Oligopoly and Oligopsony in International Trade*

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Abstract

We study the effects of international trade on firms' oligopsony power in inputs 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 such 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 are 15-50% 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. The research has mainly focused on final goods markets where 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 inputs markets is comparable to the concentration in final goods markets.[1] However, little is known about the link between market power in inputs market, which we refer to as *oligopsony power*,[2] 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 on 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, finding that the presence of oligopsony reduces the pro-competitive effects of trade by 15-50%.

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 anti-competitive effects in the other one. Such anti-competitive effects dampen the standard pro-competitive gains from 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 should encompass both trade in final goods and intermediate inputs. In the presence of domestically sourced inputs, reduction 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

[1] 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).

[2] 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).

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 and prices that are increasing both in the oligopsony power and in the oligopoly power. 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.

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 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 with a model in which firms only exploit oligopoly power. For instance, in Edmond et al. (2015), international integration in final goods markets has pro-competitive effects: firms become smaller in the final goods market and their oligopoly power declines. While such a pro-competitive 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. The increase in oligopsony power dampens the pro-competitive effects of trade: the larger the oligopsony power, the smaller the reduction in markups, and the smaller the increase in the input's price. Although international economic integration brings about an increase in welfare for consumers, the larger the oligopsony power of firms, the smaller these welfare gains are.

The effects of trade on firms' market power are reversed in case of integration in the market for the oligopsonistic input. Consider the extreme case in which firms internationally source their input and only sell their final good domestically, which could represent the market of retailers. 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 role of oligopsony power in dampening the pro-competitive gains from international trade, we calibrate our model with two asymmetric countries: the US and the rest of the world. We use UNIDO data on market concentration 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 concentration to calibrate the input supply elasticity. We find that a 5% reduction in trade costs between the US and the rest of the world generates a reduction in US domestic markups by 0.45-0.57%.

To evaluate such magnitude, 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 the same levels of market concentration of our baseline case in the alternative model. When firms only have oligopoly power, a reduction in trade costs of 5% reduces domestic US markups by 0.81-0.97%, which is 30-50% larger than the reduction predicted by our baseline model. Thus, oligopsony power greatly reduces the pro-competitive gains from trade. Such a 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.

We allow for firm heterogeneity in productivity in an extension to the calibrated model, which generates an additional channel through which trade increases oligopsony power. Since trade leads to the exit of the 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. The estimated change in domestic markups due to a reduction in trade costs, averaged across firms, is close to the one predicted by the model with homogeneous firms. However, the presence of firm heterogeneity reduces the difference in predictions between our baseline model and a model with oligopoly power only. In this extension, the pro-competitive reduction in markups from a model with oligopoly power only is 15% larger than the baseline.

Related Literature. Our paper relates to the ongoing debate on the growing market power of US firms. In the last decades, US national market concentration 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 pro-competitive effect 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, so that 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 pro-competitive gains from trade. Our approach is motivated by recent empirical research that has shown that firms are also able to influence their prices in input markets (Morlacco, 2017; Brooks et al., 2021; Hershbein et al., 2020).[3]

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, 2017; Kikkawa et al., 2018; Impullitti et al., 2014), oligopsony has received little attention until the last few years.[4] 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 (2018), who recommend labor market integration along with international trade, since trade alone exacerbates labor market distortions due to monopsony power. Such paper strengthens our policy claim, since the authors reach our conclusion using a different model, in which labor is the oligopsonistic input and workers are heterogeneous.[5]

[3]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 the authors focus only on firm-level predictions, we consider the equilibrium effects of economic integration.

[4]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.

[5]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 as given market aggregates. The first paper of this field is that of Egger et al. (2021), which features constant markups and markdowns across firms. The

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 multiproduct 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.[6]

The remainder of the paper is organized as follows. Section 2 builds the baseline model. Section 3 presents the effects of international trade on firm's 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): there is a continuum of industries, and firms are large in an industry, but small relative to the economy. Industries are indexed by $z \in [0, 1]$.

In each industry z of country i, there is a discrete number $N_i(z)$ of firms, 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}. There is Cournot competition both in the market for the input and in the market for final goods. Exporting a good from i to j requires an iceberg trade cost $\tau_{ij}(z)$, with $\tau_{ii}(z) = 1$. The number of firms is determined by free entry.

2.1 Consumer's Problem

Consumers in country $j = 1, ..., I$ have a two-tier utility function. The first tier is an additive function of the utility attained by consuming the varieties produced across the $z \in [0, 1]$

work of Macedoni (2020) extends the framework to variable markups and markdowns across firms.

[6] 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.

industries:

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

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. A firm is large in its industry but, as there is a continuum of industries, it is small relative to the economy. Hence, the firm does not internalize its effects on λ_j and, therefore, we can normalize λ_j and y_j to 1. This is a simplification also present in Eckel and Neary (2010), which is equivalent to having a quasi-linear utility function. Although, we abstract 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, the aggregate inverse demand is:

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

For the remainder of the paper we focus on a single industry and, thus, we drop the 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 workers 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 assume 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. The reason it happens is that oligopsonistic firms reduce their demand to reduce the price of the input: as the input supply is 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). This is done without loss of generality, as we show that the firm performance variables can be expressed as functions of properly defined market shares, and the definition of the size of the market is embedded in these market shares. Each firm f demands k_{fij} units of the input to produce its differentiated variety and sell it to country j. Firm f demand for the input, denoted by k_{fi}, is given by summing k_{fij} across the destinations 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 Firm's 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's f 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, the 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 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 good's and the input's market:

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

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 firm's revenues over total revenues in a destination j. Let s_{fi}^{o} denote the oligopsonistic demand share: the share of firm's f 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. Such a reduction in demand has a larger effect on the firm, the larger its market share s_{fij} is. 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 the firm reaches. 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:

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

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 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. On top of that, in our model higher oligopsony power — higher market share in the input market — increases markups as well. 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.

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 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 firm's maximum 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 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. Exploiting 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, and we ignore the integer problem, final goods market clear, input's market clear, and trade is balanced.

3 Effects of International Trade

What are the effects of international trade on firm's 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 trade of final goods or inputs. Second, we study the effects of a reduction in iceberg trade costs in a multi-country setting. We derive analytically these theoretical results under the baseline assumption of homogeneous firms. However, we show in this section that our main results also hold in an extension in which firms are heterogeneous in productivity. In this section, we also assume that there are I identical countries 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, as in Eckel and Neary (2010), as an increase in the number of countries in the context of frictionless trade, namely 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. In section 3.2, we provide derivations for changes in iceberg trade costs, which generate similar qualitative results.

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.[7] For such 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 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

[7] For instance, the symmetry is violated if $I^o = 2$ and $I = 3$, since firms from the country which does not have integrated input markets would have a different market share that the firms from the two countries with integrated input markets.

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 is, the smaller the market share in the final goods market is. 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 firm's market power in a market has to be matched by a reduction in market power in the other market. Armed with RMP and, depending on which is more convenient, ZP1 and ZP2, we can now study the effects of international economic integration.

Let us start 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 market 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 pro-competitive gains 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 integration of final goods market reduces the oligopoly power, it has an opposite effect on the oligopsony power, which increases.

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

Figure 1: Final Goods Market Integration

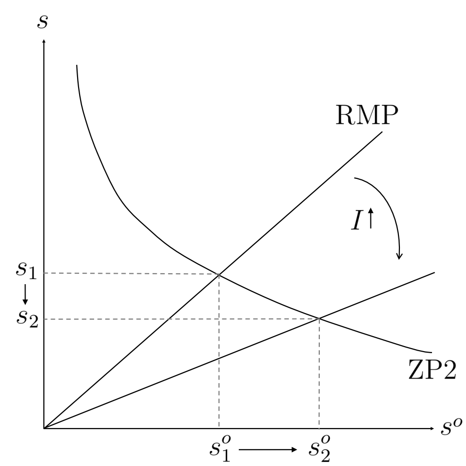
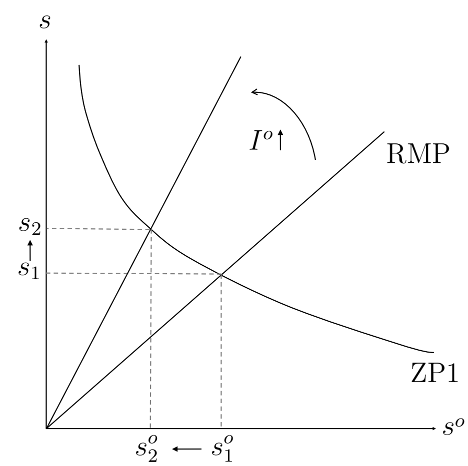


Figure 2: Input Market Integration



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.

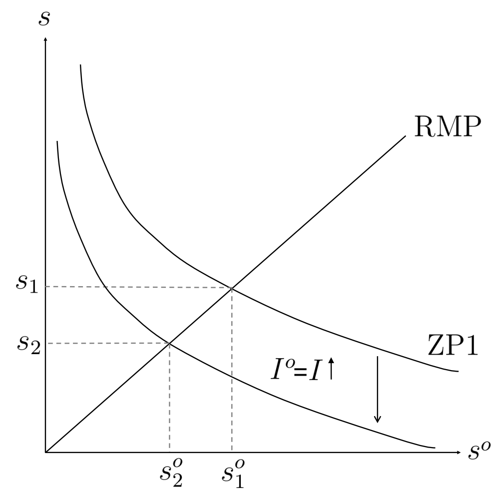
When firms are large both in the destination and in the market for inputs, the pro-competitive effects that arise from opening to trade one of the two markets are dampened by the anti-competitive effects in the other. Opening trade for final goods reduces the market power of firms in the destination, 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 market, both s^o and s decline.

3.1.1 Input Prices, Markups, and Welfare

This section summarizes how oligopsony power affects input prices, markups, and welfare 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, increasing 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,

Figure 3: Final Goods and Input Market Integration



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. 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. The pro-competitive gains from trade are dampened by the concentration in the input market.

Finally, an increase in the number of countries with integrated final goods markets increases consumer's welfare in one industry. In other words, the CES aggregate for the varieties within an industry Q_j increases with international trade. Hence, the pro-competitive effects of final goods market integration more than offset the anti-competitive effects of oligopsony. However, the larger the oligopsony power of firms, the smaller the gains.

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, firm's profits are the sum of the profits obtained in the home country and the profits obtain in export markets. Using the market clearing condition, the zero profit (ZP) condition becomes:

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

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 use of a graph similar to Figure 1. A reduction in trade costs rotates the RMP curve clockwise. Thus, the new equilibrium features higher oligopsonistic market share s^o and lower oligopolistic domestic market share s. A reduction in trade costs generates similar predictions of an increase in the number of integrated countries we explored in the previous section. 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, 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.

3.3 Extension to Heterogeneous Firms

In this section, we briefly outline an extension to the model of section 3.2 with two countries and iceberg trade costs, to the case of heterogeneous firms. We follow the standard approach of dealing with 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 is 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. 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.

Because of the presence of a discrete number of firms, we need to modify the free entry condition. In particular, the equilibrium number of firm N_i is such that all firms make positive profits, and an additional firm would have negative profits. Namely,

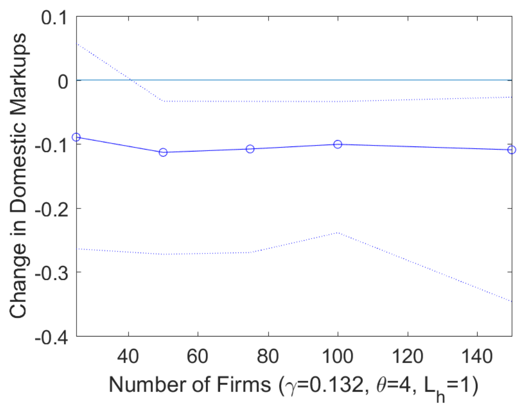
$$\pi_{fi}(N_i, N_j) > 0 \quad \forall f = 1, ..., N_i; \qquad \pi_{N_i+1i}(N_i+1, N_j) < 0 \tag{25}$$

To find the numerical equilibrium we proceed as follows. First, given a number of firms in each country N_i, we compute the equilibrium oligopsony and oligopoly shares of active firms. Second, we add or reduce the number of active to satisfy the equilibrium condition (25). It follows that, in this case, we are taking the integer problem into account.

The heterogeneous firms model confirms the results from the simple model of the previous section: the presence of oligopsony power dampens the pro-competitive gains from trade. In fact, as in our baseline model, trade forces the exit of some firms, 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.

In Figure 4, we show the effects of a 5% reduction of trade costs on the weighted average markup of domestic firms, where the weights are the market shares in the final goods market. The details on the simulation are in Appendix 7.1.1. We compute such a change for different values of the number of firms in each country. For each value of the initial number of firms, we run our simulation algorithm 100 times, and report in the Figure the mean and the 95% confidence interval. At low levels of the number of firms, there can be anti-competitive effects as some iterations exhibit positive changes in markups. In contrast, at larger number of firms, the pro-competitive gains are larger.

Figure 4: Markup Changes at Home

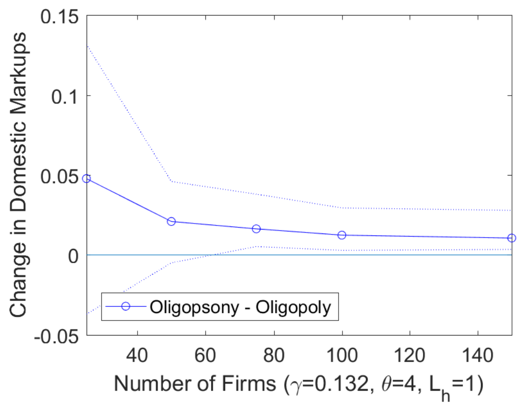


In Figure 5, we consider the difference between the change in weighted average markup in our baseline model with heterogeneous firms, and a counterfactual model of oligopoly power only. In line with our previous results, oligopsony power dampens the pro-competitive gains from trade. Our baseline model generates smaller pro-competitive gains than a model with only oligopoly power, as the difference in the average markups is predominantly positive.[8] The difference between the two models declines with the number of firms, as market power in both markets falls. In Appendix 7.1.1, we show that the difference in pro-competitive gains predicted by the baseline model and the model of oligopoly only increases with the supply elasticity parameter γ, which controls the extent of oligopsony power. Furthermore, the difference decreases with the dispersion of the underlying distribution of unit costs, which suggests that the model with homogeneous firms generates the largest difference in predictions, holding all else constant.

[8] The negative difference at low levels of number of firms is due to the presence of a discrete number of firms. With a small number of firms, the entry of one new firm can have large effects. Whether such entry occurs is highly dependent on the draws of productivity, which are specific to one iteration of the simulation.

Figure 5: Markup Changes at Home: Oligopoly VS Oligopsony

(a) Number of Firms



4 Estimating the Effects of Trade on Markups

In order to evaluate the effects of international trade on firm's 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 15-50% 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 the country-industry-year level. The data is available for 127 ISIC rev.4 (four-digit) industries in 75 countries for the years 1990-2016. Information starting earlier than 1990 is available at a higher level of industry aggregation. For 24 ISIC rev.2 (two-digit) industries in 102 countries, UNIDO covers the years 1981-2013. Additional details for our datasets are in the appendix.

In order to construct alternative measures of market concentration in inputs' market, we additionally use the World Input-Output Database (WIOD), November 2016 Release (Timmer et al., 2015). This database provides information on input-output linkages between 56 sectors across 43 countries. To match such data to the others, we consider 18 tradable sectors in WIOD database. We abstract from physical input requirements and normalize the

Input-Output tables so that they provide shares for input requirements from all industries for each country and industry.

To estimate the input supply elasticity, we study the relationship between export prices and oligopsony power. For such 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. An industry k is a Harmonized System (HS) or Standard International Trade Classification (SITC) four-digit code. The dataset covers 170 countries and is available for the years 1981-2013.[9]

4.2 Calibration

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. This way, firms merely do not internalize their effects on the price of the oligopsonistic input, but the underlining fundamentals are preserved. We choose parameter values so that the initial market share of firms in the model with oligopoly and oligopsony is the same as that in the model with oligopoly only. We consider a two-country model where 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 in Appendix 7.

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, or US industry specific size measured as employment share and output share. The foreign size share is simply given by $L_f = 1 - L_h$.

In the following section, we describe the data we use to measure the average market share in input markets, and in final goods markets, both domestic and export. Furthermore, we use export price data to compute a value for γ. Given these data, the remaining parameters

[9] In our baseline results, we use unit price data for the years 1989-2013, which follows the HS four-digit classification. For the robustness exercise later outlined, we use price data for extended time period 1981-2013, which follows the SITC classification.

are estimated by using our equilibrium conditions, and all details are in the Appendix. 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. The calibration for the oligopoly model is identical to our baseline model. Since the equilibrium conditions that we use in the calibration differ in the two models, the implied fixed costs and trade costs also differ.

4.2.1 Data on Market Shares

We use Herfindahl indexes from Feenstra and Weinstein (2017) to construct domestic and foreign oligolostic and oligopsonistic market shares. Feenstra and Weinstein (2017) use several sources to construct HI_{ik} across countries. For the United States, the authors use the data provided by the US Census of Manufacturers. As the Census classifies industries at the NAICS six-digit level, and the unit price data is at the HS four-digit code, there is a concordance issue when there is more than one HS four-digit industry per NAICS industry. In such cases, the authors assume the same Herfindahl Index for each HS four-digit code within a NAICS six-digit code. The authors obtain Herfindahl Indexes for Mexico from *Encuesta Industrial Anual* (Annual Industrial Survey) of the *Instituto Nacional de Estadistica y Geografia*. The dataset covers 205 CMAP94 categories and 232 HS four-digit industries for 1993 and 2003. For Canada, the authors purchased market concentration measures for 1996 and 2005 from Statistics Canada. For the rest of the countries, the authors use PIERS data on firm-level shipments to the US in 1992 and 2005. PIERS data provide information on sea shipments to the US of the 50,000 largest exporters. Feenstra and Weinstein (2017) assume that market concentration does not depend on the mode of transportation and adjust HIs with a fraction of sea shipments in total trade volume on country-industry level.

We drop the industry subscript for ease of notation. For our 2-country calibration exercise, we consider US market shares and construct market shares for its average trade partner and use data from year 2005. We use Herfindahl indexes as a measure of the oligopsonistic home share s_h^o. The domestic export market share $s_h^* = s_h^o \lambda_{US}$, where λ_{US} is the US output share $\lambda_{US} = \frac{X_{US}}{X_{US}+\bar{X}_{ROW}}$, and X_{US} is the US output in a given industry from UNIDO and $\bar{X}_{RoW}$ is the average output of all non-US countries in UNIDO.

We follow the same approach to calculate the oligopsonistic foreign market share s_j^o and foreign export market share s_j^* for each individual non-US country j and find the average of these market shares: $s_f^o = \frac{\sum s_j^o}{J}$ and $s_f^* = \frac{\sum s_j^*}{J}$, where $J+1$ is the total number of countries.

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			

4.2.2 Calibration of the Input Supply Elasticity

To calibrate γ, we consider the relationship between prices and oligopsonistic share. We show in Appendix 6.3.1 that average industry prices $\bar{p}_{ijkt}$ from i to j in industry k and year t can be written as:

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

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 effect that capture the average unit cost of production and delivery. We refer to $\bar{s}^o_{ikt}$ as the origin average market share, and to $\bar{s}_{jkt}$ as the destination average market share.

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

$$\ln \bar{p}_{ijkt} = \gamma CM^o_{ikt} + \beta CM^d_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{27}$$

We consider two measures of oligopsony power of firms (or origin CM) in industry k and origin i. Our baseline measure uses the reciprocal of the number of establishments provided in UNIDO dataset. Namely, we let $CM^o_{ikt} = \frac{1}{N_{ikt}}$. Such a measure exactly captures the average demand share $\bar{s}^o_{ikt}$ that emerges in all input markets where the firms from one industry are the only buyers. However, firms from different industries can use the same inputs. We create an alternative measure $CM^{o\,adj}_{ikt}$ that accounts for such a possibility, using the WIOD.[10]

[10] In Appendix 6.1.4, we outline a model in which firms purchase a vector of inputs. Prices positively depend on a weighted average of the oligopsony power of firms in each input market. Furthermore, we show how to compute firms demand share in the presence of inputs purchased by several downstream industries.

Similarly, 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 market. 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 the final goods market. 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.

Using the data for 1981-2016, described above, we estimate (27) by OLS. We consider the four alternative measures of concentration in inputs and final goods markets. Table 2 shows that the estimated γ ranges from 0.1 to 1.5 and it is statistically significant. In our calibration, we are going to use two values of γ. The first one is from the first column from Table 2 (0.132). The second one is from a robustness exercise reported in the Appendix where we use data on market concentration from Feenstra and Weinstein (2017), which yields a slightly larger γ equal to 0.235. These values for the input supply elasticity are not far from other estimates from the literature. For instance, Morlacco (2017) estimates a value of γ of 0.2. In 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 and if $\gamma = 0$, markups are independent of the oligopsonistic market share.

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 $(s^o_h)'$ 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:

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

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

	Baseline	Adj Dest CM	Adj Or CM	Adj Or/Dest CM
Origin CM	0.132***	0.109***	1.500***	1.596***
	(0.003)	(0.002)	(0.421)	(0.271)
Destination CM	0.017***	0.063***	0.026***	0.164***
	(0.003)	(0.004)	(0.004)	(0.006)
Industry-Year	Y	Y	Y	Y
Country-Pair-Year	Y	Y	Y	Y
R^2	0.57	0.57	0.57	0.57
# Observations	3584152	6894375	1896214	3450733

Robust standard errors are in the parentheses. Baseline: CMs from UNIDO dataset for origin and destination countries as dependent variables. Adj Dest CM: adjusted measure of concentration in the destination market. Adj Or CM: adjusted measure of concentration in the origin market. Adj Or/Dest CM: adjusted measures of concentration in origin and destination market. Details in the main text.

$$\hat{\mu}_h^* = \ln \frac{1 + \gamma (s_h^o)'}{1 - (s_h^*)'} - \ln \frac{1 + \gamma s_h^o}{1 - s_h^*} \tag{29}$$

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 pro-competitive effects in the domestic market in both models. In fact, the markups of US firms in the US decline by 0.57% in our baseline model and by 0.81% 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 30% smaller than that predicted by a model with only oligopoly power. The change in export markups is small and positive for the oligopsony model (0.04%), and for the oligopoly model (0.14%).

The smaller pro-competitive gains in our baseline model are 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 on 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 15%, in our baseline model the reduction is only of 4%. 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 $\gamma = 0.235$, the reduction in markups predicted by our model (0.45%) is half of that predicted by a model with only oligopoly power (0.96%). Furthermore, the difference in the change in s_h between the two models are magnified (-3% in our baseline model, -27% in the alternative).

In Figure 6, 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.

Table 3: Trade Shock: Markups and Concentration

$\gamma = 0.132$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-0.57	0.04	-3.77
Oligopoly Only	-0.81	0.14	-15.21

$\gamma = 0.235$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-0.45	0.01	-2.96
Oligopoly Only	-0.96	0.16	-26.91

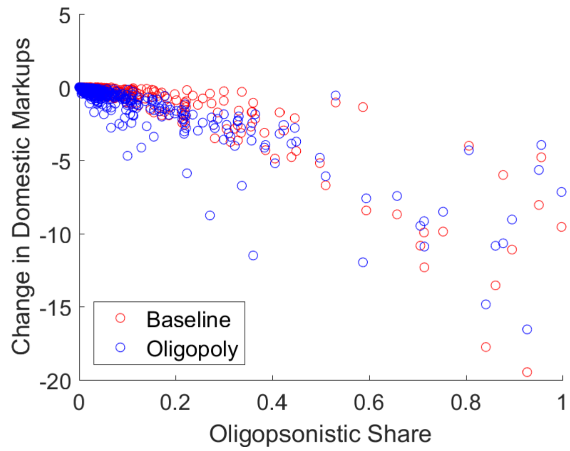
Log changes in domestic and export markups of US firms ($\hat{\mu}_h$ and $\hat{\mu}_h^*$), and in the domestic market share of US firms ($\hat{s}_h$). The values reported are averages across industries. All changes are multiplied by 100. The description for the calibration of the other parameters is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

In Table 9 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. In Table 10, we replicate our results using the measures of concentration from Feenstra and Weinstein (2017). Qualitatively, our previous results are robust. In fact, in both cases our baseline model predicts a smaller reduction in markups due to the reduction in trade costs than a model of oligopoly power only. Furthermore, our baseline model predicts a fall in domestic concentration which is smaller than that predicted by a model of oligopoly power. However, in both cases the magnitude of the difference between the two models is reduced.

4.4 Heterogeneous Firms

Since the data covers average market shares across countries and industries and does not provide firm-level information, it can be preferably matched by our model with homogeneous

Figure 6: 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 represent an industry. All changes are multiplied by 100. The description for the calibration of the other parameters is in the main text. $\gamma = 0.132$, $L_h = 0.15$.

firms. Firm-level data is 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.

First of all, we assume that the number of firms at home and abroad equals the reciprocal of the oligopsonistic market share in each country used in our baseline calibration. Furthermore, we assume that 18% of domestic firms are also exporters, 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. Furthermore, we set the shape parameter of the distribution of firm productivity $\theta = 4$, which is an assumption in line with the literature (Simonovska and Waugh, 2014). Finally, we set the shift parameters b_i to one. In the Appendix, we outline the calibration and simulation algorithm.[11]

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. In the

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

baseline case, the weighted average markup of domestic firms, where the weights are the firms oligopolistic shares, falls by 0.026% on average across industries. In contrast, in the presence of oligopoly power only markups fall by 0.03%, which is 15% larger. We also compare the results to our baseline specification with homogeneous firms.[12] Firm heterogeneity does not alter the results in our baseline model, as the reduction in domestic markups is almost identical in the model with homogeneous firms. The model of firm homogeneity generates slightly larger pro-competitive gains in the oligopoly model, as markups fall by 0.06% instead of 0.03%. The result is due to the stronger competition effects of trade brought about by the presence of few large foreign exporters, relative to the case of homogeneous firms, in which all firms export. As shown in the Appendix, results are robust to using larger values of γ, though the anti-competitive effect of oligopsony increases.

Table 4: Trade Shock: Markups and Concentration

	Heterogeneous Firms	Homogeneous Firms
Baseline	-0.026	-0.025
Oligopoly Only	-0.03	-0.057

Log changes in domestic markups of US firms, average across sectors, following a 5% reduction in trade costs. Details on the parameters in the main text

5 Conclusions

The international trade literature has explored the consequences of the presence of large exporters, which exploit their oligopoly power, on firms' prices and scope as well as on the welfare of consumers (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.

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 pro-competitive gains arising from international competition between oligopolists are dampened by the anti-competitive effects of increase in market concentration in the market for inputs. Only international integration in both final goods and input markets successfully reduces firms' market power.

[12] In this case, we consider the same set of industries that we restricted our algorithm to. We also consider the same initial levels of oligopolistic and export market shares, as well as the same parameter value $\sigma = 5$ and $L_h = L_f = 0.5$.

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 domestic input could reduce the anti-competitive effects of trade in final goods.

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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, markups, and welfare. 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, markups, and welfare stated in section 3.1. Let us start with input prices. Re-writing (19) in the symmetric country case yields:

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

Let us fix $I^o = 1$ and consider the effects of integration in the final goods markets. Using the zero profit condition, we can rewrite the price for the input as:

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

The price for the input positively depends on the demand share of firms for such an input. As the demand share increases, firms move along the supply curve for the input, and pay a higher price. 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. The pro-competitive gains from trade are dampened by the concentration in the input market.

Let us derive the equilibrium level of the CES quantity index Q_j as a function of domestic variables, using our general notation. By using the definition of aggregate quantity, we obtain $\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}} = (Q_j L_j)^{\frac{\sigma-1}{\sigma}}$. Consider the revenues for a firm from j to j, defined in (14). Since revenues $p_{fjj} x_{fjj} = s_{fjj} L_j$, and the quantity aggregator $\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}} = (Q_j L_j)^{\frac{\sigma-1}{\sigma}}$, the CES quantity index can be expressed as a function of the domestic price for the input r_j, and the market share of the domestic firm in the domestic final goods market and input market:

$$Q_j = \frac{\sigma - 1}{\sigma \tau_{jj} c_{fj} r_j} \frac{(1 - s_{fjj}) s_{fjj}^{-\frac{1}{\sigma-1}}}{1 + \gamma s_{fj}^o} \tag{33}$$

In our symmetric countries model, using 30, the CES index becomes:

$$Q = c^{-1} \left[\frac{\sigma - 1}{\sigma \tilde{\gamma}}\right]^{\frac{1}{1+\gamma}} \frac{s^{-\frac{1}{\sigma-1}} (1 - s)^{\frac{1}{1+\gamma}}}{(1 + \gamma s^o)^{\frac{1}{1+\gamma}}} \tag{34}$$

The total (log) change of the CES quantity index — which is equivalent to the change in welfare — is a function of the change in the oligopoly and oligopsony power:

$$d \ln Q = \left[\frac{1}{\sigma - 1} + \frac{s}{(1 - s)(1 + \gamma)}\right] (-d \ln s) + \left[\frac{\gamma s^o}{(1 + \gamma s^o)(1 + \gamma)}\right] (-d \ln s^o) \tag{35}$$

This measure for the change in welfare applies to a single industry and the implications for the aggregate economy can be easily derived by (1). The change in welfare is a function of the change in the oligopoly ($d \ln s$) and oligopsony ($d \ln s^o$) power of firms, and on the current level of oligopoly (s) and oligopsony (s^o) power. The change in welfare is similar to the welfare formula developed by Macedoni (2017). The change in welfare is a function of the change in the oligopoly and oligopsony power of firms, and on the current level of oligopoly and oligopsony power. In particular, a reduction in the two sources of market power generates welfare gains. Moreover, larger initial levels of market power magnify the effects of a change in market share.

An increase in I has a twofold effect on welfare. On the one hand, by reducing the market share of in the final goods markets ($-d \ln s > 0$), economic integration improves welfare. On the other hand, by increasing the demand share of firms in the input market ($-d \ln s^o < 0$), it reduces it. To verify the total effect, it is convenient to rewrite (34) using the zero profit condition $\frac{1-s}{1+\gamma s^o} = \frac{\sigma}{\sigma-1} \left[1 - \frac{F}{L s^o}\right]$:

$$Q = c^{-1}\left[\frac{\alpha(\sigma-1)}{\sigma(1-\alpha)(1+\gamma)}\right]^{\frac{1}{1+\gamma}} s^{-\frac{1}{\sigma-1}}\left[1-\frac{F}{Ls^o}\right]^{\frac{1}{1+\gamma}}$$

Using such an expression, the total change in welfare is given by:

$$d\ln Q = -\frac{1}{\sigma-1}d\ln s + \frac{F}{(1+\gamma)(Ls^o-F)}d\ln s^o$$

Thus, the total effect of an increase in the number of countries with integrated final goods markets is positive: welfare increases. The larger the oligopsony power of firms, the smaller the gains.

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:

$$s = \frac{x_{jj}^{\frac{\sigma-1}{\sigma}}}{\sum_i N_i x_{ij}^{\frac{\sigma-1}{\sigma}}} = \frac{x^{\frac{\sigma-1}{\sigma}}}{Nx^{\frac{\sigma-1}{\sigma}}+(I-1)Nx^{*\frac{\sigma-1}{\sigma}}} = s^o\frac{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}}}{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}}+(I-1)} \tag{36}$$

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:

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

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:

$$\frac{x}{x^*} = \left(\frac{p}{p^*}\right)^{-\sigma} = \left(\frac{1}{\tau}\frac{1-s^*}{1-s}\right)^{-\sigma} \tag{38}$$

From the market clearing condition:

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

$$s^* = \frac{s^o - s}{I-1} \tag{39}$$

Using (39) into (38) yields:

$$\left(\frac{x}{x^*}\right)^{\frac{1}{\sigma}} = \frac{\tau(1-s)}{1-s^*} = \frac{\tau(1-s)}{1-\frac{s^o-s}{I-1}} \tag{40}$$

Plugging (40) and (39) into (37) yields our RMP condition:

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

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 (39), 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 (39) and (17) into (19) we obtain:

$$r = \tilde{\gamma}^{\frac{1}{1+\gamma}} \left(L - \frac{F}{s^0} \right)^{\frac{\gamma}{1+\gamma}} \tag{41}$$

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, $r = \tilde{\gamma} \left[c \frac{1}{s^o} \left(x + (I-1) \tau x^* \right) \right]^{\gamma}$ 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:

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) \tag{42}$$

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}.[13] The inverse demand for input k is given by:

$$r_k = \gamma_k Y_k^{\gamma} = \gamma_k \left[\sum_v t_{kv} y_{kv}\right]^{\gamma} \tag{43}$$

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:

$$\Pi_f = \sum_j \frac{p_{fj}(x_{fj}) x_{fj}}{\tau_{fj}} - \sum_k r_k t_{kv} y_{kv} \tag{44}$$

$$\Pi_f = \sum_j \frac{p_{fj}(f(\mathbf{y_{kfj}})) f(\mathbf{y_{kfj}})}{\tau_{fj}} - \sum_k \gamma_k \left[\sum_v t_{kv} \sum_d y_{kvd}\right]^{\gamma} t_{kf} \sum_f (y_{kfj}) \tag{45}$$

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

$$\frac{\sigma - 1}{\sigma \tau_{fj}} p_{fj} (1 - s_{fj}) \frac{\partial f_{fj}}{\partial y_{kfj}} = r_k t_{kf} (1 + \gamma s_{kf}^o) \tag{46}$$

where

$$s_{kf}^o = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{47}$$

Multiplying both sides of (46) by y_{kfj}, summing over inputs k, and using Euler's theorem for homogeneous of degree one functions we find:

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

[13] 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.

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

Firm's revenues in destination j are given by:

$$\frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} = \frac{\sigma}{(\sigma-1)(1-s_{fj})}\sum_k r_k t_{kf} y_{kfj}(1+\gamma s^o_{kf}) \tag{48}$$

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:

$$\alpha_k() = \frac{r_k t_{kf} y_{kfj}}{\sum_u r_u t_{uf} y_{ufj}} \tag{49}$$

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:

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

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

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

Profits are then given by:

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

Let us re-write prices:

$$p_{fj} = \frac{\sigma \tau_{fj}}{(\sigma-1)(1-s_{fj})} \frac{\sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \sum_k \alpha_k (1+\gamma s^o_{kf}) \tag{50}$$

The average variable cost of selling to destination j is:

$$AVC_{fj} = \frac{\tau_{fj} \sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \tag{51}$$

Thus, prices are given by:

$$p_{fj} = AVC_{fj} \frac{\sigma}{\sigma-1} \frac{\sum_k \alpha_k (1+\gamma s^o_{kf})}{1-s_{fj}} \tag{52}$$

Cobb Douglas

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

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) = \prod y_k^{\alpha_k} \qquad \sum_k \alpha_k = 1 \tag{53}$$

Such an assumption implies that input cost shares (49) 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 (46) of input k and input v (for the same firm and destination). Assuming that the production function is Cobb-Douglas, we obtain:

$$\begin{aligned} \frac{\alpha_k y_v}{\alpha_v y_k} &= \frac{r_k t_k}{r_v t_v} \\ y_k &= y_v \frac{\alpha_k}{r_k t_k} \frac{r_v t_v}{\alpha_v} \end{aligned}$$

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:

$$p_{fj} = \frac{\tau_{fj}}{\prod\left(\frac{\alpha_k}{r_k t_{kf}}\right)^{\alpha_k}} \frac{\sigma}{\sigma-1} \frac{\sum_k \alpha_k(1+\gamma s^o_{kf})}{1-s_{fj}} \tag{54}$$

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:

$$s^o_{kf} = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{55}$$

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:

$$s^o_f = \frac{t_f y_f}{\sum_h Y_h} = \underbrace{\frac{Y_h}{\sum_h Y_h}}_{\text{Industry Share}} \underbrace{\frac{t_f y_f}{Y_h}}_{\text{Within-Industry} s^o} \tag{56}$$

6.2 Data

6.2.1 UNIDO Database

The UNIDO database uses M49 country codes classification, while trade data from WITS is refers to ISO classification. We use the concordance from the United Nations Statistics Division to convert M49 to ISO codes.[14]

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

[14] 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.

We use bilateral trade flows from World Bank's WITS for 1981-2016. The challenge is that these data are coded in SITC1 classification and there is no direct concordance between SITC1 and ISIC rev.2. In order to merge these two datasets, we use concordance of SITC1 to HS4 classification and HS4 to ISIC rev.2 from WITS.[15] We stick to SITC1 classification in our merged dataset because the variable of interest, unit value, is computed as total value of trade divided by supplied quantity, while measurement units of quantity differ from one SITC1 industry to another, so it is impossible to aggregate trade data on unit prices.

Notice that UNIDO dataset uses ISIC rev.2 (2 digits) and is more aggregated. In order to overcome this difficulty, for each exporter and year we construct a weight of each SITC industry within each HS4 industry as a share of exports from this industry in total exports from each country in each year. Similarly for each exporter and year we find weight of each HS4 industry in each ISIC industry. Finally, we construct a number of firms in each SITC industry based on its weight in corresponding ISIC industry and the number of firms in this ISIC industry. Notice that ISIC classification is more aggregated than our baseline SITC classification, so we split the number of firms known for each ISIC industry between SITC industries proportionate to their weight. As there are many small SITC industries, they will have low weight within their corresponding ISIC industry, and then this synthetic number of firms in some of them is smaller than 1. We dropped such industries in our baseline specification but our results are robust for the case when we replaced synthetic number of firms on a disaggregated level smaller than 1 with 1.

6.2.2 Input-Output Tables

Both WIOD and UNIDO data use ISIC classification. We merged more aggregated data at a 2-digit level, which is generally on the same level as WIOD with a few WIOD sectors including more than one UNIDO sector. To merge the WIOD dataset with trade date, we use the concordance between HS four-digit codes and ISIC two-digit codes from WITS.

6.3 Calibration of the Labor Supply Elasticity

6.3.1 Pricing Equation: from the Model to the Data

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

$$\begin{aligned} d\ln p_{ijkft} &= d\ln(c_{fit}\tau_{ijt}r_{ikt}) + d\ln\left(1+\gamma s^o_{ikft}\right) - d\ln\left(1-s_{ijkft}\right) \\ &\approx d\ln(c_{fit}\tau_{ijt}r_{ikt}) + \gamma ds^o_{ikft} + ds_{ijkft} \end{aligned} \tag{57}$$

[15] https://wits.worldbank.org/product_concordance.html

As we describe in the following section, our data comprises of highly disaggregated industry-level prices. Thus, we consider the industry average of (57):

$$d\ln \bar{p}_{ijkt} \approx d\ln \bar{c}_{ijkt} + \gamma d\bar{s}^{o}_{ikt} + d\bar{s}_{ijkt} \tag{58}$$

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 (26) is the following:

$$\ln \bar{p}_{ijkt} = \gamma \bar{s}^{o}_{ikt} + \beta \bar{s}_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{59}$$

6.3.2 Construction of Adjusted Origin CM

Consider the average demand share $\tilde{s}^{o}_{ikm}$ of firms in country i and industry k in the inputs purchased from an upstream industry m. For the sake of exposition, we drop time subscript. Such demand share is the product of two components. The first component, denoted by $\bar{s}^{o}_{ikmft}$, is the average within-industry demand share for input m. The second component, denoted by sh_{imk}, is the industry k demand share of inputs from industry m. Hence, $\tilde{s}^{o}_{ikmf}$ is given by:

$$\tilde{s}^{o}_{ikmf} = \underbrace{sh_{imk}}_{\text{Industry Share}} \quad * \quad \underbrace{\bar{s}^{o}_{ikmf}}_{\text{Within-Industry Firm Share}} \tag{60}$$

The measure of oligopsony power of a firm that affects its prices in export markets is a weighted average of $\tilde{s}^{o}_{ikmf}$ across the firm input industries m, where the weights are the average input shares in production.[16]

To derive a measure of market concentration consistent with this logic, we use data from WIOD. As input-output data is on the higher level of aggregation than trade data, we start with constructing aggregate CMs. We construct the CM for each of the $k = 1, ..., 18$ ISIC manufacturing industries in every country i, CM^{wiod}_{ik}, as the weighted sum of CMs of corresponding HS four-digit industries CM^{HS4}_{iv}, where industry v belongs to the WIOD industry k. The weights are the squared shares of each HS four-digit industry's output in

[16] This concentration measure is consistent with the extension of our model derived in Appendix sections 6.1.4 and 6.1.5 that allows for multiple inputs. In particular firm oligopsony power is the average of oligopsony powers on each input market weighted by each input share in the firm production. If firm production function is a Cobb-Douglas aggregation over a set on inputs, the input shares are constant.

the output of WIOD industry s_{iv}.[17] In particular, we compute CM_{ik}^{wiod} as:

$$CM_{ik}^{wiod} = \sum_{v \in k} CM_{iv}^{HS4} s_{iv}^2$$

We compute the industry k share in total demand for input m as:

$$sh_{imk} = \frac{x_{im} IO_{imk}}{\sum_m x_{im} IO_{imk}}$$

where IO_{imk} is the ratio of inputs from m used in industry k, relative to industry k total output, and it is taken from WIOD. x_{im} is the total output of industry m in country i.[18]

The market concentration faced by the typical firm from k when purchasing inputs from m is the product of within-industry CM CM_{ik}^{wiod} and industry share sh_{imk} in total demand for input m:

$$CM_{imk}^{input} = CM_{ik}^{wiod} sh_{imk}$$

If input m is specific to industry k ($sh_{imk} = 1$), as in our baseline specification, the market concentration in purchasing the input CM_{imk}^{input} is identical to the market concentration of industry k itself CM_{ik}^{wiod}. The smaller the industry demand share sh_{imk}, the smaller the oligopsony power attained by firms in industry k when purchasing input m.

We then compute the weighted average of CM_{imk}^{input} where the weights are the input share from industry m to industry k IO_{imk}, and obtain an adjusted measure of oligopsony power that incorporates input-output linkages:

$$CM_{ik}^{adj} = \sum_m (CM_{imk}^{input} IO_{imk}) \tag{61}$$

6.3.3 Robustness

In our baseline specification, we use the more disaggregated ISIC rev.4 for the period of 1997-2006 as it has the best coverage in terms of countries. Coverage of data on wages and labor productivity, also present in UNIDO, imperfectly overlaps with the coverage of the number of establishments, so not to decrease sample size, we chose to exclude these controls from the main specification. In Table 6, we find that, interestingly, the coefficients on wage and productivity are close to zero and insignificant, which supports our assumption that industry-year and country pair-year fixed effects absorb the variation in the unit costs of production.

Our second robustness check uses the Herfindahl indexes (HIs) computed by Feenstra and Weinstein (2017) on a country-industry level. We proxy concentration inputs' market CM_{ikt}^o with the corresponding origin and industry specific Herfindahl Index HI_{ikt}^o. Moreover, we proxy concentration in the destination market CM_{ijkt}^d with the corresponding country year and industry specific Herfindahl Index HI_{jkt}^d. Although using Herfindahl Indexes (HI) to proxy for average market share may reduce the precision of our estimates, we should

[17] With squared shares as weights, the aggregated CM can be interpreted as the Herfindahl index for the aggregated industry.

[18] Output from volume of imports $imports_{ik}$ and domestic share λ_{iik}: $x_{ik} = import_{iik} \frac{1-\lambda_{iik}}{\lambda_{iik}}$.

note that the average market share equals the HI in case of symmetric firms.[19] Due to data availability, merging the dataset on unit prices with the dataset on CMs, limits us to consider 117 countries for the years 1992 and 2005. The resulting number of HS four-digit industries is 1198.

Since the HIs from different sources have different coverage, Feenstra and Weinstein (2017) choose 1992 and 2005 as the benchmark years as most of the data is available for these years. They linearly extrapolate their data based on years available for Mexico and Canada to construct HIs for 1992 and 2005. Details are available in the Appendix of Feenstra and Weinstein (2017).

Table 5: The Effects of Oligopsony and Oligopoly Power on Prices - Alternative Measures

	UNIDO			Feenstra and Weintein	
	Baseline	FW coverage	2 Digit	Baseline	UNIDO coverage
Origin CM	0.132***	0.135***	0.086***	0.214***	0.235***
	(0.003)	(0.015)	(0.017)	(0.007)	(0.016)
Destination CM	0.017***	0.020	-0.023*	0.039***	0.041***
	(0.003)	(0.014)	(0.013)	(0.007)	(0.016)
R^2	0.57	0.57	0.66	0.60	0.57
# Observations	3584152	171342	104061	920189	171342

Robust standard errors are in the parentheses. Baseline results from Table 2 are provided for reference. UNIDO uses measures of concentration on both origin and destination markets from UNIDO database on four- and two-digit levels. FW uses alternative concentration measure from Feenstra and Weinstein (2017) as a source of CMs for origin and destination countries as dependent variables. Details in the main text.

In the first column of Table 5, we report our baseline results from Table 2. In the third column, we provide the results based on more aggregated CMs from UNIDO. The baseline results based on Feenstra and Weinstein (2017) are provided in the fourth column. Finally, UNIDO and Feenstra and Weinstein (2017) data have different coverage with the former covering more years and latter more countries. As the differences in coverage may affect the estimates, we provide the results for observations that are present in both datasets in second and fifth columns. They indicate that coverage does not affect the sign or size of our estimates, but increases standard errors due to much lower number of observations in both cases.

7 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

[19]We can relax this assumption: for a given distribution of firms' sizes there exists a mapping between average market share and Herfindahl index. Besides, even with asymmetric firms, for a given distribution of firms' sizes, higher Herfindahl indexes will be associated with higher firms' average market share.

Table 6: Effects of Wages and Productivities on Export Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Origin HI	0.132***	0.200***	0.201***	0.118***	0.120***	0.277***	0.282***	0.152***
	(0.003)	(0.004)	(0.004)	(0.021)	(0.021)	(0.015)	(0.015)	(0.003)
Destination HI	0.017***	0.017***	0.017***	0.000	0.000	0.061***	0.062***	0.03***
	(0.003)	(0.003)	(0.003)	(0.015)	(0.015)	(0.014)	(0.014)	(0.003)
Wage			0.000***		-0.000***		0.000***	
			(0.000)		(0.000)		(0.000)	
Productivity			0.000***		0.000*		-0.000***	
			(0.000)		(0.000)		(0.000)	
Industry-year FE	Y	Y	Y	Y	Y	Y	Y	N
Countrypair-year FE	Y	Y	Y	Y	Y	Y	Y	Y
Origin-indsutry-year FE	N	N	N	N	N	N	N	Y
R^2	0.57	0.57	0.57	0.63	0.63	0.57	0.57	0.59
# Observations	3584152	3020351	3020351	71366	71366	203544	203544	3583224

Robust standard errors are in the parentheses. For specifications (1)-(3) we use baseline measures of market concentration from UNIDO on 4-digit level, for (4)-(5) we use 2-digit level data from UNIDO, and for (6) and (7) we use measures of market concentration from Feenstra and Weinstein (2017). We control for wage and productivity for specifications (3), (5), (7); we do not include controls for specifications (1), (2), (4), and (6). Specification (1) is baseline regression from Table 2 and is provided for reference, specifications (2)-(7) have the same coverage with and without controls (we drop observations for which there is no information on wages or productivities). (8) is a baseline specification but with origin-industry-year fixed effects and without indsutry-year fixed effects with industries being on HS two-digit level of aggregation.

market s_h and in the foreign market s_h^*, home firms' demand share of the oligopsonistic input s_h^o, 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_f^o.

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

$$s_h L_h \left[1 - \left(\frac{\sigma-1}{\sigma}\right)\left(\frac{1-s_h}{1+\gamma s_h^o}\right)\right] + s_h^* L_f \left[1 - \left(\frac{\sigma-1}{\sigma}\right)\left(\frac{1-s_h^*}{1+\gamma s_h^o}\right)\right] - F_h = 0 \tag{62}$$

$$s_f L_f \left[1 - \left(\frac{\sigma-1}{\sigma}\right)\left(\frac{1-s_f}{1+\gamma s_f^o}\right)\right] + s_f^* L_h \left[1 - \left(\frac{\sigma-1}{\sigma}\right)\left(\frac{1-s_f^*}{1+\gamma s_f^o}\right)\right] - F_f = 0 \tag{63}$$

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:

$$\frac{s_h}{s_h^o} + \frac{s_f^*}{s_f^o} = 1 \tag{64}$$

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

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:

$$\left(\frac{s_h^*}{s_f}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{hf}c_h}{c_f}\right)\left(\frac{1-s_f}{1-s_h^*}\right)\left(\frac{1+\gamma s_h^o}{1+\gamma s_f^o}\right)\left[\left(\frac{s_f^o(1+\gamma s_f^o)}{s_h^o(1+\gamma s_h^o)}\right)\left(\frac{L_h(s_h-s_h^2)+L_f(s_h^*-(s_h^*)^2)}{L_f(s_f-s_f^2)+L_h(s_f^*-(s_f^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{66}$$

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

The system of equations (62), (63), (64), (65), (66), and (67) 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:

$$s_hL_h\left[1-\left(\frac{\sigma-1}{\sigma}\right)(1-s_h)\right]+s_h^*L_f\left[1-\left(\frac{\sigma-1}{\sigma}\right)(1-s_h^*)\right]-F_h=0 \tag{68}$$

$$s_fL_f\left[1-\left(\frac{\sigma-1}{\sigma}\right)(1-s_f)\right]+s_f^*L_h\left[1-\left(\frac{\sigma-1}{\sigma}\right)(1-s_f^*)\right]-F_f=0 \tag{69}$$

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):

$$\frac{s_h}{s_h^o}+\frac{s_f^*}{s_f^o}=1 \tag{70}$$

$$\frac{s_f}{s_f^o}+\frac{s_h^*}{s_h^o}=1 \tag{71}$$

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:

$$\left(\frac{s_h^*}{s_f}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{hf}c_h}{c_f}\right)\left(\frac{1-s_f}{1-s_h^*}\right)\left[\left(\frac{s_f^o}{s_h^o}\right)\left(\frac{L_h(s_h-s_h^2)+L_f(s_h^*-(s_h^*)^2)}{L_f(s_f-s_f^2)+L_h(s_f^*-(s_f^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{72}$$

$$\left(\frac{s_f^*}{s_h}\right)^{\frac{1}{1-\sigma}} = \left(\frac{\tau_{fh}c_f}{c_h}\right)\left(\frac{1-s_h}{1-s_f^*}\right)\left[\left(\frac{s_h^o}{s_f^o}\right)\left(\frac{L_f(s_f-s_f^2)+L_h(s_f^*-(s_f^*)^2)}{L_h(s_h-s_h^2)+L_f(s_h^*-(s_h^*)^2)}\right)\right]^{\frac{\gamma}{1+\gamma}} \tag{73}$$

The system of equations (68), (69), (70), (71), (72), and (73) 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.

7.1 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 (64).
- s_f is implied by (65).
- $\left(\frac{\tau_{fh}c_f}{c_h}\right)$ = solution to (66) in the baseline model and to (72) in the model with oligopoly power only.
- $\left(\frac{\tau_{hf}c_h}{c_f}\right)$ = solution to (67)in the baseline model and to (73) in the model with oligopoly power only.
- F_h and F_f implied by (62) and (63) in the baseline model and by (68) and (69) 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 7 and 8 provide the summary statistics for the calibrated parameters.

Table 7: 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 8: 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 (62), (63), (64), (65), (66), and (67) in the baseline model.[20] 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:

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

We also consider the identical reduction in trade costs in the oligopoly model, and solve the system of equations given by: (68), (69), (72), and (73). We then compute the change in markups as:

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

[20] We drop any industry, whose solution to the new equilibrium condition is outside the set of market shares between zero and one.

Table 9: Trade Shock: Markups and Concentration

$\gamma = 0.132$, L_h =US empl. share			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-1.13	-0.06	-5.39
Oligopoly Only	-1.26	0.09	-14.85

$\gamma = 0.132$, L_h =US output share			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-0.94	0.02	-4.96
Oligopoly Only	-1.09	0.27	-15.60

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.

Table 10: Trade Shock: Markups and Concentration

$\gamma = 0.132$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-1.76	0.15	-3.95
Oligopoly Only	-2.21	0.35	-6.60

$\gamma = 0.235$, $L_h = 0.15$			
	$\hat{\mu}_h$	$\hat{\mu}_h^*$	$\hat{s}_h$
Baseline	-1.40	0.07	-2.91
Oligopoly Only	-2.90	0.47	-11.30

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: Feenstra and Weinstein (2017) and trade data. Foreign variables are averages across all countries.

7.1.1 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:

$$s_{fij} = \frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{74}$$

$$s_{fi}^o = \frac{k_{fi}}{\sum_{f=1}^{N_i} k_{fi}} = \frac{\sum_{j=1}^{I} \tau_{ij} c_{fi} x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i} \tau_{ij} c_{fi} x_{fij}} \tag{75}$$

By substituting the equilibrium quantity

$$x_{fij} = \left[\frac{L_j(\sigma - 1)}{\sigma \sum_{i=1}^{I} \sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \frac{1 - s_{fij}}{\tau_{ij} c_{fi} r_i (1 + \gamma s_{fi}^o)} \right]^{\sigma} \tag{76}$$

into (74), we obtain the first set of equilibrium conditions:

$$s_{fij} = \frac{\left(\frac{1 - s_{fij}}{\tau_{ij} c_{fi} r_i (1 + \gamma s_{fi}^o)} \right)^{\sigma - 1}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i} \left(\frac{1 - s_{fij}}{\tau_{ij} c_{fi} r_i (1 + \gamma s_{fi}^o)} \right)^{\sigma - 1}} \qquad \forall f, ij \tag{77}$$

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

$$x_{fij} = \frac{(\sigma - 1) L_j}{\sigma r_i \tau_{ij} c_{fi}} \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o} \tag{78}$$

Substituting (78) into (75), we obtain the second set of equilibrium conditions:

$$s_{fi}^o = \frac{\sum_{j=1}^{I} L_j \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o}}{\sum_{j=1}^{I} \sum_{f=1}^{N_i} L_j \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o}} \tag{79}$$

Finally, by substituting (78) into the definition of the price for the oligopsonistic input, we obtain:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} = \tilde{\gamma}_i \left[\sum_{j=1}^{I} \sum_{f=1}^{N_i} \left(\frac{L_j(\sigma - 1)}{\sigma} \right) \frac{s_{fij}(1 - s_{fij})}{1 + \gamma s_{fi}^o} \right]^{\frac{1}{\gamma + 1}} \tag{80}$$

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. We later describe the source of data for N_i and N_{ij}^x.[21] To simulate the draws of unit costs, we first draw max $N_i * 1.5$ realizations u_{fi} from a Gumbel copula with parameter $\alpha = 10000$.[22] Such a

[21] Selection into export markets is driven by the presence of iceberg trade costs which affect the ranking of firms in a market. In fact, higher iceberg trade costs cause exporters to move down the ranking of firms by unit costs. The presence of the fixed cost F (which is paid if the firm is active, regardless whether it is active in the domestic market or in the foreign market) and the sequentiality of entry can generate the selection effects typically obtained with a difference between the fixed cost of exporting and the fixed cost of domestic production. To further understand this, consider the equilibrium allocation. If a non-exporter begins to export, the new allocation will feature some firm with negative profits and, thus, violate the definition of equilibrium. Furthermore, notice that when a firm begins exporting, it moves along the supply of the input, whose price increases. The increase in unit costs can reduce the domestic profits enough so that the combined profits are smaller than the fixed cost F. Our decision to avoid introducing a fixed cost of exporting is also done to make a better comparison between this model and the one with homogeneous firms, in which there are no export fixed costs.

[22] 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).

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 $b_i = 1$. In each market 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. Then we solve the system of equations given by (77) and (79), using the definition of (80). We calibrate the fixed costs by assuming that the profits of the least efficient firm in each country are equal to zero before the change in trade costs. This means that the fixed cost equals the operating profits of the least efficient firm in each country:

$$F_i = s_{N_i ij} L_j \left[1 - \frac{\sigma - 1}{\sigma} \frac{1 - s_{N_i ij}}{1 + \gamma s^o_{N_i i}} \right] \tag{81}$$

To study the effects of a 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.

To calibrate the model with only oligopoly power we proceed as follows. First, notice that the equilibrium market shares are defined by (77), 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 (77), 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.

Figure 7 shows how the difference between the change in weighted average markup between our baseline model and a counterfactual model of oligopoly only as a function of γ and θ. Table 11 reports the results from a change in trade costs using the calibrated model under the alternative value of $\gamma = 0.235$.

Figure 7: Markup Changes at Home: Oligopoly VS Oligopsony

(a) Supply Elasticity γ

(b) Shape Parameter of the Productivity Distribution

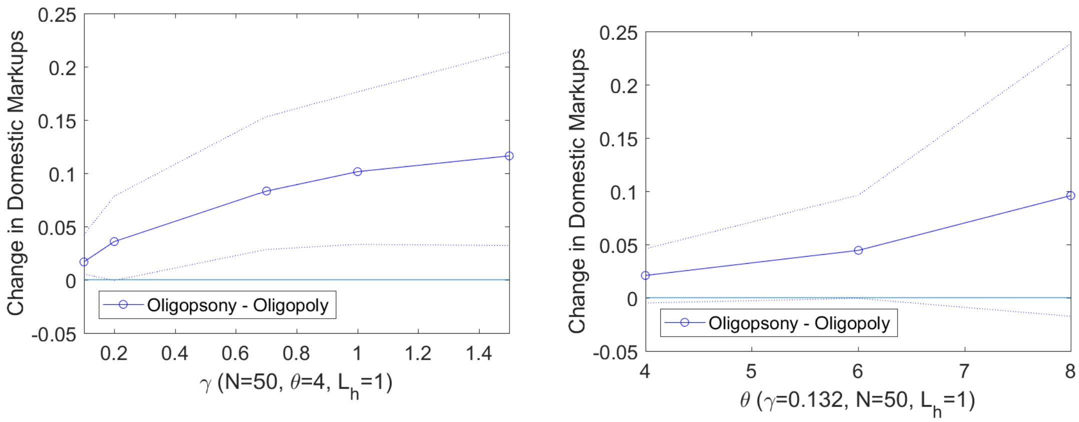

Table 11: Trade Shock: Markups and Concentration

	Heterogeneous Firms	Homogeneous Firms
Baseline	-0.023	-0.028
Oligopoly Only	-0.032	-0.064

Log changes in domestic markups of US firms, average across sectors.
Same parameters as baseline, with the exception of $\gamma = 0.235$.