Concentration and Markups in International Trade*

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February 7, 2024

PRELIMINARY AND INCOMPLETE
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Abstract

We study the relationship between concentration and markups within Global Value Chains (GVCs), with a focus on the roles of firm-to-firm trade and bilateral market power. Our theory reveals an equilibrium relationship between concentration and markups in GVCs, similar to Cournot-like models, establishing concentration as a valuable policy tool. Unlike standard methods, we show that both supplier and buyer concentration impact markups, reflecting the bilateral nature of market power. Moreover, our approach adapts concentration measures to capture the networked trade structure, offering novel insights into concentration measurement. Applying our method to Colombian firm-to-firm trade data, we gauge potential biases from a simplistic HHI-based analysis when examining concentration trends in international trade.

*We thank seminar and conference participants at the ASSA meetings, Hitotsubashi-Gakushuin conference in International Trade and FDI, Women in Macroeconomics conference, UBC Sauder, Yale, USC for comments and suggestions. We also benefitted greatly from constructive discussions by Laura Castillo-Martinez and Sebastian Heise. We thank Andrew Sharng for excellent research assistance. All errors are our own. Email: valviarezr@iadb.org (Alviarez); michele.fioretti@sciencespo.fr (Fioretti); ken.kikkawa@sauder.ubc.ca (Kikkawa); morlacco@usc.edu (Morlacco).

1 Introduction

The ongoing and widespread rise in industry concentration has raised concerns about its implications for market power.[1] This debate emerged as Global Value Chains (GVCs) grew in prominence, prompting questions about the role of dominant firms in international trade (Antràs, 2020; Gaubert and Itskhoki, 2021). The traditional approach to analyzing industry concentration is grounded in standard Cournot oligopoly theory, which suggests that an increase in the Herfindahl-Hirschman index (HHI), a standard measure of industry concentration, is linked to higher industry-level markups and lower consumer welfare. This implies that large declines in the gains from trade may occur as trade becomes more concentrated among a small number of “superstar” importers and exporters (Freund and Pierola, 2015).

However, using concentration to measure market power poses well-known challenges (Syverson, 2019). One such challenge is that measuring concentration requires a market definition, and the standard approach to gauging concentration within broad industries may not always be appropriate (Rossi-Hansberg et al., 2021). A second fundamental issue is that markups and concentration are market outcomes with no universal connection. Although Cournot-like models are popular in the trade literature, modern production networks makes the reality of many markets more complex. Notably, most of these models assume that all firms in an industry sell to anonymous price-taking buyers.[2] While this assumption may hold true for trade in final goods, it does not align well with trade in GVCs, where bilateral bargaining and two-sided market power play critical roles in determining prices (Alviarez et al., 2022).

This paper examines the relationship between concentration and markups within GVCs. Our main contribution is to show that, akin to Cournot-like models, an equilibrium relationship exists between concentration and markups in GVC trade. This highlights concentration as a useful tool for policymakers in this context, serving as a proxy for market power. However, our approach departs from standard HHI-based analyses of market power in several ways. First, we show that both supplier (exporter) and buyer (importer) concentration influence industry markups, reflecting the bilateral nature of market power. Second, while similar in tractability, our concentration measures extend traditional HHI indices to accommodate a networked trade structure, resulting in more extensive data requirements. Finally, GVC trade involves well-defined markets, which are observable in the data. Another contribution of this study is to evaluate the bias associated with using a "naive" market definition when assessing the economic consequences of concentration trends.

[1] See, e.g., Economist (2016); Autor et al. (2017); Covarrubias et al. (2020); Syverson (2019)

[2] See, e.g., Atkeson and Burstein (2008); Mrázová and Neary (2017)

Our theory builds on the pricing model of GVCs in Alviarez et al. (2022). We conceptualize the supply chain as a network of importer-exporter relationships characterized by a bilaterally oligopolistic market structure. The theory posits that the market shares of exporters and importers serve as sufficient statistics for the markup within an exporter-importer pair. Specifically, the exporter's market share proxies for the incidence of oligopoly forces, while the importer's market share proxies for the incidence of oligopoly forces in price setting, with the relative bargaining power governing their relative weight.

The co-movements between markups and market shares at the pair level imply a closed-form relationship between markups and importer and exporter concentration at the industry level. We demonstrate that, as a first-order approximation, the aggregate markup on the intermediate input imports increases linearly with an exporter concentration index and decreases linearly with an importer concentration index. The impact of these indices on aggregate markups is proportional to the industry's overall scope for oligopoly and oligopsony power, as captured by substitution elasticity across supplier varieties and the returns-to-scale parameter in the supplier's technology, respectively. The weight assigned to these concentration measures, like in the pair-level case, is determined by the firms' bargaining power.

The exporter and importer concentration indices in our model generalize traditional HHI indices to capture concentration in bilateral oligopoly settings. Specifically, each supplier's (buyer's) market share is defined at the buyer's (supplier's) level. As a result, the exporter concentration index is derived as a weighted sum of the importer-level HHI, which is given by the sum of the squared sales shares of the importer's suppliers.[3] Similarly, the importer concentration index is derived as a weighted sum of exporter-level (modified) HHI, where the latter is calculated as the weighted sum of quantities purchased by the exporter's importers, with bilateral sales as weight.

Despite requiring more granular data, our approach to measuring concentration and market power in intermediate imports is as tractable as standard concentration analysis. We apply our methodology to analyze the economic consequences of trends in concentration among exporters and importers using transaction-level data on Colombian imports from 2009 to 2020. In particular, we employ our theory to obtain the relevant concentration indices and implied markup trends. In spite of a significant rise in exporter concentration, our findings suggest that the markups faced by Colombian importers stayed largely unchanged. This stability in markups is primarily attributed to a corresponding increase in concentration among Colombian importers, which acts as a counterforce to exporters' oligopoly power.

[3]In the limit where each exporter sells to all buyers in the industry, the exporter concentration measure coincides with a standard HHI index.

These markup dynamics deviate significantly from what conventional approaches would predict. We quantify the bias in the traditional approach and demonstrate it is substantial. Our results imply that taking into account two-sided market power in GVCs is crucial for accurately understanding the dynamics of market concentration and its welfare implications.

Related Literature This paper contributes to several strands of the literature. Firstly, it adds to the body of work documenting trends in concentration and discussing their implications for industry competitiveness. Most of this literature is based on production data for the U.S., and it has shown that industry concentration has increased across various sectors (See, e.g., Barkai, 2020; Covarrubias et al., 2020; Gutiérrez and Philippon, 2017; Grullon et al., 2019). National concentration trends have occurred alongside a rise in aggregate markups (De Loecker and Eeckhout, 2018; De Loecker et al., 2020; Díez et al., 2021), which has led to an increased debate around the relationship between concentration and market power.

The literature on concentration in trade is more limited. Freund and Sidhu (2017) find that global concentration among producers around the world has declined in most industries. Bonfiglioli et al. (2021) use data on U.S. imports in 4-digit industries, finding that industry concentration among foreign exporters has recently decreased or remained stable; they also show suggestive evidence that industries with higher concentration looks more competitive. Recently, Amiti and Heise (2022) demonstrated that, when accounting for the sales of foreign exporters and the foreign sales of U.S. firms, market concentration in U.S. manufacturing remained stable between 1992 and 2012. These papers measure concentration within broad industry groupings, thus reflecting a "naive" view of international trade where exporters sell final products to price-taking consumers abroad. We focus on trade in intermediate inputs and show that in this settings, it is essential to consider concentration on both sides of the market.

The question of how antitrust authorities should consider the power of buyers and suppliers in bilateral oligopolies has been extensively explored in the industrial organization literature. Much of this literature focuses on scenarios in which one or two suppliers supply one or two buyers who compete in a downstream market. These interactions are modeled as a bargaining game to analyze the competitive effects of vertical mergers.[4] However, these vertical contracting models are not suitable to study intermediate goods markets in which multiple buyers and suppliers interact within a network of firm-to-firm relationships and negotiate bilaterally over observable prices, which are the focus of this paper.[5] Our contribution to this

[4]Notable examples include Hart et al. (1990); O'Brien and Shaffer (1992); McAfee and Schwartz (1994); Segal (1999); De Fontenay and Gans (2005); Gans (2007)

[5]A somewhat similar approach to ours is that of Hendricks and McAfee (2010), who investigate the

literature is to provide a rich yet tractable theory of prices in firm-to-firm trade, which can be used to analyze vertical mergers in the context of bilateral oligopolies and firm-to-firm trade.

2 Theoretical Framework

This section derives a formal link between industry concentration and aggregate markups in an industry's global supply chain. The theory builds on the partial equilibrium pricing model for GVCs developed by Alviarez et al. (2022), which we summarize in Section 2.1. Section 2.2 derives the main theoretical result.

2.1 A Pricing Model of GVCs

We consider an (import) industry h, where a finite number of exporters (indexed by i) and importers (indexed by j) trade differentiated varieties of an intermediate input. We let $\mathcal{Z}_j$ denote the set of exporters of input h matched with importer j, while $\mathcal{Z}_i$ denotes the set of importers matched with exporter i, with $|\mathcal{Z}_k| \in \mathbb{I}_+,\ k = \{i, j\}$. These sets are taken as given. In what follows, we will outline the industry structure and the importer-exporter bargaining problem. For clarity, we will omit the h notation unless necessary.

Each exporter i produces q_i units of a differentiated variety of the industry input h and sells it to all the importers in $\mathcal{Z}_i$, with $q_i \equiv \sum_{j \in \mathcal{Z}_i} q_{ij}$, where q_{ij} is the quantity of i's variety of input h sourced by firm j. We consider a general technology for exporter i, summarized by the following expression for the marginal cost c_i :

$$c_i = k_i q_i^{\frac{1-\theta}{\theta}}, \tag{1}$$

where $\theta \in (0, 1]$ captures returns-to-scale, and k_i is an exogenous constant. Equation (1) implies that the production technology of firm i exhibits decreasing returns to scale when θ is strictly less than one, in which case average cost is below marginal cost.[6] On the other

implications of bilateral market power on concentration analysis in the context of a homogeneous goods industry. Their industry-specific approach is based on a bilateral oligopoly theory, where suppliers and buyers submit supply and demand schedules, respectively, and prices are set to clear the markets. While the two approaches are complementary, our theory has the advantage that it can incorporate traditional pricing models from the international trade and macroeconomics literature as special limit cases, making it more suitable for studying broad manufacturing industries.

[6]It is easy to show that under this cost structure, the average cost of producing q_i units of output, $AC(q_i)$, is θ times the marginal cost, i.e. $AC(q_i) = \theta c_i$.

hand, production exhibits constant returns to scale when $\theta = 1$, in which case both the marginal and average cost are constant and equal to k_i.

On the importer side, each firm j uses different inputs to produce a differentiated variety of the final good, which they subsequently sell in a downstream market. We assume a nested CES technology at the importer $j-$level, given by:

$$q_j = \varphi_j \prod_{h \in \Omega_j} \left(q_j^h\right)^{\gamma_h}, \quad \text{with} \quad \sum_h \gamma_h = 1 \tag{2}$$

$$q_j^h = \Big(\sum_{i \in \mathcal{Z}_j} \varsigma_{ij} \ \left(q_{ij}\right)^{\frac{\rho-1}{\rho}} \Big)^{\frac{\rho}{\rho-1}}. \tag{3}$$

Equation (2) expresses the final good output of firm j, q_j, as a Cobb-Douglas composite of Ω_j intermediate inputs, where q_j^h and $\gamma_h \in (0,1)$ denote the quantity and share of intermediate input h in j's production technology.[7] In turn, each intermediate input $h \in \Omega_j$ can be written as a CES composite of differentiated input varieties q_{ij}, with $\rho > 1$ denoting the substitution elasticity across varieties, while ς_{ij} is a preference shifter for variety i.

Finally, the final good market for firm j is monopolistically competitive and characterized by the following demand function:

$$q_j = p_j^{-\nu} D_j,$$

where $\nu > 1$ is the constant demand elasticity and D_j is an exogenous demand shifter.

2.1.1 Bargaining Structure and Gains From Trade

Negotiations in each importer-exporter pair are over the input price p_{ij}, while the quantity q_{ij} is determined by the importer's demand function. The latter can be found by solving the firm's cost-minimization problem as:

$$q_{ij} = q_j^h \varsigma_{ij}^{\rho} p_{ij}^{-\rho} \left(p_j^h\right)^{\rho} \qquad \text{with} \qquad q_j^h = \gamma_h c_j q_j \left(p_j^h\right)^{-1}, \tag{4}$$

where c_j and p_j^h are the shadow cost of one unit of final and intermediate good h, respectively.

A crucial aspect of negotiations is the surplus that each counterpart gains from a successful match, which we refer to as the *gains from trade*.[8] The importer's (exporter's) gains from

[7] Note that, although not explicitly modeled for the sake of tractability, the inclusion of labor and capital in production can be accommodated by appropriately relabeling the intermediate inputs.

[8] In equilibrium, all transactions generate some positive surplus, making both buyers and suppliers better off by transacting.

trade, denoted as GFT_{ij}^{j} (GFT_{ij}^{i}), are the profits from conducting transactions with all counterparts in $\mathcal{Z}_j$ ($\mathcal{Z}_i$), minus the profits from conducting transactions with all counterparts except i (j). With these definitions and the earlier assumptions on demand and technology, we can express the gains from trade as:

$$GFT_{ij}^{i} = p_{ij}q_{ij} - \theta\ c_i q_i\ \Delta_{ij}^{x} \geq 0, \tag{5}$$

$$GFT_{ij}^{j} = \frac{1}{\nu - 1}\ c_j q_j\ \Delta_{ij}^{s} \geq 0, \tag{6}$$

where the factors $\Delta_{ij}^{x} \equiv 1 - (1 - x_{ij})^{\frac{1}{\theta}}$ and $\Delta_{ij}^{s} \equiv 1 - (1 - s_{ij})^{\frac{\eta-1}{\rho-1}}$ capture the change in the exporter's and importer's total costs in the event of a failed negotiation. These factors are proportional to x_{ij} and s_{ij}, respectively, which are given by:

$$x_{ij} \equiv \frac{q_{ij}}{q_i} \in (0,1) \tag{7}$$

$$s_{ij} \equiv \frac{p_{ij}q_{ij}}{\sum_{k \in \mathcal{Z}_j} p_{kj}q_{kj}} \in (0,1). \tag{8}$$

Here, x_{ij} is the importer *buyer's share*, defined as the share of firm j's input quantity over the total quantity supplied by exporter i. Conversely, s_{ij} is the exporter *supplier's share*, defined as the share of firm i's sales over importer j's total purchases in industry h.[9] By governing the size of the exporter's and importer's gains from trade, these share play a pivotal role in determining the firms' competitive position.

2.1.2 Bilateral Prices and Markups

Letting $\phi \in (0,1)$ denote the buyers' bargaining power, the optimal price p_{ij} can be found by solving the following generalized Nash product:

$$p_{ij} :\ \arg\max_{p} \left(GFT_{ij}^{i}(p)\right)^{1-\phi} \left(GFT_{ij}^{i}(p)\right)^{\phi}, \tag{9}$$

where GFT_{ij}^{k} for $k = \{i, j\}$ are defined in (5) and (6), respectively.

To tractably analyze the division of surplus, we invoke the *Nash equilibrium in Nash bargains* ("Nash-in-Nash") solution concept: the price negotiated between firms i and j is the pairwise Nash bargaining solution, taking as given the negotiated outcome in other links in the network (Horn and Wolinsky, 1988).

[9]Intuitively, buyer j affects supplier i´s total costs through its effect on total output, the more so the larger its *quantity* share. Conversely, supplier i affects buyer j's total costs (and revenues) via a love-of-variety channel; this effect is stronger the larger the supplier's *value* share.

Alviarez et al. (2022) demonstrate that the solution to equation (9) yields an expression for the bilateral price p_{ij} as a markup μ_{ij} over the supplier's marginal cost c_i, i.e., $p_{ij} = \mu_{ij} c_i$. The bilateral markup μ_{ij} is given by:

$$\mu_{ij} = (1 - \omega_{ij})\, \mu_{ij}^{oligopoly}(s_{ij}) + \omega_{ij} \mu_{ij}^{oligopsony}(x_{ij}), \tag{10}$$

which is a weighted average between an "oligopoly" markup $\mu_{ij}^{oligopoly} = \mu_{ij}^{oligopoly}(s_{ij})$ and an "oligopsony" markdown $\mu_{ij}^{oligopsony} = \mu_{ij}^{oligopsony}(x_{ij})$.

The oligopoly markup is the markup that suppliers would choose if they set prices unilaterally, i.e., when $\phi \to 0$. It is given by:

$$\mu_{ij}^{oligopoly}(s_{ij}) = \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} > 1, \tag{11}$$

where ε_{ij} represents the supplier's residual price elasticity of demand, which can be expressed as:

$$\varepsilon_{ij} = \rho\,(1 - s_{ij}) + (1 - \gamma + \nu\gamma)\, s_{ij}. \tag{12}$$

This elasticity is an increasing function of ρ, the substitution elasticity across input varieties, and a decreasing function of the supplier's market share s_{ij}. Consequently, the oligopoly markup in (11) decreases with ρ and increases with s_{ij}, highlighting the two key sources of supplier market power in the model. The first one is standard monopoly power, arising from input differentiation, which is stronger when input varieties are less substitutable. The second source is oligopoly power, which increases with the supplier's market share, as in standard Cournot models.

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The oligopsony markdown reflects the markup term that buyers would select if they set prices unilaterally, i.e., when $\phi \to 1$. It is given by:

$$\mu_{ij}^{oligopsony} = \theta \left(\frac{1 - (1 - x_{ij})^{\frac{1}{\theta}}}{x_{ij}} \right) \in [\theta, 1], \tag{13}$$

which is a decreasing function of the buyer's market share x_{ij} and an increasing function of the returns to scale parameter θ. Similar to the oligopoly case, these factors unveil the two sources of *oligopsony power* in the model. The extent of buyer market power is proportional to the buyer's residual supply elasticity, which is computed as $\frac{d \ln c_i}{d \ln q_{ij}} = \frac{1-\theta}{\theta} x_{ij}$. Larger buyers constitute a more significant share of the supplier's total output, creating a larger gap between the supplier's marginal and average production cost. This leads to greater gains from trade for the supplier i, as it can be seen from equation (6). Larger buyers thus face a higher residual inverse supply elasticity and command lower markdowns, provided they have enough leverage in price negotiations. Notably, buyer market power exists as long as $\theta < 1$. When $\theta = 1$, the average and marginal cost coincide, and the inverse supply elasticity is always zero. As a result, this markdown always takes the value of one, regardless of the buyer's share.

The bilateral weighting factor ω_{ij} determines the relative importance of oligopoly and oligopsony forces in pricing. It is found as:

$$\omega_{ij} \equiv \frac{\frac{\phi}{1-\phi}\lambda_{ij}}{\frac{\phi}{1-\phi}\lambda_{ij} + 1} \in (0, 1), \tag{14}$$

which is an increasing function of $\frac{\phi}{1-\phi}\lambda_{ij}$, the product of the exogenous relative buyer's bargaining power $\left(\frac{\phi}{1-\phi} \in \mathbb{R}_+\right)$, and a term $\lambda_{ij} \equiv \frac{s_{ij}}{\Delta^s_{ij}} \cdot \frac{(\nu-1)\gamma_h}{\varepsilon_{ij}-1} \geq 1$ that is inversely related to the buyer j's gains from trade with supplier i via the term Δ^s_{ij}/s_{ij}.

The weighting factor ω_{ij} can thus be interpreted as the effective buyer's bargaining power: when the buyer's bargaining power is high or their gains from trading with supplier i are low, the weight ω_{ij} converges to one, and μ_{ij} converges to the oligopsony markdown. Conversely, when either the buyer's bargaining power is zero or their gains from trading with supplier i are high, ω_{ij} goes to zero, in which case the markup μ_{ij} coincides with the oligopoly markup.[10]

2.2 Aggregate Markups

We can express the aggregate markup in industry h as the ratio of total industry sales over the variable costs incurred to produce the industry good. Formally, we have:

$$\mu \equiv \frac{\sum_i \sum_j p_{ij}q_{ij}}{\sum_i \sum_j \theta c_i q_{ij}} = \left(\sum_i \sum_j \iota_{ij}\mu_{ij}^{-1}\right)^{-1}, \tag{15}$$

where $\iota_{ij} \equiv \frac{p_{ij}q_{ij}}{\sum_i \sum_j p_{ij}q_{ij}}$, and represents the pair's share of the total industry sales. The aggregate markup is thus the harmonic weighted average of pair-level markups, with weights

[10]To a first-order approximation around $s_{ij} \to 0$, the bargaining weight converges to

$$\lim_{s_{ij}\to 0} \omega_{ij} = \phi,$$

the buyer's bargaining power.

given by the pair's share of the total industry sales.

Given the equilibrium expression for the bilateral markup in (15), we expect the aggregate markup to be proportional to the average supplier market share s_{ij} and inversely proportional to the average buyer market share x_{ij}. We define two concentration measures that will be useful in deriving the main theoretical result below. The first measure is a *supplier concentration index*, which reflects the average concentration among suppliers and is defined as:

$$HHI^{suppliers} \equiv \sum_j \varphi_j HHI_j^{s_{ij}}, \quad \text{where} \quad HHI_j^{s_{ij}} \equiv \sum_i s_{ij}^2. \tag{16}$$

Here, the supplier concentration index is defined as a weighted sum of buyer-level HHIs, where each buyer is weighted by its share in total industry sales, $\varphi_j \equiv \frac{\sum_i p_{ij} q_{ij}}{\sum_i \sum_j p_{ij} q_{ij}}$. The buyer-level HHI ($HHI_j^{s_{ij}}$) captures how concentrated the suppliers are for each buyer j and is defined as the sum of squared suppliers' market shares.

The second measure is a *buyer concentration index,* which is constructed analogously and captures average concentration among buyers in a given industry. It is defined as:

$$HHI^{buyers} \equiv \sum_i \varphi_i MHHI_i^{x_{ij}}, \quad \text{with} \quad MHHI_i^{x_{ij}} \equiv \sum_j x_{ij}^r x_{ij}. \tag{17}$$

The buyer concentration index is a weighted sum of the (modified) HHI faced by each individual supplier i in the industry, where each supplier is weighted by its share in total industry sales, $\varphi_i \equiv \frac{\sum_j p_{ij} q_{ij}}{\sum_i \sum_j p_{ij} q_{ij}}$. The supplier-level modified HHI ($MHHI_j^{x_{ij}}$) captures how concentrated are buyers of each supplier i. It is defined as the weighted sum of the buyers' shares x_{ij}, with weights equal to the share of buyer j in supplier $i's$ revenues, $x_{ij}^r \equiv \frac{p_{ij} q_{ij}}{\sum_k p_{ik} q_{ik}}$.

With these definitions, we can now derive our main theoretical result.

Proposition 1 *To a first order approximation* around $s_{ij} = 0$ and $x_{ij} = 0$, *the aggregate markup in a given industry can be written as:*

$$\begin{aligned} \mu = {} & (1-\phi)\frac{\rho}{\rho-1} + \phi \\ & + (1-\phi)\left[\frac{\rho-\tilde{\nu}}{(\rho-1)^2} HHI^{suppliers}\right] \\ & - \phi\left[\frac{1-\theta}{2\theta} HHI^{buyers}\right], \end{aligned} \tag{18}$$

where $\tilde{\nu} \equiv (1-\gamma+\nu\gamma)$.

Proof See Appendix B.1.

Equation (18) shows that, to a first order approximation, the aggregate industry markup can be written as a simple function of the buyer and supplier concentration indices and parameters. When there is low concentration among buyers and suppliers, i.e, $HHI^{suppliers} \to 0$ and $HHI^{buyers} \to 0$, the aggregate markup becomes a weighted average of the monopolistic competition markup $\left(\frac{\rho}{\rho-1}\right)$ and the monopsonistic competition markdown (1), with the buyer's bargaining power ϕ determining the relative weight.

As concentration among suppliers increases, so does the aggregate markup relative to the no-concentration benchmark. The coefficient on the supplier concentration index is decreasing in ρ, the substitution elasticity across suppliers' varieties. Since higher substitutability implies tougher competition among foreign suppliers, it follows that the supplier concentration index matters more for aggregate markups in markets where the scope of oligopoly power is higher.

Vice-versa, concentration among buyers *decreases* the aggregate markup relative to the no-concentration benchmark. The coefficient on the buyer concentration index decreases with the returns to scale parameter θ. As the scope for oligopsony power increases with the inverse supply elasticity and thus decreases with θ, the buyer concentration index matters more for aggregate markups in markets where the scope of oligopsony power is higher.

Hence, just like in the pair-level case, concentration among suppliers captures oligopoly forces, while buyer concentration captures oligopsony forces, with relative bargaining power as weight.[11]

A simple corollary of Proposition 1 is that changes in industry markups can be mapped one-to-one to changes in the two concentration measures:

$$\Delta_t^{t+k}\mu = (1-\phi)\left(\frac{\rho-\tilde{\nu}}{(\rho-1)^2}\right)\Delta_t^{t+k}HHI^{suppliers} - \phi\left(\frac{1-\theta}{2\theta}\right)\Delta_t^{t+k}HHI^{buyers}, \tag{19}$$

where $\Delta_t^{t+k}x \equiv x_{t+k} - x_t$ denotes the $k-$year difference in variable x. Notably, equation (19) highlights that an increase in idustry concentration does not necessarily imply higher markups. An increase in industry concentration leads to a rise in markups if it occurs on the suppliers' side, while an increase in concentration among buyers lowers industry markups.[12]

[11] Our formula generalizes the results for standard Bertrand or Cournot settings in Grassi (2018) and Burstein et al. (2020) to bilateral oligopoly settings.

[12] Notably, unlike the standard case, concentration trends do not necessarily reflect higher or lower competitiveness in the industry. Even when markups decrease, they may indicate a loss in industry competitiveness if markups drop below the competitive level of one.

2.3 Discussion

Our partial equilibrium theory of prices in firm-to-firm trade makes two predictions regarding the role of concentration in determining aggregate markups. Firstly, since markups depend on both oligopoly and oligopsony forces, it is necessary to consider concentration not only among suppliers but also among buyers. The two concentration measures exert countervailing forces on aggregate markups.

Secondly, the definition of the relevant market and markup-relevant concentration measures differs from that of standard models. In the standard Bertrand or Cournot models of oligopolistic competition, suppliers typically charge a unique price to all dispersed, price-taking buyers in the market. The market definition typically coincides with an industry, and the aggregate markup in a given industry can be expressed as a simple function of the industry's Herfindahl-Hirschman index (HHI) (Grassi, 2018; Burstein et al., 2020). The latter is given by:

$$HHI^{suppliers,std} = \sum_i s_i^2, \qquad \text{where} \qquad s_i = \frac{p_i q_i}{\sum_i p_i q_i} = \frac{\sum_j p_{ij} q_{ij}}{\sum_i \sum_j p_{ij} q_{ij}}, \tag{20}$$

where we use the notation $HHI^{suppliers,std}$ in equation (20) to indicate the "standard" HHI measure. A firm's market share s_i in this case correspondes to the firm's share of total industry sales.

In contrast, our theory of prices in firm-to-firm trade features bilateral prices determined by a match-specific markup over the supplier's marginal cost. In these settings, the network structure of trade creates a unique environment where suppliers and buyers interact on a one-to-one basis, resulting in a different understanding of the relevant market definition, market shares, and concentration measures.

From the perspective of each supplier, the relevant market consists of all the buyers they are currently matched with, and each buyer's share of this market is determined by their quantity over the total quantity sold by the supplier, as shown by equation (7). Similarly, from the viewpoint of each buyer, the relevant market consists of all the suppliers they are currently matched with, with each supplier's share of the market being determined by their sales relative to the total buyer expenditures (equation (8)).

The markup-relevant measures of supplier and buyer concentration in equations (16) and (17) are inherently different from what standard models suggest as they reflect these different market share definitions. For example, the size of a supplier is not directly related to its ability to set prices, as this ability also depends on the size of the firms they are matched with.

To determine the significance of considering network features when evaluating concentration, we will examine both the "model-implied" and "standard" concentration measures in our empirical analysis below. While standard models typically focus on concentration among suppliers, we will also create a "standard" measure of buyer concentration as:

$$HHI^{buyers,std} = \sum_j x_j x_j^r, \qquad \text{where} \qquad x_j = \frac{q_j}{\sum_j q_j} = \frac{\sum_i q_{ij}}{\sum_i \sum_j q_{ij}}, \tag{21}$$

where $x_j^r \equiv \frac{p_j q_j}{\sum_j p_j q_j} = \frac{\sum_i p_{ij} q_{ij}}{\sum_i \sum_j p_{ij} q_{ij}}$. The buyer concentration measure in (21) represents concentration among buyers in a model where buyers purchase inputs from all dispersed, price-taking suppliers in the industry.

One way to view the concentration measures in equations (20) and (21) is as simple measures that practitioners could use to gauge concentration among suppliers and buyers in a given industry. From the lens of our model, these measures capture the true degree of concentration only in the limit case when there is only one supplier and one buyer in the industry. Comparing the results obtained using the model-implied measures with those obtained using these standard measures can shed light on the importance of considering the network of firm-to-firm trade when measuring concentration in bilateral oligopolies.

In summary, our theory of prices in GVCs provides a new perspective on the relevant measures of concentration and firm size in firm-to-firm trade. The theory accounts for concentration among buyers and suppliers and offers a unique understanding of the relevant market definition and market shares.

3 Data and Stylized Evidence

Although our theory is applicable to a range of intermediate input markets, we have chosen to focus our empirical analysis on the market for imported intermediate inputs due to the availability of rich firm-to-firm data for import transactions. Additionally, the focus on international trade is particularly relevant given the ongoing discussion on the impact of globalization on markup trends in macroeconomics and trade literature.

This section provides an overview of the data used in our empirical analysis. We first discuss the main data sources in Section 3.1. Then, in Section 3.2, we provide a detailed explanation of how we constructed the primary variables of interest. Finally, in Section 3.3, we present several facts about importer and exporter concentration.

3.1 Data Sources

Our primary data source is the customs records of Colombia recording the full history of Colombian import transactions during 2009-2020. For each import transaction, it reports the identity of the Colombian importer, the name of foreign exporter shipping the good, the city and country of origin, the product traded, the USD value and quantity shipped, the shipment date, and the transportation mode.[13]

Products are defined at the HS 10-digit level using the Colombian product classification. Colombian buyers are identified by their national identification number or *número de identificatión tributaria* (NIT), while foreign firms have alphanumeric names in the data. The foreign firm names are very noisy; we clean these names employing machine learning algorithms to create unique suppliers identifiers in any given year. Table A.1 in Appendix A reports the statistics on the main data we use. In the average year, we count a total of about 2.5 million import transactions across 147,600 buyer-supplier pairs for a total of 43,500 million USD. The statistics on aggregate imports are validated against official statistics from UN Comtrade; we capture a large share of total import in all years in the sample.

3.2 Measuring Key Variables of Interest

We define an industry h as an HS10 product code in our data. This means that we're interested in studying the aggregate markup of an HS10-digit product in our data.

For each exporter-importer pair $i-j$, we construct the exporter's supplier share as $s_{ij}^h \equiv \frac{p_{ij}^h q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h} p_{kj}^h q_{kj}^h}$, where $\mathcal{Z}_j^h$ is the set of importer j's suppliers of input h. The numerator of this share is the sum of all imports of importer j from exporter i of product h during the year; the denominator adds all the imports of product h across all the foreign suppliers that supply to j.

Unlike the exporter's supplier share, the importer's buyer share $x_{ij}^h \equiv \frac{q_{ij}^h}{\sum_{k\in\mathcal{Z}_i^h} q_{ik}^h}$ is defined in terms of quantities. Because we only observe Colombian importers in our data, the exporter$i's$ buyer set $\mathcal{Z}_i^h$ in the the denominator only includes Colombian importers. The numerator is quantity of product h imported by j from i in a given year, while the denominator is total supplier i's export quantity of product h sold to Colombian importers. To

[13]We aggregate this data at the importer-exporter-product-year level.

Table 1: Bilateral Concentration: Summary Statistics

Variable	Mean	St. Dev.	p10	p50	p90
Panel A – Concentration at the firm level					
s_{ijt}^h	0.62	0.41	0.02	0.86	1
x_{ijt}^h	0.82	0.33	0.13	1	1
$HHI_j^{s_{ij}}$	0.87	0.24	0.46	1	1
$HHI_i^{x_{ij}}$	0.74	0.29	0.31	0.90	1
Panel B – (Aggregate) Concentration across HS10 products					
$HHI^{suppliers}$ (weighted)	0.71	0.14	0.54	0.70	0.89
HHI^{buyers} (weighted)	0.89	0.10	0.77	0.91	0.98
$HHI^{suppliers,std}$ (weighted)	0.26	0.26	0.03	0.16	0.63
$HHI^{buyers,std}$ (weighted)	0.24	0.27	0.02	0.13	0.68

Source: Authors' calculations. The table shows summary statistics on several measures of market concentration, averaged across 2009-2020.

construct the buyers concentration index, we also construct the buyer's share in value terms as $x_{ij}^{r,h} = \frac{p_{ij}^h q_{ij}^h}{\sum_{k\in\mathcal{Z}_i^h} p_{ik}^h q_{ik}^h}$.

With these market shares, we construct the model-consistent measures of supplier and buyer concentration as $HHI^{suppliers}$ and HHI^{buyers} from equations (16) and (17), respectively.

We also construct the "standard" concentration measures $HHI^{suppliers,std}$ and $HHI^{buyers,std}$ from equations (20) and (21), where the suppliers' and buyers' (quantity and value) shares are defined as $s_i^h \equiv \frac{\sum_{j\in\mathcal{Z}_k^h} p_{ij}^h q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h}\sum_{j\in\mathcal{Z}_k^h} p_{kj}^h q_{kj}^h}$, $x_j^h \equiv \frac{\sum_{i\in\mathcal{Z}_j^h} q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h}\sum_{j\in\mathcal{Z}_k^h} q_{kj}^h}$ and $x_j^{h,r} \equiv \frac{\sum_{i\in\mathcal{Z}_j^h} p_{ij}^h q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h}\sum_{j\in\mathcal{Z}_k^h} p_{kj}^h q_{kj}^h}$.

All the concentration measures vary at the level of an HS10-product and year. Table 1 reports some relevant summary statistics on these measures.

3.3 Facts on Concentration

We present some facts regarding importer and exporter concentration in our dataset. Most of the discussion will focus on the "model-implied" measures (16) and (17), but we will also compare "new" and "standard" measures towards the end.

For a given year and across HS10 products, concentration among importers tends to be more pronounced than concentration among exporters. In Panel A of Figure A.1, we overlay the histograms of importer and exporter concentration for the average year. The average importer concentration is 0.91, whereas the average exporter concentration is 0.80, with substantial heterogeneity across products. The distribution of importer concentration is relatively more skewed. This fact is consistent with the statistics in Table 1, which indicate that, even at the match-specific level, imports tend to be more concentrated than exports in Colombian data.

In Panel B of Figure A.1, we plot the histograms of the difference between concentration in 2020 and concentration in 2009 for each HS10 product. The distributions are fairly normally distributed around zero, but we observe that concentration tends to increase relatively more on the exporter side than on the importer side. On average, exporter concentration increases by 0.05 points between 2009 and 2020, while importer concentration remains relatively stable, with an average increase by 0.01 point. This phenomenon may be attributed to the fact that importer concentration was initially relatively high.

Importer and exporter concentration exhibit a positive correlation. Notably, importer concentration is particularly high in industries that constitute a large portion of Colombian imports. Figure A.2 depicts the scatter plot of the two concentration measures, where each dot corresponds to a broad product chapter defined by the Harmonized System (HS) official product classification.[14] Each industry group is weighted based on its total import share. Large import industries, such as Machinery & Equipments and Minerals, exhibit relatively high levels of concentration among importers.

The heteregenous incidence of concentration across products could reflect industry specific factors. To investigate what fraction of the variation in concentration measures is due to industry-specific (or product-specific) characteristics, we perform a variance decomposition exercise, whose results we show in Table A.2. The exercise consists of regressing the two concentration measures on different types of fixed effects. Year fixed effects exhibit limited explanatory power for concentration measures. Incorporating fixed effects for the 2-digit HS category mildly enhances the share of explained variation in exporter and importer concentration, which increases to 4% and 7%, respectively. Even when we include both year and HS10 product fixed effects, we can only explain up to 50-60% of the variation in the two concentration measures. These results indicate substantial idiosyncratic variation in concentration measures, even within an HS10 product.

Comparison with "Standard" Concentration Measures We conclude this section by discussing how the "standard" concentration measures compare with the model-implied ones presented earlier. Would we observe the same concentration patterns if we naively measured concentration using the standard measures? In Panel A of Figure A.3, we ob-

[14]See the Data Appendix for a description of these product categories.

serve that "standard" or "naive" importer and exporter concentration measures have similar distributions, unlike our baseline measures in Figure A.1. When we analyze changes in concentration, we see much more movement in importer concentration than if we had used the baseline measures. On average, importer concentration increases by 0.04 points and exporter concentration by 0.03 between 2009 and 2020.

In Figure A.4, we find a positive correlation between importer and exporter concentration even when measured using the standard method. However, unlike the baseline case, the most concentrated industries have a relatively low share of total imports. Lastly, Figure A.5 and Figure A.6 compare exporter and importer concentration measures across broad industry groupings. We find a positive correlation between the two measures, but the coefficient is small and not statistically significant.

Our findings show that using these alternative measures significantly affects the patterns of variation and the aggregate incidence of concentration. It follows that taking into account the network of firm-to-firm trade and specific market features is crucial for understanding the aggregate consequences of industry concentration.

4 Calibration and Estimation

To bring equation (19) to the data, we first need to recover the vector of primitive parameters $\boldsymbol{\beta} = (\phi, \theta, \rho, \gamma, \nu)$. The parameter ϕ reflects the importer's bargaining power in negotiations; θ is a technological parameter related to the inverse supply elasticity of exports and reflects the degree of import market power. The parameter ρ is a preference parameter capturing the substitution elasticity among different (foreign) varieties of product h and reflects the scope of export market power. Parameter γ captures the cost share of input h in production. Lastly, parameter ν captures the demand elasticity in downstream links in the network.

Our strategy for recovering this parameter vector is three-fold. In the first step, we calibrate the values of the downstream parameters ν and γ. We set the demand elasticity that importers face downstream ν to 2.5, which corresponds to an estimate of the average demand elasticity in Broda and Weinstein (2006). We then set the importer $j's$ marginal cost elasticity to each foreign input h to $\gamma \to 0$, a value which we calibrate to match the cost share of each HS10 product in production. These values of ν and γ implies that the parameter $\tilde{\nu} = 1 - \gamma + \gamma\nu = 1$.

In the second step, we obtain estimates of the parameters ρ and θ. We let these parameters vary at the HS2 product level. We calibrate their values so as to match the value of import and export supply elasticities in Colombian imports. We obtain estimates of these elasticities by using the limited information maximum likelihood (LIML) routine developed in Soderbery (2015), which we adapt to our data.[15]

Figure A.7 plots the histograms of the estimated parameters across HS2 products. Across HS2 products, the average estimated ρ is 4.82, with a standard deviation of 11.83. The average estimated θ is 0.7 instead, with a standard devistion of 0.27. These estimates imply substantial scope for both export and import market power. Table A.3 reports mean estimate by broad product group.

The last step consists of estimating a value of the importer bargaining power ϕ, which we also allow vary at the HS2 product level. We adopt the estimation procedure developed in Alviarez et al. (2022), which we describe in the Appendix B.3. Table A.3 reports mean estimate by broad product group. On average across HS2 products, the estimated importer's bargaining power is 0.64. This estimate is much larger than the value of 0 postulated by standard models of oligopolistic competition. We observe substantial heterogeneity across industries. The importer's bargaining power is particularly high in Machinery and Electricals (0.89) and Plastics (0.87), while it is relatively low in Animal Products (0.46) and Leathers (0.37).

4.1 Model Test: Concentration and Prices

We now provide suggestive evidence that concentration in GVCs is correlated to aggregate markups in the ways predicted by equation (18). An ideal test of the theory is to relate aggregate markups to the different concentration measures. A similar exercise is not feasible given the lack of information on markups. We thus consider an indirect test using aggregate unit values at the product level.

We construct product unit values as:

$$uv_{ht} = \frac{tot\ import\ value_{ht}}{tot\ import\ qty_{ht}}, \tag{22}$$

which is the theory-consistent measure of average (aggregate) price of product h. An accounting decomposition writes the unit value of product h as: $uv_{ht} = \mu_{ht} \cdot c_{ht}$. Here, $\mu_{ht} = \mu(HHI_{ht}^{buyers}, HHI_{ht}^{suppliers})$ is the aggregate markup of product h at time t in equation (18) which, for a given parameter vector, is a function of the two concentration measures.

[15]The estimator refine the methodology first developed in Feenstra (1994) and Broda and Weinstein (2006). We adapt the STATA code provided by Soderbery (2015) to our dataset.

Table 2: Concentration and Aggregate Prices

	(1)	(2)	(3)	(4)
	OLS			
Variables	$\ln uv_{ht}$			
$HHI_{ht}^{suppliers}$	0.136	0.193	0.135	0.136
	(0.010)	(0.012)	(0.010)	(0.010)
$HHI_{ht}^{suppliers} \times high\ \rho_h$		-0.136		
		(0.017)		
HHI_{ht}^{buyers}	-0.071	-0.08	-0.142	0.023
	(0.015)	(0.015)	(0.025)	(0.023)
$HHI_{ht}^{buyers} \times high\ \theta_h$			0.103	
			(0.030)	
$HHI_{ht}^{buyers} \times high\ \phi_h$				-0.148
				(0.03)
Observations	65,070	65,070	65,070	65,070
Fixed Effects	HS10; Year			
R-Squared	0.98	0.98	0.98	0.98

Notes: Robust standard errors in parentheses. The sample includes all HS10 products that did not experience year-by-year (log) changes greater than +-100%. The dummies $high\ \rho_h$, $high\ \theta_h$ and $high\ \phi_h$take a value of one when the estimated ρ , θ, and ϕ are above the median level across all HS10 products. Significance: * 0.10, ** 0.05, and *** 0.01.

The term c_{ht} reflects the unobserved marginal cost of product h,which is an average of exporter-level marginal costs.

The theory predicts that, conditional on c_{ht}, the log unit value of product h in time t ($\ln uv_{ht}$) is an increasing function of the supplier HHI $\left(HHI_{ht}^{suppliers}\right)$, and a decreasing function of the buyer HHI $\left(HHI_{ht}^{buyers}\right)$. Moreover, the (positive) correlation between $\ln uv_{ht}$ and the supplier HHI is stronger for markets where the scope for export market power is higher (where ρ is lower). Vice versa, the (negative) correlation between uv_{ht} and the buyer HHI is stronger for markets where the scope for import market power is higher (where θ is lower) and when the bargaining power of importers is high (ϕ is high).

We run the following OLS regressions:

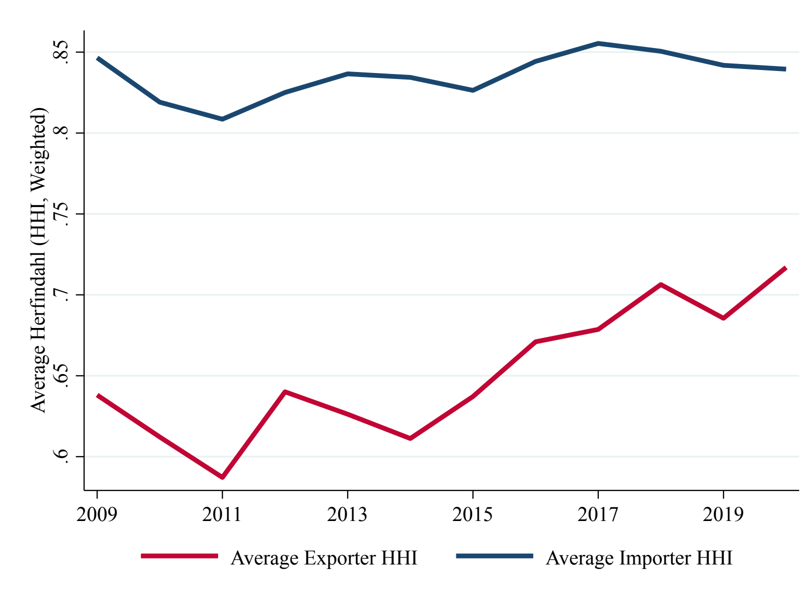
$$\begin{aligned}\ln uv_{ht} = const &+ \beta_1 HHI_{ht}^{suppliers} + \beta_2 HHI_{ht}^{suppliers} \times high\ \rho_h \\ &+ \gamma_1 HHI_{ht}^{buyers} + \gamma_2 HHI_{ht}^{buyers} \times high\ \theta_h + \gamma_3 HHI_{ht}^{buyers} \times high\ \phi_h \\ &+ \mathbf{X}_{ht}'\delta + u_{ht}.\end{aligned}$$

The term $high\ \rho_h$ is a dummy equal to one if the product is characterized by a higher-than-median elasticity of substitution ρ. Similarly, the term $high\ \theta_h$ ($high\ \phi_h$) is a dummy equal to one if the product has a higher-than-median value of θ (ϕ). $\mathbf{X}_{ht}$ is a vector of product-level controls that include product fixed effects, time fixed effects, and the (log) number of buyers and suppliers of product h at time t. The control vector partially controls for unobserved marginal cost differences in c_{ht}.

Table 2 reports the results. In line with our priors, we find in column (1) that within a given HS10 product, the unit value increases with concentration among suppliers and decreases with concentration among buyers. Columns (2)-(4) provide further evidence that unit values behave in ways predicted by the model. The strength of supplier concentration is weaker in more competitive product markets, that is, in markets characterised by a high substitution (demand) elasticity ρ. Similarly, the strength of buyer concentration is less relevant (less negative coefficient) in more competitive input markets, that is, in markets characterised by a low value of the inverse export supply elasticity, or a high θ. Lastly, we find that the strength of buyer concentration is particularly high in markets where the importers have high estimated bargaining power (high ϕ).

5 Concentration and Aggregate Markups

Figure 1: Importer and Exporter Concentration Over Time



What do trends in import and export concentration between 2009 and 2020 in Colombian import data have to say about the evolution of aggregate import markups during the same period? Figure 1 shows the evolution of aggregate import and export concentration in

Colombian data from 2009 to 2020. The aggregate concentration measures are obtained as weighted sum of product-level ones, with weights given by the share of each product in total imports. Import concentration is high throughout the sample period, averaging 0.84; it shows a relatively stable trend. Concentration among exporters is lower at an average of 0.65. While importer concentration remains relatively stable during the sample period, we observe an upward trend in exporter concentration, which increases from 0.64 in 2009 to 0.72 in 2020.

The theory tells us that to translate trends in concentration into trends in aggregate markups, it is important to account for both trends in importer and exporter concentration, with weights proportional to the relative importers' bargaining power and the scope of import and export market power. Figure 2 plots the evolution of aggregate import markup implied by the model, given the estimated parameters $\boldsymbol{\beta} = \{\phi, \rho, \theta\}$. The Figure also plots the counterfactual markup evolution in a model with one-sided market power on the side of the foreign supplier only ($\phi = 0$); the counterfactual represents the standard assumptions in the literature. The two markups trends are normalized to their value in 2009.

Figure 2: Herfindahl Change, 2010-2020

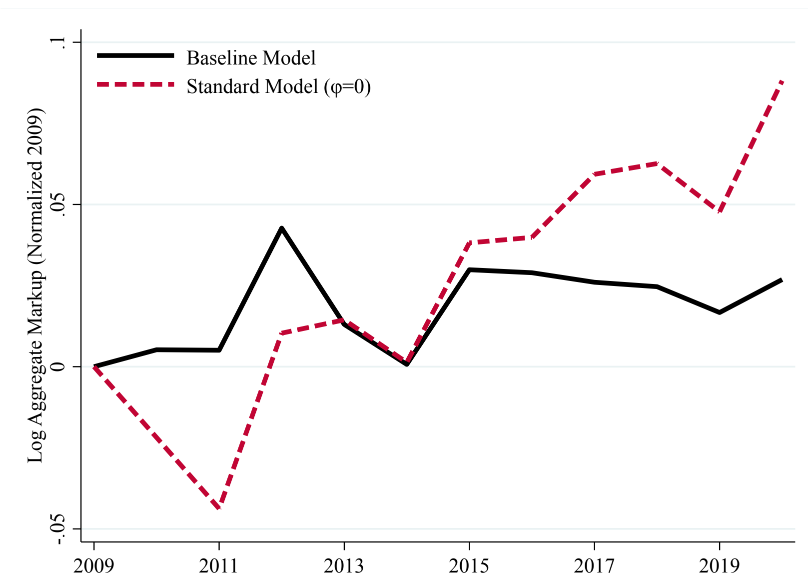


Figure 2 illustrates that there has been a moderate increase, around 3%, in the aggregate markup on Colombian imports between 2009 and 2010. This increase is attributed to a higher incidence of oligopoly power in 2020, which follows from an increase in exporter concentration during the sample period. Notably, the figure also shows that the model-predicted increase in the aggregate import markup is considerably lower than what conventional models that focus on price-taking importers would have predicted. The dashed red line in the figure represents the counterfactual increase in markups, which would have been close to 10% had a more standard Nash-Bertrand model (setting $\phi = 0$) been used. This discrepancy between the two lines is due to our estimation of high bargaining power on the importer side in Colombia, which means that the upward trend in exporter concentration has only a mild anti-competitive effect, due to the importers' countervailing power.

Figure A.8 in the Appendix further supports this argument by comparing two industries: Leathers and Machinery & Electricals. The figure demonstrates that the predictions of the standard model are accurate for Leathers, whereas they are not for Machinery & Electricals. The primary distinction is that we estimate importers' bargaining power to be relatively low in the case of Leathers, making the impact of ignoring importer concentration and oligopsony power minimal. On the other hand, in Machinery & Electricals, importers' bargaining power is high, and as a result, the baseline and standard models' predictions about the evolution of aggregate markups differ significantly.

What would happen if we used the naive concentration measures instead? Figure A.8 in the Appendix compares the trends in concentration and markups in the baseline case (Panel (a) and (c)) and when using "naive" concentration measures instead of the model-implied ones (Panel (b) and (d)). Comparing Panel (c) and (d) reveals that if we neglect the role of the network and use the naive concentration measures, we would get the markup evolution wrong. That's because there is not a strong correlation between the model-implied and standard concentration measures, as shown by Panels (a) and (b). Therefore, taking into account the network of firm-to-firm trade and specific market features is crucial for understanding the aggregate consequences of industry concentration.

Two main conclusions can be drawn from this Section. First, the level of importer bargaining power heavily influences the evolution of markups. The value of ϕ determines whether the markup reflects oligopoly or oligopsony forces, as captured by concentration among exporters and importers, respectively. Second, relying solely on standard HHI-analysis can provide a misleading view of the relationship between markups and concentration in bilateral oligopoly. Not only do standard measures fail to consider the countervailing power of importers, but they are also constructed using the wrong HHI measures. The results in this Section illustrate that the resulting biases can be significant.

6 Conclusions

A key aspect of GVCs, as well as many other intermediate input markets, is that both buyers and suppliers have market power and negotiate bilaterally over transaction prices. This paper explores the implications of bilateral oligopolies for the relationship between industry concentration and aggregate markups, using import data for Colombia as an empirical application.

Our theory of prices in firm-to-firm trade offers a new perspective on the role of concentration in determining aggregate markups. It emphasizes the importance of considering concentration among both suppliers and buyers and introduces a unique understanding of the relevant market definition and market shares. Unlike standard models, which assume pricing-to-market, the theory features pricing-to-buyer, with bilateral prices determined by a match-specific markup over the supplier's marginal cost. As a result, the model-implied measures of supplier and buyer concentration reflect different market definitions and market shares than the standard measures. Our empirical application shows the importance of taking the network features into account when evaluating concentration.

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A Additional Tables and Figures

Table A.1: Colombian Imports: Statistics

	Imports	UN Comtrade	Transactions	Pairs	Unique buyers	Unique suppliers
	(MLN USD)					
2010	42,177		2,017,428	137,454	27,517	71,190
2011	60,467		2,749,052	164,324	32,541	81,402
2012	58,767	56,833	2,951,104	172,178	35,240	85,616
2013	53,238	58,443	2,857,520	162,931	33,005	83,798
2014	46,804	62,939	2,434,251	157,281	32,187	81,942
2015	52,064	54,035	3,036,051	164,473	32,399	85,807
2016	28,816	44,831	1,915,076	134,450	28,922	73,621
2017	26,892	46,050	2,015,542	126,379	27,500	70,392
2018	29,041	51,230	1,936,597	123,599	26,973	68,630
2019	53,793	52,263	3,665,783	164,863	32,429	85,173
2020	27,294	43,487	1,835,985	115,656	25,867	64,560
Mean	43,578		2,492,217	147,599	30,416	77,466

Notes: The table reports statistics on transaction level Colombian level data. Raw data are obtained from official customs records, avaliable at https://www.dian.gov.co/. In column 3, we report official import statistics for Colombia from UN Comtrade data.

Table A.2: Variance Decomposition - Concentration Measures

	Exporter Concentration Index ($HHI_{ht}^{suppliers}$)	Importer Concentration Index (HHI_{ht}^{buyers})
Year	0.01	0.00
Year-HS2	0.04	0.07
Year-HS4	0.20	0.24
Year-HS6	0.44	0.52
Year-HS10	0.54	0.63

Notes: The table reports the results of a statistical decomposition exercise based on OLS regressions on the following estimating equation:

$$\ln HHI_{ht}^{k} = FE_t + FE_s + \varepsilon_{ijt}^{h}$$

over the period 2009-2020, where $k = \{suppliers,\ buyers\}$, FE_t denotes year fixed effects, and FE_s denotes product fixed effects, either at the 2, 4, 6, or 10 HS product classification level. Number of observations: 65,075.

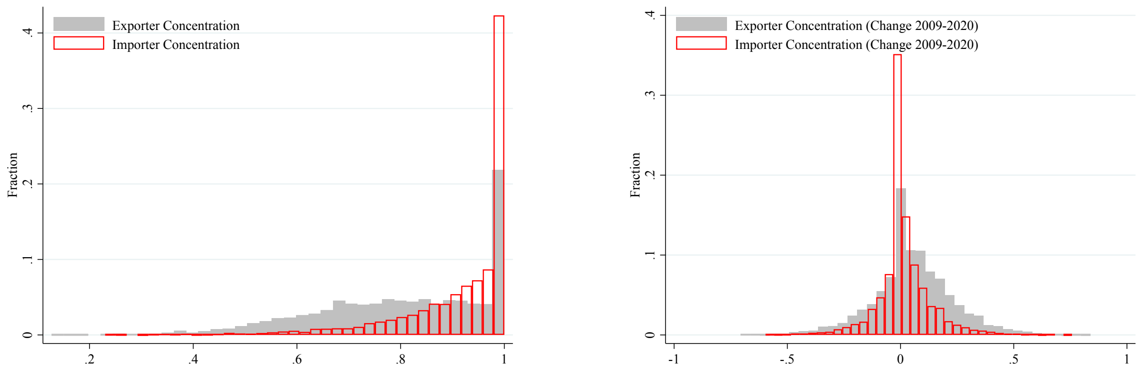
Table A.3: Estimates of ρ, θ and ϕ across Product Groups

Parameter	ρ	θ	ϕ
Method	Soderbery (2015)		Alviarez et al. (2022)
Animals	4.99	0.44	0.50
Vegetables	2.24	0.81	0.65
Foodstuff	1.96	0.69	0.70
Minerals	1.63	0.69	0.85
Chemicals	2.32	0.73	0.71
Plastics	2.21	0.53	0.87
Leathers	4.60	0.86	0.37
Wood Products	3.23	0.55	0.51
Textiles	2.31	0.78	0.65
Footwear	2.20	0.89	0.70
Stone & Glass	1.87	0.66	0.59
Metals	1.50	0.88	0.60
Mach. & Electricals	1.45	0.69	0.89
Transportation	3.10	0.92	0.65
Mix	1.75	0.64	0.58

Notes: The table reports the average estimate of ρ, θ and ϕ across product groups. Estimates of parameters ρ and θ and at the HS2 level are obtained from the limited information maximum likelihood (LIML) routine developed in Soderbery (2018), which we apply to our Colombian import data. Estimates of ϕ at the HS2 level are obtained from the estimation routine developed in Alviarez et al. (2022), which we describe in Appendix B.

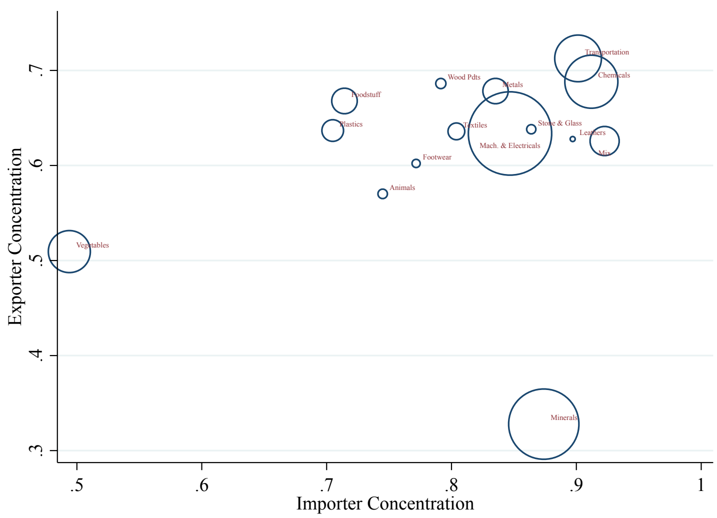
Figure A.1: Importer and Exporter Concentration: Distributions

(a) Level (b) Change (2009-2020)



Notes: The figure plots the histograms of the importer and exporter concentration indices (HHI_{ht}^{buyers} and $HHI_{ht}^{suppliers}$) across HS10 products. Panel A shows the distribution of the two concentration measure in 2014. The Figure would not change if we chose a different year, or we took an average across the different years. Panel B shows the distribution of changes in concentration measures between 2009 and 2020.

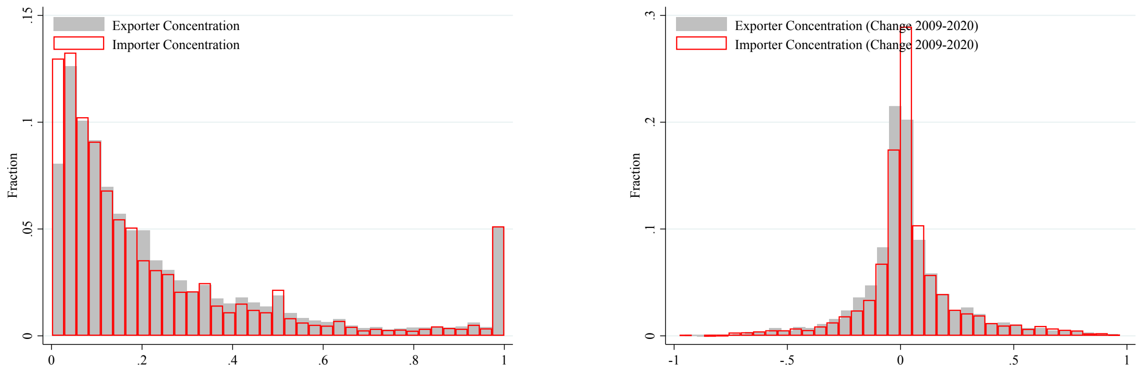
Figure A.2: Importer and Exporter Concentration: Correlation



Notes: The figure plots the weighted scatterplot of the importer and exporter concentration indices (HHI_{ht}^{buyers} and $HHI_{ht}^{suppliers}$). Each dot corresponds to a broad product chapter, as defined by the official HS product classification (See, e.g., World Customs Organization). Within each product chapter, we take the simple average of the concentration measures across HS10 products. Each dot is weighted by the import share of the product chapter in total Colombian imports.

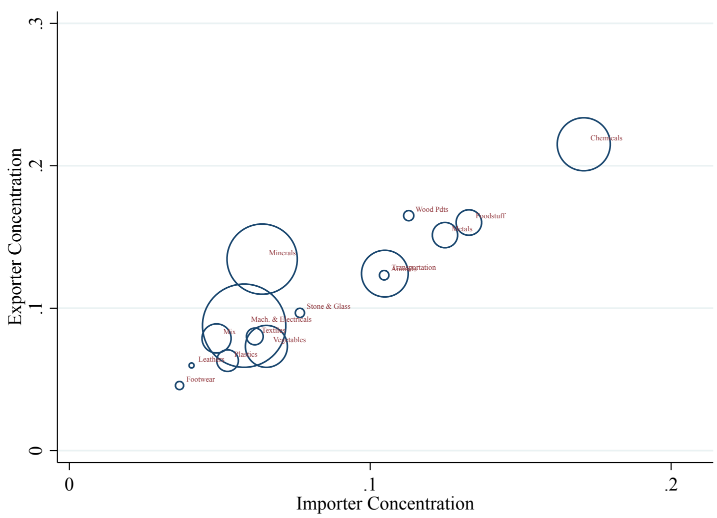
Figure A.3: Importer and Exporter Concentration: Standard Measures, Distributions

(a) Level | (b) Change (2009-2020)



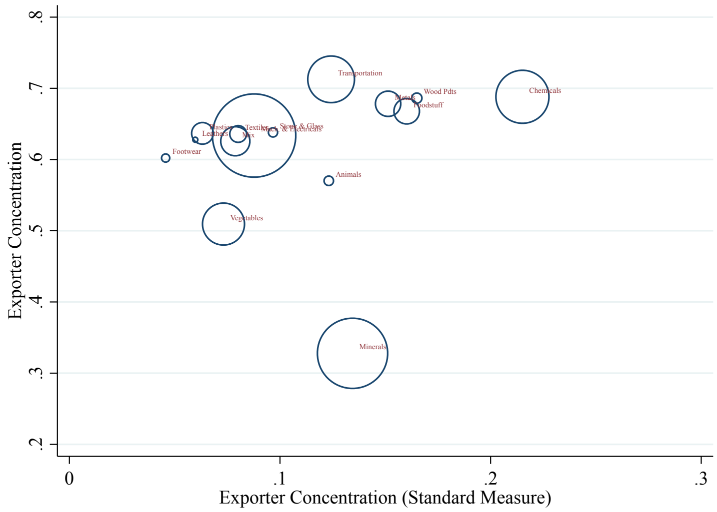
Notes: The figure plots the histograms of the importer and exporter concentration indices, constructed using the "standard" industry definitions ($HHI_{ht}^{std,buyers}$ and $HHI_{ht}^{std,suppliers}$) across HS10 products. Panel A shows the distribution of the two concentration measure in 2014. The Figure would not change if we chose a different year, or we took an average across the different years. Panel B shows the distribution of changes in concentration measures between 2009 and 2020.

Figure A.4: Importer and Exporter Concentration: Standard Measure, Correlation



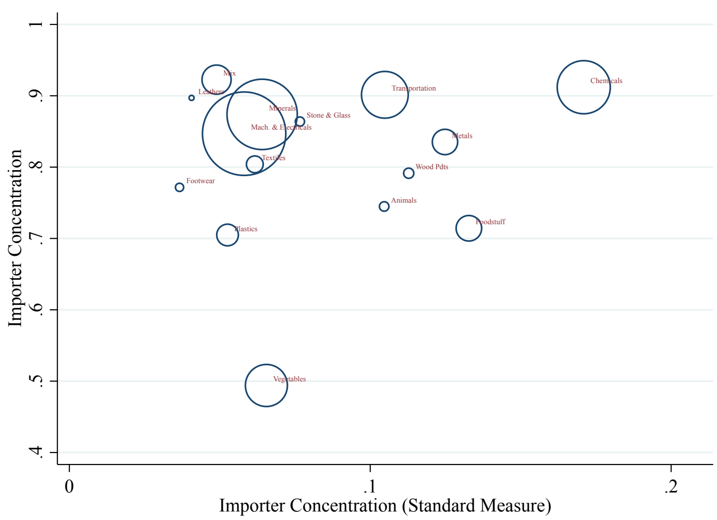
Notes: The figure plots the weighted scatterplot of the importer and exporter concentration indices, constructed using the "standard" industry definitions ($HHI_{ht}^{std,buyers}$ and $HHI_{ht}^{std,suppliers}$). Each dot corresponds to a broad product chapter, as defined by the official HS product classification (See, e.g., World Customs Organization). Within each product chapter, we take the simple average of the concentration measures across HS10 products. Each dot is weighted by the import share of the product chapter in total Colombian imports.

Figure A.5: Exporter Concentration: New vs. Standard Measures



Notes: The figure plots the weighted scatterplot of the new and standard exporter concentration indices. Each dot corresponds to a broad product chapter, as defined by the official HS product classification (See, e.g., World Customs Organization). Within each product chapter, we take the simple average of the concentration measures across HS10 products. Each dot is weighted by the import share of the product chapter in total Colombian imports.

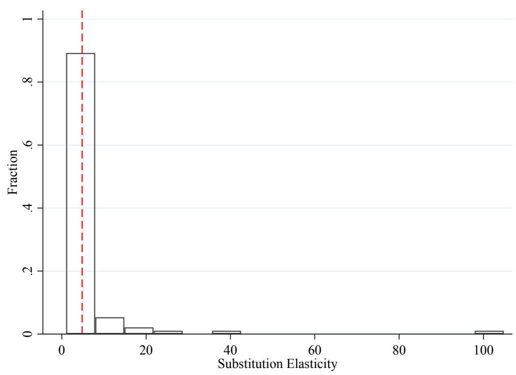
Figure A.6: Importer Concentration: New vs. Standard Measures



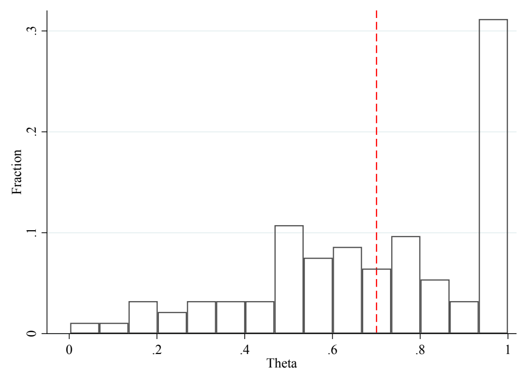
Notes: The figure plots the weighted scatterplot of the new and standard importer concentration indices.. Each dot corresponds to a broad product chapter, as defined by the official HS product classification (See, e.g., World Customs Organization). Within each product chapter, we take the simple average of the concentration measures across HS10 products. Each dot is weighted by the import share of the product chapter in total Colombian imports.

Figure A.7: Import Supply and Demand Elasticities: Results

(a) Estimates of ρ Across HS2 Products



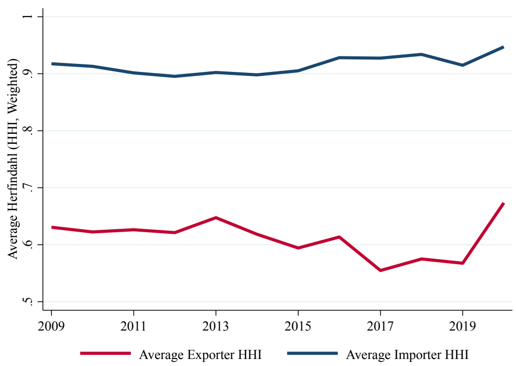
(b) Estimates of θ Across HS2 Products



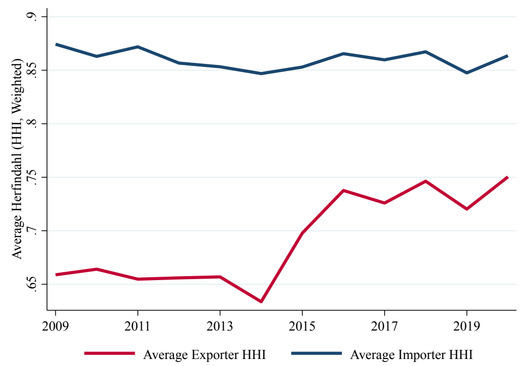
Notes: The figure plots the histograms of estimates of parameters ρ and θ at the HS2 level, obtained from the limited information maximum likelihood (LIML) routine developed in Soderbery (2015), which we apply to our Colombian import data.

Figure A.8: Concentration and Markups: By Industry

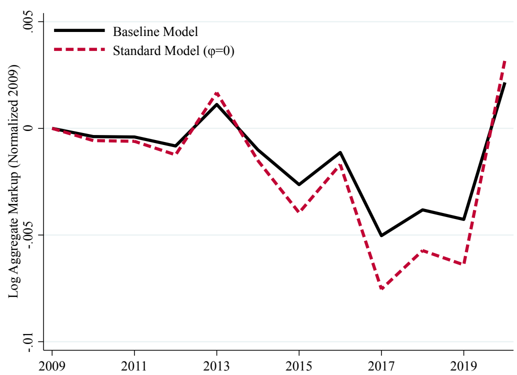
(a) Trends in Concentration: Leathers



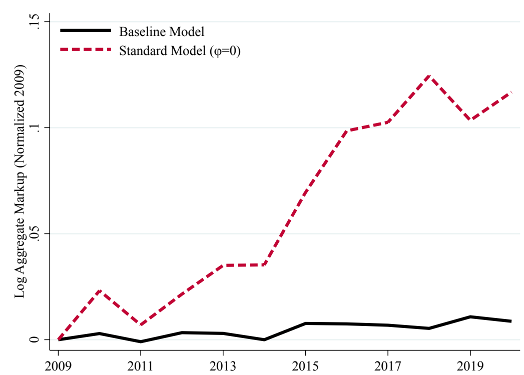
(b) Trends in Concentration: Machinery & Electricals



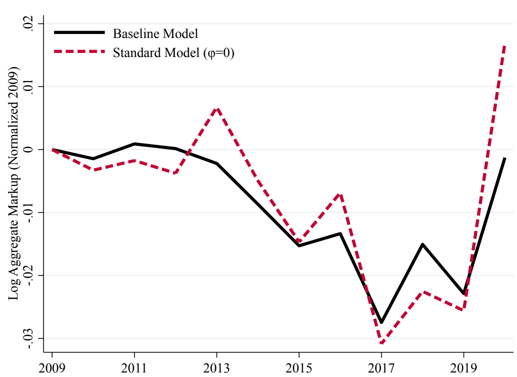
(c) Markup Evolution: Leathers



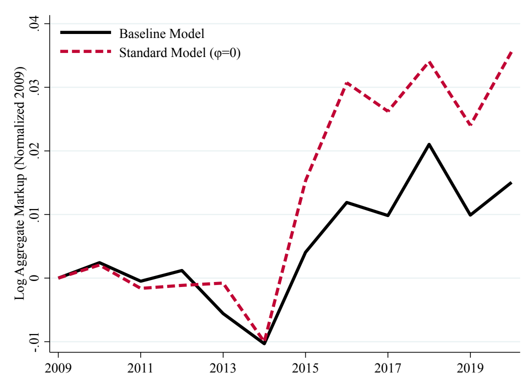
(d) Markup Evolution: Machinery & Electricals



(e) Markup Evolution: Leathers



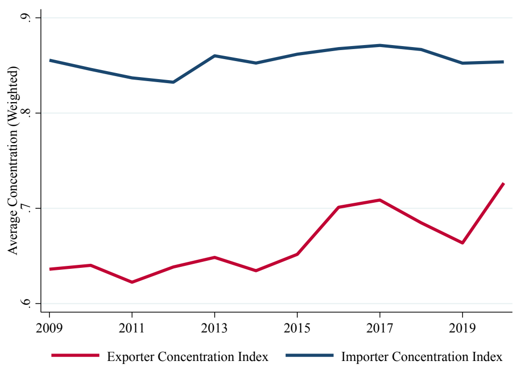
(f) Markup Evolution: Machinery & Electricals



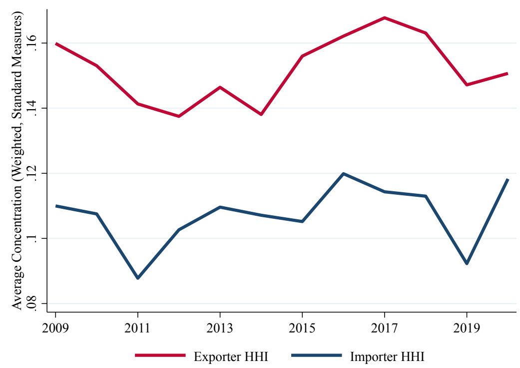
Notes: The figure plots the histograms of the importer and exporter concentration indices and implied markup evolution in two different industries: Leathers (Panels (a) and (c)) and Machinery & Electricals (Panels (b) and (d)). Panels (e) and (f) keep parameters constant.

Figure A.9: Concentration and Markups: Baseline vs. Standard Concentration Measures

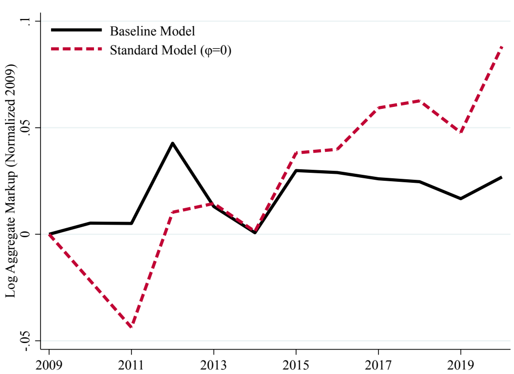
(a) Concentration: Baseline



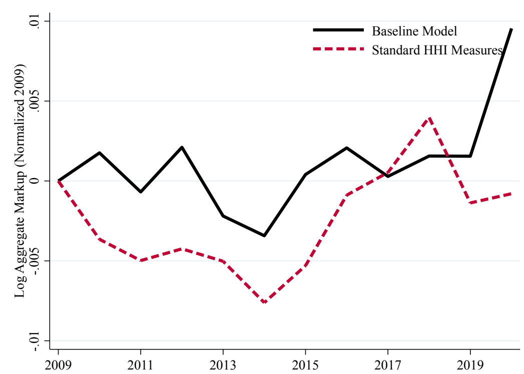
(b) Concentration: Naive HHI Measures



(c) Markup Evolution: Baseline



(d) Markup Evolution: Naive HHI Measures



Notes: The figure plots the histograms of the importer and exporter concentration indices and implied markup evolution when using the model-implied concentration measures (Panel a and c) and naive concentration measures (Panel b and d).

B Theoretical appendix

B.1 Derivation of equation (18)

We approximate the aggregate markup in equation (15) by taking a first order approximation around $s_{ij} = 0$ and $x_{ij} = 0$. When both bilateral shares are infinitesimal, the term λ_{ij} converges to 1, which means that the weighting factor ω_{ij} ϕ, the buyer's bargaining power. Therefore, bilateral markups μ_{ij} converge to $(1-\phi)\frac{\rho}{\rho-1}+\phi$. Approximating equation (15) around $\mu_{ij} = (1-\phi)\frac{\rho}{\rho-1}+\phi$ and substituting in equation (10), we obtain:

$$\mu \approx \sum_i \sum_j \iota_{ij}\mu_{ij} \tag{1}$$

$$= \sum_i \sum_j \iota_{ij}(1-\phi)\,\mu_{ij}^{oligopoly} + \sum_i \sum_j \iota_{ij}\phi\mu_{ij}^{oligopsony}. \tag{2}$$

The first term in equation (2) can be written as:

$$\begin{aligned}
\sum_i \sum_j \iota_{ij}(1-\phi)\,\mu_{ij}^{oligopoly} &= \sum_i \sum_j \iota_{ij}(1-\phi)\frac{1}{1-\frac{1}{\rho}\frac{1}{1-\frac{\rho-\tilde{\nu}}{\rho}s_{ij}}} \\
&= \sum_i \sum_j \iota_{ij}(1-\phi)\frac{1}{1-\frac{1}{\rho}\sum_{m=0}^{\infty}\left(\frac{\rho-\tilde{\nu}}{\rho}\right)^m s_{ij}^m} \\
&= \frac{\rho}{\rho-1}\sum_i \sum_j \iota_{ij}(1-\phi)\frac{1}{1-\frac{1}{\rho-1}\sum_{m=1}^{\infty}\left(\frac{\rho-\tilde{\nu}}{\rho}\right)^m s_{ij}^m} \\
&= \frac{\rho}{\rho-1}\sum_i \sum_j \iota_{ij}(1-\phi)\sum_{n=0}^{\infty}\left(\frac{1}{\rho-1}\right)^n\left(\sum_{m=1}^{\infty}\left(\frac{\rho-\tilde{\nu}}{\rho}\right)^m s_{ij}^m\right)^n \\
&\approx \frac{\rho}{\rho-1}\sum_i \sum_j \iota_{ij}(1-\phi) + \frac{\rho}{\rho-1}\frac{\rho-\tilde{\nu}}{(\rho-1)\,\rho}\sum_j \varphi_j HHI_j^{s_{ij}},
\end{aligned} \tag{3}$$

where we have leveraged the assumption that $\rho > \tilde{\nu}$, and the last line makes an approximation around $s_{ij} = 0$ by ignoring higher order terms of $\sum_{n=0}^{\infty}\left(\frac{1}{\rho-1}\right)^n\left(\sum_{m=1}^{\infty}\left(\frac{\rho-\tilde{\nu}}{\rho}\right)^m s_{ij}^m\right)^n$. The second term in (2) can be written as:

$$\begin{aligned}\sum_i \sum_j \iota_{ij}\phi\mu_{ij}^{oligopsony} &= \sum_i \sum_j \iota_{ij}\phi\theta\frac{1-(1-x_{ij})^{\frac{1}{\theta}}}{x_{ij}} \\ &\approx \sum_i \sum_j \iota_{ij}\phi\left(1-\frac{1-\theta}{2\theta}x_{ij}\right) \\ &= \sum_i \sum_j \iota_{ij}\phi - \frac{1-\theta}{2\theta}\phi\sum_i \varphi_i HHI_i^{x_{ij}}, \end{aligned} \tag{4}$$

where the second line is obtained by taking a first order approximation of $\mu_{ij}^{oligopsony}$ around $x_{ij}=0$. Combining equations (2)-(4), we arrive at equation (15).

B.2 Aggregate effects of bilateral markups on domestic prices

We focus on how bilateral markups aggregate up and constitute the price index of the buyers' outputs. To be consistent with the model setup in Section 2.1, here we assume that buyers have a Cobb-Douglas production function with γ being the Cobb-Douglas share on imports. For the rest of the inputs (with Cobb-Douglas share $1-\gamma$), we assume that all buyers face a common price of p_D. We consider an economy where buyers' outputs are aggregated up in a CES manner with elasticity ν. In this output market, buyers engage in monopolistic competition in the output market, charging a common markup of $\frac{\nu}{\nu-1}$. We derive the aggregate price index of the buyers' output bundle and investigate how the bilateral markups that buyers face affect this price index.

The price index of the buyers' output, P_F, can be written as

$$\begin{aligned} P_F &= \left(\sum_j \zeta_j^{\nu}\left(\frac{\nu}{\nu-1}c_j\right)^{1-\nu}\right)^{\frac{1}{1-\nu}} \\ c_j &= \underbrace{\left(\sum_i \varsigma_{kj}^{\rho} p_{ij}^{1-\rho}\right)^{\frac{\gamma}{1-\rho}}}_{\left(p_j^f\right)^{\gamma}} p_D^{1-\gamma}, \end{aligned}$$

where ζ_j is the buyer-specific saliency parameter. To compute how bilateral markups constitute the price index, we define μ_F as the ratio of the price index P_F over the same price index under $\mu_{ij} = 1$, $\tilde{P}_F$. Therefore,

$$\mu_F = \left(\frac{\tilde{P}_F}{P_F}\right)^{-1} = \left(\sum_j s_j \left(\sum_i s_{ij}\left(\frac{1}{\mu_{ij}}\right)^{1-\rho}\right)^{\frac{1-\nu}{1-\rho}\gamma}\right)^{\frac{-1}{1-\nu}},$$

where s_j is the share of buyer j's output among all buyers. Approximating μ_F around $s_{ij} = 0$ and $x_{ij} = 0$ yields the following:

$$\mu_F \approx (1-\gamma)\left(\frac{\rho}{\rho-1}\right)^{\gamma} + \left(\frac{\rho}{\rho-1}\right)^{-(1-\gamma)} \gamma \sum_i \sum_j \iota_{ij}\mu_{ij}. \tag{5}$$

Notice that when buyers use only their imports as their inputs, $\gamma = 1$, then equation (5) collapses to equation (1). Even in a more general case where $\gamma < 1$, the equation is an affine transformation of equation (1): The way in which bilateral markups μ_{ij} affect the aggregate markup remains the same.

B.3 Estimation of the Parameter ϕ

Let's write the log bilateral price of product h exchanged between exporter i and importer j in year t as:

$$\ln p_{ijt}^h = \ln \mu\left(\phi, \theta; \Omega_{ijt}\right) + \ln c_{it}^h + u_{ijt}^h,$$

where Ω_{ijt} denotes the information set available to a generic exporter-importer pair $i - j$ during negotiations, which includes the supplier and buyer shares (s_{ijt}^h and x_{ijt}^h) and the calibrated parameters (ν, γ, ρ, and θ). An inspection of equation (10) reveals that conditional on the information set Ω_{ijt}, the bilateral markup is only a function of the model primitiveϕ , i.e., $\mu_{ij} = \mu\left(\phi; \Omega_{ijt}\right)$.

The log price is equal to the sum of the log markup and the (duty-inclusive) log marginal cost. We write the latter as the sum of an exporter-specific component, $\ln c_{it}^h$, common to all importers, and a (conditional) mean-zero i.i.d. term u_{ijt}^h, capturing cost differences across the buyers of a given suppliers. This term accounts for unobserved factors driving marginal cost differences across buyers that our model is agnostic about, such as quality differentiation or input customization.

The previous specification implies that conditional on the relevant information sets $\boldsymbol{\Omega}_{ijkt} \equiv (\Omega_{ijt}, \Omega_{ikt})$, the expected difference in exporter $i's$ marginal cost across importers j and k is zero, namely, $E_u\left[u^h_{ijt} - u^h_{ikt}; \mathbf{\Omega}_{ijkt}\right] = 0$. Taking the difference of the expected prices that i charges to importers j and k yields the following moment condition:

$$g(\phi, \theta; \mathbf{\Omega}_{ijkt}) \equiv E_u\left[\ln p^h_{ijt} - \ln p^h_{ikt} - \left(\ln \mu\left(\phi; \Omega_{ijt}\right) - \ln \mu\left(\phi; \Omega_{ikt}\right)\right); \mathbf{\Omega}_{ijkt}\right] = 0, \forall\ i, j, k, t. \tag{6}$$

The identification of ϕ, which is discussed in Alviarez et al. (2022), relies on this equation.

The moment condition (6) is estimated via generalized method of moments (GMM),

$$\min_{\{\boldsymbol{\phi},\theta\}} \mathbf{g}(\boldsymbol{\phi})\ \mathbf{Z}'\ \mathbf{W}\ \mathbf{Z}\ \mathbf{g}(\boldsymbol{\phi})', \tag{7}$$

where $\mathbf{g}(\boldsymbol{\phi})$ stacks all moment conditions in (6) across all $i - j - k$ pairs and years and $\mathbf{W}$ is the optimal weighting matrix.