Oligopoly and Oligopsony in International Trade*

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Abstract

Large firms dominate final goods markets, in which they have oligopoly power, and also input markets, in which they have oligopsony power. Using data on market concentration, we find that both oligopoly and oligopsony power increase unit prices of export goods. We investigate the effects of international trade on the two sources of firms' market power and prices, in a theoretical model in which firms are oligopolists in the market for final goods and oligopsonists in the market for inputs. International integration in final goods markets reduces oligopoly power but it has the opposite effect on oligopsony power. Similarly, input market integration reduces oligopsony power, but it increases oligopoly power.

JEL Classification: F12, F13.

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

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1 Introduction

Large firms dominate trade flows, as a small number of the largest exporters accounts for most of countries' total exports (Freund and Pierola, 2015) and imports (Bernard et al., 2016). A growing body of literature has explored the effects of market power in final goods markets, where large firms act as oligopolists. Oligopolies affect the welfare of consumers: the larger the market power of oligopolists, the larger their markups (Atkeson and Burstein, 2008) and the smaller the number of varieties they export (Eckel and Neary, 2010). International competition across oligopolists reduces their market power, generating gains from a reduction of markups (Edmond et al., 2015), and from expanding the number of varieties exported per firm (Macedoni, 2017).

Firms are not only large in the market for final goods, but also in the market for factors of production (Azar et al., 2017; Morlacco, 2017).[1] However, little is known on the effects of trade in the presence of firm's market power in the market for factors of production. When there are few large buyers, the market is known as a oligopsony: each buyer restricts its demand in an effort to keep prices low (Boal and Ransom, 1997). The extent by which buyers restrict their demand is what we call *oligopsony power*. The goal of this paper is to study the effects of oligopsony and oligopoly power on firms' prices, and how international integration affect oligopsony and oligopoly power.

To investigate the effects of the two sources of market power on prices, we use a rich data set on unit prices from WITS and on market concentration from Feenstra and Weinstein (2017) for a wide set of countries and industries. We proxy both oligopsony and oligopoly power using appropriately defined Herfindahl Indexes. Our main empirical finding is that both higher oligopsony power and oligopoly power increases prices of export goods. Moreover, the quantitative effects of oligopsony power dominate those of oligopoly power. In particular, an increase in input market concentration by a standard deviation increases markups by 1% to 10% while an increase in one standard deviation on final goods market concentration increases markups by 0 to 1%. The empirical results are robust to a number of alternative specifications and definitions of market concentration.

To understand the effects of international integration on the two sources of market power, we build a general equilibrium model in which few large, homogeneous firms produce differentiated goods, competing oligopolistically. Moreover, firms employ an input, the market of which is oligopsonistic. Such an input could be thought as specialized labor, capital, raw materials, or some intermediate input. Firms exploit their oligopsony power in the market

[1] Azar et al. (2017) document high levels of labor market concentration in US commuting zone and that higher concentration reduces labor wages. Morlacco (2017) finds high buyer power of French firms in foreign input markets. For a survey of the evidence of buyer power see Bhaskar et al. (2002).

for the specific input, by restricting their demand to pay a lower reward, in line with the evidence of Azar et al. (2017). Moreover, firms exploit their oligopoly power in the market for final goods, by restricting their supply to charge higher markups.

Our approach is based on the models of oligopoly of Atkeson and Burstein (2008) and Edmond et al. (2015), which feature an inelastically supplied input (labor) in a perfectly competitive market, as in the standard literature (Krugman, 1980; Melitz, 2003). In contrast, we generalize several theories of firms' market power in factors' markets (Boal and Ransom, 1997; Bhaskar et al., 2002) by assuming an upward sloping supply curve for the input. A few large firms demand the input and internalize their effects on the input's reward. In line with the evidence of Morlacco (2017), the oligopsony power of a firm depends on the firm's size in the market for the specific input: the larger a firm's demand share is, the larger its oligopsony power is. Larger oligopsony power reduces consumer's welfare: by restricting the demand for the specific input, firms restrict their output and charge higher markups. Thus, our model features markups that are increasing both in the oligopoly power, as in Atkeson and Burstein (2008), and in the oligopsony power.

We study the effects of international economic integration with two thought experiments, which yield qualitatively similar results. First, we consider the exercise of Eckel and Neary (2010) and model economic integration as an increase in the number of countries engaging in frictionless trade. Second, we examine the effects of a symmetric reduction in iceberg trade costs in a multi-country model. The effects of trade on oligopoly and oligopsony power depend on which markets are affected by international economic integration.

Consider international integration in final goods markets while the input is only domestically supplied. For this example, the input can be thought of as the labor supplied in local labor markets. As in Edmond et al. (2015), trade in final goods has pro-competitive effects: firms become smaller in the final goods market and their oligopoly power declines. In contrast, the oligopsony power increases. In fact, the reduction in oligopoly power reduces profits and forces some firms to exit. Concentration in the final goods market declines because the expansion of the final goods market offsets the reduction in the number of firms from one country. However, the reduction in the number of firms increases market concentration in the domestic input market and, thus, firms have higher oligopsony power. 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 reward. Although international economic integration brings about an increase in welfare, the larger the oligopsony power of firms, the smaller the welfare gains from trade.

The effects of trade on firm's market power are reversed in case of integration in the market for the specific input. Consider firms that 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, in line with the results of Morlacco (2017). As firms from more countries purchase the same input, the demand share of each firm in input markets decline, reducing firms' oligopsony power. However, lower oligopsony power causes a reduction in firm's profits, which fosters firm's exit. The decline in the number of firms generates an increase in the oligopoly power of firms.

The presence of two sources of firms' market power in two markets makes us reconsider the effects of trade on firm's market power. In fact, when firms are large both in final goods markets and in inputs markets, the pro-competitive effects that arise by opening to trade one market are dampened by the anti-competitive effects that originate in the other one. Only economic integration in both markets reduces firm's market power in each market.

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), oligopsony has received little attention. 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 an otherwise standard Heckscher-Ohlin model. The authors find that the presence of monopsony breaks down the Stolper-Samuelson theorem and that autarky may yield higher welfare than trade. Some of the authors' prediction are confirmed by our model of oligopolists and oligopsonists producing differentiated goods: oligopsony generates distortions in the market allocation, which are exacerbated by trade in final goods.

Our paper relates to studies that analyze sources of firm's market power, other than oligopoly and oligopsony. 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.[2] Finally, Morlacco (2017) estimates the buyer power of French firms in foreign input markets.

The remainder of the paper is organized as follows. Section 2 builds a model of firms that are both oligopolists and oligopsonists. Section 3 presents the effects of international trade on firm's market power. Section 4 provides our empirical results on the effects of market

[2] 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. (2015) showed that the distortions originating from variable markups are exacerbated by trade.

power on prices. 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 identical industries, and firms are large in an industry, but small relative to the economy.

In each industry of country i, there is a discrete number N_i of firms, indexed by f. We consider a model that only features homogeneous, large firms, which engage in trade of differentiated varieties of a final good. The final goods market in each industry is oligopolistic. Moreover, to produce the differentiated final good, each firm requires an input, whose total supply in country i is denoted by K_i. The input is provided with an upward sloping supply curve, and the market for the specific input is oligopsonistic. 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 τ_{ij}, with $\tau_{ii} = 1$.

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 $z \in [0, 1]$ 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 $\sigma > 1$:

$$u_j(z) = \left[\sum_i \sum_f q_{fij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

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:

$$\int_0^1 \sum_i \sum_f p_{fij} q_{fij} dz \leq y_j \tag{3}$$

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

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

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.

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

$$p_{fij} = \frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{4}$$

2.2 Supply of the Specific Input

To model oligopsony, we assume that the supply curve for the specific input K_j in country j is upward sloping. Such an assumption generalizes several microfounded theories of oligopsony (Boal and Ransom, 1997). To highlight the role of oligopsony power, and to maintain a certain symmetry with the final goods market, we assume that the factor is supplied with constant elasticity $\gamma > 0$. Let r_j denote the price, or reward, for the input. The inverse supply curve is given by:

$$r_j = \tilde{\gamma}_j K_j^{\gamma} \tag{5}$$

where $\tilde{\gamma}_j$ 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. In contrast, 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), assume that the factors of production are inelastically supplied. If the specific factor is inelastically supplied, which is equivalent to setting $\gamma \to \infty$, firms would be able to reduce the input's price to zero.

Without loss of generality, let us assume that the input is supplied to domestic firms only.[3] Each firm f demands k_{fij} units of the specific input to produce its differentiated variety and sell it to country j. Firm f demand for the specific factor, 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 specific input is $\sum_{f=1}^{N_i} k_{fi} = \sum_{f=1}^{N_i} \sum_{j=1}^{I} k_{fij}$.

[3] 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 $\tau_{ij}c_{fij}$ 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 (5), to highlight the effect of a single firm on the reward for the input. By market clearing $\sum_{j=1}^{I}\sum_{f=1}^{N_i} k_{fij} = K_i$, hence:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} = \tilde{\gamma}_i \left[\sum_{j=1}^{I}\sum_{f=1}^{N_i} \tau_{ij}c_{fi}x_{fij}\right]^{\gamma} \tag{6}$$

Firms maximize their profits by choosing x_{fij} for each destination they serve, taking other firms' choices as given. Given the inverse demand function (4) and the inverse supply function of the input (6), the profits of firm f equal:

$$\begin{aligned}\pi_{fi} &= \sum_j p_{fij}x_{fij} - r_i \sum_j \tau_{ij}c_{fij}x_{fij} - F = \\ &= \sum_j \frac{L_j x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}} - \tilde{\gamma}_i \left[\sum_f \sum_j \tau_{ij}c_{fi}x_{fij}\right]^{\gamma} \sum_j \tau_{ij}c_{fi}x_{fij} - F = \end{aligned} \tag{7}$$

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 specific input. Because of oligopsony power, the firm choice of quantity in a destination j is not independent of the quantity choice in a destination j'. Increasing the supply in j, increases factor's price r_i, and thus the marginal 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 factor's market:

$$\frac{\sigma-1}{\sigma}\frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_i\sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}}\left[1 - \underbrace{\frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_i\sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}}}_{\text{Oligopoly Power}}\right] - r_i\tau_{ij}c_{fij}\left[1 + \gamma\underbrace{\frac{\sum_j \tau_{ij}c_{fij}x_{fij}}{\sum_f\sum_j \tau_{ij}c_{fij}x_{fij}}}_{\text{oligopsony power}}\right] = 0 \tag{8}$$

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 oligopolist market share: the share of firm's revenues over total revenues in a destination j. Let s^o_{fi} denote the oligopsonist 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:

$$s_{fij} = \frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{9}$$

$$s^o_{fi} = \frac{k_{fi}}{\sum_f k_{fi}} = \frac{\sum_j \tau_{ij} c_{fij} x_{fij}}{\sum_f \sum_j \tau_{ij} c_{fij} x_{fij}} \tag{10}$$

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 factor of production, which results in an increase in the factor'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 t the firm's demand share for the input s^o_{fi}.

Using (9) and (10) into (8) yields the optimal quantity:

$$x_{fij} = \left[\frac{L_j(\sigma-1)}{\sigma \sum_i \sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}} \frac{1 - s_{fij}}{\tau_{ij} c_{fij} r_i (1 + \gamma s^o_{fi})} \right]^{\sigma} \tag{11}$$

Using (11) into (4) yields the pricing rule:

$$p_{fij} = r_i \tau_{ij} c_{fij} \underbrace{\frac{\sigma}{\sigma - 1} \left(\frac{1 + \gamma s^o_{fi}}{1 - s_{fij}} \right)}_{\text{Markup}} \tag{12}$$

As in standard models of oligopoly (Atkeson and Burstein, 2008; Edmond et al., 2015), firms with higher oligopoly power — higher market share in the final goods market — enjoy higher markups. Moreover, higher oligopsony power — higher market share in the input market — increases markups as well. A firm with large s^o_{fi} realizes that increasing its production raises the price of the input. Therefore, larger values for s^o_{fi} make firm f restricts its supply of the final good by charging higher markups.

Firm's revenues are given by:

$$p_{fij}x_{fij} = \left[\frac{\sigma}{(\sigma-1)}\frac{\tau_{ij}c_{fij}r_i(1+\gamma s^o_{fi})}{1-s_{fij}}\right]^{1-\sigma}\left[\frac{L_j}{\sum_i\sum_f x_{fij}^{\frac{\sigma-1}{\sigma}}}\right]^{\sigma} \tag{13}$$

We can use the definition of market share $x_{fij} = \frac{s_{fij}L_j}{p_{fij}}$ to derive the optimal quantity supplied by a firm in a destination j, as a function of firm's market power:

$$x_{fij} = \frac{(\sigma-1)L_j}{\sigma r_i \tau_{ij} c_{fi}}\frac{s_{fij}(1-s_{fij})}{1+\gamma s^o_{fi}} \tag{14}$$

The larger the oligopsony power of a firm, the smaller its supply across all the destinations reached. Moreover, 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 firms are large, namely their sales account for more than half of the market, a larger market share reduces the total supply of a good.

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

$$\begin{aligned}\pi_{fij} &= x_{fij}p_{fij} - r_i\tau_{ij}c_{fij}x_{fij} = s_{fij}L_j - r_i\tau_{ij}c_{fij}\frac{s_{fij}L_j}{p_{fij}} = \\ &= s_{fij}L_j\left[1 - \frac{\sigma-1}{\sigma}\frac{1-s_{fij}}{1+\gamma s^o_{fi}}\right]\end{aligned} \tag{15}$$

Summing across the destinations reached yields firm's total profits:

$$\pi_{fi} = \sum_j \pi_{fij} - F = \sum_j s_{fij}L_j\left[1 - \frac{\sigma-1}{\sigma}\frac{1-s_{fij}}{1+\gamma s^o_{fi}}\right] - F \tag{16}$$

2.4 Market Clearing

Let us derive an expression for the total demand for K_i as well as its reward 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} (10), s_{fij} (9), and the pricing rule (12), K_i becomes

$$\begin{aligned} K_i &= \sum_{v=1}^{N_i} k_{vi} = \frac{k_{fi}}{s^o_{fi}} = \frac{1}{s^o_{fi}} \sum_{j=1}^{I} c_{fij} x_{fij} \tau_{ij} = \frac{1}{s^o_{fi}} \sum_j \frac{c_{fij}\tau_{ij} L_j s_{fij}}{p_{fij}} \\ &= \frac{\sigma - 1}{\sigma r_i} \frac{1}{s^o_{fi}(1 + \gamma s^o_{fi})} \sum_j L_j (1 - s_{fij}) s_{fij} \end{aligned} \tag{17}$$

Combining the aggregate demand for the input (17) with the aggregate supply (5) yields the equilibrium reward for the input:

$$r_i = \left[\tilde{\gamma}_i^{\frac{1}{\gamma}} \frac{\sigma - 1}{\sigma} \frac{1}{s^o_{fi}(1 + \gamma s^o_{fi})} \sum_j L_j (1 - s_{fij}) s_{fij} \right]^{\frac{\gamma}{1+\gamma}} \tag{18}$$

The final goods market clearing condition is given by:

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

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

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

Finally, let us derive the equilibrium level of the CES quantity index Q_j as a function of domestic variables. 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 (13). 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 reward for the input r_j, and the market share of the domestic firm in the domestic final goods market and input market:

$$Q_j = \frac{\sigma - 1}{\sigma \tau_{jj} c_{fj} r_j} \frac{(1 - s_{fjj}) s_{fjj}^{-\frac{1}{\sigma-1}}}{1 + \gamma s^o_{fj}} \tag{19}$$

Consistent with the findings of Edmond et al. (2015), larger oligopoly power, all else constant, reduces the welfare of consumers. Moreover, oligopsony power has a similar effect: larger oligopsony power reduces welfare.

3 The Effects of International Trade

We consider firms that are homogeneous in terms of productivity: $c_{fi} = c_i \; \forall \; f = 1, ..., N_i$. The equilibrium is a vector of the number of firms in each country N_i and specific factor price r_i, such that each firm chooses the optimal quantity x_{ij} according to (11), profits (16) equal zero, final goods market clear, factor's market clear and trade is balanced. To gather some intuition on the effects of international trade on the oligopsonist and oligopoly power of firms, let us consider a version of the baseline model with I identical countries. Let N denote the number of firms in each country, and L each country size.

What are the effects of international trade on firm's market power? To answer to this question we consider two thought experiments. First, we replicate the Eckel and Neary (2010) exercise in our framework: we 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.

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. Let I denote the number of countries with integrated final goods markets, and I^o the number of countries with integrated input markets. 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 (16) to the symmetric countries assumption yields:

$$IsL \left[1 - \frac{\sigma - 1}{\sigma} \frac{1 - s}{1 + \gamma s^o} \right] = F \tag{20}$$

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 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 plane (s, s^o), 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 (20):

$$s^o = \frac{\sigma - 1}{\sigma\gamma}\frac{1 - s}{1 - \frac{F}{IsL}} - \frac{1}{\gamma} \tag{ZP1}$$

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

where ZP1, is the zero profit condition (20) rearranged and ZP2 is obtained by substituting $I = I^o s^o s^{-1}$ using RMP. In the plane (s, s^o), the zero profit condition is represented by a negative relationship between s and s^o. All else constant, to maintain profit 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. Figure 2 illustrates that an increase in the number of countries with integrated input markets I^o causes the market share s to increase, and the demand share for the input s^o to decline. As the number of firms in the market for the input increases, the demand share of each firm declines. The decline in s^o reduces the profitability of firms and, by the zero profit condition, some firms exit. As a result, fewer firms are serving the final goods market, which increases the market share s.

When firms are large both in the destination and in the market for factors of production, the pro-competitive effects that arise from opening to trade one of the two markets are

Figure 1: Final Goods Market Integration

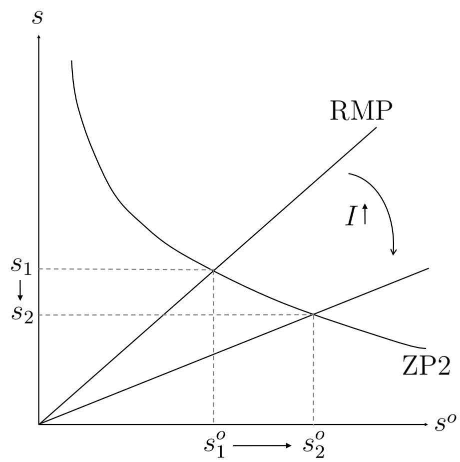
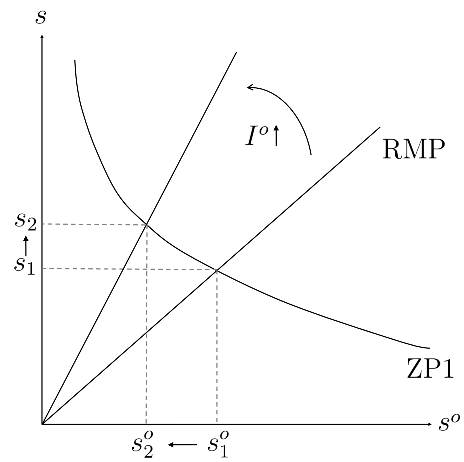
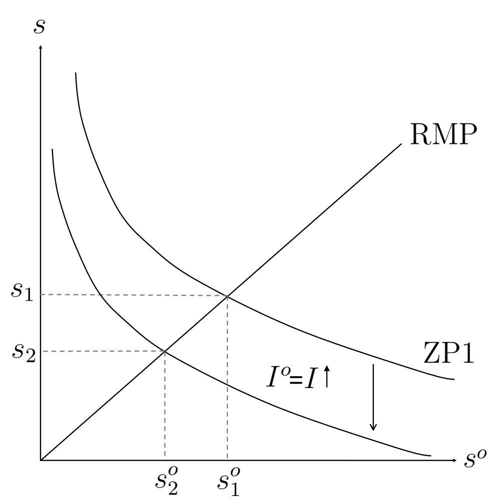


Figure 2: Input Market Integration



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 $I = I^o$. As firms lose market power in both market, both s^o and s decline.

Figure 3: Final Goods and Input Market Integration



3.1.1 Input Price, 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. The derivations are in appendix 6.1.2.

International economic integration increases the reward for 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 compensation following international economic integration. When firms have only oligopoly power, economic integration leads to higher production, which increases the input demand and, thus, reward. In the presence of oligopsony power, the rise in input market concentration dampens the gains for the input, without completely offsetting them.

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. However, the larger the oligopsony power of firms, the smaller the gains. Too see this, let us consider the total (log) change of the CES quantity index — which is equivalent to the change in welfare — as a function of the change in the oligopoly and oligopsony power:

$$d\ln Q = \left[\frac{1}{\sigma-1} + \frac{s}{(1-s)(1+\gamma)}\right](-d\ln s) + \left[\frac{\gamma s^o}{(1+\gamma s^o)(1+\gamma)}\right](-d\ln s^o) \tag{21}$$

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 ($d\ln s$) and oligopsony ($d\ln s^o$) power of firms, and on the current level of oligopoly (s) and oligopsony (s^o) power. 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.

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.[4] 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 oligopsonist 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:

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

For $\tau > 1$, the domestic market share is always larger than the export market share. Hence, export markups are lower than domestic markups.

The RMP curve, which reflects the relative domestic market power of oligopolists and oligopsonists, 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) plane, similarly to the RMP curve of the previous section. A reduction in the iceberg trade costs for final goods, rotates the RMP curve clockwise. Lower iceberg trade costs increases the competition faced by firms in the domestic final goods market. Hence, holding the oligopsony power constant, lower iceberg trade costs reduce the market power in domestic final goods markets.

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. The zero profit (ZP) condition, becomes:

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

The right-hand side of the ZP condition consists of three component. The first term, $s^o = \frac{1}{N}$, represents the direct effect of firm's entry on an individual firm's revenues. The second term, reflects the impact of trade costs on entry decisions. In fact, changes in trade costs affect entry by varying the domestic and export market shares of firms. Finally, the third term reflects the indirect effect of competition: smaller iceberg trade costs make foreign rivals

[4] In the appendix, we outline a model in which firms internationally source a set of differentiated inputs, and imports of inputs are subject to iceberg trade costs.

more competitive, reducing domestic profits and entry.

By the implicit function theorem:

$$\frac{ds}{ds^o} = -\frac{dZP/ds^o}{dZP/ds} < 0 \tag{22}$$

Hence, the ZP curve is decreasing in the (s, s^o) plane, 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.

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 rise the input price, however, the larger the oligopsony power, the lower the increase in input price. Moreover, the welfare formula in (28) is also valid for a world with iceberg trade costs.

4 Test of the Predictions of the Model

This section tests the prediction of the model on the pricing behavior of firms. From (12), the price a firm charges in a destination is a function of the marginal costs of production and delivery, of the demand share of the firm in inputs' markets, and of the market share of the firm in the destination. While the effects of oligopoly power in the market for final goods on prices have been extensively studied and documented (Atkeson and Burstein, 2008; Edmond et al., 2015; Hottman et al., 2016), our empirical contribution is to show that oligopsony power is also a quantitatively relevant source of market power that influences prices.

4.1 From the Model to the Data

To connect the theory to the data, let us consider the pricing decision of a firm f from country i exporting to country j in industry k. We assume that inputs are domestically sourced. 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 (12):

$$\begin{aligned} d\ln p_{ijkft} &= d\ln(c_{ijft}\tau_{ijt}r_{ikt}) + d\ln\left(1+\gamma ds^{o}_{ikft}\right) - d\ln\left(1-s_{ijkft}\right) \\ &\approx d\ln(c_{ijft}\tau_{ijt}r_{ikt}) + \gamma ds^{o}_{ikft} + ds_{ijkft} \end{aligned} \tag{23}$$

As we describe in the following section, our data comprises of highly disaggregated industry-level prices. Thus, we consider the industry average of (23):

$$d\ln\bar{p}_{ijkt} \approx d\ln\bar{c}_{ijkt} + \gamma d\bar{s}^{o}_{ikft} + d\bar{s}_{ijk}$$

where $\bar{p}_{ijkt} = \frac{\sum_f^{N_{ijkt}} p_{ijkft}}{N_{ijkt}}$ $\bar{s}^{o}_{ikt} = \frac{\sum_f^{N_{jkt}} s^{o}_{ikft}}{N_{ikt}}$ and $\bar{s}_{ijkt} = \frac{\sum_f^{N_{jkt}} s_{ijkft}}{N_{jkt}}$ are the average industry price, demand share in inputs' markets, and market share in the destination. Finally, $\bar{c}_{ijkt} = \frac{\sum_f^{N_{ijkt}} c_{ijft}\tau_{ijt}r_{ikt}}{N_{ijkt}}$ is the industry average marginal cost of production and delivery, which reflects firms' productivity, iceberg trade costs, and input prices.

As data on average market shares of firms across destination is hard to gather, we consider alternative measures of market concentration to proxy for the average market share in inputs' and final goods' markets. In particular, we proxy the average demand share in inputs' market $\bar{s}^{o}_{ikt}$ with the corresponding origin and industry specific Herfindahl Index HI^{o}_{ik}. Moreover, we proxy the average market share $\bar{s}_{ijkt}$ with the corresponding country pair and industry specific Herfindahl Index HI^{d}_{ijk}. Although using Herfindahl Indexes (HI) to proxy for average market share may reduce the precision of our estimates, we should note that the average market share equals the HI in case of symmetric firms.[5]

Finally, we assume that the average marginal 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

[5] 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 in the asymmetric case for a given distribution of firms' sizes, higher Herfindahl indexes will be associated with higher firms' average market share.

power on prices is the following:

$$\ln \bar{p}_{ijkt} = \gamma HI^o_{ikt} + \beta HI^d_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \qquad (24)$$

where the three components of the average marginal cost of production and delivery are estimated via fixed effects, and ϵ_{ijkt} is the error term. We refer to HI^o_{ikt} as the origin HI, which proxies oligopsony power, and to HI^d_{ijkt} as the destination HI, which proxies oligopoly power.

A possible concern that arises when using unit prices is the heterogeneity in product quality across industries and destinations. Our use of fixed effects absorbs quality related variation if those can be decomposed by exporer-, importer-, industry-, and country pair-specific components. The country-pair fixed effect addresses the "Washington apples" effect, whereby higher quality goods are shipped over longer distances. Similarly, quality differences due to destinations' level of development and tastes are captured by country-pair and industry-year fixed effects.

Our main empirical result is to document a positive relationship between oligopsony power and prices. We also confirm the results from the literature that prices increase in oligopoly power in the destination market. However, both the statistical and economic significance of our results suggest that oligopsony power has a larger quantitative effect than oligopoly power.

4.2 Data

To estimate (24), we collect data from three sources. First, we use data on unit prices from international trade data. Second, we collect data on HI for each country i and industry k. Finally, we gather data on input-output tables to conduct robustness exercises on the definition of market concentration. Let us now describe the three data sources in detail.

Unit prices

We use 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) four-digit code. The dataset covers 170 countries and is available for the years 1988-2013.

Herfindahl Indexes

As a measure of market concentration we use Herfindahl indexes (HI) computed by Feenstra and Weinstein (2017) on a country-industry level. Using our notation, these HI are denoted by HI_{ik}. Depending on the country and industry, HI_{ik} is constructed using the shares of total shipments or total sales of firms from i in industry k. Thus, HI_{ik} captures the level of market concentration that prevails across firms from the same country and industry. We use this measure of concentration as a proxy for oligopsony power. HI_{ik} exactly measure concentration in domestic input markets if all firms use the same set of domestic inputs and in the same proportions.

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.

Feenstra and Weinstein (2017) 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. Details are available in the appendix of Feenstra and Weinstein (2017).

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.

Due to data availability, merging the dataset on unit prices with the dataset on HIs, limits us to consider 117 countries for the years 1992 and 2005. The number of HS four-digit industries is 1198.

Input-Output Tables

In order to construct alternative measures of market concentration in inputs' market, we additionally use the Eora Multi-Region Input-Output database. This database provides information on input-output linkages between 26 sectors across 181 countries. Since measures of concentration we have are available for traded goods only, so we consider 11 tradable sectors in Eora 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.

In order to merge Input-Output tables with the other two datasets, we first use the concordance between HS four-digit codes and SITC rev. 3 two-digit codes.[6] Then, we use the crosswalk between SITC and Eora classification from Feenstra and Sasahara (2017).

4.2.1 Summary Statistics

Figure 4 shows the distribution of HIs in the US in 1992 and 2005 across industries. There is significant market concentration, which, according to our model, will be reflected in domestic input markets. To understand the magnitude of HIs, suppose all firms within an industry are identical. An HI of 0.2 corresponds to an average market share of 20%. Such a result is consistent with the findings of Azar et al. (2017) in the US labor market, and Morlacco (2017) in French imported inputs markets.

The distribution additionally highlights significant heterogeneity across industries, with the larger mass of industries around values below 0.2. A smaller number of industries register larger levels of market concentration, with HIs larger that 0.5.

Figure 4: Distribution of US HIs across industries

1992 2005

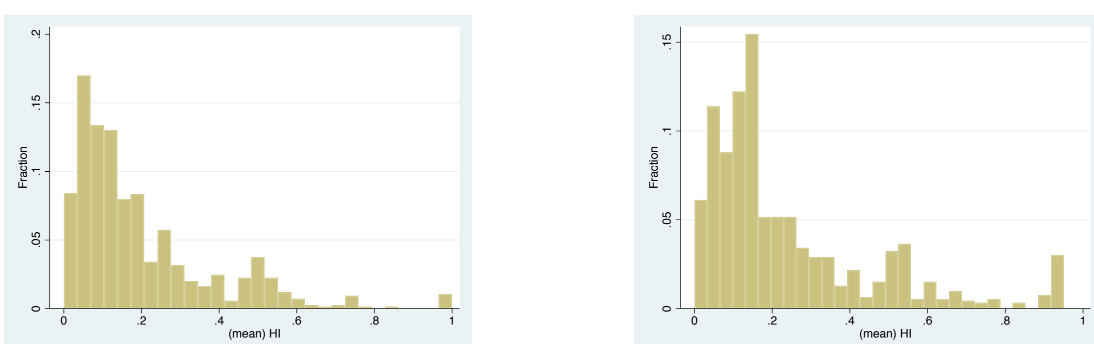


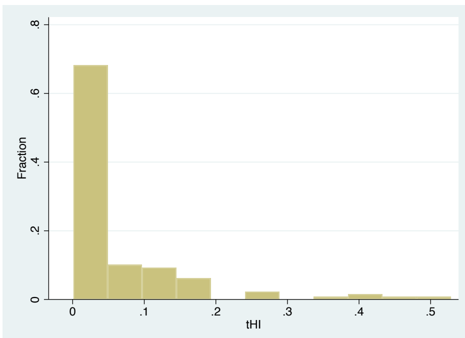
Figure 5 shows the distribution of weighted average HIs across all the countries in the

[6]https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp

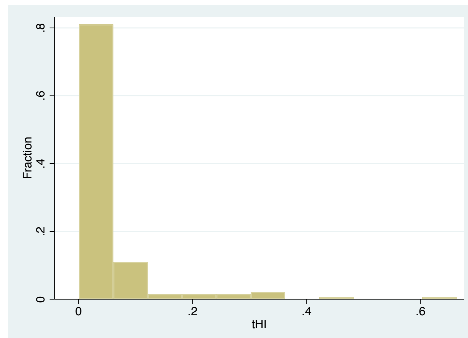
sample, where weights are squared import share of each industry in total imports for each country. As a consequence of the aggregation, the levels of concentration decline. However, the figure highlights significant cross-country heterogeneity, with average HIs ranging from 0 to 0.5.

Figure 5: Distribution of weighted average HIs across countries

1992



2005



The weigthed average HIs exactly equals the economy-wide concentration in case there are no firms producing in multiple HS four-digit industries. Since the literature has extensively documented the relevance of multiproduct firms (Bernard et al., 2011), the weighted average of industry HIs underestimates aggregate concentration. To limit the bias, we consider the distribution of the median industry HI across countries in Figure 6.

The figure shows a staggering level of concentration. The distribution shows that in more than 50% of countries the median industry for HI has a level of market concentration equivalent to that of a duopoly with two identical firms (0.5). Such a level of concentration among domestic firms, according to our model, has large effects on prices. In the next section, we test such a prediction.

Figure 6: Distribution of median world HIs

Figure 7: 1992

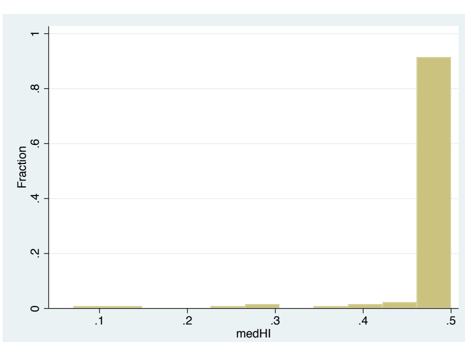
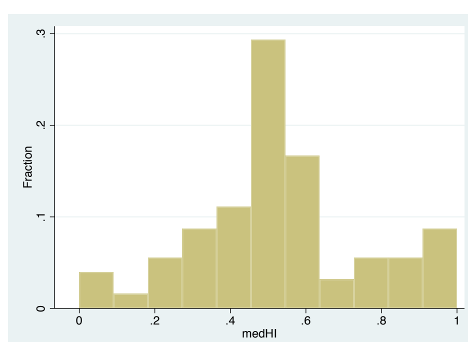


Figure 8: 2005



4.3 Results

Using the data described, we estimate (24) by OLS. We consider several specifications and table 1 presents the results.

Our baseline specification considers the relationship between our measures of market concentration and the unit prices for all country pairs in our sample. In the baseline specification, we let the measure of oligopsony power, or origin HI, $HI^o_{ikt} = HI_{ikt}$. Moreover, we assume that the measure of oligopoly power in the destination, or destination HI, is $HI^d_{ijkt} = HI_{jkt}$, and, thus, is only a function of the destination characteristics.

The first column of table 1 shows that both measures of market concentration, which proxy for market power, have positive and statistically significant coefficients. An increase in the origin HI by one standard deviation is associated with an increase in average industry prices by 3.7%. On the other hand, an increase in destination HI by one standard deviation generates an increase in industry price of 0.8%. The results are, thus, consistent with the prediction of our models. In the following paragraphs, we conduct further robustness exercises, considering alternative model specification and measures for our variables.

Alternative Destination Concentration Measure

In our baseline specification, the origin and destination HI are symmetric. Namely, the HI of the US proxies the market concentration in US input's market and the concentration of all exporters in the US final goods market. A possible concern is that the destination HI not only captures market concentration, but also the market power of firms in the destination country, 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, keeping the baseline definition for origin HI.

We follow Feenstra and Romalis (2014) and consider $HI^d_{ijkt} = HI_{ikt}\lambda_{ijk}$, where λ_{ijk} is the trade share of country i over total imports to j in industry k. To exactly measure trade shares we need domestic absorption as denominator. Due to lack of data, we consider as denominator the total values of imports to j. Country-pair-year fixed effects capture the heterogeneity across countries of ratio of total imports to domestic absorption, and hence allow to address this measurement error.

Results are in column 2 of table 1. The coefficient on the origin HI, which proxies oligopsony power, is barely affected. The coefficient on the destination HI, which proxies oligopoly power, is larger than baseline but insignificant.

Table 1: The Effects of Oligopsony and Oligopoly Power on Prices

	Baseline	Adj Dest HI	US Origin	Adj Origin HI	Adj Origin/Dest HI
Origin HI	0.150***	0.148***	0.524***	0.558***	0.558***
	(0.006)	(0.006)	(0.096)	(0.084)	(0.085)
Destination HI	0.030***	0.275	-0.008	0.027***	0.181
	(0.006)	(0.906)	(0.022)	(0.006)	(0.770)
Industry-Year	Y	Y	N	Y	Y
Country-Pair-Year	Y	Y	N	Y	Y
Destination	N	N	Y	N	N
Industry	N	N	Y	N	N
Year	N	N	Y	N	N
R^2	0.69	0.69	0.88	0.69	0.69
# Observations	883280	883280	36859	858898	858898

Robust standard errors are in the parentheses. Baseline: HIs from Feenstra and Weinstein (2017) for origin and destination countries as dependent variables. Adj Dest HI: alternative measure of concentration in the destination market. US Origin: only data on US export unit values. Adj Origin HI: alternative measure of concentration in the origin market. Adj Origin/Dest HI: alternative measures of concentration in origin and destination market. Details in the main text.

United States as the only origin

US data on market concentration comes straight from the Census of Manufacturers, and is more reliable than HIs in other countries constructed from US import data. In order to check if our results hold on a smaller subsample of more reliable data, we consider only unit prices from the US to the destination countries. As there is only one exporting country, we cannot use country-pair-year fixed effects, so for this robustness check we include destination, industry and year fixed effects. We use the baseline definitions for origin and destination HI.

The result are in column 3 of table 1. The coefficient on origin HI is positive and significant, and is larger than in other specifications. An increase by one standard deviation in the origin HI increases prices by 10%. Due to significantly lower number of observations, and destination fixed effects, the coefficient at destination HI is not significant.

Constructing Alternative Origin Concentration Measure

In the baseline specification, we assumed that each industry uses its own specific factor. In this section, we relax this assumption and assume that firms from different industries can use the same factors of production. As a result, one firm's oligopsony power depends on its input requirements and on the relative size of the firm's industry demand in the input industries. We employ detailed input-output data to construct measures of concentration in line with this logic.

As input-output data is on the higher level of aggregation than trade data, we start with constructing aggregate HIs. We construct the HI for each of the $k = 1, ..., 11$ Eora manufacturing industries in every country i, HI_{ik}^{Eora}, as the weighted sum of HIs of corresponding HS four-digit industries HI_{iv}^{HS4}, where industry v belongs to the Eora industry k. The weigths are the squared shares of each HS four-digit industry's output in the output of Eora industry s_{iv}. In particular, we compute HI_{ik}^{Eora} as

$$HI_{ik}^{Eora} = \sum_{v \in k} HI_{iv}^{HS4} s_{iv}^2$$

where we dropped the time subscript for the sake of exposition. For each industry k in country i, we compute their demand share on each factor's market m as:

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

where IO_{imk} is an input share from industry m to industry k, and x_{im} is a total output of industry m in country i.[7]

Multiplying industry k HI (HI_{ik}^{Eora}) by the demand share of industry k for inputs from industry m (IO_{imk}) yields a proxy for the oligopsony power of firms from industry k in the input market m. To obtain an aggregate measure of market concentration over the inputs purchased by firms in industry k, we take the weigthed sum of $HI_{ik}^{Eora} share_{imk}$, where the weights are each industry are the squared demand shares of industry k in each market m ($share_{imk}$). As a result, we obtain the following adjusted measure of HI for the inputs used by industry k:

$$HI_{ik}^{adj} = \sum_{m} HI_{ik}^{Eora} IO_{imk} share_{imk}^2$$

HI_{ik}^{adj} has two attractive properties: first, it reflects the fact that smaller industries using common factor are going to have lower oligopsony power. Second, industries that are using specific factors intensively are going to have higher oligopsony power.[8] In column 4 of table 1, we consider $HI_{ikt}^{o} = HI_{ikt}^{adj}$ and use the baseline measure for HI_{ijkt}^{d}. Results are qualitatively similar to the baseline specification, suggesting that our results in the previous section are not driven by the assumptions on the structure of inputs market. In this case, a one standard deviation increase in origin HI is associated with a 0.95% increase in prices, in destination HI with a 0.5% increase in prices.

Finally, adopting the adjusted measures of origin HI and destination HI in the same

[7] We find total output from volume of imports $imports_{ik}$ and domestic share λ_{iik}: $x_{ik} = import_{iik} \frac{1-\lambda_{iik}}{\lambda_{iik}}$.

[8] The theoretical assumptions behind the adjusted measure of origin HI are outlined in the appendix.

specification yields similar results to our baseline case. The result of this specification are in column 5 of table 1.

5 Conclusions

The literature in international trade 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 have argued that firms' market power in the market for inputs, in which firms exploit their oligopsony power, has major implications for prices and welfare.

Using data on market concentration from Feenstra and Weinstein (2017), we documented that concentration in the market for inputs is associated with higher prices and lower export volumes. Moreover, concentration in the input market, which is a proxy for oligopsony power, has economically larger effects than concentration in the final goods markets.

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.

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.

References

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

C. Arkolakis, A. Costinot, D. Donaldson, and A. Rodrguez-Clare. The Elusive Pro-Competitive Effects of Trade. *NBER Working Paper*, (21370), 2015.

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

J. Azar, I. Marinescu, and M. I. Steinbaum. Labor market concentration. *NBER Working Papers*, (24147), Dec. 2017.

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

A. B. Bernard, S. J. Redding, and P. K. Schott. Multiproduct Firms and Trade Liberalization. *The Quarterly Journal of Economics*, 126(3):1271–1318, 2011.

A. B. Bernard, J. B. Jensen, S. J. Redding, and P. K. Schott. Global firms. *NBER Working Paper Series*, (22727), October 2016.

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

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

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

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

C. Eckel and S. R. Yeaple. Too much of a good thing? exporters, multiproduct firms and labor market imperfections. *NBER Working Papers*, (23834), 2017.

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

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

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

R. C. Feenstra and J. Romalis. International Prices and Endogenous Quality. *The Quarterly Journal of Economics*, 129(2):477–527, 2014.

R. C. Feenstra and A. Sasahara. The China Shock, Exports and US Employment: A Global Input-Output Analysis. Technical report, National Bureau of Economic Research, 2017.

R. C. Feenstra and D. E. Weinstein. Globalization, markups, and us welfare. *Journal of Political Economy*, 125(4):1040–1074, 2017.

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

C. Hottman, S. J. Redding, and D. E. Weinstein. Quantifying the sources of firm heterogeneity. *The Quarterly Journal of Economics*, 2016.

A. K. Kikkawa, E. Dhyne, and G. Magerman. Imperfect competition in firm-to-firm trade. *Mimeo*, 2018.

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

L. Macedoni. Large multiproduct exporters across rich and poor countries: Theory and evidence. *Mimeo*, 2017.

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

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

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

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

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

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

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

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 factor can be microfounded by adding labor-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 RM 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, that allows us to endogenize the upward sloping nature of the 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 (18) in the symmetric country case yields:

$$r = \left[\tilde{\gamma}^{\frac{1}{\gamma}} \frac{\sigma - 1}{\sigma} \frac{IL(1-s)s}{s^o(1+\gamma s^o)} \right]^{\frac{\gamma}{1+\gamma}} \tag{25}$$

All else constant, increases in the market power of firms — either in the final goods or input markets — reduces the demand for the input, and hence its compensation. On the other hand, the larger the number of countries with integrated input markets, the larger the compensation of the input. 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 compensation for the input as:

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

The compensation for the input negatively depends on the demand share of firms for such an input. International economic integration increases the reward for the input: despite the increase in market concentration, increasing I leads to higher r:

$$\frac{d\ln r}{d\ln I} = \frac{\gamma}{1+\gamma} \frac{F}{Ls^o - F} \frac{d\ln s^o}{d\ln I} \tag{26}$$

To understand how the oligopsony power of firms influences factor's compensation, let us and consider the elasticity of the oligopsonist demand share relative to the number of countries:

$$\frac{d\ln s^o}{d\ln I} = \frac{(\sigma-1)s}{\sigma(1+\gamma s^o) - \frac{(\sigma-1)(1-2s-\gamma s s^o)}{1+\gamma s^o}} \tag{27}$$

The elasticity of the oligopsony power with respect to the number of countries with integrated final goods' markets is declining in s^o. 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 compensation following international economic integration. When firms have only oligopoly power, economic integration leads to higher production, which increases the input demand and, thus, reward. In the presence of oligopsony power, the rise in input market concentration dampens the gains for the input, without completely offsetting them.

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:

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

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 now consider the effects of international economic integration in final goods markets on the welfare of consumers, by examining the CES quantity index Q:

$$Q = c^{-1}\left[\frac{\sigma-1}{\sigma\tilde{\gamma}}\right]^{\frac{1}{1+\gamma}} \frac{s^{-\frac{1}{\sigma-1}}(1-s)^{\frac{1}{1+\gamma}}}{(1+\gamma s^o)^{\frac{1}{1+\gamma}}} \tag{28}$$

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:

$$d\ln Q = \left[\frac{1}{\sigma-1} + \frac{s}{(1-s)(1+\gamma)}\right](-d\ln s) + \left[\frac{\gamma s^o}{(1+\gamma s^o)(1+\gamma)}\right](-d\ln s^o) \tag{29}$$

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 (28) using the the zero profit condition $\frac{1-s}{1+\gamma s^o} = \frac{\sigma}{\sigma-1}\left[1-\frac{F}{Ls^o}\right]$.

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

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 oligopolist market share, the domestic market share in final goods market equals

$$s = \frac{x_{jj}^{\frac{\sigma-1}{\sigma}}}{\sum_i N_i x_{ij}^{\frac{\sigma-1}{\sigma}}} = \frac{x^{\frac{\sigma-1}{\sigma}}}{N x^{\frac{\sigma-1}{\sigma}} + (I-1) N x^{*\,\frac{\sigma-1}{\sigma}}} = s^o \frac{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}}}{\left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}} + (I-1)} \tag{30}$$

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

$$\frac{s}{s^*} = \left(\frac{x}{x^*}\right)^{\frac{\sigma-1}{\sigma}} \tag{31}$$

Using the pricing rule (12), 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 (4), the relative quantity of domestic goods to foreign goods equals

$$\frac{x}{x^*} = \left(\frac{p}{p^*}\right)^{-\sigma} = \left(\frac{1}{\tau}\frac{1-s^*}{1-s}\right)^{-\sigma} \tag{32}$$

From the market clearing condition,

$$\begin{aligned} Ns + (I-1)Ns^* &= 1 \\ s + (I-1)s^* &= s^o \\ s^* &= \frac{s^o - s}{I-1} \end{aligned} \tag{33}$$

Using (33) into (32) yields

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

Plugging (34) and (33) into (31) 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 16 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 (33), 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's show that $\frac{ds}{ds^o} < 0$:

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

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

$$\frac{dG\left(s, s_0\right)}{ds_0} = 1 - \frac{\sigma-1}{\sigma}\frac{1}{\left(1+\gamma s_0\right)^2}\left[1 + \frac{2}{I-1}s + \gamma\frac{I}{I-1}s^2 - \frac{2}{I-1}s_0 - \gamma\frac{1}{I-1}\left(s^o\right)^2\right]$$

as $s \leq s_0$

$$\frac{dG\left(s, s_0\right)}{ds_0} \geq 1 - \frac{\sigma-1}{\sigma}\frac{1}{I-1}\frac{1+\gamma\left(s^o\right)^2}{\left(1+\gamma s^o\right)^2} > 0$$

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

Then from implicit function theorem:

$$\frac{ds_{11}}{ds_0} = -\frac{dG/ds_0}{dG/ds_{11}} < 0$$

Let us now consider the effects of a reduction in τ on input prices. Plugging (**??**) and (16) into (18) we obtain:

$$r = \tilde{\gamma}^{\frac{1}{1+\gamma}}\left(L - \frac{F}{s^0}\right)^{\frac{\gamma}{1+\gamma}} \tag{35}$$

Hence, $\frac{dr}{ds^o} > 0$ and consequently $\frac{dr}{d\tau} < 0$, - higher trade costs lead to lower reward for the factor.

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 olygopsonistic 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. 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:

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) \tag{36}$$

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

$$r_k = \gamma_k Y_k^{\gamma} = \gamma_k \left[\sum_v t_{kv} y_{kv} \right]^{\gamma} \tag{37}$$

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:

$$\Pi_f = \sum_j \frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} - \sum_k r_k t_{kv} y_{kv} \tag{38}$$

$$\Pi_f = \sum_j \frac{p_{fj}(f(\mathbf{y_{kfj}}))f(\mathbf{y_{kfj}})}{\tau_{fj}} - \sum_k \gamma_k \left[\sum_v t_{kv} \sum_d y_{kvd} \right]^{\gamma} t_{kf} \sum_f (y_{kfj}) \tag{39}$$

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

$$\frac{\sigma - 1}{\sigma \tau_{fj}} p_{fj}(1 - s_{fj}) \frac{\partial f_{fj}}{\partial y_{kfj}} = r_k t_{kf}(1 + \gamma s^o_{kf}) \tag{40}$$

where

$$s^o_{kf} = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{41}$$

Multiplying both sides of 40 by y_{kfj}, summing over inputs k, and using Euler's theorem for homogeneous of degree one functions we find:

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

Firm's revenues in destination j are given by

$$\frac{p_{fj}(x_{fj})x_{fj}}{\tau_{fj}} = \frac{\sigma}{(\sigma - 1)(1 - s_{fj})} \sum_k r_k t_{kf} y_{kfj} (1 + \gamma s^o_{kf}) \tag{42}$$

[9] 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.

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:

$$\alpha_k() = \frac{r_k t_{kf} y_{kfj}}{\sum_u r_u t_{uf} y_{ufj}} \tag{43}$$

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 can simplify our cost to export to produce for 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:

$$p_{fj} = \frac{\sigma \tau_{fj}}{(\sigma-1)(1-s_{fj})} \frac{\sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \sum_k \alpha_k (1+\gamma s^o_{kf}) \tag{44}$$

The average variable cost of selling to destination j is

$$AVC_{fj} = \frac{\tau_{fj} \sum_u r_u t_{uf} y_{ufj}}{x_{fj}} \tag{45}$$

Thus, prices are given by

$$p_{fj} = AVC_{fj} \frac{\sigma}{\sigma-1} \frac{\sum_k \alpha_k (1+\gamma s^o_{kf})}{1-s_{fj}} \tag{46}$$

Cobb Douglas

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

$$x_{fj} = f(\mathbf{y_{kfj}}) = f(y_{1fj}, ..., y_{Kfj}) = \prod y_k^{\alpha_k} \qquad \sum_k \alpha_k = 1 \tag{47}$$

Such an assumption implies that input cost shares (43) 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, so as to drop firm and destination subscripts. Let us take the ratio between the FOC (40) of input k and input v (for the same firm and destination). Assuming that the production function is Cobb-Douglas, we obtain

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

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

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

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

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

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

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

Finally, our pricing equation simplifies to

$$p_{fj} = \frac{\tau_{fj}}{\prod \left(\frac{\alpha_k}{r_k t_{kf}} \right)^{\alpha_k}} \frac{\sigma}{\sigma - 1} \frac{\sum_k \alpha_k (1 + \gamma s_{kf}^o)}{1 - s_{fj}} \tag{48}$$

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. This extension informs us on the way to measure oligopsony power in the context of input-output linkages, as we do in the empirical analysis.

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 oligopsonist demand share.

$$s^o_{kf} = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{49}$$

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 simplify a bit 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 oligopsonist demand share is

$$s^o_f = \frac{t_f y_f}{\sum_h Y_h} = \underbrace{\frac{Y_h}{\sum_h Y_h}}_{\text{Industry Share}} \underbrace{\frac{t_f y_f}{Y_h}}_{\text{Within-Industry} s^o} \tag{50}$$

6.2 Empirics

Table 2: Effect of one Standard Deviation Change in HIs on Prices

	Baseline	Adj Dest HHI	US Exporting	Adj Origin HHI
Origin HI	3.68%***	3.63%***	9.75%***	0.95%***
	(0.245)	(0.245)	(0.186)	(0.017)
Destination HI	0.756%***	0.044%	-0.19%	0.54%***
	(0.252)	(0.0016)	(0.238)	(0.245)