Oligopoly and Oligopsony in International Trade*

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Abstract

We study the effects of international trade on firms' oligopsony power in input markets. We build a theoretical model of international trade in which firms are oligopolists in the market for final goods and oligopsonists in the market for inputs. Consistent with evidence from the literature, firms' markups increase in both the extent of oligopsony power and of oligopoly power. Trade liberalization in one market reduces firms' market power in that market, but it has the opposite effect in the other market. In particular, international trade between oligopolists in final goods markets causes oligopsony power to increase. Calibrating our model for the US, we find that the reduction in domestic markups generated by international trade is 12-44% lower due to the presence of oligopsony power.

JEL Classification: F12, F13.

Keywords: Oligopoly, Oligopsony, Market Power, Market Concentration.

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1 Introduction

The documented high concentration in exports and imports (Freund and Pierola, 2015; Bernard et al., 2018) has fostered the growth of a large body of research on large firms.[1] The research has mainly focused on final goods markets in which large firms act as oligopolists and firms' higher market power is associated with higher markups (Atkeson and Burstein, 2008). In this case, international competition between oligopolists reduces their market power and generates pro-competitive gains from trade (Edmond et al., 2015). Recent empirical research has highlighted that the level of market concentration in factors and input markets is comparable to the concentration in final goods markets.[2] However, little is known about the link between market power in input markets, which we refer to as *oligopsony power*,[3] and international trade.

The goal of this paper is to analyze the effects of international trade on the oligopsony power of large firms. We introduce a tractable model that provides insights into the effects of international economic integration on concentration in input markets and oligopsony power. This link is particularly important as changes in oligopsony power due to international competition in final goods markets lead to markup adjustments that can have major welfare implications. We calibrate this model to quantify the effects of a reduction in trade costs on markups over unit costs, finding that the presence of oligopsony dampens the reduction in markups by 12-44%.[4]

Our model offers a new perspective on the effect of trade on market concentration and markups. We show that when firms are large both in final goods markets and in input markets, increased openness in one market generates an increase in market power in the other market. This effect dampens the standard reduction in markups due to trade and, thus, only economic integration in both markets reduces firms' market power in each market. These results suggest a dual approach for policymakers: efforts to reduce trade barriers

[1]The term "large firms" refers to firms that are able to influence market aggregates and, for this reason, that are typically modeled as oligopolists (Eckel and Neary, 2010; Neary, 2010). This is in contrast to "small firms" that take market aggregates as given, as in monopolistic competition (Krugman, 1979; Melitz, 2003).

[2]Azar et al. (2020) document high levels of labor market concentration in US commuting zones, and its negative effects on wages. Morlacco (2017) finds high buyer power of French firms in foreign input markets. Buyer power, measured by markdowns, is quantitatively important across US establishments (Hershbein et al., 2020) and Chinese and Indian firms (Brooks et al., 2021). For an empirical survey on buyer power, see Bhaskar et al. (2002).

[3]A market with few buyers is organized as an oligopsony: each buyer restricts its demand in an effort to keep prices low (Boal and Ransom, 1997).

[4]In our model, the markup over unit costs is made of two components: a wedge between the price and the marginal cost (markup) and a wedge between the marginal cost and the unit cost (markdown). The markup over the marginal cost depends on oligopoly power, while the markdown depends on oligopsony power. For exposition purposes, we focus on the markup over unit costs, which includes both sources of market power.

should encompass both trade in final goods and in intermediate inputs. In the presence of domestically sourced inputs, reductions in trade barriers should be accompanied by policies aimed at reducing domestic input market concentration.

Our approach is based on the models of oligopoly of Atkeson and Burstein (2008) and Edmond et al. (2015). These two models feature an inelastically supplied input (labor) in a perfectly competitive market, as in the standard literature (Krugman, 1980; Melitz, 2003). In contrast, we generalize several theories of firms' market power in factors' markets (Boal and Ransom, 1997; Bhaskar et al., 2002) by assuming an upward-sloping supply curve for the input and that few large firms purchase the input in an oligopsonistic market. Our interpretation of the input is general as it could represent some form of specialized labor, capital, raw materials, or intermediate inputs.

Firms exploit their oligopsony power in the market for the input by restricting their demand to push this input's price down, in line with the evidence of Azar et al. (2020). Each firm employs the input to produce a variety of a differentiated good, competing oligopolistically. The presence of oligopoly power, in turn, incentivizes firms to restrict their supply to charge higher markups. Thus, our model features markups over unit costs and prices that are increasing both in the oligopsony power and in the oligopoly power.[5] In line with the evidence of Morlacco (2017) and Hershbein et al. (2020), the oligopsony power of a firm depends on the firm's demand relative to the aggregate demand for the oligopsonistic input: the larger a firm's demand share, the larger its oligopsony power.

In case the input is domestically sourced, which could exemplify the labor supplied in local labor markets, international competition among large firms causes the oligopsony power to increase. This result is in sharp contrast to a model in which firms only exploit oligopoly power. For instance, in Edmond et al. (2015), international integration in final goods markets causes firms to become smaller in the final goods market and their oligopoly power declines. While such an effect persists in our model, the reduction in oligopoly power also reduces profits and forces some firms to exit. This decrease in the number of firms increases market concentration in the domestic input market and, thus, leads to a higher oligopsony power of firms. Hence, the presence of oligopsony power causes a smaller reduction in markups. Further, the larger the oligopsony power, the smaller the reduction in markups, and the smaller the increase in the input's price.

The effects of trade on firms' market power are reversed in case of integration in the

[5]In our model, the oligopsony power of a firm is proportional to its demand share in the input market, and the oligopoly power of a firm is proportional to the firm's market share in the final goods market. Hence, changes in market power are due to changes in either or both shares. We should note that the firm market power also depends on additional parameters of the model, such as the demand elasticity across firms and the supply elasticity of the input.

market for the oligopsonistic input. Consider the extreme case in which firms, which could be interpreted as retailers, internationally source their input and only sell their final good domestically. Free trade of the input reduces the oligopsony power of firms: as firms from more countries purchase the same input, the demand share of each firm in input markets decline. As a result, lower oligopsony power causes a reduction in firms' profits, which fosters the exit of some firms and hence leads to an increase in the oligopoly power of firms.

To quantify the effect of oligopsony power on the magnitude of markup changes due to international trade, we calibrate our model with two asymmetric countries: the US and the rest of the world. We use UNIDO data on number of establishments to pin down the initial average market shares in input markets and final goods markets. As the dataset provides information at the industry-level, we calibrate our baseline model with homogeneous firms. Furthermore, we estimate the relationship between export prices and input market shares to calibrate the input supply elasticity, finding values in line with previous research (Morlacco, 2017). Our counterfactual exercise shows that a 5% reduction in trade costs between the US and the rest of the world generates a reduction in US domestic markups by 0.49-0.65%.

To provide perspective on the magnitude of our results, we compare our results to those predicted by a model in which the oligopsony power channel is shut down, and firms only have market power in the final goods market. To conduct a sensible comparison, we impose, in the alternative model, the same levels of market shares of our baseline case. When firms only have oligopoly power, a reduction in trade costs of 5% reduces domestic US markups by 0.74-0.88%, which is 12-44% larger than the reduction predicted by our baseline model. This result is both driven by the mechanism we described in our model and by the fact that, in the presence of oligopsony power, international competition has a smaller effect on domestic concentration.

Our analytical results are based on a model with homogeneous firms. However, we also move beyond our benchmark case of homogeneous firms, and verify quantitatively that our results hold in an important extension in which we allow for firm heterogeneity in terms of productivity. In this case, since trade leads to the exit of firms with lower initial oligopsony power, there is a composition effect whereby concentration in input markets increases because the surviving firms have higher oligopsony power. We make some reasonable assumptions on the distribution of firm productivity and show that our quantitative results are robust to this extension.

Related Literature. Our paper relates to the ongoing debate on the growing market power of US firms. In the last decades, the market share of the largest firms in the US has risen and so have firms' markups (Council of Economic Advisors, 2016; De Loecker et al., 2020). Large US firms grew larger but, as shown by Rossi-Hansberg et al. (2021), they expanded geographically, reducing concentration in local markets. Our model can rationalize the seemingly diverging results of increasing national concentration and markups, with a reduction in local markets concentration. The process that generated the reduction in local markets concentration, by reducing markups, led to the exit of some firms. As fewer firms in each local market survive, concentration in domestic US inputs increases. The rise in the associated oligopsony power can generate an increase in markups that dominates the effects of the reduction in local markets concentration.

The effect of international trade on markups is a crucial component of the welfare gains from trade. Generally, international trade reduces markups of domestic firms, but it increases that of exporters; whether trade generates pro-competitive gains depends on the markup distribution (Arkolakis et al., 2018). The trade literature has been focusing on markups that depend only on the firm market power in final goods markets, while our paper extends the standard approach with the aim of understanding how oligopsony influences the effects of trade on markups. Our approach is motivated by recent empirical research that showing that firms are also able to influence their prices in input markets (Morlacco, 2017; Hershbein et al., 2020; Brooks et al., 2021).[6]

Although the international trade literature has studied the role played by large oligopolists (Atkeson and Burstein, 2008; Feenstra and Ma, 2007; Eckel and Neary, 2010; Amiti et al., 2014; Edmond et al., 2015; Neary, 2016; Macedoni, 2022b; Dhyne et al., 2022; Impullitti et al., 2022), oligopsony has received little attention until the recent years.[7] Our paper closely relates to the work of MacKenzie (2018) who studies the effect of oligopsony from an allocative efficiency perspective. The author finds that the effects of trade in the presence of oligopsony are only slightly larger relative to a counterfactual case of perfect competition in labor markets. The policy recommendations of our paper are similar to those of Heiland and Kohler (2022) who recommend labor market integration along with international trade, since trade alone exacerbates labor market distortions due to monopsony power. Their paper strengthens our policy claim; the authors reach the same conclusion as us using a different model in which labor is the oligopsonistic input and workers are heterogeneous.[8]

[6] The work by Brooks et al. (2021) also features a model in which firms have oligopoly power in final goods markets and oligopsony power in input markets. While they focus on the estimation of firm-level markups as a function of oligopoly and oligopsony power, we consider the equilibrium effects of economic integration.

[7] The early work of Bishop (1966), Feenstra (1980), Markusen and Robson (1980), and McCulloch and Yellen (1980) studied the effects of a monopsonistic industry in a Heckscher-Ohlin model. Our model confirms some of the authors' predictions: oligopsony generates distortions in the market allocation, which are exacerbated by trade in final goods.

[8] The papers mentioned above rely on oligopsonistic competition in factors' markets. A parallel emerging literature introduces monopsonistic competition in labor markets into models of trade, in which firms are able to affect their firm-specific labor demand, while taking market aggregates as given. The first paper in

Finally, our paper relates to studies that analyze sources of firms' market power other than oligopoly. Raff and Schmitt (2009) consider the ability of retailers to exercise market power by signing exclusive or non-exclusive contracts with manufacturers. Bernard and Dhingra (2015) study the effects of exporters-importers contracts on welfare. Eckel and Yeaple (2017) discuss the market power that large multi-product firms have over workers when they are able to invest in identifying workers' skills. A feature of these papers, shared by ours, is that trade, by increasing domestic market concentration, exacerbates market distortions leading to ambiguous welfare effects.[9]

The remainder of the paper is organized as follows. Section 2 builds the baseline model. Section 3 presents the effects of international trade on firms' market power. Section 4 calibrates the model and evaluates the effect of oligopsony on markups. Section 5 concludes.

2 Model

Consider a static model of international trade. There are I countries indexed by i for origin, and j for destination, and in each country there are L_i consumers. To maintain tractability in the presence of large firms, we follow the framework proposed by Eckel and Neary (2010) and Neary (2016): there is a continuum of industries, and firms are large in an industry but small relative to the economy. Industries are indexed by $z \in [0, 1]$. Since the oligopsonistic power of firms stems from firms being large, this assumption allows us to focus on the oligopsony power of firms in the factor of production specific to their industry. In fact, since firms are larger in their industry, they influence the price of the specific factor they employ, but being small relative to the economy, they do not influence all the other factors' prices. By doing so, we abstract from any cross-industry interactions.

In each industry z of country i, there is a discrete number of firms $N_i(z)$, indexed by f. The final goods market in each industry is oligopolistic. Moreover, to produce the differentiated final good, each firm requires an input, which is specific to the industry, and whose total supply in country i is denoted by $K_i(z)$. The input is provided with an upward-sloping supply curve, and the market for the input is oligopsonistic. The unit requirement for the input is c_{fi}. Both the market for the input and the market for final goods are characterized by Cournot competition with the number of firms determined by free entry. Finally, exporting a good from i to j requires an iceberg trade cost $\tau_{ij}(z)$, with $\tau_{ii}(z) = 1$.

this field is that of Egger et al. (2021), which features constant markups and markdowns across firms. The work of Macedoni (2022a) extends the framework to variable markups and markdowns across firms.

[9] Markusen (1989) obtains an analogous result in a two-sector model in which an industry features the costless assembly of differentiated inputs. Similarly, Arkolakis et al. (2018) showed that the distortions originating from variable markups are exacerbated by trade.

2.1 Consumers' Problem

Consumers in country $j = 1, ..., I$ have a two-tier utility function. The first tier is the Cobb-Douglas aggregator over the continuum of industries $z \in [0, 1]$:

$$U_j = \int_0^1 \ln u_j(z) dz \tag{1}$$

Following Atkeson and Burstein (2008) and Edmond et al. (2015), we assume that $u_j(z)$ is a Constant Elasticity of Substitution (CES) quantity index with elasticity of substitution $\sigma(z) > 1$:

$$u_j(z) = \left[\sum_{i=1}^{I} \sum_{f=1}^{N_i(z)} q_{fij}^{\frac{\sigma(z)-1}{\sigma(z)}} \right]^{\frac{\sigma(z)}{\sigma(z)-1}} \tag{2}$$

where q_{fij} is the quantity of the variety produced by firm f, exported from i to j, which is sold at the price p_{fij}. Consumers maximize utility (1) by choosing q_{fij}, subject to the following budget constraint:

$$\int_0^1 \sum_{i=1}^{I} \sum_{f=1}^{N_i(z)} p_{fij} q_{fij} dz \leq y_j \tag{3}$$

where y_j is the per capita income in j. The first order condition with respect to q_{fij} yields:

$$\lambda_j p_{fij} = \frac{q_{fij}^{-\frac{1}{\sigma(z)}}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i(z)} q_{fij}^{\frac{\sigma(z)-1}{\sigma(z)}}} \tag{4}$$

where $\lambda_j = y_j^{-1}$ is the marginal utility of income. We follow Eckel and Neary (2010) by assuming that firms are large in their industry and small relative to the economy. Analytically, this implies that firms do not internalize their effects on λ_j. Following Eckel and Neary (2010), we can normalized per capita income to one ($y_j = 1$), which implies, by the definition of λ_j, that $\lambda_j = 1$: the framework proposed by Eckel and Neary (2010) is equivalent to having a quasi-linear utility function. Although this approach implies an abstraction from income effects, we should note that the price for the oligopsonistic input, which we describe in the next section, is not fixed and can vary across countries.

Letting $x_{fij} = L_j q_{fij}$ denote the aggregate demand for the final good, the aggregate inverse demand is then:

$$p_{fij} = \frac{L_j x_{fij}^{-\frac{1}{\sigma(z)}}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i(z)} x_{fij}^{\frac{\sigma(z)-1}{\sigma(z)}}} \tag{5}$$

For the remainder of the paper we focus on a single industry and, thus, we drop argument z from our notation. We want to reiterate that, even though we omit the industry argument, industries can have different supply and demand parameters, which we utilize in our calibration in Section 4. Given the functional form for the upper tier of the utility function, and our income normalization, we can abstract from interactions across industries.

2.2 Supply of the Oligopsonistic Input

To model oligopsony, we assume that the supply curve for the specific input K_i is upward-sloping. To highlight the role of oligopsony power, and to maintain symmetry with the final goods market, we assume that the input is supplied with constant elasticity $1/\gamma > 0$. Let r_i denote the price for the input. The inverse supply curve is given by:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} \tag{6}$$

where $\tilde{\gamma}_i$ is a country-specific supply shifter. In Appendix 6.1.1, we outline an extension to the baseline model in which households experience disutility from supplying the input.

Our formulation contrasts the traditional literature in international trade dealing both with small (Krugman, 1980; Melitz, 2003) and large firms (Eckel and Neary, 2010; Edmond et al., 2015), which assumes that inputs in production are inelastically supplied. If the input is inelastically supplied, which is equivalent to setting $\gamma \to \infty$, and firms are oligopsonistic, the equilibrium price of the input drops to zero. This happens because oligopsonistic firms reduce their demand to reduce the price of the input: if the input supply is perfectly inelastic, firms can reduce their demand until the price is zero without affecting the equilibrium quantity of the input.

To ease the notation, let us assume that the input is supplied to domestic firms only (we relax this assumption in Appendix 6.1.4). Each firm f demands k_{fij} units of the input to produce its differentiated variety and sell it to country j. Firm f's total demand for the input, denoted by k_{fi}, is given by summing k_{fij} across the destinations that the firm reaches, namely $k_{fi} = \sum_{j=1}^{I} k_{fij}$. Thus, aggregate demand for the input is $\sum_{f=1}^{N_i} k_{fi} = \sum_{f=1}^{N_i} \sum_{j=1}^{I} k_{fij}$. Instead, if the input is internationally sourced, the aggregate demand would be given by $\sum_{i=1}^{I} \sum_{j=1}^{I} \sum_{f=1}^{N_i} k_{fij}$.

2.3 Firms' Problem

Firms pay a fixed cost F which is independent of the quantity produced and it is expressed in units of the numeraire. The unit requirements to produce a variety x_{fij} from i to j

by a firm f is $\tau_{ij}c_{fi}$ and is expressed in units of the oligopsonistic input. Hence, firm f's demand for the input is $k_{fij} = \tau_{ij}c_{fi}x_{fij}$. Let us re-write the inverse supply function of k (6) to highlight the effect of a single firm on the price for the input. From market clearing condition $\sum_{j=1}^{I}\sum_{f=1}^{N_i} k_{fij} = K_i$, hence:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} = \tilde{\gamma}_i \left[\sum_{j=1}^{I}\sum_{f=1}^{N_i} \tau_{ij}c_{fi}x_{fij}\right]^{\gamma} \tag{7}$$

Firms maximize their profits by choosing x_{fij} for each destination they serve, taking other firms' choices as given. Given the inverse demand function (5) and the inverse supply function of the input (7), the profits of firm f equal:

$$\begin{aligned}\pi_{fi} &= \sum_{j=1}^{I} p_{fij}x_{fij} - r_i \sum_{j=1}^{I} \tau_{ij}c_{fi}x_{fij} - F = \\ &= \sum_{j=1}^{I} \frac{L_j x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} - \tilde{\gamma}_i \left[\sum_{j=1}^{I}\sum_{f=1}^{N_i} \tau_{ij}c_{fi}x_{fij}\right]^{\gamma} \sum_{j=1}^{I} \tau_{ij}c_{fi}x_{fij} - F =\end{aligned} \tag{8}$$

Firms are oligopolists in that they internalize their effects on the quantity index in the demand function. Moreover, firms are oligopsonists: they internalize their effects on r_j through their demand of the input. Because of oligopsony power, a firm's choice of quantity in a destination j is not independent of the quantity choice in a destination j'. Increasing the supply in j increases the input's price r_i and, thus, the unit costs of the quantity supplied across all destinations.

The first-order condition with respect to quantity highlights the effects of market power in the final goods and the inputs market:

$$\frac{\sigma-1}{\sigma} \frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \left[1 - \underbrace{\frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}}}_{\text{Oligopoly Market Share}}\right] - r_i\tau_{ij}c_{fi}\left[1 + \gamma \underbrace{\frac{\sum_{j=1}^{I} \tau_{ij}c_{fi}x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i} \tau_{ij}c_{fi}x_{fij}}}_{\text{Oligopsony Demand Share}}\right] = 0 \tag{9}$$

To provide intuition for the first-order condition, we can represent both the extent of oligopoly and oligopsony power by adequately defined revenue and demand shares. Let s_{fij} denote the oligopolistic market share: the share of a firm's revenues over total revenues in a destination j. Let s_{fi}^{o} denote the oligopsonistic demand share: the share of a firm's demand for the input over total demand in country i. The two market shares are defined as:

$$s_{fij} = \frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{10}$$

$$s_{fi}^{o} = \frac{k_{fi}}{\sum_{f=1}^{N_i} k_{fi}} = \frac{\sum_{j=1}^{I}\tau_{ij}c_{fi}x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i}\tau_{ij}c_{fi}x_{fij}} \tag{11}$$

By oligopoly power, the firm realizes that by increasing its supply of the good, it increases the quantity aggregate and, thus, reduces the inverse demand function for all the goods in the market. The effect on the firm of such a reduction in demand increases with the firm's market share s_{fij}. In addition, firms exhibit oligopsony power. By increasing the supply of a good, the firm increases the demand for the input, which results in an increase in the input's price r_i. The rise in r_i increases the variable costs of production for all the destinations reached by the firm. The effect of an increase in r_i is proportional to the firm's demand share for the input s_{fi}^{o}.

Using (10) and (11) into (9) yields the optimal quantity:

$$x_{fij} = \left[\frac{L_j(\sigma-1)}{\sigma\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}}\frac{1-s_{fij}}{\tau_{ij}c_{fi}r_i(1+\gamma s_{fi}^{o})}\right]^{\sigma} \tag{12}$$

Plugging (12) in (5) yields the pricing rule:

$$p_{fij} = r_i\tau_{ij}c_{fi}\underbrace{\frac{\sigma}{\sigma-1}\left(\frac{1+\gamma s_{fi}^{o}}{1-s_{fij}}\right)}_{\text{Markup Over Unit Costs}} \tag{13}$$

For ease of explanation, we define the markup as the ratio of price over unit costs $\frac{p_{fij}}{r_i\tau_{ij}c_{fi}}$. In our model, there are two wedges between the price and the unit costs. First, there is a markup over marginal costs, which depends on the market share of the firm in the final goods market. Second, there is a markdown on the input price, which is the ratio of marginal costs to unit costs, and which depends on the market share of the firm in the input market. Using our definition of markups, we are able to discuss both sources of market power in a single firm-level variable. As in standard models of oligopoly (Atkeson and Burstein, 2008; Edmond et al., 2015), firms with higher oligopoly power — with higher market share in the final goods market — enjoy higher markups. In addition, in our model, higher oligopsony power — higher market share in the input market — increases markups. A firm with large s_{fi}^{o} realizes that increasing its production raises the price of the input, therefore, at larger values for s^o_{fi}, firm f restricts its supply of the final good by charging higher markups.

A firm's revenues are given by:

$$p_{fij}x_{fij} = \left[\frac{\sigma}{(\sigma-1)}\frac{\tau_{ij}c_{fi}r_i(1+\gamma s^o_{fi})}{1-s_{fij}}\right]^{1-\sigma}\left[\frac{L_j}{\sum_{i=1}^{I}\sum_{f=1}^{N_i}x_{fij}^{\frac{\sigma-1}{\sigma}}}\right]^{\sigma} \tag{14}$$

To obtain a simpler expression for the optimal quantity x_{fij} supplied by a firm in a destination j, as a function of a firm's market power, we can rearrange the definition of market share in the following way: $x_{fij} = \frac{s_{fij}L_j}{p_{fij}}$, and use the pricing rule (13):

$$x_{fij} = \frac{(\sigma-1)L_j}{\sigma r_i \tau_{ij} c_{fi}}\frac{s_{fij}(1-s_{fij})}{1+\gamma s^o_{fi}} \tag{15}$$

The larger the oligopsony power of a firm, the smaller its supply across all the destinations reached. Interestingly, there is a non-monotone, hump-shaped relationship between supply of the final good and market share in a destination. When firms are small, a larger market share is positively related to the supply of a good. When a firm's sales account for more than half of the market, a larger market share reduces the supply of the firm.

We exploit the definition of market share, $x_{fij} = \frac{s_{fij}L_j}{p_{fij}}$, to derive a simple expression for a firm's profits as a function of oligopoly and oligopsony power:

$$\begin{aligned}\pi_{fij} &= x_{fij}p_{fij} - r_i\tau_{ij}c_{fi}x_{fij} = s_{fij}L_j - r_i\tau_{ij}c_{fi}\frac{s_{fij}L_j}{p_{fij}} = \\ &= s_{fij}L_j\left[1-\frac{\sigma-1}{\sigma}\frac{1-s_{fij}}{1+\gamma s^o_{fi}}\right]\end{aligned} \tag{16}$$

Profits in a destination j are increasing both in oligopoly and oligopsony power. Summing across the destinations reached yields a firm's total profits:

$$\pi_{fi} = \sum_{j=1}^{I}\pi_{fij} - F = \sum_{j=1}^{I}s_{fij}L_j\left[1-\frac{\sigma-1}{\sigma}\frac{1-s_{fij}}{1+\gamma s^o_{fi}}\right] - F \tag{17}$$

2.4 Equilibrium

Let us derive the total demand for K_i as well as its price r_i. The total demand for the oligopsonistic input is the sum of individual demands for all firms in i. Using the definition of s^o_{fi} (11), s_{fij} (10), and the pricing rule (13), K_i becomes:

$$K_i = \sum_{v=1}^{N_i} k_{vi} = \frac{k_{fi}}{s^o_{fi}} = \frac{1}{s^o_{fi}} \sum_{j=1}^{I} c_{fi} x_{fij} \tau_{ij} = \frac{1}{s^o_{fi}} \sum_{j=1}^{I} \frac{c_{fi}\tau_{ij} L_j s_{fij}}{p_{fij}} =$$
$$= \frac{\sigma - 1}{\sigma r_i} \frac{1}{s^o_{fi}(1+\gamma s^o_{fi})} \sum_{j=1}^{I} L_j (1 - s_{fij}) s_{fij} \tag{18}$$

Combining the aggregate demand for the input (18) with the aggregate supply (6) yields the equilibrium price for the input:

$$r_i = \left[\tilde{\gamma}_i^{\frac{1}{\gamma}} \frac{\sigma - 1}{\sigma} \frac{1}{s^o_{fi}(1+\gamma s^o_{fi})} \sum_{j=1}^{I} L_j (1 - s_{fij}) s_{fij} \right]^{\frac{\gamma}{1+\gamma}} \tag{19}$$

The final goods market clearing condition is given by:

$$\sum_{i=1}^{I} \sum_{f=1}^{N_i} s_{fij} = 1 \tag{20}$$

Similarly, the sum of the oligopsonistic market shares equals one:

$$\sum_{f=1}^{N_i} s^o_{fi} = 1 \tag{21}$$

For our baseline results, we consider firms that are homogeneous in terms of productivity: $c_{fi} = c_i \ \forall \ f = 1, ..., N_i$, and focus on the symmetric equilibrium whereby all surviving firms produce the same quantities. The equilibrium is a vector of the number of firms in each country N_i and input price r_i, such that each firm chooses the optimal quantity x_{ij} according to (12), profits (17) equal zero[10], and we ignore the integer problem, final goods markets clear, input markets clear, and trade is balanced.

3 Effects of International Trade

What are the effects of international trade on firms' market power? To answer this question, we consider two thought experiments. First, we replicate the Eckel and Neary (2010) exercise and study the effects of an increase in the number of countries that engage in frictionless

[10]As common in models with homogeneous oligopolists, for tractability, we ignore the integer problem (Neary, 2010). Free entry implies that profits are exactly equal to zero: for such a condition to be satisfied for any set of parameters, the number of firms must be a real number, instead of an integer.

trade of final goods or inputs. Second, we study the effects of a reduction in iceberg trade costs in a multi-country setting. We analytically derive these theoretical results under the baseline assumption of homogeneous firms. However, we show in section 4.4 that our main results also hold in an extension in which firms are heterogeneous in productivity. In this section, we also assume that countries are symmetric but allow for countries' asymmetry in our quantitative exercise.

3.1 International Economic Integration

In this section, we study the effects of international economic integration modeled, following Eckel and Neary (2010), as an increase in the number of countries in the context of frictionless trade, that is, all iceberg trade costs τ_{ij} are equal to one. This stylized thought experiment shows the effects of oligopoly in the presence of trade in the simplest way possible.

Let I denote the number of countries with integrated final goods markets, and I^o the number of countries with integrated input markets. We consider a fully symmetric equilibrium and this assumption places some restrictions on the values for I and I^o.[11] For this reason, our comparative statics exercise can be best examined as follows. In the initial allocation, countries are in autarky ($I = I^o = 1$). Then, in order to understand the effects of international integration in final goods, we compare the initial allocation to one in which $I > 1$ and $I^o = 1$ (or $I^o > 1$ and $I = 1$ for the case of integration in input markets). If the number of integrated countries equals two, the exercise is equivalent to the case of integration in two-country models traditionally examined in the literature.

Since all firms are identical, and there are no iceberg trade costs of exporting, the market share of a firm in the final goods market of any country is given by $s = \frac{1}{IN}$, while the demand share of each firm for the input is $s^o = \frac{1}{I^o N}$. Adapting the zero profit condition (17) to the symmetric countries assumption yields:

$$IsL\left[1 - \frac{\sigma - 1}{\sigma}\frac{1 - s}{1 + \gamma s^o}\right] = F \tag{22}$$

To understand how international economic integration affects the market power in the final goods and input markets, we consider two equilibrium conditions. The first one represents the relative market power (RMP) of firms in the final goods markets as a function of

[11]For instance, the symmetry is violated if $I^o = 2$ and $I = 3$. In this case, there is one country that does not have an integrated input market. As a result, the oligopsony power of firms in this country would be different from that of firms in the other two countries, violating the symmetry assumption.

the number of integrated countries:

$$\frac{s}{s^o} = \frac{I^o}{I} \qquad \text{(RMP)}$$

The relative market power of firms $\frac{s}{s^o}$ is inversely related to the relative number of integrated countries $\frac{I^o}{I}$. All else constant, the larger the number of integrated countries in the final goods market, the smaller the market share in the final goods market. In the (s, s^o) space, RMP represents a linear relationship between s and s^o, whose slope depends on the relative number of integrated countries for the two markets. The positive slope represents the fact that an increase in the size of a firm, all else constant, increases the firm's market power in both markets.

The second equation is the zero profit condition (22):

$$s^o = \frac{\sigma - 1}{\sigma\gamma} \frac{1 - s}{1 - \frac{F}{IsL}} - \frac{1}{\gamma} \qquad \text{(ZP1)}$$

$$s = 1 - \frac{\sigma}{\sigma - 1} \left[1 + \gamma s^o - \frac{F}{I^o s^o L} - \frac{\gamma F}{I^o L} \right] \qquad \text{(ZP2)}$$

where ZP1 is the zero profit condition (22) rearranged and ZP2 is obtained by substituting $I = I^o s^o s^{-1}$ using RMP. In the (s, s^o) space, the zero profit condition is represented by a negative relationship between s and s^o. All else constant, to maintain profits constantly at zero, an increase in a firm's market power in a market has to be matched by a reduction in market power in the other market. We can now study the effects of international economic integration.[12]

Let us start by considering the effects of integration in the final goods market. As Figure 1 shows, if the number of countries I that engage in trade of the final goods increases, the market share s declines, while the demand share s^o for the input increases. Integration of final goods markets increases the competition faced by oligopolists who lose market share s. As the number of firms active in the final goods market increases, each of them have a smaller share. Economic integration generates the reduction in markups illustrated by Edmond et al. (2015). However, by the zero profit condition, the reduction in the market share causes some firms to exit. The exit of firms increases the concentration in the oligopolistic input market. As a result, the demand share s^o increases. While the integration of final goods

[12]Since the RMP is an increasing function in the (s, s^o) space and ZP1 and ZP2 are decreasing functions, an analytical solution is guaranteed. However, for the analytical solution to be an equilibrium, it is required that the market shares are both less than 1. For that to occur, the fixed cost F must be small enough, and a necessary condition is that $F < IL$. In fact, operating profits (the left-hand-side of (22)) are increasing in s and s^o. If $s = 1$, operating profits equal IL and they must be larger than the fixed cost F. In fact, if these operating profits are less than the fixed cost F, the solution to the equation implies that $s > 1$.

markets reduces the oligopoly power, it has an opposite effect on the oligopsony power, which increases.

Figure 1: Final Goods Market Integration

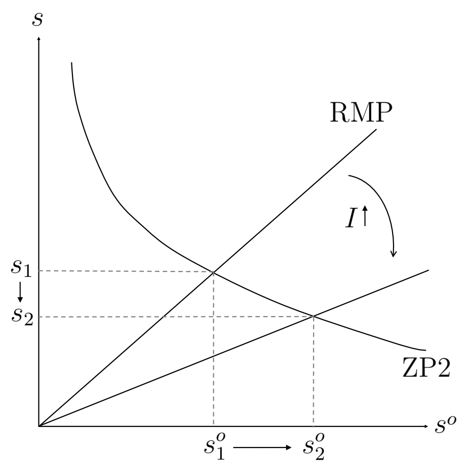
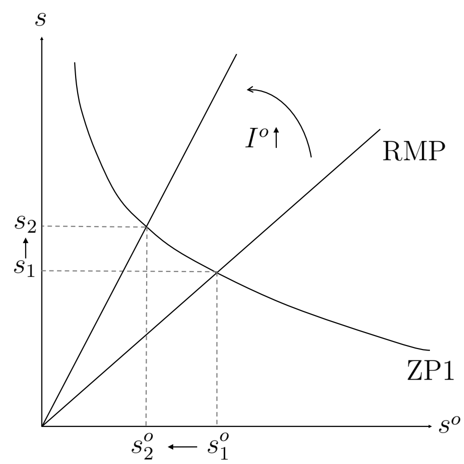
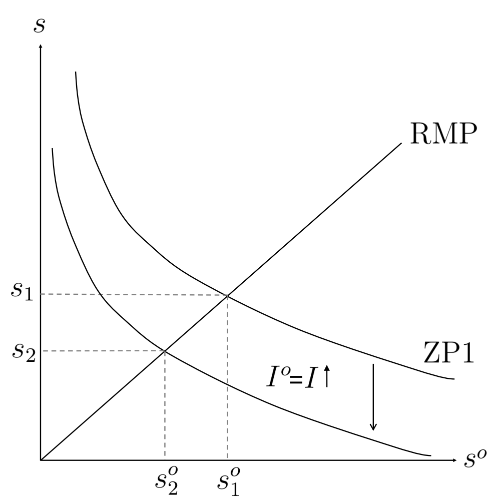


Figure 2: Input Market Integration



Integration of the input market has the opposite effect. As shown in Figure 2, an increase in the number of countries with integrated input markets I^o causes the market share s to increase, and the demand share for the input s^o to decline. As the number of firms in the market for the input increases, the demand share of each firm declines. The decline in s^o reduces the profitability of firms and, by the zero profit condition, some firms exit. As a result, fewer firms are serving the final goods market, which increases the market share s.

Figure 3: Final Goods and Input Market Integration



When firms are large both in the destination and in the market for inputs, the reduction in market power that arises from opening to trade one of the two markets is dampened by the increase in market power in the other. Opening trade for final goods reduces the market power of firms in the destination, but since the number of firms in each country falls, the oligopsony power increases. On the other hand, free trade in inputs reduces the oligopsony power, but it increases the market share of firms in their domestic economy. Only economic integration in all markets reduces the market power of firms both in the market for final goods and in the market for inputs. Figure (3) illustrates the effects of an increase in the number of integrated countries, assuming for exposition purposes that $I = I^o$. As firms lose market power in both markets, both s^o and s decline.

Input Prices and Markups. Let us summarize how oligopsony power affects input prices and markups in the presence of an increase in the number of countries with integrated final goods markets. For simplicity, in the derivations, we set $I^o = 1$. The derivations are in Appendix 6.1.2.

International economic integration increases the price of the input: despite the increase in market concentration, an increase in I leads to higher r. The larger the oligopsony power of firms, the smaller the increase in the input's price following international economic integration. Economic integration leads to higher production, which increases the input demand and, thus, the input price. Oligopsony power dampens the gains for the input, without completely offsetting them, due to the rise in input market concentration.

An increase in the number of countries with integrated final goods markets has a twofold effect on markups. On the one hand, a reduction in market share brings down markups. On the other, the increase in oligopsony market power has a positive effect on markups. The first effect dominates, and economic integration reduces the markups of firms. However, the larger the oligopsony power of firms, the smaller the reduction in markups.

3.2 Effects of a Reduction in Trade Costs

In this section, we study the effects of international economic integration modeled as a reduction in the iceberg trade costs. We keep the assumption of I symmetric countries and assume that the input is domestically sourced. In Appendix 6.1.4, we outline a model in which firms internationally source a set of differentiated inputs, and imports of inputs are subject to iceberg trade costs. Let $\tau_{ij} = \tau_{ji} = \tau$ for $i \neq j$ and $\tau_{ii} = 1$, $c_i = c$ and $L_i = L$ for $\forall i \in \{1, ...I\}$. As in the previous section, due to symmetry, $N_i = N$ and $r_i = r$. We leave the detailed derivations to Appendix 6.1.3.

To simplify the notation, let the market share in the final goods market be $s = s_{jj}$ in the domestic economy, and $s^* = s_{ij} = s_{ji}$ in export markets. As the input is domestically sourced, the oligopsonistic share is the reciprocal of the number of firms from one country: $s^o = \frac{1}{N}$. The domestic and export market share in final goods are linked by the following relationship:

$$\frac{s^{\frac{1}{\sigma-1}}}{1-s} = \tau \frac{s^{*\frac{1}{\sigma-1}}}{1-s^*} \tag{23}$$

Intuitively, in the presence of iceberg trade costs ($\tau > 1$), the domestic market share is larger than the export market share. Hence, export markups are lower than domestic markups.

By market clearing $Ns+(I-1)Ns^* = 1$ and $N = \frac{1}{s^o}$ by definition. Using these conditions, we can re-write (23) as our RMP curve, which reflects the relative domestic market power of oligopolists and oligopsonists and is represented by the following expression:

$$\frac{1-s}{s^{\frac{1}{\sigma-1}}} = \frac{1}{\tau} \frac{1 - \frac{s^o - s}{I-1}}{\left(\frac{s^o-s}{I-1}\right)^{\frac{1}{\sigma-1}}} \qquad \text{(RMP)}$$

Appendix 6.1.3 proves that the RMP curve is represented by an increasing function in the (s, s^o) space, similarly to the RMP curve of the previous section.

In the presence of symmetric countries and iceberg trade costs, a firm's profits are the sum of the profits obtained in the home country and the profits obtained in export markets. Using the market clearing condition, the zero profit (ZP) condition becomes:

$$ZP\left(s, s^o\right) \equiv s^o + \frac{\sigma-1}{\sigma}\frac{1}{1+\gamma s^o}\left[\frac{s}{I-1}\left(Is - 2s^o\right)\right] - \frac{\sigma-1}{\sigma}\frac{1}{1+\gamma s^o}\left(s^o - \frac{1}{I-1}\left(s^o\right)^2\right) = \frac{F}{L}$$

By the implicit function theorem:

$$\frac{ds}{ds^o} = -\frac{\partial ZP/\partial s^o}{\partial ZP/\partial s} < 0 \tag{24}$$

Hence, the ZP curve is decreasing in the (s, s^o) space, analogously to the previous section. Holding the profits equal to zero, higher market power in domestic final goods markets has to be met by a reduction in market power in the domestic input.

The effects of a reduction in iceberg trade costs can be studied by the use of a graph similar to Figure 1. A reduction in trade costs rotates the RMP curve clockwise. Thus, the new equilibrium features a higher oligopsonistic market share s^o and a lower oligopolistic domestic market share s. The effects of a reduction in trade costs are analogous to the effects of an increase in the number of integrated countries, which we explored in the previous section. In fact, lowering iceberg trade costs reduces the domestic oligopoly power in final goods, but it increases the oligopsony power in the input.

Lower trade costs increase export revenues while reducing domestic sales. Thus, the oligopoly power in export markets increases while the domestic oligopoly power declines. The shift in oligopoly power forces firms to reallocate their resources from the domestic, high-markup production, to the export, low-markup production. As a result, a firm's profits decline forcing some firms to exit. As fewer firms are demanding the domestic input, the oligopsony power increases.

The effects of a reduction in iceberg trade costs on input prices are similar to the experiment of increasing the number of integrated countries. Lower trade costs increase the input price, however, the larger the oligopsony power, the lower the increase in input price.

4 Estimating the Effects of Trade on Markups

In order to evaluate the effects of international trade on firms' market power and markups, we use our model to examine the effects of a reduction in trade costs between the US and the rest of the world. Our main result is that the reduction in markups predicted by our model is 12-44% lower than the prediction of a model featuring only oligopoly power. We begin by describing the sources of data for our calibration. Then, we present the calibration strategy. Third, we show our main counterfactual results. Finally, we show that the results are robust to extending the model to heterogeneous firms.

4.1 Data

Our quantitative exercise hinges on data availability on firms' market shares in input markets and final goods markets. To obtain such data, we use the UNIDO industrial statistics database, which provides information on the number of establishments at the country-industry-year level. With this data, it is not possible to compute market shares at the firm-level. However, the UNIDO dataset allows us to compute average market shares of establishments at the country-industry-year level, which is an appropriate statistic for our model with homogeneous firms. The data are available for 127 ISIC rev.4 (four-digit) industries in 75 countries for the years 1996-2012. Information starting earlier than 1996 is available at a higher level of industry aggregation. Additional details for our datasets are in the appendix.

To estimate the input supply elasticity, we study the relationship between export prices and oligopsony power. For this reason, we gather information on unit prices using data on bilateral trade flows from the World Bank's WITS database. The data contain information on physical quantities, which allows us to obtain unit prices $\bar{p}_{ijkt}$ for each country pair ij, industry k and year t. We consider industries k at a four-digit level of aggregation of the Harmonized System (HS); our trade data cover 170 countries and are available for the years 1981-2013.

4.2 Calibration

For our quantitative exercise, we consider a version of the model outlined in section 3.2 with two countries; one country is the US and the other represents the rest of the world. We allow for countries to be asymmetric and provide the description of the equilibrium in such a model and the details of the calibration in Appendix 6.4. We apply our two-country model separately to 706 HS four-digit industries. For the calibration, we use data for the year 2005. We denote with subscript h home (US) variables, and with subscript f foreign (rest of the world) variables.

Our baseline model requires the calibration of eight parameters: the size of the home country L_h and foreign country L_f; firms fixed costs F_h and F_f; the relative input requirements for production and delivery $\left(\frac{\tau_{hf}c_h}{c_f}\right)$ and $\left(\frac{\tau_{fh}c_f}{c_h}\right)$; the elasticity of substitution σ; and the supply elasticity of the specific input γ. We treat each HS four-digit industry separately and calibrate a set of industry-specific parameters. We take HS four-digit specific σ from Soderbery (2015). For the US size, we normalize it as a share and consider several measures: US share of world GDP (0.15), or US industry-specific size measured as employment share and output share from UNIDO. The foreign size share is simply given by $L_f = 1 - L_h$. The parameter γ is common across sectors and is estimated in the next section.

The calibration of the fixed costs and input requirements for production and delivery requires data on market shares. For this reason, we obtain the domestic demand share for the oligopsonistic input as the reciprocal of the number of firms in a sector. In particular, UNIDO provides data on the number of firms in country i (N_i) for each sector. In our model, $s_i^o = N_i^{-1}$. We use the US-specific oligopsonistic share for the home country. For the foreign country, we compute the average oligopsonistic share for non-US countries included in UNIDO. Namely, $s_f^o = \frac{1}{I}\sum_{i\neq US}^{I} s_i^o$.

We obtain the export market share for country i as $s_i^* = s_i^o\lambda_i$, where λ_i is the share of exports of country i defined as $\lambda_i = \frac{EX_i}{X_i+\bar{X}_{ROW}}$, where EX_i are the exports of country i, X_i is the output of country i, and $\bar{X}_{RoW}$ is the average output of all countries different from i in UNIDO. We set $s_h^* = s_{US}^*$ for the home country, and $s_f^* = \frac{1}{I}\sum_{i\neq US}^{I} s_i^*$ for the foreign country. Finally, we use the market-clearing conditions to impute the domestic market shares in final goods markets s_h and s_f. The descriptive statistics for the market shares are in Table 1.

Table 1: Summary Statistics: Market Shares

	Mean	Std. Dev.	Min	Max
s_h^o	0.06	0.14	0.00	1.00
s_f^o	0.09	0.14	0.00	0.99
s_h	0.06	0.12	0.00	0.83
s_f	0.02	0.03	0.00	0.37
s_h^*	0.04	0.09	0.00	0.80
s_f^*	0.01	0.02	0.00	0.24
Observations	706			

Given the data on market shares and the other parameters, we calibrate relative input requirements for production and delivery by exploiting the relationship between domestic and export market share (23). Furthermore, we use the zero profit condition (ZP) to calibrate the fixed costs.

We consider two alternative models: our baseline model featuring oligopoly and oligopsony power, and an alternative model that features only oligopoly power. To isolate the effects of oligopoly power from any other assumptions, we allow for an upward-sloping supply curve in our alternative model. However, we do not allow firms to internalize their effects on the price of the oligopsonistic input. In the quantitative exercise, both models feature the same level of firms market shares. This implies that the parameter values for the fixed costs and for the relative unit costs of production and delivery will differ across the two models.[13]

4.2.1 Calibration of the Input Supply Elasticity

To calibrate γ, we consider the relationship between prices and oligopsonistic share. We show in Appendix 6.3 that average industry prices $\bar{p}_{ijkt}$ from i to j in industry k and year t can be written as:

$$\ln \bar{p}_{ijkt} = \gamma \bar{s}^o_{ikt} + \beta \bar{s}_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{25}$$

where $\bar{s}^o_{ikt}$ and $\bar{s}_{ijkt}$ are the average oligopsonistic and oligopolistic market shares. ξ_{kt} and θ_{ijt} are industry-year and country pair-year fixed effects that capture the average unit cost of production and delivery. Note that the oligopolistic market share varies on both origin and destination levels, thus capturing the heterogeneity of countries of origin and its effect on the destination market prices.

To measure oligopsony and oligopoly power in the data, we use different concentration

[13]In fact, conditional on the same market share, markups and, thus, profits in the model with oligopsony power are larger than those in the model with oligopoly power only. Hence, the fixed cost implied by the zero profit condition will be different in the two calibrations.

measures that we label CM. CM^o_{ikt} measures concentration in the origin and thus proxies oligopsony power over domestic inputs while CM^d_{ijkt} measures concentration in the destination market. The general form of our main estimating equation is then:

$$\ln \bar{p}_{ijkt} = \gamma CM^o_{ikt} + \beta CM^d_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{26}$$

To estimate (26), we use data for 1996-2012 described above. Our measure of oligopsony power uses the reciprocal of the number of establishments provided in the UNIDO dataset. Namely, we let $CM^o_{ikt} = \frac{1}{N_{ikt}}$.[14] Such a measure exactly captures the average demand share $\bar{s}^o_{ikt}$. Additionally, we consider two measures of oligopoly power (or destination CM) in industry k and country of destination j. Our baseline measure is also taken directly from UNIDO as we let $CM^d_{ijkt} = \frac{1}{N_{jkt}}$. Such a measure implicitly assumes that oligopoly power in the destination is only a function of the destination characteristics. This means that the CM of the US proxies for the concentration faced by all exporters to the US in final goods markets. A possible concern is that the destination CM not only captures market concentration but also the market power of firms in the destination country. An increase in concentration in the US might imply a reduction of market power of firms exporting to the US, which would underestimate the effects of oligopoly power. To mitigate such concern, we consider an alternative measure of the concentration in final goods markets. In particular, we compute the adjusted concentration measure in a destination as $CM^{d\,adj}_{jkt} = \sum_{i \in I_j} \frac{1}{N_{ikt}} \lambda_{ijkt}$, where λ_{ijkt} is the import share of goods from i in country j. $CM^{d\,adj}_{jkt}$ captures the average level of market power in destination j faced by any firm.[15]

We consider three separate sets of fixed effects. The first set is the combination of industry-year and country-pair-year fixed effects, the second and the third are the combination of country-pair-industry and year fixed effects with industries defined at the HS four-digit level in the second set and at the HS two-digit level in the third set. Table 2 shows that the estimated γ ranges from 0.079 to 0.233 and is statistically significant for the first and third sets of fixed effects; γ is close to 0 and insignificant for the second set of fixed effects, suggesting that the main result is driven by the differences between industries on a disaggregated level rather than by the time variation.

In our calibration, we are going to use two values of γ. The first one is from the third column in Table 2 (0.195), which is the baseline specification with country-pair-industry fixed effects where an industry is an HS two-digit code. For robustness, we also consider the estimate from the fourth column of Table 2 (0.079), which is the lowest value for γ that we find. These values for the input supply elasticity are not far from other estimates from

[14] This measure is equivalent to the demand share s^o_i used in the calibration described in section 4.2.

[15] This measure is equivalent to the export market share s^*_i used in the calibration described in section 4.2.

the literature. For instance, Morlacco (2017) estimates a value of γ of 0.2. By contrast, examining export supply elasticities, Soderbery (2015) finds larger values in the range of 0.9-1.5, which are the values we find when considering the adjusted origin CM. We decide to use low values for γ, as they provide the most conservative evaluation for the effects of oligopsony. In fact, larger values of γ imply a larger effect for oligopsony on markups because the markup elasticity with respect to s^o is increasing in γ, and markups are independent of s^o when $\gamma = 0$. This result implies that the more elastic the labor supply is, the larger the benefit for firms of having a larger oligopsony power.

Table 2: The Effects of Oligopsony and Oligopoly Power on Prices

	Baseline			Adj Dest CM		
Origin CM	0.081***	-0.002	0.195***	0.079***	-0.002	0.233***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Destination CM	-0.001	-0.017***	0.117***	0.063***	0.009*	-0.035***
	(0.002)	(0.003)	(0.002)	(0.005)	(0.005)	(0.005)
Industry-Year	Y	N	N	Y	N	N
Country-Pair-Year	Y	N	N	Y	N	N
Country-Pair-Industry-4dig	N	Y	N	N	Y	N
Country-Pair-Industry-2dig	N	N	Y	N	N	Y
Year	N	Y	Y	N	Y	Y
R^2	0.68	0.83	0.53	0.68	0.83	0.53
# Observations	7825704	7289183	7774924	7825704	7289183	7774924

Results from OLS estimation of (26), where the dependent variable is the log unit values. Robust standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Baseline: CMs from the UNIDO dataset for origin and destination countries as dependent variables. Adj Dest CM: adjusted measure of concentration in the destination market. Industry-Year and Country-Pair-Industry Fixed Effects are at the HS four-digit aggregation level. Country-Pair-Industry-2dig are at HS two-digit aggregation level. Details are in the main text.

4.3 Counterfactuals

We study the effects of a reduction in τ_{hf} and τ_{fh} by 5% in each industry by computing the new equilibrium values of market share given the new vector of trade costs. Using the values of s_h', $(s_h^*)'$ and $(s_h^o)'$ after the reduction in trade costs, we can compute the log change in domestic and export markups $\hat{\mu}_h$ and $\hat{\mu}_h^*$ before and after the change in trade costs as:

$$\hat{\mu}_h = \ln \frac{1 + \gamma (s_h^o)'}{1 - s_h'} - \ln \frac{1 + \gamma s_h^o}{1 - s_h} \tag{27}$$

$$\hat{\mu}_h^* = \ln \frac{1 + \gamma (s_h^o)'}{1 - (s_h^*)'} - \ln \frac{1 + \gamma s_h^o}{1 - s_h^*} \tag{28}$$

Similarly, we consider the same trade costs shock in a model featuring only oligopoly power, and compute the corresponding change in markups.

Table 3 shows the results from a 5% reduction in trade costs in our baseline calibration. The reduction in trade costs produces a reduction in domestic markups in both models. In fact, the markups of US firms in the US decline by 0.49% in our baseline model and by 0.88% in the model that only considers oligopoly power. The presence of oligopsony power has a large effect on markups, as the reduction in domestic markups is 44% smaller than that predicted by a model with only oligopoly power. The change in export markups is small and positive for the oligopsony model (0.02%) and for the oligopoly model (0.15%).

The smaller change in markups in our baseline model is not only the result of the presence of the oligopsonistic share s_h^o in markups. Another mechanism is driven by the differences in the change in the domestic market share s_h. In the presence of oligopsony power, the same reduction in trade costs produces a significantly smaller reduction in concentration in domestic markets. These differences are sizable: while in the oligopoly model the domestic market share falls by 22%, in our baseline model, the reduction is only 3%. Furthermore, in the model with oligopsony power, a reduction in domestic concentration leads, all else constant, to an increase in domestic input markets concentration, which has a partial positive effect on markups.

The quantitative effect of oligopsony power increases in the value of γ. In fact, for $\gamma = 0$, the input demand share does not effect markups, and higher values of γ magnify the effects of s^o on markups. For $\gamma = 0.079$, the reduction in markups predicted by our model (0.65%) is 12% smaller than that predicted by a model with only oligopoly power (0.74%). Furthermore, the difference in the change in s_h between the two models is minimized (-5% in our baseline model, -9% in the alternative).

In Figure 4, we plot the relationship between the industry-specific changes in domestic markups ($\hat{\mu}_h$) against the initial level of the oligopsonistic share s_h^o. The larger the initial level of oligopsony power, the larger the reduction in markups. Furthermore, there is a larger difference between the predictions of the two models at larger values of s_h^o. In Table 7 of the appendix, we consider how results change in the case of alternative measures of market size for the US, using US employment or output share in an industry relative to the world.

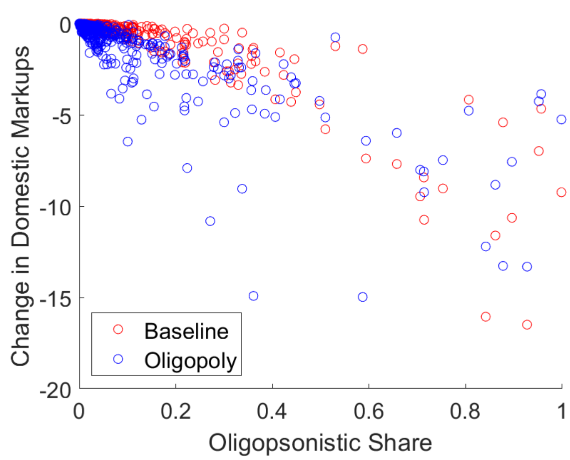
Table 3: Trade Shock: Markups and Concentration

$\gamma = 0.195$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-0.49	0.02	-3.16
Oligopoly Only	-0.88	0.15	-22.34

$\gamma = 0.079$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-0.65	0.06	-4.66
Oligopoly Only	-0.74	0.12	-9.35

Log changes in domestic and export markups of US firms ($\hat{\mu}_h$ and $\hat{\mu}_h^*$), and in the domestic market share of US firms ($\hat{s}_h$). The values reported are averages across industries. All changes are multiplied by 100. The description for the calibration of the other parameters is in the main text.

Figure 4: Trade Shock: Markups and Concentration



Log changes in domestic and export markups of US firms ($\hat{\mu}_h$) in the baseline and oligopoly model, plotted against the initial oligopsonistic share s_h^o. Each point represents an industry. All changes are multiplied by 100. The description for the calibration of the other parameters is in the main text. $\gamma = 0.195$, $L_h = 0.15$.

4.4 Extension to Heterogeneous Firms

In this section, we discuss how robust our results are to an important extension to the model of section 3.2 with two countries and iceberg trade costs, in which we allow for firm heterogeneity in productivity. We replicate our baseline quantification exercise, confirming the result that a model that only features oligopoly power predicts larger reductions in markups than the model with both oligopoly and oligopsony power. Since limitations in the data force us to make additional assumptions to calibrate the model with heterogeneous firms, we take these quantitative results with a grain of salt and interpret them mainly as evidence that the main results of our paper are not driven by the assumption of homogeneous firms.

We follow the standard approach of dealing with heterogeneous large firms in international trade of Edmond et al. (2015) by assuming that there is a fixed number of potential entrants. Only a fraction of the entrants are active, as N_i firms are active from each economy i. We assume that unit costs c_{fi} are drawn from a Pareto distribution with shape parameter θ and shift parameter b_i. In addition to the fixed cost F that all active firms pay as in our baseline model, there is a fixed cost of exporting F_X in units of the numeraire.

To avoid multiplicity of equilibria, entry in each market is sequential: in each destination j, we rank order firms by their unit costs $\tau_{ij}c_{fi}r_i$, so that the firms with the lowest costs are the first to be active in the market. The equilibrium number of firms N_i is such that all firms make positive profits, and an additional firm would have negative profits. Namely,

$$\pi_{fi}(N_i, N_j) > 0 \quad \forall f = 1, ..., N_i; \qquad \pi_{N_i+1i}(N_i + 1, N_j) < 0 \tag{29}$$

Since the data cover average market shares across countries and industries and does not provide firm-level information, it can be preferably matched by our model with homogeneous firms. Firm-level data are crucial in estimating the parameters of the model with firm heterogeneity that control the distribution of productivity across firms. As a result, to apply the counterfactual exercise previously shown to the case of firm heterogeneity, we need to make some assumptions on the export performance of the two countries and on the values attained by the parameters of the distribution of firms productivity θ, for which we consider two values in line with the estimates of the literature: $\theta = 4$ and $\theta = 8$. The details of the calibration are in Appendix 6.5.

In Table 4, we compare the change in domestic markups in our baseline model with heterogeneous firms to a model of heterogeneous firms that only have oligopoly power. We consider the weighted average markup of domestic firms, where the weights are the firms' unit costs (Edmond et al., 2018). When $\theta = 4$, the average markup falls by 0.006% on average across industries. By contrast, in the presence of oligopoly power, only markups fall by 0.007%, which is 14% larger. When $\theta = 8$, the average markup falls by 0.005% in our baseline model, and by 0.011% in the model with only oligopoly, which is 45% larger. As in our baseline model, trade forces some firms to exit, which increases the oligopsony power of the surviving firms. Furthermore, there is a composition effect whereby the average oligopsony power increases because trade selects out the firms with low oligopsony power and only firms with larger oligopsony power survive.

Table 4: Trade Shock: Markups with Heterogeneous Firms

	$\theta = 4$	$\theta = 8$
Baseline	-0.006	-0.005
Oligopoly Only	-0.007	-0.011

Cost-weighted average of the log changes in domestic markups of US firms, averaged across sectors, following a 5% reduction in trade costs. We set $\gamma = 0.195$. Details on the parameters in Appendix 6.5.

5 Conclusions

The international trade literature has explored the consequences of the presence of large exporters, that exploit their oligopoly power, for firms' prices (Eckel and Neary, 2010; Edmond et al., 2015). In this paper, we argue that firms' market power in the market for inputs, in which firms exploit their oligopsony power, has major implications for markups over unit costs.

Our theoretical model shows that while international integration in the market for final goods reduces firms' market power in the final goods market, it has the opposite effect on the market power of firms in input markets. The reduction in market power arising from international competition between oligopolists is dampened by the increase in market power in the market for inputs. Only international integration in both final goods and input markets successfully reduces firms' market power.

The policy implication is straightforward: to maximize the welfare gains from trade, trade agreements should foster trade both in final goods markets and in input markets. In the presence of domestic inputs, policies that reduce market concentration for the domestic input could reduce the increase in concentration due to trade in final goods.

References

M. Amiti, J. Konings, and O. Itskhoki. Imports, Exports, and Exchange Rate Disconnect. *American Economic Review*, 104(7):1942–78, 2014.

C. Arkolakis, A. Costinot, D. Donaldson, and A. Rodríguez-Clare. The Elusive Pro-Competitive Effects of Trade. *The Review of Economic Studies*, 86(1):46–80, 2018.

A. Atkeson and A. Burstein. Pricing-to-Market, Trade Costs, and International Relative Prices. *American Economic Review*, 98(5):1998–2031, 2008.

J. Azar, I. Marinescu, and M. I. Steinbaum. Labor market concentration. *The Journal of Human Resources*, 2020.

A. B. Bernard and S. Dhingra. Contracting and the Division of the Gains from Trade. *NBER Working Papers*, (21691), Oct. 2015.

A. B. Bernard, J. B. Jensen, S. J. Redding, and P. K. Schott. Firms in International Trade. *Journal of Economic Perspectives*, 21(3):105–130, 2007.

A. B. Bernard, J. B. Jensen, S. J. Redding, and P. K. Schott. Global firms. *Journal of Economic Literature*, 56(2):565–619, 2018.

V. Bhaskar, A. Manning, and T. To. Oligopsony and monopsonistic competition in labor markets. *The Journal of Economic Perspectives*, 16(2):155–174, 2002.

R. L. Bishop. Monopoly under general equilibrium: Comment. *The Quarterly Journal of Economics*, 80(4):652–659, 1966.

W. M. Boal and M. R. Ransom. Monopsony in the labor market. *Journal of Economic Literature*, 35(1):86–112, 1997.

W. J. Brooks, J. P. Kaboski, Y. A. Li, and W. Qian. Exploitation of labor? classical monopsony power and labor's share. *Journal of Development Economics*, 150:102627, 2021.

Council of Economic Advisors. Benefits of competition and indicators of market power. 2016.

J. De Loecker, J. Eeckhout, and G. Unger. The Rise of Market Power and the Macroeconomic Implications. *The Quarterly Journal of Economics*, 135(2):561–644, 2020.

E. Dhyne, A. K. Kikkawa, and G. Magerman. Imperfect Competition in Firm-to-Firm Trade. *Journal of the European Economic Association*, 03 2022.

J. Eaton, S. Kortum, and F. Kramarz. An Anatomy of International Trade: Evidence From French Firms. *Econometrica*, 79(5):1453–1498, 2011.

C. Eckel and P. J. Neary. Multi-Product Firms and Flexible Manufacturing in the Global Economy. *Review of Economic Studies*, 77(1):188–217, 2010.

C. Eckel and S. R. Yeaple. Too Much of a Good Thing? Exporters, Multiproduct Firms and Labor Market Imperfections. *NBER Working Papers*, (23834), 2017.

C. Edmond, V. Midrigan, and D. Y. Xu. Competition, markups, and the gains from international trade. *American Economic Review*, 105(10):3183–3221, 2015.

C. Edmond, V. Midrigan, and D. Y. Xu. How Costly Are Markups? *NBER Working Paper*, (24800), 2018.

H. Egger, U. Kreickemeier, C. Moser, and J. Wrona. Exporting and Offshoring with Monopsonistic Competition. *The Economic Journal*, 132(644):1449–1488, 2021.

R. Feenstra and H. Ma. Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition. *in E. Helpman, D. Marin and T. Verdier, eds., The Organization of Firms in a Global Economy, Harvard University Press.*, (13703), 2007.

R. C. Feenstra. Monopsony distortions in an open economy: A theoretical analysis. *Journal of International Economics*, 10(2):213 – 235, 1980.

C. Freund and M. D. Pierola. Export superstars. *Review of Economics and Statistics*, 97, 2015.

I. Heiland and W. Kohler. Heterogeneous workers, trade, and migration. *European Economic Review*, 144:104077, 2022.

B. Hershbein, C. Macaluso, and C. Yeh. Monopsony in the U.S. labor market. *forthcoming in Americal Economic Review*, 2020.

G. Impullitti, O. Licandro, and P. Rendahl. Technology, market structure and the gains from trade. *Journal of International Economics*, 135:103557, 2022.

P. Krugman. Increasing returns, monopolistic competition, and international trade. *Journal of international Economics*, 9(4):469–479, 1979.

P. Krugman. Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, 1980.

L. Macedoni. Monopsonistic competition, trade, and the profit share. *The Scandinavian Journal of Economics*, 124(2):488–515, 2022a.

L. Macedoni. Large multiproduct exporters across rich and poor countries: Theory and evidence. *Journal of Development Economics*, 156:102835, 2022b.

G. MacKenzie. Trade and Market Power in Product and Labor Markets. *Mimeo*, 2018.

J. R. Markusen. Trade in producer services and in other specialized intermediate inputs. *The American Economic Review*, 79(1):85–95, 1989.

J. R. Markusen and A. J. Robson. Simple general equilibrium and trade with a monopsonized sector. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 13(4): 668–682, 1980.

R. McCulloch and J. L. Yellen. Factor market monopsony and the allocation of resources. *Journal of International Economics*, 10(2):237–247, May 1980.

M. J. Melitz. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725, 2003.

M. Morlacco. Market power in input markets: Theory and evidence from french manufacturing. *Mimeo*, 2017.

P. J. Neary. Two and a half theories of trade. *World Economy*, 33(1):1–19, 2010.

P. J. Neary. International trade in general oligopolistic equilibrium. *Review of International Economics*, 24(4):669–698, 2016.

V. Nocke and S. Yeaple. Globalization and multiproduct firms. *International Economic Review*, 55(4):993–1018, 2014.

H. Raff and N. Schmitt. Buyer power in international markets. *Journal of International Economics*, 79(2):222 – 229, 2009.

E. Rossi-Hansberg, P.-D. Sarte, and N. Trachter. Diverging trends in national and local concentration. *NBER Macroeconomics Annual*, 35:115–150, 2021.

I. Simonovska and M. Waugh. Trade models, trade elasticities, and the gains from trade. *NBER Working Paper No. 20495*, (20495), 2014.

A. Soderbery. Estimating import supply and demand elasticities: Analysis and implications. *Journal of International Economics*, 96(1):1–17, 2015.

6 Appendix

6.1 Theory

This section provides the details of our theoretical results, and outlines the extensions to our baseline model mentioned in the main text. First, we show how the supply curve for the oligopsonistic input can be microfounded by adding input-disutility to consumers' utility. Second, we show how we derive the results on the effects of international integration on input prices and markups. Third, we derive the RMP and ZP curves in a model with iceberg trade costs. Fourth, we show how our model predictions in terms of prices generalize to a model where firms purchase multiple inputs. Finally, we describe how the definition of oligopsony power changes when firms from multiple industries demand the same input.

6.1.1 Endogenous Supply of the Input

Consider the following utility function, which allows us to endogenize the upward sloping supply for the input. Consumers in country $j = 1, ..., I$ have the following Cobb-Douglas aggregation of the CES quantity index Q_j we use in the baseline model, and the disutility from supplying the input k_j^c, which is denoted by H_j:

$$u_j = Q_j^{\alpha} H_j^{1-\alpha}$$

We assume an exponential disutility from supplying k_j^c:

$$H_j = \exp(-(k_j^c)^{1+\gamma})$$

Consumers' per capita income is denoted by $y_j = w_j + r_j k_j^c$, where w_j is the labor wage and r_j represents the payments to the input k_j^c. Consumers maximize utility by choosing q_{fij} and k^c, subject to the following budget constraint:

$$\sum_i \sum_f p_{fij} q_{fij} \leq w_j + r_j k_j^c$$

Solving the consumer's problem yields the following inverse demand function for the variety produced by firm f from i to j:

$$\frac{p_{fij}}{y_j} = \frac{q_{fij}^{-\frac{1}{\sigma}}}{Q_j^{\frac{\sigma-1}{\sigma}}} = \frac{q_{fij}^{-\frac{1}{\sigma}}}{\sum_i \sum_f q_{fij}^{\frac{\sigma-1}{\sigma}}}$$

and the individual inverse supply of the input:

$$\frac{r_j}{y_j} = \frac{(1-\alpha)(1+\gamma)}{\alpha}(k_j^c)^\gamma$$

Let $x_{fij} = L_j q_{fij}$ denote the aggregate demand and $K_j = L_j k_j^c$ denote aggregate supply of the input. Aggregate inverse demand and supply are given by:

$$\frac{p_{fij}}{y_j} = \frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}}$$
$$\frac{r_j}{y_j} = \tilde{\gamma}_j K_j^\gamma$$

where $\tilde{\gamma}_j = \frac{(1-\alpha)(1+\gamma)}{\alpha L_j^\gamma}$. Taking per capita income as the numeraire, and thus normalizing y_j to one, yields the same expressions we use in the baseline model.

6.1.2 International Integration

This section derives the effects of international economic integration on input prices and markups stated in section 3.1. Let us fix $I^o = 1$ and consider the effects of integration in the final goods markets. Let us start with input prices. Re-writing (19) in the symmetric country case yields:

$$r = \left[\tilde{\gamma}^{\frac{1}{\gamma}} \frac{\sigma-1}{\sigma} \frac{IL(1-s)s}{s^o(1+\gamma s^o)}\right]^{\frac{\gamma}{1+\gamma}} \tag{30}$$

Notice that $\frac{\sigma-1}{\sigma}\frac{IL(1-s)s}{s^o(1+\gamma s^o)}$ equals the total variable costs of a firm multiplied by the number of firms $(1/s^o)$. Using the zero profit condition, we can rewrite the price for the input as:

$$r=\left[\tilde{\gamma}^{\frac{1}{\gamma}}\left(L-\frac{F}{s^o}\right)\right]^{\frac{\gamma}{1+\gamma}}$$

where $\left(L-\frac{F}{s^o}\right)$ denote the aggregate variable costs written as the difference between aggregate revenues (or market size) L and aggregate expenditures on fixed costs F/s^o. An increase in s^o leads to an increase in r because, given a constant size of the market L, the increase in market power in input markets is matched by an increase in r to maintain aggregate profits at zero.

International economic integration increases the price for the input: despite the increase in market concentration, increasing I leads to higher r:

$$\frac{d\ln r}{d\ln I}=\frac{\gamma}{1+\gamma}\frac{F}{Ls^o-F}\frac{d\ln s^o}{d\ln I} \tag{31}$$

To understand how the oligopsony power of firms influences the input's price, let us consider the elasticity of the oligopsonistic demand share relative to the number of countries. To do so, we substitute (RMP) into the zero profit condition (22), and take the total derivative:

$$\frac{d\ln s^o}{d\ln I}=\frac{(\sigma-1)s}{\sigma(1+\gamma s^o)-\frac{(\sigma-1)(1-2s-\gamma s s^o)}{1+\gamma s^o}} \tag{32}$$

The larger the oligopsony power, the smaller the increase in the oligopsony power following an increase in the number of countries. Thus, the larger the oligopsony power of firms, the smaller the increase in the input's price following international economic integration. Economic integration leads to higher production, which increases the input demand and, thus, the input price. Oligopsony power dampens the gains for the input, without completely offsetting them, because of the rise in input market concentration.

An increase in the number of countries with integrated final goods markets has a twofold effect on markups over unit costs. On the one hand, a reduction in market share brings down markups. On the other, the increase in oligopsony market power has a positive effect on markups. The first effect dominates, and economic integration reduces the markups of firms:

$$\begin{aligned}\frac{d\ln\mu}{d\ln I}&=\frac{\gamma s^o}{1+\gamma s^o}\frac{d\ln s^o}{d\ln I}+\frac{s}{1-s}\frac{d\ln s}{d\ln I}=\\&=\frac{s+\gamma s^o}{(1-s)(1+\gamma s^o)}\frac{d\ln s^o}{d\ln I}-\frac{s}{1-s}=\\&=-\frac{s}{1-s}\left[\frac{1+(\sigma-1)s+\sigma\gamma s^o}{\sigma(1+\gamma s^o)-\frac{(\sigma-1)(1-2s-\gamma s s^o)}{1+\gamma s^o}}\right]\end{aligned}$$

where we used the result that $d\ln s=d\ln s^o-d\ln I$ from (RMP). What is the effect of oligopsony power on the markup elasticity? On the one hand, for a given change in the number of firms, larger oligopsony power generates smaller reduction in markups following integration. On the other hand, larger oligopsony power generates smaller changes in the number of firms, which then generates smaller changes in markups. The first effect dominates, as the markup elasticity is, in absolute value, increasing in s^o. The larger the oligopsony power of firms, the smaller the reduction in markups.

6.1.3 Iceberg Trade Costs

This section presents the detailed derivations of the model discussed in section 3.2. Recall the assumption of symmetric countries, and that $s^o = 1/N$. First, we derive the RMP curve that reflects the relationship between oligopoly and oligopsony power in the domestic market. Let an asterisk denote variables associated with exports. Since all firms are identical, all firms also export to all $I-1$ destinations different from the domestic country. Moreover, as all countries are identical, export quantities and prices are identical across destination.

Using the definition of oligopolistic market share, the domestic market share in final goods market equals:

$$s = \frac{x_{jj}^{\frac{\sigma-1}{\sigma}}}{\sum_i N_i x_{ij}^{\frac{\sigma-1}{\sigma}}} = \frac{x^{\frac{\sigma-1}{\sigma}}}{N x^{\frac{\sigma-1}{\sigma}} + (I-1) N x^{*\,\frac{\sigma-1}{\sigma}}} = s^o \frac{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}}}{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}} + (I-1)} \tag{33}$$

Similarly, export oligopoly power equals:

$$s^* = s^o \frac{1}{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}} + (I-1)}$$

Thus, the ratio of domestic market share to export market share equals:

$$\frac{s}{s^*} = \left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}} \tag{34}$$

Using the pricing rule (13), domestic prices $p = \frac{\sigma}{\sigma-1} rc \frac{1+\gamma s^o}{1-s}$ and export prices $p^* = \frac{\sigma}{\sigma-1} \tau rc \frac{1+\gamma s^o}{1-s^*}$. Hence, from demand (5), the relative quantity of domestic goods to export goods equals:

$$\frac{x}{x^*} = \left(\frac{p}{p^*}\right)^{-\sigma} = \left(\frac{1}{\tau}\frac{1-s^*}{1-s}\right)^{-\sigma} \tag{35}$$

From the market clearing condition:

$$\begin{aligned} Ns + (I-1)Ns^* &= 1 \\ s + (I-1)s^* &= s^o \\ s^* &= \frac{s^o - s}{I-1} \end{aligned} \tag{36}$$

Using (36) into (35) yields:

$$\left(\frac{x}{x^*}\right)^{\frac{1}{\sigma}} = \frac{\tau(1-s)}{1-s^*} = \frac{\tau(1-s)}{1-\frac{s^o-s}{I-1}} \tag{37}$$

Plugging (37) and (36) into (34) yields our RMP condition:

$$\begin{aligned}\frac{1-s}{s^{\frac{1}{\sigma-1}}} &= \frac{1}{\tau}\frac{1-s^*}{s^{*\frac{1}{\sigma-1}}} \\ \frac{1-s}{s^{\frac{1}{\sigma-1}}} &= \frac{1}{\tau}\frac{1-\frac{s^o-s}{I-1}}{\left(\frac{s^o-s}{I-1}\right)^{\frac{1}{\sigma-1}}} \qquad \text{(RMP)}\end{aligned}$$

The left hand side of this expression is decreasing in s (on the (0;1) interval from ∞ to 0) and right hand side is increasing on the same interval (from $\frac{1}{\tau}\frac{1-s^o}{s^o}$ to ∞), so there exists a unique solution for s. Moreover, the right-hand side is decreasing in τ and increasing in s^o. Hence, along the RMP, $\frac{ds}{ds^o} < 0$, and a reduction in τ rotates the RMP curve clockwise.

Let us now derive the ZP curve. In the current model, the zero profit condition (17) becomes:

$$\pi = L\left[s\left(1-\frac{\sigma-1}{\sigma}\frac{1-s}{1+\gamma s^o}\right) + (I-1)\,s^*\left(1-\frac{\sigma-1}{\sigma}\frac{1-s^*}{1+\gamma s^o}\right)\right] = F$$

A reduction in iceberg trade costs would increase the share of profits from export markets and reduce the domestic share of profits. Using (36), and rearranging, we obtain our ZP curve:

$$ZP\left(s,s^o\right) \equiv s^o + \frac{\sigma-1}{\sigma}\frac{1}{1+\gamma s^o}\left[\frac{s}{I-1}\left(Is-2s^o\right)\right] - \frac{\sigma-1}{\sigma}\frac{1}{1+\gamma s^o}\left(s^o - \frac{1}{I-1}\left(s^o\right)^2\right) = \frac{F}{L}$$

Now let us show that $\frac{ds}{ds^o} < 0$:

$$\frac{\partial ZP\left(s,s^o\right)}{\partial s} = \frac{\sigma-1}{\sigma}\frac{1}{1+\gamma s^o}\left(\frac{2I}{I-1}s - \frac{2}{I-1}s^o\right) > 0$$

as $s \geq \frac{s^o}{I}$

$$\frac{\partial ZP\left(s,s^o\right)}{\partial s^o} = 1 - \frac{\sigma-1}{\sigma}\frac{1}{\left(1+\gamma s^o\right)^2}\left[1+\frac{2}{I-1}s + \gamma\frac{I}{I-1}s^2 - \frac{2}{I-1}s^o - \gamma\frac{1}{I-1}\left(s^o\right)^2\right]$$

as $s \leq s^o$

$$\frac{\partial ZP\left(s,s^o\right)}{\partial s^o} \geq 1 - \frac{\sigma-1}{\sigma}\frac{1}{I-1}\frac{1+\gamma\left(s^o\right)^2}{\left(1+\gamma s^o\right)^2} > 0$$

as $\gamma > 0$ and $s^o \leq 1$.

From the implicit function theorem:

$$\frac{ds}{ds^o} = -\frac{\partial ZP/\partial s^o}{\partial ZP/\partial s} < 0$$

Let us now consider the effects of a reduction in τ on input prices. Plugging (36) and (17) into (19) we obtain:

$$r = \tilde{\gamma}^{\frac{1}{1+\gamma}} \left(L - \frac{F}{s^0} \right)^{\frac{\gamma}{1+\gamma}} \tag{38}$$

Hence, $\frac{dr}{ds^o} > 0$ and consequently $\frac{dr}{d\tau} < 0$, which means that higher trade costs lead to lower price for the input.

Let us now examine the effects of changes in τ on prices and quantities. Domestic prices are given by:

$$p = \frac{\sigma}{\sigma - 1} rc \frac{1 + \gamma s^o}{1 - s}$$

As $\frac{dr}{d\tau} < 0$, $\frac{ds^o}{\tau} < 0$, and $\frac{ds}{\tau} > 0$ it follows that $\frac{dp}{d\tau}$ has an ambiguous sign. A reduction in trade costs increases oligopsony power, but reduces oligopoly power, thus the ambiguous sign.

The domestic supply of goods is:

$$x = \frac{sL}{p} = \frac{\sigma - 1}{\sigma c} \frac{s(1-s)}{r(1+\gamma s)}$$

as the numerator is increasing in τ and the denominator is decreasing, $\frac{dx}{d\tau} > 0$.

Recall that, $r = \tilde{\gamma} \left[c \frac{1}{s^o} (x + (I-1) \tau x^*) \right]^\gamma$ and using $\frac{dr}{d\tau} < 0$, $\frac{dx}{d\tau} > 0$, and $\frac{ds^o}{d\tau} < 0$ we get that $\frac{dx^*}{d\tau} < 0$.

Export prices equal:

$$p^* = \frac{\sigma}{\sigma - 1} c\tau \left[\frac{r}{1 - s^*} (1 + \gamma s^o) \right]$$

where the first term in square brackets is decreasing in τ and reflects oligopsonistic effect, while the second term is increasing in τ and reflects the direct effect of higher trade costs and lower market power in the destination market.

Notice, however, that even though the changes in prices are ambiguous, domestic sales are increasing in τ and export sales are decreasing:

$$\frac{d(px)}{d\tau} > 0, \frac{d(p^*x^*)}{d\tau} < 0$$

as $px = Ls$ and $p^*x^* = Ls^*$.

6.1.4 Multiple Inputs

This section outlines an extension to the baseline model, in which firms purchase a number of differentiated inputs and the purchase of differentiated inputs from abroad requires the payment of an iceberg trade costs. Our results motivate the second measure of oligopsony power we use in the calibration of γ, in which prices depend on the average oligopsony power an industry faces upstream. As the number of subscripts increases quickly, we drop the origin country subscript. Let us focus on the problem of firm f, which exports to $j = 1, ..., I$ countries.

To produce output x_{fj} to country j, firm f uses $k = 1, ..., K$ inputs. We assume that each country supplies differentiated inputs, but we disregard the origin country subscript. Firm f uses y_{kfj} units of input k to produce the output for destination j according to the following production function:

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) \tag{39}$$

where we assume that $f()$ is increasing, concave and exhibits constant returns to scale. $\mathbf{y_{kfj}}$ is the vector of inputs used in producing for destination j The total demand of firm f for input k is $y_{kf} = \sum_{j=1}^{I} y_{kfj}$. Acquiring y_{kf} units of the input is subject to an iceberg trade cost t_{kf}.[16] The inverse demand for input k is given by:

$$r_k = \gamma_k Y_k^{\gamma} = \gamma_k \left[\sum_v t_{kv} y_{kv} \right]^{\gamma} \tag{40}$$

where v is the index of all firms using input k in production. Revenues are identical to the baseline problem. To include iceberg trade costs, it suffices to divide revenues by τ_{fj}. Profits are given by:

$$\Pi_f = \sum_j \frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} - \sum_k r_k t_{kv} y_{kv} \tag{41}$$

$$\Pi_f = \sum_j \frac{p_{fj}(f(\mathbf{y_{kfj}}))f(\mathbf{y_{kfj}})}{\tau_{fj}} - \sum_k \gamma_k \left[\sum_v t_{kv} \sum_d y_{kvd} \right]^{\gamma} t_{kf} \sum_f (y_{kfj}) \tag{42}$$

Firms maximize their profits by choosing $\mathbf{y_{kfj}}$. The first order conditions are given by:

$$\frac{\sigma - 1}{\sigma \tau_{fj}} p_{fj}(1 - s_{fj}) \frac{\partial f_{fj}}{\partial y_{kfj}} = r_k t_{kf}(1 + \gamma s_{kf}^o) \tag{43}$$

where

$$s_{kf}^o = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{44}$$

Multiplying both sides of (43) by y_{kfj}, summing over inputs k, and using Euler's theorem for homogeneous of degree one functions we find:

$$\frac{\sigma - 1}{\sigma \tau_{fj}} p_{fj}(1 - s_{fj}) y_{kfj} \frac{\partial f_{fj}}{\partial y_{kfj}} = r_k t_{kf} y_{kfj}(1 + \gamma s_{kf}^o)$$

$$\frac{\sigma - 1}{\sigma \tau_{fj}} p_{fj}(1 - s_{fj}) \sum_k y_{kfj} \frac{\partial f_{fj}}{\partial y_{kfj}} = \sum_k r_k t_{kf} y_{kfj}(1 + \gamma s_{kf}^o)$$

[16]The proper notation for such iceberg trade cost would be: t_{kij} where k is the input supplied from i used by firms from j.

$$\frac{\sigma-1}{\sigma\tau_{fj}} p_{fj}(1-s_{fj})x_{fj} = \sum_k r_k t_{kf} y_{kfj}(1+\gamma s^o_{kf})$$
$$\frac{\sigma-1}{\sigma\tau_{fj}} p_{fj}(1-s_{fj}) = \sum_k \frac{r_k t_{kf} y_{kfj}}{x_{fj}}(1+\gamma s^o_{kf})$$
$$p_{fj} = \frac{\sigma\tau_{fj}}{(\sigma-1)(1-s_{fj})} \sum_k \frac{r_k t_{kf} y_{kfj}}{x_{fj}}(1+\gamma s^o_{kf})$$

Firm's revenues in destination j are given by:

$$\frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} = \frac{\sigma}{(\sigma-1)(1-s_{fj})} \sum_k r_k t_{kf} y_{kfj}(1+\gamma s^o_{kf}) \tag{45}$$

Let $\alpha_k()$ denote the share of expenditures on input k over the total cost expenditures for the production of a good to a destination j, namely:

$$\alpha_k() = \frac{r_k t_{kf} y_{kfj}}{\sum_u r_u t_{uf} y_{ufj}} \tag{46}$$

Hence, since $r_k t_{kf} y_{kfj} = \alpha_k \sum_u r_u t_{uf} y_{ufj}$, firm's revenues can be written as:

$$\frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} = \frac{\sigma}{(\sigma-1)(1-s_{fj})} \sum_k \alpha_k \sum_u r_u t_{uf} y_{ufj}(1+\gamma s^o_{kf})$$
$$= \frac{\sigma}{(\sigma-1)(1-s_{fj})} \sum_u r_u t_{uf} y_{ufj} \sum_k \alpha_k(1+\gamma s^o_{kf})$$

Exploiting the definition of market share, we obtain the cost to export to destination j:

$$\frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} = s_{fj} y_j L_j$$
$$\frac{\sigma}{(\sigma-1)(1-s_{fj})} \sum_u r_u t_{uf} y_{kuj} \sum_k \alpha_k(1+\gamma s^o_{kf}) = s_{fj} y_j L_j$$
$$\sum_u r_u t_{uf} y_{ufj} = \frac{\sigma-1}{\sigma} s_{fj}(1-s_{fj}) y_j L_j \frac{1}{\sum_k \alpha_k(1+\gamma s^o_{kf})}$$

Profits are then given by:

$$\Pi_f = \sum_j p_{fj} x_{fj} - \sum_j \sum_k r_k t_{kf} y_{kfj} - F =$$
$$= \sum_j s_{fj} y_j L_j \left[1 - \frac{\sigma-1}{\sigma} \frac{1-s_{fj}}{\sum_k \alpha_k(1+\gamma s^o_{kf})}\right] - F$$

Let us re-write prices:

$$p_{fj} = \frac{\sigma\tau_{fj}}{(\sigma-1)(1-s_{fj})} \frac{\sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \sum_k \alpha_k (1+\gamma s^o_{kf}) \tag{47}$$

The average variable cost of selling to destination j is:

$$AVC_{fj} = \frac{\tau_{fj} \sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \tag{48}$$

Thus, prices are given by:

$$p_{fj} = AVC_{fj} \frac{\sigma}{\sigma-1} \frac{\sum_k \alpha_k (1+\gamma s^o_{kf})}{1-s_{fj}} \tag{49}$$

Cobb Douglas

Let us assume that the production function is Cobb-Douglas:

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) = \prod y_k^{\alpha_k} \qquad \sum_k \alpha_k = 1 \tag{50}$$

Such an assumption implies that input cost shares (46) are constant. With a Cobb-Douglas utility function, we can simplify the price equation, by finding a closed form expression for the average variable costs.

Let us fix a firm f and a destination j, to drop firm and destination subscripts. Let us take the ratio between the FOC (43) of input k and input v (for the same firm and destination). Assuming that the production function is Cobb-Douglas, we obtain:

$$\frac{\alpha_k y_v}{\alpha_v y_k} = \frac{r_k t_k}{r_v t_v}$$
$$y_k = y_v \frac{\alpha_k}{r_k t_k} \frac{r_v t_v}{\alpha_v}$$

Substituting the demand for input k into the total variable cost function yields:

$$\sum_k r_k t_k y_k = y_v \frac{r_v t_v}{\alpha_v} \sum_k \alpha_k = y_v \frac{r_v t_v}{\alpha_v}$$

Substituting the demand for input k into the production function yields:

$$x = \prod y_k^{\alpha_k} = y_v \frac{r_v t_v}{\alpha_v} \prod \left(\frac{\alpha_k}{r_k t_k}\right)^{\alpha_k}$$

Hence, the average cost of the firm is a function of the iceberg trade cost of exporting to the destination and a Cobb-Douglas aggregation of each input cost:

$$AVC_{fj} = \frac{\tau_{fj} \sum_u r_u t_{uf} y_{ufj}}{x_{fj}} = \frac{\tau_{fj}}{\prod \left(\frac{\alpha_k}{r_k t_{kf}}\right)^{\alpha_k}}$$

Finally, our pricing equation simplifies to:

$$p_{fj} = \frac{\tau_{fj}}{\prod \left(\frac{\alpha_k}{r_k t_{kf}}\right)^{\alpha_k}} \frac{\sigma}{\sigma - 1} \frac{\sum_k \alpha_k (1 + \gamma s^o_{kf})}{1 - s_{fj}} \tag{51}$$

6.1.5 Multiple Industries

This section briefly outlines an extension to the baseline model, in which firms from different industries purchase the same input k. Combined with the previous section, the results provide a theoretical foundation for the second measure of oligopsony power we use in the calibration of γ. In fact, this extension informs us on how to measure oligopsony power in the context of input-output linkages.

To simplify the notation let industries be denoted by subscript $h = 1, ..., H$. To bring this to the data, we simply need to be careful with the definition of oligopsonistic demand share:

$$s^o_{kf} = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{52}$$

The demand share of a firm f for input k is the ratio between the firm's demand and the total demand for the input. To further simplify the notation, let us only consider input k. The total demand for the input from industry h is:

$$Y_h = \sum_{f \in h} t_f y_f$$

The oligopsonistic demand share is:

$$s^o_f = \frac{t_f y_f}{\sum_h Y_h} = \underbrace{\frac{Y_h}{\sum_h Y_h}}_{\text{Industry Share}} \underbrace{\frac{t_f y_f}{Y_h}}_{\text{Within-Industry} s^o} \tag{53}$$

6.2 Data

6.2.1 UNIDO Database

The UNIDO database uses M49 country codes classification, while trade data from WITS uses the ISO classification. We use the concordance from the United Nations Statistics Division to convert M49 to ISO codes.[17]

To connect the UNIDO data and the data on unit prices, we match ISIC industries (from UNIDO) with HS four-digit industries (from WITS) using the crosswalk from WITS. In the

[17]https://unstats.un.org/unsd/methodology/m49/overview/

presence of multiple ISIC codes corresponding to one HS code, we add up corresponding values within the HS code. In the presence of multiple HS codes linked to one ISIC code, we construct a country specific weight of each HS code within ISIC code using the ratio of export of an HS code relative to the exports of all HS code within the ISIC code for each country.

6.3 Calibration of the Labor Supply Elasticity

Consider the pricing decision of a firm f from country i exporting to country j in industry k. Since our data cover multiple years, we also add a time subscript t. We consider the following approximation of the total derivative of log prices (13):

$$\begin{aligned} d\ln p_{ijkft} &= d\ln(c_{fit}\tau_{ijt}r_{ikt}) + d\ln\left(1+\gamma s^o_{ikft}\right) - d\ln\left(1 - s_{ijkft}\right) \\ &\approx d\ln(c_{fit}\tau_{ijt}r_{ikt}) + \gamma ds^o_{ikft} + ds_{ijkft} \end{aligned} \tag{54}$$

As we describe in the following section, our data comprise of highly disaggregated industry-level prices. Thus, we consider the industry average of (54):

$$d\ln\bar{p}_{ijkt} \approx d\ln\bar{c}_{ijkt} + \gamma d\bar{s}^o_{ikt} + d\bar{s}_{ijkt} \tag{55}$$

where $\bar{p}_{ijkt} = \frac{\sum_f^{N_{ijkt}} p_{ijkft}}{N_{ijkt}}$, $\bar{s}^o_{ikt} = \frac{\sum_f^{N_{ijkt}} s^o_{ikft}}{N_{ijkt}}$, and $\bar{s}_{ijkt} = \frac{\sum_f^{N_{ijkt}} s_{jkft}}{N_{ijkt}}$ are the average industry price, demand share in inputs' markets, and market share in the destination. N_{ijkt} is the number of firms that exports from i to j in industry k and year t. Finally, $\ln\bar{c}_{ijkt} = \frac{\sum_f^{N_{ijkt}} \ln\tilde{c}_{ijft}}{N_{ijkt}}$ is the industry average unit cost of production and delivery, which reflects firms' productivity, iceberg trade costs, and input prices.

We assume that the average unit cost of production and delivery can be decomposed in an industry-year component ξ_{kt} that reflects industry-specific shocks, and a country-pair-year component θ_{ijt} that controls for input prices, productivity levels, and for bilateral trade costs. Namely, we let $\ln\bar{c}_{ijkt} = \xi_{kt} + \theta_{ijt}$. Thus, the regression model we use to estimate the effects of oligopoly and oligopsony power on prices (25) is the following:

$$\ln\bar{p}_{ijkt} = \gamma\bar{s}^o_{ikt} + \beta\bar{s}_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{56}$$

6.4 Asymmetric Country model

Oligopoly and Oligopsony Power Let us denote home variables with subscript h and foreign variables with subscript f. Furthermore, let an asterisk * denote export variables. There are six unknowns in the model, which are the market share of home firms in the home market s_h and in the foreign market s^*_h, home firms' demand share of the oligopsonistic input s^o_h, the market share of foreign firms in the foreign market s_f and in the home market s^*_f, and foreign firms' demand share of the oligopsonistic input s^o_f.

The first two equilibrium conditions are the zero profit conditions, which are easily extended to the asymmetric country case:

$$s_h L_h \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{1 - s_h}{1 + \gamma s_h^o}\right)\right] + s_h^* L_f \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{1 - s_h^*}{1 + \gamma s_h^o}\right)\right] - F_h = 0 \tag{57}$$

$$s_f L_f \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{1 - s_f}{1 + \gamma s_f^o}\right)\right] + s_f^* L_h \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{1 - s_f^*}{1 + \gamma s_f^o}\right)\right] - F_f = 0 \tag{58}$$

Market clearing in the home economy implies that $N_h s_h + N_f s_f^* = 1$. Notice that, since firms are homogeneous, $s_h^o = 1/N_h$ and $s_f^o = 1/N_f$. Therefore, our market clearing conditions become:

$$\frac{s_h}{s_h^o} + \frac{s_f^*}{s_f^o} = 1 \tag{59}$$

$$\frac{s_f}{s_f^o} + \frac{s_h^*}{s_h^o} = 1 \tag{60}$$

Taking the ratio of firm revenues to the same destination yields the following relationship:

$$\left(\frac{s_{ij}}{s_{jj}}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{ij} c_i}{\tau_{jj} c_j}\right)\left(\frac{1 - s_{jj}}{1 - s_{ij}}\right)\left(\frac{1 + \gamma s_i^o}{1 + \gamma s_j^o}\right)\left(\frac{r_i}{r_j}\right)$$

Using the equilibrium equation for the price of the oligopsonistic input, we obtain:

$$\frac{r_i}{r_j} = \left[\left(\frac{s_j^o(1 + \gamma s_j^o)}{s_i^o(1 + \gamma s_i^o)}\right)\left(\frac{L_i(s_{ii} - s_{ii}^2) + L_j(s_{ij} - s_{ij}^2)}{L_j(s_{jj} - s_{jj}^2) + L_i(s_{ji} - s_{ji}^2)}\right)\right]^{\frac{\gamma}{1+\gamma}}$$

Combining the last two equations yields our last two equilibrium conditions:

$$\left(\frac{s_h^*}{s_f}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{hf} c_h}{c_f}\right)\left(\frac{1 - s_f}{1 - s_h^*}\right)\left(\frac{1 + \gamma s_h^o}{1 + \gamma s_f^o}\right)\left[\left(\frac{s_f^o(1 + \gamma s_f^o)}{s_h^o(1 + \gamma s_h^o)}\right)\left(\frac{L_h(s_h - s_h^2) + L_f(s_h^* - (s_h^*)^2)}{L_f(s_f - s_f^2) + L_h(s_f^* - (s_f^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{61}$$

$$\left(\frac{s_f^*}{s_h}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{fh} c_f}{c_h}\right)\left(\frac{1 - s_h}{1 - s_f^*}\right)\left(\frac{1 + \gamma s_f^o}{1 + \gamma s_h^o}\right)\left[\left(\frac{s_h^o(1 + \gamma s_h^o)}{s_f^o(1 + \gamma s_f^o)}\right)\left(\frac{L_f(s_f - s_f^2) + L_h(s_f^* - (s_f^*)^2)}{L_h(s_h - s_h^2) + L_f(s_h^* - (s_h^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{62}$$

The system of equations (57), (58), (59), (60), (61), and (62) yields the equilibrium values of s_h, s_h^*, s_h^o, s_f, s_f^*, and s_f^o, given the parameters L_h, L_f, F_h, F_f, $\left(\frac{\tau_{hf} c_h}{c_f}\right)$, and $\left(\frac{\tau_{fh} c_f}{c_h}\right)$, σ, and γ.

Oligopoly Power Only The first two equilibrium conditions are the zero profit conditions, which are easily extended to the asymmetric country case:

$$s_h L_h \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)(1 - s_h)\right] + s_h^* L_f \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)(1 - s_h^*)\right] - F_h = 0 \tag{63}$$

$$s_f L_f \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)(1 - s_f)\right] + s_f^* L_h \left[1 - \left(\frac{\sigma - 1}{\sigma}\right)(1 - s_f^*)\right] - F_f = 0 \tag{64}$$

The market clearing conditions are identical to the previous case (where we leave the oligopsonistic market share defined as one over the number of firms in one country):

$$\frac{s_h}{s_h^o} + \frac{s_f^*}{s_f^o} = 1 \tag{65}$$

$$\frac{s_f}{s_f^o} + \frac{s_h^*}{s_h^o} = 1 \tag{66}$$

Using the equilibrium equation for the price of the oligopsonistic input, we obtain:

$$\frac{r_i}{r_j} = \left[\left(\frac{s_j^o}{s_i^o}\right)\left(\frac{L_i(s_{ii} - s_{ii}^2) + L_j(s_{ij} - s_{ij}^2)}{L_j(s_{jj} - s_{jj}^2) + L_i(s_{ji} - s_{ji}^2)}\right)\right]^{\frac{\gamma}{1+\gamma}}$$

Finally, the relative revenues are:

$$\left(\frac{s_h^*}{s_f}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{hf} c_h}{c_f}\right)\left(\frac{1 - s_f}{1 - s_h^*}\right)\left[\left(\frac{s_f^o}{s_h^o}\right)\left(\frac{L_h(s_h - s_h^2) + L_f(s_h^* - (s_h^*)^2)}{L_f(s_f - s_f^2) + L_h(s_f^* - (s_f^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{67}$$

$$\left(\frac{s_f^*}{s_h}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{fh} c_f}{c_h}\right)\left(\frac{1 - s_h}{1 - s_f^*}\right)\left[\left(\frac{s_h^o}{s_f^o}\right)\left(\frac{L_f(s_f - s_f^2) + L_h(s_f^* - (s_f^*)^2)}{L_h(s_h - s_h^2) + L_f(s_h^* - (s_h^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{68}$$

The system of equations (63), (64), (65), (66), (67), and (68) yields the equilibrium values of s_h, s_h^*, s_h^o, s_f, s_f^*, and s_f^o, given the parameters L_h, L_f, F_h, F_f, $\left(\frac{\tau_{hf} c_h}{c_f}\right)$, and $\left(\frac{\tau_{fh} c_f}{c_h}\right)$, σ, and γ.

6.4.1 Calibration

The details of our calibration are as follows. Given data on s_h^o, s_f^o, s_h^*, and s_f^* described in the main text, as well as values for γ, L_h, and L_f,

- s_h is implied by (59).
- s_f is implied by (60).
- $\left(\frac{\tau_{fh} c_f}{c_h}\right)$ = solution to (61) in the baseline model and to (67) in the model with oligopoly power only.

- $\left(\frac{\tau_{hf}c_h}{c_f}\right)$ = solution to (62)in the baseline model and to (68) in the model with oligopoly power only.
- F_h and F_f implied by (57) and (58) in the baseline model and by (63) and (64) in the model with oligopoly power only.

We drop all industries with relative input requirements for production and delivery $\left(\frac{\tau_{ij}c_i}{c_j}\right)$ above 100. Tables 5 and 6 provide the summary statistics for the calibrated parameters.

Table 5: Summary Statistics: Trade and Fixed Costs (Baseline)

	Mean	Std. Dev.	Min	Max
F_h	0.02	0.06	0.00	0.69
F_f	0.01	0.02	0.00	0.26
$\left(\frac{\tau_{hf}c_h}{c_f}\right)$	0.54	1.05	0.05	25.72
$\left(\frac{\tau_{fh}c_f}{c_h}\right)$	6.40	8.27	0.13	82.87
Observations	706			

Table 6: Summary Statistics: Trade and Fixed Costs (Oligopoly)

	Mean	Std. Dev.	Min	Max
F_h	0.02	0.06	0.00	0.68
F_f	0.02	0.06	0.00	0.68
$\left(\frac{\tau_{hf}c_h}{c_f}\right)$	0.54	1.05	0.05	25.65
$\left(\frac{\tau_{fh}c_f}{c_h}\right)$	4.72	7.58	0.10	80.00
Observations	706			

Having calibrated the parameters of the model, we can consider the effects of a reduction in τ_{hf} and τ_{fh} by 5%. Given the new vector of trade costs, we solve the system of equations defined by (57), (58), (59), (60), (61), and (62) in the baseline model.[18] Using the values of s'_h, $(s^*_h)'$ and $(s^o_h)'$ after the change in trade costs, we can compute the log change in domestic and export markups $\hat{\mu}_h$ and $\hat{\mu}^*_h$ before and after the change in trade costs as:

$$\hat{\mu}_h = \ln \frac{1 + \gamma(s^o_h)'}{1 - s'_h} - \ln \frac{1 + \gamma s^o_h}{1 - s_h}$$

[18]We drop any industry, whose solution to the new equilibrium condition is outside the set of market shares between zero and one. As our model cannot easily reconcile the data from these industries, we prefer to not consider those rather than relying on additional assumptions and less on the data available. We also drop industries whose oligopsonistic market share, using the aggregation procedure used above, is greater than one (3%).

$$\hat{\mu}_h^* = \ln \frac{1+\gamma(s_h^o)'}{1-(s_h^*)'} - \ln \frac{1+\gamma s_h^o}{1-s_h^*}$$

We also consider the identical reduction in trade costs in the oligopoly model, and solve the system of equations given by: (63), (64), (67), and (68). We then compute the change in markups as:

$$(\hat{\mu}_h)_{\text{OLI}} = \ln \frac{1}{1-s_h'} - \ln \frac{1}{1-s_h}$$
$$(\hat{\mu}_h^*)_{\text{OLI}} = \ln \frac{1}{1-(s_h^*)'} - \ln \frac{1}{1-s_h^*}$$

Table 7: Trade Shock: Markups and Concentration

$\gamma = 0.195$, L_h =US empl. share			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	−1.00	−0.07	−4.23
Oligopoly Only	−1.27	0.09	−20.03

$\gamma = 0.195$, L_h =US output share			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	−0.87	−0.01	−4.07
Oligopoly Only	−1.19	0.32	−21.16

Log changes in domestic and export markups of US firms ($\hat{\mu}_h$ and $\hat{\mu}_h^*$), and in the domestic market share of US firms ($\hat{s}_h$). Averages across industries. All changes are multiplied by 100. Sample: UNIDO and trade data. Foreign variables are averages across all countries.

6.5 Heterogeneous Firms Model: Simulation Algorithm

To compute the equilibrium production of final goods and demand for the oligopsonistic input of active firms in the heterogeneous firms model, it is convenient to consider as equilibrium variables the oligopsony shares s_{fi}^o and the oligopoly shares s_{fij}. Recall that these market shares are defined as:

$$s_{fij} = \frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{69}$$

$$s_{fi}^o = \frac{k_{fi}}{\sum_{f=1}^{N_i} k_{fi}} = \frac{\sum_{j=1}^{I}\tau_{ij}c_{fi}x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i}\tau_{ij}c_{fi}x_{fij}} \tag{70}$$

By substituting the equilibrium quantity

$$x_{fij} = \left[\frac{L_j(\sigma - 1)}{\sigma \sum_{i=1}^{I} \sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \frac{1 - s_{fij}}{\tau_{ij} c_{fi} r_i (1 + \gamma s_{fi}^o)} \right]^{\sigma} \tag{71}$$

into (69), we obtain the first set of equilibrium conditions:

$$s_{fij} = \frac{\left(\frac{1-s_{fij}}{\tau_{ij} c_{fi} r_i (1+\gamma s_{fi}^o)} \right)^{\sigma-1}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i} \left(\frac{1-s_{fij}}{\tau_{ij} c_{fi} r_i (1+\gamma s_{fi}^o)} \right)^{\sigma-1}} \qquad \forall f, ij \tag{72}$$

Second, by using the definition of market share, we can write firms optimal quantity as:

$$x_{fij} = \frac{(\sigma - 1) L_j}{\sigma r_i \tau_{ij} c_{fi}} \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o} \tag{73}$$

Substituting (73) into (70), we obtain the second set of equilibrium conditions:

$$s_{fi}^o = \frac{\sum_{j=1}^{I} L_j \frac{s_{fij}(1-s_{fij})}{1+\gamma s_{fi}^o}}{\sum_{j=1}^{I} \sum_{f=1}^{N_i} L_j \frac{s_{fij}(1-s_{fij})}{1+\gamma s_{fi}^o}} \tag{74}$$

Finally, by substituting (73) into the definition of the price for the oligopsonistic input, we obtain:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} = \tilde{\gamma}_i \left[\sum_{j=1}^{I} \sum_{f=1}^{N_i} \left(\frac{L_j(\sigma - 1)}{\sigma} \right) \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o} \right]^{\frac{1}{\gamma+1}} \tag{75}$$

In our algorithm, we fix the initial number of firms N_i and the number of firms that export in each country N_{ij}^x. For the calibration exercise, we use UNIDO data to pick N_i for each industry. Then, we set $N_{ij}^x = 0.18 N_i$, rounding to the nearest integer, which is in line with the evidence of Bernard et al. (2007) for US firms. We cannot use the average export market share to pin down the number of exporters as in the baseline case, because in the presence of heterogeneous firms, the average market share is informative both of the intensive and the extensive margin of exports. To simulate the draws of unit costs, we first draw max $N_i * 1.5$ realizations u_{fi} from a Gumbel copula with parameter $\alpha = 10000$.[19] Such a parameter controls the correlation of draws between home and foreign, and thus how similar the realizations of unit costs are. We choose a relatively high parameter value to aid the speed of our calibration and counterfactual. We compute the unit costs draws as $c_{fi} = u_{fi}^{\frac{1}{\theta}}$, where we assumed that $b_i = 1$. Furthermore, we consider two values for the shape parameter of the distribution of firm productivity $\theta = 4$ and $\theta = 8$, which is an assumption in line with the literature (Eaton et al., 2011; Simonovska and Waugh, 2014).[20] In each market

[19]The Gumbel copula is a commonly used distribution for the case in which the realizations of two random variables are correlated. For instance it is used by Edmond et al. (2015) and Nocke and Yeaple (2014).

[20]We let $\sigma = 5$, and $L_h = L_f = 0.5$. Since firms are heterogeneous, finding the equilibrium number of

j, we rank order firms by their unit costs $\tau_{ij} c_{fi} r_i$. We pick a value for τ_{ij}, such that the unit cost of the least efficient exporter to j are equal to the unit costs of the least efficient domestic producer of j. We calibrate the fixed cost of exporting F_{ij}^X, so that the export profits of the least efficient exporter from i to j are equal to zero. Then we solve the system of equations given by (72) and (74), using the definition of (75). We calibrate the fixed costs F by assuming that the profits of the least efficient firm in each country are equal to zero. This means that the fixed cost equals the operating profits of the least efficient firm in each country:

$$F_i = s_{N_i ij} L_j \left[1 - \frac{\sigma - 1}{\sigma} \frac{1 - s_{N_i ij}}{1 + \gamma s_{N_i i}^o} \right] \tag{76}$$

To study the effects of a 5% change in trade costs we proceed as follows. First, given the new level of trade costs, we compute the equilibrium production among active firms. If the smallest profits (namely, the profits of the smallest firm) are positive, a new firm enters. If the profits of the least efficient firm are negative, such a firm exit. To avoid having to set up additional rules, we assume that both entry and exit begin in the home economy, and the foreign economy follows. The equilibrium number of firms is found when adding an additional firm causes the profits of the least efficient firms to become negative.[21]

To calibrate the model with only oligopoly power we proceed as follows. First, notice that the equilibrium market shares are defined by (72), where the oligopsony shares of all firms are set to zero. We consider an oligopoly model where the market share in the final goods markets are identical to the one arising in our baseline model. Hence, we use the market shares s_{fij} obtained in our baseline model in (72), to obtain the realization of unit costs c_{fi}. We calibrate the iceberg trade costs and the fixed costs of production in the same way as our baseline model.

firms requires solving the equilibrium allocation across firms every time a new firm enters or exits. Thus, to increase the speed of the algorithm, we restrict the sample of industries to contain industries with at least 10 firms and less than 250 in each country.

[21] We should note that by assuming away income effects due to the assumption of a continuum of industries, we are abstracting from the effects of changes in total profits on income.