and lower-tier elasticities. The fact that larger firms adjust their markups by more when facing a trade shock is consistent with the evidence by Tybout (2003) for trade liberalization episodes across various countries.

Given Equation (28), and since the pro-competitive gains from trade depend on the response of markups in the domestic market, on imports, and on exports, we show below that variation in the pro-competitive gains across countries depends on four key determinants: (1) Each country's import shares, (2) countries' export shares, (3) the difference between lower- and upper-tier elasticities on imports, as well as (4) the corresponding difference for exports.

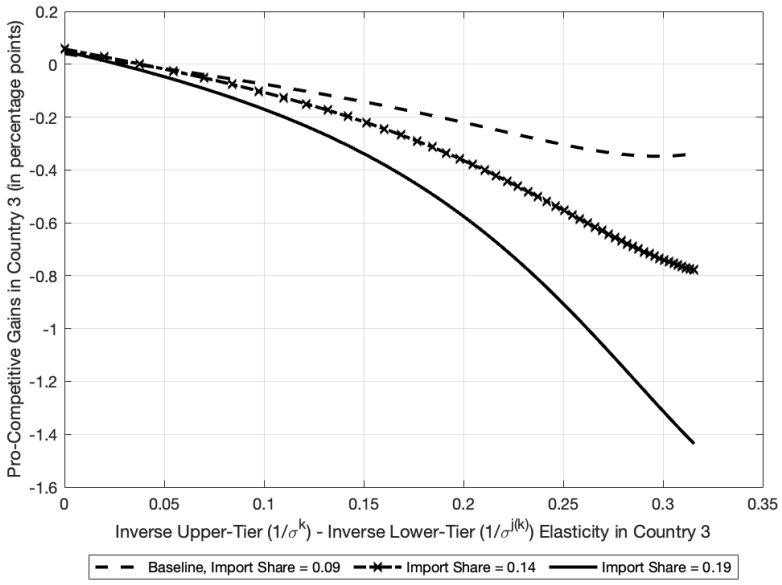
Import Shares and Demand Elasticities on Imports. Figure 1 plots the pro-competitive gains from trade for Country 3 against the difference between lower- and upper-tier elasticities in Country 3 as well as for varying degrees of import penetration. To change country 3's import share in Figure 1, we reduce iceberg costs on its imports, which increases its import share from 9% in the baseline to 14%, and in addition, we reduce country 3's productivity, which increases its import share to 19%.[14]

First, as evident from this figure, a larger import share reduces the pro-competitive gains from trade. To understand this result, notice that increasing tariffs reduces the market share and, therefore, markups of foreign exporters to a country, which implies smaller losses from a trade war under variable markups compared to fixed markups, i.e., reducing the pro-competitive gains from trade (Helpman and Krugman, 1989). Larger import shares magnify this effect and, therefore, dampen the pro-competitive gains from trade. To elaborate, larger import shares imply that either a larger fraction of firms serving the domestic market are foreign firms or foreign firms are on average larger (or both). Since foreign firms reduce markups in response to a tariff war, in contrast to domestic firms, which raise them, having a greater fraction of foreign firms tends to reduce the pro-competitive gains from trade. Moreover, when foreign firms are larger in a market, they adjust their markups to a greater extent in response to changes in trade costs, as discussed above.[15]

[14] We reduce iceberg costs on Country 3's imports from 1.5 to 1.05 and reduce Country 3's productivity from 2 to 1. Reported import shares refer to the average import share in Country 3 across all elasticity differences, under variable markups and the baseline tariff structure.

[15] According to Equation (28), the markup elasticity depends on foreign firms' individual market shares, not

Figure 1: Pro-Competitive Gains and Import-Side Statistics



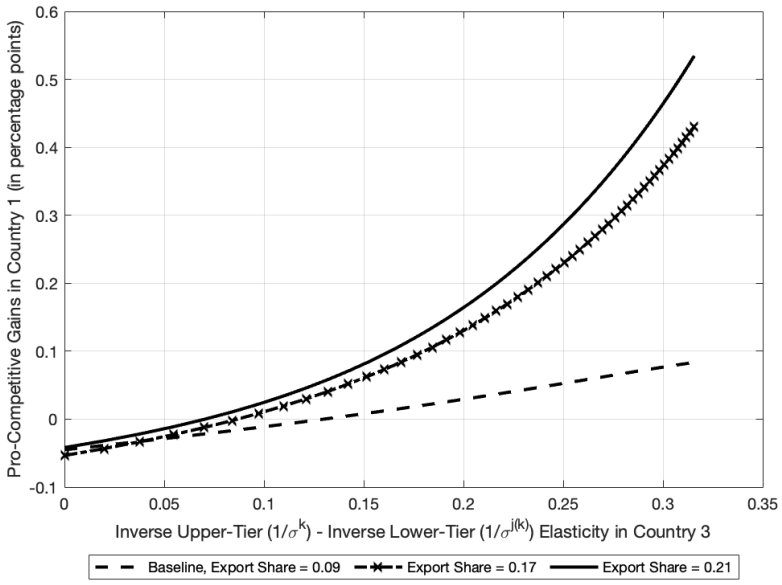
Second, a *larger* inverse elasticity σ_n^k at the upper tier relative to the inverse $\sigma_n^{j(k)}$ at the lower tier leads to smaller pro-competitive gains from trade (i.e., smaller losses from a trade war under variable markups compared to fixed markups). We offer the following explanation for this relationship: On the one hand, foreign firms selling to Country 3 optimally reduce their markups and prices by more after a trade war when the gap between upper- and lower-tier elasticities is larger, which reduces the welfare losses from a trade war (i.e., results in smaller pro-competitive gains from trade). On the other hand, however, tariffs also increase the *dispersion* of markups across domestic producers after a trade war since, as explained above, larger firms raise their markups by more, amplifying welfare losses (i.e., increasing pro-competitive gains from trade). This increase in markup dispersion is also magnified by a greater elasticity gap.[16] Which effect dominates is ultimately a quantitative question addressed in Section 6, but since the second force operates through markup *dispersion*—a second-order effect— we find that the first force typically dominates. As a result, the pro-competitive gains from trade tend to decline with the gap between upper- and lower-tier elasticities on imports.[17]

the aggregate import share. However, in this example, larger import shares are associated with larger foreign firms on average.

[16]In our model with inelastic labor supply and full employment, the *level* of markups charged by domestic firms does not affect welfare since it is a pure transfer between consumers and firms; only the *dispersion* of markups matters (see, e.g., Edmond, Midrigan and Xu, 2015). In a more general setting with elastic labor supply and non-employment, however, the level of markups may matter as well, and a larger elasticity gap would lead to a larger increase in domestic producers' markups after a trade war, thereby increasing the welfare losses from a trade war (i.e., implying higher pro-competitive gains from trade).

[17]Even when upper- and lower-tier elasticities in Country 3 are identical (i.e., the x-axis is zero), there are still positive pro-competitive gains from trade. As described below, this stems from differences in elasticities

Figure 2: Pro-Competitive Gains and Export-Side Statistics



Export Shares and Demand Elasticities in Export Markets. Figure 2 summarizes how the pro-competitive gains from trade depend on export market shares as well as the difference between lower- and upper-tier elasticities on a country's exports. Specifically, we perform the exact same exercise described above and change Country 3's import share and elasticities. However, we instead now plot the pro-competitive gains from trade for country 1 to understand how changes in export shares and elasticities in export markets shape pro-competitive effects.[18]

The findings shown in this figure are essentially the opposite of those seen in Figure 1: The pro-competitive gains from trade are increasing in a country's export share as well as the difference between lower- and upper-tier elasticities on its exports.[19] Larger export shares imply that either a larger fraction of firms are exporters or these firms are on average larger in the export market (or both). Hence, when country 1 has a larger export share, following an increase in trade costs, a greater fraction of country 1's firms reduce their markups, and to a larger extent, since the elasticity of markups to market share is increasing in market share. This reduction in markups in the export market reduces total national income, which results in larger losses from a trade war under variable markups than under fixed markups (i.e., larger pro-competitive gains from trade). Furthermore, *larger* gaps between inverse elasticities at the upper and lower tier in the export market magnify these effects and result in larger pro-competitive gains from trade. Since exporters are put at a disadvantage through tariffs, their

for Country 3's exports.

[18]Note that country 1 and 2 are identical.

[19]We define Country 1's export share as Country 1's exports to Country 3 divided by total expenditure in Country 3.

market shares shrink, and they optimally lower their markups. This reduction will be especially strong when the difference between lower- and upper-tier elasticities is sizable.[20]

In summary, this stylized model shows that the pro-competitive gains from trade relate to the interplay between market shares and demand elasticities, on both imports and exports. Importantly, these relationships also highlight that pro-competitive gains across countries are closely related: A lower import share in Country 3 translates into higher pro-competitive gains in Country 3, but means that these gains will be lower in other countries. In Section 6, we determine to what extent these insights apply to the full model and how they shape pro-competitive effects across countries.

4 Data and Estimation

4.1 Data

We combine several data sources to quantify the model. First, we use information on imports and exports during the year 2015 from UN Comtrade, disaggregated by 4-digit Harmonized System codes (HS4), respectively. We include 29 countries in the analysis, which account for the vast majority of global trade and represent a mix of richer and poorer economies.[21] To capture spending on domestic goods, we match the trade data to information on expenditure on domestic goods provided by the GTAP 8 database for each country.[22] We assume that each upper-tier CES aggregate in Equation (2) corresponds to a section in the HS nomenclature (HS1

[20]Note that, similar to the discussion on the import side, the fact that larger exporters—who charge higher markups— reduce their markups by more following an increase in trade costs reduces markup dispersion and misallocation. This in turn results in smaller losses from a trade war under variable markups than under fixed markups (i.e., smaller pro-competitive gains from trade). However, as this illustrative model shows and as we confirm in our full quantitative model in Section 6, this effect is a second-order effect, dominated by the reduction in the level of export markups and national income.

[21]We have included the following countries: Australia, Austria, Bangladesh, Belgium, Brazil, China, Denmark, Egypt, France, Germany, Greece, India, Indonesia, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Peru, Republic of Korea, Romania, Russian Federation, Spain, Sweden, USA, United Kingdom, Vietnam, and a constructed "Rest of the World." Our selection comprises 29 countries, which we selected based on three criteria: (1) capturing most of the worldwide trade, (2) representing a composition of richer and poorer countries from various regions, and (3) the availability of information on the number of firms. Specifically, we considered the 20 largest economies in terms of GDP, excluding Iran, Saudi Arabia, and Taiwan, due to data limitations in certain dimensions. We have also removed Canada from the analysis, due to several instances in which the units in which quantities are reported change over time. However, none of our results depend on this choice. Additionally, we included six of the world's richest countries in terms of GDP per capita (Austria, Belgium, Denmark, New Zealand, Norway, and Sweden) and six less affluent ones (Bangladesh, Egypt, Greece, Peru, Romania, and Vietnam) to ensure a balanced representation of both richer and poorer nations.

[22]The GTAP database mainly uses national input-output tables to construct each country's expenditure on domestic and foreign goods across sectors, and we use the information on "sales of domestic product, at market prices" as well as "imports, at market prices" to infer a country's domestic expenditure share. Since the information on domestic good spending is provided within GTAP's sectoral classification, which is broader than the HS4 classification, we first crosswalk it to the HS4 level and assume that the domestic share in each HS4 category is equal to that of the corresponding GTAP sector. We then aggregate up further to the HS2 level for the analysis.

henceforth), outlined in Tables D.2 and D.3, and we infer α_n^k as the share of total expenditure spent on goods produced by sector k in country n. We define a sub-sector $j(k)$ as an HS2 category within an HS1 sector k.[23]

To estimate the elasticity of substitution for each sector-country pair, we use trade data for the period between 1995 and 2015 in each country. To account for frequent changes in the HS classification over time, we construct a time-consistent sectoral classification using an updated version of Van Beveren, Bernard and Vandenbussche (2012) and crosswalk the data in each year accordingly.[24] To infer productivity and trade cost parameters, we also use information on the number of firms by sector and country from the UNIDO Industry Stat 4 Database and data on bilateral distance, free trade agreements, as well as whether or not two countries share a common language or border from CEPII.[25]

The final piece of information we require for the quantitative model is the extent of heterogeneity in the firm size distribution across sectors. For this purpose, we follow Chaney (2008) and Feenstra and Romalis (2014), who use industry-specific estimates of the relationship between firm rank and size to empirically inform the model about the extent of firm-level heterogeneity in terms of productivity in each industry. We adopt this approach and construct an empirical firm size distribution $\mathcal{F}_n^{j(k)}$ for each country and HS2 sector and infer the relative sizes of firms from the rank-size coefficient.[26] Due to data availability, we assume that the relationship between rank and size can vary by sector but is the same across countries. Specifically, we follow Feenstra and Romalis (2014) and assume that the sectoral rank-size coefficients observed in the U.S. also apply to other countries.[27]

To infer the number of firms from a source country selling a product in a destination country $F_{in}^{j(k)}$, we use the information on the number of exporters from the Exporter Dynamics Database by the World Bank and the number of domestic firms from the UNIDO Industry Stat 4 database. Given that the most productive firms are more competitive and thus are more capable of selling in export markets, we assume that their participation in the export markets depends on their productivity rank.[28] We also use information on sector-specific tariffs imposed by countries on

[23]This choice is mainly driven by the availability of data on the number of firms in each country and sector which is not readily available for all countries on a more disaggregated level.

[24]More specifically, the issue is that HS categories can change over time and, for example, in some cases, (1) one HS code may be split into multiple new HS codes or (2) several HS codes are merged into one. In those cases, to ensure that categories do not cover different goods in one year versus the other, we keep track of these changes and create categories containing all relevant HS codes. For example, category 722210 splits into 722211 and 722219 in the year 1996, and we, therefore, create a synthetic category that contains all three categories and hence all goods that are part of 722210 in 1995 and before and of 722211 and 722219 afterward.

[25]Since the UNIDO data is reported on the ISIC level, we crosswalk it to the HS classification using concordances provided by the UN Statistics Division and WITS.

[26]Since the reported estimates of these coefficients ζ_k in Feenstra and Romalis (2014) are based on the three-digit SITC classification, we crosswalk them to HS2 product categories.

[27]Note that, as we show below, the inferred productivity distribution still varies across countries due to differences in demand.

[28]For example, in an illustrative world of three countries, suppose that country A has ten firms. One firm from country A sells to country B, and three firms from A sell to C. Then, the most productive firm in country A will sell to A, B, and C. Country A's second and third most productive firms will sell to A and C. The remaining fourth to tenth productive firm will cater only to the domestic market A. Thus, firms' presence in

each other, which we collect from the WITS database. Specifically, we use applied ad valorem tariffs in each HS2 product category for 2015 and match them to the dataset.

Finally, we use several additional data sources in the model with multinationals, which we describe in Appendix B.2. Table D.1 provides detailed summary statistics of the final dataset.

4.2 Estimation of the Elasticities of Substitution

Lower-Tier Elasticities. We estimate lower-level (HS2) elasticities of substitution separately for each country via an approach that is in line with Feenstra (1994), Broda and Weinstein (2006), and Soderbery (2015).[29] Specifically, we first utilize that Equation (7) can be written in logs and in first differences with respect to time as

$$\Delta \ln(s_{int,f}^{j(k)}) = -(\sigma_n^{j(k)} - 1)\Delta \ln(p_{int,f}^{j(k)}) + \sigma_n^{j(k)} \Delta P_n^{j(k)}, \tag{29}$$

where Δ refers to the change in a variable between periods t and $t+1$. To eliminate the price index from this expression, we difference this equation again with respect to a reference variety m and obtain

$$\Delta^m \ln(s_{int,f}^{j(k)}) = -(\sigma_n^{j(k)} - 1)\Delta^m \ln(p_{int,f}^{j(k)}) + \xi_{int,f}^{j(k)}, \tag{30}$$

which is log-linear in the price of a variety $p_{int,f}^{j(k)}$. As discussed in more detail below, within our framework and the estimation, a variety refers to an HS4-origin pair selling to a destination n. We further introduce the term $\xi_{int,f}^{j(k)}$ to allow for potential measurement error as well as for unobservable shocks to demand. We note that while firms' optimal pricing decision and equilibrium market shares in our model depend on both upper- and lower-tier elasticities, the relationship between *observed prices and market shares* depends on lower-tier elasticities only, as implied by the model equation (7) or its empirical counterpart in Equation (30).

We follow Feenstra (1994), Broda and Weinstein (2006), and Soderbery (2015) and allow for the possibility that supply is upward-sloping and can be written as

$$\Delta^m \ln(p_{int,f}^{j(k)}) = \left[\frac{\kappa_n^{j(k)}}{1 + \kappa_n^{j(k)}}\right] \Delta^m \ln(s_{int,f}^{j(k)}) + \delta_{int,f}^{j(k)}, \tag{31}$$

where $\kappa_n^{j(k)}$ captures the inverse supply elasticity and $\delta_{int,f}^{j(k)}$ denotes unobservable supply shocks. In this setting, the demand elasticity $\sigma_n^{j(k)}$ can, for example, be readily estimated by using an instrumental-variable approach (using, for example, tariffs, as in Fajgelbaum et al., 2020) or assumptions regarding the relationship between demand and supply shocks (their orthogonality,

foreign markets is tied to their ranking in the productivity distribution.

[29] Elasticity estimates based on the Feenstra method have been frequently used and referred to in other papers, such as Broda, Limão and Weinstein (2008), Hsieh and Klenow (2009), Khandelwal (2010), or Ossa (2014, 2015). However, Section 6.4 assesses the robustness of our results to using an alternative approach based on Fajgelbaum et al. (2020).

for example). In the baseline specification, we choose to adopt the common identifying assumption that these shocks are orthogonal (see, e.g., Feenstra, 1994), that is, $E[\xi_{int,f}^{j(k)}\delta_{int,f}^{j(k)}] = 0$, in which case one can multiply the two shocks to convert the structural equations of demand and supply into one estimation equation,

$$\left(\Delta^m \ln(p_{int,f}^{j(k)})\right)^2 = \lambda_{1,j(k)}\left(\Delta^m \ln(s_{int,f}^{j(k)})\right)^2 + \lambda_{2,j(k)}\left(\Delta^m \ln(p_{int,f}^{j(k)})\right)\left(\Delta^m \ln(s_{int,f}^{j(k)})\right) + u_{int,f}^{j(k)},$$

where $\lambda_{j(k)} = 1/(\sigma_n^{j(k)} - 1)$. We estimate this equation via the hybrid estimator method (LIML) developed in Soderbery (2015), which addresses potential small sample biases as well as grid search inefficiencies present in previous implementations of Feenstra (1994). In practice, since firm-level information for each country is not readily available, we treat each HS4-origin-destination combination that we observe in the data as one variety.[30]

Note that our specification nests settings in which the supply curve is horizontal, in which case $\kappa_n^{j(k)} = 0$. In practice, and in line with recent evidence by Fajgelbaum et al. (2020), we find the estimated $\kappa_n^{j(k)}$ to be quite small for many sectors, suggesting supply to be at least close to horizontal. Consequently, also our main results are similar when we impose supply to be horizontal ex ante. We provide more details on specifications based on alternative approaches to estimation in Section 6.4.

Upper-Tier Elasticities. Once the lower-tier demand and supply-side parameters, $\sigma_n^{j(k)}$ and $\kappa_n^{j(k)}$, are estimated, we can use them along with the resulting residuals to infer elasticities on the sectoral (HS1) level, σ_n^k. To estimate σ_n^k, we follow Fajgelbaum et al. (2020), who use a similar CES preference structure and estimate the upper-level demand elasticity σ_n^k via a regression that, in our notation, translates into

$$\Delta \ln s_{nt}^{j(k)} = \gamma_{nkt} + (1 - \sigma_n^k)\Delta \ln p_{nt}^{j(k)} + \epsilon_{nt}^{j(k)}, \tag{32}$$

where $\gamma_{nkt} = -(1 - \sigma_n^k)\Delta \ln \mathcal{P}_{nt}^k$, $s_{nt}^{j(k)} = q_{nt}^{j(k)} p_{nt}^{j(k)} / q_{nt}^k p_{nt}^k$ and

[30]The assumption that each *HS4-source-destination* combination is supplied by one producer is arguably a realistic one for many countries in our sample. Using the World Bank's Exporter Dynamics Database, the median number of exporters in *HS2-destination* pairs for the countries that are part of our sample is as follows (for the years 2012–2014): Bangladesh (2), Denmark (4), Egypt (3), Mexico (4), Norway (3), Peru (3), and Spain (10). On the more disaggregated HS4 level, these numbers will hence be even smaller. Our results are also very similar when we instead treat each HS6-origin-destination combination that we observe in the data as one variety and the correlation between both sets of estimates equals 79.8%. Lastly, We also assessed the importance of this assumption for large destination markets in our sample, like the U.S.. To this end, while this data is not available for all countries, we estimated import demand elasticities for the U.S. using HS10-level data, by assuming that a given HS10-origin pair imported by the U.S. is supplied by one producer, which is a weaker assumption. We also repeat the estimation using U.S. imports at the HS8 level. We find that the estimated elasticities using HS8 or HS10 product categories are highly correlated to those using HS6 categories, with correlation coefficients of 0.44 and 0.56, respectively.

$$\Delta \ln p_{nt}^{j(k)} = \frac{1}{1-\sigma_n^{j(k)}} \ln \left(\sum_{i,f \in \mathcal{C}_{nt}^{j(k)}} s_{int,f}^{j(k)} e^{(1-\sigma_n^{j(k)})\Delta \ln p_{int,f}^{j(k)} + \Delta \xi_{int,f}^{j(k)}} \right) - \frac{1}{1-\sigma_n^{j(k)}} \ln \frac{S_{nj(k),t+1}(\mathcal{C}_{nj(k)t})}{S_{nj(k),t}(\mathcal{C}_{nj(k)t})}, \tag{33}$$

where $s_{int}^{j(k)}$ denotes the share of continuing variety i in all continuing varieties, $\mathcal{C}_{nj(k)t}$ is the set of continuing varieties in product $j(k)$ between t and t + 1, and $S_{nj(k),t}(\mathcal{C}_{nj(k)t})$ is the share of the varieties in the set C in the total imports of product k at time t.[31] In line with Fajgelbaum et al. (2020), we assume that the upper-tier elasticity is the same across all sectors and hence only varies by country in our specification.

We do not, however, instrument for $\Delta \ln p_{nt}^{j(k)}$ via tariffs as Fajgelbaum et al. (2020) do, but instead use the inferred supply-side residuals from Equation (31) as an instrument. The primary reason for this choice is that there is only little variation in tariffs over time for several countries, especially compared to the large changes that took place during the U.S.-China trade war used in Fajgelbaum et al. (2020). In particular, we construct an instrument that is a simple average of realized $\delta_{int,f}^{j(k)}$ across continuing varieties

$$\Delta Z_{nt}^{j(k)} = \ln \left(\frac{1}{N_{nt}^{j(k),C}} \sum_{i,f \in \mathcal{C}_{nt}^{j(k)}} e^{\delta_{int,f}^{j(k)}} \right), \tag{34}$$

where $N_{nt}^{j(k),C}$ denotes the number of continuing varieties between periods t and $t+1$. Under the assumptions stated above, in particular the orthogonality between demand and supply side residuals, this instrument affects the equilibrium price but is uncorrelated with the error term on the demand side.[32]

Parameter Estimates. Table 1 summarizes our parameter estimates across countries. As summarized in Part I of this table, among the five sectors with the lowest demand elasticities are works of art, precious stones and pearls, as well as the aircraft industry. In contrast, clothing,

[31] Note that since the model presented in Section 2 is static, it does not readily feature a notion of new or disappearing varieties. Therefore, the first line of Equation (33) represents the model-implied relationship between prices and shares. However, given the empirical importance of new varieties (see Broda and Weinstein, 2006), we follow Fajgelbaum et al. (2020) and account for their impact via the term in the second line.

[32] In principle, one could also use the approach employed in Fajgelbaum et al. (2020) to estimate lower-tier elasticities. We do, however, not do so in the baseline specification for two reasons. First, for more than 50% of country pairs, tariffs equal zero in the data. Second, it is frequently the case that a country does not adjust its tariffs over the sample period against any exporter in a particular industry or only against very few. In those cases, $\sigma_n^{j(k)}$ cannot be estimated for this particular country-sector pair and would for example need to be imputed. The current approach avoids such cases. Nonetheless, we study the robustness of our results to estimating $\sigma_n^{j(k)}$ via Fajgelbaum et al. (2020)'s approach in Section 6.4.

Table 1: Distribution of parameter estimates for σ

I. Sectors with the lowest and highest elasticities (lower-tier):

Industry	Median $\sigma_n^{j(k)}$
Works of Art, Collectors' Pieces and Antiques (97)	1.69
Raw Hides, Skins, and Leather (41)	1.76
Precious Stones, Pearls (71)	1.83
Stone, Plaster, Cement (68)	1.85
Aircraft, Spacecraft (88)	1.88
⋮	⋮
Furniture, Bedding, etc. (94)	6.19
Aluminium and Articles thereof (76)	7.04
Books, Newspapers, Pictures (49)	7.37
Cloth. Accessories, not knitted (62)	8.31
Cloth. Accessories, knitted (61)	8.74

II. Demand Elasticities across Countries

	Lower-Tier (σ_{HS2})					Upper-Tier (σ_{HS1})
	Median	1st Quartile	3rd Quartile	Share stat. > 1	Share stat. different from U.S. σ	Estimate
Australia	3.20	1.46	7.18	87.05	67.86	1.07
Austria	5.60	1.64	16.36	85.40	59.42	1.01
Bangladesh	5.41	1.97	12.72	84.17	71.43	1.08
Belgium	2.61	1.60	7.04	92.11	66.67	1.09
Brazil	4.28	1.78	7.54	85.92	73.47	1.07
China	3.71	1.95	7.15	83.22	60.00	1.24
Denmark	2.86	1.61	7.72	92.25	55.56	1.39
France	3.18	1.72	6.92	89.87	60.27	1.01
Germany	4.35	1.69	7.39	89.61	70.00	1.02
Greece	2.33	1.62	4.20	83.21	61.22	1.46
India	3.54	1.56	10.56	92.59	71.43	1.07
Indonesia	2.69	1.71	4.23	88.51	66.00	1.07
Italy	1.70	1.26	3.73	85.23	57.97	1.14
Japan	1.94	1.36	4.37	84.03	60.00	1.07
Rep. of Korea	4.57	3.19	8.91	84.89	51.56	1.01
Mexico	3.97	2.26	7.61	88.19	60.87	1.09
Netherlands	3.70	1.51	12.95	87.79	62.50	1.01
New Zealand	3.38	1.67	9.23	85.81	69.23	1.01
Norway	2.87	1.99	4.19	82.98	67.16	1.07
Peru	2.89	1.50	5.90	79.59	65.63	6.54
Romania	3.25	1.67	6.29	88.36	66.67	1.63
Russia	2.74	1.73	5.36	91.49	69.64	1.01
Vietnam	4.51	2.21	14.42	96.69	85.71	1.01
Spain	3.16	2.13	4.77	84.25	62.16	1.24
Sweden	2.66	1.71	5.16	90.76	68.09	4.83
Egypt	2.16	1.32	4.81	90.32	88.00	1.07
United Kingdom	2.36	1.43	6.51	84.93	63.38	1.07
USA	2.16	1.45	5.37	90.60	-	1.04
ROW	3.05	1.24	10.36	77.16	43.08	1.07

Notes: The first part of this table displays the five sectors with the highest and lowest estimates of $\sigma_n^{j(k)}$ across countries. The second part provides summary statistics for the parameter estimates of σ_n^k and $\sigma_n^{j(k)}$. The former is estimated for 1-digit HS product categories and the latter for 2-digit sectors. The median and quartiles are taken over product categories. Standard errors for $\sigma_n^{j(k)}$ are computed via the delta method and we refer to an estimate as statistically greater than one whenever the corresponding t-statistic exceeds 1.96. The reported fractions are similar when assessing if the estimates are significantly different from 0. Analogously, we assess whether or not the estimates for $\sigma_n^{j(k)}$ are statistically different from the U.S. via two-sided t-tests.

aluminum, and furniture are sectors with the highest demand elasticities in our sample. These findings are largely in line with prior expectations and anecdotal evidence. The sectors with low elasticities are for example either frequently mentioned in the context of high markups (precious stones, aircraft, cement) or are highly differentiated (art).[33] On the other end, our estimates suggest that, for example, demand for clothing, furniture, and aluminum is, on average, quite elastic, and firms in these sectors hence earn low markups.

Our estimates are also largely consistent with those obtained, for example, by Broda and Weinstein (2006), who estimate median values for $\sigma_n^{j(k)}$ for the U.S. that range from 2.2 to 3.7. As evident from Part II of Table 1, the median estimate for most countries falls into this range. We estimate $\sigma_n^{j(k)}$ to be particularly low for Italy, Japan, the U.S., and Egypt. On the other end, we estimate comparably large elasticities of substitution for Vietnam, South Korea, and Austria. Table 1 also shows that most elasticities are precisely estimated, with for the majority of countries more than 80% being significantly greater than 1. More importantly, in the majority of cases, we can also reject that elasticities are the same as those estimated for the U.S., which supports our decision to allow for country-specific import demand elasticities. Specifically, we find that across all potential country-pair-sector combinations, about 70% of elasticities are significantly different.

Generally, we find that about one-third of the variation in the inverse $\sigma_n^{j(k)}$ can be explained by product and importer fixed effects, with nearly 60% of this variation being a result of the elasticity of substitution varying across products. This is consistent with the idea in Feenstra (1994) that product categories are differently differentiated and that certain categories are, hence, more or less substitutable in all countries. Variation across countries, on the other hand, suggests that demand for goods tends to be generally more elastic in some countries than in others—for example, because of varying income levels—which might explain why the median $\sigma_n^{j(k)}$ is comparably high in several poor economies, such as of Vietnam, Mexico, and Bangladesh. The parameter estimates, in general, relate to income as expected. A regression of $\sigma_n^{j(k)}$ on GDP per capita (in logs) suggests that the demand elasticity is about 7% lower in the richest economies compared to the poorest ones.[34] Furthermore, a significant fraction of the variation in the elasticity of substitution is a result of country-product-specific factors. This suggests the presence of country-product-specific determinants of $\sigma_n^{j(k)}$, for example, because of country-product-specific standards, or country-product-specific tastes.

Appendix Tables D.4 and D.5 describe in more detail why our estimates differ across countries. Specifically, these tables summarize each country's three most important import and export sectors, along with the corresponding lower-tier inverse elasticities in each industry. This table offers several main takeaways. First, countries tend to import a similar composition of goods, with machinery and vehicles, for example, being the largest import sectors in most

[33]The low elasticity estimate for cement is likely due to the fact that it can only be shipped for very short distances and is, therefore, rarely traded internationally. In such a case, international price changes will, therefore, affect traded quantities only a little.

[34]Note that these results are also consistent with the findings of Simonovska (2015), who estimates that doubling a destination's per capita income results in an 18% increase in the average price.

countries. We, however, observe a considerable degree of country-specific variation in demand elasticities within industries. That is, demand for goods in a given sector is differently elastic in one country compared to another, for example, because of differences in income or tastes. For instance, the inverse elasticity of *Electrical Machinery and Equipment* is markedly higher in the UK than in Vietnam or Peru. The export mix, on the other hand, tends to be more dispersed across countries, and developing as well as resource-rich countries (e.g., Bangladesh, Norway, Brazil, or Australia) especially tend to export and import noticeably different goods. Belgium and the Netherlands, for example, export, on average, relatively low-elasticity goods, which is partially a result of the high export share of *Pharmaceutical Products*. On the other hand, Bangladesh and Vietnam have a large export share in relatively high-elasticity sectors like clothing and footwear.

We also find that import and export elasticities are frequently quite different within the same country-sector pair; that is, the estimated lower-tier elasticities differ for a country's exports compared to its imports in the same industry. The three most important import and export sectors in Austria and Belgium are identical, for example, but we find that the elasticities for exports are smaller than those for imports in every case. The opposite is true in Italy, where sectoral import elasticities are lower than export ones.

Lastly, the rightmost column of Table 1 summarizes how the estimates on the upper tier compare to the lower-tier demand elasticities described above. We find that these estimates are largely sensible. First, they are lower than the estimated values for $\sigma_n^{j(k)}$ in the vast majority of cases, suggesting that goods within sectors are closer substitutes than across.[35] Within the model, this relationship therefore implies that markups will be increasing in firm size, which is consistent with what has been widely documented in previous work. Second, the median and mean across our estimates equals 1.07 and 1.41, respectively, which is in line with the across-sector elasticity of substitution used by Edmond, Midrigan and Xu (2015).

4.3 Estimation of Productivity and Trade Costs

Once we estimated the demand elasticities in the previous step, we estimate bilateral trade costs as well as firm-specific productivity levels in each sector-country pair. To ensure that our counterfactual results will not be driven by the assumption of a parametric productivity distribution, we follow a non-parametric approach and infer firm-specific productivity levels in each sector-country pair using information on the empirical relationship between firm rank and size, the number of firms in each sector-country pair, as well as domestic market shares and trade flows in each sector.[36] Specifically, for a firm f in a given sub-sector $j(k)$, we use

[35] Two notable exceptions are Sweden and Peru. In exceptional cases in which the upper-tier elasticity is estimated to be larger than the lower-tier one, we assume that the two elasticities are equal, thereby shutting down pro-competitive forces.

[36] In this regard, our approach differs from, for example, Arkolakis et al. (2019), who assume that productivity follows a Pareto distribution and restrict this distribution to be the same across sectors. Consequently, the distribution of markups will not necessarily be invariant to trade costs in our setting, which introduces an additional channel through which trade can have pro-competitive effects.

equations (11)-(14) to derive the firm's productivity relative to that of the best firm (indexed by $f = 1$) as a product of the ratio of market shares and markups

$$\frac{A_{n,f}^{j(k)}}{A_{n,1}^{j(k)}} = \left(\frac{s_{nn,f}^{j(k)}}{s_{nn,1}^{j(k)}}\right)^{\frac{1}{\sigma_n^{j(k)}-1}} \frac{\mu_{nn,f}^{j(k)}}{\mu_{nn,1}^{j(k)}}, \tag{35}$$

where markups are themselves a function of market shares, as evident from Equation (15).

To calculate the market share of each firm in the domestic market, $s_{nn,f}^{j(k)}$, we exploit the relationship between firm rank and size. In particular, denoting the total domestic market share of all firms in market n in sub-sector $j(k)$ by $s_{nn}^{j(k)}$, we can write

$$s_{nn}^{j(k)} = \sum_{f=1}^{F_{nn}^{j(k)}} s_{nn,f}^{j(k)}. \tag{36}$$

Manipulating this equation delivers

$$s_{nn,1}^{j(k)} = \frac{s_{nn}^{j(k)}}{\sum_{f=1}^{F_{nn}^{j(k)}} \frac{s_{nn,f}^{j(k)}}{s_{nn,1}^{j(k)}}}. \tag{37}$$

Given the observed domestic share in the numerator and the inferred rank-size distribution in the denominator, we can find the domestic market share of the best producer on the left-hand side. We can then compute the domestic market share of any firm f as

$$s_{nn,f}^{j(k)} = \left(\frac{s_{nn,f}^{j(k)}}{s_{nn,1}^{j(k)}}\right) s_{nn,1}^{j(k)}. \tag{38}$$

Having calculated firms' domestic market shares and given the productivity of the best firm $A_{n,1}^{j(k)}$, we can use Equation (35) to compute the productivity of all firms. It remains to infer the productivity of the best firm, which we discuss below.

To estimate the iceberg costs $d_{in}^{j(k)}$ and the best-firm productivity $A_{n,1}^{j(k)}$ in sub-sector j(k), we target bilateral market shares in the data.[37] To this end, we use data on the bilateral distance between country pairs i and n ($dist_{in}$) as well as on whether or not two countries share a common border ($border_{in}$), a common language ($lang_{in}$), and if there is a free trade agreement between the two countries (fta_{in}). We impose the following log-linear functional form on iceberg costs

$$log(d_{in}^{j(k)}) = \beta_0^{j(k)} + \beta_1^{j(k)} \times dist_{in} + \beta_2^{j(k)} \times border_{in} + \beta_3^{j(k)} \times lang_{in} + \beta_4^{j(k)} \times fta_{in}. \tag{39}$$

For each sub-sector $j(k)$ separately, we jointly estimate the iceberg cost parameters $(\beta_0^{j(k)}, ..., \beta_4^{j(k)})$

[37] Note that we estimate the productivity of the best firm in each country separately for each sector, and countries are therefore allowed to be differently productive across sectors.

Table 2: Estimates: Productivity and Misallocation

	Productivity		Misallocation
	Mean	Median	
	(1)	(2)	(3)
Australia	6.23	6.04	0.2413
Austria	5.03	4.71	0.1631
Bangladesh	0.10	0.08	0.1265
Belgium	5.35	5.03	0.1655
Brazil	1.07	0.96	0.0298
China	1.37	1.30	0.0637
Denmark	6.16	5.82	0.0579
France	5.27	5.04	0.0727
Germany	6.33	5.79	0.0412
Greece	1.70	1.61	-0.0096
India	0.20	0.19	0.2149
Indonesia	0.43	0.42	0.2350
Italy	4.51	4.41	0.1095
Japan	4.73	4.56	0.2108
S.Korea	3.77	3.54	0.0147
Mexico	1.19	1.07	0.1324
Netherlands	6.21	6.01	0.2452
New Zealand	4.08	3.95	0.1615
Norway	7.49	7.01	0.1239
Peru	0.57	0.53	-0.0933
Romania	1.13	0.94	-0.0264
Russia	0.97	0.87	0.1070
Vietnam	0.41	0.29	0.0533
Spain	3.31	3.13	0.1080
Sweden	5.78	5.53	-0.1266
Egypt	0.34	0.32	0.2588
UK	6.15	5.70	0.3508
USA	9.61	9.06	0.1495

Iceberg Cost Paramater Estimates:

	Mean	Median
	(4)	(5)
$\beta_1^{j(k)}$ (Distance)	0.1293	0.1019
$\beta_2^{j(k)}$ (Border)	-0.1161	-0.0928
$\beta_3^{j(k)}$ (Language)	-0.0847	-0.0691
$\beta_4^{j(k)}$ (FTAs)	-0.0321	-0.0208

Notes: The estimated values in columns (1) and (2) refer to the productivity of the best firm in the respective market. Note that the productivity of the ROW is normalized to one and hence not reported separately in this table.

along with the productivity of the best firm in all countries ($A_{n,1}^{j(k)}$) to minimize the distance between model-implied market shares and those observed in the data

$$\min_{\beta_0^{j(k)},\beta_1^{j(k)},\beta_2^{j(k)},\beta_3^{j(k)},\beta_4^{j(k)},\{A_{n,1}^{j(k)}\}_{n=1}^{N}} \left[\ln(s_{in}^{j(k),model}) - \ln(s_{in}^{j(k),data})\right]^2. \tag{40}$$

This minimization problem for each sub-sector $j(k)$ has $N+4$ parameters (we normalize the best productivity of ROW in all sub-sectors to one). Given that our sample consists of 96 HS2 sub-sectors and 29 countries, we therefore estimate $33 \times 96 = 3,168$ parameters in this procedure.[38]

The intuition behind this estimation procedure is that bilateral market shares depend on bilateral trade costs as well as firms' productivities across the world. To elaborate on this minimization procedure, note that the overall market share of country i in country n and sub-sector $j(k)$ equals

$$s_{in}^{j(k),model} = \sum_{f=1}^{F_{in}^{j(k)}} s_{in,f}^{j(k)} \tag{41}$$

Given the best-firm productivity, we calculate the productivity of all firms in each country as outlined above and given by Equation (35). Moreover, given the iceberg cost parameters and all productivities, we calculate the marginal cost of each firm in any source country i serving any destination country n and then solve equations (11)-(14) for the model-implied bilateral market shares for each firm.

Model fit and comparison with previous estimates. To evaluate the fit of the model and determine to what extent the resulting estimates are reasonable, we compare our estimates and model outcomes against both the data and previous estimates in the literature. First, Appendix C plots model-implied bilateral market shares in each upper-tier sector against those observed in the data.[39] As evident from these figures, the model matches bilateral market shares well, and the R^2 in most cases exceeds 60%. Moreover, our predictions for the degree of intra-industry trade appear reasonable. Specifically, the mean Grubel-Lloyd Index over all sectors and countries in our model equals 0.44, which is only slightly smaller than the data counterpart of 0.52, which is reassuring given that this statistic is not directly targeted in our

[38] As stated above, due to data availability, we assume that the relationship between firm rank and size can vary by sector but is the same across countries, but as Equation (35) shows, productivity distributions still varies across countries due to, for example, differences in demand. In principle, however, the estimation approach we employ can also be applied to settings in which the rank-size relationship varies flexibly across countries since Equation (35) still applies in such cases and our estimation approach does not require us to assume a particular parametric productivity distribution. We therefore believe it would be an interesting extension to incorporate productivity more flexibly into our framework and, for example, understand the quantitative importance of outliers in more detail.

[39] Note that we estimate iceberg costs and productivities for each *lower-tier* sub-sector $j(k)$. To save space, however, we plot market shares for each *upper-tier* sector k by including all respective sub-sectors.

estimation.[40]

Second, Table 2 summarizes the resulting productivity estimates in each country, which are largely in line with previous findings. In particular, as also shown graphically in Appendix Figure D.1, we find that richer economies are, on average, more productive than poorer ones, with the U.S., Norway, Australia, and Germany being, on average, the most productive in our sample. Productivity is lowest in Bangladesh, India, and Egypt. We also find levels of misallocation (as defined in Section 2.6) that are in line with existing work. Edmond, Midrigan and Xu (2015), for example, report misallocation levels between 7% and 9% in Taiwan, which is mostly in line with the values we obtain for the East Asian economies in our dataset with, for example, 6.4% for China or 5.3% for Vietnam.[41]

Third, Table 2 summarizes and Figure D.2 plots histograms of the estimated iceberg cost coefficients in Equation (39). As expected, a greater distance is on average associated with a higher trade cost, while a common language, a shared border, and a free-trade agreement between countries translate into lower iceberg costs. To provide a sense of how important these costs are, we use the average values of these coefficients, as reported in Table 2, to compute the average trade cost for each country pair and plot them against bilateral expenditure shares for each pair. The result is shown in Figure D.3. While this figure abstracts from the importance of sectoral variation in the coefficients and the importance of country-level productivities, it already shows a sizable impact of trade costs and can explain about 41% of the variation in bilateral expenditure shares.

Lastly, Appendix Table D.6 summarizes the model-implied ex post trade elasticities for each country based on the estimates we obtained in this section and Section 4.2. Specifically, starting at factual tariffs and trade costs, we simulate a 20% reduction in iceberg trade costs and compute ex post trade elasticities for each country, defined as the elasticity of the ratio of total imports to expenditure on domestic goods with respect to iceberg trade costs. Our results imply that the cross-country median and average trade elasticities equal 2.05 and 2.17, respectively, and range from 1.17 to 5.83. These values are lower than the trade elasticity used

[40]The extent of intra-industry trade in our model also aligns well with the numbers reported by Edmond, Midrigan and Xu (2015) of 0.45 in their model and 0.37 in their data. Hence, while the extent of head-to-head competition in our model is quite close to that in Edmond, Midrigan and Xu (2015), firms engage in direct competition even more frequently in our data that spans several countries, in contrast to only one country in Edmond, Midrigan and Xu (2015). Based on the findings by Edmond, Midrigan and Xu (2015) and as we also show in Section 6.4, a larger degree of productivity correlation and head-to-head competition across countries would increase the pro-competitive gains from trade. We also find that the median Grubel-Lloyd Index declines following the global trade war counterfactual studied in Section 6 from 0.44 to 0.41, pointing to a moderate decline in intra-industry trade.

[41]It is important to note that, as mentioned in Section 2.6, the notion of "efficient" productivity in a multi-country setting is based on a global planner's perspective, not necessarily on that of an individual country. Indeed, as Table 2 shows, this "efficient" productivity in some countries is lower than the productivity in the baseline equilibrium, resulting in a negative misallocation. For these countries, aggregate production per labor under marginal-cost pricing is smaller than that in the baseline equilibrium. The main reason for this result is that these countries are net exporters of high-markup products, because of large estimated demand elasticities on their imports relative to their exports. As a result, these countries lose export profits under marginal-cost pricing, resulting in lower "efficient" productivity compared to the baseline equilibrium.

in Edmond, Midrigan and Xu (2015), who target a value of 4. However, our ex post trade elasticities are in line with recent evidence by Boehm, Levchenko and Pandalai-Nayar (2023) who document generally lower trade elasticities ranging from 0.76 to 2 based on MFN tariff changes. Our values are also comparable to the findings by Fajgelbaum et al. (2020), who estimate elasticities ranging between 1.19 and 2.53, depending on the level of disaggregation. Nevertheless, we evaluate the robustness of our findings to these estimates in Section 6.4 and show that they also hold when we use elasticities that more closely match those used in Edmond, Midrigan and Xu (2015).

5 Supporting Evidence Using Cross-Country Firm-Level Data

The set of estimated parameters and variables in the previous section, including lower- and upper-tier substitution elasticities, productivities, trade costs, and the number of firms, determine the equilibrium markups in each sector-country pair and also the degree to which markups are variable and respond to changes in market shares. Since markups and their elasticity with respect to market shares are at the heart of our analysis, in this section we use external data sources to provide supporting evidence for the implied markups and their implications within the structure of our model.

In particular, we first show that our model-implied markups are positively correlated with data-driven variable profit margins as well as markups in several countries, and are negatively correlated with labor shares. We further show that the extent to which model-implied markups vary with market shares is largely in line with that in the data. Taken together, these results are reassuring and lend credence to the parameter estimates and the model structure jointly since, in this section, we rely on data sources and data moments that were not used in estimating the model. These results can be, therefore, viewed as an external validation of the estimated model.

To this end, we rely on the ORBIS firm-level dataset in this section, which provides balance sheet information on both larger and smaller companies in several countries along a wide range of dimensions. We restrict our sample (in both data and model) to eight European countries, for which ORBIS has particularly good coverage, to avoid having to rely on the smaller sample sizes for a range of other countries in the dataset.[42] These countries have a particularly rich data coverage on the key variables that we use here, including revenue, wage bill, capital stock, and material costs. Since we rely on trade data for the year 2015, we focus on the same year in our analysis. To limit the impact of outliers, we winsorize all variables at 5% and 95%.

[42]Specifically, we use data for Austria, Belgium, France, Germany, Italy, Norway, Spain, and Sweden.

5.1 Markups, Variable Profit Margins, and Labor Shares

To provide supporting evidence for the overall markup distribution implied by our estimated model, we construct two measures using ORBIS firm-level data: variable profit margins and markups. As for variable profit margins, we first compute firm-level revenue-variable cost margins defined as sales over the sum of wage bills, material costs, and capital costs for each firm.[43] The resulting firm-level variable profit margin has a mean of 1.41 and a standard deviation of 0.38. We then use the average of these variable profit margins across all companies within an HS2 code in each country as the measure of the sector-country-level variable profit margin, to be compared with our model-implied statistics.[44] We map four-digit SIC codes reported in ORBIS to HS2 codes in our trade data, using the concordance developed by Pierce and Schott (2012).[45]

Furthermore, as for markups, we first estimate firm-level markups in our ORBIS data using a production-function approach (Hall, Blanchard and Hubbard, 1986; De Loecker and Warzynski, 2012). Specifically, we assume that labor is the flexible input in the production technology and estimate a production function to estimate the elasticity of output with respect to labor.[46] We then infer markups as the ratio between the labor elasticity of output and the labor share in sales.[47] The estimated markups have a mean of 1.79 and a standard deviation of 1.15. We then treat the average markup within each HS2-country pair as the sector-country-level markup in the analysis.

We then employ our estimated model and solve for its equilibrium to show that model-implied markups are positively correlated with data-implied variable profit margins and markups discussed above. To this end, we first note that firms in the model potentially sell to multiple destinations and charge different markups across destinations (depending on their equilibrium market shares as well as substitution elasticities). We define firm-level markups within our model framework as a quantity-weighted average of firms' markups across destinations. As Appendix A.3 shows, this constructed markup of firm f located in country i in sector $j(k)$ is equal to

$$\mu_{i,f}^{j(k)} = \frac{p_{i,f}^{j(k)}}{w_i / A_{i,f}^{j(k)}}, \tag{42}$$

[43] To infer capital costs, we use 10-year government bond yields for each country as the net interest rate, and we assume that the depreciation rate equals 10% in all sectors and countries. We infer the capital costs by multiplying firm-level capital stocks (which are observable in the data) by the sum of net interest rate and depreciation rate. The results are robust to not including capital costs in the denominator.

[44] Our results using ORBIS data presented in this section are robust to using the cross-firm median, rather than the average in our benchmark, of the respective statistics.

[45] Both in our trade data and the concordance table, we use import classifications.

[46] Since we observe sales and not the quantity of production, we deflate sales using industry price deflators from EU KLEMS.

[47] In general, the ratio between the labor elasticity of output and the labor share in sales is equal to the product of markup and wage markdown; see Yeh, Macaluso and Hershbein (2022) and Syverson (2024) among others. Here, although admittedly restrictive, we assume that firms have no labor market power, and therefore our ratio estimator recovers markups.

where $p_{i,f}^{j(k)}$ is a quantity-weighted average of prices that this firm charges across the world, and $A_{i,f}^{j(k)}$ and w_i are, as defined before, the firm's productivity and country i's wage, respectively. Appendix A.3 also shows that this constructed firm-level markup is exactly equal to the inverse of firm-level labor share, consistent with the predictions and findings in the literature (e.g., Edmond, Midrigan and Xu, 2015).[48]

To map model-implied markups to data-implied profit margins and markups, we perform what we did in the data: we take the cross-firm average profit margin and markup within each HS2-country pair in the model. Encouragingly, we find that variable profit margins and markups in the ORBIS data are positively correlated with our model-implied markups, with the correlation coefficient being equal to 26% and 32%, respectively.[49] Moreover, the median of model-implied markups across HS2-country pairs equals 1.72, whereas the same statistic for markups and variable profit margins in the ORBIS data equals 1.81 and 1.48, respectively. These results show that, not only the correlation, but also the level of markups and profit margins in the model and in the external data source align reasonably well.

The negative relationship between markups and labor shares in the model discussed above provides us with another way to evaluate the credibility of our estimated model by testing whether or not sectoral labor shares in the data are indeed correlated with our model-implied markups. To explore this idea empirically, we compute firm-level labor shares in our ORBIS data as wage bills divided by value added (i.e., sales minus material costs).[50] The resulting firm-level labor shares have a mean of 0.49 and a standard deviation of 0.22. We then construct cross-firm average labor shares within HS2-country pairs and compare them with our model-implied average markups at the HS2-country level described above. As expected, there is a negative association between labor shares in the data and average markups in the model, with a correlation coefficient of -31%.

5.2 Elasticity of Markups With Respect to Sales Shares

The paper's main focus is to determine the pro-competitive effects of trade, which depend crucially on how markups vary in response to changes in market shares after tariff adjustments. The extent to which markups are variable and respond to changes in market shares is, therefore, a key statistic that governs our counterfactual results. This section examines the relationship between markups and market shares in our model and compares it to that in the ORBIS data to lend credence to the key pro-competitive force in our estimated model as an external validation.

To this end, we regress firm-level labor shares on firm-level sales shares for all firms f in

[48] This relationship follows from optimal firm behavior and the observation that each firm's first-order condition implies that the markup should equal the labor elasticity of output (which is one in our framework) divided by the labor share in sales. See also the pioneering work by Hall, Blanchard and Hubbard (1986) and De Loecker and Warzynski (2012) for more details.

[49] We also weight each HS2-country pair by the number of firms we observe for that pair in the ORBIS data, since some HS2-country pairs report only a few firms.

[50] Our result is robust to defining the labor share as wage bill divided by sales.

country i in sector j, separately for each HS2-country pair:

$$\text{LaborShare}_{ij,f} = a_0 + a_1 s_{ij,f} + \epsilon_{ij,f}. \tag{43}$$

Specifically, $s_{ij,f}$ describes sales of firm f located in country i relative to total sales of all firms located in country i. Hence, this measure captures a firm's sales share among all firms located in the same country within a particular industry j.

Since labor shares are inversely related to markups (as discussed above), this regression provides indirect information on the elasticity of markups with respect to sales shares.[51] In particular, one would expect the coefficient a_1 to be negative if larger firms have relatively lower labor shares and higher markups. The same insight has been widely used in the literature. Edmond, Midrigan and Xu (2015), for instance, run the same regression and employ the estimates of a_1 and a_1/a_0 to infer the markup distribution and the elasticity of markups with respect to sales shares in their framework.

We run these regressions in both our ORBIS data as well as the estimated model. Since we do not observe the share of foreign firms in each sector-country pair, we construct firm-level sales shares in both data and model as sales of a firm relative to total sales of all producers in that sector-country pair.

Encouragingly, we find that the estimates of regression (43) in the model are largely in line with those in the data. In particular, across all HS2-country pairs, the correlation coefficients between the estimated a_1 and a_1/a_0 in the model versus data are 0.42 and 0.41, respectively.

Lastly, the median estimate of a_1 in the ORBIS data across all HS2-country pairs equals -4.2, compared to -2.2 in the model. While the model performs well in capturing the elasticity of markups with respect to sales shares in an external data set that was not used in the estimation procedure, this correlation is stronger in the data compared to the model; that is, markups co-move with sales shares more strongly in the data compared to the model. Intuitively, this is most likely an artifact of using a relatively coarse lower-tier CES aggregation in our model (i.e., HS2), which pushes lower-tier elasticities downward, limiting the elasticity of markups with respect to sales shares.[52] Consequently, the pro-competitive effects of trade that we quantify in the next section can be considered rather conservative. In fact, Section 6.4 shows that using larger lower-tier elasticities—which imply a stronger markup elasticity— magnifies our findings.

6 Counterfactual Analysis

In this section, we ask to what extent the findings of Section 3 apply to the full quantitative model. We do so for two main reasons. First, we determine if the pro-competitive gains are

[51] In particular, up to the assumption that firms in the same HS2-country pair have the same Cobb-Douglas production function, variations in labor shares directly translate into variations in markups.

[52] As noted before, we chose HS2 as our lower-tier aggregation mainly because of data availability on the number of firms in each sector-country pair.

sizable for the given set of estimated parameters and if they vary meaningfully across countries. Second, we ask if policymakers can affect the pro-competitive gains via targeted policies by, for example, selectively taxing some sectors as opposed to others.

In our main counterfactual, we simulate the consequences of a global trade war in which all countries raise tariffs by 50 percentage points. As we did in Section 3, we do so in two different ways, one in which firms adjust markups in response to changing competition (i.e, our baseline model), and one in which firms are assumed to be infinitesimal and therefore always face the lower-tier demand elasticity, leading to a constant markup. This approach again allows us to assess how relevant the pro-competitive gains are in our setting and to understand in which way variable markups affect the model's outcomes.[53]

6.1 The Pro-Competitive Gains from Trade

We first determine how large the pro-competitive gains from trade are across countries in the full quantitative model. Table 3 presents the results.[54] As this table shows, we find a sizable degree of dispersion in the pro-competitive gains from trade across countries, with pro-competitive gains from trade that reach between 0.4 and 0.7 percentage points in the U.S. and China and pro-competitive losses of between 1.3 and 2.5 percentage points in New Zealand, Mexico, the UK, Austria, Vietnam, and the Netherlands. Interestingly, we find that, broadly consistent with Arkolakis et al. (2019), in about two-thirds of countries the pro-competitive gains are negative, with the main exceptions being larger countries such as the U.S. and China, for which we predict sizable gains.

We find that the relationships we documented in Section 3 also largely hold in the full model. Specifically, the pro-competitive gains across countries vary noticeably with (1) each country's import and export share, (2) the difference between lower- and upper-tier elasticities on its imports, and (3) the difference between lower- and upper-tier elasticities on its exports. We document these results both graphically and via regressions.

First, as evident from Panel (a) of Figure 3, countries with a higher import share experience lower pro-competitive gains from trade. As before, this is primarily due to a greater fraction of foreign firms lowering their markups in response to tariffs and to the fact that larger firms optimally adjust their markups by more than smaller firms do.[55]

Second, as Panel (b) of Figure 3 shows, countries with a *greater* export share experience higher losses from a trade war under variable markups than under fixed markups (i.e., larger pro-

[53] As discussed in Section 3, we consider tariff wars instead of tariff liberalizations since tariffs are generally small in our sample and also given the importance and incidence of tariff wars in the past few years. We therefore continue to use our definition of the pro-competitive gains from trade as the opposite of welfare changes under variable markups versus those under fixed markups.

[54] Tables E.1 and E.2 in the Appendix present counterfactual outcomes in more detail in the baseline and the fixed-markup model, respectively.

[55] According to Equation (28), the markup elasticity depends on foreign firms' individual market shares, not the aggregate import share. However, since we impose the same rank-size relationship for firms across countries, larger import shares are associated with larger foreign firms on average or a greater fraction of foreign firms.

Table 3: Global Tariff War (all countries increase tariffs by 50pp)

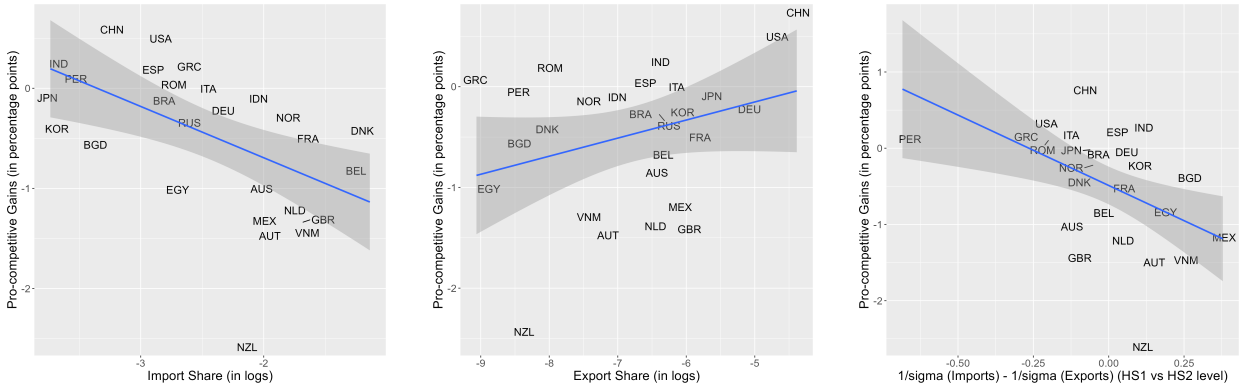
	Variable Markups			Fixed Markups			Pro-Competitive Gains
	Welfare	Wages	Profits	Welfare	Wages	Profits	
	(1)	(2)	(3)	(4)	(5)	(6)	(4) - (1)
Australia	-1.27	-1.42	-3.58	-2.20	-2.99	-4.77	-0.93
Austria	-3.77	-2.47	-7.78	-5.17	-3.56	-10.25	-1.41
Bangladesh	-3.52	-0.72	-11.56	-4.01	-1.49	-12.50	-0.48
Belgium	-4.38	-4.92	-9.73	-5.13	-6.16	-10.76	-0.75
Brazil	-3.31	-1.84	-10.43	-3.51	-2.11	-10.94	-0.20
China	-1.60	-0.84	-3.67	-0.94	-1.21	-1.61	0.66
Denmark	-2.51	-2.52	-6.26	-2.86	-2.66	-7.14	-0.35
France	-2.37	-2.20	-6.64	-2.80	-4.10	-6.16	-0.43
Germany	-4.09	-4.84	-13.40	-4.24	-6.59	-12.69	-0.15
Greece	-2.83	-1.72	-7.40	-2.69	-1.70	-7.24	0.15
India	-3.15	-1.10	-5.93	-2.98	-1.46	-5.64	0.17
Indonesia	-1.48	-3.91	-0.69	-1.66	-2.31	-2.77	-0.17
Italy	-2.06	-1.55	-5.20	-1.99	-1.40	-5.22	0.07
Japan	-1.11	-0.82	-2.10	-1.13	-0.82	-2.28	-0.02
S.Korea	-1.19	-0.77	-4.34	-1.52	-0.93	-5.63	-0.33
Mexico	-2.90	-1.15	-9.30	-4.17	-2.18	-11.78	-1.27
Netherlands	-1.05	-6.06	0.57	-2.36	-4.74	-4.04	-1.31
New Zealand	-3.29	-2.48	-9.21	-5.80	-6.62	-10.52	-2.50
Norway	-0.63	-1.78	-0.70	-0.85	-1.27	-1.98	-0.22
Peru	-3.33	-1.24	-20.41	-3.31	-1.21	-20.51	0.02
Romania	-2.40	-1.40	-7.66	-2.29	-1.46	-7.52	0.11
Russia	-2.72	-0.97	-7.33	-2.99	-1.34	-7.96	-0.27
Vietnam	-6.70	-5.05	-17.50	-8.07	-7.93	-18.16	-1.37
Spain	-1.92	-1.86	-4.20	-1.81	-2.01	-4.09	0.11
Sweden	-5.83	-1.80	-33.50	-6.40	-1.91	-35.27	-0.57
Egypt	-0.23	-1.49	-0.62	-1.17	-1.39	-2.58	-0.93
UK	-1.01	-2.71	-2.79	-2.35	-5.16	-4.17	-1.34
USA	0.01	-1.36	-0.10	0.43	-1.47	0.75	0.42
ROW	-1.50	-5.34	-3.29	0.25	-5.99	-0.03	1.74

Notes: Columns (1) to (6) report the percentage change in the respective variable, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent. All variables are in real terms.

competitive gains from trade).[56] Tariffs place exporters at a disadvantage, leading to reduced market shares and prompting them to optimally lower their markups, which results in an additional loss. When a country has a larger export share, following an increase in trade costs, a greater fraction of firms from this country optimally reduces markups in foreign markets, and to a larger extent, which results in larger losses from a trade war under variable markups than under fixed markups. As evident from Panel (b), we find that the high presence of China and the U.S. in foreign markets contributes to the fact that these countries are among the few economies that experience pro-competitive gains. Hence, the positive impact of trade on

[56]We measure the export share of a country as its total exports relative to total consumption in other countries. However, the findings presented in this section are robust to other measures, for example, when we instead employ sales-weighted bilateral export shares.

Figure 3: Pro-Competitive Gains, Market Shares, and Demand Elasticities



(a) Import Shares (b) Export Shares (c) Demand Elasticities

Notes: The y-axis in all panels reports the pro-competitive gains (in percentage points), as measured by the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) reports each country's total imports as a fraction of its total spending. The x-axis in Panel (b) measures each country's total exports relative to total consumption in other countries. The x-axis in Panel (c) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

welfare through product market competition appears to be of particular importance in larger countries, while playing a smaller role in small economies.

Third, the difference between upper- and lower-tier elasticities matters for the extent of cross-country variation in the pro-competitive gains from trade. To visualize its importance across countries, we rely on insights from Section 3 that the pro-competitive gains are (1) decreasing in the inverse elasticity on the upper versus the lower tier on imports and (2) increasing in the inverse elasticity on the upper versus the lower tier on exports. Hence, the pro-competitive gains should depend negatively on the difference in the inverse elasticity on the upper versus the lower tier for imports minus that for exports. As evident from Panel (c) of Figure 3, this relationship also holds in the full model. Importantly, it can also explain a sizable difference in the pro-competitive gains across countries, with about -1.2 percentage points in Vietnam and Mexico and about +0.5 percentage points in the U.S. and China.

Interestingly, we find that this relationship also holds when we plot the difference between the upper- and lower-tier elasticities for imports only. Therefore, as was the case in the illustrative model in Section 3, the welfare impact of markup reductions by foreign firms after a trade war quantitatively dominates that of increases in the dispersion of markups across domestic producers. Consequently, the pro-competitive gains from trade tend to diminish as the gap between upper- and lower-tier elasticities on the import side widens, and countries with a large difference between these elasticities are more likely to experience *negative* pro-competitive effects from trade.

How important are these factors in explaining the overall pro-competitive gains from trade? To shed light on this question, we regress the pro-competitive gains on import and export shares,

Table 4: Regression Results: The Pro-competitive Gains from Trade

Dependent Variable: Pro-Competitive Gains ($-\Delta$% Welfare [$\times$100] (variable vs fixed markups))				
	(1)	(2)	(3)	(4)
	Pro-Comp. Gains	Pro-Comp. Gains	Pro-Comp. Gains	Pro-Comp. Gains
Inverse sigma for imports	-2.524***	-2.376***	-2.588***	-2.467***
(HS1 versus HS2)	(-4.11)	(-3.92)	(-4.66)	(-4.71)
Import Share (logs)		-0.495***	-0.455***	-0.432***
		(-4.28)	(-3.87)	(-3.33)
Inverse sigma for exports			3.836**	2.673*
(HS1 versus HS2)			(2.33)	(1.76)
Export Share (logs)				0.119
				(1.38)
R^2	0.2664	0.5212	0.5616	0.5971

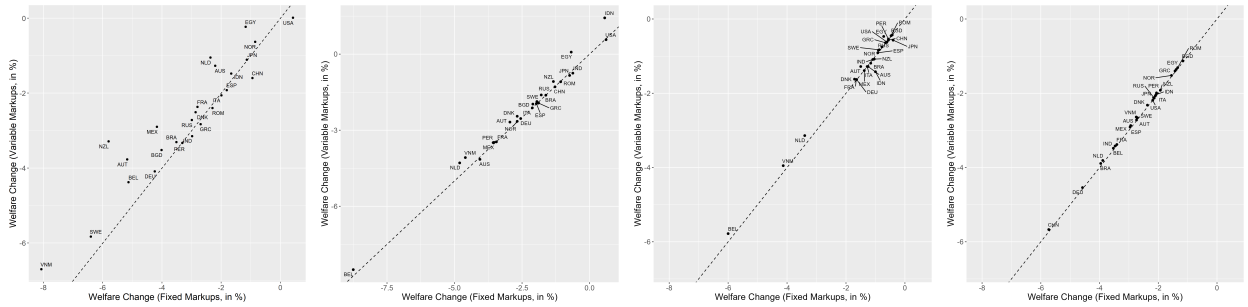
Notes: The dependent variable in each regression is the percentage change in welfare associated with a 50 percentage point increase in tariffs across all countries under variable compared to fixed markups, but with a negative sign, so that positive values can be interpreted as pro-competitive gains from trade. All values for $1/\sigma$ are weighted by trade volumes. Robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

as well as the gap between upper- and lower-tier elasticities for both imports and exports. As expected, the results, reported in Table 4, show that the pro-competitive gains from trade are negatively related to both the import share and the import-side elasticity gap. In contrast, the coefficients on the export share and the export-side elasticity gap are positive, although the coefficients on the export side tend to be less precisely estimated than those on the import side.[57] Overall, we find that variation in import and export shares, along with differences in upper- and lower-tier elasticities, accounts for a large fraction of about 60% of the cross-country variation in pro-competitive gains from trade across countries.

As a final check, to confirm the quantitative importance of import markups for the pro-competitive gains across countries, we compute changes in import and domestic markups within the model and examine how they relate to the pro-competitive gains. First, as shown in Panel (e) of Figure E.7, there is a clear positive relationship between changes in import markups following a trade war and the pro-competitive gains from trade, with a correlation of about 77%. This positive relationship stems from the fact that countries that experience a larger reduction in import markups following a trade war have smaller welfare losses under variable markups compared to those under fixed markups (i.e., smaller pro-competitive gains from trade). This result can also be seen in Appendix Table E.3, where we regress the pro-competitive gains from trade on changes in import and domestic markups. These results confirm that import (and export) markups are an important determinant of the pro-competitive gains from trade, while

[57]The reason for this is twofold. First, most countries have a relatively small share in the world's total consumption, leading to limited cross-country variation in the export share. Second, the elasticity gap on a country's exports is effectively an average over the elasticity gaps in all other countries, which does not vary as much across exporters.

Figure 4: Cross-Country Heterogeneity and the Pro-Competitive Gains from Trade



(a) Baseline Model (b) Cross-Country Homogeneous Elasticities (c) Cross-Country-Sector Homogeneous Elasticities (d) Almost-Full Symmetry

Notes: Panel (a) plots the change in welfare associated with a global trade war in which tariffs are raised by 50 percentage points in the baseline model with cross-country heterogeneous elasticities. The y-axis reports changes in welfare under variable markups, while the x-axis reports these changes under fixed markups. Panel (b) reports the same outcome in the alternative model with cross-country homogeneous elasticities. The model used for Panel (c) uses the median U.S. HS2 elasticity for all subsectors and countries and the U.S. HS1 elasticity for all sectors and countries. Panel (d) is based on a model in which all countries additionally share the same productivity, number of firms, and α_n^k as in the U.S., and all imports of a country are subject to the same bilateral tariffs and iceberg costs as those of the U.S. All values are reported in percent.

the level of domestic markups does not matter and is only relevant via its impact on markup dispersion.

The magnitude of the pro-competitive gains. As suggested by Arkolakis et al. (2019), in a large class of trade models, the pro-competitive gains from trade are small due to offsetting effects of trade on domestic markup dispersion, import markups, and export markups. In this section, we revisit this conclusion in the presence of cross-country-sector heterogeneity in the elasticity of import and export markups.

Specifically, we compare the impact of a global trade war in the baseline model to several alternative specifications in which we reduce the extent of cross-country-sector heterogeneity in the elasticity of import and export markups. In the first exercise (cross-country homogeneous elasticities, hereafter), we set all upper-tier elasticities in all countries equal to the value estimated for the U.S. and lower-tier elasticities in each sector equal to the respective values estimated for the United States. The results are summarized in Panel (b) of Figure 4 and have two main takeaways compared to the baseline specification of Panel (a).[58] First, when elasticities are homogeneous across countries, the model implies relatively small and mostly negative pro-competitive gains from trade, as evident from the fact that the majority of countries lie to the left of and close to the 45-degree line.[59] This observation is consistent with the find-

[58]The results are also presented in detail in Table E.6.

[59]The pro-competitive gains from trade have a median across countries of only -0.20 percentage points and an average of -0.36 percentage points.

ings of Arkolakis et al. (2019), who document small but negative pro-competitive gains from trade. Hence, this result, at least on average, appears to be robust to using the two-tier CES framework developed in Atkeson and Burstein (2008) and Edmond, Midrigan and Xu (2015), even though this framework does not belong to the class of models studied in Arkolakis et al. (2019).[60]

Second, the introduction of cross-country heterogeneity in elasticities results in quantitatively larger pro-competitive gains and losses and noticeably more dispersion across countries compared to the cross-country homogeneous-elasticity model. For some countries, such as the Netherlands, New Zealand, or Vietnam, we find the pro-competitive gains to be highly negative, while they are moderately positive for the U.S. and China. Hence, once we allow for more asymmetry in demand and, ultimately, markups, pro-competitive effects tend to become quantitatively more meaningful, translating into gains for some and losses for other countries.

The result that the pro-competitive gains are mostly negative and small in the cross-country homogeneous-elasticity model of Panel (b) is even more striking when we impose additional symmetry across countries. Specifically, in Panel (c), we additionally eliminate any cross-sectoral variation in demand elasticities and assume that all lower-tier elasticities in all countries are equal to the median estimate for the U.S. In this case, almost all observations are located close to (and slightly above) the 45-degree line, implying that the pro-competitive gains are very small and negative. Lastly, in Panel (d), we assume that all countries additionally share the same sectoral productivity, number of firms, expenditure share α_n^k, bilateral tariffs, and iceberg costs as in the U.S., which reduces variation in the pro-competitive gains even further.[61]

Why are the pro-competitive gains from trade mostly negative and small when we impose a certain degree of symmetry across countries? To shed light on this result, we note that there is much less variation in the elasticity gap on imports versus exports in the models in Panels (b)-(d) compared to the baseline model in Panel (a). In fact, while in the baseline model the elasticity gap between upper and lower tiers on imports versus exports ranges from -0.25 to 0.25 for the majority of countries (see the x-axis in Panel (c) of Figure 3), this statistic ranges only from -0.1 to 0.1 in the cross-country homogeneous-elasticity model, and equals 0 in the models in Panel (c) and Panel (d). Hence, given the lack of sizable variation in the elasticity gap, what mostly matters for the pro-competitive gains in the models in Panels (b)-(d) are import and export shares. Since import shares are almost always larger than export shares (see the x-axis in Panels (a) and (b) of Figure 3), responses in import markups are larger than those in export markups—conditional on elasticities—, rendering the pro-competitive gains mostly negative. In our baseline model, however, larger variations in the elasticity gap on imports versus exports lead to larger negative pro-competitive gains for countries with a higher elasticity gap on *imports*

[60] These findings also hold when we, for example, use China's elasticity estimates, instead of those estimated for the U.S., for all countries. As evident from Appendix Figure E.1, also in this case, the pro-competitive gains are slightly negative or zero for all countries.

[61] We take the cross-country average for the sectoral iceberg costs of exporting from each country to the U.S. Note that in this setup countries still differ along one dimension: the cost of exporting from China to Germany (which is the same as that from the U.S. to Germany), for example, is different from the cost of exporting from Germany to China.

Table 5: Pro-competitive gains and sectoral variation in tariffs

Policy	Pro-competitive gains in the U.S. (in pp)	Welfare change in the U.S. (%)	
		Fixed Markups	Variable Markups
Taxing sectors with:			
- Low import share and $\sigma_n^{j(k)}$	0.21	1.15	0.94
- High import share and $\sigma_n^{j(k)}$	0.06	-0.17	-0.23
- Low $\sigma_n^{j(k)}$	0.22	1.02	0.80
- High $\sigma_n^{j(k)}$	0.03	-0.23	-0.26

Notes: The pro-competitive gains (in percentage points) are measured as the difference in the welfare change under fixed versus variable markups. In the first counterfactual exercise, reported in the first two rows, the U.S. imposes an additional 50% tariffs on 33% of its imports that have the lowest import share and lower-tier elasticity versus the largest values for these measures. In the second counterfactual, reported in the last two rows, sectors are grouped in the same way, but sectors are sorted solely by upper-tier elasticity instead. All other tariffs imposed by the U.S. and other countries are held at factual levels.

versus exports, and slightly positive pro-competitive gains for countries with a higher elasticity gap on *exports versus imports*.

6.2 Targeted Policies

To what extent can policymakers affect the pro-competitive gains from trade? To answer this question, we depart from a scenario in which all sectors experience the same tariff increase and focus on the relationship between sectoral variation in tariffs and pro-competitive effects. Specifically, we perform several counterfactual exercises in which tariffs are imposed on sectors with different degrees of import penetration and different elasticity gaps between the lower and the upper tier.

To this end, we group sectors into distinct categories. In the first counterfactual exercise, we assume that the U.S. imposes an additional 50% tariffs on 33% of its imports that have the lowest import share and lower-tier elasticity.[62] In the second counterfactual, we assume instead that the U.S. imposes the same additional tariffs on 33% of its imports with the largest values for the aforementioned measures.[63] All other tariffs imposed by the U.S. and other countries are held at factual levels.

Table 5 summarizes the results and demonstrates that the pro-competitive gains from trade

[62] As discussed before, all firms in each country face the same upper-tier (HS1) elasticity. Hence, a smaller lower-tier (HS2) elasticity implies a smaller difference between upper- and lower-tier elasticities, given that lower-tier elasticities are larger than the upper-tier one.

[63] Constructing fully comparable groups is challenging due to the fact that sectors vary across multiple dimensions and the results can be sensitive to these other differences. To ensure that the two groups are equally large in terms of affected import values, we first rank sectors by import share and lower-tier elasticity separately. We then take their average rank to obtain a combined score. We then assign sectors to groups covering 33% of imports, once for the sectors at the top of the ranking and once for those at the bottom.

are very different in these two cases. We find that the pro-competitive gains are positive and equal 0.21 percentage points when the U.S. taxes primarily sectors with a low import share and low upper-tier elasticity. Taxing the other group, however, results in much smaller pro-competitive effects. These results align well with those found in Figure 3 above.

We also assess separately to what extent the pro-competitive gains differ when sectors with lower versus higher lower-tier elasticities are taxed.[64] We find that the pro-competitive gains are much smaller when tariffs are imposed on sectors with higher $\sigma_n^{j(k)}$. These results therefore suggest that countries can affect the pro-competitive effects of trade in a meaningful way via cross-sector variation in the imposed policy.

6.3 Profit Shifting, Markups, and Misallocation

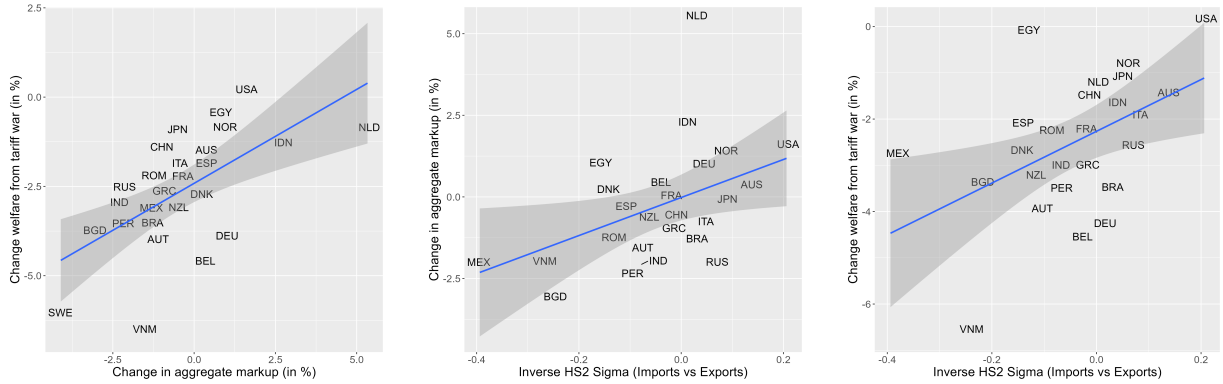
The main focus of the paper is to quantify the pro-competitive gains from trade across countries in a setting with rich heterogeneity in demand, productivity, and trade costs. Our setting, however, has not only implications for the pro-competitive impact of trade, but also for other outcomes, such as the relocation of profits and the extent of misallocation. In this section, we briefly discuss these additional implications and how they relate to the pro-competitive gains from trade.

First, we discuss to what extent welfare changes across countries are driven by changes and the relocation of profits. To this end, we employ our baseline model with variable markups. As suggested by Figure 5, we find that the impact of a global tariff war on welfare in our baseline model depends to a large extent on changes in profits and markups. As evident from Panel (a), countries that experience the largest increases in aggregate markups (as derived in Equation (26)) tend to also lose the least in terms of welfare from the global tariff war, and vice versa. The correlation coefficient between the change in welfare and the change in the aggregate markup equals 72.8%. Appendix Table E.1 provides a detailed overview of the counterfactual outcomes for each country in our baseline model with variable markups.

As discussed in more detail in Firooz and Heins (2025), the main reason for this relationship is profit shifting. On the one hand, countries that export and specialize in goods with low demand elasticities and, hence, high markups are disproportionately affected by tariffs due to lost profits. On the other hand, firms from countries that have a relatively high share of consumption and imports in high-markup sectors tend to experience large increases in profits, as these firms are now able to capture high profits on goods that were previously imported. Taken together, as shown in Panel (b), the change in the aggregate markup depends positively on the trade-weighted average of lower-tier inverse elasticities $1/\sigma_n^{j(k)}$ for a country's imports relative to its exports with a correlation coefficient of 41.2%. Intuitively, the average inverse demand elasticities for imports relative to exports is highly indicative of the average profit per dollar that countries pay on imports compared to the average profit per dollar that countries earn on exports (see Equation (18)). Consequently, as Panel (c) shows, net importers of high-

[64] For this case, sectors are grouped in the same way as before, but sectors are sorted solely by upper-tier elasticity instead.

Figure 5: Profit Shifting and Welfare Changes across Countries



(a) Welfare and Markups (b) Markups and Elasticities (c) Welfare and Elasticities

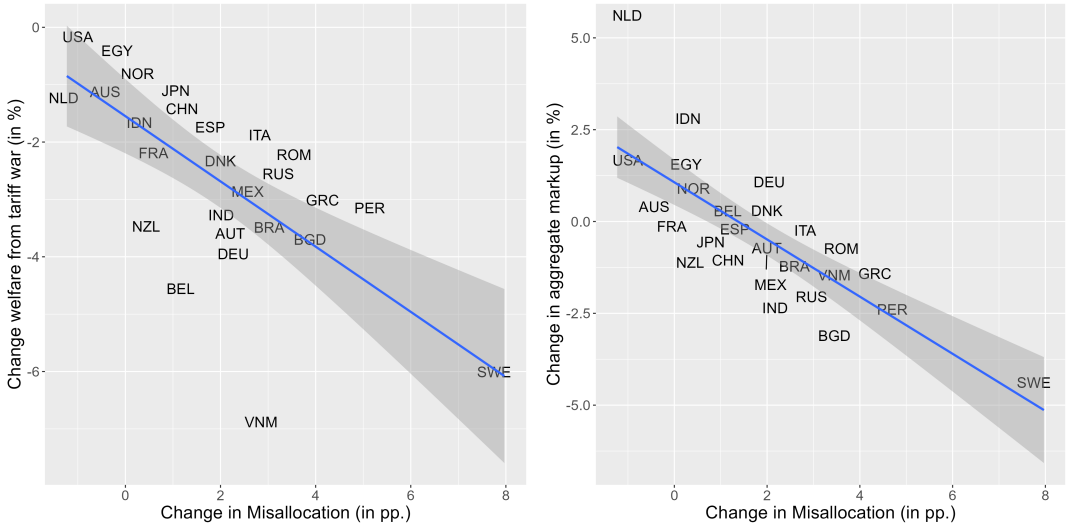
Notes: The y-axis in Panels (a) and (c) reports the welfare change associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) and the y-axis in Panel (b) describe the change in the aggregate markup, as derived in Section 2.6. All of these values are reported in percent. The x-axis in Panels (b) and (c) reflects the difference in the trade-weighted average of lower-tier (HS2) inverse elasticities $1/\sigma_n^{j(k)}$ of imports versus that of exports.

markup goods, most notably the U.S., suffer only little from a trade war or might even benefit overall, while net exporters of high-markup products tend to experience larger welfare losses due to disproportionately strong declines in export profits.

It is important to note two observations related to Figure 5. First, the most relevant elasticities governing profits and profit shifting are lower-tier, not upper-tier, elasticities. This is because exporters are, on average, small relative to total domestic sales, and therefore, markups paid on imports and those earned on exports are mostly driven by lower-tier elasticities (see Equation (13)). Consequently, we find that, in practice, upper-tier elasticities do not play a major role for the patterns shown in Figure 5, and we therefore plot predicted welfare changes against variation in lower-tier elasticities in this figure. However, we find that these lower-tier elasticities in themselves are not an important determinant of the pro-competitive gains, and for example including the average inverse demand elasticities for imports relative to exports on the HS2-level in the regressions shown in Table 4 delivers a small and insignificant effect. Hence, when it comes to the pro-competitive gains, demand elasticities on the lower- and upper-tier tend to only matter jointly, since they govern the extent to which markups respond to changes in competition.

Second, the results presented in Figure 5 do not qualitatively depend on the presence of variable markups. In fact, one observes similar relationships in the fixed-markup variant of the model. As shown in Figure E.2, as long as the difference between average import and export markups varies across countries, countries would be differently affected by profit shifting during a trade war. However, as discussed in more detail above, we find that the incidence of country-sector-specific elasticities tends to magnify the channels that we quantify.

Figure 6: Misallocation, Markups, and Welfare



(a) Welfare and Misallocation

(b) Markups and Misallocation

Notes: The y-axis in Panel (a) reports changes in welfare associated with a global trade war in which tariffs are raised by 50 percentage points. The x-axis in both panels reports changes in misallocation. Figure (b) reports the change in aggregate markups on the y-axis.

The findings in this section and Section 6.1 are particularly noteworthy and informative for the U.S.: While we find that (i) the U.S. is one of the countries with the largest pro-competitive gains from trade, we also find that (ii) the U.S. slightly benefits from a global trade war (under either variable or fixed markups). While they may seem contradictory, these two results highlight two different aspects of the U.S. economy. To elaborate, result (i) is a statement about the *relative* changes in welfare and shows that the gains from trade for the U.S. are larger under variable markups *compared to* those under fixed markups. This result stems mainly from the fact that, as Figure 3 shows, the U.S. has a relatively small import share, a relatively large export share, and a larger elasticity gap on exports versus imports. These forces combined lead to favorable changes in export versus import markups after trade liberalization, thereby generating pro-competitive gains from trade for the U.S. In contrast, result (ii) is a statement about *absolute* changes in welfare under either variable or fixed markups, and is mainly driven by the fact that the U.S. is a net importer of high-markup products.

Lastly, we investigate changes in misallocation (as defined in Section 2.6) in a global trade war and how they relate to welfare and aggregate markups. As Figure 6a shows, changes in welfare and misallocation are strongly negatively correlated (with a correlation coefficient of -0.76), which is consistent with the findings in the literature (e.g., Edmond, Midrigan and Xu, 2015). That is, countries with a larger increase in misallocation in a global trade war experience larger welfare losses. As this figure shows, in response to a global trade war, misallocation rises in most countries, with the U.S. and the Netherlands being notable exceptions. To explain

these cross-country heterogeneous changes in misallocation, Figure 6b plots how changes in misallocation relate to changes in aggregate markups. Interestingly, we show that countries with a larger increase in misallocation are those with a greater decline in aggregate markups. This observation is mainly due to the profit-shifting channel and the fact that net exporters of high-markup goods experience stronger declines in profits in a global trade war, which translates into greater losses in income. Hence, according to Equation (23), aggregate productivity falls, and misallocation rises in those countries.

6.4 Robustness, Extensions, and Alternative Models

How important are the extensive margin, cross-country correlation in productivity, and the presence of multinationals for the pro-competitive gains from trade? To answer these questions, we perform several counterfactual exercises in which we shut down selected channels of the model or use alternative modeling and estimation assumptions and compare the results to those obtained in the baseline case.

Extensive margin. In our benchmark model, we focused exclusively on the intensive margin, holding the number of firms in each market fixed and thereby omitting the extensive margin. In an alternative specification, we allow for an extensive margin by introducing a destination–sector-specific fixed cost of exporting, calibrated using the observed number of exporters in each destination–sector pair. We then repeat the global tariff war exercise under both variable and fixed markups.[65] As shown in Table E.7, the welfare effects—and in particular, the pro-competitive gains from trade—are similar to those in our benchmark model without fixed costs. This finding is consistent with Edmond, Midrigan and Xu (2015), who demonstrate that, because marginal entrants are relatively unproductive, fixed costs have only a limited quantitative impact on welfare outcomes. Moreover, Table E.8 and Figure E.3 confirm that, as in the benchmark model, the pro-competitive gains from trade are negatively associated with both import shares and the import-side elasticity gap, and depend positively on export shares and the export-side elasticity gap.

Alternative approaches to estimate elasticities. In Section 4, we estimated lower-tier elasticities via an approach that allows for the possibility of an upward-sloping supply curve. Given that firm-level marginal costs are constant in our framework, however, we have also assessed to what extent the results change if we instead impose a horizontal supply curve and re-estimate these elasticities under that assumption. We found that the resulting elasticities for the industries that deliver a positive estimate have a fairly high correlation with the previous ones, with a correlation of about 40%. This similarity is due to the fact that, in line with recent findings by Fajgelbaum et al. (2020), our estimates of the inverse export supply elasticity tend

[65] As is standard in this literature, the model with fixed costs may admit multiple equilibria, depending on the sequence of firm entry. We assume that the order of entry within each market is determined by firms' marginal costs, i.e., a firm with the lowest marginal cost in a given destination market enters first.

to be small in most sectors: For exporters to the U.S., for example, we estimate a median inverse elasticity of 0.026. Further, less than one-third of inverse export supply elasticities are statistically different from 0, which is consistent with supply being horizontal in the majority of sectors. The resulting estimates of $\sigma_n^{j(k)}$ are therefore similar to the case in which we impose a horizontal export supply curve in the estimation.

Consequently, we also found the counterfactual results to be comparable to those we obtained in a framework that allows for an upward-sloping supply curve. In Table E.9 to E.12, we report the main results for a framework in which we use these alternative elasticities. Specifically, also in these settings, we find a negative correlation between (1) import shares and the pro-competitive gains, and (2) the elasticity gap and the pro-competitive gains. As shown in Tables E.11 and E.12, the results are largely similar when we additionally incorporate a fixed cost into the model. These findings suggest that our main results are not driven by the assumption of an upward-sloping supply curve in the estimation.

For these reasons, we have chosen to use the estimates for $\sigma_n^{j(k)}$ obtained via a framework that allows for an upward-sloping supply curve in the baseline specification, which also has two additional advantages. First, our estimates for $\sigma_n^{j(k)}$ are effectively based on the Feenstra method, which has been extensively used and referred to in other papers, refined in meaningful ways over time, and which nests settings in which supply is horizontal. Second, our estimates can also be readily compared to those obtained in other work, and we find that our parameter estimates are largely consistent with those obtained, for example, by Broda and Weinstein (2006), who estimate median values for $\sigma_n^{j(k)}$ for the U.S. that range from 2.2 to 3.7. As evident from Table 1, the median estimate for most countries falls into this range. This result is comforting insofar as it suggests that our counterfactual findings are not driven by unusual estimates of demand elasticities.[66]

Furthermore, as another robustness check, we reestimated the demand elasticities via a method that was recently used by Fajgelbaum et al. (2020) and which identifies $\sigma_n^{j(k)}$ and σ_n^k from changes in tariffs. In line with our analysis, we extend their methodology to allow $\sigma_n^{j(k)}$ to be sector-specific in the estimation. There are, however, two complications that prevent us from applying this approach to estimate both sector and country-specific elasticities, as we did in the baseline case: First, for more than 50% of country pairs, tariffs equal zero in the data. Second, it is frequently the case that a country does not adjust its tariffs over the sample period against any exporter in a particular industry or only against very few. In those cases, $\sigma_n^{j(k)}$ cannot be

[66] An additional important practical implication of imposing a horizontal supply curve, is that the estimation in that case more frequently results in elasticities that are either negative or smaller than one, which requires us to either replace or impute such estimates and potentially introduces additional noise into the analysis. This imputation can, for example, be done by replacing these estimates (1) with the median estimate across sectors for the same country, or (2) by imputing them via a regression on country- and sector-fixed effects. The results presented in Table E.9 to E.12 are based on the latter approach. The primary reason why imposing supply to be horizontal more frequently results in infeasible estimates is due to the fact that, as for example described in Leamer (1981) and Soderbery (2015), the assumption of $\kappa_n^{j(k)} = 0$ effectively pins down $\sigma_n^{j(k)}$ for a given variety. In this case, the relationship between demand and supply elasticities is hence not hyperbolic, which effectively prohibits the common approach of restricting the estimation to the feasible region (see e.g. Feenstra (1994) and Broda and Weinstein (2006)).

estimated for this particular country-sector pair due to no or too few identifying observations. For that reason, we restrict $\sigma_n^{j(k)}$ to be sector-specific in this part and compare our findings to the corresponding results in the baseline case. Appendix Figure E.6 summarizes the results. We find that also in this specification, the pro-competitive gains from trade are negatively correlated with the import share. Hence, countries such as the U.S. experience pro-competitive gains from trade, while these gains are negative in the majority of other economies.

Larger lower-tier elasticities. In Figure 4d, we have evaluated the pro-competitive effects of trade when we use the median demand elasticity estimated for the U.S. for all countries and sectors. As another robustness check in this setting without cross-country and cross-sectoral heterogeneity in elasticities, we employ a larger lower-tier elasticity of 10.5, in line with the estimate in Edmond, Midrigan and Xu (2015), to ensure that our results are not driven by relatively small lower-tier elasticities. As evident from Table E.13, we find that a larger elasticity on the lower tier tends to magnify the results, and we obtain average pro-competitive gains of -0.67%, with a median of -0.49%. Interestingly, we find that the pro-competitive gains are negative for the majority of countries and close to zero for large countries such as the U.S., China, and India. Hence it appears that, in the absence of cross-sectoral and cross-country variation, even larger countries do not experience sizable pro-competitive gains, as evident from both Tables E.6 and E.13. It is worth emphasizing that without cross-country and cross-sectoral heterogeneity in elasticities, the role of profit shifting is very limited since exported and imported products face the same elasticity in the lower tier as well as in the upper tier. As a result, in such a setting, there is no systematic difference between markups on imported products versus those on exported products, which limits profit shifting between countries.

Initial misallocation and the pro-competitive gains. Do the pro-competitive gains from trade depend on countries' initial degree of misallocation? In other words, do countries with larger initial misallocation experience larger pro-competitive gains from trade? To answer this question, Panel (a) of Figure E.7 plots the pro-competitive gains from trade across countries against their initial misallocation. As this figure shows, the pro-competitive gains from trade are overall smaller for countries with larger initial misallocation, which might seem counterintuitive at first, especially because one might have expected that fostering competition through international trade would be particularly helpful if countries have a large degree of misallocation to begin with (e.g., Edmond, Midrigan and Xu, 2015). To shed light on this result, Panel (b) shows that a larger initial misallocation is partly due to a larger difference between upper- and lower-tier elasticities at home, leading larger firms to charge higher markups in the domestic market, which increases markup dispersion.[67] This large elasticity gap at home has two competing forces on the pro-competitive gains from trade. On the one hand, it increases

[67]The elasticity gap in the domestic market is of particular importance for misallocation due to the fact that expenditure on domestic goods is typically larger than export sales. Note, however, that misallocation also depends on the elasticity gap in foreign markets and the fraction of firms that export to each destination. Hence, the correlation in Panel (b) is not perfect.

domestic markups and markup dispersion after a trade war (i.e., larger pro-competitive gains) since larger firms increase their markups to a greater extent. In fact, as Panel (c) shows, changes in domestic markups after a trade war are positively correlated with initial misallocation. On the other hand, however, the same large elasticity gap at home results in import markups falling to a larger extent after a trade war, thereby implying smaller pro-competitive gains from trade. Indeed, as Panel (d) shows, countries with a larger initial misallocation experience a larger decline in import markups after a trade war, which in turn translates into smaller pro-competitive gains from trade (Panel (e)). Quantitatively, the results in Panel (a) suggest that the latter effect dominates since the former force is a second-order effect working through markup dispersion. Therefore, the pro-competitive gains from trade are overall smaller for countries with larger initial misallocation.

Cross-country correlation in productivity. A potentially additional factor of importance for the pro-competitive gains is how correlated productivity is across countries. Specifically, as pointed out by Edmond, Midrigan and Xu (2015), if this correlation is strong, countries engage in more "head-to-head" competition when trade costs fall, suggesting larger pro-competitive gains from trade. To evaluate the extent to which this channel contributes to our findings, we compute for each country pair how correlated productivity is across sectors. This measure hence captures how common it is that countries have similar productivities in each sector as opposed to there being strong comparative advantages with each country being differently productive in each sector.

As summarized in Table E.14, our quantitative model predicts that productivity tends to be strongly correlated for most country pairs, in line with Edmond, Midrigan and Xu (2015). In other words, a fairly strong correlation is needed for the model to match the data. For example, the median model-predicted correlation between U.S. productivity and other countries equals 72.3%. Consequently, for most country pairs, there is comparably strong "head-to-head" competition when countries are allowed to compete freely. Interestingly, there are only few, but notable exceptions: Vietnam, Mexico, and Romania, with correlations ranging between 9.8% and 21.9%. These countries are all economies with relatively lower levels of income per capita and tend to specialize in quite different sets of goods.

To address to what extent this is of quantitative importance, we simulate the impact of a bilateral trade war between the U.S. and each of the other countries and relate the resulting pro-competitive gains to the correlations described above. As evident from Figure E.8, we indeed find a moderately positive relationship (with a correlation coefficient of 28.3%) between the degree of "head-to-head" competition and the pro-competitive gains from trade. Further, we find that for the U.S., especially the low correlation in productivity with its neighbor Mexico translates into a decline in the pro-competitive gains. Hence, it appears that the degree of direct competition is especially important for the impact of tariffs on a country's main trade partners.

Trade elasticities across models. One concern when comparing the baseline model with the fixed-markup variant is that, since these models have presumably different trade elasticities,

trade shares might respond differently to tariffs, which complicates the interpretation of the results. For that reason, in an additional robustness check, we ensure that changes in trade are the same across the two models by adjusting the tariff change in the fixed-markup model such that the resulting changes in trade match those in the baseline model. In particular, for a given country, we increase tariffs across the world (i.e., global tariff war) in the fixed-markup model such that the change in imports for this country is equal to that in the baseline model. We do this exercise separately for all countries in our sample. Table E.15 summarizes the results and shows that our main results on the pro-competitive gains from trade are very similar to those obtained in the baseline case. Hence, the results hold even when changes in trade are the same across the two models.

Multinational production. As an additional robustness check, we find that the results change only little when we employ the model with multinational production, as evident from the results presented in Appendix Table E.16. The correlation between the predicted welfare changes in the baseline model and those in the model with multinationals equals 82%. This correlation is even stronger in terms of the pro-competitive gains: The correlation between the pro-competitive gains from trade in the baseline model and those in the model with multinationals equals 91%.

Changes in iceberg trade costs. The counterfactuals described above focus on changes in tariffs, which generate additional government revenue. This channel, however, is not crucial for the results. As shown in Table E.17 and Figure E.10, our findings are quite similar if we instead study a global 50% increase in the iceberg trade costs, without any changes in tariffs. Hence, changes in tariffs and iceberg costs tend to have similar pro-competitive effects.

Standard errors. To investigate the sensitivity of the results to noise in the demand elasticity estimates, we compute standard deviations of the welfare results for the main counterfactual via a procedure that closely resembles a bootstrap approach. More specifically, based on the standard errors we obtained for the demand elasticity estimates $\sigma_n^{j(k)}$, we construct a 95% confidence interval for each estimate and draw a sample of 100 values of $\sigma_n^{j(k)}$ for each sector-country pair. We then re-estimate iceberg costs and productivities for each of these 100 samples, evaluate the global trade war counterfactual, and compute standard deviations across the resulting outcomes.

As evident from Appendix Table E.18, we find that the standard deviations are smaller than the predicted pro-competitive gains (in absolute value) in the majority of countries, with the exceptions being cases in which these gains are small. For all countries for which we estimate sizable pro-competitive losses, the standard deviation is noticeably smaller than the point estimate, and our estimates are, for example, statistically significant at the 1% level for Bangladesh, Belgium, Denmark, France, Mexico, the Netherlands, New Zealand, Norway, Egypt, Vietnam, and the UK. Also, for those countries with the highest pro-competitive gains, China and the U.S., the predictions are significant at least at the 10% level. As expected, the

majority of cases for which the results are not statistically significant are countries with pro-competitive effects close to 0, such as Italy, Japan, or Peru. These findings and the fact that standard deviations are, on average, small compared to the welfare predictions suggest that the statistical significance of the parameter estimates carries through to the counterfactual predictions.

7 Conclusion

This paper develops a multi-sector model of international trade and profit shifting in which both import and export markups are endogenously determined and depend on the competitiveness of each market. Further, the markup distributions for both imports and exports are allowed to vary across countries and sectors. Using a rich set of country- and industry-specific import demand elasticities, productivity distributions, trade costs, and tariffs, we evaluate the pro-competitive gains from trade across countries and their main determinants. Our findings suggest that the pro-competitive gains from trade are highly dependent on a country's import and export share as well as the difference between sectoral and product-level demand elasticities. We find that the pro-competitive gains are negative in most countries and that only large or less open economies experience pro-competitive gains as opposed to losses. Lastly, we show that especially markup heterogeneity across countries generates more sizable pro-competitive effects than found in previous work.

Especially the asymmetry in pro-competitive effects has potentially important implications for policy as well as for the ability of countries to reach agreements regarding trade and competition. In particular, while larger, less open countries significantly benefit from foreign competition and have therefore incentives to advocate for more competition from abroad, trade tends to have less positive effects in smaller, more open economies due to the distortionary effect of higher markups charged by foreign firms, which also have relevant distributional consequences. The importance of such considerations for optimal trade policy and global inequality would, in our view, be an important area for future research. Our results also highlight that sectoral variation in tariffs can allow countries to affect the pro-competitive effects of trade in either direction. It would be interesting to understand how sectoral tariff variation seen in past trade conflicts or other trade policies have either amplified or mitigated pro-competitive effects and how to characterize optimal tariffs in such cases.

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Appendices

A Derivations and Solving for the Equilibrium

A.1 Optimal Pricing and Markups

This section derives the optimal price-setting rule in our setting. The profit-maximization problem of a firm f is given by

$$\max_{p_{in,f}^{j(k)}, q_{in,f}^{j(k)}} p_{in,f}^{j(k)} q_{in,f}^{j(k)} - q_{in,f}^{j(k)} mc_{in,f}^{j(k)}, \tag{44}$$

where $mc_{in,f}^{j(k)}$ denotes the firm's marginal cost. Using the demand schedules, we can rewrite this optimization problem as

$$\max_{p_{in,f}^{j(k)}, q_{in,f}^{j(k)}} (q_n^{j(k)})^{1/\sigma_n^k - 1/\sigma_n^{j(k)}} (Q_n^k)^{1/\sigma_n^k} (q_{in,f}^{j(k)})^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}} \mathcal{P}_n^k - q_{in,f}^{j(k)} mc_{in,f}^{j(k)}. \tag{45}$$

Given that each firm in sub-sector $j(k)$ perceives itself to be infinitesimal relative to the entire set of sub-sectors $J(k)$, $\mathcal{P}_n^k$ and Q_n^k are taken as given, and the first-order condition can be written as

$$\begin{aligned} &\frac{\sigma_n^{j(k)} - 1}{\sigma_n^{j(k)}} (q_n^{j(k)})^{1/\sigma_n^k - 1/\sigma_n^{j(k)}} (Q_n^k)^{1/\sigma_n^k} (q_{in,f}^{j(k)})^{-\frac{1}{\sigma_n^{j(k)}}} \mathcal{P}_n^k \\ &+ (1/\sigma_n^k - 1/\sigma_n^{j(k)}) (q_n^{j(k)})^{1/\sigma_n^k - 1/\sigma_n^{j(k)} - 1} \cdot \frac{\partial q_n^{j(k)}}{\partial q_{in,f}^{j(k)}} (Q_n^k)^{1/\sigma_n^k} (q_{in,f}^{j(k)})^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}} = mc_{in,f}^{j(k)}. \end{aligned} \tag{46}$$

Using Equation (6), we can write

$$\frac{\partial q_n^{j(k)}}{\partial q_{in,f}^{j(k)}} = \left(\frac{q_n^{j(k)}}{q_{in,f}^{j(k)}} \right)^{1/\sigma_n^{j(k)}}, \tag{47}$$

and simplify the first-order condition to

$$\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}(q_n^{j(k)})^{1/\sigma_n^k-1/\sigma_n^{j(k)}}(Q_n^k)^{1/\sigma_n^k}(q_{in,f}^{j(k)})^{-\frac{1}{\sigma_n^{j(k)}}}\mathcal{P}_n^k$$

$$+(1/\sigma_n^k-1/\sigma_n^{j(k)})(q_n^{j(k)})^{1/\sigma_n^k-1/\sigma_n^{j(k)}-1}\cdot\left(\frac{q_n^{j(k)}}{q_{in,f}^{j(k)}}\right)^{1/\sigma_n^{j(k)}}(Q_n^k)^{1/\sigma_n^k}(q_{in,f}^{j(k)})^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}}=mc_{in,f}^{j(k)}$$

$$\Leftrightarrow (q_n^{j(k)})^{1/\sigma_n^k-1/\sigma_n^{j(k)}}(Q_n^k)^{1/\sigma_n^k}(q_{in,f}^{j(k)})^{-\frac{1}{\sigma_n^{j(k)}}}\mathcal{P}_n^k\left[(q_{in,f}^{j(k)})^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}}(q_n^{j(k)})^{1/\sigma_n^{j(k)}-1}(\frac{1}{\sigma_n^k}-\frac{1}{\sigma_n^{j(k)}})+\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}\right]=mc_{in,f}^{j(k)}$$

$$\Leftrightarrow p_{in,f}^{j(k)}\left[(\frac{q_{in,f}^{j(k)}}{q_n^{j(k)}})^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}}(\frac{1}{\sigma_n^k}-\frac{1}{\sigma_n^{j(k)}})+\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}\right]=mc_{in,f}^{j(k)}. \tag{48}$$

Lastly, Equation (7) implies that

$$\left(\frac{q_{in,f}^{j(k)}}{q_n^{j(k)}}\right)^{\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}}=\left(\frac{p_{in,f}^{j(k)}}{P_n^{j(k)}}\right)^{1-\sigma_n^{j(k)}}=s_{in,f}^{j(k)}, \tag{49}$$

where the last equality follows from the definition

$$s_{in,f}^{j(k)}=\frac{p_{in,f}^{j(k)}q_{in,f}^{j(k)}}{\sum_{f'}p_{in,f'}^{j(k)}q_{in,f'}^{j(k)}}, \tag{50}$$

with $s_{in,f}^{j(k)}$ being the sales share in country n of firm f from country i in sub-sector $j(k)$. Using Equation (49), we can then write

$$q_{in,f}^{j(k)}=\left(\frac{p_{in,f}^{j(k)}}{P_n^{j(k)}}\right)^{-\sigma_n^{j(k)}}q_n^{j(k)}, \tag{51}$$

and the market share becomes

$$s_{in,f}^{j(k)}=\frac{(p_{in,f}^{j(k)})^{1-\sigma_n^{j(k)}}}{\sum_{f'}(p_{in,f'}^{j(k)})^{1-\sigma_n^{j(k)}}}=\frac{(p_{in,f}^{j(k)})^{1-\sigma_n^{j(k)}}}{[(\sum_{f'}(p_{in,f'}^{j(k)})^{1-\sigma_n^{j(k)}})^{1/(1-\sigma_n^{j(k)})}]^{1-\sigma_n^{j(k)}}}=\left(\frac{p_{in,f}^{j(k)}}{P_n^{j(k)}}\right)^{1-\sigma_n^{j(k)}}. \tag{52}$$

The first-order condition can hence be written as

$$\frac{p_{in,f}^{j(k)}}{mc_{in,f}^{j(k)}}=\frac{1}{\left[s_{in,f}^{j(k)}(\frac{1}{\sigma_n^k}-\frac{1}{\sigma_n^{j(k)}})+\frac{\sigma_n^{j(k)}-1}{\sigma_n^{j(k)}}\right]}. \tag{53}$$

Defining the weighted average of the substitution elasticities as

$$\varepsilon_{in,f}^{j(k)} = \frac{1}{\sigma_n^{j(k)}(1 - s_{in,f}^{j(k)}) + \frac{1}{\sigma_n^k} s_{in,f}^{j(k)}}, \tag{54}$$

the optimal markup of firm f can be written as

$$\frac{p_{in,f}^{j(k)}}{mc_{in,f}^{j(k)}} = \frac{\varepsilon_{in,f}^{j(k)}}{\varepsilon_{in,f}^{j(k)} - 1}. \tag{55}$$

A.2 Aggregate Productivity and Aggregate Markup

This section outlines the derivation of aggregate productivity and aggregate markups in our multi-country, multi-sector setting. The total output produced in a country is a function of its aggregate productivity and aggregate labor:

$$Q_i = A_i L_i \tag{56}$$

Total labor is the sum of all the labor employed by each firm across all industries:

$$L_i = \sum_k \sum_j \sum_f l_{i,f}^{j(k)} = \sum_k \sum_j \sum_f \frac{q_{i,f}^{j(k)}}{A_{i,f}^{j(k)}}. \tag{57}$$

The total quantity of goods produced by a firm f equals the total quantity produced for the home market plus that for the foreign market (multiplied by the iceberg costs):

$$q_{i,f}^{j(k)} = q_{ii,f}^{j(k)} + \sum_{n \neq i} d_{in}^{j(k)} q_{in,f}^{j(k)}.$$

It must therefore be the case that

$$A_i = \left[\sum_{k=1}^{K} \sum_{j=1}^{J(k)} \left(\sum_{f=1}^{F_{ii}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{ii,f}^{j(k)}}{Q_i} + \sum_{n \neq i} d_{in}^{j(k)} \sum_{f=1}^{F_{in}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{in,f}^{j(k)}}{Q_i} \right) \right]^{-1}. \tag{58}$$

We define the aggregate markup as the ratio of the aggregate price relative to the marginal cost

$$\mu_i = \frac{\mathcal{P}_i}{w_i / A_i} \implies \frac{1}{\mu_i} = \frac{1}{A_i} \frac{w_i}{\mathcal{P}_i}$$

Substituting Equation (58), we get:

$$\frac{1}{\mu_i} = \left(\sum_{k=1}^{K} \sum_{j=1}^{J(k)} \left(\sum_{f=1}^{F_{ii}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{ii,f}^{j(k)}}{Q_i} + \sum_{n \neq i} d_{in}^{j(k)} \sum_{f=1}^{F_{in}^{j(k)}} \frac{1}{A_{i,f}^{j(k)}} \frac{q_{in,f}^{j(k)}}{Q_i} \right) \right) \frac{w_i}{\mathcal{P}_i}.$$

Using the pricing equation (11), we can therefore write:

$$\mu_i = \left[\sum_{k=1}^{K} \sum_{j=1}^{J(k)} \left(\sum_{f=1}^{F_{ii}^{j(k)}} \frac{1}{\mu_{ii,f}^{j(k)}} \frac{q_{ii,f}^{j(k)} p_{ii,f}^{j(k)}}{\mathcal{P}_i Q_i} + \sum_{n \neq i} \frac{d_{in}^{j(k)}}{\tau_{in}^{j(k)}} \sum_{f=1}^{F_{in}^{j(k)}} \frac{1}{\mu_{in,f}^{j(k)}} \frac{p_{in,f}^{j(k)} q_{in,f}^{j(k)}}{\mathcal{P}_i Q_i} \right) \right]^{-1}. \tag{59}$$

A.3 Constructing Firm-Level Markups

We define the overall markup of firm f located in country i in sector $j(k)$ as

$$\mu_{i,f}^{j(k)} \equiv \frac{p_{i,f}^{j(k)}}{w_i / A_{i,f}^{j(k)}}, \tag{60}$$

where we define the quantity-weighted average price $p_{i,f}^{j(k)}$ as

$$p_{i,f}^{j(k)} \equiv \frac{p_{ii,f}^{j(k)} q_{ii,f}^{j(k)} + \sum_{n \neq i} \frac{p_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} q_{in,f}^{j(k)}}{q_{i,f}^{j(k)}}, \tag{61}$$

with $q_{i,f}^{j(k)}$ being the total production of firm f

$$q_{i,f}^{j(k)} = q_{ii,f}^{j(k)} + \sum_{n \neq i} d_{in}^{j(k)} q_{in,f}^{j(k)}. \tag{62}$$

Using the optimal pricing in Equation (11) to substitute for $p_{in,f}^{j(k)}$, we show that the firm-level markup $\mu_{i,f}^{j(k)}$ is a quantity-weighted average of markups that this firm charges across the world:

$$\mu_{i,f}^{j(k)} = \frac{\mu_{ii,f}^{j(k)} q_{ii,f}^{j(k)} + \sum_{n \neq i} \mu_{in,f}^{j(k)} d_{in}^{j(k)} q_{in,f}^{j(k)}}{q_{i,f}^{j(k)}}. \tag{63}$$

Lastly, plugging Equation (61) in Equation (60) and using the fact that $q_{i,f}^{j(k)} = A_{i,f}^{j(k)} L_{i,f}^{j(k)}$, it is straightforward to show that the firm-level markup $\mu_{i,f}^{j(k)}$ is exactly equal to the inverse of the firm's labor share.

A.4 Solving for the Equilibrium

To solve for the equilibrium, we follow the following steps.

1. We start with a guess on the vector of wages $\{w_n\}_{n=1}^{N}$.

2. Using our guess on wages and information on the number of firms in each market, iceberg costs, tariffs, and productivities, we calculate the marginal cost of firm f from country i serving country n in sub-sector $j(k)$.

3. We solve the system of equations (8) and (11)-(14) and compute firms' market shares, prices, markups, and demand elasticities.

4. From the prices computed above, we use Equation (4) to calculate sectoral price indices $\mathcal{P}_n^k$.

5. Use equations (16)-(19) to compute aggregate profits, tariff revenues, sectoral expenditures, and total expenditures.

6. Check the trade deficit equation (20) and update our guess for wages until this equation is satisfied.

Step 5 merits further explanation. To solve for aggregate profits and tariff revenues, we solve for aggregate and sectoral expenditures. From equations (17), (18) and (19), we get:

$$I_n = w_n L_n + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} X_i^{j(k)} + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)} s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} X_n^{j(k)} + D_n. \quad (64)$$

Substituting equation (16), we get:

$$\begin{aligned} I_n = w_n L_n + \sum_{i=1}^{N}\left[\sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} \alpha_i^k \left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k}\right] I_i + \\ \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)} s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} \alpha_n^k \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k} I_n + D_n. \end{aligned} \quad (65)$$

This can be written as:

$$\begin{aligned} \left[1 - \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)} s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} \alpha_n^k \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k} - \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{f=1}^{F_{nn}^{j(k)}} \frac{s_{nn,f}^{j(k)}}{\varepsilon_{nn,f}^{j(k)}(1+t_{nn}^{j(k)})} \alpha_n^k \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k}\right] I_n \\ - \sum_{i\neq n}^{N}\left[\sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} \alpha_i^k \left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k}\right] I_i = w_n L_n. \end{aligned} \quad (66)$$

This is a system of N equations and N unknowns to be solved for aggregate expenditure I_n. In matrix form, it can be rewritten as:

$$\Lambda I = \Psi, \quad (67)$$

where

$$I = \begin{pmatrix} I_1 \\ \vdots \\ \vdots \\ I_N \end{pmatrix}_{N\times 1}, \Psi = \begin{pmatrix} w_1 L_1 \\ \vdots \\ \vdots \\ w_N L_N \end{pmatrix}_{N\times 1}, \Lambda = (\mathbb{I}_N - \Omega).$$

Here, $\mathbb{I}_N$ is an identity matrix of size N

$$\mathbb{I}_N = \begin{pmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{pmatrix}_{N\times N},$$

and

$$\Omega = \begin{pmatrix} \zeta_1 + \Pi_{11} & \Pi_{12} & \dots & \Pi_{1N} \\ \Pi_{21} & \zeta_2 + \Pi_{22} & \dots & \Pi_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \Pi_{N1} & \Pi_{N2} & \dots & \zeta_N + \Pi_{NN} \end{pmatrix}_{N\times N},$$

where

$$\zeta_n = \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)} s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} \alpha_n^k \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k},$$

and

$$\Pi_{ni} = \left[\sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} \alpha_i^k \left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k}\right].$$

We solve the system of equations in (67) to obtain aggregate incomes. We then use Equation (16) to calculate sectoral expenditures. Finally, using equations (18),(19), and (20), we can calculate aggregate profits, tariff revenues, and trade deficits.

B The Model with Multinationals

B.1 Solving for the Equilibrium in the Model with Multinationals

The baseline model assumes that all production in each country is done by its own firms, and as a result, all profits generated in each country are owned by individuals in that country. Given the rising role of multinational companies across the world, and as a robustness exercise, this section adds multinational companies to the model to explore how they affect the pro-competitive gains from trade in the presence of profit shifting.

Let $\gamma_n^{j(k)}$ denote the share of multinational enterprises in the country n's production in sub-sector $j(k)$. Moreover, denote by $\lambda_{in}^{j(k)}$ the share of country i in total multinational activities in sub-sector $j(k)$ in country n. We keep the assumption that labor is immobile between countries, and therefore, multinational enterprises employ labor in the host country. Moreover, we assume that the profits from production are shared between countries based on their share in production. Since part of the profits is owned by foreign countries, country n's total profits Y_n can now be written as

$$Y_n = \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{ni}^{j(k)}}(1-\gamma_n^{j(k)})\frac{s_{ni,f}^{j(k)}X_i^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{m\neq n}\sum_{f=1}^{F_{mi}^{j(k)}}\gamma_m^{j(k)}\lambda_{nm}^{j(k)}\frac{s_{mi,f}^{j(k)}X_i^{j(k)}}{\varepsilon_{mi,f}^{j(k)}(1+t_{mi}^{j(k)})}, \tag{68}$$

where the first term describes country n's profits earned from production in country n and the second term reflects country n's profits earned in other countries from owning shares of multinational companies.[1]

All the equilibrium conditions stated before hold in this model except for total profits Y_n and trade deficits D_n. In the model with multinationals, the labor market clearing condition can be written more compactly than the trade deficit equation, and we, therefore, work with the former in practice. Specifically, the labor market clearing condition, in this case, is identical to that in the model without multinationals, Equation (21), since the wage bill equals the total revenue earned by firms residing in country n across the world net of profits regardless of who owns these profits.

To solve the model with multinational firms, we follow the steps outlined above but incorporate several changes to integrate multinational activity. First, in Step 5, we use Equation (68) instead of equation (18). Second, since in the model with multinationals, the labor market clearing condition can be written more compactly than the trade deficit equation, we use equation (21) in step 6 instead of equation (20).

To solve for aggregate income in Step 5, we use equations (68), (17) and (19):

$$I_n = w_n L_n + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{ni}^{j(k)}}(1-\gamma_n^{j(k)})\frac{s_{ni,f}^{j(k)}X_i^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{m\neq n}\sum_{f=1}^{F_{mi}^{j(k)}}\gamma_m^{j(k)}\lambda_{nm}^{j(k)}\frac{s_{mi,f}^{j(k)}X_i^{j(k)}}{\varepsilon_{mi,f}^{j(k)}(1+t_{mi}^{j(k)})} + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}}\frac{t_{in}^{j(k)}s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}}X_n^{j(k)} + D_n. \tag{69}$$

Using Equation (16), we get:

[1]Note that we do not endogenize the decisions made by multinationals regarding where to locate. In particular, we are assuming that the total share of multinationals, $\gamma_n^{j(k)}$, and the share of each country in multinational activities in other countries, $\lambda_{in}^{j(k)}$, remain unchanged in the counterfactual equilibrium. One can hence interpret our counterfactual results in this robustness exercise as the short-run effects before multinationals decide to relocate in response to changes in trade barriers.

$$I_n = w_n L_n + \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{ni}^{j(k)}}(1-\gamma_n^{j(k)})\frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})}\alpha_i^k\left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k} I_i +$$
$$\sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{m\neq n}\sum_{f=1}^{F_{mi}^{j(k)}}\gamma_m^{j(k)}\lambda_{nm}^{j(k)}\frac{s_{mi,f}^{j(k)}}{\varepsilon_{mi,f}^{j(k)}(1+t_{mi}^{j(k)})}\alpha_i^k\left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k} I_i + \tag{70}$$
$$\sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}}\frac{t_{in}^{j(k)}s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}}\alpha_n^k\left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k} I_n + D_n.$$

This is a system of N equations in N unknowns, which can be written in matrix form as:

$$\Lambda I = \Psi, \tag{71}$$

where

$$I = \begin{pmatrix} I_1 \\ \vdots \\ \vdots \\ I_N \end{pmatrix}_{N\times 1}, \Psi = \begin{pmatrix} w_1 L_1 \\ \vdots \\ \vdots \\ w_N L_N \end{pmatrix}_{N\times 1},$$

$$\Lambda = (\mathbb{I}_N - \Omega),$$

$$\mathbb{I}_N = \begin{pmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{pmatrix}_{N\times N},$$

$$\Omega = \begin{pmatrix} \zeta_1 + \Pi_{11} & \Pi_{12} & \dots & \Pi_{1N} \\ \Pi_{21} & \zeta_2 + \Pi_{22} & \dots & \Pi_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \Pi_{N1} & \Pi_{N2} & \dots & \zeta_N + \Pi_{NN} \end{pmatrix}_{N\times N}.$$

We can therefore write:

$$\underset{N\times N}{\Pi_{in}} = \sum_{k=1}^{K}\sum_{j=1}^{J(k)} \begin{pmatrix} (1-\gamma_1^{j(k)}) & \lambda_{12}^{j(k)}\gamma_2^{j(k)} & \dots & \lambda_{1N}^{j(k)}\gamma_N^{j(k)} \\ \lambda_{21}^{j(k)}\gamma_1^{j(k)} & (1-\gamma_2^{j(k)}) & \dots & \lambda_{2N}^{j(k)}\gamma_N^{j(k)} \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \lambda_{N1}^{j(k)}\gamma_1^{j(k)} & \lambda_{N2}^{j(k)}\gamma_2^{j(k)} & \dots & (1-\gamma_N^{j(k)}) \end{pmatrix}_{N\times N} \cdot \begin{pmatrix} \chi_{11}^{j(k)} & \chi_{12}^{j(k)} & \dots & \chi_{1N}^{j(k)} \\ \chi_{21}^{j(k)} & \chi_{22}^{j(k)} & \dots & \chi_{2N}^{j(k)} \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \chi_{N1}^{j(k)} & \chi_{N2}^{j(k)} & \dots & \chi_{NN}^{j(k)} \end{pmatrix}_{N\times N},$$

where

$$\chi_{ni}^{j(k)} = \sum_{f=1}^{F_{ni}^{j(k)}} \frac{s_{ni,f}^{j(k)}}{\varepsilon_{ni,f}^{j(k)}(1+t_{ni}^{j(k)})} \alpha_i^k \left(\frac{P_i^{j(k)}}{\mathcal{P}_i^k}\right)^{1-\sigma_i^k},$$

and

$$\zeta_n = \sum_{k=1}^{K}\sum_{j=1}^{J(k)}\sum_{i=1}^{N}\sum_{f=1}^{F_{in}^{j(k)}} \frac{t_{in}^{j(k)} s_{in,f}^{j(k)}}{1+t_{in}^{j(k)}} \alpha_n^k \left(\frac{P_n^{j(k)}}{\mathcal{P}_n^k}\right)^{1-\sigma_n^k}.$$

B.2 Additional Data Sources

When solving the model with multinationals, we use several data sources to compute the share of each country in the profits generated in each sector in foreign countries. To infer the total share of multinationals in each sector-country pair, $\gamma_n^{j(k)}$, we use OECD data on *inward activity of multinationals by industrial sector*. For each country and each of the two-digit ISIC (revision 4) sectors, these data report gross operating surplus by multinationals as well as national totals. Therefore, we can identify the total share of multinationals in gross operating profits in each two-digit ISIC sector country, and we assume that all HS2 sectors belonging to a two-digit ISIC sector have the same share.[2] For countries that do not exist in the OECD data, we use UNCTAD and WDI data to construct the total inflow of FDI stock divided by total capital stock to infer the share of multinationals in that country. Since this information is not sector-specific, we assume that all sectors have the same share of multinationals for these countries.

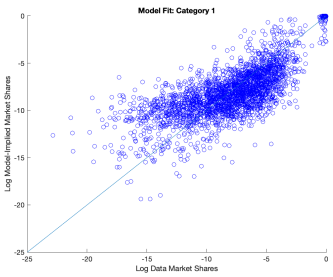
Lastly, to infer the share of each country in total multinational activities in other countries, $\lambda_{in}^{j(k)}$, we use OECD data on *inward activity of multinationals by investing country*. These data report the gross operating surplus in the manufacturing sector by an investor country in a recipient country. Since detailed information for each sector is not available, we assume these shares are the same across all sectors. Moreover, for the countries not included in the OECD dataset, we use UNCTAD data on inward FDI stock for an investor country in a recipient country.

[2]We use data for 2015 or the closest available year.

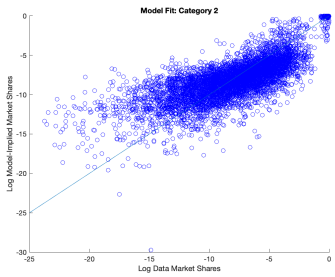
C Market Shares in Data versus Model

The following figures plot the market shares (in logs) in the model against those observed in the data for each upper-tier CES sector.

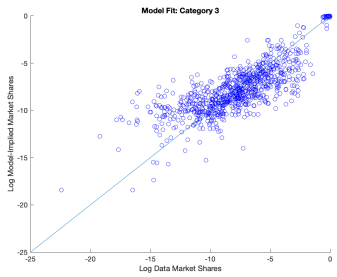
Figure C.1: Log Market Shares (Data) vs Log Market Shares (Model) - Categories 1-9



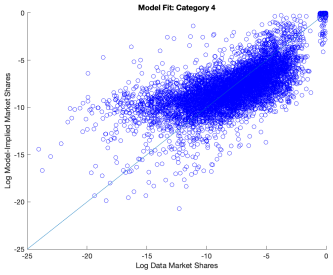
(a) Category 1



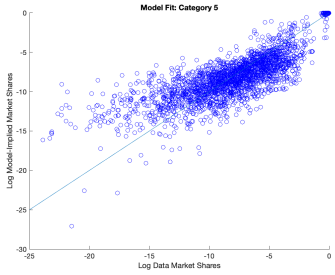
(b) Category 2



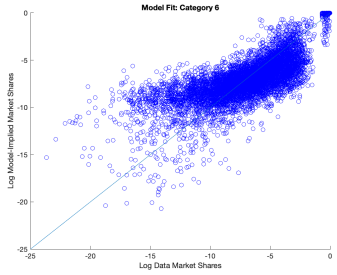
(c) Category 3



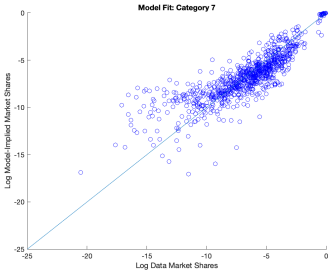
(d) Category 4



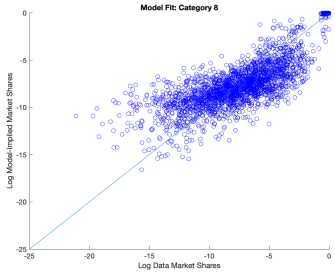
(e) Category 5



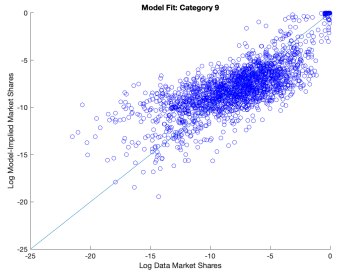
(f) Category 6



(g) Category 7

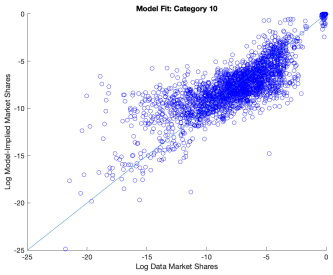


(h) Category 8

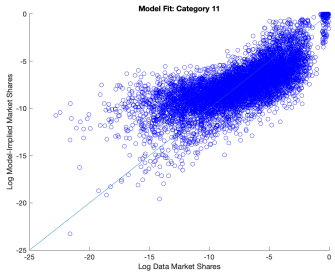


(i) Category 9

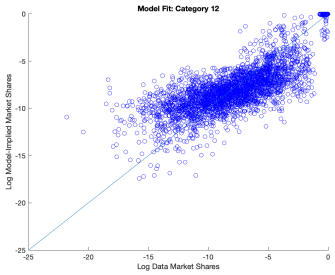
Figure C.2: Log Market Shares (Data) vs Log Market Shares (Model) - Categories 10-21



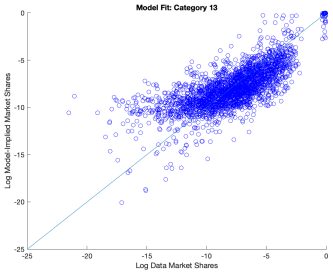
(a) Category 10



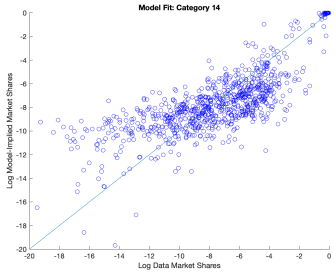
(b) Category 11



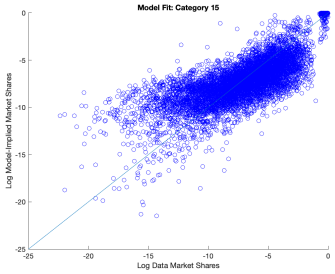
(c) Category 12



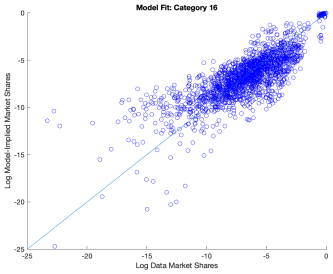
(d) Category 13



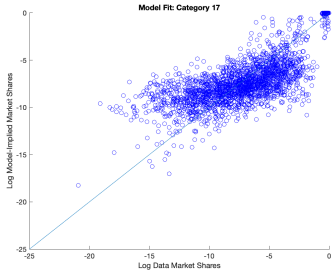
(e) Category 14



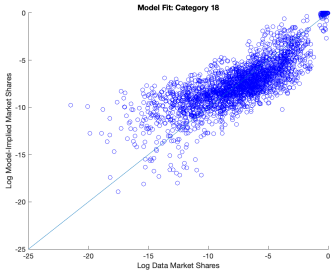
(f) Category 15



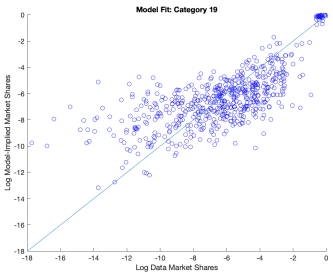
(g) Category 16



(h) Category 17



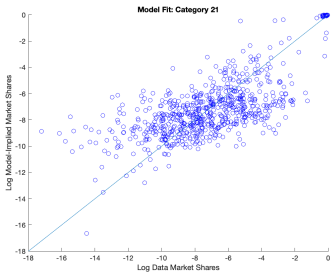
(i) Category 18



(j) Category 19



(k) Category 20



(l) Category 21

D Additional Tables and Figures

Table D.1: Summary Statistics

Trade, Wages, Tariffs, MNEs, and Markups:			
	Mean	Std. Deviation	N
Imports (in mn. $)	204.67	2483.84	71,141
Weight (in mn. kg)	599.93	116,063.70	71,141
Expenditure Shares, α_n^k (in %)	3.89	15.53	74,017
Wage Bill (in bn. $)	2244.18	3702.61	29
Tariff (MFN, ad valorem)	8.46	35.99	71,141
Tariff (applied, ad valorem)	5.86	35.34	71,141
Share of Multinationals in Sector-Country, $\gamma_n^{j(k)}$	0.22	0.11	36,720
Share of Investor in Recipient Country, $\lambda_{in}^{j(k)}$	0.03	0.07	870
Number of Firms by Country (across all sectors):			
Country		Mean	Median
Australia		744.3	288.0
Austria		208.5	78.5
Bangladesh		290.1	127.5
Belgium		250.4	76.5
Brazil		1582.6	635.0
China		3475.0	1880.0
Denmark		109.5	41.5
France		1517.8	553.5
Germany		1620.7	540.5
Greece		484.0	192.0
India		2032.3	1175.0
Indonesia		255.8	121.5
Italy		3091.1	1097.5
Japan		2147.2	707.5
Korea, Rep.		1476.8	45.0
Mexico		479.7	136.5
Netherlands		102.1	31.0
New Zealand		127.5	47.0
Norway		42.5	27.5
Peru		550.7	191.0
Romania		414.4	153.0
Russia		1871.5	773.0
Vietnam		586.2	224.0
Spain		1400.7	442.0
Sweden		403.0	161.0
Egypt		49.1	23.0
United Kingdom		995.9	294.5
United States		2532.7	934.5

Notes: Imports, weights, expenditure shares, and tariffs are reported at the HS2 level. The wage bill varies by country.

Table D.2: HS2 Sector Classification (HS Nomenclature 2012 by World Customs Organization)

Section	Name	HS2	Sector Name
01	Live Animals;Animal Products	01	Live animals
		02	Meat & edible meat offal
		03	Fish and crustaceans,molluscs & other aquatic invertebrates
		04	Dairy produce;birds' eggs;natural honey
		05	Products of animal origin
02	Vegetable Products	06	Live trees,bulbs;Roots;flowers
		07	Edible vegetables
		08	Edible fruits; citrus fruits' peels
		09	Coffee,tea, & spices
		10	Cereals
		11	Milling industry products;malts;starch,gluten
		12	Oil seeds & oleaginous fruits; straw and fodder
		13	Lac;gums,raisins & other vegetable extracts
		14	Vegetable plaiting materials
03	Animal or vegetable fats and oils and their Cleavage products; prepared edible fats; Animal or vegetable waxes	15	Animal or vegetable fats;oils
04	Prepared foodstuffs; Beverages, Spirits and Vinegar; Tobacco and Manufactured tobacco Substitutes	16	Preparation of meat, fish or crustaceans, molluscs or aquatic invertebrates
		17	Sugars & sugar confectionery
		18	Cocoa & cocoa preparations
		19	Preparation of cereals,flower, starch,mill, pastrycooks'products
		20	Fruit, nuts or other plant parts
		21	Miscellaneous edible preparations
		22	Beverages,spirits & vinegar
		23	Residues & waste from food industries;prepared animal fodder
		24	Tobacco & manufactured tobacco substitutes
05	Mineral Products	25	Salt;sulphur;earths & stone;lime & cement
		26	Ores,slag & ash
		27	Mineral fuels,mineral oils,distillation products;bituminous substances
06	Products of Chemical or Allied Industries	28	Inorganic chemicals;organic compounds or precious metals
		29	Organic chemicals
		30	Pharmaceutical products
		31	Fertilizers
		32	Tanning & Dyeing extracts; paints & varnishes;ink
		33	Essential oils & resinoids;perfumery,cosmetic or toilet preparations
		34	Soap,washing preparations;waxes,candles;"dental waxes"
		35	Albuminoidal substances; modified starches;glues;enzymes
		36	Explosives;pyrotechnic products;matches;pyrophoric alloys
		37	Photographic or cinematographic goods
		38	Miscellaneous chemical products
07	Plastics and Rubber Articles	39	Plastics & articles thereof
		40	Rubber & articles thereof
08	Raw Hides and Skin, Leather, Fur Skins and Articles thereof; Saddlery and Harness; Travel goods, Handbags and similar containers; Articles of animal gut (other than silk-worm gut)	41	Raw hides & skins(other than fur skins)& leather
		42	Leather articles;saddlery & harness; travel goods,Animal gut
		43	Fur skins & artificial fur; manufactures thereof
09	Wood and articles of Wood; Wood Charcoal; Cork and articles of Cork; Manufactures of straw, of Esparto or of other plaiting materials; Basketware and Wickerwork	44	Wood & wood articles;wood charcoal
		45	Cork & articles of cork
		46	Manufactures of straw,of esparto or other plating materials
10	Pulp of Wood or of other fibrous Cellulosic material; recovered (Waste and scrap) paper or paperboard; paper or paperboard and articles thereof	47	Pulp of Wood or other fibrous cellulosic materials;recovered
		48	Paper & paper board
		49	Printed books,newspapers,pictures;manuscripts,typescripts

Table D.3: HS2 Sector Classification under HS Nomenclature 2012 by World Customs Organization (cont.)

Section	Name	HS2	Sector Name
11	Textiles and Textiles Articles	50	Silk
		51	Wool,fine or coarse animal hair;horse hair,yarn
		52	Cotton
		53	Other vegetable textile fibres;Paper yarn & woven fabrics
		54	Man-made filaments
		55	Man-made staple fibres
		56	Wadding,felt & non-wovens,special yarns
		57	Carpets & other textile floor coverings
		58	Special woven fabrics;tufted woven fabrics;lace;tapestry
		59	Impregnated,coated,covered or laminated textile fabrics
		60	Knitted or croched fabrics
		61	Articles of apparel & clothing accessories,knitted/croched
		62	Articles of apparel & clothing accessories, not knitted or croched
		63	Other made up textile articles;sets;worn clothing;rags
12	Footwear, Headgear, Umbrellas, Sun Umbrellas, Walking-sticks, Seat-Sticks, Whips,	64	Footwear,gaitors
	Riding-Crops and parts thereof; prepared feathers and articles made therewith ;Artificial	65	Headgears & parts thereof
	flowers; Articles of Human hair	66	Umbrellas,sun umbrellas,walking sticks,seed sticks,whips
		67	Prepared feathers & down;artificial flowers;articles of human hair
13	Articles of stone	68	Articles of stone,plaster,cement,asbestos or mica or similar materials
		69	Ceramic products
		70	Glass & glassware
14	Natural or cultured pearls, precious or	71	Natural or cultured pearls,
	semi-precious stones, precious metals,		precious or semi-precious stones, precious metals
	Imitation jewellery;Coin		
15	Base Metals and Articles of Base Metals	72	Iron & Steel
		73	Articles of Iron or steel
		74	Copper & articles thereof
		75	Nickels & articles thereof
		76	Aluminium & articles thereof
		77	(Reserved for possible future use in the harmonized System)
		78	Lead & articles thereof
		79	Zinc & articles thereof
		80	Tin & articles thereof
		81	Other base metals;cements; articles thereof
		82	Tools,Implements,cutlery,spoons
			& forks, of base metal;parts thereof of base metal.
		83	Miscellaneous articles of base metal
16	Machinery and mechanical appliances;	84	Nuclear Reactors, Boilers, Machinery
	Electrical equipment; parts thereof; Sound		mechanical appliances; parts thereof
	Recorders and Reproducers, Television image	85	Electrical machinery & equipment parts;
	and Sound Recorders and Reproducers, and		sound recorders & reproducers, television image.
	parts and accessories of such articles		
17	Vehicles, Aircraft, Vessels and associated Transport Equipment	86	Railway or tramway locomotives, rolling-stock,
			railway or tramway track fixtures
			fittings and parts thereof;
			mechanical (including electro-mechanical)
			traffic signalling equipment of all kinds.
		87	Vehicles other than railway or tramway rolling-stock,
			parts & accessories thereof.
		88	Air crafts,spacecraft, & parts thereof.
		89	Ships, boats & floating structures
18	Optical, Photographic, Cinematographic,	90	Optical, photographic, cinematographic, measuring
	Measuring, Checking, Precision, Medical or		checking, precision, medical or surgical instruments
	surgical instruments and Apparatus; Clocks		apparatus; parts and accessories thereof.
	and Watches; Musical Instruments; parts and	91	Clocks & watches;parts thereof
	accessories thereof	92	Musical instruments;parts and articles accessories.
19	Arms and Ammunition; parts and accessories thereof	93	Arms and ammunition; parts and accessories thereof.
20	Miscellaneous Manufactured Articles	94	Furniture; bedding, mattresses, mattress supports
			cushions and similar stuffed furnishings;
			lamps and lighting fittings, not elsewhere specified or included;
			illuminated signs, illuminated name-plates and the like;
			prefabricated buildings.
		95	Toys, games and sports requisites; parts and accessories thereof.
		96	Miscellaneous manufactured articles.
21	Works of Art, Collectors' pieces and Antiques	97	Works of art, collectors' pieces and antiques.

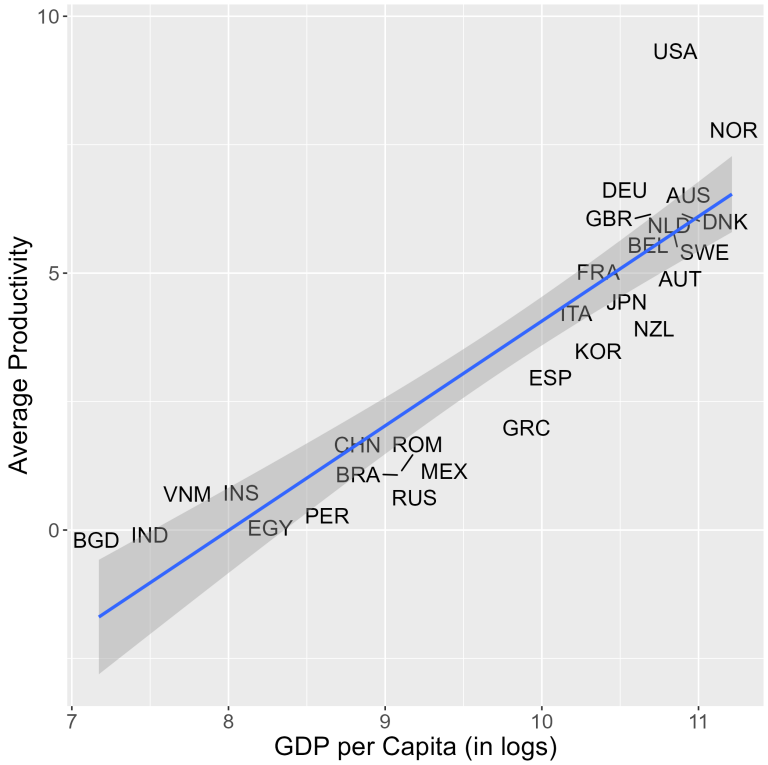
Table D.4: Inverse Lower-Tier Elasticities and Import/Export Shares for each country's largest sectors

	Imports			Exports		
Country	Product Category (HS2 level)	Share	$1/\sigma$	Product Category (HS2 level)	Share	$1/\sigma$
Australia	Elec. Machinery/Equipment (85)	16.94	.31	Ores, Slag, and Ash (26)	27.48	.13
Australia	Vehicles (87)	12.92	.32	Mineral Fuels/Oils, etc. (27)	26.08	.73
Australia	Mineral Fuels/Oils, etc. (27)	11.21	.23	Precious Stones, Pearls (71)	7.24	.46
Austria	Elec. Machinery/Equipment (85)	14.3	.12	Elec. Machinery/Equipment (85)	15.31	.23
Austria	Vehicles (87)	10.73	.18	Machinery, Mech. Appliances (84)	14.01	.86
Austria	Machinery, Mech. Appliances (84)	9.51	.04	Vehicles (87)	9.34	.73
Bangladesh	Cotton (52)	14.89	.03	Cloth. Accessories, not knitted (62)	40.24	.13
Bangladesh	Mineral Fuels/Oils, etc. (27)	10.87	.41	Cloth. Accessories, knitted (61)	38.44	.22
Bangladesh	Machinery, Mech. Appliances (84)	8.18	.01	Paper, Paperboard (48)	4.73	.05
Belgium	Pharmaceutical Products (30)	14.59	.11	Pharmaceutical Products (30)	13.28	.77
Belgium	Mineral Fuels/Oils, etc. (27)	12.44	.25	Mineral Fuels/Oils, etc. (27)	11.65	.33
Belgium	Vehicles (87)	11.58	.01	Vehicles (87)	10.61	.46
Brazil	Elec. Machinery/Equipment (85)	16.04	.09	Ores, Slag, and Ash (26)	12.93	.23
Brazil	Mineral Fuels/Oils, etc. (27)	14.65	.20	Seeds and Grains (12)	11.25	.07
Brazil	Machinery, Mech. Appliances (84)	10.26	.14	Mineral Fuels/Oils, etc. (27)	8.53	.56
China	Elec. Machinery/Equipment (85)	25.91	.08	Elec. Machinery/Equipment (85)	40.04	.21
China	Mineral Fuels/Oils, etc. (27)	12.99	.19	Machinery, Mech. Appliances (84)	6.24	.86
China	Precious Stones, Pearls (71)	6.36	.59	Furniture, Bedding, etc. (94)	3.82	.46
Denmark	Elec. Machinery/Equipment (85)	15.26	.21	Pharmaceutical Products (30)	14.54	.24
Denmark	Vehicles (87)	7.96	.48	Elec. Machinery/Equipment (85)	11.7	.46
Denmark	Machinery, Mech. Appliances (84)	7.5	.19	Machinery, Mech. Appliances (84)	10.33	.07
Egypt	Mineral Fuels/Oils, etc. (27)	13.93	.19	Mineral Fuels/Oils, etc. (27)	28.47	.27
Egypt	Elec. Machinery/Equipment (85)	9.04	.95	Elec. Machinery/Equipment (85)	6.61	.34
Egypt	Vehicles (87)	8.66	.74	Vegetables and Roots (7)	4.76	.61
France	Elec. Machinery/Equipment (85)	12.7	.21	Vehicles (87)	10.3	.22
France	Mineral Fuels/Oils, etc. (27)	10.68	.20	Aircraft, Spacecraft (88)	10.1	.70
France	Vehicles (87)	9.7	.42	Machinery, Mech. Appliances (84)	9.48	.17
Germany	Elec. Machinery/Equipment (85)	17.64	.13	Vehicles (87)	19.57	.02
Germany	Vehicles (87)	9.94	.22	Elec. Machinery/Equipment (85)	14.57	.13
Germany	Machinery, Mech. Appliances (84)	8.18	.28	Machinery, Mech. Appliances (84)	12.79	.46
Greece	Mineral Fuels/Oils, etc. (27)	26.73	.43	Mineral Fuels/Oils, etc. (27)	27.52	.68
Greece	Elec. Machinery/Equipment (85)	8.48	.43	Aluminium & Articles thereof (76)	5.92	.03
Greece	Pharmaceutical Products (30)	8.08	.19	Pharmaceutical Products (30)	5.3	.27
India	Mineral Fuels/Oils, etc. (27)	27.55	.28	Precious Stones, Pearls (71)	13.56	.32
India	Precious Stones, Pearls (71)	15.73	.64	Mineral Fuels/Oils, etc. (27)	12.29	.09
India	Elec. Machinery/Equipment (85)	12.65	.13	Pharmaceutical Products (30)	7.11	.08
Indonesia	Mineral Fuels/Oils, etc. (27)	17.62	.56	Mineral Fuels/Oils, etc. (27)	21.12	.20
Indonesia	Elec. Machinery/Equipment (85)	15.06	.46	Animal/Vegetable Oils & Fats (15)	11.94	.18
Indonesia	Machinery, Mech. Appliances (84)	11.38	.46	Elec. Machinery/Equipment (85)	8.02	.43

Table D.5: Inverse Lower-Tier Elasticities and Import/Export Shares for each country's largest sectors (cont.)

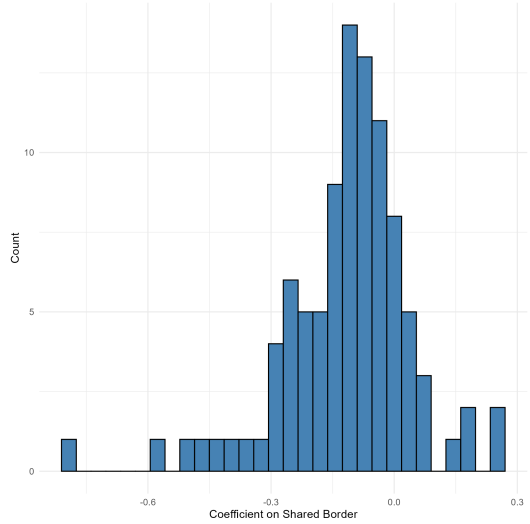
	Imports			Exports		
Country	Product Category (HS2 level)	Share	$1/\sigma$	Product Category (HS2 level)	Share	$1/\sigma$
Italy	Mineral Fuels/Oils, etc. (27)	12.89	.36	Machinery, Mech. Appliances (84)	15.27	.54
Italy	Elec. Machinery/Equipment (85)	10.8	.95	Elec. Machinery/Equipment (85)	10.76	.40
Italy	Vehicles (87)	8.92	.46	Vehicles (87)	8.33	.17
Japan	Mineral Fuels/Oils, etc. (27)	20.88	.33	Elec. Machinery/Equipment (85)	25.4	.27
Japan	Elec. Machinery/Equipment (85)	19.87	.40	Vehicles (87)	20.91	.02
Japan	Pharmaceutical Products (30)	5.67	.80	Machinery, Mech. Appliances (84)	12.48	.66
Mexico	Elec. Machinery/Equipment (85)	30.52	.20	Elec. Machinery/Equipment (85)	28.29	.12
Mexico	Machinery, Mech. Appliances (84)	10.6	.06	Vehicles (87)	24.3	.02
Mexico	Vehicles (87)	9.69	.21	Machinery, Mech. Appliances (84)	9.11	.04
Netherlands	Elec. Machinery/Equipment (85)	19.88	.27	Elec. Machinery/Equipment (85)	17.76	.21
Netherlands	Mineral Fuels/Oils, etc. (27)	14.93	.27	Mineral Fuels/Oils, etc. (27)	16.06	.28
Netherlands	Pharmaceutical Products (30)	5.77	.35	Pharmaceutical Products (30)	9.69	.62
New Zealand	Vehicles (87)	13.53	.04	Dairy, Eggs, Honey (4)	19.06	.12
New Zealand	Elec. Machinery/Equipment (85)	13.4	.30	Meat and Edible Meat (2)	13.92	.26
New Zealand	Mineral Fuels/Oils, etc. (27)	10.08	.09	Wood and Articles of Wood (44)	8.21	.31
Norway	Elec. Machinery/Equipment (85)	13.82	.34	Mineral Fuels/Oils, etc. (27)	49.08	.42
Norway	Vehicles (87)	10.78	.37	Fish, Seafood (3)	12.11	.09
Norway	Machinery, Mech. Appliances (84)	9.57	.32	Elec. Machinery/Equipment (85)	5.34	.09
Peru	Elec. Machinery/Equipment (85)	16.38	.13	Ores, Slag, and Ash (26)	29.75	.31
Peru	Mineral Fuels/Oils, etc. (27)	10.28	.26	Precious Stones, Pearls (71)	17.2	.64
Peru	Machinery, Mech. Appliances (84)	10.03	.22	Fruits and Nuts (8)	6.61	.20
ROW	Elec. Machinery/Equipment (85)	22.24	.46	Mineral Fuels/Oils, etc. (27)	22.45	.68
ROW	Machinery, Mech. Appliances (84)	7.96	.46	Elec. Machinery/Equipment (85)	17.98	.21
ROW	Mineral Fuels/Oils, etc. (27)	7.5	.56	Precious Stones, Pearls (71)	6.12	.01
S. Korea	Mineral Fuels/Oils, etc. (27)	23.69	.24	Elec. Machinery/Equipment (85)	35.19	.27
S. Korea	Elec. Machinery/Equipment (85)	23.28	.21	Vehicles (87)	11.32	.82
S. Korea	Machinery, Mech. Appliances (84)	5.07	.22	Machinery, Mech. Appliances (84)	6.95	.20
Romania	Elec. Machinery/Equipment (85)	19.09	.30	Elec. Machinery/Equipment (85)	20.48	.09
Romania	Machinery, Mech. Appliances (84)	9.52	.72	Vehicles (87)	14.12	.43
Romania	Vehicles (87)	8.71	.23	Machinery, Mech. Appliances (84)	7.87	.46
Russia	Elec. Machinery/Equipment (85)	18.13	.23	Mineral Fuels/Oils, etc. (27)	59.69	.68
Russia	Machinery, Mech. Appliances (84)	12.45	.37	Iron and Steel (72)	4.93	.04
Russia	Vehicles (87)	8.55	.20	Precious Stones, Pearls (71)	3.19	.71
Spain	Mineral Fuels/Oils, etc. (27)	14.05	.23	Vehicles (87)	18.48	.11
Spain	Vehicles (87)	12.73	.17	Elec. Machinery/Equipment (85)	6.99	.30
Spain	Elec. Machinery/Equipment (85)	10.88	.19	Machinery, Mech. Appliances (84)	6.8	.11
Sweden	Elec. Machinery/Equipment (85)	18.03	.46	Elec. Machinery/Equipment (85)	14.74	.46
Sweden	Vehicles (87)	11.71	.02	Machinery, Mech. Appliances (84)	13.29	.08
Sweden	Mineral Fuels/Oils, etc. (27)	10.22	.56	Vehicles (87)	12.51	.23
USA	Elec. Machinery/Equipment (85)	21.94	.46	Elec. Machinery/Equipment (85)	15.1	.95
USA	Vehicles (87)	12.76	.02	Machinery, Mech. Appliances (84)	11.14	.08
USA	Mineral Fuels/Oils, etc. (27)	9.01	.56	Vehicles (87)	8.84	.21
UK	Elec. Machinery/Equipment (85)	14.09	.93	Vehicles (87)	12.66	.23
UK	Vehicles (87)	12.7	.42	Machinery, Mech. Appliances (84)	11.14	.03
UK	Mineral Fuels/Oils, etc. (27)	8.3	.42	Precious Stones, Pearls (71)	10.67	.09
Vietnam	Elec. Machinery/Equipment (85)	28.93	.12	Elec. Machinery/Equipment (85)	38.56	.95
Vietnam	Machinery, Mech. Appliances (84)	9.08	.25	Footwear (64)	8.43	.38
Vietnam	Iron and Steel (72)	4.81	.22	Cloth. Acc., not knitted (62)	6.35	.23

Figure D.1: Productivity Estimates and GDP per Capita

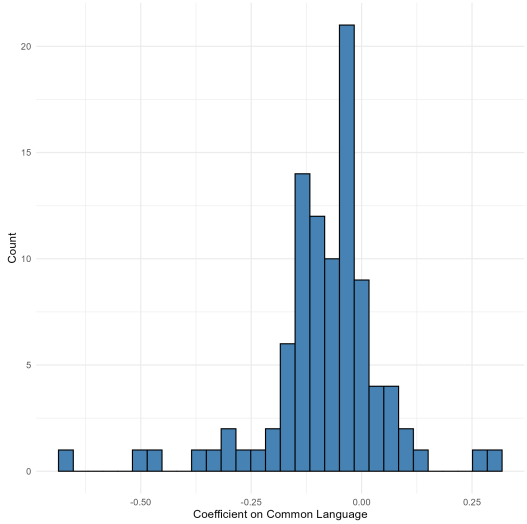


Notes: This figure plots the estimated average productivity in each country, as summarized in Table 2, against its GDP per capita (in logs).

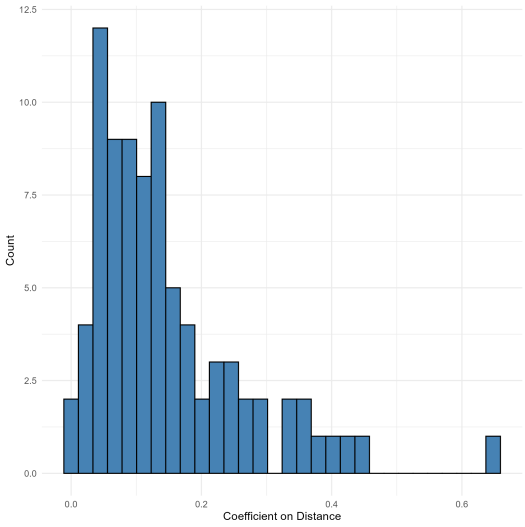
Figure D.2: Estimated Iceberg Cost Coefficients - Histograms



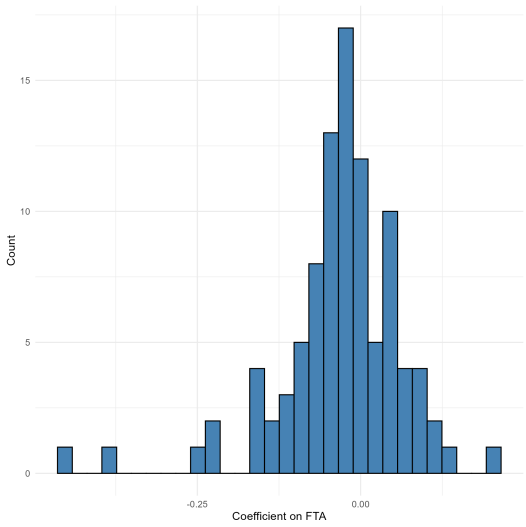
(a) Common Border



(b) Common Language



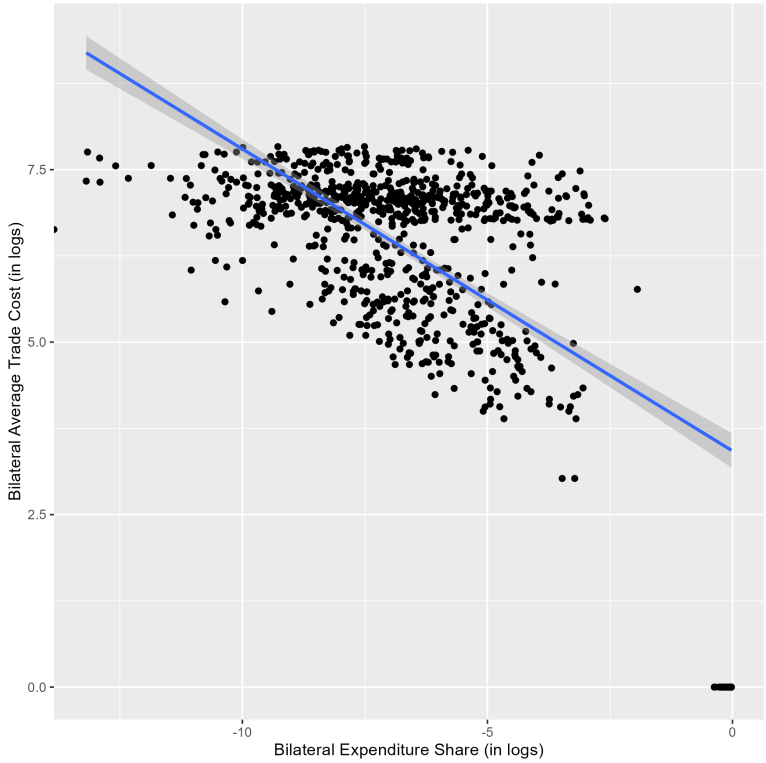
(c) Distance



(d) Free-Trade Agreement

Notes: These histograms plot the distribution of the estimated coefficients across sectors in Equation (39). Panel a) plots the coefficient associated with a common border, Panel b) the coefficient associated with a common language, Panel c) the coefficient associated with distance, and Panel d) the coefficient associated with a free-trade agreement.

Figure D.3: Average Bilateral Trade Costs and Expenditure Shares



Notes: This figure plots the estimated average bilateral trade costs across sectors against aggregate bilateral expenditure shares.

Table D.6: Model-Implied Ex Post Trade Elasticities

Country	Model-Implied Ex Post Trade Elasticity	
	At Factual Tariffs	At Counterfactual Tariffs
	(1)	(2)
Australia	2.8686	2.0523
Austria	1.9924	1.9210
Bangladesh	2.7736	1.6433
Belgium	1.7986	1.7602
Brazil	2.4642	1.7796
China	1.9239	1.7690
Denmark	2.4780	1.9284
France	2.2486	1.4702
Germany	2.1450	1.9338
Greece	1.1716	1.0941
India	1.5906	1.4952
Indonesia	2.2880	1.7472
Italy	1.4284	1.0935
Japan	1.5243	1.7004
S.Korea	2.4196	1.7833
Mexico	2.4858	1.7118
Netherlands	2.2277	1.7769
New Zealand	2.8156	2.5113
Norway	2.7757	1.9199
Peru	2.3090	1.6223
Romania	1.1718	1.0787
Russia	2.0470	1.4909
Vietnam	1.9621	1.8000
Spain	1.6280	1.2207
Sweden	5.8301	2.8548
Egypt	1.9437	1.4340
UK	1.9313	0.9590
USA	1.5183	1.0637
ROW	1.1825	0.8608
Median	2.0470	1.7118
Average	2.1705	1.6371

Notes: This table reports model-implied ex post trade elasticities when iceberg trade costs are reduced by 20%. The results reported in column (1) are based on a scenario in which tariffs are held at factual levels. The results reported in column (2) are based on a scenario in which tariffs are held at the counterfactually higher levels.

E Extensions and Robustness

Table E.1: Global Tariff War (all countries increase tariffs by 50pp), Variable Markups

	Welfare	Wages	Profits			Import Shares	Prices
			Overall	Domestic	Export		
Australia	-1.27	-1.42	-3.58	.28	-58.17	-69.29	-2.22
Austria	-3.77	-2.47	-7.78	-1.38	-63.12	-77.77	7.26
Bangladesh	-3.52	-.72	-11.56	-2.3	-55.19	-60.82	17.57
Belgium	-4.38	-4.92	-9.73	.47	-57.25	-69.62	2.49
Brazil	-3.31	-1.84	-10.43	.06	-56.04	-63.98	5.78
China	-1.6	-.84	-3.67	-.36	-63.9	-72.16	5.48
Denmark	-2.51	-2.52	-6.26	1.14	-58.08	-70.01	6.02
France	-2.37	-2.2	-6.64	.39	-53.11	-67.28	3.4
Germany	-4.09	-4.84	-13.4	3.85	-57.54	-67.35	.42
Greece	-2.83	-1.72	-7.4	-1.02	-51.69	-51.94	13.95
India	-3.15	-1.1	-5.93	-2.39	-55.47	-60.92	11.06
Indonesia	-1.48	-3.91	-.69	2.43	-55.05	-69.57	-5.26
Italy	-2.06	-1.55	-5.2	-.67	-50.13	-54.96	9.78
Japan	-1.11	-.82	-2.1	-.45	-57.51	-66.61	4.53
S.Korea	-1.19	-.77	-4.34	.78	-55.09	-65.85	10.14
Mexico	-2.9	-1.15	-9.3	-.95	-63.55	-70.78	8.19
Netherlands	-1.05	-6.06	.57	7.08	-59.94	-72.62	-6.81
New Zealand	-3.29	-2.48	-9.21	.17	-59.94	-75.09	.04
Norway	-.63	-1.78	-.7	1.72	-49.02	-68.66	-3.67
Peru	-3.33	-1.24	-20.41	2.22	-57.38	-61.21	19.74
Romania	-2.4	-1.4	-7.66	-.74	-50.67	-51.54	13.27
Russia	-2.72	-.97	-7.33	-1.55	-54.89	-59.33	15.54
Vietnam	-6.7	-5.05	-17.5	-.24	-57.86	-66.54	7.53
Spain	-1.92	-1.86	-4.2	-.76	-51.42	-57.89	2.96
Sweden	-5.83	-1.8	-33.5	7.36	-66.59	-78.14	18.61
Egypt	-.23	-1.49	-.62	1.09	-46.62	-61.54	-2.25
UK	-1.01	-2.71	-2.79	.6	-51.71	-66.8	-9.28
USA	.01	-1.36	-.1	.95	-57.66	-62.69	-12.86
ROW	-1.5	-5.34	-3.29	.99	-54.54	-56.52	-7.88

Notes: Each column reports the percentage change in the respective variable. Welfare, wages, and profits are reported in real terms. The percentage change in real domestic profits is the % change in real profits earned by firms from country n in the domestic market, i.e., $\left(\frac{(Y_{nn}/P_n)^{\text{counterfactual}}}{(Y_{nn}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Similarly, the percentage change in real export profits is the % change in real profits earned by firms from country n by exporting goods to other countries, i.e., $\left(\frac{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{counterfactual}}}{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Changes in import shares are calculated as the % change in the share of imports in total spending.

Table E.2: Global Tariff War (all countries increase tariffs by 50pp), Fixed Markups

	Welfare	Wages	Profits			Import Shares	Prices
			Overall	Domestic	Export		
Australia	-2.2	-2.99	-4.77	-.67	-55.11	-66.61	-4.36
Austria	-5.17	-3.56	-10.25	-3.31	-61.51	-74.37	7.89
Bangladesh	-4.01	-1.49	-12.5	-2.82	-52.28	-61.17	15.51
Belgium	-5.13	-6.16	-10.76	-.43	-55.43	-66.68	2.52
Brazil	-3.51	-2.11	-10.94	-.43	-54.51	-61.46	8.08
China	-.94	-1.21	-1.61	.71	-54.46	-75	2.88
Denmark	-2.86	-2.66	-7.14	.42	-57.08	-67.9	7.51
France	-2.8	-4.1	-6.16	-.02	-45.54	-62.59	-2.72
Germany	-4.24	-6.59	-12.69	3.59	-55.73	-63.93	4.12
Greece	-2.69	-1.7	-7.24	-.93	-50.51	-51.02	16.06
India	-2.98	-1.46	-5.64	-2.22	-52.4	-58.24	8.92
Indonesia	-1.66	-2.31	-2.77	.6	-51	-68.82	-3.05
Italy	-1.99	-1.4	-5.22	-.73	-49.46	-53.88	13.47
Japan	-1.13	-.82	-2.28	-.65	-55.11	-65.48	4.63
S.Korea	-1.52	-.93	-5.63	.19	-53.18	-65.51	10.13
Mexico	-4.17	-2.18	-11.78	-2.21	-63.39	-70.75	10.71
Netherlands	-2.36	-4.74	-4.04	1.91	-57.14	-71.17	-5.05
New Zealand	-5.8	-6.62	-10.52	-1.34	-54.94	-79.18	-.24
Norway	-.85	-1.27	-1.98	.92	-50.13	-66.73	2.58
Peru	-3.31	-1.21	-20.51	2.07	-56.81	-60.24	24.07
Romania	-2.29	-1.46	-7.52	-.7	-49.15	-50.24	14.86
Russia	-2.99	-1.34	-7.96	-1.76	-53.23	-59.05	15.23
Vietnam	-8.07	-7.93	-18.16	-1.94	-53.53	-63.5	5.56
Spain	-1.81	-2.01	-4.09	-.65	-49.87	-56.55	3.49
Sweden	-6.4	-1.91	-35.27	7.25	-67.59	-78.45	23.69
Egypt	-1.17	-1.39	-2.58	-.59	-43.21	-53.74	-1.61
UK	-2.35	-5.16	-4.17	-.44	-51.46	-67.7	-7.21
USA	.43	-1.47	.75	1.43	-51.48	-69.34	-9.81
ROW	.24	-5.99	-.03	2.97	-54.6	-58.46	-4.14

Notes: Each column reports the percentage change in the respective variable. Welfare, wages, and profits are reported in real terms. The percentage change in real domestic profits is the % change in real profits earned by firms from country n in the domestic market, i.e., $\left(\frac{(Y_{nn}/P_n)^{\text{counterfactual}}}{(Y_{nn}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Similarly, the percentage change in real export profits is the % change in real profits earned by firms from country n by exporting goods to other countries, i.e., $\left(\frac{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{counterfactual}}}{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Changes in import shares are calculated as the % change in the share of imports in total spending.

Table E.3: Import and Domestic Markups and the Pro-Competitive Gains

	Dependent Variable: Pro-Competitive Gains	
	(1)	(2)
	Change in markups for best firm	Change in markups for all firms
Δ % Domestic Markups	-0.0645	-0.0327
	(-0.41)	(-0.15)
Δ % Import Markups	0.702***	0.887***
	(9.42)	(7.46)
R^2	0.568	0.419

Notes: This table reports the results of regressing the pro-competitive gains on changes in domestic and import markups. Column (1) reports the results when this markup change is computed based on the most productive firm in each country. Column (2) reports the results when this markup change is computed as a weighted average over all firms in a country. Both the dependent variable and the regressors are measured in percent. t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table E.4: Global Tariff War (all countries increase tariffs by 50pp), Variable Markups, Homogeneous Elasticities across Countries

	Welfare	Wages	Profits			Import Share	Prices
			Overall	Domestic	Export		
ROW	-1.40	-2.65	-4.14	0.64	-51.88	-54.12	8.00
Australia	-4.15	-3.16	-9.58	-1.66	-55.53	-59.63	13.44
Austria	-2.68	-6.11	-7.01	0.65	-48.30	-52.68	8.21
Bangladesh	-1.97	-2.97	-3.25	-0.91	-44.82	-49.65	-3.84
Belgium	-8.50	-15.53	-20.99	0.66	-49.26	-41.67	17.71
Brazil	-1.62	-2.26	-3.68	-0.03	-48.10	-47.75	4.81
China	-1.29	-1.05	-2.87	-0.55	-52.15	-54.62	11.66
Denmark	-2.45	-9.02	-5.35	4.02	-44.93	-58.42	3.88
France	-3.46	-5.24	-9.05	-0.05	-50.00	-52.78	12.72
Germany	-2.54	-5.02	-7.20	0.50	-49.79	-50.42	10.14
Greece	-1.93	-2.64	-4.71	-0.61	-47.49	-51.89	9.98
India	-0.75	-3.82	-2.17	1.41	-43.37	-49.02	1.61
Indonesia	1.43	-9.00	4.74	6.71	-41.19	-59.83	-8.55
Italy	-2.12	-3.95	-5.85	0.10	-48.30	-48.90	10.38
Japan	-0.84	-2.92	-1.48	0.10	-41.27	-45.56	-1.94
S.Korea	-0.81	-2.80	-2.14	0.33	-42.89	-45.97	1.71
Mexico	-3.49	-4.19	-8.50	-0.82	-51.21	-50.62	5.48
Netherlands	-4.29	-10.82	-10.74	2.63	-48.24	-49.49	10.39
New Zealand	-1.08	-7.24	0.67	4.42	-50.41	-77.02	-6.20
Norway	-2.65	-5.19	-4.49	0.91	-47.25	-66.47	2.77
Peru	-3.48	-5.06	-9.60	-2.00	-42.91	-38.89	1.11
Romania	-1.09	-2.14	-2.73	0.04	-48.63	-55.93	7.97
Russia	-1.61	-1.48	-3.94	-0.29	-51.93	-58.54	16.70
Vietnam	-4.08	-10.87	-8.81	3.78	-48.13	-51.39	9.12
Spain	-1.95	-2.83	-5.09	-0.26	-49.26	-51.94	11.73
Sweden	-1.87	-2.78	-4.80	-0.24	-49.80	-53.84	11.16
Egypt	0.08	-4.82	0.97	3.58	-42.42	-57.78	-6.10
UK	0.77	-7.19	0.98	5.92	-38.48	-55.10	-4.74
USA	0.57	-3.17	0.48	2.55	-39.90	-50.30	-5.77

Notes: Each column reports the percentage change in the respective variable. Welfare, wages, and profits are reported in real terms. The percentage change in real domestic profits is the % change in real profits earned by firms from country n in the domestic market, i.e., $\left(\frac{(Y_{nn}/P_n)^{\text{counterfactual}}}{(Y_{nn}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Similarly, the percentage change in real export profits is the % change in real profits earned by firms from country n by exporting goods to other countries, i.e., $\left(\frac{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{counterfactual}}}{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Changes in import shares are calculated as the % change in the share of imports in total spending.

Table E.5: Global Tariff War (all countries increase tariffs by 50pp), Fixed Markups, Homogeneous Elasticities across Countries

	Welfare	Wages	Profits			Import Share	Prices
			Overall	Domestic	Export		
ROW	-1.41	-2.56	-4.15	0.58	-51.79	-54.02	7.78
Australia	-4.06	-3.31	-9.35	-1.58	-55.04	-60.00	12.37
Austria	-2.95	-5.90	-7.61	0.21	-48.65	-52.63	8.35
Bangladesh	-2.10	-2.73	-3.67	-1.21	-45.82	-50.57	-3.13
Belgium	-8.75	-15.20	-21.46	0.03	-49.33	-41.79	17.41
Brazil	-1.62	-2.24	-3.69	-0.04	-48.13	-47.76	4.51
China	-1.28	-1.02	-2.82	-0.56	-52.39	-54.92	11.79
Denmark	-2.68	-8.56	-5.96	3.22	-44.39	-58.57	3.15
France	-3.45	-5.18	-9.04	-0.10	-49.92	-52.79	12.25
Germany	-2.55	-4.99	-7.18	0.45	-49.76	-50.47	9.73
Greece	-1.89	-2.50	-4.76	-0.65	-47.34	-51.45	9.13
India	-0.62	-3.86	-1.87	1.57	-42.14	-49.21	0.36
Indonesia	0.56	-4.97	2.15	3.99	-36.53	-60.42	-11.73
Italy	-2.12	-3.88	-5.88	0.06	-48.33	-48.91	10.03
Japan	-0.74	-2.25	-1.65	0.11	-41.95	-45.86	-1.42
S.Korea	-0.86	-2.77	-2.23	0.26	-42.54	-45.50	1.30
Mexico	-3.57	-4.08	-8.84	-1.11	-50.94	-50.10	4.72
Netherlands	-4.81	-9.69	-12.49	1.40	-48.74	-49.23	10.39
New Zealand	-1.34	-7.01	0.34	3.72	-47.83	-77.77	-7.38
Norway	-2.68	-4.78	-4.84	0.44	-44.56	-67.29	1.99
Peru	-3.54	-4.97	-9.78	-2.15	-43.01	-38.94	0.89
Romania	-1.07	-1.97	-2.82	-0.02	-48.43	-55.31	7.50
Russia	-1.79	-1.40	-4.35	-0.54	-53.10	-60.69	18.17
Vietnam	-4.60	-10.53	-9.69	2.75	-48.69	-52.75	9.66
Spain	-1.97	-2.78	-5.14	-0.31	-49.31	-52.00	11.44
Sweden	-1.95	-2.68	-4.97	-0.42	-49.89	-53.75	10.90
Egypt	-0.68	-4.13	-0.44	1.83	-37.19	-58.10	-9.32
UK	0.73	-7.17	1.04	5.90	-37.90	-55.15	-5.43
USA	0.61	-3.15	0.57	2.58	-39.28	-50.22	-6.17

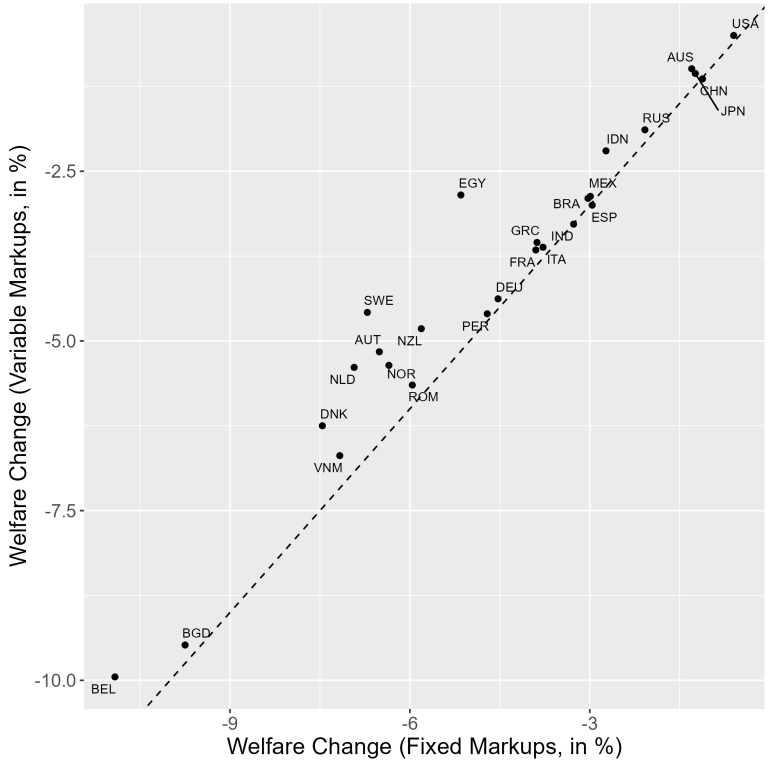
Notes: Each column reports the percentage change in the respective variable. Welfare, wages, and profits are reported in real terms. The percentage change in real domestic profits is the % change in real profits earned by firms from country n in the domestic market, i.e., $\left(\frac{(Y_{nn}/P_n)^{\text{counterfactual}}}{(Y_{nn}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Similarly, the percentage change in real export profits is the % change in real profits earned by firms from country n by exporting goods to other countries, i.e., $\left(\frac{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{counterfactual}}}{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Changes in import shares are calculated as the % change in the share of imports in total spending.

Table E.6: Global Tariff War (all countries increase tariffs by 50 pp), Homogeneous Elasticities across Countries and Sectors

	Variable Markups	Fixed Markups	Pro-Competitive Gains
	Welfare	Welfare	
Australia	-0.89	-1.03	-0.14
Austria	-3.65	-4.56	-0.92
Bangladesh	-4.77	-5.19	-0.42
Belgium	-5.35	-6.13	-0.78
Brazil	-1.10	-1.14	-0.04
China	-0.76	-0.80	-0.04
Denmark	-4.10	-5.14	-1.04
France	-1.67	-1.74	-0.07
Germany	-2.13	-2.25	-0.12
Greece	-1.16	-1.38	-0.21
India	-0.98	-1.15	-0.17
Indonesia	-2.07	-2.26	-0.19
Italy	-0.64	-0.84	-0.20
Japan	-1.12	-1.16	-0.03
S.Korea	-2.81	-3.12	-0.32
Mexico	-1.49	-1.73	-0.23
Netherlands	-5.46	-6.28	-0.82
New Zealand	-2.63	-3.21	-0.58
Norway	-2.84	-3.36	-0.52
Peru	-2.00	-2.08	-0.08
Romania	-1.85	-2.15	-0.30
Russia	-1.03	-1.02	0.01
Vietnam	-4.14	-4.33	-0.19
Spain	-1.21	-1.31	-0.10
Sweden	-2.15	-3.50	-1.35
Egypt	-1.87	-3.01	-1.14
UK	-1.07	-1.50	-0.43
USA	-0.34	-0.34	-0.01
ROW	-0.65	-0.71	-0.06

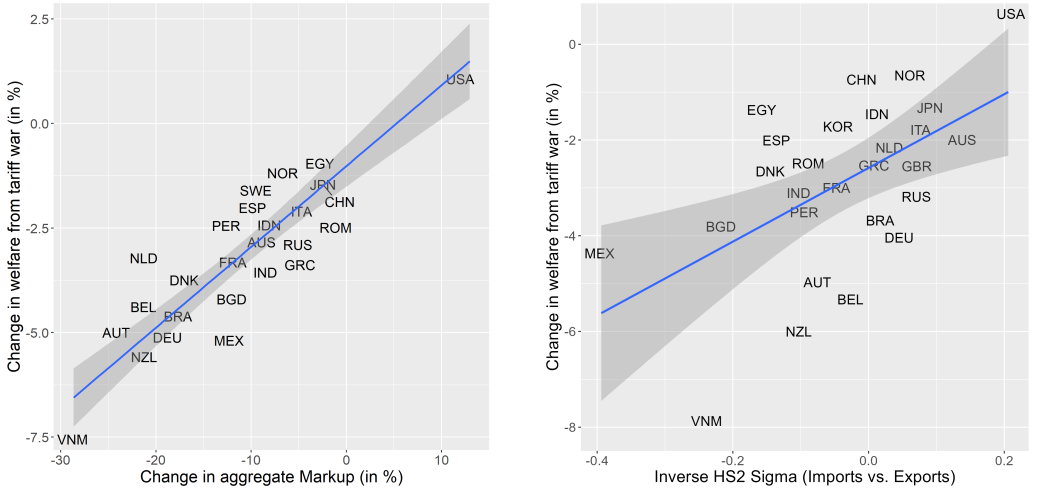
Notes: This table summarizes the results of the main counterfactual, when all upper-tier demand elasticities are set equal to the value estimated for the U.S. and all lower-tier demand elasticities equal to the median lower-tier demand elasticity estimated for the U.S.. Pro-competitive gains are computed as the difference in the welfare change between the fixed- and the variable-markup case. All values are reported as a percentage, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent.

Figure E.1: Robustness - Homogeneous-Elasticity Model (using China's elasticity estimates)



Notes: This figure plots the change in welfare associated with a global trade war in which tariffs are raised by 50 percentage points in the alternative model with cross-country homogeneous elasticities when elasticity estimates for China are used. The y-axis reports changes in welfare under variable markups, while the x-axis reports these changes under fixed markups. All values are reported in percent.

Figure E.2: Profit Shifting and Welfare Changes across Countries (Fixed-Markup Specification)



(a) Welfare and Markups (b) Welfare and Elasticities

Notes: Panel (a) plots the change in welfare associated with a global trade war in which tariffs are raised by 50 percentage points on the y-axis in the fixed-markup model against changes in the aggregate markup on the x-axis. Panel (b) plots the change in welfare against the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS2 level.

Table E.7: Global Tariff War (all countries increase tariffs by 50pp) - Fixed-Cost Model

	Variable Markups			Fixed Markups			Pro-Competitive Gains
	Welfare	Wages	Profits	Welfare	Wages	Profits	
	(1)	(2)	(3)	(4)	(5)	(6)	(4) - (1)
Australia	-4.22	-4.7	-5.92	-5.16	-6.2	-7.14	-.94
Austria	-4	-2.73	-7.96	-5.57	-3.86	-10.65	-1.58
Bangladesh	-3.47	-.78	-11.4	-4.31	-1.59	-12.97	-.83
Belgium	-4.87	-5.51	-10.06	-5.76	-6.75	-11.31	-.89
Brazil	-3.25	-1.87	-10.25	-3.6	-2.16	-11.04	-.34
China	-1.66	-.88	-3.72	-1.05	-1.26	-1.77	.61
Denmark	-2.63	-2.59	-6.4	-3.07	-2.73	-7.45	-.44
France	-2.9	-2.79	-7.04	-3.47	-4.68	-6.82	-.57
Germany	-4.01	-4.91	-13.21	-4.29	-6.66	-12.8	-.28
Greece	-2.99	-1.81	-7.55	-3.07	-1.86	-7.67	-.07
India	-4.49	-2.96	-6.89	-4.6	-3.42	-6.93	-.12
Indonesia	-1.88	-4.31	-1.02	-2.06	-2.66	-3.17	-.18
Italy	-2.39	-1.82	-5.5	-2.44	-1.68	-5.69	-.05
Japan	-1.82	-1.66	-2.69	-1.88	-1.66	-2.92	-.06
S.Korea	-1.05	-.76	-4.04	-1.5	-.93	-5.58	-.45
Mexico	-3.06	-1.37	-9.36	-4.39	-2.38	-11.96	-1.33
Netherlands	-4.6	-9.65	-2.5	-5.9	-8.38	-6.92	-1.3
New Zealand	-4.83	-3.91	-10.7	-7.48	-7.96	-12.38	-2.65
Norway	-1.06	-2.24	-1.06	-1.28	-1.66	-2.4	-.22
Peru	-3.28	-1.23	-20.25	-3.47	-1.25	-20.89	-.19
Romania	-2.43	-1.43	-7.66	-2.52	-1.56	-7.8	-.09
Russia	-2.89	-1.18	-7.43	-3.32	-1.56	-8.32	-.43
Vietnam	-7.34	-5.75	-17.95	-9.09	-8.71	-19.21	-1.75
Spain	-4.77	-5.56	-6.09	-5	-5.91	-6.32	-.23
Sweden	-5.95	-1.81	-33.78	-6.65	-1.93	-35.93	-.7
Egypt	-3.17	-4.77	-3.23	-4.03	-4.63	-5.01	-.86
UK	-3.21	-5.12	-4.67	-4.44	-7.4	-5.97	-1.24
USA	-.11	-1.51	-.19	.29	-1.61	.62	.4

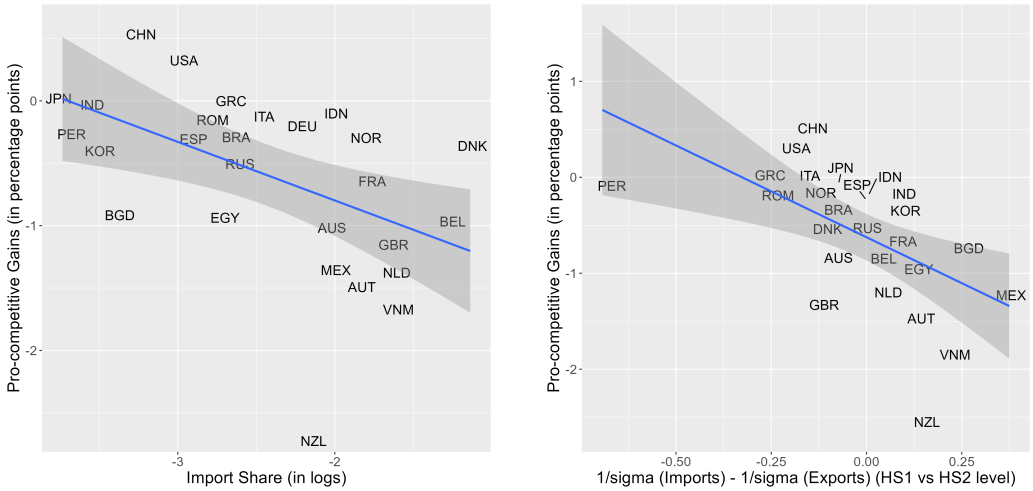
Notes: This table summarizes the outcomes of a global tariff war in which all countries increase tariffs by 50 percentage points in the fixed-cost model described in the main text. Columns (1) to (6) report the percentage change in the respective variable, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent. All variables are reported in real terms.

Table E.8: Regression Results: The Pro-competitive Gains from Trade (Fixed-Cost Model)

	(1) Pro-Comp. Gains	(2) Pro-Comp. Gains	(3) Pro-Comp. Gains	(4) Pro-Comp. Gains
Inverse sigma for imports (HS1 versus HS2)	-2.727*** (-3.93)	-2.575*** (-3.63)	-2.833*** (-4.89)	-2.708*** (-5.12)
Import Share (logs)		-0.449*** (-4.35)	-0.391*** (-3.89)	-0.373*** (-3.28)
Inverse sigma for exports (HS1 versus HS2)			5.074*** (3.22)	3.637** (2.67)
Export Share (logs)				0.143 (1.62)
R^2	0.306	0.518	0.589	0.637

Notes: The dependent variable in each regression is the percentage change in welfare associated with a 50 percentage point increase in tariffs across all countries under variable compared to fixed markups, but with a negative sign, so that positive values can be interpreted as pro-competitive gains from trade. All inverse demand elasticities are weighted by trade volumes. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure E.3: Pro-competitive Effects, Demand Elasticities, and Import Shares (Fixed-Cost Model)



(a) Import Shares

(b) Demand Elasticities

Notes: The y-axis in Panels (a) and (b) reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) reports each country's imports as a fraction of total spending. The x-axis in Panel (b) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

Table E.9: Global Tariff War (all countries increase tariffs by 50pp) - Horizontal Supply Curve

	Variable Markups			Fixed Markups			Pro-Competitive Gains
	Welfare	Wages	Profits	Welfare	Wages	Profits	
	(1)	(2)	(3)	(4)	(5)	(6)	(4) - (1)
Australia	-6.38	-2	-11.6	-6.35	-2	-11.61	.03
Austria	-3.15	-2.71	-6.67	-4.24	-2.02	-8.83	-1.08
Bangladesh	-3.34	-1.74	-9.68	-3.74	-2.02	-10.76	-.4
Belgium	-.51	-4.5	-3.01	-.44	-4.8	-2.88	.08
Brazil	-3.56	-1.76	-8.3	-2.75	-1.95	-6.94	.81
China	-1.3	-.63	-2.09	-1.09	-.63	-1.82	.21
Denmark	-4.17	-3.22	-11.92	-4.43	-3.22	-12.6	-.26
France	-3.05	-2.09	-6.97	-3.14	-2.05	-7.16	-.09
Germany	-.46	-2.85	-1.89	-.59	-2.82	-2.08	-.13
Greece	-2.51	-2.61	-4.97	-3.05	-2.39	-5.65	-.54
India	-3.19	-2.36	-6.38	-2.46	-2.71	-5.12	.72
Indonesia	-.73	-2.16	-1.69	-.93	-1.42	-2.46	-.21
Italy	2.54	-2.65	1.51	3.12	-2.7	2.17	.57
Japan	3.23	-1.31	3.07	3	-1.29	2.83	-.24
S.Korea	-2.74	-1.25	-6.11	-2.73	-1.23	-6.24	.01
Mexico	-4.19	-4.45	-22.93	-9.38	-12.36	-29.05	-5.18
Netherlands	-3.21	-3.79	-9.62	-3.24	-3.65	-9.6	-.03
New Zealand	-2.98	-2.1	-9.51	-2.98	-2.17	-9.7	0
Norway	1.51	-5.01	.54	.51	-4.77	-.71	-1
Peru	-19.02	-6.64	-41.28	-18.44	-6.6	-40.97	.58
Romania	-3.03	-1.51	-5.78	-3.33	-1.4	-6.12	-.3
Russia	-3.97	-1.15	-9.41	-4.07	-1.13	-9.63	-.1
Vietnam	-7.14	-4.68	-18.14	-7.59	-4.92	-19.18	-.45
Spain	-.67	-2.19	-2.85	-1.45	-2.45	-3.76	-.78
Sweden	-1.79	-1.94	-3.86	-1.84	-1.92	-3.96	-.05
Egypt	-.5	-1.63	-2.24	.86	-1.82	-1.23	1.36
UK	3.3	-5.02	2.21	3.39	-5.05	2.34	.09
USA	4.47	-4.74	4.26	5.04	-4.68	5	.57
ROW	-3.45	-2.09	-9.99	-3.13	-2.44	-9.39	.32

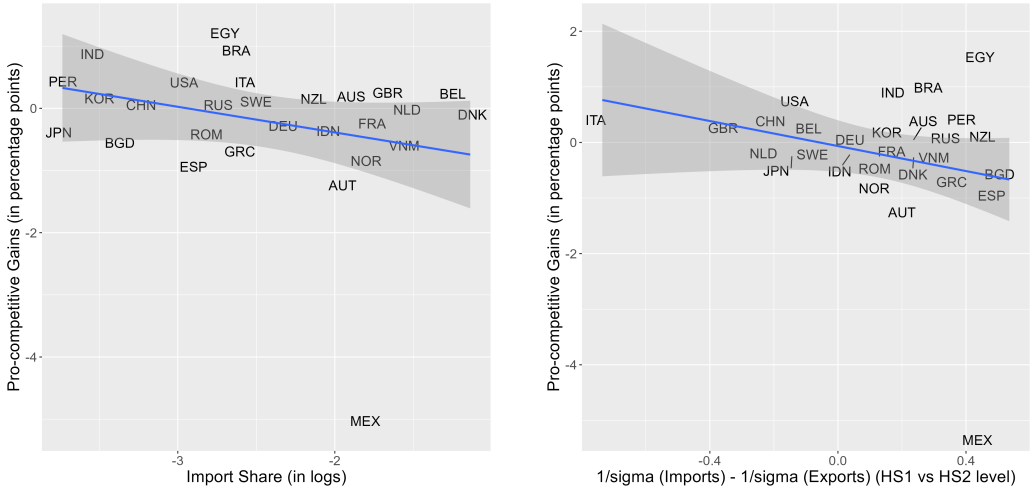
Notes: This table summarizes the outcomes of a global tariff war in which all countries increase tariffs by 50 percentage points when demand elasticities are estimated based on the assumption of a horizontal supply curve, as described in the main text. Columns (1) to (6) report the percentage change in the respective variable, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent. All variables are reported in real terms.

Table E.10: Regression Results: The Pro-competitive Gains from Trade (Horizontal Supply Curve)

	(1) Pro-Comp. Gains	(2) Pro-Comp. Gains	(3) Pro-Comp. Gains	(4) Pro-Comp. Gains
Inverse sigma for imports (HS1 versus HS2)	-0.544* (-1.72)	-0.711** (-2.42)	-0.800*** (-3.07)	-0.854*** (-2.84)
Import Share (logs)		-0.253** (-2.32)	-0.264** (-2.29)	-0.292** (-2.36)
Export Share (logs)			-0.0360 (-0.33)	-0.0254 (-0.23)
Inverse sigma for exports (HS1 versus HS2) × Export Share				0.284 (1.06)
R^2	0.062	0.187	0.192	0.234

Notes: The dependent variable in each regression is the percentage change in welfare associated with a 50 percentage point increase in tariffs across all countries under variable compared to fixed markups, but with a negative sign, so that positive values can be interpreted as pro-competitive gains from trade. All inverse demand elasticities are weighted by trade volumes. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure E.4: Pro-competitive Effects, Demand Elasticities, and Import Shares (Horizontal Supply Curve)



(a) Import Shares

(b) Demand Elasticities

Notes: The y-axis in Panels (a) and (b) reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) reports each country's imports as a fraction of total spending. The x-axis in Panel (b) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

Table E.11: Global Tariff War (all countries increase tariffs by 50pp) - Fixed-Cost Model, Horizontal Supply Curve

	Variable Markups			Fixed Markups			Pro-Competitive Gains
	Welfare	Wages	Profits	Welfare	Wages	Profits	
	(1)	(2)	(3)	(4)	(5)	(6)	(4) - (1)
Australia	-8.83	-4.69	-13.82	-8.74	-4.61	-13.78	.09
Austria	-4.27	-3.57	-7.82	-5.48	-2.88	-10.14	-1.21
Bangladesh	-5.2	-2.91	-11.83	-5.39	-3.01	-12.75	-.19
Belgium	-9.34	-13.16	-11.42	-9.19	-13.35	-11.22	.15
Brazil	-4.17	-2.31	-8.89	-3.35	-2.48	-7.53	.82
China	-1.72	-.9	-2.53	-1.5	-.89	-2.24	.22
Denmark	-5.07	-3.74	-12.99	-5.32	-3.73	-13.67	-.24
France	-5.08	-3.99	-8.91	-5.15	-3.94	-9.08	-.07
Germany	-1.93	-4.09	-3.37	-2.02	-4.01	-3.51	-.09
Greece	-20.56	-22.14	-22.03	-20.99	-21.96	-22.59	-.44
India	-4.03	-3.04	-7.23	-3.37	-3.45	-6.02	.67
Indonesia	-1.1	-2.37	-2.11	-1.28	-1.61	-2.86	-.18
Italy	-4.42	-8.32	-5.4	-3.94	-8.39	-4.84	.48
Japan	-1.42	-6.64	-1.34	-1.66	-6.6	-1.6	-.25
S.Korea	-3.26	-1.71	-6.62	-3.25	-1.68	-6.75	.02
Mexico	-4.36	-4.5	-23.19	-9.56	-12.42	-29.3	-5.2
Netherlands	-3.92	-4.33	-10.43	-3.89	-4.15	-10.35	.02
New Zealand	-3.91	-2.65	-10.62	-3.89	-2.71	-10.82	.01
Norway	-1.74	-7.96	-2.63	-2.68	-7.68	-3.83	-.94
Peru	-19.25	-6.83	-41.47	-18.64	-6.78	-41.12	.62
Romania	-4.52	-2.59	-7.28	-4.67	-2.34	-7.48	-.15
Russia	-4.35	-1.41	-9.81	-4.43	-1.38	-10.02	-.08
Vietnam	-8.26	-5.49	-19.26	-8.68	-5.73	-20.28	-.42
Spain	-6.22	-6.78	-8.33	-6.96	-7.01	-9.18	-.74
Sweden	-2.87	-2.9	-4.91	-2.89	-2.86	-4.98	-.02
Egypt	-1.18	-2.28	-2.83	.12	-2.5	-1.89	1.29
UK	-1.22	-9.23	-2.15	-1.13	-9.26	-2.01	.1
USA	2.97	-6.22	2.83	3.57	-6.13	3.61	.6
ROW	-7.25	-6.03	-13.32	-6.92	-6.35	-12.73	.32

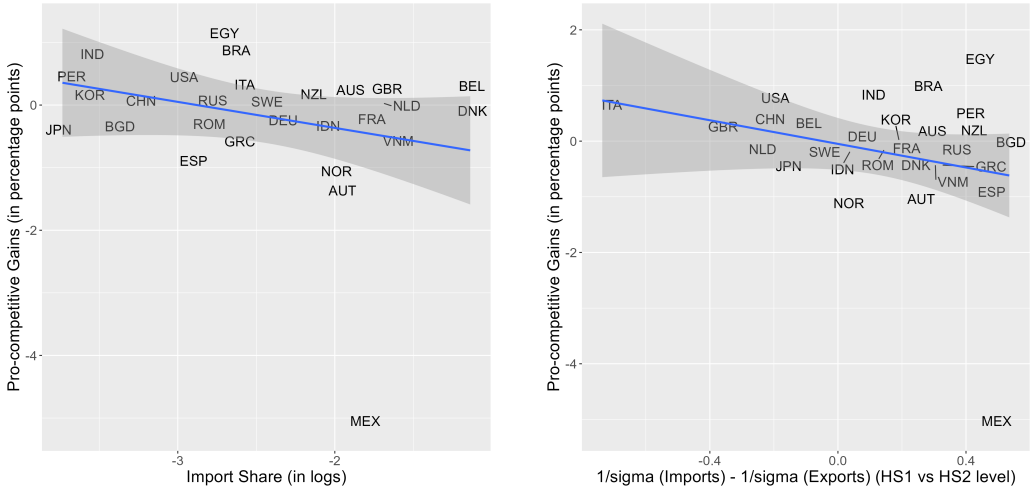
Notes: This table summarizes the outcomes of a global tariff war in which all countries increase tariffs by 50 percentage points when demand elasticities are estimated based on the assumption of a horizontal supply curve and in the presence of a fixed cost, as described in the main text. Columns (1) to (6) report the percentage change in the respective variable, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent. All variables are reported in real terms.

Table E.12: Regression Results: The Pro-competitive Gains from Trade (Fixed-Cost Model, Horizontal Supply Curve)

	(1) Pro-Comp. Gains	(2) Pro-Comp. Gains	(3) Pro-Comp. Gains	(4) Pro-Comp. Gains
Inverse sigma for imports (HS1 versus HS2)	-0.470 (-1.58)	-0.634** (-2.23)	-0.746** (-2.79)	-0.808** (-2.65)
Import Share (logs)		-0.249** (-2.28)	-0.264** (-2.32)	-0.296** (-2.51)
Export Share (logs)			-0.0452 (-0.45)	-0.0331 (-0.32)
Inverse sigma for exports (HS1 versus HS2) × Export Share				0.327 (1.26)
R^2	0.049	0.179	0.188	0.247

Notes: The dependent variable in each regression is the percentage change in welfare associated with a 50 percentage point increase in tariffs across all countries under variable compared to fixed markups, but with a negative sign, so that positive values can be interpreted as pro-competitive gains from trade. All inverse demand elasticities are weighted by trade volumes. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure E.5: Pro-competitive Effects, Demand Elasticities, and Import Shares (Fixed-Cost Model, Horizontal Supply Curve)

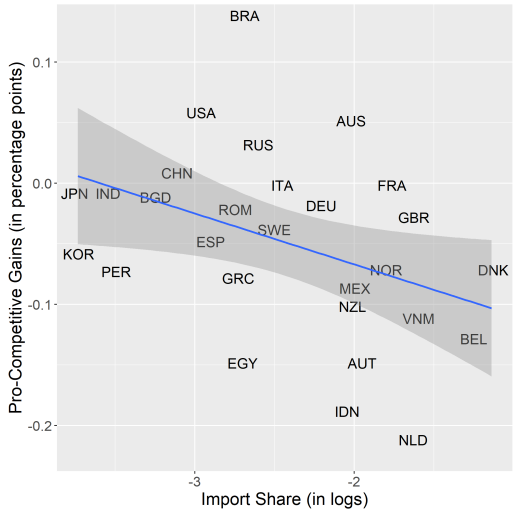


(a) Import Shares

(b) Demand Elasticities

Notes: The y-axis in Panels (a) and (b) reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) reports each country's imports as a fraction of total spending. The x-axis in Panel (b) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

Figure E.6: Pro-competitive Effects and Import Shares (Elasticities estimated via Fajgelbaum et al. (2020))



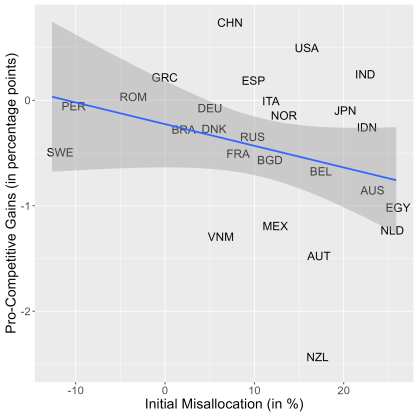
Notes: The y-axis in this plot reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis reports each country's imports as a fraction of total spending.

Table E.13: Global Tariff War (all countries increase tariffs by 50 pp), Homogeneous Elasticities across Countries and Sectors (lower-tier elasticity = 10.5)

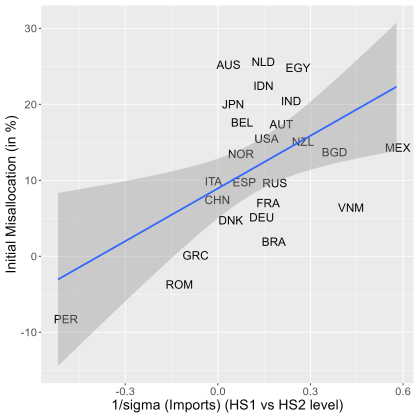
	Variable Markups	Fixed Markups	Pro-Competitive Gains
	Welfare	Welfare	
Australia	-0.33	-2.45	-2.12
Austria	-1.42	-2.36	-0.94
Bangladesh	-1.13	-1.73	-0.60
Belgium	-1.89	-3.74	-1.85
Brazil	-1.07	-1.86	-0.79
China	-0.92	-1.09	-0.17
Denmark	-0.79	-1.63	-0.84
France	-0.69	-1.87	-1.17
Germany	-4.56	-7.22	-2.67
Greece	-0.19	-0.68	-0.49
India	-0.56	-0.58	-0.03
Indonesia	-1.87	-1.03	0.84
Italy	-1.02	-1.14	-0.12
Japan	-0.58	-0.45	0.13
S.Korea	-0.46	-0.89	-0.43
Mexico	-0.38	-1.67	-1.29
Netherlands	-1.02	-2.29	-1.27
New Zealand	-1.22	-2.79	-1.57
Norway	-0.27	-0.37	-0.11
Peru	-0.33	-0.22	0.11
Romania	-0.17	-0.18	-0.01
Russia	-0.86	-1.40	-0.54
Vietnam	-3.12	-6.05	-2.92
Spain	-0.30	-0.76	-0.46
Sweden	-1.06	-1.23	-0.17
Egypt	-0.27	-0.58	-0.31
UK	-0.70	-1.98	-1.28
USA	-0.30	-0.37	-0.07
ROW	-3.24	-1.44	1.80

Notes: This table summarizes the results of the main counterfactual, when all upper-tier elasticities are set equal to the value estimated for the U.S. and all lower-tier elasticities equal to 10.5 (as in Edmond, Midrigan and Xu, 2015). Pro-competitive gains are computed as the difference in the welfare change between the fixed- and the variable-markup case. All values are reported as a percentage, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent.

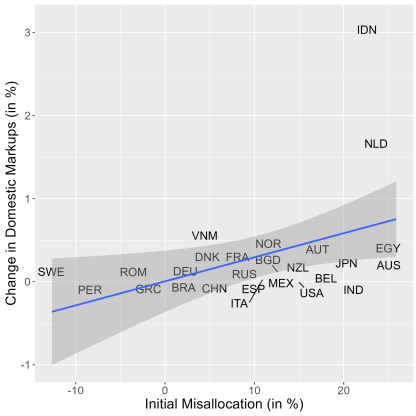
Figure E.7: The Pro-Competitive Gains, Misallocation, and Import Markups



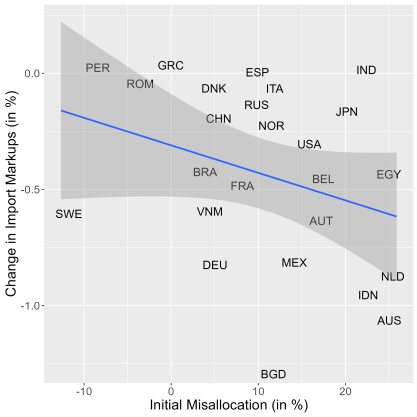
(a) Misallocation and the Pro-Competitive Gains from Trade



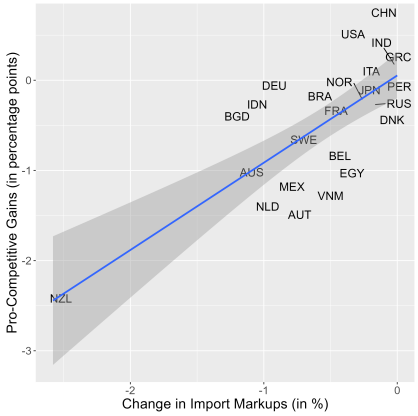
(b) Misallocation and the Difference between upper- and lower-tier elasticities



(c) Changes in Domestic Markups and Misallocation



(d) Changes in Import Markups and Misallocation



(e) Changes in Import Markups and the Pro-Competitive Gains from Trade

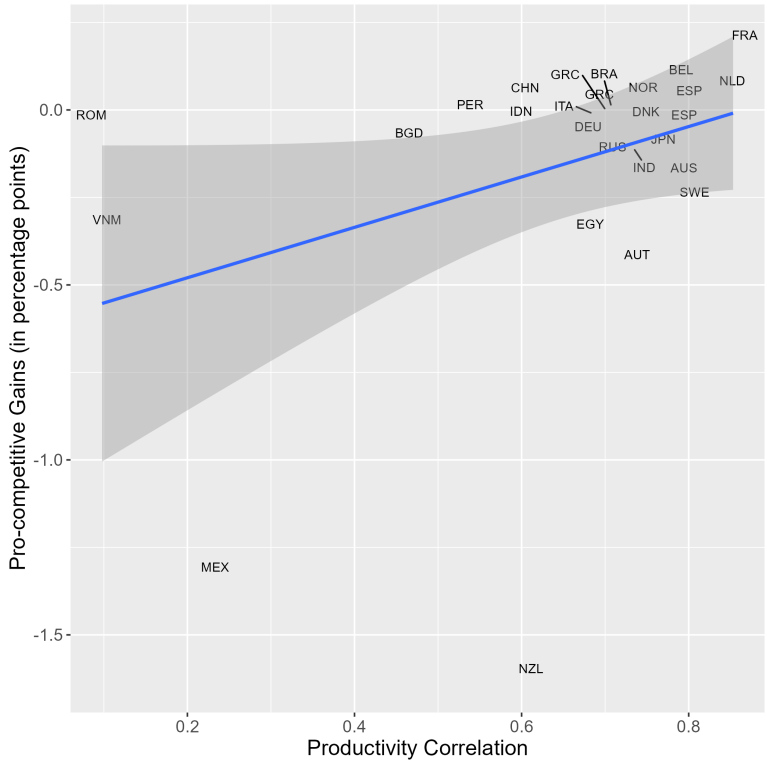
Notes: Panel (a) plots the pro-competitive gains from trade when tariffs in all countries are increased by 50 percentage points against the initial levels of misallocation. Panel (b) plots the initial levels of misallocation against the difference between import demand elasticities on the upper- versus the lower tier. Panel (c) plots the initial levels of misallocation against the average domestic markup in each country. Panel (d) plots changes in import markups against the initial levels of misallocation. Panel (e) plots the pro-competitive gains from trade against the model-predicted changes in import markups.

Table E.14: Model-implied correlation between U.S. productivity and that of other countries

Country	Correlation of Productivity between the U.S. and other countries
Australia	0.7696
Austria	0.7521
Bangladesh	0.4512
Belgium	0.7769
Brazil	0.7074
China	0.6206
Denmark	0.7630
France	0.8531
Germany	0.7048
Greece	0.7006
India	0.7342
Indonesia	0.6215
Italy	0.6847
Japan	0.7561
S.Korea	0.7283
Mexico	0.2194
Netherlands	0.8385
New Zealand	0.5971
Norway	0.7232
Peru	0.5526
Romania	0.0979
Russia	0.7273
Vietnam	0.1177
Spain	0.8087
Sweden	0.7929
Egypt	0.6682
UK	0.8297
Median	0.7232

Notes: This table reports the model-implied correlation between U.S. productivity across sectors and that of other countries.

Figure E.8: Pro-Competitive Gains and Correlation in Productivity



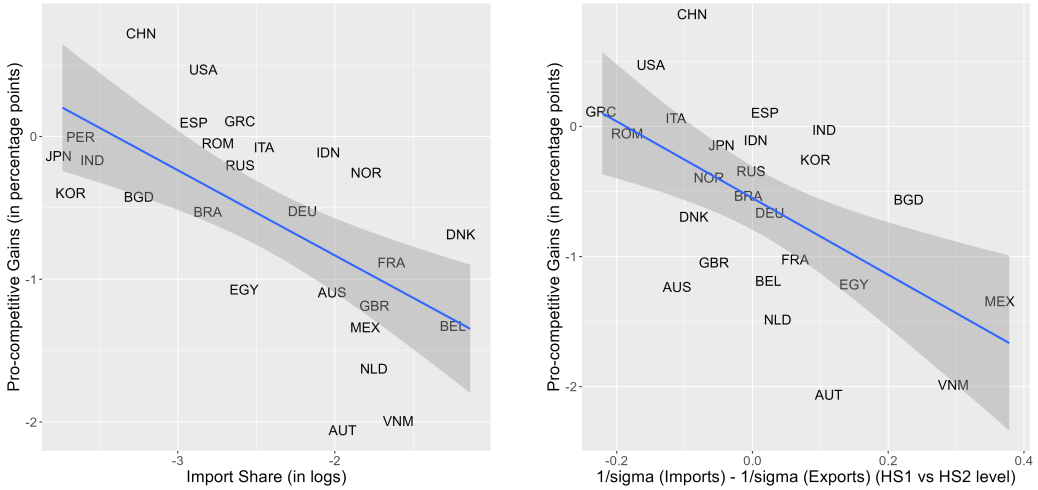
Notes: This figure plots the bilateral pro-competitive gains against the extent of correlation between productivity of U.S. firms and that of firms in other countries.

Table E.15: Global Tariff War (Changes in Trade Matched across Models)

	Variable Markups		Fixed Markups		Pro-Competitive Gains
	Welfare	Imports	Welfare	Imports	
Australia	-1.27	-69.29	-2.43	-69.15	-1.16
Austria	-3.77	-77.77	-5.76	-77.61	-1.99
Bangladesh	-3.52	-60.82	-4.01	-61.17	-0.48
Belgium	-4.38	-69.62	-5.64	-69.44	-1.26
Brazil	-3.31	-63.98	-3.77	-64.05	-0.46
China	-1.60	-72.16	-0.81	-71.71	0.79
Denmark	-2.51	-70.01	-3.13	-70.47	-0.62
France	-2.37	-67.28	-3.32	-66.65	-0.95
Germany	-4.09	-67.35	-4.68	-67.06	-0.59
Greece	-2.83	-51.94	-2.79	-52.20	0.05
India	-3.15	-60.92	-3.25	-61.10	-0.10
Indonesia	-1.48	-69.57	-1.66	-68.82	-0.17
Italy	-2.06	-54.96	-2.07	-54.99	-0.01
Japan	-1.11	-66.61	-1.18	-66.63	-0.07
S.Korea	-1.19	-65.85	-1.52	-65.51	-0.33
Mexico	-2.90	-70.78	-4.17	-70.75	-1.27
Netherlands	-1.05	-72.62	-2.61	-73.20	-1.56
New Zealand	-3.29	-75.09	-4.98	-74.38	-1.69
Norway	-0.63	-68.66	-0.95	-69.11	-0.32
Peru	-3.33	-61.21	-3.40	-61.36	-0.07
Romania	-2.40	-51.54	-2.38	-51.39	0.02
Russia	-2.72	-59.33	-2.99	-59.05	-0.27
Vietnam	-6.70	-66.54	-8.76	-66.41	-2.06
Spain	-1.92	-57.89	-1.89	-57.64	0.03
Sweden	-5.83	-78.14	-6.40	-78.45	-0.57
Egypt	-0.23	-61.54	-1.37	-57.70	-1.13
UK	-1.01	-66.80	-2.13	-65.82	-1.12
USA	0.01	-62.69	0.41	-64.40	0.40
ROW	-1.50	-56.52	0.39	-56.48	1.89

Notes: This table summarizes the results of the main counterfactual when all changes in imports in the fixed and variable-markup model are restricted to be equal, as described in the main text. Pro-competitive gains are computed as the difference in the welfare change between the fixed- and the variable-markup case. All values are reported as a percentage, i.e., a value of 1.2 refers to a change in the respective variable by 1.2 percent.

Figure E.9: Pro-competitive Effects, Demand Elasticities, and Import Shares (Changes in Trade Matched across Models



(a) Import Shares

(b) Demand Elasticities

Notes: This plot summarizes the results of the main counterfactual when all changes in imports in the fixed and variable-markup model are restricted to be equal, as described in the main text. The y-axis in Panels (a) and (b) reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups associated with a global trade war in which all tariffs are raised by 50 percentage points. The x-axis in Panel (a) reports each country's imports as a fraction of total spending. The x-axis in Panel (b) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

Table E.16: Global Tariff War (all countries increase tariffs by 50pp), Variable Markups, Multinationals

	Welfare	Wages	Profits			Prices
			Overall	Domestic	Export	
Australia	-1.58	-1.42	-4.22	0.25	-17.12	-2.22
Austria	-5.12	-2.47	-9.22	-1.58	-21.09	7.26
Bangladesh	-3.10	-0.72	-11.36	-2.32	-55.20	17.57
Belgium	-5.65	-4.92	-9.80	0.41	-15.53	2.49
Brazil	-3.12	-1.84	-11.04	-0.06	-37.40	5.78
China	-1.54	-0.84	-3.77	-0.37	-50.06	5.48
Denmark	-4.78	-2.52	-9.43	1.22	-19.23	6.02
France	-4.67	-2.20	-9.17	0.24	-16.26	3.39
Germany	-5.19	-4.84	-10.78	3.56	-16.32	0.42
Greece	-2.50	-1.72	-7.73	-0.94	-45.52	13.95
India	-3.01	-1.10	-6.11	-2.42	-46.45	11.06
Indonesia	-1.46	-3.91	-0.51	2.50	-44.68	-5.26
Italy	-2.53	-1.55	-6.20	-0.71	-30.85	9.78
Japan	-2.27	-0.82	-3.88	-0.47	-17.75	4.53
S.Korea	-1.97	-0.77	-6.25	0.77	-22.61	10.14
Mexico	-3.26	-1.15	-10.49	-1.10	-32.97	8.19
Netherlands	-1.32	-6.06	-0.90	6.55	-3.24	-6.82
New Zealand	-3.11	-2.48	-9.09	0.16	-33.10	0.04
Norway	-1.36	-1.78	-2.18	1.66	-9.22	-3.67
Peru	-2.20	-1.24	-20.32	2.55	-56.27	19.74
Romania	-1.75	-1.40	-7.67	-0.75	-50.09	13.27
Russia	-2.46	-0.97	-7.65	-1.57	-45.07	15.54
Vietnam	-5.21	-5.05	-16.97	-0.36	-56.59	7.53
Spain	-1.96	-1.86	-4.65	-0.80	-25.03	2.96
Sweden	-11.43	-1.80	-24.81	8.01	-28.3	18.61
Egypt	-0.10	-1.49	-0.49	1.12	-46.57	-2.25
UK	0.18	-2.71	-0.48	0.36	-1.61	-9.28
USA	0.68	-1.36	1.08	0.78	2.68	-12.86
ROW	-1.29	-5.34	-3.34	0.88	-54.27	-7.88

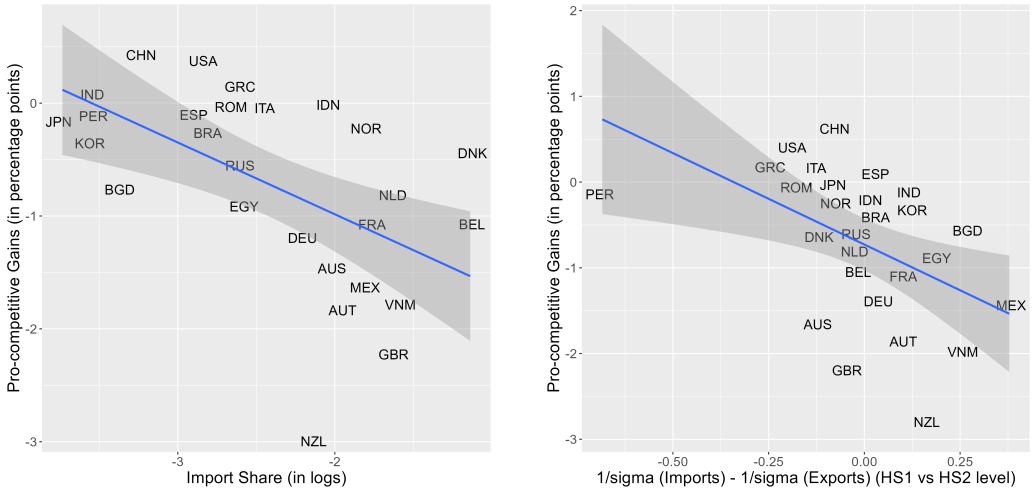
Notes: This table summarizes the outcomes of a global tariff war in which all countries increase tariffs by 50 percentage points in the presence of multinational firms. Each column reports the percentage change in the respective variable. Welfare, wages, and profits are reported in real terms. The percentage change in real domestic profits is the % change in real profits earned by firms from country n in the domestic market, i.e., $\left(\frac{(Y_{nn}/P_n)^{\text{counterfactual}}}{(Y_{nn}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$. Similarly, the percentage change in real export profits is the % change in real profits earned by firms from country n by exporting goods to other countries, i.e., $\left(\frac{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{counterfactual}}}{(\sum_{i \neq n} Y_{ni}/P_n)^{\text{2015 tariffs}}} - 1\right) \times 100$.

Table E.17: Regression Results: The Pro-competitive Gains from Trade (50% increase in iceberg costs)

	(1) Pro-Comp. Gains	(2) Pro-Comp. Gains	(3) Pro-Comp. Gains	(4) Pro-Comp. Gains
Inverse sigma for imports (HS1 versus HS2)	-2.753*** (-3.53)	-2.570*** (-3.44)	-2.813*** (-4.07)	-2.786*** (-4.24)
Import Share (logs)		-0.612*** (-4.23)	-0.566*** (-3.72)	-0.561*** (-3.58)
Inverse sigma for exports (HS1 versus HS2)			4.407** (2.30)	4.140** (2.10)
Export Share (logs)				0.0274 (0.26)
R^2	0.22	0.49	0.528	0.529

Notes: The dependent variable in each regression is the percentage change in welfare associated with a 50 percent increase in iceberg costs across all countries under variable compared to fixed markups, but with a negative sign, so that positive values can be interpreted as pro-competitive gains from trade. All inverse demand elasticities are weighted by trade volumes. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure E.10: Pro-competitive Effects, Demand Elasticities, and Import Shares (50% increase in iceberg costs)



(a) Import Shares (b) Demand Elasticities

Notes: The y-axis in Panels (a) and (b) reports the pro-competitive gains (in percentage points), as measured as the difference in the welfare change under fixed versus variable markups in a counterfactual exercise in which all iceberg trade costs are raised by 50 percent. The x-axis in Panel (a) reports each country's imports as a fraction of total spending. The x-axis in Panel (b) reflects the difference in the trade-weighted average inverse demand elasticity of imports versus that of exports at the HS1 compared to the HS2 level.

Table E.18: Standard Errors - Global Tariff War

	Welfare Change			
	Variable Markups	Fixed Markups	Pro-Competitive Gains	Standard Errors
	(1)	(2)	(3)	(4)
Australia	-1.27	-2.20	-0.93	0.56
Austria	-3.77	-5.17	-1.40	0.69
Bangladesh	-3.52	-4.01	-0.49	0.12
Belgium	-4.38	-5.13	-0.75	0.22
Brazil	-3.31	-3.51	-0.20	0.79
China	-1.60	-0.94	0.66	0.33
Denmark	-2.51	-2.86	-0.35	0.09
France	-2.37	-2.80	-0.43	0.11
Germany	-4.09	-4.24	-0.15	0.57
Greece	-2.83	-2.69	0.14	0.15
India	-3.15	-2.98	0.17	0.21
Indonesia	-1.48	-1.66	-0.18	0.20
Italy	-2.06	-1.99	0.07	0.31
Japan	-1.11	-1.13	-0.02	0.03
S.Korea	-1.19	-1.52	-0.33	0.16
Mexico	-2.90	-4.17	-1.27	0.27
Netherlands	-1.05	-2.36	-1.31	0.19
New Zealand	-3.29	-5.80	-2.51	0.75
Norway	-0.63	-0.85	-0.22	0.06
Peru	-3.33	-3.31	0.02	0.08
Romania	-2.40	-2.29	0.11	0.14
Russia	-2.72	-2.99	-0.27	0.16
Vietnam	-6.70	-8.07	-1.37	0.61
Spain	-1.92	-1.81	0.11	0.13
Sweden	-5.83	-6.40	-0.57	0.48
Egypt	-0.23	-1.17	-0.94	0.27
UK	-1.01	-2.35	-1.34	0.40
USA	0.01	0.43	0.42	0.25
ROW	-1.50	0.24	1.74	0.39

Notes: This table summarizes the outcomes of a global tariff war in which all countries increase tariffs by 50 percentage points. Columns (1) and (2) report the percentage change in welfare, i.e., a value of 1.2 refers to a change in welfare by 1.2 percent.