Multinational Production and Trade Policy*

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Abstract

Multinational enterprises dominate international trade, yet much of the literature on optimal trade policy has overlooked their significance. Using Census data, we show that in response to the 2018–2019 U.S. import tariffs on China, arms'-length trade declined more sharply than related-party trade, and import prices fell within ongoing arms'-length and related-party importer-exporter relationships. Theoretically, we show that multinational production shapes the aggregate trade elasticity via the substitution of labor within multinational enterprises across different countries of production. When markets are competitive, and abstracting from entry costs to become a multinational enterprise, we obtain a neutrality result for optimal tariffs: unilaterally optimal second-best tariffs are uniform across sectors and countries, despite variation in multinational activity. Finally, we explore how imperfect competition and transfer pricing affect the optimal tariff level.

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1 Introduction

Multinational enterprises (MNEs) carry out most international commerce and account for around a quarter of world GDP. In the U.S., they account for a quarter of private sector employment and around 70 percent of aggregate exports and imports (Antràs et al., 2023). In recent years, trade policy has risen again to the forefront of the economic policy debate. Despite the large importance of MNEs for international trade flows, nearly all existing studies of welfare maximizing trade policies have ignored them.[1]

In 2018-2019, the US and China entered into a trade conflict that resulted in both countries imposing significantly higher tariffs on each other's goods. The conflict escalated in waves of tariff increases, with several lists of goods imported from China receiving subsequently higher tariffs. Notably, the tariffs imposed by the U.S. administration initially affected more strongly products with a relatively high share of related-party imports—trade between parent companies and their foreign affiliates—compared to products that were targeted later in the trade war or those not subjected to tariffs at all.

In this paper, we explore how multinational production (MP) shapes the response of bilateral trade flows to tariffs and how this, in turn, influences the optimal tariff rate. In the first part of the paper, we use confidential micro data on U.S. imports from the Longitudinal Firm Trade Transactions Database (LFTTD) of the U.S. Census Bureau to run regressions of changes in U.S. import quantities, values, and prices on import tariff changes over 1 to 24 month periods. Our regression setup builds on the analysis by Fajgelbaum et al. (2020). Importantly, however, we run the regressions separately for "related party" (RP) transactions, i.e., within multinationals, and transactions that occur at arm's length (AL), using an indicator provided by the LFTTD. Moreover, since the LFTTD is at the transaction-level, providing identifiers for the U.S. importer, foreign exporter, the 10-digit Harmonized System (HS10) product, and the country of origin, we run the regressions not only at the aggregated country-product level as in Fajgelbaum et al. (2020) but also at the importer-country-product and importer-exporter-country-product levels, i.e., within importers and within importer-exporter relationships.

We find four main results. First, continuing RP relationships reduce trade by more than continuing AL relationships in response to the tariffs. Second, once we aggregate across relationships to the firm- or country-level, the ranking flips and AL trade declines by more than RP trade. These findings suggest that there is a strong extensive margin response of AL trade: firms terminate many AL relationships in response to the tariffs, leading to a stronger decline for AL trade than for RP trade at the more aggregated levels once we include these ending relationships. Third, import prices exclusive of tariffs decline both within relationships and at the firm-level, but remain nearly unchange at the more aggregated country-product level. This finding is new relative to the existing literature, such as Amiti et al. (2019), which has found, consistent with our results, virtually no price effects at the more aggregated country-product level. Our findings suggest a selection margin

[1]The handbook chapter on trade policy by Caliendo and Parro (2022) provides a recent summary of the literature.

by which firms that sourced from China at relatively low prices before the tariffs change stopped importing from China in response to the tariffs, which offsets the price decline for firms continuing to source from China. Finally, we find that the import price response is relatively similar, but slightly stronger for AL than for RP relationships. The reduction in AL prices could be due to foreign suppliers reducing their markups. Instead, the decline in RP prices could reflect transfer pricing. Our results indicate that focusing only on the aggregate country by product level gives an incomplete picture of multinationals' adjustment to the tariff change.

Our empirical findings motivate a general equilibrium model of trade and horizontal multinational production. In the model, firms are divided into two categories: multinational companies and local firms. Both types use labor to produce varieties for domestic and international markets, charging markups over marginal cost. While local firms produce exclusively at their headquarters, multinational firms can produce globally, but face bilateral frictions that reduce productivity at their foreign affiliates. The decision to become a multinational is endogenous, driven by fixed costs associated with establishing foreign production.

A novel feature of our framework is that, to match the data, we allow multinational firms to engage in transfer pricing: foreign affiliates adjust intra-firm prices in response to tariff changes to reduce the overall tariff burden. Specifically, affiliates set a lower price for shipments to a destination when the tariff rate is higher. This mechanism, which we model explicitly, has important implications for trade policy. It can offset the intended price effects of tariffs and weaken the effectiveness of trade policy tools, especially when multinationals account for a large share of trade flows.

Our model builds on Antràs et al. (2024) and features a double CES Armington structure. One elasticity governs substitution between goods from different origin countries; the other governs substitution between labor inputs across production locations within multinational firms.

This structure implies that multinational production shapes the responsiveness of trade flows to tariffs—that is, the trade elasticity. When all frictions to multinational production (MP) are eliminated, the elasticity is governed by the substitutability between production locations within a firm. When MP frictions are prohibitively high, all production remains domestic, and the trade elasticity is instead driven by substitution between goods from different countries. For intermediate levels of MP frictions, we characterize how the trade elasticity depends on the two Armington elasticities and observable measures of multinational activity. Since multinational activity responds to tariffs, the trade elasticity is not constant but adjusts according to the tariff rates. When fixed costs to becoming a global firm are eliminated and markups are removed, the general equilibrium model becomes isomorphic to a special case of Ramondo and Rodríguez-Clare (2013). However, in contrast to their framework, the trade elasticity in our model may either increase or decrease as MP frictions decline.

We use this framework to study optimal tariffs in an open economy consisting of a small Home country and multiple large foreign countries. To model the small open economy, we extend the methods developed by Caliendo and Feenstra (2024) and Demidova et al. (2024) to a setting with multinational production. The small-country assumption implies that Home's trade policy does not

affect foreign wages, which allows us to derive analytical solutions for optimal trade policy using the dual approach of Lucas and Stokey (1983) and Costinot et al. (2015).

We begin by deriving unilateral second-best optimal import tariffs in a special case of the model without markups and without fixed costs of becoming a multinational firm. In this setting, the Home government sets trade policy solely to manipulate the terms of trade (ToT) in its favor. For a small open economy, the optimal import tariff is inversely related to a weighted average of the trade elasticity of the Home country's exports and is uniform across countries and sectors. This result echoes the standard insight in the literature that the optimal tariff is the inverse of the trade elasticity.

However, in the presence of multinational enterprises (MNEs), the trade elasticity is no longer a primitive parameter but an equilibrium object. When the elasticity of substitution across goods is lower than the elasticity of substitution across production locations within firms, the implied trade elasticity is higher than in trade-only models—leading to lower optimal tariffs. The intuition is straightforward: manipulating the ToT raises the domestic wage. Because labor is more substitutable across locations than goods are across varieties, a higher wage incentivizes domestically owned firms to shift production abroad and serve all markets through their foreign affiliates.

Beyond terms-of-trade considerations, imperfect competition introduces a new rationale for trade policy: the shifting of profits across borders (see Ossa (2011)). Although the profit-shifting motive is present in trade-only models, the optimal tariff remains unaffected and continues to equal the inverse of the trade elasticity. With multinational production, however, this result no longer holds. Incorporating profits in a setting with MNEs introduces trade imbalances in equilibrium that reflect the country's net income—that is, the difference between profits earned by domestic firms operating abroad and profits earned by foreign firms operating at home.

These profit-shifting incentives interact with trade imbalances in shaping optimal policy. Although a full characterization of the optimal tariff is still work in progress, our quantitative results suggest that whether the country runs a trade surplus or a trade deficit plays a crucial role. When the country runs a trade deficit, optimal import tariffs are higher than under perfect competition but remain below the levels implied by trade-only models. In contrast, when the country runs a trade surplus, the optimal tariff is lower. Moreover, when MNEs engage in transfer pricing, optimal tariffs fall further, as transfer pricing alters the price effects of tariffs and reduces the tariff revenue.

These theoretical findings suggest that the U.S. policy of imposing higher tariffs on products with greater intra-firm trade shares may have been suboptimal. To explore this implication quantitatively, we extend our model to include multiple sectors and countries. While this quantitative analysis is still in progress, preliminary results indicate that—when we account for imperfect competition and assume global firms do not engage in transfer pricing—optimal import tariffs are substantially higher. This outcome is consistent with the U.S. running a trade deficit with the rest of the world, which amplifies the profit-shifting motive. The strength of this motive, however, depends critically on the extent to which multinational firms engage in transfer pricing.

Significant progress has been made in the analysis of optimal tariffs for both large and small

open economies since the work of Gros (1987). A consistent finding across various microfoundations is that even small countries can exploit their market power abroad to improve their terms of trade by imposing tariffs, with the effectiveness of this strategy closely tied to the trade elasticity (see Caliendo and Parro (2022) for a comprehensive summary). Costinot et al. (2020) show that larger and more productive firms respond more strongly to changes in trade policy, while Antràs and Helpman (2004) highlight how firms' decisions to vertically integrate or outsource abroad shape global trade flows. Perhaps surprisingly, however, the literature has given limited attention to multinational enterprises—the largest and most productive firms—which should play a central role in shaping trade policy outcomes. In a slightly different context, a notable exception is the work by Dyrda et al. (2024), which explores the optimal design of the international *corporate tax* system to address profit-shifting motives in an economy with multinational firms. While tariffs also generate profit-shifting, they are not considered in the authors' analysis.

It has been widely recognized that tariffs can lead to tariff jumping FDI (e.g., Goldberg (1995)) and that even the threat of tariffs can induce foreign investment (Blonigen and Feenstra (1996)). In a two-country model of multinational production with a proximity concentration trade-off, Helpman et al. (2004) and Cole and Davies (2011) show that Nash equilibrium tariffs are lower when accounting for FDI. Tintelnot (2017) and Flaaen and Pierce (2019) show that tariffs can lead to third-country effects when considering export-platform FDI. Ludema (2002) analyzes preferential trade agreements in the presence of multinational enterprises. Holmes et al. (2015) examine the interaction of technology transfer via multinational production and market access in China. We contribute to this literature by developing a tractable multi-sector and multi-country framework for trade and multinational production, characterizing how multinational production shapes the trade elasticity, and solving for the optimal (second-best) tariff policies.

The rest of the paper is structured as follows. Section 2 describes our empirical findings on the selection of tariffs and the responses of trade flows during the US-China trade war. Section 3 presents our model and Section 4 presents our main theoretical findings. Section 5 describes the calibration of the quantitative model and provides numerical results on optimal import tariffs. Section 6 concludes.

2 Motivating Empirical Facts

In this section, we present empirical facts regarding related party imports and tariffs during the recent U.S.-China trade war to motivate the setup of our model. We first describe the data and then present the empirical findings.

2.1 Data for Descriptive Analyses

We use four main datasets. First, we obtain confidential transaction-level U.S. import data from the Longitudinal Firm Trade Transactions Database (LFTTD) of the U.S. Census Bureau. These data capture the universe of U.S. import transactions in goods, and contain for each import transaction

an identifier for the U.S. importer, the 10-digit HS code traded, and the country of origin. The data also report an identifier of the foreign seller and an indicator of whether the transaction is between related parties.[2] We use the data for the period 2016-2020.

We perform several data cleaning steps. First, we drop import transactions not for consumption, i.e., warehouse entries. Second, we drop transactions that do not contain both an import value and a quantity. This step ensures that we compute prices (unit values) across a consistent set of observations for which we have both values and quantities.[3] Third, we construct the origin country based on the foreign manufacturer's ID, which reports the ultimate manufacturer of the good. The manufacturer country may differ from the origin country of the shipment in cases where the plant shipping the good is located in a different country.[4] In robustness below we show that our results are similar when we use the reported origin country. We construct pre-tariff prices as the ratio of the value and the quantity shipped.

We merge the import transactions data with monthly data on base tariff rates at the HS10-country level from the U.S. International Trade Commission. In 2019 and 2020, to ensure that we properly capture the additional trade war tariffs, we compare the base tariff rates against USTR documents and update the ad valorem tariffs when necessary to reflect trade war changes.[5] For each country-product-month triplet, the data contain information on the base tariff rate, additional ad valorem or specific tariffs, and the effective tariff rate.

We supplement our confidential trade data with the publicly available version of the data, which is available monthly at the 10-digit HS code by country level, to compute some summary statistics below for the period 2016-2020.[6] The data contain information on the 6-digit NAICS industry of the import, which we use to combine it with information on the share of related party imports in total imports from China for each 6-digit NAICS industry in 2017, available from the Census Bureau.[7] Since the related party share is reported as an industry-level statistic, in the public data all HS10 products that belong to the same industry will have the same related party share.[8] The publicly available data covers 20,077 HS10 products from 233 countries over the period 2016-2020.

Figure 1 provides a histogram of the distribution of the related party share from China across HS10 products in 2017, based on the public trade data. For most products, the share of related

[2]The foreign seller is identified by a Manufacturer ID (MID), which is an alphanumeric code that combines information on the seller's country, name, street address, and city. Based on Section 402(e) of the Tariff Act of 1930, related party trade includes import transactions between parties with various types of relationships including "any person directly or indirectly, owning, controlling, or holding power to vote, 6 percent of the outstanding voting stock or shares of any organization".

[3]This cleaning step is not possible with the publicly available version of the data. Heise (2024) shows that about 17 percent of transactions do not report a quantity in 1992-2017, accounting for around 17 percent of imports.

[4]For example, a shipment by a plant located in Saudi Arabia but shipping from Iraq would record the country of origin as Iraq but the country of the manufacturer as Saudi Arabia.

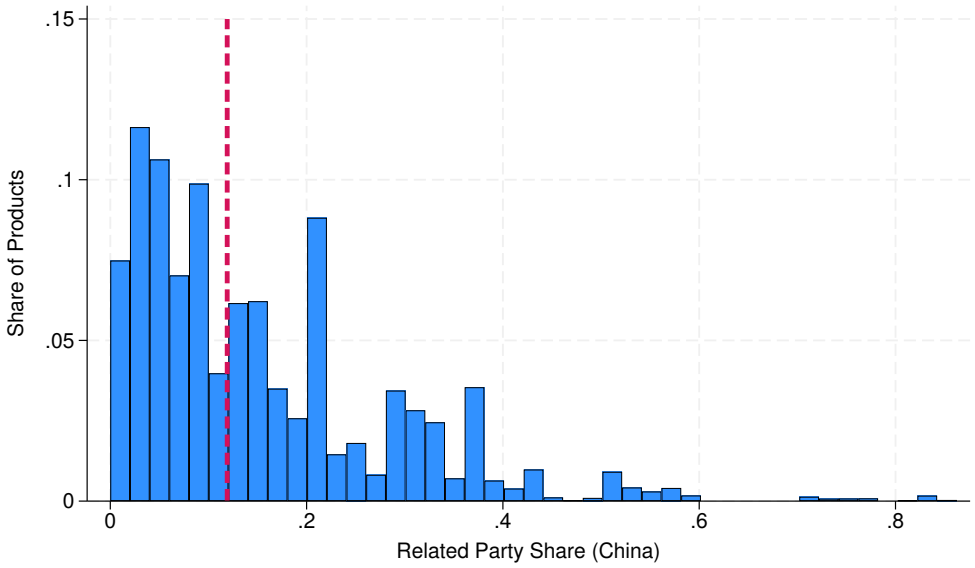
[5]See https://dataweb.usitc.gov/tariff/annual and https://ustr.gov/issue-areas/enforcement/section-301-investigations/tariff-actions.

[6]https://id-provider.tco.census.gov/nidp/saml2/sso?id=kerberos/ftdsecure&sid=1&option=credential&sid=1. Raw data can be downloaded from this link with a free account.

[7]https://www.census.gov/foreign-trade/Press-Release/related_party/index.html.

[8]This restriction does not apply to the confidential LFTTD data above, where we have an indicator of related party status for each transaction.

Figure 1: Related Party Share from China



party imports from China is relatively low. The mean is 0.15 and the median is 0.12 (indicated by the red vertical line). However, there is considerable heterogeneity, and for some products the related party share is as high as 0.8.

2.2 Policy During the Recent U.S.-China Trade War

We now describe the tariff changes during the U.S.-China trade war in 2018-19 and how these changes correlated with related party trade. During the trade war, there were several rounds of Section 301 tariffs placed on a wide variety of products from China. These rounds were announced and implemented throughout 2018 and 2019 in the form of four *lists*. List 1, which was implemented on July 6, 2018, set a tariff of 25% on 1,678 10-digit HS products with a total trade volume of $34 billion.[9] List 2 was implemented on August 23 and set a tariff of 25% on 444 additional products worth $16 billion. These goods included, for example, semiconductors, chemicals, and plastics. List 3, implemented on September 24, set tariffs at an initial rate of 10% for a further 9,064 products with a value of $200 billion. While these tariffs were set to increase to 25% on January 1, 2019, this planned increase was subsequently delayed and only came into effect on May 10, 2019. Finally, list 4 was implemented on September 1, 2019, and set tariffs of 15% for 5,993 products worth $125 billion. These goods included for example footwear, diapers, and food products. Additional tariffs were planned as part of list 4 for December 15, but these tariffs were not implemented. The list 4 tariffs were reduced to 7.5% on February 14, 2020. The remaining 2,898 products in our data were not subject to new tariffs for China.

The tariffs set by the Trump administration initially targeted products with relatively high

[9]While the tariffs were imposed at the 8-digit HS level, we report here the number of 10-digit codes hit by the tariff to be consistent with the level of the observations of our dataset.

Table 1: Related party (RP) Share of Imports from China

	All		Intermediates		Final goods	
	Avg. share	Median share	Avg. share	Median share	Avg. share	Median share
Round 1	0.313	0.301	0.335	0.327	0.303	0.284
Round 2	0.272	0.296	0.244	0.204	0.306	0.333
Round 3	0.145	0.117	0.143	0.101	0.143	0.117
Round 4	0.111	0.066	0.135	0.146	0.095	0.048
Non-targeted	0.161	0.130	0.185	0.183	0.114	0.071

Notes: Goods are classified as intermediate or final according to the Broad Economic Categories rev. 5 (BEC5) code corresponding to their HS code. BEC5 codes with a third digit of 1 are classified as intermediate goods and BEC5 codes with a third digit of 2 or 3 (capital goods or goods for consumption) are classified as final consumption goods. Dual use goods are not included in these calculations.

multinational activity. Column 1 of Table 1 shows the simple average of the related party share of trade from China for the products for each of the four tariff lists, and column 2 shows the median. We find that the related party share was highest for the products that were hit with tariffs earlier, on lists 1 and 2. The related party share was significantly lower for lists 3 and 4, and in fact below the share for those products that were not hit with tariffs.

Columns 3-6 present similar statistics by end use category. Goods are classified as intermediate or final according to the Broad Economic Categories rev. 5 (BEC5) code corresponding to their HS code. BEC5 codes with a third digit of 1 are classified as intermediate goods and BEC5 codes with a third digit of 2 or 3 (capital goods or goods for consumption) are classified as final goods. While the Trump administration targeted predominantly intermediate goods on the earlier lists, the related party share pattern holds within both intermediates and final goods.[10]

2.3 Tariff Regressions

We now turn to the micro data from the LFTTD and analyze how heterogeneity by related party status influences the effect of tariffs on U.S. imports, using similar regressions as Fajgelbaum et al. (2020). We implement reduced-form regressions and analyze the effect of monthly tariff changes on import quantities, values, and prices (exclusive of tariffs). We perform these regressions initially at the country by product by month level before running regressions with more disaggregated data including the importer or the importer-exporter dimension. Our analysis reveals that looking only at the aggregate data gives an incomplete picture of firms' adjustment to the tariffs. While in the country-product level regressions we find that AL imports declined more strongly than RP imports in response of the tariffs, this pattern is reversed for continuing importer-exporter AL vs. RP relationships, suggesting an important role for relationship exit. Moreover, continuing relationships experienced declines in import prices as a result of the tariffs, yet prices were relatively unchanged at the aggregate country-product level.

[10] Appendix A.1 contains an alternative version of the table where capital goods are classified as intermediates. The same patterns hold.

Country-Product Level Regressions

Let i index a source country, g an HS10 product, t a month between 2016:m1 and 2020:m12, $s(g)$ the 4-digit NAICS industry associated with good g. We aggregate the transaction-level data to the igt level and run specifications of the form

$$\Delta \ln y_{igt} = \eta_{gt} + \eta_{it} + \eta_{is(g)} + \sigma \Delta \ln(1 + \tau_{igt}) + \varepsilon_{igt}, \tag{1}$$

where y_{igt} is either the quantity or value imported or the unit value for imports from country i of good g in month t, η_{gt}, η_{it}, and $\eta_{is(g)}$ are product-time, country-time, and country-sector fixed effects, respectively, and τ_{igt} is the statutory tariff rate for the product and country. Standard errors are clustered at the 8-digit HS code level. This regression corresponds to the reduced-form regression run by Fajgelbaum et al. (2020). As in Amiti et al. (2019), our regression only includes observations that are associated with price changes smaller than 3 log points in absolute value.

Panel a of Table 2 presents the results. The first column shows that over a one-month period, a 10 percent increase in tariffs is associated with a 6.1 percent decline in quantity imported of the affected product from the targeted country, a 7.0 percent decline in the value imported, and a significant 0.8 percent decline in the pre-tariff price. The magnitude of the quantity and value effects then declines in absolute value over the first three months, before strengthening again. After 12 months, a 10 percent tariff increase is associated with a 17.6 percent, 18.3 percent, and 5.8 percent decline in quantity, value, and price, respectively. The small price effect is consistent with previous research for example by Amiti et al. (2019), who show that foreign exporters did not reduce their price in response to the tariff. While our price effect is small, however, it is significant, in contrast to earlier work, since we use the country of the ultimate manufacturer, rather than the country of origin of the shipment, as described above. In Appendix A.3, we repeat the analysis instead using the country of origin and find and insignificant price effect after 12 months, as in earlier work.

We next run the regression separately for AL and RP trade. Specifically, we aggregate the transaction-level data to the country by product by month by related party status level, and re-run regression (1) separately for AL and RP trade. We present the results in panel b of Table 2. Looking first at quantity imported, we see that the elasicity of the response is relatively similar across AL and RP for a one-month horizon. However, as the time horizon lengthens, the quantity response of AL trade rises more strongly than that of RP trade. Over a 12-month horizon, a 10 percent increase in tariffs reduces the quantity imported under AL trade by 18.7 percent, compared to 12.2 percent for RP trade. The pattern is similar for the value imported. Thus, it appears that firms find it easier to shift sourcing across different AL suppliers than to move production between different countries across affiliates of the firm, for example because of specialization or sunk costs within RP relationships.

Turning to the tariff-exclusive price, we find that the response to the tariff is negative and significant for AL trade over nearly all horizons. However, consistent with the earlier findings, the elasticity is quite small, around -0.1. In contrast, there is almost no change in the prices under RP

Table 2: Country-Product Level Tariff Regressions

	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo	24 mo
Panel a: All transactions													
Quantity	-0.6132***	-0.5384***	-0.2323***	-0.4200***	-0.5706***	-0.9658***	-1.316***	-1.524***	-1.689***	-1.783***	-1.765***	-1.768***	-2.032***
	(0.0793)	(0.0668)	(0.0657)	(0.0619)	(0.0593)	(0.0608)	(0.0615)	(0.0615)	(0.0599)	(0.0613)	(0.0628)	(0.0641)	(0.0752)
Value	-0.7016***	-0.6738***	-0.4192***	-0.5821***	-0.7366***	-1.090***	-1.421***	-1.590***	-1.770***	-1.853***	-1.830***	-1.826***	-2.194***
	(0.0704)	(0.0607)	(0.0575)	(0.0551)	(0.0535)	(0.0549)	(0.0569)	(0.0570)	(0.0556)	(0.0572)	(0.0578)	(0.0596)	(0.0702)
Price	-0.0884**	-0.1354***	-0.1870***	-0.1621***	-0.1661***	-0.1245***	-0.1045***	-0.06587**	-0.08122***	-0.07009**	-0.06518**	-0.05819**	-0.1624***
	(0.0438)	(0.0326)	(0.0314)	(0.0301)	(0.0287)	(0.0290)	(0.0295)	(0.0296)	(0.0291)	(0.0292)	(0.0291)	(0.0289)	(0.0325)
Observations	5,440,000	5,273,000	5,109,000	4,958,000	4,821,000	4,693,000	4,566,000	4,451,000	4,345,000	4,237,000	4,136,000	4,038,000	2,809,000
Panel b: By transaction type													
Quantity													
- AL	-0.5191***	-0.4425***	-0.1789**	-0.4116***	-0.5396***	-0.9834***	-1.339***	-1.548***	-1.745***	-1.843***	-1.829***	-1.865***	-2.151***
	(0.0942)	(0.0770)	(0.0735)	(0.0684)	(0.0657)	(0.0655)	(0.0660)	(0.0672)	(0.0653)	(0.0647)	(0.0648)	(0.0658)	(0.0793)
- RP	-0.5646***	-0.5411***	-0.3314***	-0.3444***	-0.3787***	-0.7507***	-0.9069***	-0.9971***	-1.148***	-1.286***	-1.266***	-1.218***	-1.574***
	(0.1447)	(0.1190)	(0.1135)	(0.1086)	(0.1058)	(0.1084)	(0.1097)	(0.1138)	(0.1143)	(0.1163)	(0.1170)	(0.1185)	(0.1452)
Value													
- AL	-0.6551***	-0.6251***	-0.3593***	-0.5689***	-0.7234***	-1.117***	-1.470***	-1.636***	-1.840***	-1.940***	-1.911***	-1.935***	-2.307***
	(0.0821)	(0.0692)	(0.0639)	(0.0606)	(0.0592)	(0.0588)	(0.0593)	(0.0607)	(0.0595)	(0.0594)	(0.0593)	(0.0606)	(0.0733)
- RP	-0.4900***	-0.5462***	-0.4241***	-0.3695***	-0.4638***	-0.7923***	-0.9699***	-1.058***	-1.214***	-1.333***	-1.302***	-1.258***	-1.738***
	(0.1267)	(0.1050)	(0.0983)	(0.0961)	(0.0911)	(0.0933)	(0.0956)	(0.0991)	(0.0979)	(0.1006)	(0.1004)	(0.1031)	(0.1267)
Price													
- AL	-0.1360***	-0.1826***	-0.1805***	-0.1573***	-0.1838***	-0.1339***	-0.1313***	-0.08863***	-0.0954***	-0.0971***	-0.0819***	-0.0705**	-0.1566***
	(0.0487)	(0.0370)	(0.0354)	(0.0332)	(0.0316)	(0.0317)	(0.0329)	(0.0334)	(0.0320)	(0.0318)	(0.0314)	(0.0311)	(0.0352)
- RP	0.07459	-0.005175	-0.09278*	-0.02508	-0.08507	-0.04164	-0.06297	-0.0605	-0.0659	-0.0465	-0.0362	-0.0403	-0.1636**
	(0.0768)	(0.0567)	(0.0546)	(0.0532)	(0.0518)	(0.0522)	(0.0514)	(0.0537)	(0.0521)	(0.0521)	(0.0537)	(0.0534)	(0.0638)
Observations - AL	4,371,000	4,231,000	4,092,000	3,967,000	3,854,000	3,749,000	3,644,000	3,550,000	3,464,000	3,377,000	3,298,000	3,221,000	2,228,000
Observations - RP	2,396,000	2,303,000	2,221,000	2,146,000	2,078,000	2,017,000	1,957,000	1,903,000	1,852,000	1,800,000	1,751,000	1,704,000	1,157,000

Source: Census Bureau and authors' calculations. Table reports the results of regressing the change in the quantity, value, or price (y_{igt}) on the change in the tariff (τ_{igt}). The regressions include product-time, country-time, and country-sector fixed effects. Standard errors, adjusted for clustering by HS8 product code are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

trade.

In Appendix A.2, we run similar regressions in publicly available data. As described, in the public trade data we only have the RP shares at the 6-digit NAICS industry level, which we merge with the trade data. We find that products in high-RP share industries experience a *greater* decrease in imports in response to tariffs than low-RP share products, in constrast to this section's finding that AL trade declines more in response to tariffs than RP trade. These findings show that other factors than multinational activity must generate the greater decline of imports in high-RP share industries compared to low-RP share industries in response to tariffs. Therefore, the publicly available data cannot be used to draw conclusions about the relative responsiveness of AL and RP trade to tariffs.

Firm-Country-Product Level Regressions

While the country-product level regressions shed light on the aggregate effects of the tariffs, our data permit us to analyze the response of importers at more disaggregated levels. We next examine the tariff effects within continuing U.S. importers. Let f index the U.S. importer. We aggregate the raw transaction-level data to the $figt$ level and run specifications of the form

$$\Delta \ln y_{figt} = \eta_{fig} + \eta_{gt} + \eta_{it} + \eta_{is(g)} + \sigma \Delta \ln(1 + \tau_{igt}) + \varepsilon_{figt}, \tag{2}$$

where η_{fig} is an importer by country by product fixed effect. The presence of this fixed effect implies that the regression is restricted to U.S. importers that import a specific product from a given country both before and after the tariff change. As before, we drop observations with price changes greater than 3 log points in absolute value, and cluster standard errors at the product-level.

Results in Table 3, show relatively similar patterns for quantities and import values as the more aggregated results, though the elasticities are smaller. From the results in panel a, over a one-month horizon a 10 percent increase in tariffs reduces a firm's quantity imported of a specific product from a given country by 2.4 percent and its import value by 3.3 percent. This response grows over longer time horizons to an 8.8 percent decline in quantity and a 11.3 percent fall in import value over 24 months. Over longer time horizons beyond six months we find, as before, that quantities and values imported under AL appear to be more responsive to the change in tariffs than RP trade (panel b). The exception to this is the very long horizon of 24 months, where the responses are similar. Interestingly, the quantity response for AL actually becomes *positive* at around three months before turning negative again. This pattern might reflect firms initially drawing down their inventories, for example because they are uncertain about whether the tariffs are persistent, but eventually being forced to re-order at the higher tariff rates. Over even longer horizons, firms might eventually be able to switch to other suppliers, leading to a decline in imports.

The change in prices at the firm-level is larger than what we found for the more aggregated regressions. Overall, in response to a 10 percent tariff increase import prices exclusive of tariffs fall

Table 3: Firm-Country-Product Level Tariff Regressions

	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo	24 mo
Panel a: All transactions													
Quantity	-0.2427***	-0.1039**	0.08753*	-0.009222	-0.1285***	-0.4228***	-0.5855***	-0.7020***	-0.7976***	-0.8673***	-0.8832***	-0.8713***	-0.8759***
	(0.0502)	(0.0468)	(0.0464)	(0.0485)	(0.0414)	(0.0419)	(0.0420)	(0.0431)	(0.0411)	(0.0403)	(0.0387)	(0.0408)	(0.0537)
Value	-0.3299***	-0.2421***	-0.07787	-0.1835***	-0.3081***	-0.5779***	-0.7529***	-0.8797***	-0.9886***	-1.065***	-1.084***	-1.076***	-1.131***
	(0.0501)	(0.0484)	(0.0489)	(0.0530)	(0.0485)	(0.0508)	(0.0512)	(0.0533)	(0.0513)	(0.0492)	(0.0472)	(0.0504)	(0.0664)
Price	-0.08717***	-0.1382***	-0.1654***	-0.1743***	-0.1796***	-0.1551***	-0.1674***	-0.1776***	-0.1910***	-0.1975***	-0.2008***	-0.2049***	-0.2555***
	(0.0182)	(0.0149)	(0.0148)	(0.0169)	(0.0182)	(0.0199)	(0.0220)	(0.0241)	(0.0215)	(0.0203)	(0.0182)	(0.0185)	(0.0257)
Observations	19,520,000	18,460,000	17,470,000	16,600,000	15,860,000	15,230,000	14,560,000	14,000,000	13,530,000	13,070,000	12,700,000	12,430,000	7,457,000
Panel b: By transaction type													
Quantity													
- AL	-0.1994***	-0.0321	0.1646***	0.0326	-0.0810*	-0.3627***	-0.5513***	-0.6880***	-0.7752***	-0.8553***	-0.9122***	-0.9114***	-0.9286***
	(0.0534)	(0.0518)	(0.0536)	(0.0562)	(0.0487)	(0.0504)	(0.0492)	(0.0503)	(0.0474)	(0.0446)	(0.0427)	(0.0462)	(0.0611)
- RP	-0.3938***	-0.3448***	-0.2061***	-0.0680	-0.1906***	-0.4618***	-0.4560***	-0.5613***	-0.7552***	-0.7144***	-0.6731***	-0.6162***	-0.9300***
	(0.0942)	(0.0823)	(0.0761)	(0.0800)	(0.0700)	(0.0707)	(0.0737)	(0.0766)	(0.0763)	(0.0811)	(0.0817)	(0.0812)	(0.1107)
Value													
- AL	-0.2971***	-0.1764***	-0.0073	-0.1484**	-0.2660***	-0.5297***	-0.7324***	-0.8797***	-0.9755***	-1.066***	-1.121***	-1.119***	-1.189***
	(0.0536)	(0.0545)	(0.0576)	(0.0628)	(0.0582)	(0.0614)	(0.0615)	(0.0630)	(0.0596)	(0.0558)	(0.0528)	(0.0577)	(0.0770)
- RP	-0.3826***	-0.4408***	-0.3185***	-0.1849**	-0.3156***	-0.5396***	-0.5478***	-0.6632***	-0.8823***	-0.8672***	-0.8449***	-0.7677***	-1.114***
	(0.0898)	(0.0750)	(0.0698)	(0.0749)	(0.0670)	(0.0692)	(0.0718)	(0.0756)	(0.0793)	(0.0841)	(0.0845)	(0.0845)	(0.1154)
Price													
- AL	-0.0977***	-0.1442***	-0.1719***	-0.1810***	-0.1851***	-0.1671***	-0.1812***	-0.1917***	-0.2003***	-0.2103***	-0.2087***	-0.2080***	-0.2605***
	(0.0211)	(0.0165)	(0.0167)	(0.0196)	(0.0204)	(0.0221)	(0.0250)	(0.0261)	(0.0246)	(0.0229)	(0.0205)	(0.0210)	(0.0293)
- RP	0.0112	-0.0960**	-0.1124***	-0.1169***	-0.1249***	-0.0778**	-0.0918***	-0.1019***	-0.1271***	-0.1529***	-0.1718***	-0.1515***	-0.1838***
	(0.0426)	(0.0375)	(0.0328)	(0.0324)	(0.0295)	(0.0325)	(0.0348)	(0.0367)	(0.0333)	(0.0347)	(0.0334)	(0.0335)	(0.0479)
Observations - AL	14,930,000	14,090,000	13,300,000	12,610,000	12,030,000	11,540,000	11,010,000	10,570,000	10,210,000	9,871,000	9,610,000	9,429,000	5,550,000
Observations - RP	4,604,000	4,350,000	4,126,000	3,929,000	3,756,000	3,603,000	3,449,000	3,310,000	3,182,000	3,053,000	2,928,000	2,838,000	1,707,000

Source: Census Bureau and authors' calculations. Table reports the results of regressing the change in the quantity, value, or price (y_{igt}) on the change in the tariff (τ_{igt}). The regressions include firm-product-country, product-time, country-time, and country-sector fixed effects. Standard errors, adjusted for clustering by HS8 product code are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

by about 2.5 percent over 24 months. Prices of AL imports fall by slightly more, consistent with foreign suppliers reducing their markups. But prices also decline significantly for RP trade, falling by about 2 percent in response to a 10 percent tariff increase over 24 months. This price decline is consistent with transfer pricing, as firms shift some of their profits to the U.S. by reducing the import price. Thus, once we go to the more disaggregated firm-level, we do find evidence of import price adjustments, consistent with standard trade models.

Relationship-Country-Product Level Regressions

We finally examine the tariff response within continuing importer-exporter relationships. Let x index the foreign exporter. We now aggregate the raw transaction-level data to the $fxigt$ level and run specifications of the form

$$\Delta \ln y_{fxigt} = \eta_{fxig} + \eta_{gt} + \eta_{it} + \eta_{is(g)} + \sigma \Delta \ln(1 + \tau_{igt}) + \varepsilon_{fxigt}, \tag{3}$$

where η_{fxig} is an importer by exporter by country by product fixed effect. This fixed effect implies that the regression is restricted to U.S. importer - foreign exporter relationships that trade a specific product both before and after the tariff change. As before, we drop observations with price changes greater than 3 log points in absolute value, and cluster standard errors at the product-level.

Results in Table 4 are broadly consistent with the firm-level regressions, but the elasticities are now even smaller than before. From panel a, over a one-month horizon a 10 percent increase in tariffs reduces the quantity traded and the value imported in a relationship by 1.5 percent and 2.3 percent, respectively, with the response growing to 6.8 percent and 9.0 percent, respectively, over 24 months. The price response is relatively similar in magnitude to the firm-level regressions, indicating a reduction in the price excluding tariffs of 2.2 percent in response to a 10 percent tariff over 24 months.

The comparison of AL and RP relationships in panel b indicates that at the relationship-level, the quantity and value imported respond more strongly to tariffs for RP relationships compared to AL relationships, flipping the previous ordering. Over a 24 month horizon, a 10 percent increaes in tariffs is associated with a decline in quantity imported of 6.0 percent for AL relationships. For RP relationships, the decline in quantity is 11.4 percent, nearly twice as large. In contrast, the price response is relatively similar at the relationship-level compared to the firm-level, although slightly smaller. Similar to before, AL relationships see a greater decline in import prices than AL relationships.

Summary

Overall, we draw several conclusions from our results. First, continuing RP relationships reduce trade by more than continuing AL relationships in response to the tariffs. Second, however, once we aggregate across relationships to the firm- or country-level, the ranking flips and AL trade adjusts more to the tariffs. These findings suggest that there is a strong extensive margin response of AL

Table 4: Relationship-Country-Product Level Tariff Regressions

	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo	24 mo
Panel a: All transactions													
Quantity	-0.1486***	-0.07937**	0.09448**	0.03710	-0.09609***	-0.3355***	-0.4571***	-0.5344***	-0.6313***	-0.6609***	-0.6371***	-0.6204***	-0.6778***
	(0.0442)	(0.0390)	(0.0384)	(0.0378)	(0.0323)	(0.0313)	(0.0322)	(0.0347)	(0.0335)	(0.0341)	(0.0346)	(0.0369)	(0.0534)
Value	-0.2260***	-0.1846***	-0.03827	-0.1027**	-0.2462***	-0.4630***	-0.5921***	-0.6871***	-0.7851***	-0.8383***	-0.8243***	-0.7964***	-0.9011***
	(0.0425)	(0.0406)	(0.0395)	(0.0414)	(0.0372)	(0.0364)	(0.0353)	(0.0370)	(0.0362)	(0.0361)	(0.0362)	(0.0402)	(0.0572)
Price	-0.07740***	-0.1053***	-0.1328***	-0.1398***	-0.1501***	-0.1274***	-0.1350***	-0.1527***	-0.1537***	-0.1774***	-0.1872***	-0.1760***	-0.2234***
	(0.0145)	(0.0122)	(0.0118)	(0.0139)	(0.0153)	(0.0181)	(0.0229)	(0.0246)	(0.0211)	(0.0196)	(0.0176)	(0.0172)	(0.0236)
Observations	22,480,000	20,630,000	19,080,000	17,760,000	16,680,000	15,780,000	14,860,000	14,090,000	13,440,000	12,820,000	12,310,000	11,940,000	6,195,000
Panel b: By transaction type													
Quantity													
- AL	-0.1268***	-0.0220	0.1571***	0.0760*	-0.0362	-0.2636***	-0.3986***	-0.4857***	-0.5765***	-0.6157***	-0.6134***	-0.6088***	-0.6022***
	(0.0459)	(0.0440)	(0.0437)	(0.0423)	(0.0381)	(0.0367)	(0.0367)	(0.0398)	(0.0381)	(0.0378)	(0.0389)	(0.0422)	(0.0624)
- RP	-0.2321**	-0.2933***	-0.1662**	-0.1397*	-0.3399***	-0.5487***	-0.5980***	-0.6870***	-0.8697***	-0.8814***	-0.7883***	-0.7392***	-1.136***
	(0.0959)	(0.0822)	(0.0753)	(0.0789)	(0.0741)	(0.0741)	(0.0753)	(0.0803)	(0.0812)	(0.0854)	(0.0874)	(0.0880)	(0.1186)
Value													
- AL	-0.2162***	-0.1318***	0.0281	-0.0687	-0.1918***	-0.4041***	-0.5473***	-0.6517***	-0.7399***	-0.8070***	-0.8072***	-0.7952***	-0.8297***
	(0.0448)	(0.0461)	(0.0456)	(0.0480)	(0.0444)	(0.0423)	(0.0409)	(0.0427)	(0.0407)	(0.0394)	(0.0394)	(0.0447)	(0.0664)
- RP	-0.2615***	-0.3889***	-0.2975***	-0.2425***	-0.4430***	-0.6022***	-0.6701***	-0.7637***	-0.9638***	-0.9761***	-0.9134***	-0.8210***	-1.316***
	(0.0960)	(0.0767)	(0.0717)	(0.0755)	(0.0715)	(0.0758)	(0.0766)	(0.0827)	(0.0854)	(0.0901)	(0.0931)	(0.0950)	(0.1276)
Price													
- AL	-0.0893***	-0.1098***	-0.1289***	-0.1446***	-0.1556***	-0.1404***	-0.1488***	-0.1660***	-0.1634***	-0.1912***	-0.1938***	-0.1864***	-0.2274***
	(0.0160)	(0.0132)	(0.0131)	(0.0157)	(0.0175)	(0.0201)	(0.0267)	(0.0273)	(0.0239)	(0.0221)	(0.0195)	(0.0182)	(0.0263)
- RP	-0.0294	-0.0957***	-0.1314***	-0.1028***	-0.1031***	-0.0535	-0.0721**	-0.0767**	-0.0941***	-0.0947***	-0.1251***	-0.0818**	-0.1793***
	(0.0409)	(0.0348)	(0.0310)	(0.0320)	(0.0314)	(0.0349)	(0.0336)	(0.0372)	(0.0349)	(0.0351)	(0.0348)	(0.0367)	(0.0495)
Observations - AL	17,180,000	15,710,000	14,480,000	13,430,000	12,570,000	11,870,000	11,140,000	10,550,000	10,060,000	9,595,000	9,237,000	8,975,000	4,505,000
Observations - RP	5,133,000	4,748,000	4,437,000	4,174,000	3,944,000	3,744,000	3,549,000	3,375,000	3,214,000	3,055,000	2,903,000	2,794,000	1,530,000

Source: Census Bureau and authors' calculations. Table reports the results of regressing the change in the quantity, value, or price (y_{igt}) on the change in the tariff (τ_{igt}). The regressions include importer-exporter-product-country, product-time, country-time, and country-sector fixed effects. Standard errors, adjusted for clustering by HS8 product code are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

trade: firms terminate many AL relationships in response to the tariffs, leading to a stronger decline for AL trade than for RP trade at the more aggregated levels which include these ending relationships. Intuitively, it could be relatively difficult for multinationals to fully close down affiliates, while it might be easier to stop trading with a given foreign supplier.

Our third finding is that import prices exclusive of tariffs decline both within relationships and at the firm-level. This finding is new relative to the existing literature, which has found, consistent with our results, virtually no price effects at the more aggregated country-product level. This finding could arise if firms which sourced from China at relatively low prices before the tariffs stopped importing from China in response to the tariffs. This force could offset the decline in prices within continuing importers, leading to relatively unchanged prices at the country-product level. It is possible that firms which sourced at low prices from China prior to the tariffs are relatively more sensitive to price in deciding where to source.

Finally, we find that the import price response is relatively similar, but slightly stronger for AL than for RP relationships. The reduction in AL prices could be due to foreign suppliers reducing their markups. Instead, the decline in RP prices could reflect transfer pricing. Our model below will allow for transfer pricing to capture this channel.

3 Theoretical Framework

In our model there are N countries and K sectors. We use the letters i, l, and m to denote countries and the letters k or s to denote sectors. Goods are identified by the variety type $\omega \in \Omega_m^k$, the origin of the good $i \in \mathcal{N}$, the location of production $l \in \mathcal{N}$, and the sector $k \in \mathcal{K}$. So $q_{i,lm}^k(\omega)$ denotes the quantity of sector k variety ω produced in country l and shipped to country m by a firm headquartered in i.[11]

Within each country, there are two types of firms: local and global firms. Local firms produce domestically and serve every country through exporting. Global firms produce domestically and abroad and use all locations of production to serve other countries. While the total measure of firms of a given origin is exogenous, the decision to become a global firm, and therefore the number of global firms, is endogenous.

On the demand side, each country m is characterized by a representative household which receives labor income, tariff revenues and profits of local and global firms headquartered in m, and uses its income to consume goods produced by global and local firms from all countries.

3.1 Preferences and Endowments

The representative household in country m has preferences given by:

$$U_m = \prod_{k=1}^{K} (Q_m^k)^{c_m^k},$$

[11] The expressions *headquarters*, *origin-countries* and *origin-ideas* are used interchangeably.

where Q_m^k represents the total quantity of the composite good from sector k consumed in country m, and $e_m^k \in (0,1)$ is country m's expenditure share on sector k. This composite good is a CES aggregate

$$Q_m^k = \left[\sum_{i=1}^{N} \int_{\omega \in \Omega_i^k} Q_{i,m}^k(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

with $Q_{i,m}^k(\omega)$ country m's consumption of variety ω originated in country i. The (exogenous) set of varieties from country i sector k is given by Ω_i^k, and $\sigma > 1$ is the elasticity of substitution between goods from different origin countries.[12]

This preference structure implies a demand system given by

$$P_{i,m}^k(\omega) Q_{i,m}^k(\omega) = \left(\frac{P_{i,m}^k(\omega)}{P_m^k}\right)^{1-\sigma} e_m^k E_m \tag{5}$$

where E_m denotes the income of the household, and P_m^k the price index of the composite final good given by

$$P_m^k = \left[\sum_{i=1}^{N} \int_{\omega \in \Omega_i^k} P_{i,m}^k(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}. \tag{6}$$

Households supply one unit of labor inelastically and labor is assumed to be freely mobile across sectors within a country, implying a single wage in country m, w_m.

3.2 Global and Local Firms

We consider two types of firms, local and multinational firms. For simplicity, we assume multinational firms operate globally, hence we refer to them as global firms. This abstracts from hetergeneity among multinational enterprises in their plant location decisions (e.g., Tintelnot (2017)), which are not the focus of our study. Our modeling decision is motivated by tractability and evidence from many countries that a few superstar firms carry out most of aggregate trade (Bernard et al. (2018)). Due to their size, these superstar firms are likely well approximated as global firms.

Local Firms A local firm produces a unique variety ω in the same country in which it is headquartered, and from there serves all markets through exporting. Output for destination market m increases linearly with labor input,

$$q_{i,im}^k(\omega) = \frac{A_i^k \times z(\omega)}{\tau_{im}^k} \ell_{i,im}^k(\omega), \tag{7}$$

where $\tau_{im}^k > 1$ is the iceberg cost to move sector k's goods from country i to m, and $A_i^k \times z(\omega)$ is firm's total productivity, which is the product of a country-sector specific component and a firm specific component. We impose the normalization that $\tau_{ii} = 1$.

[12]The parameter σ also controls the substitution of varieties within an origin, however, this will place little role in our analysis.

We do not assume a specific market structure, instead we assume that firms charge prices that are a constant markup μ^k over marginal costs[13]

$$p_{i,im}^k(\omega) = \mu^k \times \frac{\tau_{im}}{A_i^k \times z(\omega)} w_i \tag{8}$$

This allow us to nest both monopolistic and perfect competition models without modifying the structure of preferences.

Global Firms. Global firms differ from local firms along two dimensions: their ability to produce in multiple locations and serve foreign markets from these sites, and in their ability to price to market.

The output of a global firm destined for market m and produced at location l is proportional to labor input, with the production function given by:

$$q_{i,lm}^k(\omega) = \frac{A_i^k \times z(\omega)}{\tau_{lm}^k \times \gamma_{i,l}^k} \ell_{i,lm}^k(\omega), \tag{9}$$

where $\gamma_{i,l}^k \geq 1$ captures the efficiency loss from producing outside the firm's headquarters, with the normalization $\gamma_{i,i}^k = 1$. In addition to these variable production costs, global production incurs a fixed cost f_i^k, paid in units of headquarter labor, reflecting the overhead required to coordinate operations across borders. These fixed costs govern firms' selection into local or multinational status.

To supply consumers in destination market m, global firms aggregate output from all production sites. This aggregation proceeds in two steps. First, subsidiaries sell their output to an affiliated intermediary in market m. Second, the intermediary sells to an assembler, who combines inputs from all locations using a CES production function with elasticity of substitution $\varepsilon > 1$. The resulting bundled good offered to consumers is:

$$Q_{i,m}^k(\omega) = \left[\sum_{l=1}^{N} q_{i,lm}^k(\omega)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{10}$$

The structure with affiliated intermediaries and assemblers enables a parsimonious modeling of transfer-pricing strategies by multinationals.

As with local firms, we do not assume a particular market structure for global firms, but instead specify a pricing rule. Multinationals set a transfer price for intra-firm sales to the intermediary, which equals a markup over marginal cost:

$$p_{i,lm}^k(\omega) = \mu\left(t_{lm}^k\right) \times \frac{\tau_{lm}^k \times \gamma_{i,l}^k}{A_i^k \times z(\omega)} w_l. \tag{11}$$

Unlike local firms, the markup for intra-firm transactions $\mu(t_{lm}^k)$ depends on the gross ad valorem

[13]Note that $P_{i,m}^k(\omega) = t_{im}^k p_{i,im}^k(\omega)$, as local firms produce exclusively from their headquarters location, implying no differentiation in prices across destination markets.

tariff t_{lm}^k set by the destination country:

$$\mu\left(t_{lm}^k\right) = \mu^k\left(t_{lm}^k\right)^{-\rho_{tp}}, \quad \rho_{tp} \in [0,1]. \tag{12}$$

This function is designed to capture two key aspects. First, when $\rho_{tp} = 0$, the transfer price follows the arm's-length principle, meaning multinationals set prices for intra-firm transactions as they would for arm's-length sales charging the same markup as local firms μ^k. In this case, intra-firm prices reflect market-based transactions.[14,15] When $\rho_{tp} > 0$, however, the intra-firm price is lower than under arm's-length pricing, with the gap increasing in the destination country's tariff. This is consistent with the empirical findings in Bernard et al. (2006).[16] Furthermore, for $\rho_{tp} > 0$, changes in tariffs lead to different price elasticities for intra-firm versus arm's-length prices, aligning with our results in Section X [disclosure pending—expected May 2025].

While these price differences can be consistent with firms' optimal choices reflecting allocative decisions (e.g., Neiman 2011), a substantial body of evidence attributes them to transfer-pricing strategies aimed at profit shifting, which is the approach we take here (see, for example, Clausing 2003; Hellerstein and Villas-Boas 2010; Cristea and Nguyen 2016; Davies et al. 2018).

We model multinationals' profit-shifting behavior in reduced form through the intermediary structure. The intermediary purchases output from the subsidiary at prices $p_{i,lm}^k(\omega)$, pays the import tariff t_{lm}^k, and resells it to the assembler at prices

$$\tilde{p}_{i,lm}^k(\omega) = \left(t_{lm}^k\right)^{\rho_c+1} p_{i,lm}^k(\omega), \qquad \rho_c > 0. \tag{13}$$

Thus, higher tariffs lower the subsidiary's price and margin softening the burden of taxes by the intermediary. In turn, the intermediary increases its markups passing the cost of the tariff to consumers, shifting profits from the production site to the destination market. This feature is especially relevant for the analysis of optimal tariffs, as profit shifting can distort the incidence and effectiveness of trade policy.

Finally, global firms sell the assembled bundled good in destination market m at cost. This implies a price for the bundled good offer to consumers, $P_{i,m}^k(\omega)$, given by

$$P_{i,m}^k(\omega) = \left[\sum_{l=1}^{N}\left(\tilde{p}_{i,lm}^k(\omega)\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}. \tag{14}$$

[14]The arm's length principle is the international standard endorsed by OECD countries for determining the pricing of transactions between associated enterprises across borders. It is primarily used for tax purposes to ensure that multinational enterprises (MNEs) set prices for intra-group transactions as if they were conducted between independent parties under comparable conditions. This principle is articulated in Article 9 of the 2010 OECD Model Tax Convention on Income and on Capital.

[15]Note that in our model, multinationals do not engage in arm's-length sales.

[16]Bernard et al. (2006) find empirical support for ρ_{tp} values between 0.56 and 0.60.

3.3 Equilibrium

We begin this section by outlining the role of the government, followed by a detailed description of the model's equilibrium.

Government. The government in country m collects revenue from import tariffs t_{lm}^k on sector k goods imported from countries $l \neq m$. These revenues are rebated as lump-sum transfers, T_m, to the representative household in m:

$$T_m = \sum_{k=1}^{K} \sum_{i=1}^{N} \int_{\omega \in \Omega_i^k} \sum_{l=1}^{N} \left(t_{lm}^k - 1 \right) p_{i,lm}^k(\omega)\, q_{i,lm}^k(\omega)\, d\omega. \tag{15}$$

Consequently, household income E_m is given by

$$E_m = w_m L_m + \bar{\Pi}_m + T_m, \tag{16}$$

where $\bar{\Pi}_m$ represents the aggregate profits of firms headquartered in m, the sum of the profits of global firms, $\pi_{m,lj}^k(\omega)$, which produce from multiple locations l and serve different destination markets j, as well as the profits of the intermediaries located in market j, $\tilde{\pi}_{m,lj}^k(\omega)$, minus the fixed costs paid by this firms to become MNEs

$$\bar{\Pi}_m = \sum_{k=1}^{K} \sum_{j=1}^{N} \int_{\omega \in \Omega_m^k} \sum_{l=1}^{N} \left(\pi_{m,lj}^k(\omega) + \tilde{\pi}_{m,lj}^k(\omega) \right) d\omega - \sum_{k=1}^{K} w_m f_m^k G_m^k.$$

Firm Selection and Productivity Thresholds. As in standard models of trade, profits are increasing functions in firm's productivity level. The presence of fixed costs for becoming a multinational enterprise and increasing profits imply that only the most productive firms in the economy become global firms. This leads to a productivity threshold, $\tilde{z}_m^k$, above which firms headquartered in country m with productivity $z > \tilde{z}_m^k$ operate as multinationals, producing in every location. Letting $\Phi(\cdot)$ denote the ex-ante cumulative distribution of firm productivities, and given a fixed number of firms M_m^k, the number of global firms is given by

$$G_m^k = M_m^k \left(1 - \Phi\left(\tilde{z}_m^k \right) \right). \tag{17}$$

Equilibrium Definition. An equilibrium, given import tariffs $\mathbf{t} = \{t_{\ell m}^k\}_{\ell,m,k}$, consists of an allocation, prices, firm measures, and productivity thresholds that satisfy the following conditions: (i) households maximize utility subject to their budget constraint, i.e., equations (4) to (6) hold; ii) firms set prices according to equations (8), (11), (13), and (14), respectively; iii) firms select into global and local firms, as stated in equations (17); iv) the government runs a balanced budget,

provided in (15); and (iv) labor markets clear

$$w_m L_m = \sum_{k=1}^{K} G_m^k w_m f_m^k + \sum_{k=1}^{K} \sum_{i=1}^{N} \sum_{j=1}^{N} \int_{\omega \in \Omega_i^k}^{k} w_m \ell_{i,mj}^k (\omega) \, d\omega. \tag{18}$$

The definition of equilibrium is standard; however, equation (18) warrants further discussion. The labor market condition equates the total supply of labor to total demand, which includes the fixed cost payments associated with multinational operations in country m, the labor used by local firms in m for production, and specific to our model, the labor employed by foreign multinationals operating in m.

Trade Imbalances. The balance of payments identity states that the current account equals the sum of net exports and net income from abroad, which includes returns to holdings of both real and financial assets

$$CA_m = NX_m + NI_m. \tag{19}$$

Intuitively, if a country spends more than the value of its production ($NX_m < 0$), either it is borrowing from abroad ($CA_m < 0$) or its assets abroad yield a higher return than assets held by foreigners in the domestic economy ($NI_m > 0$). In our model, the current account equals to zero since there is no lending or borrowing across countries. Furthermore, since the only asset in our model is firm ownership, net income equals the difference between profits generated by domestic firms located abroad and profits generated by foreign firms located at home, and therefore net exports are given by[17]

$$NX_m = \sum_{k=1}^{K} \sum_{i=1}^{N} \sum_{j=1}^{N} \int_{\omega \in \Omega_i^k} \pi_{i,mj}^k (\omega) + \tilde{\pi}_{i,jm}^k (\omega) \, d\omega - \sum_{k=1}^{K} \sum_{i=1}^{N} \sum_{l=1}^{N} \int_{\omega \in \Omega_m^k} \pi_{m,li}^k (\omega) + \tilde{\pi}_{m,li}^k (\omega) \, d\omega. \tag{20}$$

The assumption that profits are redistributed based on firm ownership implies that trade flows need not be balanced.

4 Optimal unilateral import tariffs

A central contribution of this paper is to study the optimal import tariffs in the presence of multinational enterprises, and how these multinationals alter the forces that determine optimal tariffs in trade models.

The problem of the domestic planner is to maximize domestic welfare, subject to the equilibrium conditions, and the import tariffs of the rest of the world. To build intuition for the mechanisms and to highlight the primitive economic forces that shape the optimal tariffs, we present simplified versions of our model.

[17] We derive this expression in Appendix B.1.

4.1 Optimal tariffs for a Small Open Economy with perfect competition

We consider first a small open economy under perfect competition, where firms set prices equal to marginal cost, and markups are therefore equal to one. To maintain perfect competition, we eliminate firm selection into global production by setting the fixed costs f_m^k to zero, which implies that all firms are global. The absence of profits guarantees that trade is balanced in this version of the model.

In Appendix C.1, we show that the equilibrium in this model reduces to finding the vector of wages that satisfies the labor market condition for all countries:

$$w_i\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) L_i = \sum_{j \in \mathcal{N}} \Lambda_{ij}\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) w_j\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) L_j \quad \forall i \in \mathcal{N} \tag{21}$$

where Λ_{ij} represent the share of country j's income spent on goods from country i. Equation (21) explicitly highlights how each component of the previous constraint depends on the entire set of import tariffs.

We build on Alvarez and Lucas Jr (2007) and, more recently, Caliendo and Feenstra (2024) and Demidova et al. (2024) to model a small open economy. We adopt the following parametrization for population, trade costs, and multinational production frictions across all destination countries j and all sector k, and analyze the limit of the sequence of equilibria indexed by n, as country m becomes arbitrarily small, i.e., as $n \to 0$:

$$\begin{aligned}
\tilde{L}_m &= n^{\frac{\sigma-1}{\varepsilon-1}} \times L_m \\
\tilde{\tau}_{mj} &= n^{-1/(\varepsilon-1)} \times \tau_{mj} \\
\tilde{\gamma}_{m,j}^k &= n^{-1/(\varepsilon-1)} \times \gamma_{m,j}^k, \quad \forall j \text{ and } k
\end{aligned}$$

This parameterization implies that as the country becomes smaller, imports shrink, and, through trade balance, exports contract as well. For a sequence with constant iceberg costs for exporting, the value of exports reduces to zero, which can only be sustained as an equilibrium with wages that rise to infinity. In a pure trade model, rising iceberg costs for exports alleviate this pressure on wages, resulting in a finite equilibrium wage with non-zero import shares—suitable for quantitative analysis. However, with finite wages and increasing export cost, domestic firms serve foreign markets primarly through multinational production and export platforms. The rising MP frictions ensure that production does not entirely relocate outside the domestic economy.

In Appendix D, we show that as country m becomes arbitrarily small, there exists an equilibrium in which the vector of wages w_{-m} can be determined independently of country m's variables (including country m's import tariffs), and the equilibrium wage w_m remains finite. Therefore, in the limit country m is a small open economy, and the domestic planner chooses its import tariffs to

maximize welfare subject a single constraint, country m's trade balance condition

$$w_m\left(\boldsymbol{t_m}\right) L_m\left[1-\tilde{\Lambda}_{mm}\left(\boldsymbol{t_m}, w_m\left(\boldsymbol{t_m}\right)\right)\right]=\sum_{j \neq m} \tilde{\Lambda}_{mj}\left(w_m\left(\boldsymbol{t_m}\right)\right) w_j L_j \tag{22}$$

where we use $\tilde{x}$ to denote the limit of x for $n \to 0$.

Equation (22) reveals the domestic planner's incentives to impose import tariffs in this environement with perfect competition. Import tariffs manipulate the terms of trade by influencing relative wages trading-off better terms-of-trade at the cost of introducing distortions in relative prices. We summarize the main result of this subsection in the following proposition:

Proposition 1. In a Small Open Economy with perfect competition, country m's optimal import tariffs are homogeneous across countries and sectors, and equal to:

$$t_{lm}^k - 1 = t_m - 1 = 1/\sum_{k=1}^{k}\sum_{l \neq m} \omega_{ml}^k \theta_{ml}^k \tag{23}$$

where ω_{ml}^k is the ratio between exports from country m to l in sector k and total exports, and θ_{ml}^k is the trade elasticity with respect to wages:

$$\theta_{ml}^k \equiv -\frac{\partial \log\left(\lambda_{ml}^k/\lambda_{ll}^k\right)}{\partial \log w_m}$$

with λ_{ml}^k country l's trade share in sector k goods.

The optimal tariff balances two effects: manipulating the terms of trade by raising domestic wages and the distortionary impact of tariffs on relative prices. Since the terms of trade only depend on relative wages and the household preferences imply no substitution effects across sectors, it would be suboptimal for country m to manipulate terms of trade bilaterally, because that would further introduce distortions in relative import prices. This leads to homogeneous tariffs across countries and sectors.[18]

The level of the import tariff balances the terms-of-trade manipulation with the distortionary effect between domestic and foreign prices. By increasing the domestic wage, import tariffs make domestic production more costly. This affects both domestic firms as well as foreign firms with multinational operations in the Home country, ultimately affecting the export capacity of the country. The trade elasticity to wages captures exactly how those exports are affected (θ_{ml}^k), and these responses are weighted by how important are exports in that sector over all exports (ω_{ml}^k). This weighted sum constitutes the export supply elasticity for country m.

Unlike standard trade models in which the trade elasticity is constant (a summary of such models is in Caliendo and Parro 2022), the presence of multinational production makes these elasticities

[18]The homogeneity result across sectors relies heavily on the Cobb-Douglas assumption. See Lashkaripour and Lugovskyy (2023) for a relaxtion of this assumption in models without multinational production.

endogenous. Specifically, we show:

$$\theta_{ml}^{k} = (\sigma - 1) + (\varepsilon - \sigma)\left(1 - \lambda_{m,ml}^{k}\right) \tag{24}$$

where $\lambda_{m,ml}^{k}$ is the share of m's total sales to l originating in m. If multinational production is absent, trade flows depend solely on the elasticity of substitution across varieties $\sigma - 1$, the standard trade elasticity in Armington models. When MNEs are active, the elasticity is not longer constant and depends on both the size of the MP activity and the relative magnitudes between the elasticity of labor across location of productions governed by ε, and the elasticity of substitution across goods governed by σ. Notably, when the former is larger than the latter, it is easier for firms to serve different locations by relocating production across affiliates, reducing the benefits of terms-of-trade manipulation. In this case, optimal tariffs are lower relative to standard trade-only models.

Proposition 1 allows for a final re-interpretation of this result related with those in Gros (1987). In models with perfect competition and differentiated varieties, the domestic planner uses import tariffs to exert market power abroad by reducing production and therefore increasing its price. In Armington models the optimal import tariff is therefore related to the elasticity of demand which also governs the trade elasticity. Our optimal import tariff has a similar interpretation. The domestic planner exerts its market power abroad and it does so by setting import tariffs that are functions of the elasticity of demand. In our nested CES structure with global firms, the elasticity of demand is given by equation (24), which is the elasticity of demand in models like Atkeson and Burstein (2008).

4.1.1 Optimal tariffs for a Large Open Economy with perfect competition

We extend the analysis to large open economies and show that the main insights from the small open economy case remain valid. For analytical tractability, we consider a two-country, single-sector setup. In Section 5.3, we show numerically that our formula approximates well the optimal policy in an environment with multiple countries and sectors.

Proposition 2. In a large open economy, the optimal import tariff is given by:

$$t_{lm} - 1 = \frac{1}{\Lambda_{ll}\theta_{ml}}$$

where Λ_{ll} is Foreign's own consumption share, and θ_{ml} is the trade elasticity in this case given by:

$$\theta_{ml} = (\varepsilon - 1) - (\varepsilon - \sigma) \times \sum_{i=1}^{N} (\lambda_{i,ml} \times \lambda_{i,l}) \times \left(\frac{\lambda_{i,ml}}{\lambda_{ml}} - \frac{\lambda_{i,ll}}{\lambda_{ll}}\right),$$

As in the SOE case, multinational activity reduces the optimal tariff, particularly when $\varepsilon > \sigma$, as firms can flexibly reallocate production across affiliates in response to domestic wage changes. Our results underscore how multinational production alters the optimal tariff structure by endogenizing trade elasticities. Compared to standard trade models, the presence of MNEs reduces both the gains

and distortions from tariff imposition, leading to lower optimal tariffs when production relocation is highly elastic.

4.2 Optimal tariffs for a Small Open Economy with imperfect competition

4.2.1 Without transfer-pricing for global firms

In this subsection, we reintroduce firm pricing behavior while maintaining the assumption that $\rho_{tp} = \rho_c = 0$; that is, global firms do not engage in transfer pricing for profit-shifting purposes. The presence of firm profits implies that trade is no longer balanced in this version of the model.

In Appendix XX, we show that the equilibrium can still be reduced to finding a vector of wages that satisfies labor market clearing in all countries. However, the system now includes additional equations governing aggregate profits. We retain the same parameterization for population, iceberg trade costs, and MP frictions, and study the limiting behavior of this economy as country m becomes arbitrarily small. In this limit, the domestic planner chooses import tariffs to maximize real income—which now includes firm profits—subject to the Home country's labor market clearing condition:

$$w_m L_m = \sum_{j \neq m} \frac{1}{\mu} \Lambda_{m,mj} \left(w_j L_j + \bar{\Pi}_j \right) + \sum_i \frac{1}{\mu} \Lambda_{i,mm} \left(w_m L_m + \bar{\Pi}_m \right),$$

with aggregate profits given by:

$$\bar{\Pi}_m \left[1 - \left(1 - \frac{1}{\mu} \right) \Lambda_{m,mm} \right] = \sum_{i \neq m} \sum_l \left(1 - \frac{1}{\mu} \right) \Lambda_{m,li} \left(w_i L_i + \bar{\Pi}_i \right) + \left(1 - \frac{1}{\mu} \right) \Lambda_{m,mm} w_m L_m,$$

and where:

$$\Lambda_{i,mj} \equiv \frac{\lambda_{i,mj} \lambda_{i,j} / t_{mj}}{\sum_r \sum_h \lambda_{h,rj} \lambda_{h,j} / t_{rj}}.$$

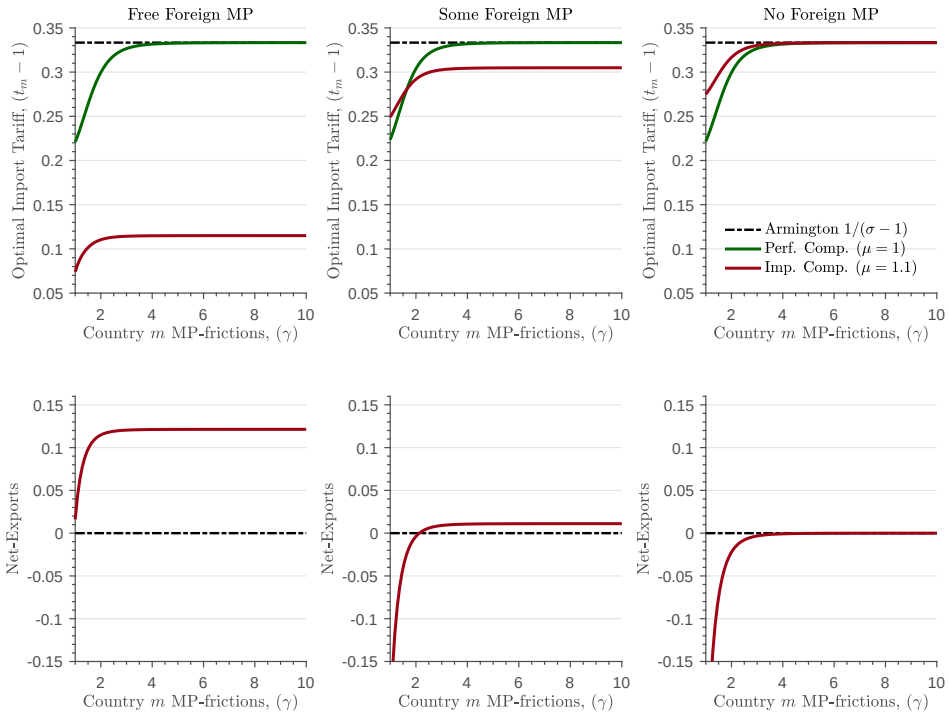
Here, $\lambda_{i,mj}$ and $\lambda_{i,j}$ are defined as before.

Characterizing optimal import tariffs in this environment is still a work in progress. However, some qualitative features are preserved: optimal tariffs remain uniform across countries and sectors due to the small open economy assumption and Cobb-Douglas preferences at the sectoral level.

Figure 2 compares optimal tariffs across different model variants. Columns correspond to different assumptions about foreign MP frictions—none (first column), moderate (second), and prohibitively high (third). The top panels show optimal tariffs as a function of Home's MP frictions; the bottom panels depict resulting net exports.

The black dotted line shows the trade-only benchmark, where the optimal tariff equals the inverse of the trade elasticity, $\sigma - 1$, and trade is balanced (net exports are zero). The green line represents our model with multinational production under perfect competition—equation (23) in

Figure 2: Optimal Import Tariff with Imperfect Competition



Proposition 1. Because $\sigma < \varepsilon$, the optimal tariff is strictly lower than in the trade-only case. Profits are zero, and net exports remain balanced.

The red line represents the case with imperfect competition. In the third column (high foreign MP frictions), Home enjoys net income from its firms located abroad but hosts no foreign production, leading to a trade deficit. The optimal tariff rises relative to the perfect competition case as the government uses trade policy to repatriate profits. As Home's MP frictions grow, this motive weakens and the optimal tariff converges to the trade-only benchmark which is invariant to the presence of firm's profits.

In the first column (low foreign MP frictions), Home hosts substantial foreign production and runs a trade surplus. Here, raising tariffs will have the oppotisite effect but on foreign firms' profits, making the optimal tariff lower than in the perfect competition case. Notably, even as Home's MP frictions rise, the optimal tariff does not converge to the Armington formula due to the persistent trade surplus.

The second column highlights the nuanced relationship between trade imbalances and tariff levels under intermediate levels of MP frictions for both Home and Foreign.

4.2.2 With transfer-pricing for global firms

[TBD]

5 Quantitative Results for a Large Open Economy

In section 5.1 we describe the data used for the calibration. In section 5.2, we describe the calibration strategy. Finally, in section 5.3 we present the quantitative results.

5.1 Data

Tariff Data. Quantification of our large open economy model requires tariff data from all countries. We combine data on bilateral tariffs at the HS6 level from UNCTAD-TRAINS and the WTO-IDB dataset.

Output and Trade Shares. The OECD AMNE Analytical Database provides data on output that contains information on the industry, the location of production, and the country of ownership. Output of domestic firms is further split into output by MNEs and output by non-MNEs, using data from the OECD AMNE Analytical Database - Domestic MNEs. Industry-level trade flows come from the OECD AMNE Inter-country Input-Output tables.

Measure of Local and Global Firms. We use Orbis Historical Data to compute the measure of global and local firms for each country and industry.

Labor Force We set the size of the labor force proportional to the size of manufacturing employment, computed from the ILO database.

Countries and Sectors We group countries into ten regions and the United States. We group manufacturing industries into two sectors, based on whether the related party share of US imports from China is above or below the median. The high-RP sector includes chemicals, minerals, and automobiles. The low RP sector includes agriculture, apparel, machinery, materials, and metals.

5.2 Calibration

The main parameters of the model are the elasticities of substitution, ε and σ, the fixed costs of selection into MP, f_m^k, country-sector specific productivity, A_m^k, trade costs, $\tau_{\ell i}$, MP frictions, $\gamma_{m,\ell}^k$, markups of local firms, μ^k, the tariff elasticity of markups of affiliates of global firms, ρ^{tp} and the tariff elasticity of the markup of intermediaries, ρ^c. We quantify these parameters via a combination of estimation and calibration.

Elasticities of Substitution and Tariff Elasticity of Markups. The estimation of ε, σ is in progress. In the remainder of the paper, we set $\varepsilon = 6$, $\sigma = 4$.

The tariff elasticity of markups of global affiliates can be estimated from a regression of log changes in pre-tariff prices on log tariff changes, controlling for country-of-production-time fixed

effects[19] (see equation (F.5) in Appendix F):

$$d \ln p^{k,G}_{i,lmt}(\omega) = -\rho_{tp} d \ln(t^k_{lmt}) + \xi_{lt} + \epsilon^k_{ilmt} \tag{25}$$

We estimate equation (25) using the 24-month log change in the pre-duty unit value, computed from the LFFTD at the relationship-product level, from 2016 to 2020. We restrict the sample to related-party imports, consistently with the model assumption that all trade by global firms is intermediated by an affiliated firm located in the destination market. In addition, we include a country-time fixed effect, a country-sector fixed effect, a product-time fixed effect, and an importer-exporter-product-country fixed effect.

The tariff elasticity of markups of affiliated intermediaries cannot be identified without data on the difference between the price charged in the related-party transaction and the price effectively paid by final users. In our baseline calibration, we assume that affiliated intermediaries fully offset the reduction in the markup of global subsidiaries, $\rho_c = \rho_{tp}$.

Finally, we set markups to $\mu^k = \frac{\sigma}{\sigma-1}$ and compare results from a baseline calibration without transfer pricing, i.e. $\rho_c = \rho_{tp} = 0$, to a calibration in which the markup of global firms decreases by 15%, i.e. $\rho_c = \rho_{tp} = 0.15$ (based on Table 4).

Fixed costs of selection into MP, f^k_m, country-sector specific productivity, A^k_m, trade costs, $\tau_{\ell i}$, and MP frictions, $\gamma^k_{m,\ell}$. In principle, these parameters could be estimated through model inversion. However, a critical moment required for the model inversion are the trade flows associated with affiliates of global firms, which are not available from the AMNE Database.[20] Standard methods of imputation relying on proportionality assumptions are inconsistent with the model, unless one is willing to impose the restriction that $\sigma = \varepsilon$. For this reason, we resort to moments matching as our baseline calibration strategy.

The key moments we target are: i) the MNE share of the value of output produced by firms headquartered in m in country m, in each sector k; ii) the share of output in location ℓ, produced by firms headquartered in m in sector k; iii) the bilateral trade shares; iv) the share of global firms by country of ownership and sector; v) relative income across countries.

To reduce the dimensionality of the problem, we parameterize trade costs as a function of distance (from CEPII data), $\log \tau_{ij} = \alpha^d + \beta^d dist_{ij}$, and we parametrize MP frictions as a function of distance, letting the coefficient depend on the sector, $\log \gamma^k_{ij} = \alpha^\gamma + \beta^\gamma_k dist_{ij}$.

In Figure H.1 in Appendix H, we show the fit between the model-simulated moments and the data.

[19] While the equation holds exactly in the model, we introduce an error term that accounts for measurement error or unobservable time-varying factors that are assumed to be uncorrelated with the coefficient of interest.

[20] The AMNE Database only contains information on the output of affiliates by country of origin, without providing information on where the output is sold.

5.3 Optimal Import Tariff in a quantitative model of multinational-production

We compute optimal unilateral tariffs for the US in the following three scenarios: i) perfect competition (i.e. $\mu^k = 1$); ii) imperfect competition, with no selection into MP; iii) benchmark calibration, featuring imperfect competition and selection into MP. For scenarios i) and ii), we assume that all firms are global (i.e. we set $f_m^k = 0$), and recalibrate the remaining parameters after dropping the share of global firms by country of origin from the set of targeted moments.

Figure 3a reports the numerical results from this exercise. In each scenario, the yellow bar shows the optimal import tariff, calculated under the restriction of uniform tariffs across all countries and sectors and under the assumption of no foreign retaliation. We contrast the optimal import tariff with the formula derived in Proposition 1. While this formula was derived under restrictive assumptions, it remains a good approximation for the optimal tariffs in large open economies with perfect competition.

Imperfect competition adds a new motive for the planner to impose import tariff on its trade partners, to shift profits towards domestic firms. Intuitively, an increase in import tariffs reallocates demand from goods produced abroad to goods produced domestically. Given the presence of MP frictions, domestic-owned affiliates located abroad face a stronger incentive to relocate production to the domestic country, relative to foreign-owned affiliates. As a result, on top of the terms of trade improvement, an import tariff reallocates profits from foreign-owned to domestic-owned companies. The second column in Figure 3a reveals that this incentive is quantitatively relevant, as it increases the optimal tariff rate by 4 percentage points.

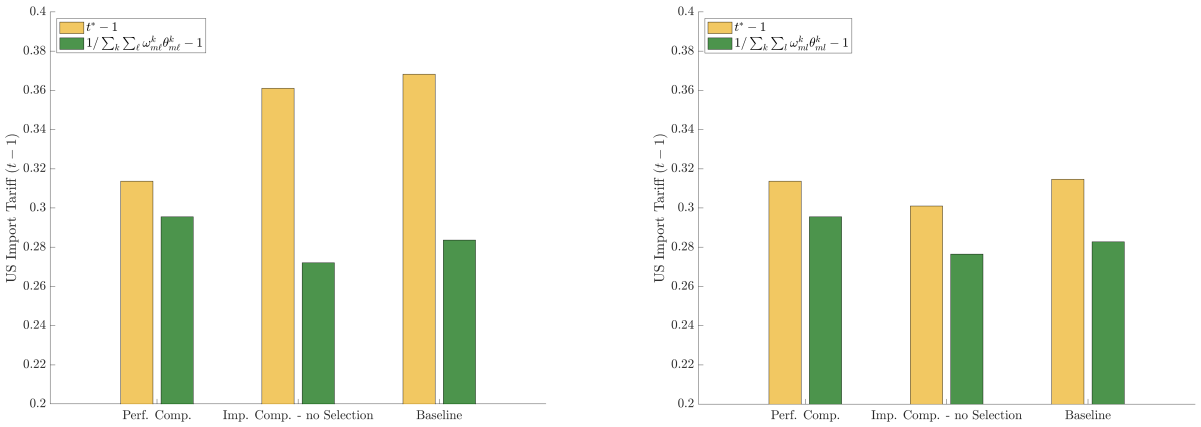
Importantly, the profit shifting motive would be absent in a version of the model with positive profits but no MNEs, as all domestic-owned firms would already be producing in the domestic country. To show this point, we compute optimal import tariffs in a version of the model with prohibitively high MP frictions, which is isomorphic to a standard Armington model with no MP. Figure H.3 and H.4 show that results in the no MP case are unaffected by the presence of profits.

Finally, the third scenario suggests that the *profit shifting motive* mostly operates along the intensive margin. While an increase in the profitability of domestic production and an increase in the domestic wage reduces the incentives for domestic firms to become global firms, the introduction of the extensive margin of selection into MP has a limited impact on the optimal import tariff.

In Figure 3b, we show that the contribution of the *profit shifting motive* is affected by the extent to which multinational firms are able to engage in transfer pricing. Under the assumptions that the tariff elasticity of markups of affiliates is $\rho_{tp} = 0.15$ and affiliated intermediaries in the destination country entirely pass on the cost of the tariff to households, i.e. $\rho_c = 0.15$, the optimal tariff *decreases* with imperfect competition. Intuitively, for any given foreign wage level, transfer pricing leaves import prices paid by domestic households unchanged while reducing tariff revenues collected by the domestic government. On top of that, global firms that engage in transfer pricing have weaker incentives to relocate production to the domestic country, which reduces the effectiveness of tariffs at both manipulating the terms of trade and shifting profits.

Figure H.2 reports the welfare gains associated with optimal import tariffs. In line with this class

Figure 3: Comparison of Tariff Analysis



(a) Baseline calibration

(b) Transfer pricing, $\rho_{tp} = \rho_c = 0.15$

Notes: The yellow column represents the value of the optimal US unilateral import tariff. The green column reports the reciprocal of the average trade elasticity, defined in Proposition 1. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = \sigma/(\sigma - 1)$. The baseline scenario is the calibrated model with selection into MP and positive markups. In the right panel, we recalibrate the model in the three scenarios, under the assumption that global firms engage in transfer pricing, setting $\rho_{tp} = \rho_c = 0.15$.

of models, we find relatively small welfare gains in the perfect competition benchmark ($\sim 0.63\%$), which rise to around 0.95% in the imperfect competition case.

6 Conclusions

TBA

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Multinational Production and Trade Policy

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Online Appendix (Not for Publication)

A Additional Empirical Results

A.1 Additional Descriptive Results

Table A.1 presents an alternative version of Table 1 where capital goods are classified as intermediates. We still find that the related party share was lower in earlier tariff lists. We note that only one 10-digit HS code was classified as final consumption good on list 1, and no final consumption goods were on list 2.

Table A.1: Related party (RP) Share of Imports from China - Alternative Classification of Goods

	Intermediates		Final goods	
	Avg. share	Median share	Avg. share	Median share
Round 1	0.314	0.300	0.548	0.548
Round 2	0.262	0.296	–	–
Round 3	0.150	0.120	0.113	0.099
Round 4	0.152	0.146	0.083	0.048
Non-targeted	0.197	0.215	0.090	0.066

Notes: Goods are classified as intermediate or final according to the Broad Economic Categories rev. 5 (BEC5) code corresponding to their HS code. BEC5 codes with a third digit of 1 or 2 (intermediate and capital final use) are classified as intermediate goods and BEC5 codes with a third digit of 3 are classified as final consumption goods.

A.2 Regressions with Publicly Available RP Shares

In this appendix, we run country-product level regressions similar to those in Section 2.3 using publicly available data. We show that using publicly available data and related-party shares would give a misleading picture.

As described, in the public data we only have the share of RP trade by 6-digit NAICS industry, in annual data. We map these RP shares to their associated HS10 codes. Since we do not observe monthly RP and AL imports, we cannot run the same regressions we run in the LFTTD data. Instead, we run regressions where we interact the tariff change with the RP share of the industry associated with a given HS10 product. Specifically, let i index a source country, g an HS10 product, t a month between 2016:m1 and 2020:m12, and $s(g)$ and $n(g)$ the 4-digit and the 6-digit NAICS industry associated with good g, respectively. We then run specifications of the form

$$\Delta \ln m_{igt} = \eta_{gt} + \eta_{it} + \eta_{is(g)} + \sigma \Delta \ln(1 + \tau_{igt}) + \rho \Delta \ln(1 + \tau_{igt}) \cdot \phi^{CN}_{n(g)} + \varepsilon_{igt}, \tag{A.1}$$

where m_{igt} is the quantity imported from country i of good g in month t, η_{gt}, η_{it}, and $\eta_{is(g)}$ are product-time, country-time, and country-sector fixed effects, respectively, and τ_{igt} is the statutory tariff rate for the product and country. The variable $\phi^{CN}_{n(g)}$ is the share of imports of industry n associated with product g from China that is sourced via a related party in 2017. Our coefficient of interest is ρ, which captures whether the trade elasticity differs for products based on the related party share.[1]

We first run the regression excluding the related party term and report the results in column 1 of panel a of Table A.2. Standard errors are two-way clustered at the 8-digit HS code and country level. This regression

[1] Note that we do not need to include $\phi^{CN}_{n(g)}$ on its own since it is absorbed by the product-time fixed effect.

Table A.2: Tariffs and Related Party Share

	(1) No related share	(2) Baseline	(3) P50 dummy	(4) Quarterly
$\Delta \ln(1+\tau_{igt})$	-0.9890***	-0.7221***	-0.7420***	-0.7593***
	(0.1269)	(0.1388)	(0.1533)	(0.2702)
$\Delta \ln(1+\tau_{igt}) \cdot \phi^{CN}_{n(g)}$		-1.4817***		-3.2956***
		(0.4583)		(0.6171)
$\Delta \ln(1+\tau_{igt}) \cdot \mathbb{I}(\phi^{CN}_{n(g)} > P50)$			-0.3468**	
			(0.1715)	
Product-Time Fixed effects	Yes	Yes	Yes	Yes
Country-Time Fixed effects	Yes	Yes	Yes	Yes
Country-Sector Fixed Effects	Yes	Yes	Yes	Yes
R2	0.1252	0.1252	0.1252	0.1177
Observations	5,537,684	5,537,684	5,537,684	2,601,559

Source: Census Bureau and authors' calculations. Table reports the results of regressing the monthly change in the quantity imported (m_{igt}) on the change in the tariff (τ_{igt}) as well as the tariff change interacted with the related party share. The regressions include product-time, country-time, and country-sector fixed effects. Standard errors, adjusted for clustering by HS8 product code and country are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

corresponds to the reduced-form regression run by Fajgelbaum et al. (2020). The results indicate a tariff elasticity of about one, i.e., a one percent increase in tariffs is associated with a one percent decline in quantity imported. This elasticity is slightly lower than in Fajgelbaum et al. (2020) due to the different time period used.

The second column runs our baseline specification (A.1). We find that the tariff elasticity is significantly higher in absolute value when the related party share is higher: at the mean tariff change (0.08), going from the 25th percentile to the 75th percentile of the related party share from China (from 0.05 to 0.21) is associated with an additional decline in imports of 2 log points.

In column 3, we re-run the regression but replace the continuous related party share for imports from China with a dummy variable that is equal to one if the related party share is above the median (0.12), $\mathbb{I}(\phi^{CN}_{n(g)} > P50)$. The results are consistent with our earlier findings: at the median tariff change, going from a related party share below the median to one above the median reduces imports by about 2.5 log points.

Since our regressions are run at the monthly level, our dataset contains many missing observations for cases when a particular country-product is not imported in a given month. This feature of the data may bias our results. In column 4, we therefore aggregate import quantities to the quarterly level, and use the average tariff rate of the quarter. We find similar results, with a stronger significance of the interaction term.

Overall, these regressions show that trade in industries with a higher RP share is more responsive to tariff changes. This finding suggests that RP trade might be more responsive to tariff shocks. However, the regressions performed in the LFTTD data in the main text indicate that this is not the case. At the country-product level, AL imports are more responsive to tariffs than RP imports.

A.3 Regression Results with Country of Origin

Table A.3: Country-Product Level Tariff Regressions with Country of Origin

	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo	24 mo
Panel a: All transactions													
Quantity	-0.7545***	-0.6088***	-0.3710***	-0.5526***	-0.7138***	-1.145***	-1.486***	-1.696***	-1.883***	-2.000***	-1.982***	-1.963***	-2.224***
	(0.0806)	(0.0687)	(0.0669)	(0.0639)	(0.0619)	(0.0640)	(0.0641)	(0.0644)	(0.0628)	(0.0634)	(0.0640)	(0.0657)	(0.0744)
Value	-0.8192***	-0.7455***	-0.5245***	-0.7108***	-0.8572***	-1.244***	-1.572***	-1.753***	-1.945***	-2.035***	-2.021***	-2.005***	-2.346***
	(0.0708)	(0.0608)	(0.0592)	(0.0568)	(0.0552)	(0.0581)	(0.0598)	(0.0605)	(0.0586)	(0.0593)	(0.0598)	(0.0611)	(0.0702)
Price	-0.06473	-0.1368***	-0.1535***	-0.1582***	-0.1433***	-0.09877***	-0.0859***	-0.05643*	-0.06139**	-0.03571	-0.03985	-0.04206	-0.1211***
	(0.0434)	(0.0328)	(0.0309)	(0.0301)	(0.0295)	(0.0291)	(0.0290)	(0.0289)	(0.0285)	(0.0281)	(0.0279)	(0.0282)	(0.0320)
Observations	5,240,000	5,078,000	4,920,000	4,774,000	4,641,000	4,517,000	4,394,000	4,283,000	4,181,000	4,076,000	3,978,000	3,883,000	2,699,000
Panel b: By transaction type													
Quantity													
- AL	-0.7217***	-0.5450***	-0.3396***	-0.5686***	-0.7145***	-1.177***	-1.513***	-1.766***	-1.966***	-2.087***	-2.084***	-2.094***	-2.371***
	(0.0925)	(0.0763)	(0.0718)	(0.0679)	(0.0651)	(0.0651)	(0.0646)	(0.0660)	(0.0657)	(0.0648)	(0.0645)	(0.0655)	(0.0777)
- RP	-0.7941***	-0.6412***	-0.5362***	-0.4948***	-0.5830***	-0.9043***	-1.132***	-1.246***	-1.398***	-1.592***	-1.497***	-1.468***	-1.793***
	(0.1409)	(0.1167)	(0.1102)	(0.1051)	(0.1039)	(0.1050)	(0.1065)	(0.1094)	(0.1078)	(0.1096)	(0.1083)	(0.1101)	(0.1289)
Value													
- AL	-0.8126***	-0.7064***	-0.4871***	-0.7175***	-0.8668***	-1.291***	-1.642***	-1.844***	-2.054***	-2.155***	-2.143***	-2.170***	-2.502***
	(0.0797)	(0.0668)	(0.0633)	(0.0609)	(0.0583)	(0.0595)	(0.0598)	(0.0612)	(0.0612)	(0.0603)	(0.0601)	(0.0610)	(0.0730)
- RP	-0.6710***	-0.6472***	-0.5736***	-0.4823***	-0.6169***	-0.9395***	-1.174***	-1.249***	-1.383***	-1.538***	-1.466***	-1.463***	-1.853***
	(0.1247)	(0.1033)	(0.0952)	(0.0912)	(0.0903)	(0.0914)	(0.0927)	(0.0949)	(0.0928)	(0.0948)	(0.0932)	(0.0949)	(0.1136)
Price													
- AL	-0.0909*	-0.1614***	-0.1475***	-0.1489***	-0.1522***	-0.1134***	-0.1294***	-0.0779**	-0.0880***	-0.0680**	-0.0588*	-0.0767**	-0.1313***
	(0.0490)	(0.0368)	(0.0347)	(0.0333)	(0.0321)	(0.0324)	(0.0321)	(0.0319)	(0.0305)	(0.0305)	(0.0304)	(0.0302)	(0.0357)
- RP	0.1231*	-0.0060	-0.0374	0.0125	-0.0339	-0.0352	-0.0425	-0.0035	0.0144	0.0539	0.0308	0.0058	-0.0598
	(0.0707)	(0.0558)	(0.0506)	(0.0496)	(0.0485)	(0.0480)	(0.0493)	(0.0503)	(0.0495)	(0.0488)	(0.0499)	(0.0504)	(0.0589)
Observations - AL	4,162,000	4,027,000	3,895,000	3,775,000	3,667,000	3,566,000	3,466,000	3,376,000	3,295,000	3,212,000	3,136,000	3,062,000	2,117,000
Observations - RP	2,434,000	2,340,000	2,257,000	2,183,000	2,114,000	2,052,000	1,991,000	1,936,000	1,884,000	1,831,000	1,781,000	1,733,000	1,177,000

Source: Census Bureau and authors' calculations. Table reports the results of regressing the change in the quantity, value, or price (y_{igt}) on the change in the tariff (τ_{igt}). The regressions include product-time, country-time, and country-sector fixed effects. Standard errors, adjusted for clustering by HS8 product code are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

B Theoretical Results

B.1 Equilibrium Conditions

First, we restate the equilibrium conditions:

1. Labor market clearing conditions:

$$L_m = \sum_{k=1}^{K}\sum_{i=1}^{N}\int_0^{M_i^k}\sum_{j=1}^{N}\ell_{i,mj}^k(\omega)d\omega + \sum_{k=1}^{K}M_m^{k,G}f_m^k \tag{B.1}$$

2. Budget constraint:

$$E_m = w_m L_m + \Pi_m + T_m \tag{B.2}$$

3. Cutoff rule for selection into global firms:

$$\pi_m^{k,G}(\tilde{z}_m^k) - w_m f_m^k \geq \pi_m^{k,L}(\tilde{z}_m^k) \tag{B.3}$$

where a strict inequality at $\tilde{z}_m^k = 1$ implies that all firms are global. More in details:

$$\tilde{z}_m^k = \max\left\{\left(\frac{w_m f_m^k}{\overline{\pi}_m^{k,G} - \overline{\pi}_{m,j}^{k,L}}\right)^{\frac{1}{\sigma-1}}, 1\right\}$$

where $\overline{\Pi}_m^{k,G}, \overline{\Pi}_m^{k,L}$ denotes the component of profits that does not depend on productivity.

4. Measure of global firms:

$$G_m^{k,G} = (1 - \Phi(\tilde{z}_m^k))M_m^k \tag{B.4}$$

Prices The endogenous variables that enter the previous equations can be expressed as a function of wages w_m, expenditures E_m and the share of global firms $G_m^{k,G}$. To see why, first recall that prices of local and global firms headquartered in m that sell goods to country j in sector k are:

$$P_{m,i}^{k,G}(\omega) = \left[\sum_{l=1}^{N}((t_{li}^k)^{1+\rho_c}p_{m,li}^{k,G}(\omega))^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$
$$P_{m,i}^{k,L}(\omega) = t_{mi}^k p_{m,mi}^{k,L}(\omega)$$

where

$$p_{m,li}^{k,G}(\omega) = \mu^k(t_{li}^k) \times \tau_{li} \times \gamma_{m,l}^k \frac{w_l}{A_m^k \times z_m^k(\omega)} = \frac{\overline{p}_{m,li}^{k,G}(\omega)}{z_m^k(\omega)}$$
$$p_{m,mi}^{k,L}(\omega) = P_{m,i}^{k,L}(\omega) = \mu^k \times \tau_{mi} \times \frac{w_m}{A_m^k \times z_m^k(\omega)} = \frac{\overline{p}_{m,i}^{k,L}}{z_m^k(\omega)}$$

where we use the notation $\bar{(\cdot)}$ to denote the component that is common to all firms. Similarly, the price index of origin-goods m sold to country i in sector k by global firms can be rewritten as:

$$P_{m,i}^{k,G}(\omega) = \frac{\mu_k^G}{z_m^k(\omega)} \left[\sum_{\ell=1}^{N} \left((t_{\ell i}^k)^{1+\rho_c} \mu^k(t_{\ell i}^k) \times \tau_{\ell i} \times \gamma_{m,\ell}^k \frac{w_\ell}{A_m^k} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} = \frac{1}{z_m^k(\omega)} \overline{P}_{m,i}^{k,G}$$

Then, the price index in location i can be expressed as:

$$P_i^k = \left[\sum_{o=1}^{N} M_o^k \left(\left(\overline{P}_{o,i}^{k,L} \right)^{1-\sigma} \int_1^{\tilde{z}_o^k} (z_o^k)^{\sigma-1} g(z) dz + \left(\overline{P}_{o,i}^{k,G} \right)^{1-\sigma} \int_{\tilde{z}_o^k}^{\infty} (z_o^k)^{\sigma-1} g(z) dz \right) \right]^{\frac{1}{1-\sigma}}$$

Profits and Threshold Rule for Selection into Multinationals Profits from selling to country i by affiliates of firms headquartered in m in sector k are given by:

$$\begin{aligned} \pi_{m,li}^{k,G}(z) &= \left(1 - \frac{1}{\mu^k(t_{li})}\right) \frac{1}{(t_{li}^k)^{1+\rho_c}} \left(p_{m,li}^{k,G}(z) \right)^{1-\varepsilon} \left(P_{m,i}^{k,G}(z) \right)^{\varepsilon-\sigma} (P_i^k)^{\sigma-1} e_i^k E_i \\ &= z^{\sigma-1} \underbrace{\left(1 - \frac{1}{\mu^k(t_{li}^k)}\right) \frac{1}{(t_{li}^k)^{1+\rho_c}} \left(\bar{p}_{m,lj}^{k,G} \right)^{1-\varepsilon} \left(\bar{P}_{m,i}^{k,G} \right)^{\varepsilon-\sigma} z^{\sigma-1} (P_i^k)^{\sigma-1} e_i^k E_i}_{\bar{\pi}_{m,li}^{k,G}} \end{aligned}$$

where we notice once again that profits can be expressed as the product of a component common to all firms and an increasing function of idiosyncratic productivity. In each destination country, affiliated intermediaries purchase from affiliates located in country l at price $t_{li}^k p_{m,li}^{k,G}(\omega)$ and resell to the assembler at price $(t_{li}^k)^{1+\rho_c} p_{m,li}^{k,G}(\omega)$. Their profits are equal to:

$$\widetilde{\pi}_{m,li}^{k,G}(z) = \left(1 - \frac{1}{t^{\rho_c}}\right) \left(\bar{p}_{m,lj}^{k,G} \right)^{1-\varepsilon} \left(\bar{P}_{m,i}^{k,G} \right)^{\varepsilon-\sigma} z^{\sigma-1} (P_i^k)^{\sigma-1} e_i^k E_i = z^{\sigma-1} \widetilde{\bar{\pi}}_{m,li}^{k,G}$$

Summing across locations of production and destination countries, gross profits of a firm headquartered in i of productivity z in sector k are:

$$\pi_m^{k,G}(z) = z^{\sigma-1} \sum_i \left[\sum_l (\bar{\pi}_{m,li}^{k,G} + \widetilde{\bar{\pi}}_{m,li}^{k,G}) \right] = z^{\sigma-1} \bar{\pi}_m^{k,G}$$

For local firms:

$$\pi_m^{k,L}(z) = z^{\sigma-1} \left(1 - \frac{1}{\mu^k}\right) \sum_j \frac{1}{t_{mj}^k} \left(\overline{p}_{m,mi}^{k,L} \right)^{1-\sigma} (P_j^k)^{\sigma-1} e_j^k E_j = z^{\sigma-1} \bar{\pi}_m^{k,L}$$

Therefore, the productivity threshold above which a firm becomes global can be found as:

$$\tilde{z}_m^k = \max \left\{ \left(\frac{w_m f_m^k}{\overline{\pi}_m^{k,G} - \overline{\pi}_m^{k,L}} \right)^{\frac{1}{\sigma-1}}, 1 \right\}$$

Integrating over the productivity distribution, we can then define aggregate gross profits of firms headquartered in m:

$$\begin{aligned}\Pi_m &= \sum_{k=1}^{K}\sum_{j=1}^{N}\int_{\omega\in\Omega_m^k}\sum_{\ell=1}^{N}(\pi_{m,lj}^k(\omega)+\tilde{\pi}_{m,lj}^k(\omega))d\omega \\ &= \sum_{k=1}^{K}M_m^k\sum_{j=1}^{N}\int_{\tilde{z}_m^k}^{\infty}\sum_{\ell=1}^{N}(\pi_{m,lj}^{k,G}(z)+\tilde{\pi}_{m,lj}^{k,G}(z))dz+\sum_{k=1}^{K}M_m^k\sum_{j=1}^{N}\int_1^{\tilde{z}_m^k}\pi_{m,mj}^{k,L}(z)dz \\ &= \Pi_m^{k,G}+\Pi_m^{k,L}\end{aligned} \tag{B.5}$$

Labor Demand Labor demand by global and local firms, net of labor used for payments of fixed costs, is:

$$\ell_{m,lj}^{k,G}(z) = \left(\frac{1}{\mu^k(t_{lj}^k)}\right)\frac{1}{(t_{lj}^k)^{1+\rho_c}}\left(\bar{p}_{m,lj}^{k,G}\right)^{1-\varepsilon}\left(\bar{P}_{m,j}^{k,G}\right)^{\varepsilon-\sigma}z^{\sigma-1}(P_j^k)^{\sigma-1}\frac{e_j^kE_j}{w_l},\quad \text{for } l=1,\cdots,N$$

$$\ell_{m,mj}^{k,L}(z) = \left(\frac{1}{\mu^k}\right)\frac{1}{t_{mj}^k}\left(\bar{p}_{m,mi}^{k,L}\right)^{1-\sigma}(P_j^k)^{\sigma-1}z^{\sigma-1}\frac{e_j^kE_j}{w_m}$$

Then, labor used in production in country m in sector k is:

$$\begin{aligned}\ell_m^k &= \sum_o M_o^k\frac{\int_{\tilde{z}_o^k}^{\infty}z^{\sigma-1}g(z)dz}{w_m}\sum_j\frac{1}{\mu^k(t_{mj}^k)}\frac{1}{(t_{mj}^k)^{1+\rho_c}}\left(\bar{p}_{o,mj}^{k,G}\right)^{1-\varepsilon}\left(\bar{P}_{o,j}^{k,G}\right)^{\varepsilon-\sigma}(P_j^k)^{\sigma-1}e_j^kE_j \\ &+ M_o^k\left(\frac{1}{\mu^k}\right)\frac{\int_1^{\tilde{z}_o^k}z^{\sigma-1}g(z)dz}{w_m}\sum_j\frac{1}{t_{mj}^k}\left(\bar{P}_{o,j}^{k,L}\right)^{1-\sigma}(P_j^k)^{\sigma-1}e_j^kE_j\end{aligned}$$

Then, labor market clearing requires:

$$L_m = \sum_k \ell_m^k + \sum_k G_m^{k,G}f_m^k$$

Tariff Revenues Tariff revenues generated from the sales of a global or local firm i of productivity z to country m in sector k:

$$T_{i,lm}^{k,G}(z) = \frac{t_{lm}^k-1}{(t_{lm}^k)^{1+\rho_c}}\left(\bar{p}_{i,lm}^{k,G}\right)^{1-\varepsilon}\left(\bar{P}_{i,m}^{k,G}\right)^{\varepsilon-\sigma}z^{\sigma-1}(P_m^k)^{\sigma-1}e_j^kE_j\quad\forall l=1,2,\ldots,N$$

$$T_{i,im}^{k,L}(z) = \frac{t_{im}^k-1}{t_{im}^k}\left(\bar{p}_{i,im}^{k,L}\right)^{1-\sigma}(P_j^k)^{\sigma-1}z^{\sigma-1}e_j^kE_j$$

Therefore, total tariff revenues in country m from sector k are:

$$\begin{aligned}T_m^k &= \sum_o M_o^k\int_{\tilde{z}_o^k}^{\infty}z^{\sigma-1}g(z)dz\sum_l\frac{t_{lm}^k-1}{(t_{lm}^k)^{1+\rho_c}}\left(\bar{p}_{o,lm}^{k,G}\right)^{1-\varepsilon}\left(\bar{P}_{o,m}^{k,G}\right)^{\varepsilon-\sigma}(P_m^k)^{\sigma-1}e_m^kE_m \\ &+ \sum_o M_o^k\int_1^{\tilde{z}_o^k}z^{\sigma-1}g(z)dz\frac{t_{om}^k-1}{t_{om}^k}\left(\bar{P}_{o,m}^{k,L}\right)^{1-\sigma}(P_m^k)^{\sigma-1}e_m^kE_m\end{aligned}$$

Net Exports and Balance of Payment Identity We use $X^k_{i,lm}$ to denote the pre-tariff value of production of sector k goods originated in i, produced in country l, exported to country m :

$$X^k_{i,lm} = \int_{\omega \in \Omega^k_l} p^k_{i,lm}(\omega) q^k_{i,lm}(\omega) d\omega \tag{B.6}$$

By definition, net exports are given by

$$NX_m = \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{j=1}^{N} X^k_{i,mj} - \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{l=1}^{N} X^k_{i,lm} \tag{B.7}$$

Now, from the budget constraint of the household we know that income E_m equals total consumption:

$$E_m = \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} P^k_{i,m}(\omega) Q^k_{i,m}(\omega) d\omega \tag{B.8}$$

Adding and subtracting equation (B.8) from equation (B.7) we get

$$NX_m = \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{j=1}^{N} \int_{\omega \in \Omega^k_i} p^k_{i,mj}(\omega) q^k_{i,mj}(\omega) d\omega + \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} \pi^k_{i,m}(\omega) d\omega + T_m - E_m \tag{B.9}$$

where we used the profits of the assembler in country m of country i 's product to write:

$$\sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} P^k_{i,m}(\omega) Q^k_{i,m}(\omega) d\omega - \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{l=1}^{N} X^k_{i,lm} = \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} \pi^k_{i,m}(\omega) d\omega + T_m \tag{B.10}$$

Expressing total sales as the sum of profits and labor payments, we obtain:

$$NX_m = \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{j=1}^{N} \int_{\omega \in \Omega^k_i} \left(\pi^k_{i,mj}(\omega) + w_m \ell^k_{i,mj}(\omega)\right) d\omega + \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} \pi^k_{i,m}(\omega) d\omega + T_m - E_m \tag{B.11}$$

Next, we use that total income is given by $E_m = w_m L_m + \widetilde{\Pi}_m + T_m$, and use the labor market clearing condition to get:

$$NX_m = \sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{j=1}^{N} \int_{\omega \in \Omega^k_i} \pi^k_{i,mj}(\omega) d\omega + \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} \pi^k_{i,m}(\omega) d\omega - \left(\sum_{k=1}^{K} w_m G^k_m f^k_m + \Pi_m\right)$$

Finally, we use the definition of aggregate profits $\widetilde{\Pi}_m$, to obtain

$$NX_m = \sum_{k=1}^{K}\sum_{i=1}^{N} \int_{\omega \in \Omega^k_i} \left(\sum_{j=1}^{N} \pi^k_{i,mj}(\omega) + \pi^k_{i,m}(\omega)\right) d\omega - \sum_{k=1}^{K}\sum_{j=1}^{N} \int_{\omega \in \Omega^k_m} \left(\sum_{l=1}^{N} \pi^k_{m,lj}(\omega) + \pi^k_{m,j}(\omega)\right) d\omega$$

Equilibrium Definition In this section, we provide a more compact definition of the equilibrium conditions. In particular, we combine the labor market clearing condition, the firms' threshold rule and a country's budget constraint with the expressions provided in the previous section and the properties of the Pareto distribution, to obtain a system of $N \times N \times (N \times K)$ equations where the $N \times N \times (N \times K)$ unknowns

are $\{E_m, w_m, \{G_m^{k,G}\}_{k\in K}\}_{m\in\mathcal{N}}$:

$$G_m^{k,G} w_m f_m^k = \frac{\vartheta^k - \sigma + 1}{\vartheta^k}\left[\Pi_m^{k,G} - \frac{\left(\frac{G_m^{k,G}}{M_m^k}\right)^{\frac{\vartheta^k-\sigma+1}{\vartheta^k}}}{1-\left(\frac{G_m^{k,G}}{M_m^k}\right)^{\frac{\vartheta^k-\sigma+1}{\vartheta^k}}}\Pi_m^{k,L}\right] \tag{B.12}$$

$$E_m = \left(\sum_{\ell'}\sum_{k'}\frac{1}{t_{\ell' i}^{k'}} e_m^{k'}\lambda_{l'm}^{k'}\right)^{-1}\left[w_m L_m + \Pi_m - \sum_k G_m^{k,G} w_m f_m^k\right] \tag{B.13}$$

$$w_m L_m = \sum_j \Lambda_{mj}\left[w_j L_j + \Pi_j - \sum_k G_j^{k,G} w_j f_j^k\right] - \Pi_m + \sum_k G_m^{k,G} w_m f_m^k \tag{B.14}$$

where

$$\Lambda_{mj} = \frac{\sum_k \frac{e_j^k \lambda_{mj}^k}{t_{mj}^k}}{\left(\sum_{l'}\sum_{k'}\frac{1}{t_{l'm}^{k'}} e_j^k \lambda_{l'j}^{k'}\right)}, \quad \text{with} \quad \lambda_{lj}^k = \frac{\sum_i t_{lj}^k P_{i,lj}^{k,G} Q_{i,lj}^{k,G} + t_{lj}^k P_{l,lj}^{k,L} Q_{l,lj}^{k,L}}{e_j^k E_j} \tag{B.15}$$

and where aggregate profits are defined in equation (B.5). As shown in the previous section, aggregate profits can be expressed as a function of $\{E_m, w_m, \{G_m^{k,G}\}_{k\in K}\}_{m\in\mathcal{N}}$.

C Perfect Competition Benchmark

This section focuses on the benchmark with perfect competition and no fixed costs. In Section C.1, we show how the system of equilibrium conditions can be simplified in the perfect competition benchmark. In C.2, we compute the gains from trade, in Section C.3 we characterize the trade elasticity. The derivations on the existence and uniqueness of the equilibrium in the SOE limit are available upon request.

C.1 Equilibrium Conditions

In this section, we describe some of the model properties in a benchmark with two simplifying assumptions. First, we set fixed costs f_m^k to zero, which implies that all firms are global, and normalize the exogenous measure of firms to one in all countries. As an implication, we can drop the threshold condition (B.12) which determines selection into multinational companies. Second, we assume perfect competition, i.e. $\mu^k = 1$ and drop profits from constraints (B.13) and (B.14). The absence of profits implies that trade is balanced. Combining the trade balance condition with the labor market clearing condition, we can express (B.13) and (B.14) as a single constraint in terms of the vector of wages only. As a result, the equilibrium conditions reduce to a system of equations for the vector of wages:

$$w_i\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) L_i = \sum_{j\in\mathcal{N}} \Lambda_{ij}\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) w_j\left(\boldsymbol{t}_m, \boldsymbol{t}_{-m}\right) L_j \quad \forall i \in \mathcal{N} \tag{C.1}$$

where the definition of Λ_{ij} is unchanged from (B.15).

C.2 Gains from trade

As in standard trade models, in the decentralized equilibrium the utility of the household equals its real income, $U_m = E_m/P_m$. Because the country collects tariff revenue the income of the household is not equal to wage income and so

$$\frac{U_m}{L_m} = \frac{W_m/P_m}{\sum_{\ell\in\mathcal{N}}\sum_k \left(e_m^k \lambda_{\ell m}^k/\left(t_{\ell m}^k\right)\right)}. \tag{C.2}$$

The term in the denominator equals the ratio of country m's total expenditure to its wage income. When country m collects import tariff the two differ in equilibrium exactly by the tariff revenue. Demidova et al. (2022) refer to this term as country m's tariff multiplier.

We now show that our model implies that the household welfare allows for a sufficient statistic representation given by

$$\frac{U_m}{L_m} = \prod_k \left[e_m^k A_m^k \times \frac{(\lambda_{mm}^k)^{1/(1-\sigma)}}{\sum_{\ell\in\mathcal{N}}\sum_{k\in\mathcal{K}} \left(e_m^k \lambda_{\ell m}^k/\left(t_{\ell m}^k\right)\right)} \frac{(\lambda_{m,mm}^k)^{\frac{1}{1-\varepsilon}} \times (\lambda_{m,m}^k)^{\frac{1}{1-\sigma}}}{(\lambda_{mm}^k)^{\frac{1}{1-\sigma}}} \right]^{e_m^k}. \tag{C.3}$$

where λ_{mm}^k is country mj's trade share in sector k, $\lambda_{m,m}^k$ is country m's expenditure share in goods originated in m in sector k, and $\lambda_{m,mm}^k$ is country m's assembly share from location m of good originated in m in sector k. The first term measures country $m's$ welfare in autarky $U_m/L_m = \prod_k A_m^k$, which implies that equation (C.3) captures the gains from trade and multinational production relative to autarky, i.e. the welfare gains from openness (Ramondo and Rodríguez-Clare (2013)). As explained in section 3.3 the assumption of Cobb-Douglas preferences implies a log-additive structure that allows us to ignore cross elasticities of substitution between sectors.

Proposition 1. Welfare in country j has a sufficient statistic representation given by:

$$\frac{U_m}{L_m} = \prod_k e_m^k (GO_m^k)^{e_m^k} = \prod_k e_m^k \frac{(\lambda_{mm}^k)^{1/(1-\sigma)}}{\sum_{k\in\mathcal{K}}\sum_{\ell\in\mathcal{N}} \left(e_m^k \lambda_{\ell m}^k/\left(t_{\ell m}^k\right)\right)} \frac{(\lambda_{m,mm}^k)^{\frac{1}{1-\varepsilon}} \times (\lambda_{m,m}^k)^{\frac{1}{1-\sigma}}}{(\lambda_{mm}^k)^{\frac{1}{1-\sigma}}}, \qquad \text{for all} \quad m \in \mathcal{N}. \tag{C.4}$$

Proof. We start by noticing that the utility of the household equals its real income:

$$E_m = \sum_{i\in\mathcal{I}}\sum_{\ell\in\mathcal{L}}\sum_{m\in\mathcal{N}} \left(t_{\ell m}^k\right) P_{i,\ell m}^k Q_{i,\ell m}^k. \tag{C.5}$$

Welfare can then be expressed as,

$$\frac{U_m}{L_m} = \frac{W_m}{P_m} \times \left(\frac{W_m L_m}{\sum_k \sum_{i\in\mathcal{I}} \sum_{\ell\in\mathcal{L}} \left(t_{\ell m}^k\right) P_{i,\ell m}^k Q_{i,\ell m}^k} \right)^{-1}. \tag{C.6}$$

Starting from the labor market clearing condition and using the pricing equation, we can express

country m's value added as

$$W_m L_m = \sum_{i\in\mathcal{I}} \sum_{\ell\in\mathcal{N}} L_{i,m\ell} W_m = \sum_{i\in\mathcal{I}} \sum_{\ell\in\mathcal{N}} \sum_{k\in K} P^k_{i,m\ell} Q^k_{i,m\ell}.$$

Note that in the right-hand-side of this equation we have country $m's$ total exports, and therefore through the trade balance condition, we get,

$$W_m L_m = \sum_{i\in\mathcal{I}} \sum_{\ell\in\mathcal{N}} \sum_{k\in K} P^k_{i,\ell m} Q^k_{i,\ell m}. \tag{C.7}$$

Equations (C.5) to (C.7) combined imply,

$$\frac{U_m}{L_m} = \frac{W_m}{P_m} \times \left(\sum_{i\in\mathcal{I}} \sum_{m\in\mathcal{N}} \sum_{k\in K} \frac{1}{\left(t^k_{mj}\right)} \frac{\left(t^k_{mj}\right) P^k_{i,\ell m} Q^k_{i,\ell m}}{\sum_k \sum_{i\in\mathcal{I}} \sum_{\ell\in\mathcal{L}} \left(t^k_{\ell m}\right) P^k_{i,\ell m} Q^k_{i,\ell m}} \right)^{-1}$$

Note that:

$$\begin{aligned} \frac{\sum_{i\in\mathcal{I}} \left(t^k_{\ell m}\right) P^k_{i,\ell m} Q^k_{i,\ell m}}{\sum_k \sum_{i\in\mathcal{I}} \sum_{\ell'\in\mathcal{L}} \left(t^k_{\ell' j}\right) P^k_{i,\ell' m} Q^k_{i,\ell' m}} &= \frac{\sum_{i\in\mathcal{I}} \left(t^k_{\ell m}\right) P^k_{i,\ell m} Q^k_{i,\ell m}}{\sum_{i\in\mathcal{I}} \sum_{\ell'\in\mathcal{L}} \left(t^k_{\ell' j}\right) P^k_{i,\ell' m} Q^k_{i,\ell' m}} \frac{\sum_{i\in\mathcal{I}} \sum_{\ell'\in\mathcal{L}} \left(t^k_{\ell' j}\right) P^k_{i,\ell' m} Q^k_{i,\ell' m}}{\sum_k \sum_{i\in\mathcal{I}} \sum_{\ell'\in\mathcal{L}} \left(t^k_{\ell' j}\right) P^k_{i,\ell' m} Q^k_{i,\ell' m}} \\ &= e^k_m \lambda^k_{\ell m} \end{aligned}$$

is country m- sector k import share from country ℓ. Then, country m's welfare can be re-cast as:

$$\frac{U_m}{L_m} = \frac{W_m/P_m}{\sum_{\ell\in\mathcal{N}} \sum_{k\in K} \left(e^k_m \lambda^k_{\ell m} / \left(t^k_{\ell m}\right)\right)}. \tag{C.8}$$

We now relate a country's real wage income W_m/P_m to MP shares. For that we first define two new shares. First, we let $\lambda^k_{i,\ell m}$ denote country m's assembly share from location ℓ of good origin i in sector k, defined as

$$\lambda^k_{i,\ell m} = \frac{\left(t^k_{\ell n}\right) P^k_{i,\ell m} Q^k_{i,\ell m}}{\sum_{j\in\mathcal{L}} \left(t^k_{jm}\right) P^k_{i,jm} Q^k_{i,jm}}. \tag{C.9}$$

Second, we let $\lambda^k_{i,m}$ denote country m's expenditure share in goods originated in i out of total expenditures on sector k goods, defined as

$$\lambda^k_{i,m} = \frac{\sum_{\ell\in\mathcal{L}} \left(t^k_{\ell m}\right) P^k_{i,\ell m} Q^k_{i,\ell m}}{\sum_{o\in\mathcal{I}} \sum_{j\in\mathcal{L}} \left(1 + t^k_{jm}\right) P^k_{o,jm} Q^k_{o,jm}}. \tag{C.10}$$

Note that equations (C.9) and (C.10) imply

$$\lambda^k_{jm} = \sum_{i\in\mathcal{I}} \lambda^k_{i,jm} \times \lambda^k_{i,m}. \tag{C.11}$$

The next step is to use the expressions for prices and combine them with the definition in equations (C.10) and (C.11).

We first combine equation (C.10) with the price of an Armington variety to express assembly shares as a function of countries wage'

$$\lambda_{i,\ell m} = \frac{\left(\left(t^k_{\ell m}\right)\tau_{\ell m} W_\ell \gamma^k_{i\ell}/A^k_i\right)^{1-\varepsilon}}{\sum_{\ell\in\mathcal{L}}\left(t^k_{jm}\tau_{jm}W_j\gamma^k_{ij}/A^k_i\right)^{1-\varepsilon}}. \tag{C.12}$$

Since the price index in country j for goods originated in i is given by $(P^k_{im})^{1-\varepsilon} = \sum_{\ell\in\mathcal{L}}\left(\left(t^k_{\ell m}\right)\tau_{\ell m}W_k\gamma^k_{i\ell}/A^k_i\right)^{1-\varepsilon}$ we can express the price index in terms of the assembly share $\lambda^k_{i,\ell m}$ as

$$P^k_{im} = \frac{\left(t^k_{\ell m}\right)\tau_{\ell m}W_m\gamma^k_{i\ell}/A^k_i}{\left(\lambda^k_{i,\ell m}\right)^{1/(1-\varepsilon)}}, \qquad \text{for all } \ell\in\mathcal{L}. \tag{C.13}$$

It is important to note that equation (C.13) holds for any location ℓ from which country m is buying from. In particular, it holds for purchases from country m itself and so

$$P^k_{im} = \left(\lambda^k_{i,mm}\right)^{-\frac{1}{1-\varepsilon}} \times \left(W_m\gamma^k_{im}/A^k_i\right). \tag{C.14}$$

Plugging this into the ideal price index in sector k, we find:

$$P^k_m = \left[\sum_{i\in\mathcal{I}}\left(\lambda^k_{i,mm}\right)^{-\frac{1-\sigma}{1-\varepsilon}} \times (\gamma^k_{im}A^k_i)^{-(1-\sigma)}\right]^{\frac{1}{1-\sigma}} W_m. \tag{C.15}$$

The last step is to re-write these prices in terms of the MP shares. We start with equation (C.10) and use the zero profit condition for assemblers to get:

$$\lambda_{i,m} = \frac{P_{in}Q_{in}}{\sum_{a\in\mathcal{I}}P_{an}X_{an}}.$$

Combining with the demand system that implies $\lambda^k_{i,n} = \left(\frac{P^k_{im}}{P^k_m}\right)^{1-\sigma}$, we can write the real wage in terms of sector k good as:

$$\frac{W_m}{P^k_m} = (\lambda^k_{i,m})^{\frac{1}{1-\sigma}}\left(\lambda^k_{i,mm}\right)^{\frac{1}{1-\varepsilon}}\gamma^k_{im}A^k_i, \tag{C.16}$$

and we note as before that this must hold for any origin good i, in particular for those originated at country m. Finally, note that:$P_m = \prod_k\left(\frac{P^k_m}{e^k_m}\right)^{e^k_m}$. Then:

$$\frac{W_m}{P_m} = \prod_k\left[e^k_m(\lambda^k_{m,m})^{\frac{1}{1-\sigma}}\left(\lambda^k_{m,mm}\right)^{\frac{1}{1-\varepsilon}}A^k_m\right]^{e^k_m}, \tag{C.17}$$

Putting together equations (C.8) and (C.17) we get:

$$\frac{U_m}{L_m} = \prod_k \left[e_m^k \frac{A_m^k (\lambda_{mm}^k)^{1/(1-\sigma)}}{\sum_{\ell \in \mathcal{N}} \sum_{k \in \mathcal{K}} \left(e_{\ell m}^k \lambda_{\ell m}^k / \left(t_{\ell m}^k \right) \right)} \frac{(\lambda_{m,mm}^k)^{\frac{1}{1-\varepsilon}} \times (\lambda_{m,m}^k)^{\frac{1}{1-\varepsilon}}}{(\lambda_{mm}^k)^{\frac{1}{1-\sigma}}} \right]^{e_m^k}. \tag{C.18}$$

□

C.3 Trade elasticity

Trade elasticity. We define the trade elasticity as the partial equilibrium response of imports from ℓ relative to domestic consumption due to a permanent change in wages. Given the multiplicative nature of trade costs, wages and tariffs in the Armington framework, it would be equivalent to define the trade elasticity with respect to changes in trade costs or tariffs applied to imports. In this section, we exploit the log-additive nature of our Cobb-Douglas preference system and focus on the trade elasticity in a single sector. For this reason, we remove the superscript k.

$$\theta_{m\ell} \equiv -\frac{\partial \log \left(\lambda_{m\ell} / \lambda_{mm} \right)}{\partial \log \tau_{m\ell}}. \tag{C.19}$$

In the next proposition, we show that the trade elasticity is affected by the same determinants as welfare: (i) the two elasticity of substitution (σ and ε), and (ii) the trade, MP, and assembly shares ($\lambda_{m\ell}, \lambda_{i,m}$,and $\lambda_{i,\ell m}$).

Proposition 2. The trade elasticity between country m and country ℓ is

$$\theta_{m\ell} = (\varepsilon - 1) - (\varepsilon - \sigma) \times \sum_{i \in \mathcal{I}} \left(\lambda_{i,m\ell} \times \lambda_{i,\ell} \right) \times \left(\frac{\lambda_{i,m\ell}}{\lambda_{m\ell}} - \frac{\lambda_{i,\ell\ell}}{\lambda_{\ell\ell}} \right). \tag{C.20}$$

Proof. We showed in Proposition 1 that trade, MP, and assembly shares can be written as:

$$\lambda_{m\ell} = \sum_{i \in \mathcal{I}} \lambda_{i,m\ell} \times \lambda_{i,\ell}, \tag{C.21}$$

$$\lambda_{i,m\ell} = \frac{\lambda_{i,jj}^{-\frac{1-\sigma}{1-\varepsilon}} A_{i\ell}^{\sigma-1}}{\sum_{a \in \mathcal{I}} \lambda_{a,\ell\ell}^{-\frac{1-\sigma}{1-\varepsilon}} A_{a\ell}^{\sigma-1}}, \tag{C.22}$$

$$\lambda_{i,m\ell} = \frac{\left((t_{m\ell}) \, \tau_{m\ell} W_m / A_{im} \right)^{1-\varepsilon}}{\sum_{\ell \in \mathcal{L}} \left((t_{\ell m}) \, \tau_{\ell m} W_\ell / A_{i\ell} \right)^{1-\varepsilon}}. \tag{C.23}$$

where the double subscript, e.g. A_{im}, in productivity is used to denote the product between a country i's productivity A_i and the MP frictions γ_{im}. We start by substituting equations (C.22)

and (C.23) into equation (C.21) to express trade shares as functions of equilibrium wages:

$$\lambda_{m\ell} = \frac{\sum_{i\in\mathcal{I}}\left[\left(\left(t_{m\ell}\right)\tau_{m\ell}W_m/A_{im}\right)^{1-\varepsilon}\times\left(\sum_{j\in\mathcal{L}}\left(\left(t_{j\ell}\right)\tau_{j\ell}W_j/A_{ij}\right)^{1-\varepsilon}\right)^{\frac{\varepsilon-\sigma}{1-\varepsilon}}\right]}{\sum_{a\in\mathcal{I}}\left(\sum_{j\in\mathcal{L}}\left(\left(t_{j\ell}\right)\tau_{j\ell}W_j/A_{aj}\right)^{1-\varepsilon}\right)^{\frac{1-\sigma}{1-\varepsilon}}}.$$

It follows that,

$$\frac{\lambda_{m\ell}}{\lambda_{\ell\ell}} = \left(\left(t_{m\ell}\right)\tau_{m\ell}\frac{W_m}{W_\ell}\right)^{1-\varepsilon}\times\frac{\sum_{i\in\mathcal{I}}\left(A_{im}\right)^{\varepsilon-1}\times\left(\sum_{j\in\mathcal{L}}\left(\left(t_{j\ell}\right)\tau_{j\ell}W_j/A_{ij}\right)^{1-\varepsilon}\right)^{\frac{\varepsilon-\sigma}{1-\varepsilon}}}{\sum_{a\in\mathcal{I}}\left(A_{a\ell}\right)^{\varepsilon-1}\times\left(\sum_{j\in\mathcal{L}}\left(\left(t_{j\ell}\right)\tau_{j\ell}W_j/A_{aj}\right)^{1-\varepsilon}\right)^{\frac{\varepsilon-\sigma}{1-\varepsilon}}}. \tag{C.24}$$

The last step is to compute the partial derivative of equation (C.24) with respect to $\tau_{m\ell}$ keeping wages fixed. Define,

$$\mathbb{A}_{m\ell} \equiv \sum_{i\in\mathcal{I}}\left(A_{im}\right)^{\varepsilon-1}\times\left(\sum_{j\in\mathcal{L}}\left(\left(t_{j\ell}\right)\tau_{j\ell}W_j/A_{ij}\right)^{1-\varepsilon}\right)^{\frac{\varepsilon-\sigma}{1-\varepsilon}}.$$

Then,

$$\theta_{m\ell} = \left(\varepsilon-1\right) - \frac{1}{\mathbb{A}_{m\ell}}\frac{\partial\mathbb{A}_{m\ell}}{\partial\log\tau_{m\ell}} + \frac{1}{\mathbb{A}_{\ell\ell}}\frac{\partial\mathbb{A}_{\ell\ell}}{\partial\log\tau_{m\ell}},$$

with

$$\begin{aligned}\frac{1}{\mathbb{A}_{m\ell}}\frac{\partial\mathbb{A}_{m\ell}}{\partial\log\tau_{m\ell}} &= \left(\varepsilon-\sigma\right)\times\left(\sum_{i\in\mathcal{I}}\lambda_{i,m\ell}\times\frac{\lambda_{i,m\ell}\times\lambda_{i,\ell}}{\lambda_{m\ell}}\right),\\ \frac{1}{\mathbb{A}_{\ell\ell}}\frac{\partial\mathbb{A}_{\ell\ell}}{\partial\log\tau_{m\ell}} &= \left(\varepsilon-\sigma\right)\times\left(\sum_{a\in\mathcal{I}}\lambda_{a,m\ell}\times\frac{\lambda_{a,\ell\ell}\times\lambda_{a,\ell}}{\lambda_{\ell\ell}}\right).\end{aligned}$$

Therefore, the trade elasticity between country m and ℓ equals

$$\theta_{m\ell} = \left(\varepsilon-1\right) - \left(\varepsilon-\sigma\right)\times\left[\sum_{i\in\mathcal{I}}\left(\lambda_{i,m\ell}\times\lambda_{i,\ell}\right)\times\left(\frac{\lambda_{i,m\ell}}{\lambda_{m\ell}} - \frac{\lambda_{i,\ell\ell}}{\lambda_{\ell\ell}}\right)\right].$$

□

In general, the trade elasticity is not constant and is shape by the amount of trade and MP in the economy. However, there are two extreme cases in which $\theta_{m\ell}$ becomes constant and only depends on either the elasticity of substitution across varieties (σ or ε) as in standard models of trade.

Corollary 1. When either MP is free ($\gamma_{ij} = 1$ for all i and ℓ) or prohibitively costly ($\gamma_{ij} = \infty$ for all i and ℓ) the trade elasticity between country m and country ℓ is constant and equals to $\theta_{m\ell} = \varepsilon - 1$ and $\theta_{m\ell} = \sigma - 1$, respectively.

Proof. In the first case, it is easy to check that $\lambda_{i,mn} = \lambda_{a,mn} = \lambda_{mn}$. Substituting this into equation

(C.20) yields

$$\theta_{m\ell} = (\varepsilon - 1) - (\varepsilon - \sigma) \times \sum_{i \in \mathcal{I}} (\lambda_{i,m\ell} \times \lambda_{i,\ell}) \times \left(\frac{1}{\sum_{a \in \mathcal{I}} \lambda_{i,\ell}} - \frac{1}{\sum_{a \in \mathcal{I}} \lambda_{i,\ell}} \right) = (\varepsilon - 1)\,.$$

For the other case, we note that if $\gamma_{i\ell} = \infty$ for all countries i and locations ℓ trade shares between any two countries become

$$\frac{\lambda_{m\ell}}{\lambda_{\ell\ell}} = \frac{((t_{m\ell})\,\tau_{m\ell} W_m / A_{mm})^{1-\sigma}}{(W_\ell / A_{\ell\ell})^{1-\sigma}},$$

and clearly $\theta_{m\ell} = \sigma - 1$. □

Corollary 2. If the elasticity across location of production is higher than the elasticity across goods, i.e., if $\varepsilon > \sigma$, then the trade elasticity is higher in the presence of MP.

Proof. Remember from Corollary 1 when MP becomes prohibitively costly the trade elasticity between country m and country j is constant and equal to $\theta_{m\ell} = \sigma - 1$. Then, it suffices to show that $\theta_{m\ell} > \sigma - 1$. From Proposition 1 we have

$$\theta_{m\ell} - (\sigma - 1) > (\varepsilon - \sigma) \left[1 - \sum_{i \in \mathcal{I}} (\lambda_{i,m\ell} \times \lambda_{i,\ell}) \times \left(\frac{\lambda_{i,mj}}{\lambda_{m\ell}} - \frac{\lambda_{i,\ell\ell}}{\lambda_{\ell\ell}} \right) \right].$$

Then $\theta_{m\ell} > \sigma - 1$ if and only if the term in squared brackets is non-negative, which is true since

$$1 - \sum_{i \in \mathcal{I}} (\lambda_{i,m\ell} \times \lambda_{i,\ell}) \times \left(\frac{\lambda_{i,m\ell}}{\lambda_{m\ell}} - \frac{\lambda_{i,\ell\ell}}{\lambda_{\ell\ell}} \right) = \sum_{i \in \mathcal{I}} (\lambda_{i,m\ell} \times \lambda_{i,\ell}) \left(\frac{1 - \lambda_{i,m\ell}}{\lambda_{m\ell}} + \frac{\lambda_{i,\ell\ell}}{\lambda_{\ell\ell}} \right) > 0.$$

□

D The Small Open Economy Limit (SOE)

From now on we focus on country 0. Population, MP-frictions, and iceberg costs are -re-parameterized such that for country $j = 0$ (Home) we have:

$$\begin{aligned} \tilde{L}_0 &= n^{\frac{\sigma-1}{\varepsilon-1}} L_0 \\ \tilde{\tau}_{0j} &= n^{-1/(\varepsilon-1)} \tau_{0j}, \qquad j = 1, 2, \ldots, N \\ \tilde{\gamma}_{0j} &= n^{-1/(\varepsilon-1)} \gamma_{0,j}, \qquad j = 1, 2, \ldots, N. \end{aligned} \tag{D.1}$$

We take labor of country N as the numeraire: $\tilde{w}_N = 1$. In this section, we show that as country 0 becomes arbitrary small (i.e., as $n \to 0$), the equilibrium converges to the one in which $(\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_N)$ can be solved independently of country $0's$ variables, and that $\tilde{w}_0$ is finite. Since in equilibrium Foreign prices are independent of country 0's variables we see this limit as an equilibrium where

country 0 is a small open economy.[2]

In this section we proceed in two steps. First we re-write the relevant equations in terms of the new parameterization equation (D.1). We then take the limit with $n \to 0$ and establish the main result.

1. Working with the equilibrium conditions. We first define:

$$\tilde{\lambda}^k_{o,ij} = \frac{\left(t^k_{ij}\tau_{ij}\gamma_{o,i}\tilde{w}_i\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{\ell j}\tau_{\ell j}\gamma_{o,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + n\left(t^k_{0j}\tau_{0j}\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda^k_{o,ij}, \qquad o,i,j = 1,2,\ldots,N \tag{D.2}$$

$$\tilde{\lambda}^k_{0,ij} = \frac{\left(t^k_{ij}\tau_{ij}\gamma_{0,i}\tilde{w}_i\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{\ell j}\tau_{\ell j}\gamma_{0,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(t^k_{0j}\tau_{0j}\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda^k_{0,ij}, \qquad i,j = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{o,0j} = n\frac{\left(t^k_{0j}\tau_{0j}\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{\ell j}\tau_{\ell j}\gamma_{o,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + n\left(t^k_{0j}\tau_{0j}\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}} \equiv n\lambda^k_{o,0j}, \qquad o,j = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{0,0j} = \frac{\left(t^k_{0j}\tau_{0j}\tilde{w}_0\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{\ell j}\tilde{\tau}_{\ell j}\gamma_{0,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(t^k_{0j}\tau_{0j}\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda^k_{0,0j}, \qquad j = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{o,i0} = \frac{\left(t^k_{i0}\tau_{i0}\gamma_{o,i}\tilde{w}_i\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{\ell 0}\tau_{l0}\gamma_{o,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(t^k_{00}\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda^k_{o,i0}, \qquad o,i = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{0,i0} = n\frac{\left(t^k_{i0}\tau_{i0}\gamma_{0,i}\tilde{w}_i\right)^{1-\varepsilon}}{n\sum_{\ell=1}^N \left(t^k_{\ell 0}\tau_{\ell 0}\gamma_{0,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(\tilde{w}_0\right)^{1-\varepsilon}} \equiv n\lambda^k_{0,i0}, \qquad i = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{o,00} = \frac{\left(\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}}{\sum_{\ell=1}^N \left(t^k_{l0}\tau_{\ell 0}\gamma_{o,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(\gamma_{o,0}\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda^k_{o,00}, \qquad o = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{0,00} = \frac{\left(\tilde{w}_0\right)^{1-\varepsilon}}{n\sum_{\ell=1}^N \left(t^k_{\ell 0}\tau_{\ell 0}\gamma_{0,\ell}\tilde{w}_\ell\right)^{1-\varepsilon} + \left(\tilde{w}_0\right)^{1-\varepsilon}} \equiv \lambda_{0,00}.$$

[2]For now we don't address the problem of showing that an equilibrium exists and that is unique for all n. This step is important since it allow us to conclude that there is a well defined equilibrium in the limit.

Note that:

$$
\begin{aligned}
n \times \lambda_{o,0j}^k + \sum_{i=1}^N \lambda_{o,ij}^k &= 1, \ o, j \geq 1 \\
\lambda_{0,0j}^k + \sum_{i=1}^N \lambda_{0,ij}^k &= 1, \ j \geq 1 \\
\lambda_{o,00}^k + \sum_{i=1}^N \lambda_{o,i0}^k &= 1, \ o \geq 1 \\
\lambda_{0,00}^k + n \times \sum_{i=1}^N \lambda_{0,i0}^k &= 1.
\end{aligned}
$$

We can then define:

$$
\tilde{\lambda}_{o,i}^k = \frac{(\gamma_{o,i})^{1-\sigma} \left(A_o^k\right)^{\sigma-1} \left(\lambda_{o,ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^N (\gamma_{o',i})^{1-\sigma} \left(A_{o'}^k\right)^{\sigma-1} \left(\lambda_{o',ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}} + n^{\frac{\sigma-1}{\varepsilon-1}} (\gamma_{0,i})^{1-\sigma} \left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}} \equiv \lambda_{o,i}^k, \qquad o, i \geq 1 \tag{D.3}
$$

$$
\tilde{\lambda}_{0,i}^k = n^{\frac{\sigma-1}{\varepsilon-1}} \frac{(\gamma_{0,i})^{1-\sigma} \left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^N \left(\tilde{\gamma}_{o',i}\right)^{1-\sigma} \left(A_{o'}^k\right)^{\sigma-1} \left(\tilde{\lambda}_{o',ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}} + n^{\frac{\sigma-1}{\varepsilon-1}} (\gamma_{0,i})^{1-\sigma} \left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,ii}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}} \equiv n^{\frac{\sigma-1}{\varepsilon-1}} \lambda_{0,i}^k, \qquad i \geq 1
$$

$$
\tilde{\lambda}_{o,0}^k = \frac{(\gamma_{o,0})^{1-\sigma} \left(A_o^k\right)^{\sigma-1} \left(\lambda_{o,00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^N (\gamma_{o',0})^{1-\sigma} \left(A_{o'}^k\right)^{\sigma-1} \left(\lambda_{o',00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}} + \left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}} \equiv \lambda_{o,0}^k, \qquad o \geq 1
$$

$$
\tilde{\lambda}_{0,0}^k = \frac{\left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^N (\gamma_{o',0})^{1-\sigma} \left(A_{o'}^k\right)^{\sigma-1} \left(\lambda_{o',00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}} + \left(A_0^k\right)^{\sigma-1} \left(\lambda_{0,00}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}} \equiv \lambda_{0,0}^k.
$$

Note that:

$$
n^{\frac{\sigma-1}{\varepsilon-1}} \lambda_{0,i}^k + \sum_{o=1}^N \lambda_{o,j}^k = 1, \quad \lambda_{0,0}^k + \sum_{o=1}^N \lambda_{o,0}^k = 1.
$$

We can now define the following expenditure shares:

$$\tilde{\lambda}^k_{ij} = n^{\frac{\sigma-1}{\varepsilon-1}}\lambda^k_{0,ij}\lambda^k_{0,j} + \sum_{o=1}^{N}\lambda^k_{o,ij}\lambda^k_{o,j} \equiv \lambda^k_{ij} \qquad i,j = 1,2,\ldots,N \tag{D.4}$$

$$\tilde{\lambda}^k_{0j} = n^{\frac{\sigma-1}{\varepsilon-1}}\left(\lambda^k_{0,0j}\lambda^k_{0,j} + n^{\frac{\varepsilon-\sigma}{\varepsilon-1}}\sum_{o=1}^{N}\lambda^k_{o,0j}\lambda^k_{o,j}\right) \equiv n^{\frac{\sigma-1}{\varepsilon-1}}\lambda^k_{0j}, \qquad j = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{i0} = n\lambda^k_{0,i0}\lambda^k_{0,0} + \sum_{o=1}^{N}\lambda^k_{o,i0}\lambda^k_{o,0} \equiv \lambda^k_{i0}, \qquad i = 1,2,\ldots,N$$

$$\tilde{\lambda}^k_{00} = \lambda^k_{0,00}\lambda^k_{0,0} + \sum_{o=1}^{N}\lambda^k_{o,00}\lambda^k_{o,0} \equiv \lambda^k_{00}.$$

Note that:

$$n^{\frac{\sigma-1}{\varepsilon-1}}\lambda^k_{0j} + \sum_{i=1}^{N}\lambda^k_{ij} = 1, \quad \lambda^k_{00} + \sum_{i=1}^{N}\lambda^k_{i0} = 1.$$

Finally, for any $k \in \mathcal{K}$ we define:

$$\tilde{\Lambda}_{ij} = \frac{\sum_{k=1}^{K}\lambda^k_{ij}\alpha_k/t^k_{ij}}{\sum_{\ell=1}^{N}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{\ell j}/t^s_{\ell j}\right) + n^{\frac{\sigma-1}{\varepsilon-1}}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{0j}/t^s_{0j}\right)} \equiv \Lambda_{ij}, \qquad i,j = 1,2,\ldots,N \tag{D.5}$$

$$\tilde{\Lambda}_{0j} = n^{\frac{\sigma-1}{\varepsilon-1}}\frac{\sum_{k=1}^{K}\lambda^k_{0j}\alpha_k/t^k_{0j}}{\sum_{\ell=1}^{N}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{\ell j}/t^s_{\ell j}\right) + n^{\frac{\sigma-1}{\varepsilon-1}}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{0j}/t^s_{0j}\right)} \equiv n^{\frac{\sigma-1}{\varepsilon-1}}\Lambda_{0j}, \qquad j = 1,2,\ldots,N$$

$$\tilde{\Lambda}_{i0} = \frac{\sum_{k=1}^{K}\lambda^k_{i0}\alpha_k/t^k_{i0}}{\sum_{\ell=1}^{N}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{\ell 0}/t^s_{\ell 0}\right) + \sum_{s=1}^{K}\left(\alpha_s\lambda^s_{00}\right)} \equiv \Lambda_{i0}, \qquad i = 1,2,\ldots,N$$

$$\tilde{\Lambda}_{00} = \frac{\sum_{k=1}^{K}\lambda^k_{00}\alpha_k}{\sum_{\ell=1}^{N}\sum_{s=1}^{K}\left(\alpha_s\lambda^s_{\ell 0}/t^s_{\ell 0}\right) + \sum_{s=1}^{K}\left(\alpha_s\lambda^s_{00}\right)} \equiv \Lambda_{00}.$$

Note,

$$n^{\frac{\sigma-1}{\varepsilon-1}}\Lambda_{0j} + \sum_{i=1}^{N}\Lambda_{ij} = 1, \qquad \Lambda_{00} + \sum_{i=1}^{N}\Lambda_{i0} = 1.$$

2. The Labor Market clearing condition. We take equation (21) and use equations (D.1) and (D.5) to get:

$$\tilde{w}_I L_I = \sum_{J=0}^{N}\tilde{\Lambda}_{IJ}\tilde{w}_J L_J,$$

$$\tilde{w}_i L_i = \Lambda_{i0}\tilde{w}_0 n^{\frac{\sigma-1}{\varepsilon-1}}L_0 + \sum_{j=1}^{N}\Lambda_{ij}\tilde{w}_j L_j, \qquad i = 1,2,\ldots,N \tag{D.6}$$

$$\tilde{w}_0 L_0 = \Lambda_{00}\tilde{w}_0 L_0 + \sum_{j=1}^{N}\Lambda_{0j}\tilde{w}_j L_j. \tag{D.7}$$

3. The limit economy. We can now characterize the limit equilibrium as $n \to 0$. Suppose that $w_0 \in (0, \infty)$, which will be verified later. Then, our previous equation implies that our variables without tildes converge to positive values, and so the system (D.6)-(D.7) reduces to:

$$w_i L_i = \sum_{j=1}^{N} \Lambda_{ij} w_j L_j, \qquad i = 1, 2, \ldots, N \tag{D.8}$$

$$w_0 L_0 = \Lambda_{00} w_0 L_0 + \sum_{j=1}^{N} \Lambda_{0j} w_j L_j. \tag{D.9}$$

Focus for a moment in equation (D.8), which we copy again below

$$\begin{aligned}
w_i L_i &= \sum_{j=1}^{N} \tilde{\Lambda}_{ij} w_j L_j, \qquad i = 1, 2, \ldots, N \\
\Lambda_{ij} &= \frac{\sum_{k=1}^{K} \lambda_{ij}^k \alpha_k / t_{ij}^k}{\sum_{\ell=1}^{N} \sum_{s=1}^{K} \left(\alpha_s \lambda_{\ell j}^s / t_{\ell j}^s \right)} \qquad i, j = 1, 2, \ldots, N \\
\lambda_{ij}^k &= \sum_{o=1}^{N} \lambda_{o,ij}^k \lambda_{o,j}^k, \qquad i, j = 1, 2, \ldots, N, \forall k \\
\lambda_{o,j}^k &= \frac{\left(\gamma_{o,j}\right)^{1-\sigma} \left(A_o^k\right)^{\sigma-1} \left(\lambda_{o,jj}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^{N} \left(\gamma_{o',j}\right)^{1-\sigma} \left(A_{o'}^k\right)^{\sigma-1} \left(\lambda_{o',jj}^k\right)^{-\frac{\sigma-1}{\varepsilon-1}}}, \qquad o, j = 1, 2, \ldots, N, \forall k \\
\lambda_{o,ij}^k &= \frac{\left(t_{ij}^k \tau_{ij} \gamma_{o,i} w_i\right)^{1-\varepsilon}}{\sum_{\ell=1}^{N} \left(t_{\ell j}^k \tau_{\ell j} \gamma_{o,\ell} w_\ell\right)^{1-\varepsilon}}, \qquad , o, ij \geq 1, \forall k.
\end{aligned} \tag{D.10}$$

This system does not depend on country 0's wage (w_0) nor on the import tariff that country 0 imposes to the rest of the countries. Then, given the import tariff set by all countries, system (D.10) defines an autonomous system for $\mathbf{w}_{-0} \equiv (w_1, w_2, \ldots, w_{N-1}, 1)$. Per our preview results an equilibrium exists and it is unique. Furthermore, $\mathbf{w}_{-0}$ does not depend on country $0's$ import tariff.

Proposition 3. The equilibrium of the SOE economy limit has a unique equilibrium wage vector $\mathbf{w}_{-0}$ that is independent of country 0's trade policy. The wage vector $\mathbf{w}_{-0}$ solves system (D.10).

We now move to characterize the equilibrium value for w_0 and show that $w_0 \in (0, \infty)$. Country 0's wage is pin down by the equation:

$$\sum_{j=1}^{N} \Lambda_{0j} w_j L_j = w_0 L_0 \left(1 - \Lambda_{00}\right).$$

Given the unique equilibrium vector $\mathbf{w}_{-0}$, the left hand side of the previous equation is decreasing in w_0, approaches infinity as $w_0 \to 0$, and approaches zero as $w_0 \to \infty$ since:

$$
\begin{aligned}
\Lambda_{0j}\left(w_0\right) &= \frac{\sum_{k=1}^{K}\lambda_{0j}^{k}\left(w_0\right)\alpha_k/t_{0j}^{k}}{\sum_{\ell=1}^{N}\sum_{s=1}^{K}\alpha_s\lambda_{\ell j}^{s}/t_{\ell j}^{s}}\\
\lambda_{0j}^{k}\left(w_0\right) &= \lambda_{0,0j}^{k}\left(w_0\right)\lambda_{0,j}^{k}\left(w_0\right)\\
\lambda_{0,j}^{k}\left(w_0\right) &= \frac{\left(\gamma_{0,j}\right)^{1-\sigma}\left(A_0^k\right)^{\sigma-1}\left(\lambda_{0,jj}^{k}\left(w_0\right)\right)^{-\frac{\sigma-1}{\varepsilon-1}}}{\sum_{o'=1}^{N}\left(\gamma_{o',j}\right)^{1-\sigma}\left(A_{o'}^k\right)^{\sigma-1}\left(\lambda_{o',jj}^{k}\right)^{-\frac{\sigma-1}{\varepsilon-1}}}\\
\lambda_{0,0j}^{k}\left(w_0\right) &= \frac{\left(t_{0j}^{k}\tau_{0j}w_0\right)^{1-\varepsilon}}{\sum_{\ell=1}^{N}\left(t_{\ell j}^{k}\tau_{\ell j}\gamma_{0,\ell}w_\ell\right)^{1-\varepsilon}+\left(t_{0j}^{k}\tau_{0j}w_0\right)^{1-\varepsilon}}\\
\lambda_{0,jj}^{k}\left(w_0\right) &= \frac{\left(\gamma_{0,j}w_j\right)^{1-\varepsilon}}{\sum_{\ell=1}^{N}\left(t_{\ell j}^{k}\tau_{\ell j}\gamma_{0,\ell}w_\ell\right)^{1-\varepsilon}+\left(t_{0j}^{k}\tau_{0j}w_0\right)^{1-\varepsilon}}\\
\lambda_{0j}^{k}\left(w_0\right) &\propto \frac{\left(t_{0j}^{k}\tau_{0j}w_0\right)^{1-\varepsilon}}{\left[\sum_{\ell=1}^{N}\left(t_{\ell j}^{k}\tau_{\ell j}\gamma_{0,\ell}w_\ell\right)^{1-\varepsilon}+\left(t_{0j}^{k}\tau_{0j}w_0\right)^{1-\varepsilon}\right]^{\frac{\varepsilon-\sigma}{\varepsilon-1}}}.
\end{aligned}
$$

The right-hand side, on the other hand approaches zero as $w_0 \to 0$, and approaches infinity as $w_0 \to \infty$. This follows from the fact that $\left(1-\tilde{\Lambda}_{00}\right)$ is bounded below by 0 and above by 1 for all values of w_0. Therefore, the two curves cross at least once and in those points $w_0 \in (0,\infty)$. We note that we cannot rule out that the curves cross multiple times.

Proposition 4. The equilibrium of the SOE economy limit has a unique equilibrium wage vector $\mathbf{w}_{-0}$ that is independent of country 0's trade policy. The wage vector $\mathbf{w}_{-0}$ solves system (D.8). Furthermore, there is a unique finite equilibrium value for w_0 which solves equation (D.9).

4. Deriving the trade elasticity. We define the trade elasticity in sector k as

$$
\theta_{0j}^{k} \equiv -\frac{\partial \log\left(\lambda_{0j}^{k}/\lambda_{jj}^{k}\right)}{\partial \log\left(t_{0j}^{k}\right)}.
$$

We note that

$$
\theta_{0j}^{k} = -\frac{\partial\lambda_{0j}^{k}}{\partial w_0}\frac{w_0}{\lambda_{0j}^{k}} = (\varepsilon-1)-(\varepsilon-\sigma)\,\lambda_{0,0j}^{k}\left(w_0\right).
$$

Hence, the trade elasticity is **not constant,** and it depends on the size of MP-costs.

E Optimal Import Tariff in LOE, Two Countries, One Sector

We denote the total expenditure of country n by E_n and the expenditure (inclusive of tariffs) on goods from the rest of the world i as E_{in}. The share of the total expenditure in country n that is spent on imported goods is given by $\lambda_{in} = E_{in}/E_n$. Denote by t_{in} the one plus ad-valorem import tariff applied by country n to goods imported from country i.

Note that we can write tariff revenue as:

$$T_n = (t_{in} - 1)\frac{E_{in}}{t_{in}} = (t_{in} - 1)\frac{\lambda_{in}}{t_{in}}E_n,$$

and so total expenditure is given by:

$$E_n = w_n L_n + (t_{in} - 1)\frac{\lambda_{in}}{t_{in}}E_n.$$

We use this equation to solve for per-capita expenditure and obtain:

$$\frac{E_n}{L_n} = w_n \frac{t_{in}}{t_{in} - (t_{in} - 1)\lambda_{in}}.$$

Now use that $\lambda_{in} + \lambda_{nn} = 1$ to get:

$$\frac{E_n}{L_n} = w_n \frac{t_{in}}{1 + (t_{in} - 1)\lambda_{nn}}. \tag{E.1}$$

Trade is balanced, and therefore the value of exports equals the value of imports:

$$\frac{\lambda_{in}}{t_{in}}E_n = \frac{\lambda_{ni}}{t_{ni}}E_i, \tag{E.2}$$

where the tariff that the rest of the world applies to goods from n is t_{ni}.

Welfare per capita in country n equals country's real income per worker,

$$U_n = \frac{E_n}{L_n P_n} = \frac{w_n}{P_n}\frac{t_{in}}{1 + (t_{in} - 1)\lambda_{nn}}. \tag{E.3}$$

Fully differentiating equation E.3, to obtain

$$\hat{U}_n = \left(\frac{\hat{w_n}}{P_n}\right) + \frac{(1 - \lambda_{nn})}{1 + (t_{in} - 1)\lambda_{nn}}\hat{t}_{in} - \frac{(t_{in} - 1)\lambda_{nn}}{1 + (t_{in} - 1)\lambda_{nn}}\hat{\lambda}_{nn}, \tag{E.4}$$

where a variable with 'hats' refers to the log difference, namely $\hat{x} \equiv d\ln(x)$.

We notice now that all endogenous variables in this economy are functions of the relative wage $\bar{w}$ and the tariff t_{in}, while the relative wage $\bar{w}$ is only a function of the tariff t_{in} and is the quantity that solves equation E.2. We will use this to derive expressions for $\hat{\lambda}_{nn}$ and $\left(\frac{\hat{w_n}}{P_n}\right)$ as functions of $\hat{t}_{in}$.

First we note that $\hat{\lambda}_{nn}$ equals

$$\hat{\lambda}_{nn} = \left[\frac{\partial\lambda_{nn}}{\partial t_{in}}\frac{t_{in}}{\lambda_{nn}}\hat{t}_{in} + \frac{\partial\lambda_{nn}}{\partial\bar{w}}\frac{\bar{w}}{\lambda_{nn}}\hat{\bar{w}}\right] = \left[\frac{\partial\lambda_{nn}}{\partial t_{in}}\frac{t_{in}}{\lambda_{nn}} + \left(\frac{\partial\lambda_{nn}}{\partial\bar{w}}\frac{\bar{w}}{\lambda_{nn}}\right) \times \left(\frac{\partial\bar{w}}{\partial\tau_{in}}\frac{t_{in}}{\bar{w}}\right)\right]\hat{t}_{in}.$$

We note that $-\frac{\partial\lambda_{nn}}{\partial\bar{w}}\frac{\bar{w}}{\lambda_{nn}} = \frac{\partial\lambda_{nn}}{\partial t_{in}}\frac{t_{in}}{\lambda_{nn}}$ and therefore,

$$\hat{\lambda}_{nn} = \frac{\partial\lambda_{nn}}{\partial t_{in}}\frac{t_{in}}{\lambda_{nn}}\left(1 - \frac{\partial\bar{w}}{\partial t_{in}}\frac{t_{in}}{\bar{w}}\right)\hat{t}_{in}.$$

Now we use that $\lambda_{nn} + \lambda_{in} = 1$ and the definition of the trade elasticity θ_{in} to obtain:

$$\lambda_{in}\theta_{in} = \frac{\partial \lambda_{nn}}{\partial t_{in}} \frac{t_{in}}{\lambda_{nn}}.$$

Therefore,

$$\hat{\lambda}_{nn} = \lambda_{in}\theta_{in} \left(1 - \frac{\partial \bar{w}}{\partial t_{in}} \frac{t_{in}}{\bar{w}}\right) \hat{t}_{in}. \tag{E.5}$$

The last two elements we need then are the response of relative wages to tariffs $\left(\hat{\frac{w_n}{P_n}}\right)$, and the general equilibrium response of relative wages $\hat{\bar{w}}$. Depending on the specification of MP frictions we have different general equilibrium responses for relative wages $\frac{\partial \bar{w}}{\partial t_{in}} \frac{t_{in}}{\bar{w}}$, and values for assembly and trade shares. We explore now some special cases and derive the optimal policy before moving to the more general case.

Case I – No-MP case. First, we assume that $\gamma_{in} \to \infty$ for all i and n. In this case, $\lambda_{n,in} = 0$, $\theta_{in} \to (\sigma - 1)$, and relative wages are given by

$$\frac{w_n}{P_n} = \lambda_{n,n}^{\frac{1}{1-\sigma}} A_{nn} = \lambda_{nn}^{\frac{1}{1-\sigma}} A_{nn}.$$

Then, the change in the real wage is given $\left(\hat{\frac{w_n}{P_n}}\right) = \frac{1}{1-\sigma}\hat{\lambda}_{nn}$, while the total change in welfare is

$$\hat{U}_n = \left[\left(\frac{1}{1-\sigma} - \frac{(t_{in}-1)\,\lambda_{nn}}{1+(t_{in}-1)\,\lambda_{nn}}\right) \lambda_{in}\theta_{in} \left(1 - \frac{\partial \bar{w}}{\partial t_{in}} \frac{t_{in}}{\bar{w}}\right) + \frac{(1-\lambda_{nn})}{1+(t_{in}-1)\,\lambda_{nn}}\right] \hat{t}_{in}, \tag{E.6}$$

where we use both equation E.4 along with equation E.5. The optimal tariff is then the solution to $\hat{U}_n = 0$ which implies,

$$(t_{in} - 1) = \frac{1}{\sigma \lambda_{nn}} \left[\frac{1-\lambda_{nn}}{\lambda_{in}} \left(1 - \frac{\partial \bar{w}}{\partial t_{in}} \frac{t_{in}}{\bar{w}}\right)^{-1} - 1\right]. \tag{E.7}$$

The last step is to compute the full general equilibrium response of relative wages to taxes $\frac{\partial \bar{w}}{\partial t_{ni}} \frac{t_{ni}}{\bar{w}}$ which is determined by the trade balance condition

$$\frac{\lambda_{ni}}{t_{ni}} X_n = \frac{\lambda_{in}}{t_{in}} X_i,$$

along with the equation for trade shares

$$\lambda_{ni} = \frac{(t_{ni} w_i / A_i)^{(1-\sigma)}}{(w_n/A_n)^{(1-\sigma)} + (t_{ni} w_i / A_i)^{(1-\sigma)}},$$

and it is given by:

$$\frac{\partial \bar{w}}{\partial t_{in}} \frac{t_{in}}{\bar{w}} = \frac{\sigma \tilde{\lambda}_{nn}}{1 + (\sigma - 1)\left[\tilde{\lambda}_{ii} + \tilde{\lambda}_{nn}\right]}, \tag{E.8}$$

where $\tilde{\lambda}_{ii} \equiv \frac{t_{ni}\lambda_{ii}}{1+(t_{ni}-1)\lambda_{ii}}$ is the share of production sold to domestic consumers in country i.

Combining equations E.7 and E.8it is easy to show that the optimal tariff is given by

$$(t_{in} - 1) = \frac{1}{(\sigma - 1)\,\tilde{\lambda}_{ii}}. \tag{E.9}$$

Note that if $\tau_{in} = 1$, i.e., the foreign country place no tariff on Home's goods, then $\tilde{\lambda}_{ii} = \frac{t_{in}\lambda_{ii}}{1+(t_{in}-1)\lambda_{ii}} = \lambda_{ii}$ and we recover the standard formula.

Case II – Free-MP case. First, we assume that $\gamma_{in} = 1$ for all i and n. In this case, $\lambda_{n,in} = \lambda_{in}$, the trade elasticity collapses to $\theta_{in} \to (\varepsilon - 1)$, and relative wages are given by

$$\frac{w_n}{P_n} = (\lambda_{n,nn})^{\frac{1}{1-\varepsilon}} A_{nn} = (\lambda_{nn})^{\frac{1}{1-\varepsilon}} A_{nn}.$$

In this case, the change in the real wage is given by $\left(\hat{\frac{w_n}{P_n}}\right) = \frac{1}{1-\varepsilon}\hat{\lambda}_{nn}$, and so following similar steps as before it is easy to show that the optimal tariff implied by the model is in this case

$$(\tau_{in} - 1) = \frac{1}{\varepsilon\lambda_{nn}}\left[\frac{1-\lambda_{nn}}{\lambda_{ni}}\left(1 - \frac{\partial\bar{w}}{\partial t_{in}}\frac{t_{in}}{\bar{w}}\right)^{-1} - 1\right]. \tag{E.10}$$

We note that the general equilibrium response of relative wages is still determine by the trade balance condition with the difference that now trade shares are given by:

$$\lambda_{in} = \frac{(t_{in}w_i/A_i)^{(1-\varepsilon)}}{(w_n/A_n)^{(1-\varepsilon)} + (t_{in}w_i/A_i)^{(1-\varepsilon)}}.$$

Comparing the equations to those we had in the previous case it is straightforward to conclude that in this case equation E.10 reduces to

$$(t_{in} - 1) = \frac{1}{(\varepsilon - 1)\,\tilde{\lambda}_{ii}}.$$

Case III – Arbitrary MP costs. With arbitrary MP-costs relative wages can be express as

$$\frac{w_n}{P_n} = \lambda_{n|n}^{\frac{1}{1-\sigma}} (\lambda_{n,nn})^{\frac{1}{1-\varepsilon}} A_{nn}.$$

Fully differentiating this expression we obtain,

$$\left(\hat{\frac{w_n}{P_n}}\right) = \frac{1}{1-\sigma}\hat{\lambda}_{n,n} + \frac{1}{1-\varepsilon}\hat{\lambda}_{n,nn}. \tag{E.11}$$

Now remember that $\lambda_{n,n}$ and $\lambda_{n,nn}$ are each given by

$$\lambda_{i|j} = \frac{\lambda_{i,jj}^{-\frac{1-\sigma}{1-\varepsilon}} A_{ij}^{\sigma-1}}{\sum_{a\in\mathcal{I}} \lambda_{a,jj}^{-\frac{1-\sigma}{1-\varepsilon}} A_{aj}^{\sigma-1}}, \qquad \lambda_{i,mj} = \frac{\left(t_{mj} W_m / A_{im}\right)^{1-\varepsilon}}{\sum_{\ell\in\mathcal{L}} \left(t_{\ell j} W_\ell / A_{i\ell}\right)^{1-\varepsilon}},$$

and so

$$\begin{aligned}
\hat{\lambda}_{n,n} &= -\frac{1-\sigma}{1-\varepsilon}\left(\hat{\lambda}_{n,nn} - \hat{\lambda}_{i,nn}\right)\left(1-\lambda_{n,n}\right), \\
\hat{\lambda}_{n,nn} &= (1-\varepsilon)\left(\frac{\hat{\bar{w}}}{\hat{t}_{in}} - 1\right)\hat{t}_{in}\left(1-\lambda_{n,nn}\right), \\
\hat{\lambda}_{i,nn} &= (1-\varepsilon)\left(\frac{\hat{\bar{w}}}{\hat{t}_{in}} - 1\right)\hat{t}_{in}\left(1-\lambda_{i,nn}\right).
\end{aligned} \tag{E.12}$$

Plugging this back into equation E.4 and using equation E.5, we obtain that the log change in welfare is equal to:

$$\hat{U}_n = \left[\left(\frac{\left(\lambda_{i,nn}-\lambda_{n,nn}\right)\left(1-\lambda_{n|n}\right)-\left(1-\lambda_{n,nn}\right)}{\theta_{in}\lambda_{in}} - \frac{\left(t_{in}-1\right)\lambda_{nn}}{1+\left(t_{in}-1\right)\lambda_{nn}}\right)\lambda_{in}\theta_{in}\left(1-\frac{\partial\bar{w}}{\partial t_{in}}\frac{t_{in}}{\bar{w}}\right) + \frac{\left(1-\lambda_{nn}\right)}{1+\left(t_{in}-1\right)\lambda_{nn}}\right]\hat{t}_{in}. \tag{E.13}$$

It is easy to show that when MP costs are prohibitively, i.e., $\gamma_{in}\to\infty$ for all i and n, $\lambda_{n,n}=1$ and $\theta_{in}=\sigma-1$ and so equation E.13 collapses into equation E.6. Similarly, when MP is free, i.e., $\gamma_{in}=1$ for all i and n, $\lambda_{i,nn}=\lambda_{n,nnn}$ and $\theta_{in}=\varepsilon-1$, and so equation E.13 collapses into equation E.10.

The optimal import tariff in this case solves $\hat{U}_n=0$, hence

$$\left(t_{in}-1\right) = \frac{1}{\lambda_{nn}\left(\theta_{in}+1\right)}\left[\left(1-\frac{\partial\log\bar{w}}{\partial\log t_{in}}\right)^{-1}-1\right]. \tag{E.14}$$

The structure of the optimal tariff is the same as before, what makes the value different are: (i) the trade elasticity θ_{in} which depends on the size of the MP costs; (ii) the general equilibrium response of relative wages to changes in tariffs $\frac{\partial\log\bar{w}}{\partial\log t_{in}}$. We have characterized the former, we now move to characterizing the latter.

To characterize the general equilibrium response of wages we start with the trade balance condition, equation E.2, and our equation for aggregate spending equation E.1 to get

$$\bar{w}\frac{L_n}{L_i}\frac{\lambda_{in}}{1+\left(t_{in}-1\right)\lambda_{nn}} = \frac{\lambda_{ni}}{1+\left(t_{ni}-1\right)\lambda_{ii}}.$$

Fully differentiating this expression and using that $\hat{t}_{ni}=0$, we obtain

$$\hat{\bar{w}} = \tilde{\lambda}_{nn}\frac{1}{\lambda_{in}}\hat{\lambda}_{nn} - \tilde{\lambda}_{ii}\frac{1}{\lambda_{ni}}\hat{\lambda}_{ii} + \tilde{\lambda}_{nn}\hat{t}_{in}. \tag{E.15}$$

where we defined $\tilde{\lambda}_{ii} \equiv \frac{t_{ni}\lambda_{ii}}{1+(t_{ni}-1)\lambda_{ii}}$. Substituting in equation E.5, and solving for $\frac{\partial \log \bar{w}}{\partial \log t_{in}}$ we get:

$$\hat{\bar{w}}\left(1+\tilde{\lambda}_{nn}\theta_{in}\right) = \tilde{\lambda}_{nn}\left(\theta_{in}+1\right)\hat{t}_{in} - \frac{\tilde{\lambda}_{ii}}{\lambda_{ni}}\hat{\lambda}_{ii}. \tag{E.16}$$

Finally, note that λ_{ii} is a function of $\bar{w}$ only. Therefore,

$$\hat{\lambda}_{ii} = \frac{\partial \lambda_{ii}}{\partial \bar{w}}\frac{\bar{w}}{\lambda_{ii}}\hat{\bar{w}} = \frac{\partial \lambda_{ii}}{\partial t_{ni}}\frac{t_{ni}}{\lambda_{ii}}\hat{\bar{w}} = \lambda_{ni}\theta_{ni}\hat{\bar{w}}. \tag{E.17}$$

Combining equations E.16 and E.17, and solving for $\hat{\bar{w}}$, we obtain

$$\hat{\bar{w}} = \frac{\tilde{\lambda}_{nn}\left(\theta_{in}+1\right)}{1+\tilde{\lambda}_{nn}\theta_{in}+\tilde{\lambda}_{ii}\theta_{ni}}\hat{t}_{in}. \tag{E.18}$$

Finally, combining equations E.14 and E.18 we get:

$$\left(t_{in}-1\right) = \frac{\tilde{\lambda}_{nn}}{\lambda_{nn}}\frac{1}{1-\tilde{\lambda}_{nn}+\tilde{\lambda}_{ii}\theta_{ni}}.$$

The last step is to remember that $\tilde{\lambda}_{nn} = \frac{t_{in}\lambda_{nn}}{1+(t_{in}-1)\lambda_{nn}}$, and so:

$$t_{in}-1 = \frac{1}{\tilde{\lambda}_{ii}\theta_{ni}}. \tag{E.19}$$

F Restricted Gravity Equations

The pre-tariff value of country m's imports of good ω produced in country l by a firm headquartered in i in sector k, is given by:

$$\begin{aligned} p^{k,G}_{i,lmt}(\omega)q^{k,G}_{i,lmt}(\omega) = &\frac{1}{t^{1+\rho_c}_{lmt}}\left[\left(\mu^k w_{lt}(t^k_{lmt})^{1+\rho_c-\rho_{tp}}\tau_{lm}\gamma^k_{i,l}\right)^{1-\varepsilon}\left(A^k_i z(\omega)\right)^{\sigma-1}\right] \\ &\times \underbrace{\left[\left(\sum_{l'\in\mathcal{N}}\left((t^k_{l'mt})^{1+\rho_c-\rho_{tp}}\mu^k\tau_{l'm}\gamma^k_{i,l'}w_{l't}\right)^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}\right]^{\varepsilon-\sigma}}_{(\bar{P}^k_{i,mt})^{\varepsilon-\sigma}}\left(P^k_{mt}\right)^{\sigma-1}e^k_m E_{mt} \end{aligned} \tag{F.1}$$

The introduction of a time index clarifies which variables depend on the tariff rates and the associated equilibrium. Taking logs, the previous expression can be decomposed as follows:

$$\ln p^{k,G}_{i,lmt}(\omega)q^{k,G}_{i,lmt}(\omega) = \alpha^k + \left[(1-\varepsilon)(1+\rho_c-\rho_{tp})-1-\rho_c\right]\ln(t^k_{lmt}) + \eta_{lm} + \eta_{\ell t} + \eta^k_{il} + \eta^k_i(\omega) + \eta^k_{imt} + \eta^k_{mt} + \eta_{mt} \tag{F.2}$$

Equation (F.2) represents a log-linear relation between import values, a constant, a term capturing wages in the location of production (η_{lt}), constant trade costs (η_{lm}) and MP frictions (η^k_{il}), firm

ω's productivity ($\eta_i^k(\omega)$), the sectoral price index of goods produced by global firms of origin i and sold to country m (η_{imt}^k)[3], the sectoral price index in country m (η_{mt}^k) and country m's aggregate expenditures (η_{mt}). Expressing equation (F.2) in first-differences yields the following estimating equation:

$$d\ln p_{i,lmt}^{k,G} q_{i,\ell mt}^{k,G}(\omega) = \left[(1-\varepsilon)(1+\rho_c-\rho_{tp})-1-\rho_c\right] d\ln(t_{lmt}^k) + \xi_{lt} + \xi_{imt}^k + \epsilon_{ilmt}^k \tag{F.3}$$

where ξ_{lt} is a location-of-production×time fixed effects, and ξ_{imt}^k is a country-of-ownership×destination×sector×time fixed effect, and ϵ_{ilmt}^k is an error term that captures measurement error. The destination×sector×time fixed effect η_{mt}^k and the destination×time fixed effect η_{mt} are not included in the estimating equation, as they are collinear with ξ_{imt}^k. Given the assumption of homogeneous wages across sectors, the location-of-production×time fixed effects ξ_{lt} is identifiable from sectoral variation of tariff rates on imports from country l.

The tariff elasticity of markups of global affiliates ρ_{tp} can be identified from the following relationship between pre-tariff prices and tariffs for each variety ω:

$$p_{i,lmt}^k(\omega) = \mu^k \left(t_{lit}^k\right)^{-\rho_{tp}} \times \tau_{li} \times \gamma_{m,l}^k \frac{w_{lt}}{A_m^k \times z_m^k(\omega)} \tag{F.4}$$

Taking logs and expressing the equation in first differences, we find:

$$d\ln p_{i,lmt}^k(\omega) = -\rho_{tp} d\ln t_{lit}^k + \xi_{lt} + \epsilon_{ilmt}^k \tag{F.5}$$

where the country-of-production×time fixed effect controls for changes in the wage in the exporting country, and all the remaining time-constant fixed effects are differenced out.

Conditional on the estimation of ρ_{tp}, equation (F.3) still features two elasticities, ε and ρ_c, that cannot be separately identified without additional information on the price set by affiliated intermediaries.[4] For this reason, we impose the assumption that intermediaries fully offset the reduction in the markups of affiliates, i.e. $\rho_c = \rho_{tp}$. This reduces equation (F.3) to:

$$d\ln p_{i,lmt}^{k,G} q_{i,lmt}^{k,G}(\omega) = \left[\rho_{tp}+\varepsilon\right] d\ln(t_{lmt}^k) + \xi_{lt} + \xi_{imt}^k + \epsilon_{ilmt}^k \tag{F.6}$$

Analogously, the pre-tariff value of country m's imports of variety ω produced by a local firm in country l, in sector k, follows a restricted gravity equation:

$$p_{lmt}^{k,L}(\omega) q_{lmt}^{k,L}(\omega) = \frac{1}{t_{lmt}^k} \left(\mu^k t_{lmt}^k \tau_{lm} w_{lt} \left(A_l z(\omega)\right)^{-1}\right)^{1-\sigma} \left(P_{mt}^k\right)^{\sigma-1} e_{k,m} E_{mt}^{\sigma-1} \tag{F.7}$$

Following similar steps, we obtain a log-linear relationship between changes in the import value of

[3] More precisely, $\eta_{imt}^k = (\varepsilon-\sigma)\ln\left[\left(\sum_{l\in\mathcal{N}}\left(t_{lmt}^k \mu^k \left(t_{lmt}^k\right)\tau_{lm}\gamma_{i,l}^k w_{lt}\right)^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}\right]$ captures the common component of the price index of global firms that does not depend on productivity z.

[4] An estimation of the markup of intermediaries would require data on both the price of imports at the border and the price effectively paid by households for each variety ω.

imports of local firm ω and changes in tariff rates, controlling for a location-of-production×time fixed effect, and a destination×sector×time fixed effect.

$$d \ln p_{lmt}^{k,L}(\omega) q_{lmt}^{k,L}(\omega) = -\sigma d \ln(t_{lmt}^{k}) + \xi_{lt} + \xi_{mt}^{k} + \epsilon_{lmt}^{k} \tag{F.8}$$

G Data

G.1 Tariff Data.

Our baseline measure of tariff rate is the ad-valorem effectively applied rate, which is based on the UNCTAD estimate of the ad-valorem rate and already accounts for preferential trade agreements. In practice, this variable is often missing or reported with error.[5] For this reason, we fill missing values and replace outliers with tariff rates from the WTO-IDB dataset. After this cleaning procedure, there are still values of tariff rates above 100%, which are replaced with the average MFN tariff rate.

To compute the industry-level average tariff rates, we map HS6 Codes into our industry classification and we take a weighted average of tariff rates, using the volume of imports in 2016 as weights.

G.2 OECD AMNE Database

We combine data from the OECD AMNE Database to construct a matrix of industry-level trade flows and a matrix of bilateral output, which divides output produced in a given country and sector by country of ownership of the firm. Output of domestic firms is then further differentiated into output by global firms and output by local firms. We use the following datasets:

Matrix of Bilateral Output (MBO): this matrix reports gross output produced in each country, by industry and country of ownership. We use this dataset to compute the share of sector k's output in country ℓ produced by firms headquartered in i, for all $l, i = 1, \ldots, N$. Data is available from 2000 to 2020 and we calibrate the steady state of the model to 2016.

Analytical Database - Domestic MNEs (AAMNE - Domestic) : This dataset reports gross output, export, imports and gross value added produced by domestic companies, distinguishing between MNEs and non-MNEs. We use this dataset to compute the total output shares produced by domestic MNEs and non-MNEs. Data is available until 2016.

Analytical Database (AAMNE) This datasets splits gross output, value added, exports and imports by location of production, industry and whether the firm is domestic or foreign-owned.

[5]There are cases in which the estimated value of the tariff rate is the midpoint of the bounds on the tariff lines included in a given HS code.

AMNE - ICIO This dataset expands the $(N \times K) \times (N \times K + 1)$[6] Inter Country Input Output (ICIO) matrices of trade flows from the WIOD Database into a $(2N \times K) \times (2N \times K + 1)$ matrix, where trade flows between industry-country pairs are further split into transactions involving domestically or foreign-owned firms. More precisely, the trade flows $X_{\ell m}^{k \to k'}$ from industry k in country ℓ to industry k' in country m are decomposed into: $X_{\ell \to m, \ell m}^{k \to k'}$, $\sum_{i \neq \ell} X_{i \to m, \ell m}^{k \to k'}$, $\sum_{i \neq m} X_{\ell \to i, \ell m}^{k \to k'}$, $\sum_{i \neq l} \sum_{j \neq m} X_{i \to j, \ell m}^{k \to k'}$. In other words, the matrix does not report the full matrix of trade flows by country of ownership and rather aggregates foreign affiliates into a single category. Since our model does not feature intermediate inputs, we sum exports of intermediate inputs to exports of final goods to construct trade flows from country ℓ to country m in industry k. As a result, the AMNE-ICIO matrix collapses to a $(2N \times K) \times 1$ matrix where an entry corresponds to: $X_{\ell, \ell m}^{k} = \sum_{k'} \sum_{i} X_{\ell \to i, \ell m}^{k \to k'} + \sum_{i} X_{\ell \to i, \ell m}^{k \to F}$ for domestically-owned trade flows and $\sum_{j \neq \ell} X_{j, \ell m}^{k} = \sum_{j} \sum_{k'} \sum_{i} X_{\ell \to i, \ell m}^{k \to k'} + \sum_{j \neq \ell} \sum_{i} X_{\ell \to i, \ell m}^{k \to F}$ for trade flows by foreign subsidiaries located in country ℓ.

G.3 ORBIS Historical Data

We use Orbis Historical Data to compute the measure of global and local firms for each country and industry. We first download information on the industry of the firm from the Firm Description Data, which contains the firm identifier (BVDID) and its industry code according to three different classifications: NACE Rev.2 (4 digit), the NAICS 2012 (4 digit) and the USSIC Code (3 digit). Since firms can own activities in multiple industries, each firm identifier can be assigned different codes corresponding to the core industry, the primary industry and secondary industries. Our model does not feature multi-sector firms, for this reason we only assign firms to their core industry.

We then merge the Firm Description data with the Links files in the Ownership Data. Each row of this dataset represents a link between a target firm and its shareholders, for a given vintage year. The possible types of relation are:

- SHH: single shareholder of first level
- CTP: first level shareholder identified via the Calculated Total Percentage
- ISH: shareholder at first level who is the immediate shareholder
- HQ: when the target company is a branch or foreign company, its single shareholder is its headquarter
- DUO 25 : domestic ultimate owner with a definition min 25% ownership stake
- GUO 25: global ultimate owner with a definition min 25% ownership stake

[6]The rows correspond to the country-industry source and the columns correspond to the country-industry destination or final demand. More correctly, final demand is further divided into Household Final Consumption Expenditure, Non-Profit Institutions Serving Households, General Government Final Consumption, Gross Fixed Capital Formation, Inventories, and Final Consumption Expenditure of Resident Households Abroad, which have been aggregated into a single final demand category.

- DUO 50 : domestic ultimate owner with a definition min 50% ownership stake

- GUO 50 : global ultimate owner with a definition min 50% ownership stake

- DUO 50 C: domestic ultimate owner with a definition min 50% ownership stake, only with owner (shareholder) types B, C, A and F

- GUO 50 C: global ultimate owner with a definition min 50% ownership stake, only with owner (shareholder) types B, C, A, and F (Banks, Financial Companies, Insurance Companies and Industrial Companies)

- GUO 25 C: global ultimate owner with a definition min 25% ownership stake, only with owner (shareholder) types B, C, A, and F

We define a firm as independent if it corresponds to one of the following categories: *Individuals and Families*, *Public authorities/State*, *Employees/Managers/Directors* or if it has no shareholder with more than 50% of ownership stake.[7] We then restrict the sample to independent firms and to the links between a subsidiary and their global ultimate owner (GUO 50).[8] Whenever the nationality of the firm owning the GUO 50 does not coincide with that of the GUO 50 C, we only maintain the former link.

In order to compute the number of local and global firms for each country of origin, we perform the following steps to map the moments from the data into their model analogues. There are three dimensions along which the predictions of the model might be inconsistent with the data.

First, the model does not feature multi-establishment firms, while in the data a shareholder can hold multiple subsidiaries in the same country and industry. In the baseline calibration, we count all subsidiaries in the same country and industry as a single establishment.

Second, a related issue arises when a shareholder owns subsidiaries in different industries. In the baseline calibration, we assign all subsidiaries to the industry of the shareholder and count them as a single unit.

Finally, a third issue arises in the count of foreign affiliates. We first define a firm as local if it does not own subsidiaries or if it only owns subsidiaries in the country of ownership. We then classify a shareholder as global if it owns at least one subsidiary in a different country from the country of ownership. However, the model implies that a global firm owns a subsidiary in each location of production, a feature that is clearly absent in the data. Therefore, we compute the cumulative number of affiliates in country ℓ owned by country i in industry k in three different ways:

[7] We therefore use a loose definition of independence, which includes both firms with no shareholders with more than 25% and firms with a B independence indicator, i.e. no shareholder above 50%.

[8] An implication of this choice is that if there is a chain of linkages, e.g. a domestic affiliate is owned by a domestic owner which is owned by a foreign global ultimate owner, we are treating both firms as being owned by the foreign owners. We then follow two alternative approaches: in the baseline approach, we treat these two firms as a single foreign-owned affiliate, consistently with the interpretation that the model does not feature multi-establishment firms; in the second, we maintain both firms in the sample and effectively count them as owned by two different foreign owners.

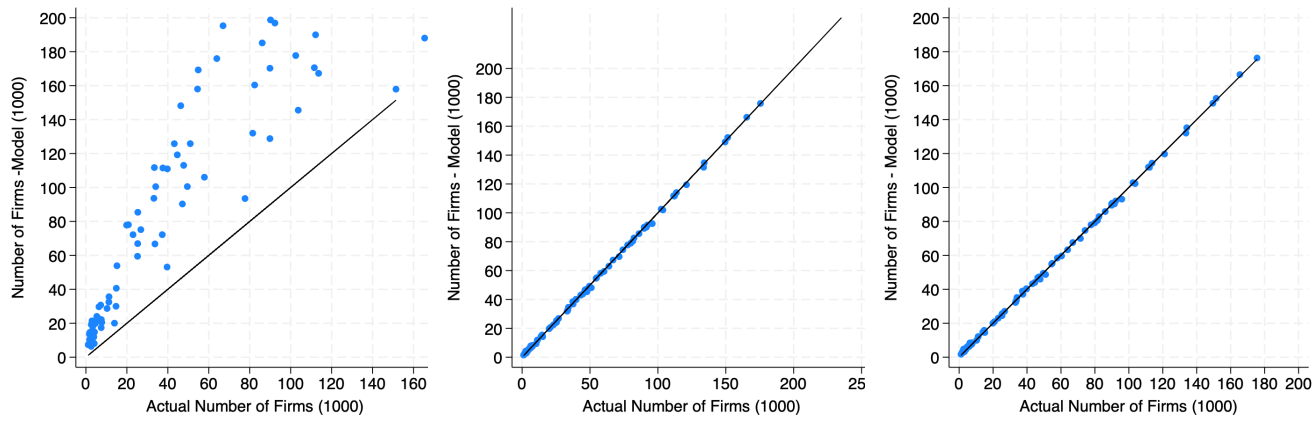
1. we introduce fictitious subsidiaries in each location of production for each global shareholder included in the dataset.

2. we compute the average number of affiliates owned by global firms headquartered in i.

3. we compute the number of affiliates as the median number of affiliates owned by global firms headquartered in i

While option 1 leads to an overestimation of the number of firms in each country, it does not alter the ratio between the number of global firms and local firms for each country of origin which, along with the corresponding output levels, is the key moment affecting the calibration of the fixed costs. To clarify this with a numerical example, suppose that there are three countries, and there are ten global firms in country A, all of them owning a subsidiary in country B and zero subsidiaries in country C. The first approach introduces 10 fictitious subsidiaries in country C. Since the output share of A's subsidiaries in country C is zero, the calibration would still match the intensive margin through prohibitively high MP frictions. In the second and third approach instead (which coincide in this abstract case), the number of global firms, and hence the number of affiliates in each foreign country, would be reduced to 5. Figures G.1a, G.1b and G.1c report the correlation between the model implied number of firms and the actual number of firms in the data. These figures are produced using the industry and country classification described in the following section.

Figure G.1: Comparison model implied number of firms and actual number of firms

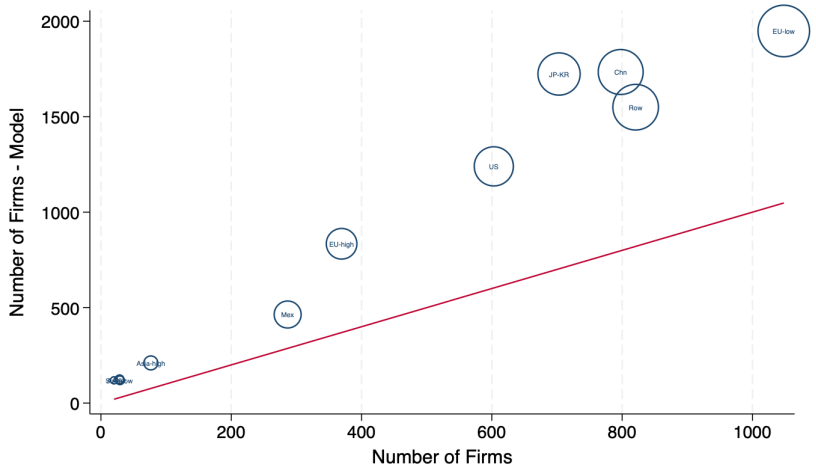


(a) Max **(b)** Median **(c)** Mean

G.4 Classification of Countries

We classify countries based on two criteria. We first group countries into the following geographic areas: North America, Central America, South America, Europe, Africa, Middle East, South-East Asia, Eastern Asia. Within Europe and Asia, we then classify countries based on the share of national output produced by US-owned affiliates and by their relevance for US imports. In particular,

Figure G.2: Comparison model implied number of firms and actual number of firms - aggregate



we split Europe into terciles and assign the first tercile to a residual Rest of the World group. The medium tercile contains the largest European US trade partners, including France, Germany, Italy, Spain and most of Central and Northern Europe (Austria, Bulgaria, Czech Republic, Denmark, Finland, Iceland, Norway, Portugal, Romania, Slovakia, Sweden), while the highest tercile contains export-oriented countries, such as Belgium, Netherlands, and the United Kingdom, and countries featuring a high share of multinational companies due to either low manufacturing costs (Poland, Hungary) or high tax incentives (Cyprus, Switzerland, Luxembourg, Ireland). Asian countries are divided into the following groups: China; Japan and Korea; countries with high US MP (Singapore, Thailand, Malaysia, Hong Kong and Taiwan); countries with low US MP (India, Vietnam, Indonesia and Philippines). The residuals country-groups are: Canada; US; Mexico; South America (Brazil, Chile, Colombia and Argentina) and Rest of the World, which includes the remaining European countries in the sample, New Zealand, Australia, Middle Eastern countries (Israel and Saudi Arabia), and African countries (Morocco and South Africa).

Table G.1 contains relevant summary statistics for each country-group.

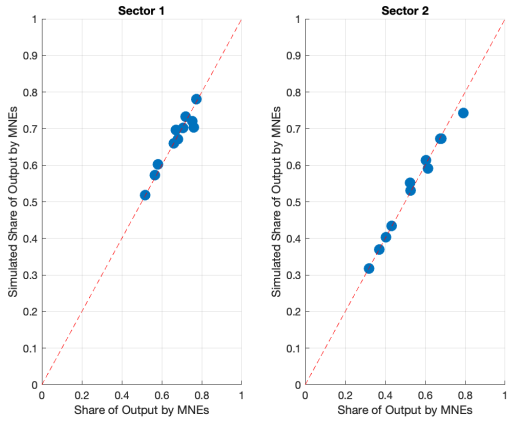
Table G.1: MNE and Trade Shares by Country Group - 11 regions

Country Group	**MNE Share GO (%)**	**MNE Share EXGR (%)**	**US Output Share (%)**	**China Output Share (%)**	**Domestic Output Share (%)**	**Exports to US (%)**	**Share US imports (%)**	**Relative Expenditures**	M^G **Share**	**Relative L**
EU - Med	40.68	56.56	6.10	0.54	82.46	17.24	14.19	88.41	5.56	1.68
EU - High	37.07	49.80	18.47	0.46	62.40	18.51	7.44	25.27	5.02	0.33
Canada	30.25	42.24	23.65	0.10	57.27	69.33	9.56	9.89	12.46	0.11
US	53.95	62.99	75.34	0.28	75.34	0	0	100.00	1.49	1.00
S Am	26.48	33.97	7.91	0.44	79.35	23.66	2.32	24.26	0.23	0.73
Mexico	38.68	57.88	14.23	0.50	70.69	78.84	13.71	10.65	1.51	0.44
Jap, Kor	51.13	67.71	1.83	0.17	95.34	19.35	10.79	59.48	1.90	0.91
Asia - High	37.73	51.91	9.09	3.21	69.69	12.22	4.54	22.79	8.65	1.06
Asia - Low	29.34	46.54	1.52	1.35	88.27	25.61	6.56	48.50	6.33	2.64
China	52.12	67.41	1.29	91.96	91.96	26.75	27.53	208.91	0.53	3.44
ROW	28.11	39.24	3.57	0.74	83.36	13.45	3.36	39.99	1.43	1.28

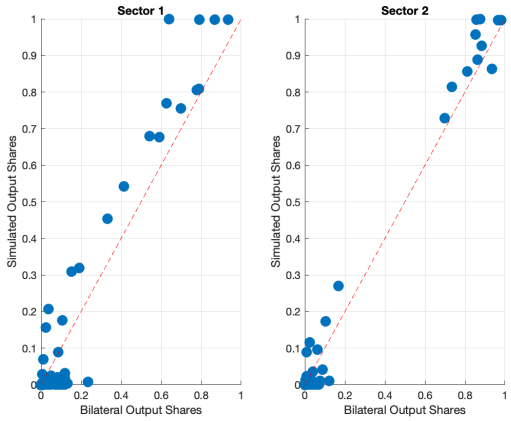
The first column reports the share of total output produced domestically by domestic multinational companies. The second column reports the share of exports accounted for by multinational companies. The third and fourth column reports the share of domestic gross output produced by US-owned and Chines-owned companies. The fifth column reports the share of output that is sold domestically. The sixth column reports the ratio between exports to the United states and total exports. The seventh column reports the ratio between exports from the country reported in the row to the US and the total US imports (the entries of the column sum to 100). The eighth column reports relative (to the US) expenditures. The ninth column reports the share of global firms. The tenth column reports relative (to the US) manufacturing employment.

H Additional Figures

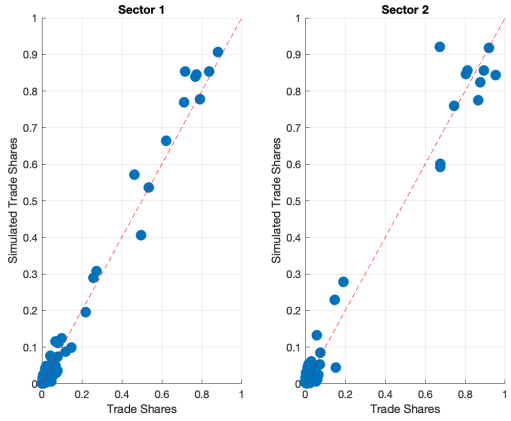
Figure H.1: Correlation between model-simulated moments and empirical moments



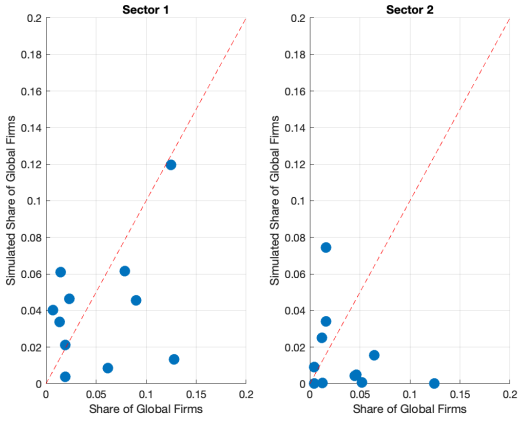
(a) Share of Output by MNEs



(b) Bilateral Output Shares

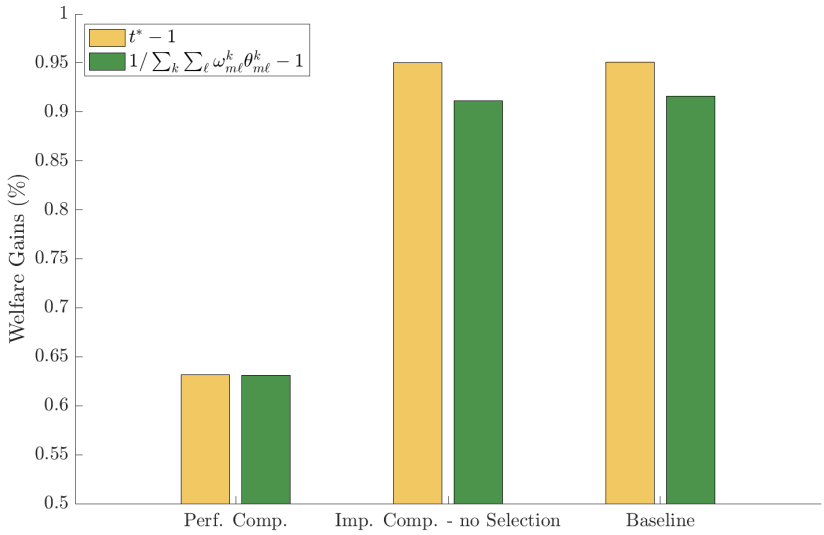


(c) Trade Shares



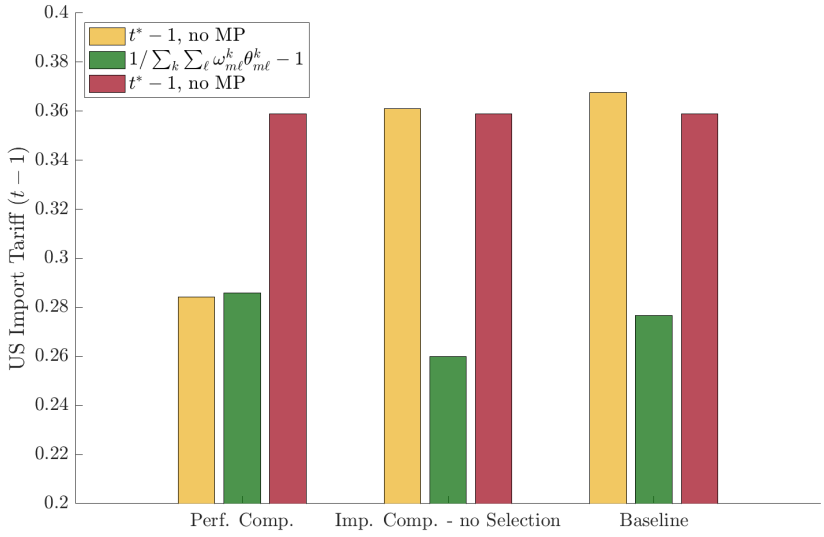
(d) Share Global Firms

Figure H.2: Welfare Gains from Unilateral Optimal Import Tariffs



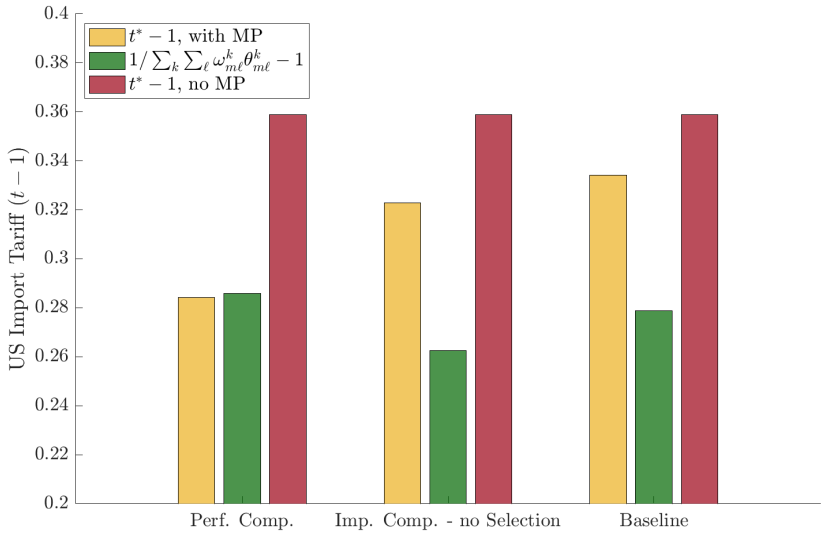
The yellow column represents the welfare gains from imposing the optimal US unilateral import tariff on all countries. The green column reports the welfare gains from imposing an import tariff on all countries equal to the reciprocal of the average trade elasticity. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = \sigma/(\sigma - 1)$. The baseline scenario is the calibrated model with selection into MP and positive markups.

Figure H.3: Optimal Unilateral Import Tariff, in Baseline and Armington Model with no MP



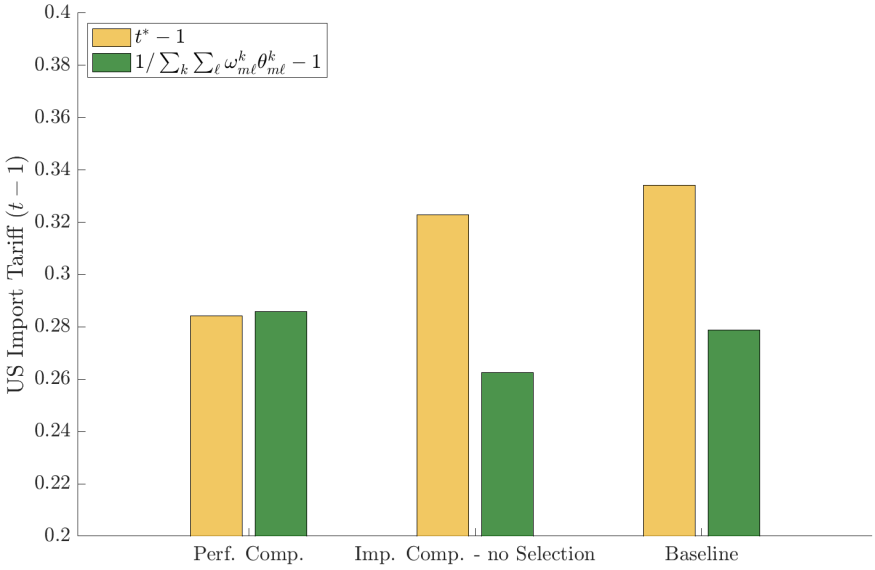
The yellow column represents the optimal US unilateral import tariff on all countries. The green column reports the reciprocal of the average trade elasticity. The red column represents the optimal unilateral import tariff in a model with no MP. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = \sigma/(\sigma - 1)$. The baseline scenario is the calibrated model with selection into MP and positive markups.

Figure H.4: Optimal Unilateral Import Tariff, in Baseline and Armington Model with no MP, low markups



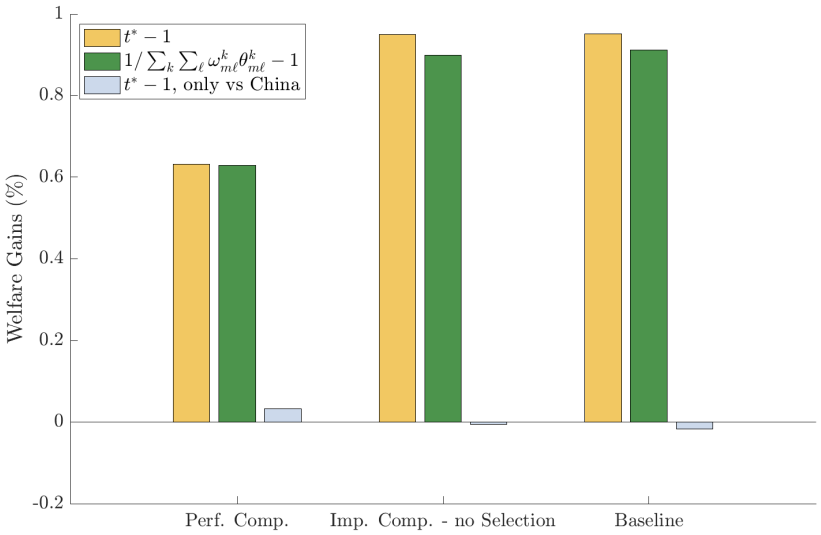
The yellow column represents the optimal US unilateral import tariff on all countries. The green column reports the reciprocal of the average trade elasticity. The red column represents the optimal unilateral import tariff in a model with no MP. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = 0.15$. The baseline scenario is the calibrated model with selection into MP and positive markups.

Figure H.5: Optimal Import Tariffs, Low Markups



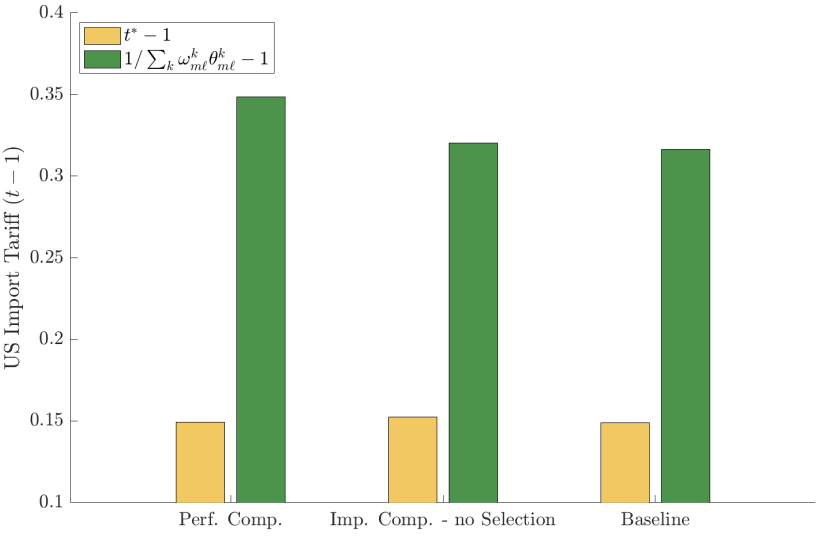
The yellow column represents the optimal US unilateral import tariff on all countries. The green column reports the reciprocal of the average trade elasticity. The red column represents the optimal unilateral import tariff in a model with no MP. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = 0.15$. The baseline scenario is the calibrated model with selection into MP and positive markups.

Figure H.6: Welfare Gains from Bilateral Import Tariffs on China



The yellow column represents the welfare gains from imposing the optimal US unilateral import tariff on all countries. The green column reports the welfare gains from imposing an import tariff on all countries equal to the reciprocal of the average trade elasticity. The light-blue column represents the welfare changes from imposing the optimal unilateral import tariff only on imports from China. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = \sigma/(\sigma - 1)$. The baseline scenario is the calibrated model with selection into MP and positive markups.

Figure H.7: Optimal Bilateral Import Tariffs on China



The yellow column represents the value of the optimal US unilateral import tariff. The green column reports the reciprocal of the bilateral trade elasticity of US exports to China. The perfect competition scenario imposes that all firms are global and markups are equal to 1. In the imperfect competition scenario, we maintain that all firms are global and set markups to $\mu^k = \sigma/(\sigma - 1)$. The baseline scenario is the calibrated model with selection into MP and positive markups.