Oligopoly and Oligopsony in International Trade*

Luca Macedoni[†] Aarhus University

Vladimir Tyazhelnikov[‡] The University of Sydney

June 2019

Abstract

We study the effects of international trade on firms' oligopsony power in inputs markets. Combining international trade data with measures of market concentration, we find that higher oligopsony power is associated with higher unit prices of export goods, and this effect is much larger than the effect of oligopoly power in final goods 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. 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 competition between oligopolists in final goods markets causes oligopsony power to increase.

JEL Classification: F12, F13.

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

*We thank Robert Feenstra and John Romalis for early suggestion, support, and for providing the data. We also thank seminar participants at Aarhus University, ETSG, University of New South Wales, and Australasian Trade Workshop 2019.

[†]lmacedoni@econ.au.dk

[‡]vladimir.tyazhelnikov@sydney.edu.au

1 Introduction

The documented high concentration in exports and imports (Freund and Pierola, 2015; Bernard et al., 2016) 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). While recent empirical research has highlighted that a level of market concentration in factors and inputs markets is comparable to the concentration in final goods markets,[1] 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. 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. First, we document a large positive relationship between oligopsony power and prices of export goods. Second, we introduce a tractable model that provides insights on the effects of international economic integration on concentration in input markets and oligopsony power.

We use a rich dataset on unit prices from WITS and on market concentration from Feenstra and Weinstein (2017) for a wide set of countries and industries in 1992 and 2005 to show that higher oligopsony power is associated with higher prices of exported goods and find that this effect is economically larger than the effect of oligopoly power. In patricular, a one standard deviation increase in input market concentration is associated with 1% to 10% higher markups, while an increase in one standard deviation in final goods market concentration corresponds to markups that are higher by 0 to 1%. These results are robust to a number of alternative specifications and definitions of market concentration; moreover, we use an alternative dataset and document the predominant effect of oligopsony power on prices for 1980-2013.

The model we develop in this paper 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

[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. Hershbein and Macaluso (2018) document that there are three or less employers advertising vacancies in 30% of the metropolitan areas in the US. For a survey of the evidence of 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).

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. Only economic integration in both markets reduces firms' market power in each market. These results suggest a dual approach for policy makers: 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 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 demand relative to the aggregate demand for the oligopsonistic input: the larger a firm's demand share, the larger its oligopsony power.

The model features few large, homogeneous firms[3] that purchase an input in an oligopsonistic market. Our interpretation of the input is general as it could represent some form specialized labor, capital, raw materials, or some intermediate input. Firms exploit their oligopsony power in the market for the input by restricting their demand to pay a lower price in line with the evidence of Azar et al. (2017). 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 that are increasing both in the oligopsony power and in the oligopoly power.

Consider the case in which the input is domestically sourced (for example, it can be thought of as 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. Such a pro-competitive effect persist in our model. However, the reduction in oligopoly power reduces profits and forces some firms to exit. This decrease in the number of firms increases market concentration

[3]The assumption of homogeneous firms allows us to represent our results in the simplest possible setting. In the presence of firm heterogeneity in productivity, our results would still hold, as trade in final goods increases domestic concentration by forcing the exit of the least efficient firms (Melitz, 2003). For instance, see Heiland and Kohler (2018).

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 reward. Although international economic integration brings about an increase in welfare, 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. In this case 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, reducing firms' oligopsony power. However, lower oligopsony power causes a reduction in firms' profits, which fosters the exit of some firms and consequently leads to an increase in the oligopoly power of firms.

Our paper relates to the ongoing debate on 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 and Eeckhout, 2017). Large US firms grew larger but, as shown by Rossi-Hansberg et al. (2018), 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.

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. Our model of oligopolists and oligopsonists producing differentiated goods confirms some of the authors' predictions: oligopsony generates distortions in the market allocation, which are exacerbated by trade in final goods.

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.[4] 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 provides our empirical results on the effects of oligopsony power on prices. Section 3 builds a model of firms that are both oligopolists and oligopsonists. Section 4 presents the effects of international trade on firm's market power. Section 5 concludes.

2 Empirical Evidence

This section provides evidence on the effects of oligopsony power on prices. Our main empirical result is a strong and 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 (Atkeson and Burstein, 2008; Edmond et al., 2015; Hottman et al., 2016). However, both the statistical and economic significance of our results suggest that oligopsony power has a much larger quantitative effect than oligopoly power.

2.1 Empirical Strategy

Let us consider the log price $\ln p_{ijkft}$ of a firm f from country i exporting to country j, in industry k, in year t. We assume that the firm charges a markup over the marginal cost of production and delivery $\tilde{c}_{ijft}$. Following Atkeson and Burstein (2008), we assume that the markup depends on the market share of the firm in the destination s_{ijkft}, defined as the firm-industry-destination revenues over total industry-destination revenues. Furthermore, to account for oligopsony power (Morlacco, 2017), we assume that the markup also depends on the demand share of the firm in the domestic input market s^o_{ikft}. Such a demand share is defined as the ratio of the firm-industry-origin demand for inputs, over the total industry-origin demand for inputs. Thus, we only consider the effects of oligopsony power on domestic input markets.

[4] 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.

Consider the following approximation of log prices:

$$\ln p_{ijkft} = \ln(\tilde{c}_{ijft}) + \gamma s^o_{ikft} + \beta s_{ijkft} \tag{1}$$

where γ and β are two parameters capturing the relationship between prices and market power. As we describe in the following section, our data comprises of highly disaggregated industry-level prices. Thus, we consider the industry average of (1):

$$\ln \bar{p}_{ijkt} = \ln \bar{c}_{ijkt} + \gamma \bar{s}^o_{ikft} + \bar{s}_{ijk}$$

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. 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 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_{ikt}. Moreover, we proxy the average market share $\bar{s}_{ijkt}$ with the corresponding country pair and industry specific Herfindahl Index HI^d_{ijkt}. 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 power on prices is the following:

$$\ln \bar{p}_{ijkt} = \gamma HI^o_{ikt} + \beta HI^d_{ijkt} + \xi_{kt} + \theta_{ijt} + \epsilon_{ijkt} \tag{2}$$

where the two 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,

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

which proxies oligopsony power, and to HI^d_{ijkt} as the destination HI, which proxies oligopoly power.[6]

2.2 Data

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.[7]

Our main measures of market concentration are the Herfindahl Indexes (HIs) computed by Feenstra and Weinstein (2017) on a country-industry level. Using our notation, these HIs 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. 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 resulting number of HS four-digit industries is 1198. Details are in the Appendix.

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. Thus, it allows us to compute a more refined measure of oligopsony power that takes into account the input-output linkages across industries. Since the measures of concentration we have are available for traded goods only, 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.

[6] 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 exporter-, 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. Additionally, we use industry-level measures of wages and productivity in case our set of fixed effects do not capture all meaningful variation in the exporting country.

[7] 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.

Measures of Market Concentration

We consider two measures of oligopsony power of firms (or origin HI HI^o_{ikt}) in industry k and origin i. Our baseline measure directly uses the HI provided by Feenstra and Weinstein (2017). Namely, we let $HI^o_{ikt} = HI_{ikt}$. Such a measure exactly captures the concentration 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. 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. To account for such a possibility we construct an adjusted measure of origin HI, denoted by $HI^{o\,adj}_{ik}$. Using the Eora database, we compute for each industry its level of oligopsony power in upstream sectors. Then, we compute $HI^{o\,adj}_{ik}$ by taking a weigthed average of oligopsony power in upstream sectors, where the weigths are the input shares.[8] $HI^{o\,adj}_{ik}$ has two attractive properties. First, it reflects the fact that industries using an input common to other industries have a lower oligopsony power relative to our baseline measure. Second, the oligopsony power of an industry depends on which inputs are used intensively.

Similarly, we consider two measures of oligopoly power or destination HI in in industry k and country of destination j. Our baseline measure is taken directly from Feenstra and Weinstein (2017). Namely, we let $HI^d_{ijkt} = HI_{jkt}$. Such a measure implicitly assumes that oligopoly power in the destination is only a function of the destination characteristics. This means that the HI 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 HI 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, keeping the baseline definition for origin HI. We follow Feenstra and Romalis (2014) and consider and adjusted destination HI $HI^{d\,adj}_{ijkt} = HI_{ikt}\lambda_{ijk}$, where λ_{ijk} is the trade share of country i over total imports to j in industry k. The concentration faced by firms exporting to j is the product of the origin-industry concentration and the origin-industry share in the destination expenditures on the industry goods.[9] This measure reflects that the market power of firms from i is larger in destinations with larger expenditure shares on goods from i.

[8]The appendix provides the detailed description on the derivations for $HI^{o\,adj}_{ik}$.

[9]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 the ratio of total imports to domestic absorption, and hence allow us to address this measurement error.

2.3 Results

Using the data described, we estimate (2) by OLS. We consider the four alternative measures of concentration in inputs and final goods markets. Table 1 presents the results. The main result is that market concentration in inputs markets increases unit prices of export goods. Furthermore, market concentration in final goods markets increases unit prices. However, the economic and statistical significance of the effects of input market concentration are larger than those of final goods markets concentration.

In the first column of Table 1, we use our baseline measures of concentration in origin and destination markets. Both measures of market concentration 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 the destination HI by one standard deviation generates an increase in industry price of 0.8%.

In column 2 of Table 1, we maintain the baseline measure of origin HI and use the adjusted destination HI $HI^{d\,adj}_{ijkt}$. The coefficient on the origin HI, which proxies oligopsony power, is barely affected. The coefficient on the adjusted destination HI, which proxies oligopoly power, is larger than the baseline result but is insignificant.

In column 3 of Table 1, we consider $HI^{o}_{ikt} = HI^{o\,adj}_{ikt}$ and use the baseline measure for HI^{d}_{ijkt}. Results are qualitatively similar to the baseline specification, suggesting that our baseline results 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, and in destination HI with a 0.5% increase in prices. Finally, adopting the adjusted measures of origin HI and destination HI in the same specification yields similar results to our baseline case. The result of this specification are in column 4 of Table 1.

2.4 Robustness

In this section, we describe the results of our robustness analysis. First, we consider unit prices for trade flows from the US only to all the destination countries available in the sample. Such a choice is motivated by the fact that 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. As there is only one exporting country, we cannot use country-pair-year fixed effects and just include destination, industry, and year fixed effects. We use the baseline definitions for origin and destination HI. The result are Table XXX in the appendix. The coefficient at 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

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

	Baseline	Adj Dest HI	Adj Or HI	Adj Or/Dest HI
Origin HI	0.150***	0.148***	0.558***	0.558***
	(0.006)	(0.006)	(0.084)	(0.085)
Destination HI	0.030***	0.275	0.027***	0.181
	(0.006)	(0.906)	(0.006)	(0.770)
Industry-Year	Y	Y	Y	Y
Country-Pair-Year	Y	Y	Y	Y
R^2	0.69	0.69	0.69	0.69
# Observations	883280	883280	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: adjusted measure of concentration in the destination market. Adj Or HI: adjusted measure of concentration in the origin market. Adj Or/Dest HI: adjusted measures of concentration in origin and destination market. Details in the main text.

coefficient at destination HI is not significant.

Our second robustness check uses the information provided by the UNIDO industrial database. UNIDO industrial statistics database provides information on the number of establishments, number of workers, total wage payments, and value added at 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.[10] 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. We construct concentration measure HI_{ik} as the inverse of the number of establishments in each country-industry-year. We compute the average wage in each of ISIC industry in each country as total wage payments divided by the number of employees in the corresponding industry. Similarly, we compute labor productivity as value added in a given industry divided by the number of firms in this industry.

We use the years 1992 and 2005 as in our baseline specification. The UNIDO data allow us to verify that our results do not depend on the measures of concentration used, and on our assumption that marginal costs of production can be decomposed to country, industry and country-pair specific components. In particular, we consider the following specification:

$$\ln \bar{p}_{ijkt} = \gamma HI^o_{ikt} + \beta HI^d_{jkt} + \xi_{kt} + \theta_{ijt} + w_{ikt} + \phi_{ikt} + \epsilon_{ijkt} \tag{3}$$

where, in addition to the variables used in (2), we add as controls the average wage w_{ikt} and

[10] Relative to the database on Herfindahl Indexes by Feenstra and Romalis (2014), the industry coverage is significantly smaller. Details are in the Appendix.

average labor productivity ϕ_{ikt} in country i, industry k, and year t.

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

		4 digit		2 digit	
	Baseline	UNIDO	FW	UNIDO	FW
Origin HI	0.150***	0.078***	0.097***	0.153***	0.095***
	(0.006)	(0.010)	(0.008)	(0.008)	(0.008)
Destination HI	0.030***	-0.001	0.031***	-0.012*	0.031***
	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)
Controls	N	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y	Y
Countrypair-year FE	Y	Y	Y	Y	Y
R^2	0.69	0.76	0.74	0.72	0.71
# Observations	883280	321021	455368	495846	454163

Robust standard errors are in the parentheses. Baseline results from Table 1 are provided for reference. In all other regressions, the controls are measures of productivity and wages. FW: uses Feenstra and Weinstein (2017) as source of HIs for origin and destination countries as dependent variables. UNIDO: alternative measures of concentration on both origin and destination markets from UNIDO database on four- and two-digit levels. Details in the main text.

In the first column of Table 2, we report our baseline results from Table 1, while in column 2 we use the measures of concentration from UNIDO computed at the four-digit level. In column 4, we add as control the average industry wage and industry labor productivity both computed at the four-digit level. The last two columns show the results with the UNIDO industry data at the two-digit level. Our main results hold in these alternative specifications. The coefficient on the origin HI is positive and significant while the coefficient on the destination HI is smaller and is insignificant. 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 marginal costs of production.[11]

In addition, the UNIDO data have the advantage of a better coverage in terms of years, as it spans from 1981 to 2013 at the two-digit industry level, so we estimate (2) for each year. The estimated coefficients on oligopoly and oligopsony power, with their 90% confidence interval, are shown in figure 7 in the appendix. Using the extended time period provided by UNIDO further supports our results. The effect of oligopoly power on prices is close to zero and fairly constant. On the other hand, the effect of oligopsony power is positive and significant. Moreover, the latter coefficient appears to have been declining over time.

[11]The results do not depend on the controls used. See Table 4 in the Appendix.

3 Model

The evidence showed that higher market concentration in the origin-industry and in the destination-industry are both associated with higher prices. In this section, we build a model of firms that are large both in the market of inputs and in the market for final goods. The model generates a pricing rule that is consistent with the evidence. Furthermore, we investigate the effects of international economic integration on the two sources of market power.

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.

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.[12] 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 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 $\tau_{ii} = 1$.

3.1 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:

$$U_j = \int_0^1 \ln u_j(z) dz \tag{4}$$

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 $\sigma > 1$:

$$u_j(z) = \left[\sum_{i=1}^{I} \sum_{f=1}^{N_i} q_{fij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{5}$$

[12]Hence, our model only features the top firms in each industries, which are the firms, according to Rossi-Hansberg et al. (2018), that are responsible of the increase in market concentration at the US national level. The model could be extended by introducing a perfectly or monopolistically competitive frindge following Parenti (2018). The results would be qualitatively similar.

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 (4) by choosing q_{fij}, subject to the following budget constraint:

$$\int_0^1 \sum_{i=1}^{I} \sum_{f=1}^{N_i} p_{fij} q_{fij} dz \leq y_j \tag{6}$$

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

$$\lambda_j p_{fij} = \frac{q_{fij}^{-\frac{1}{\sigma}}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i} q_{fij}^{\frac{\sigma-1}{\sigma}}}$$

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:

$$p_{fij} = \frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{7}$$

3.2 Supply of the Oligopsonistic Input

To model oligopsony, we assume that the supply curve for the 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 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:

$$r_j = \tilde{\gamma}_j K_j^{\gamma} \tag{8}$$

where $\tilde{\gamma}_j$ is a country specific supply shifter. In Appendix 6.2.1, we outline an extension to the baseline model in which workers experience disutility from supplying the input.[13] 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) assumes that the factors of production are inelastically supplied. If the factor is inelastically supplied, which is equivalent to setting $\gamma \to \infty$, firms would be able to reduce the input's price to zero.

[13] We ignore inputs of different productivity, such as workers of different skills, although Hershbein and Macaluso (2018) find evidence of a positive relationship between demand for skills and oligopsony power.

Without loss of generality, let us assume that the input is supplied to domestic firms only.[14] 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 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 input is $\sum_{f=1}^{N_i} k_{fi} = \sum_{f=1}^{N_i} \sum_{j=1}^{I} k_{fij}$.

3.3 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 (8), 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:

$$r_i = \tilde{\gamma}_i K_i^{\gamma} = \tilde{\gamma}_i \left[\sum_{j=1}^{I} \sum_{f=1}^{N_i} \tau_{ij} c_{fi} x_{fij} \right]^{\gamma} \tag{9}$$

Firms maximize their profits by choosing x_{fij} for each destination they serve, taking other firms' choices as given. Given the inverse demand function (7) and the inverse supply function of the input (9), the profits of firm f equal:

$$\begin{aligned} \pi_{fi} &= \sum_{j=1}^{I} p_{fij} x_{fij} - r_i \sum_{j=1}^{I} \tau_{ij} c_{fij} x_{fij} - F = \\ &= \sum_{j=1}^{I} \frac{L_j x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I} \sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} - \tilde{\gamma}_i \left[\sum_{j=1}^{I} \sum_{f=1}^{N_i} \tau_{ij} c_{fi} x_{fij} \right]^{\gamma} \sum_{j=1}^{I} \tau_{ij} c_{fi} x_{fij} - F = \end{aligned} \tag{10}$$

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 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

[14] If the input is internationally sourced, the aggregate demand would be given by $\sum_{i=1}^{I} \sum_{j=1}^{I} \sum_{f=1}^{N_i} k_{fij}$.

in the final good's and the factor's market:

$$\frac{\sigma-1}{\sigma}\frac{L_j x_{fij}^{-\frac{1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}}\left[1-\underbrace{\frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}}}_{\text{Oligopoly Power}}\right]-r_i\tau_{ij}c_{fij}\left[1+\gamma\underbrace{\frac{\sum_{j=1}^{I}\tau_{ij}c_{fij}x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i}\tau_{ij}c_{fij}x_{fij}}}_{\text{Oligopsony power}}\right]=0 \tag{11}$$

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:

$$s_{fij} = \frac{x_{fij}^{\frac{\sigma-1}{\sigma}}}{\sum_{i=1}^{I}\sum_{f=1}^{N_i} x_{fij}^{\frac{\sigma-1}{\sigma}}} \tag{12}$$

$$s^o_{fi} = \frac{k_{fi}}{\sum_{f=1}^{N_i} k_{fi}} = \frac{\sum_{j=1}^{I}\tau_{ij}c_{fij}x_{fij}}{\sum_{j=1}^{I}\sum_{f=1}^{N_i}\tau_{ij}c_{fij}x_{fij}} \tag{13}$$

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 to the firm's demand share for the input s^o_{fi}.

Using (12) and (13) into (11) yields the optimal quantity:

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

Using (14) into (7) yields the pricing rule:

$$p_{fij} = r_i\tau_{ij}c_{fij}\underbrace{\frac{\sigma}{\sigma-1}\left(\frac{1+\gamma s^o_{fi}}{1-s_{fij}}\right)}_{\text{Markup}} \tag{15}$$

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.[15] 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:

$$p_{fij}x_{fij} = \left[\frac{\sigma}{(\sigma-1)}\frac{\tau_{ij}c_{fij}r_i(1+\gamma s^o_{fi})}{1-s_{fij}}\right]^{1-\sigma}\left[\frac{L_j}{\sum_{i=1}^{I}\sum_{f=1}^{N_i}x_{fij}^{\frac{\sigma-1}{\sigma}}}\right]^{\sigma} \tag{16}$$

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 (15):

$$x_{fij} = \frac{(\sigma-1)L_j}{\sigma r_i \tau_{ij} c_{fi}}\frac{s_{fij}(1-s_{fij})}{1+\gamma s^o_{fi}} \tag{17}$$

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:

$$\begin{aligned}\pi_{fij} &= x_{fij}p_{fij} - r_i\tau_{ij}c_{fij}x_{fij} = s_{fij}L_j - r_i\tau_{ij}c_{fij}\frac{s_{fij}L_j}{p_{fij}} = \\ &= s_{fij}L_j\left[1-\frac{\sigma-1}{\sigma}\frac{1-s_{fij}}{1+\gamma s^o_{fi}}\right] \end{aligned} \tag{18}$$

Profits in a destination j are increasing both in oligopoly and oligopsony power. Summing

[15] The pricing rule used in the motivational evidence (1) can be obtained by taking the following approximation of the total derivative of log prices $d\ln p_{ijkft} \approx d\ln(\tilde{c}_{ijft}) + \gamma ds^o_{ikft} + ds_{ijkft}$.

across the destinations reached yields firm's total profits:

$$\pi_{fi} = \sum_{j=1}^{I} \pi_{fij} - F = \sum_{j=1}^{I} s_{fij} L_j \left[1 - \frac{\sigma - 1}{\sigma} \frac{1 - s_{fij}}{1 + \gamma s_{fi}^o} \right] - F \tag{19}$$

3.4 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_{fi}^o (13), s_{fij} (12), and the pricing rule (15), K_i becomes:

$$\begin{aligned} K_i &= \sum_{v=1}^{N_i} k_{vi} = \frac{k_{fi}}{s_{fi}^o} = \frac{1}{s_{fi}^o} \sum_{j=1}^{I} c_{fij} x_{fij} \tau_{ij} = \frac{1}{s_{fi}^o} \sum_{j=1}^{I} \frac{c_{fij} \tau_{ij} L_j s_{fij}}{p_{fij}} \\ &= \frac{\sigma - 1}{\sigma r_i} \frac{1}{s_{fi}^o (1 + \gamma s_{fi}^o)} \sum_{j=1}^{I} L_j (1 - s_{fij}) s_{fij} \end{aligned} \tag{20}$$

Combining the aggregate demand for the input (20) with the aggregate supply (8) yields the equilibrium reward for the input:

$$r_i = \left[\tilde{\gamma}_i^{\frac{1}{\gamma}} \frac{\sigma - 1}{\sigma} \frac{1}{s_{fi}^o (1 + \gamma s_{fi}^o)} \sum_{j=1}^{I} L_j (1 - s_{fij}) s_{fij} \right]^{\frac{\gamma}{1+\gamma}} \tag{21}$$

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:

$$\sum_{f=1}^{N_i} s_{fi}^o = 1$$

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 (16). 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:

$$Q_j = \frac{\sigma - 1}{\sigma \tau_{jj} c_{fj} r_j} \frac{(1 - s_{fjj}) s_{fjj}^{-\frac{1}{\sigma-1}}}{1 + \gamma s_{fj}^o} \tag{22}$$

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.[16]

4 The Effects of International Trade

Using the model outlined in the previous section, this section studies how international trade affects oligopoly and oligopsony power. 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 (14), profits (19) equal zero[17], 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.

4.1 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

[16] In the presence of firm heterogeneity in productivity, the welfare of consumers also depend on how the factors of production are allocated across firms. We abstract from such source of inefficiency in this paper. When firms are heterogeneous, firms with larger oligopsony power tend to under-demand the oligopsonistic factor relative to firms with less oligopsony power. If trade in final goods reallocates production towards firms with larger oligopsony power, the misallocation might be reduced. See MacKenzie (2018) for details.

[17] We ignore the integer problem.

with integrated final goods markets, and I^o the number of countries with integrated input markets. We focus on the effects of market integration on the firms in the original set of integrated countries.[18] 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 (19) to the symmetric countries assumption yields:

$$IsL\left[1 - \frac{\sigma - 1}{\sigma}\frac{1 - s}{1 + \gamma s^o}\right] = F \tag{23}$$

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 (23):

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

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

where ZP1, is the zero profit condition (23) 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.

[18] The effects on the firms in countries that join the world market are qualitatively similar.

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.

Figure 1: Final Goods Market Integration

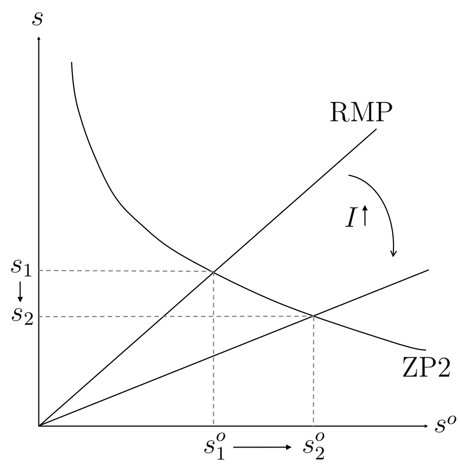
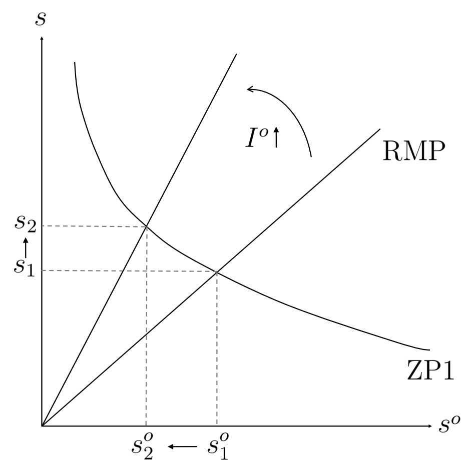


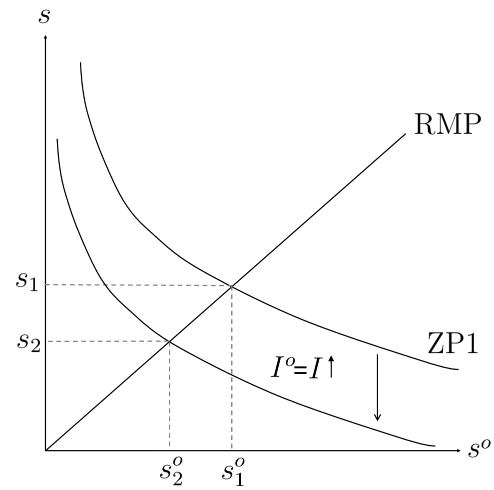
Figure 2: Input Market Integration



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 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



4.1.1 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. The derivations are in Appendix 6.2.2.

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 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. To 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:

$$d\ln Q = \left[\frac{1}{\sigma-1} + \frac{s}{(1-s)(1+\gamma)}\right](-d\ln s) + \left[\frac{\gamma s^o}{(1+\gamma s^o)(1+\gamma)}\right](-d\ln s^o) \tag{24}$$

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. A similar level-effect of firms' market shares is also present in the welfare formula developed by Macedoni (2017)

4.2 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.[19] 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 6.2.3.

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 reflects the relative domestic market power of oligopolists and oligop-

[19] 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.

sonists 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 6.2.3 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 more competitive, reducing domestic profits and entry.

By the implicit function theorem:

$$\frac{ds}{ds^o} = -\frac{dZP/ds^o}{dZP/ds} < 0 \qquad (25)$$

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 (31) is also valid in the version of the model with iceberg trade costs.

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 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 document that concentration in the market for inputs, which is a proxy for oligopsony power, is associated with higher prices and this effect is economically larger than concentration in the final goods markets has.

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.

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6 Appendix

6.1 Evidence

6.1.1 Data

Herfindahl Indexes

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.

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).

Input-Output Tables

In order to merge the Eora 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.[20] Then, we use the crosswalk between SITC and Eora classification from Feenstra and Sasahara (2017).

UNIDO Database

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.[21]

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 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.

The yearly data we use is 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.[22] 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.

6.1.2 Summary Statistics

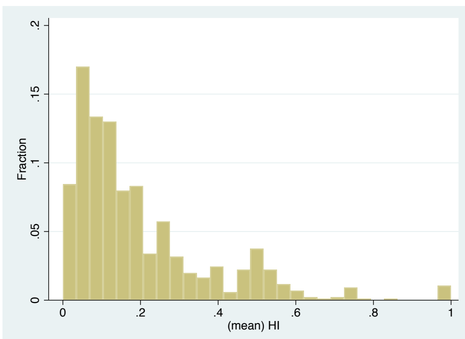
Figure 4 shows the distributions of HIs from Feenstra and Weinstein (2017) in the US in 1992 and 2005 across industries, which highlights significant market concentration. To

[20] https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp
[21] https://unstats.un.org/unsd/methodology/m49/overview/
[22] https://wits.worldbank.org/product_concordance.html

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 than 0.5.

Figure 4: Distribution of US HIs across industries

1992



2005

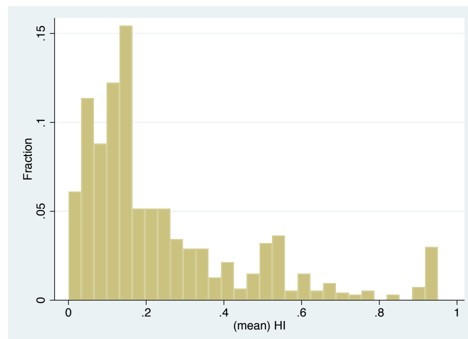
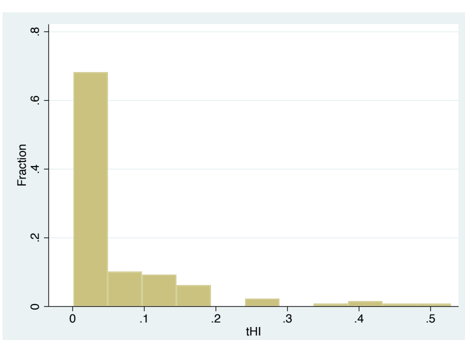


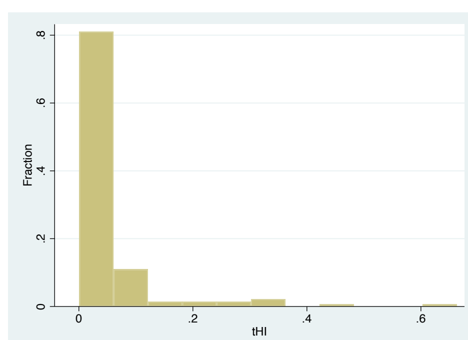
Figure 5 shows the distribution of weighted average HIs across all the countries in the sample, where weights are squared import share of each industry in total imports for each country. As a consequence of the aggregation, the levels of concentration decline. However, the figure highlights significant cross-country heterogeneity, with average HIs ranging from 0 to 0.5.

Figure 5: Distribution of weighted average HIs across countries

1992



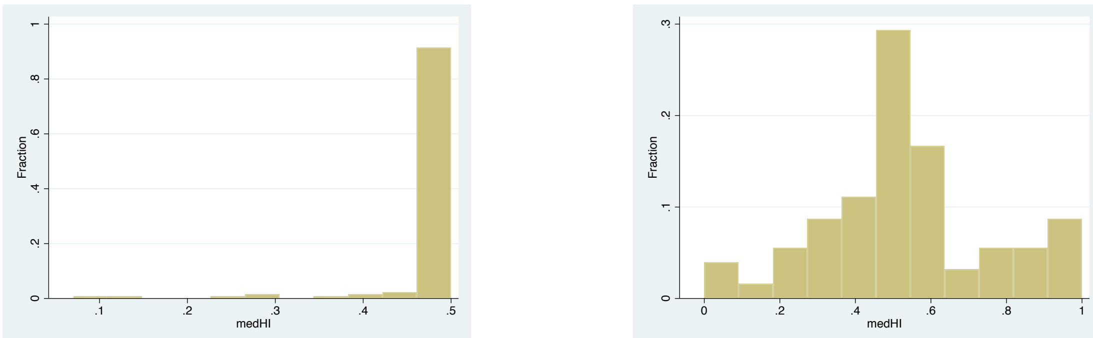
2005



The weighted 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).

Figure 6: Distribution of median world HIs

1992 2005



6.1.3 Construction of Adjusted Origin HI

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:

$$\tilde{s}^o_{ikmf} = \underbrace{sh_{imk}}_{\text{Industry Share}} * \underbrace{\bar{s}^o_{ikmf}}_{\text{Within-Industry Firm Share}} \tag{26}$$

The measure of oligopsony power of a firm that affects its prices in export markets is a weigthed average of $\tilde{s}^o_{ikmf}$ across the firm input industries m, where the weights are the average input shares in production.[23]

To derive a measure of market concentration consistent with this logic, we use data from Eora. 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^{Eora}_{ik}, as the weighted sum of HIs of corresponding HS four-digit industries HI^{HS4}_{iv}, where industry v belongs to the Eora industry k. The weights 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^{Eora}_{ik} as:

$$HI^{Eora}_{ik} = \sum_{v \in k} HI^{HS4}_{iv} s^2_{iv}$$

[23] This concentration measure is consistent with the extension of our model derived in Appendix sections 6.2.4 and 6.2.5 that allows for multiple inputs. In particular firm oligopsony power is the average of olipopsony 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.

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 Eora. x_{im} is the total output of industry m in country i.[24]

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

$$HI_{imk}^{input} = HI_{ik}^{Eora} sh_{imk}$$

If input m is specific to industry k ($sh_{imk} = 1$), as in our baseline specification, the market concentration in purchasing the input HI_{imk}^{input} is identical to the market concentration of industry k itself HI_{ik}^{Eora}. 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 weigthed average of HI_{imk}^{input} where the weigths 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:

$$HI_{ik}^{adj} = \sum_m (HI_{imk}^{input} IO_{imk}) \tag{27}$$

Table 3: 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)

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

6.1.4 Robustness

Table 4: Effects of Wages and Productivities on Export Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Origin HI	0.097***	0.097***			0.095***		
	(0.008)	(0.008)			(0.008)		
Destination HI	0.031***	0.031***			0.031***		
	(0.008)	(0.008)			(0.008)		
Origin HI UNIDO			0.078***	0.078***		0.153***	0.153***
			(0.010)	(0.010)		(0.008)	(0.008)
Destination HI UNIDO			-0.001	-0.001		-0.012*	-0.012*
			(0.007)	(0.007)		(0.007)	(0.007)
Wage		0.000		-0.000***	-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)	(0.000)		(0.000)
Industry-year FE	Y	Y	Y	Y	Y	Y	Y
Countrypair-year FE	Y	Y	Y	Y	Y	Y	Y
R^2	0.74	0.74	0.76	0.76	0.74	0.71	0.71
# Observations	455368	455368	321021	321021	454163	495846	495846

Robust standard errors are in the parentheses. For specifications (1), (2), (5) we use baseline measures of market concentration from Feenstra and Weinstein (2017), for (3), (4), (6), (7) we use measures of market concentration from UNIDO data. We control for wage and productivity for specifications (2), (4), (5), (6); we do not include controls for specifications (1), (3) and (6) but we drop observations for which there is no information on wages or productivities. Specifications (1)-(4) use four-digit UNIDO data, specifications (5)-(7) use two-digit.

Figure 7: Export Price Elasticity of Market Concentration 1980-2013

Oligopoly Power

Oligopsony Power

6.2 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.

6.2.1 Endogenous Supply of the Input

Consider the following utility function, which 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.

6.2.2 International Integration

This section derives the effects of international economic integration on input prices, markups and welfare stated in section 4.1. Let us start with input prices. Re-writing (21) in the symmetric country case yields:

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

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:

$$\frac{d \ln r}{d \ln I} = \frac{\gamma}{1+\gamma} \frac{F}{Ls^o - F} \frac{d \ln s^o}{d \ln I} \tag{29}$$

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:

$$\frac{d \ln s^o}{d \ln I} = \frac{(\sigma - 1)s}{\sigma(1+\gamma s^o) - \frac{(\sigma-1)(1-2s-\gamma s s^o)}{1+\gamma s^o}} \tag{30}$$

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:

$$Q = c^{-1}\left[\frac{\sigma-1}{\sigma\tilde{\gamma}}\right]^{\frac{1}{1+\gamma}} \frac{s^{-\frac{1}{\sigma-1}}(1-s)^{\frac{1}{1+\gamma}}}{(1+\gamma s^o)^{\frac{1}{1+\gamma}}} \tag{31}$$

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:

$$d\ln Q = \left[\frac{1}{\sigma-1}+\frac{s}{(1-s)(1+\gamma)}\right](-d\ln s) + \left[\frac{\gamma s^o}{(1+\gamma s^o)(1+\gamma)}\right](-d\ln s^o) \tag{32}$$

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 (31) 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.

6.2.3 Iceberg Trade Costs

This section presents the detailed derivations of the model discussed in section 4.2. 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:

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

Similarly, export oligopoly power equals:

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

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

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

Using the pricing rule (15), 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 (7), the relative quantity of domestic goods to foreign goods equals:

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

From the market clearing condition:

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

Using (36) into (35) yields:

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

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

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

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

Let us now derive the ZP curve. In the current model, the zero profit condition 19 becomes:

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

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

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

Now let'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 $s \leq s_0$

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

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

Then from implicit function theorem:

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

Let us now consider the effects of a reduction in τ on input prices. Plugging (**??**) and (19) into (21) we obtain:

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

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

Export prices equal:

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

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

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

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

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

6.2.4 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:

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

where we assume that $f()$ is increasing, concave and exhibits constant returns to scale. $\mathbf{y_{kfj}}$ is the vector of inputs used in producing for destination j The total demand of firm f for input k is $y_{kf} = \sum_{j=1}^{I} y_{kfj}$. Acquiring y_{kf} units of the input is subject to an iceberg trade cost t_{kf}.[25] The inverse demand for input k is given by:

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

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

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

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

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

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

where

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

Multiplying both sides of 43 by y_{kfj}, summing over inputs k, and using Euler's theorem for

[25] 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.

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:

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

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

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

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

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

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:

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

Let us re-write prices:

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

The average variable cost of selling to destination j is:

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

Thus, prices are given by:

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

Cobb Douglas

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

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

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

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

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

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

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

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

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

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

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

Finally, our pricing equation simplifies to:

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

6.2.5 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:

$$s_{kf}^o = \frac{t_{kf} y_{kf}}{\sum_v t_{kv} y_{kv}} \tag{52}$$

The demand share of a firm f for input k is the ratio between the firm's demand and the total demand for the input. To 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:

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