Concentration and Markups in International Trade

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Abstract

This paper examines the relationship between concentration and markups in international trade, highlighting the role of firm-to-firm trade and bilateral market power. We derive an equilibrium link between concentration and markups, showing that both supplier and buyer concentration matter. To capture the rigidity of trade relationships, we introduce novel concentration measures. Applying this framework to Colombian import data (2009–2020), we find that rising exporter concentration was offset by increasing importer concentration, leading to stable markups. This contrasts with standard HHI-based analyses, underscoring the need to account for bilateral market power and the networked structure of trade in GVCs.

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1 Introduction

The rise of global supply chains has placed intermediate input markets at the center of economic activity. These markets now account for a substantial share of both gross output and international trade, making them essential to understanding production costs and final goods prices. Unlike final goods markets–where many atomistic buyers interact with producers–input markets often resemble *bilateral oligopolies*, with large suppliers and buyers negotiating prices bilaterally. This concentration raises fundamental questions about global market power, particularly as multinational firms grow increasingly dominant (Autor et al., 2020; Keller and Yeaple, 2020; Alviarez et al., 2025). Yet despite its significance, measuring market power remains a key empirical challenge.

A growing body of research examines the relationship between concentration and market power. Standard oligopoly theory suggests that as industries become more concentrated, markups rise and consumer surplus declines. However, many markets deviate from this textbook framework, and concentration alone is often a poor predictor of firms' ability to set prices (Syverson, 2019). Despite these limitations, concentration measures remain widely used in economic and antitrust research, largely because they are easier to observe than markups. An open question, however, is when and how concentration actually reflects market power.

This paper shows that concentration can serve as a useful tool for understanding markups in international trade, where most transactions involve intermediate inputs. We develop a model of firm-to-firm trade in which both importers and exporters exert market power. The network of trade relationships is treated as exogenous, capturing the "lock-in" effects that characterize global supply chains (Antràs, 2020). Our analysis yields two key insights. First, aggregate markups depend on both supplier (exporter) and buyer (importer) concentration, underscoring the two-sided nature of market power in these settings. Second, standard concentration indices must be adjusted to account for the rigidity of trade relationships, requiring a narrower market definition than conventional models assume. Applying our framework to Colombian import data, we illustrate how standard concentration measures may misrepresent markup dynamics in supply chains.

Our theory builds on the pricing theory of firm-to-firm trade in Alviarez et al. (2022). Our main contribution is a formula linking aggregate industry markups on imported intermediate inputs to both exporter (supplier) and importer (buyer) concentration. Higher exporter concentration raises markups through oligopoly power, while higher importer concentration lowers them through countervailing oligopsony power. The extent to which supplier and buyer concentration influence markups depends on supply and demand elasticities, which determine the scope for oligopoly and oligopsony forces. The bargaining power of importers and exporters shapes the balance between these forces.

We find that Colombian importers wield substantial bargaining power–often exceeding

that of exporters. Our identification strategy builds on Alviarez et al. (2022) and leverages cross-sectional variation in prices across importers for a given exporter, as well as their co-movement with exporter and importer market shares. Combined with the upward-sloping supply elasticity of foreign exports, these estimates indicate significant oligopsony power among Colombian importers. These findings confirm the empirical relevance of two-sided market power in our data.

The tractability of our model comes at the cost of several assumptions. A crucial assumption is that importer-exporter relationships are exogenously fixed, meaning that a firm's outside option is limited to its existing set of buyers or suppliers. This assumption reflects lock-in effects, such as high search and matching costs, relationship-specific investments, high intangible flows, and contractual imperfections. This structure carries important implications for measuring concentration. Specifically, our framework generates refined Herfindahl-Hirschman indices (HHI) that, while requiring more granular data than standard measures, remain similarly tractable and more accurately reflect the constraints of firm-to-firm trade.

We find that between 2009 and 2020, exporter concentration increased, while importer concentration remained persistently high with a slight upward trend. In contrast, standard industry-based HHI indices indicate weaker exporter trends and a sharp decline in importer concentration. This discrepancy highlights the limitations of conventional concentration measures in capturing the market structure of firm-to-firm trade.

Despite rising exporter concentration, our theory implies that high importer concentration and strong buyer power have counteracted its effects, keeping markups largely unchanged. These findings underscore the need to account for both exporter and importer concentration, as well as the persistence of trade relationships, to more accurately assess competition in global value chains.

This paper contributes to the literature on concentration trends and their broader economic implications. Most existing studies focus on U.S. production data, documenting rising industry concentration across various sectors (Covarrubias et al., 2020; Grullon et al., 2019; Kwon et al., 2024). These trends have been linked to higher aggregate markups (De Loecker et al., 2020; Hall, 2018; Traina, 2018), fueling debate over the relationship between concentration and market power.

Standard concentration measures, however, face notable challenges (Syverson, 2019). Rossi-Hansberg et al. (2021) show that defining markets locally rather than nationally reverses observed trends, while Amiti and Heise (2022) find that accounting for foreign trade flows significantly alters the picture of U.S. manufacturing concentration. Our study adds to this literature by emphasizing the role of intermediate input markets and their distinct market structure.

An important caveat is that our analysis focuses on intermediate input transactions in firm-to-firm trade. Unlike much of the literature, which examines concentration on final

goods markets, we measure concentration in upstream markets. This matters because our findings reflect the structure of input markets rather than final goods markets. While input market concentration affects final good markups through input costs and has clear welfare implications, our study does not directly assess its impact on consumer prices. Doing so would require further assumptions, which lie beyond the scope of this paper.

Our work also relates to the industrial organization literature on bilateral oligopolies and buyer power in vertical relationships. Much of this research examines settings where a few suppliers negotiate with a few buyers, often in the context of vertical mergers (Hart et al., 1990; O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994; Segal, 1999; De Fontenay and Gans, 2005; Gans, 2007). The most closely related work is Hendricks and McAfee (2010), who study a homogeneous goods industry and similarly highlight the importance of both buyer and seller concentration. Our approach, however, is more tractable and well-suited for empirical analysis. By embedding traditional pricing models from international trade and macroeconomics as special cases, our framework provides a flexible structure that can accommodate a wider range of industries while maintaining analytical tractability.

2 Theoretical Framework

This section establishes a formal link between *industry concentration* and *aggregate markups* in an industry's global supply chain. Our theory builds on the pricing model for global value chains developed by Alviarez et al. (2022), summarized in Section 2.1. Section 2.2 derives the main theoretical result.

2.1 A Pricing Model of GVCs

The industry consists of a finite number of *exporters* (indexed by i) and *importers* (indexed j) trading an intermediate input h. Let $\mathcal{Z}_j^h$ ($\mathcal{Z}_i^h$) denote the set of exporters (importers) matched with importer j (exporter i). Hereafter, we omit the h notation unless necessary.

Each exporter i produces a differentiated variety of the input, selling $q_i = \sum_{j \in \mathcal{Z}_i} q_{ij}$ units to its importers, where q_{ij} is the quantity sourced by importer j. The marginal cost of production, common across importers, is:

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

where $\theta \in (0, 1]$ governs returns to scale, and k_i is an exogenous constant.

Each importer j uses intermediate inputs to produce a differentiated final good for

sale in a downstream market. Production follows a nested CES structure:

$$q_j = \prod_{h \in \Omega_j} \left(q_j^h\right)^{\gamma_h}, \quad q_j^h = \left(\sum_{i \in \mathcal{Z}_j} \varsigma_{ij} \left(q_{ij}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}. \tag{2}$$

Here, $\gamma_h \in (0,1)$ is the output elasticity of input h, which determines its cost share, $\rho > 1$ is the substitution elasticity, and ς_{ij} is a preference shifter.

Each firm sources each given input exclusively from either domestic suppliers or foreign exporters, but not both. This assumption, made to align the model with the data, implies that competition occurs only among suppliers within the same sourcing category (domestic or foreign) for a given input h.[1]

Finally, the final good market is monopolistically competitive, with demand governed by a CES function with elasticity ν.

2.1.1 Bargaining Structure and Gains From Trade

We consider a behavioral model of vertical conduct in which the importer first selects an output level for each input variety, $\{q_{ij}\}$, given prices $\{p_{ij}\}$. The importer and exporter then bargain over p_{ij} to maximize a Nash product:[2]

$$\max_{p_{ij}} \left(\pi_i^D(p_{ij}, q_{ij})\right)^{1-\phi} \left(\pi_j^U(p_{ij}, q_{ij})\right)^{\phi}, \tag{3}$$

where $\phi \in (0,1)$ represents the importer's bargaining power. The negotiated price p_{ij} follows the *Nash-in-Nash* solution concept, taking as given the negotiated outcomes in other links of the network (Horn and Wolinsky, 1988).

Since bargaining occurs over price and the importer chooses the price, quantities always move along the importer's demand function, which can be derived from cost minimization as:

$$q_{ij} = \gamma c_j q_j \varsigma_{ij}^{\rho} \left(\frac{p_{ij}}{p_j^h}\right)^{-\rho}, \tag{4}$$

where $p_j^h = \left(\sum_i \varsigma_{ij}^{\rho} p_{ij}^{1-\rho}\right)^{\frac{1}{1-\rho}}$ is the price index of input h, and c_j is importer j's marginal cost of production.

To characterize the relative importance of each trading relationship, we define the surplus-relevant market shares:

$$s_{ij} \equiv \frac{p_{ij} q_{ij}}{\sum_{k \in \mathcal{Z}_j} p_{kj} q_{kj}} \in (0,1), \qquad x_{ij} \equiv \frac{q_{ij}}{\sum_{k \in \mathcal{Z}_i} q_{ik}} \in (0,1). \tag{5}$$

[1] Although not explicitly modeled, the inclusion of labor and capital in production can be accommodated by appropriately relabeling the intermediate inputs.

[2] This setup corresponds to the "monopolistic bargaining" game in Demirer and Rubens (2024) or partial bargaining in Toxvaerd.

Here, s_{ij} represents exporter i's *supplier share*, i.e., its sales as a fraction of importer j's total imports, while x_{ij} represents importer j's *buyer share*, i.e., its purchases as a fraction of exporter i's total output.

Using these definitions, we express the "downstream" and "upstream" profits of exporter i and importer j, respectively, as:

$$\pi_i^D(p_{ij}, q_{ij}) = p_{ij}q_{ij} - \theta c_i q_i \Delta_{ij}^x, \qquad \pi_j^U(p_{ij}, q_{ij}) = p_j q_j \Delta_{ij}^s - p_{ij}q_{ij}, \tag{6}$$

where $\Delta_{ij}^x \equiv 1-(1-x_{ij})^{\frac{1}{\theta}}$ and $\Delta_{ij}^s \equiv 1-(1-s_{ij})^{\frac{\eta-1}{\rho-1}}$ capture the change in the exporter's total costs and importer's total revenues in the event of a failed negotiation.[3]

2.1.2 Bilateral Prices and Markups

The optimal price p_{ij} can be found by solving equation (3). 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 outcome in other links in the network (Horn and Wolinsky, 1988).

Alviarez et al. (2022) demonstrate that the solution to equation (3) 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:

$$\mu_{ij} = (1-\omega_{ij})\,\mu_{ij}^{oligopoly}(s_{ij}) + \omega_{ij}\mu_{ij}^{oligopsony}(x_{ij}), \tag{7}$$

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:

$$\mu_{ij}^{oligopoly}(s_{ij}) = \frac{\varepsilon_{ij}}{\varepsilon_{ij}-1} > 1, \tag{8}$$

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

$$\varepsilon_{ij} = \rho\,(1-s_{ij}) + (1-\gamma+\nu\gamma)\,s_{ij}. \tag{9}$$

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 (8) 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

[3] In this framework, all transactions generate positive surplus, ensuring trade occurs between all $i-j$ pairs.

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.

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:

$$\mu_{ij}^{oligopsony} = \theta \left(\frac{1 - (1 - x_{ij})^{\frac{1}{\theta}}}{x_{ij}} \right) \in [\theta, 1] \,, \tag{10}$$

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:

$$\omega_{ij} \equiv \frac{\frac{\phi}{1-\phi}\lambda_{ij}}{\frac{\phi}{1-\phi}\lambda_{ij} + 1} \in (0, 1) \,, \tag{11}$$

which is an increasing function of $\frac{\phi}{1-\phi}\lambda_{ij}$, the product of the exogenous relative buyer's bargaining power and a term $\lambda_{ij} \equiv \frac{s_{ij}}{\Delta_{ij}^s} \cdot \frac{(\nu-1)\gamma_h}{\varepsilon_{ij}-1} \geq 1$ that is inversely related to the buyer j's gains from trade with supplier i via the term Δ_{ij}^s / 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.[4]

[4]The bargaining weight converges to the buyer's bargaining power, ϕ, when $s_{ij} \to 0$, $\lim_{s_{ij} \to 0} \omega_{ij} = \phi$.

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:

$$\mu \equiv \frac{\sum_i \sum_j p_{ij} q_{ij}}{\sum_i \sum_j \theta c_i q_{ij}} = \left(\sum_i \sum_j \iota_{ij} \mu_{ij}^{-1} \right)^{-1}, \tag{12}$$

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

Given the equilibrium expression for the bilateral markup in (12), 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:

$$HHI^{suppliers} \equiv \sum_j \varphi_j HHI_j^{s_{ij}}, \quad \text{where} \quad HHI_j^{s_{ij}} \equiv \sum_i s_{ij}^2. \tag{13}$$

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:

$$HHI^{buyers} \equiv \sum_i \varphi_i MHHI_i^{x_{ij}}, \quad \text{with} \quad MHHI_i^{x_{ij}} \equiv \sum_j x_{ij}^r x_{ij}. \tag{14}$$

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:

$$\begin{aligned}\mu \approx & (1-\phi)\frac{\rho}{\rho-1}+\phi \\ & +(1-\phi)\left[\frac{\rho-\tilde{\nu}}{(\rho-1)^2}HHI^{suppliers}\right] \\ & -\phi\left[\frac{1-\theta}{2\theta}HHI^{buyers}\right], \end{aligned} \tag{15}$$

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

Proof See Appendix B.1.

Equation (15) 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.[5]

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:

$$\Delta_t^{t+k}\mu = (1-\phi)\left(\frac{\rho-\tilde{\nu}}{(\rho-1)^2}\right)\Delta_t^{t+k}HHI^{suppliers} - \phi\left(\frac{1-\theta}{2\theta}\right)\Delta_t^{t+k}HHI^{buyers}, \tag{16}$$

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

where $\Delta_t^{t+k} x \equiv x_{t+k} - x_t$ denotes the $k-$year difference in variable x. Notably, equation (16) 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.[6]

2.3 Discussion and Comparison with Standard Approaches

Our partial equilibrium theory of prices in firm-to-firm trade diverges from conventional Cournot-like trade models in two dimensions. Firstly, we allow prices to be set bilaterally, rather than unilaterally by exporters. From the perspective of our theory, unilateral price-setting by exporters corresponds to the case where ϕ approaches 0. Equation (16) illustrates the implication of bilateral market power: when both sides of the transactions can influence prices, markups depend not only on concentration among exporters, but also on concentration among importers. Importantly, the two concentration measures have opposite effects on markups. While exporter concentration is positively associated with markups, reflecting oligopoly power, importer countervailing power is proportional to concentration among importers, resulting in a negative relationship between markups and importer concentration.

The second fundamental divergence between our theory and conventional trade models lies in the definition of the market. A key premise of our pricing theory of GVCs is that, during negotiations, exporters (importers) do not consider the possibility of adding or removing links to their network of buyers (suppliers) in case of a failed agreement. Essentially, a firm's perceived outside option during negotiations is its existing buyer or supplier set, resembling an infinite cost of switching trade partners.

In contrast, standard Cournot models of trade assume that exporters sell to all buyers in a destination country. Viewed through the lens of a firm-to-firm trade model, the implicit assumption is that, from the perspective of buyers, the cost of switching suppliers is negligible, suggesting that all exporters in an industry compete directly against each other. Furthermore, conventional views of the relevant market are encompassed within our theory as the limit case where there is only one representative importer in the industry.

The previous discussion implies that conventional models are nested by our theory as limit case of parameters and network structure. When taking $\phi \to 0$ and with one representative importer, changes in industry markups can be written as:

$$\Delta_t^{t+k} \mu = \left(\frac{\rho - \tilde{\nu}}{(\rho - 1)^2} \right) \Delta_t^{t+k} HHI^{suppliers,std}, \tag{17}$$

[6]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.

where we use the notation $HHI^{suppliers,std}$ to indicate the "standard" HHI measure, defined as (Grassi, 2018; Burstein et al., 2020):

$$HHI^{suppliers,std} = \sum_i s_i^2, \qquad \text{where} \qquad s_i = \frac{p_i q_i}{\sum_i p_i q_i} = \frac{\sum_j p_{ij} q_{ij}}{\sum_i \sum_j p_{ij} q_{ij}}. \tag{18}$$

The market being defined at the industry level, a firm's market share s_i in this case correspondes to the firm's share of total industry sales.

While standard models typically focus on concentration among suppliers, the related conventional measure of importer concentration is:

$$HHI^{buyers,std} = \sum_j x_j x_j^r, \qquad \text{where} \qquad x_j = \frac{q_j}{\sum_j q_j} = \frac{\sum_i q_{ij}}{\sum_i \sum_j q_{ij}}, \tag{19}$$

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 (19) represents concentration among buyers in a model where buyers purchase inputs from all dispersed, price-taking suppliers in the industry.

One way to interpret the concentration measures in equations (18) and (19) is that they represent simple indicators that practitioners could utilize to assess concentration among suppliers and buyers in a given industry. However, the markup-relevant measures of supplier and buyer concentration in equations (13) and (14) are inherently different from those in (18) and (19), respectively, reflecting the distinct view on what constitutes a market and the ease with which firms can switch trade partners.

From the perspective of our model, the conventional measures accurately capture the degree of concentration only in the limit case when there is only one supplier and one buyer in the industry. Hence, the bias in a naive HHI-based approach increases in industries characterized by numerous heterogeneous importers and exporters. Comparing the results obtained using the model-implied measures with those obtained using standard measures can provide insights into the importance of considering the network of firm-to-firm trade when measuring concentration in bilateral oligopolies.

Figure 1 illustrates this concept. Each red circle represents a foreign exporter, while blue circles represent domestic importers. The number inside each red circle indicates the exporter's share of the importers' imports, while the numbers inside the blue circles indicate the importers' share of the exporters' sales.

From the perspective of a conventional HHI-based approach, the industries appear similar. The standard exporter Herfindahl index ranges between 0.16 and 0.17 in both cases, suggesting that both industries are competitive. However, when viewed through the lens of our theory, the two industries exhibit striking differences. Even without considering bilateral market power, in Industry 1, each importer exclusively purchases from a single foreign exporter. Consequently, exports are entirely concentrated from the

perspective of individual importers, resulting in an average exporter HHI of 1. Conversely, in Industry 2, there is only one importer who procures from multiple foreign exporters. In this scenario, conventional HHI measures accurately reflect concentration in the industry, even when considering firm-to-firm trade.

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. In what follows, we illustrate the implications of our approach in an application using Colombian transaction-level import data.

3 Data and Stylized Evidence

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.[7]

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.

[7]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.

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 exporteri'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 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 (13) and (14), respectively.

We also construct the "standard" concentration measures $HHI^{suppliers,std}$ and $HHI^{buyers,std}$ from equations (18) and (19), where the suppliers' and buyers' (quantity and value) shares are defined as $s_i^h \equiv \frac{\sum_{j\in\mathcal{Z}_i^h} p_{ij}^h q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h}\sum_{j\in\mathcal{Z}_k^h} p_{kj}^h q_{kj}^h}$, $x_j^h \equiv \frac{\sum_{i\in\mathcal{Z}_j^h} q_{ij}^h}{\sum_{k\in\mathcal{Z}_j^h}\sum_{j\in\mathcal{Z}_k^h} q_{kj}^h}$ 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 "network-based" concentration measures defined in equations (13) and (14), but we will also discuss how they compare to traditional measures later in this section.

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.[8] 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

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

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.

Finally, we explore the comparison between the "standard" concentration measures and the model-implied ones discussed earlier. Figure A.3 illustrates the incidence of exporter and importer concentration in Colombian imports using network-based and standard measures. The figure depicts the cumulative distribution function (CDF) of importer and exporter concentration, with the red and black lines representing network-based and standard measures, respectively. The disparity between network-based and standard measures is evident, with concentration appearing much lower when employing standard measures, attributable to the broader market definition they entail.

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.

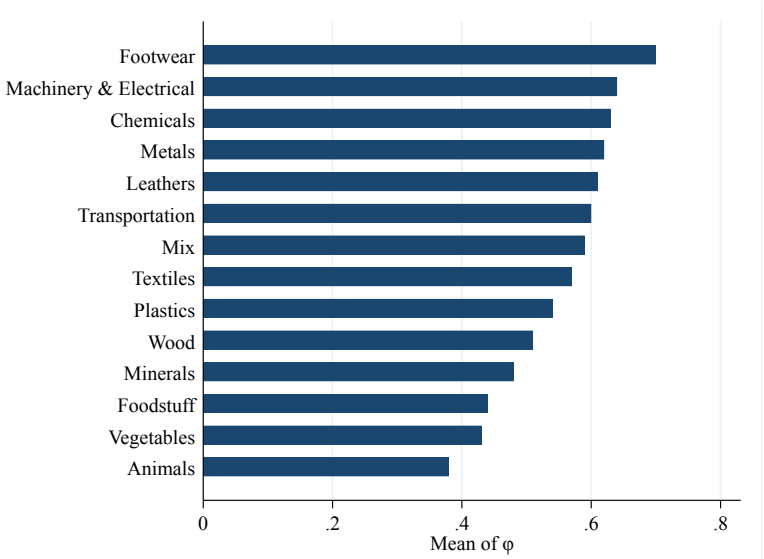
3.4 Calibration and Estimation of Key Parameters

To bring equation (16) 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 involves two steps. In the first step, we calibrate the values of the parameters ρ, θ, ν and γ. We follow Alviarez et al. (2022) and set the values of ρ, ν, and γ equal to 10, 4, and 0.5, respectively. The value of ν, the demand elasticity that importers face downstream, is in the ballpark of estimates in Broda and Weinstein (2006). We set the importer $j's$ marginal cost elasticity to foreign inputs to $\gamma = 0.5$, a value which we calibrate to match the cost share of foreign inputs in production. The value of ρ captures high substitutability across foreign varieties of intermediate inputs, which we define at the HS10 level. Lastly, we set $\theta = 0.8$ to match the cost share of variable inputs in production.

Armed with these estimates, we proceed to estimate the importer bargaining power ϕ, which we allow vary at the HS2 product level. We adopt the estimation strategy developed in Alviarez et al. (2022), which we describe in details in Appendix B.3. This strategy can be summarized as follows. Our theory implies that the markup at the bilateral

Figure 1: Importers' Bargaining Power: Estimates



Notes: The figure displays the estimates of the importers' bargaining power (ϕ) by broad HS categories. See Appendix B.3 for details on estimation routine, which follows the approach in Alviarez et al. (2022).

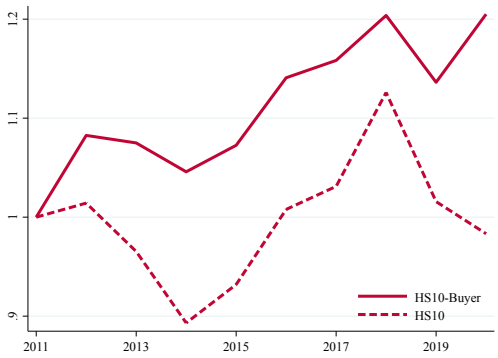
pair level can be expressed as a function of parameters that need to be estimated and market shares, which are observed. Conditional on the exporter's marginal cost, assumed constant across buyers of a given exporter, the difference in the bilateral price that a given exporter charges to two different importers j and j' equals the difference in markups. We estimate ϕ as the value that minimizes the distance between the observed price difference across exporter-importer j-importer j' triples and their markup differences.

Figure A.3 shows estimates by broad product group. Across HS2 products, the estimated importer's bargaining power ranges between 0.5 and 0.7, displaying significant heterogeneity across industries. This suggests that Colombian importers' bargaining power is at least as strong as that of their foreign counterparts. In the average industry, the bargaining power of Colombian importers is about twice as high as that of foreign exporters.

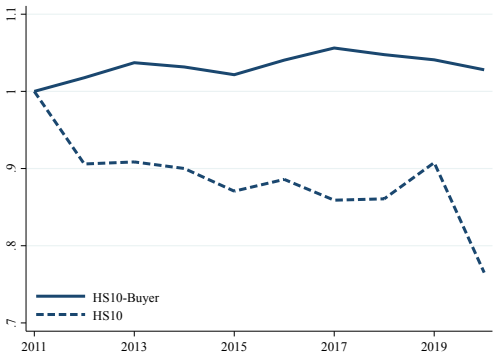
In contrast to standard models of oligopolistic competition, which typically assume price-taking buyers, our estimates reveal substantial bargaining power on the side of importers. Furthermore, these estimates align with findings from related studies in the literature. For example, in companion research using U.S. import data, we find that U.S. importers' bargaining power exceeds that of foreign exporters by a factor of four (Alviarez et al., 2022). Similarly, using data on Argentinian importers, Atkin et al. (2024) demonstrate that Argentinian importers hold the market power in the majority of their interactions with most trading partners. These findings suggest potentially significant implications of our theory for understanding the role of concentration in international trade, as we elaborate in the next Section.

Figure 2: Importer and Exporter Concentration Over Time

(a) Exporter Concentration



(b) Importer Concentration



4 Concentration and Aggregate Markups

The trends in import and export concentration between 2011 and 2020 in Colombian import data provide insights into the evolution of aggregate import markups during the same period. Figure 2 illustrates the evolution of exporter and importer concentration in Colombian data over this timeframe. The left panel focuses on exporter concentration, while the right figure on importer concentration, both normalized to the initial year. The solid line in each figure corresponds to the concentration measures implied by our model, wwhile the dashed line is the standard HHI index. 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.

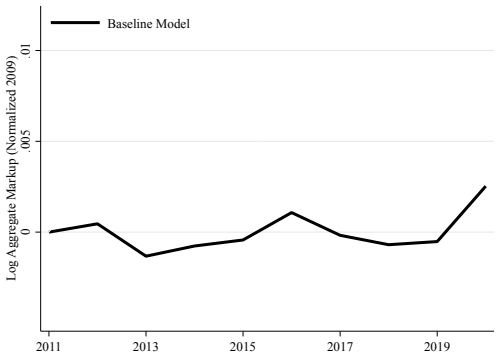
In the network-based measures, import concentration remains consistently high throughout the sample period, averaging 0.84, with a relatively stable trend. Exporter concentration, on the other hand, is lower, averaging 0.65, but exhibits an upward trend over time, increasing from 0.6 in 2011 to 0.72 in 2020. While importer concentration remains relatively stable throughout the sample period, there is a noticeable increase in exporter concentration.

Conversely, the trends observed in the standard concentration measures appear markedly different. Exporter concentration does not exhibit any clear trend, while importer concentration demonstrates a decline of approximately 10 percentage points over the sample period. These contrasting patterns indicate that adopting a naive HHI-based approach to analyzing concentration in GVC trade may lead to significant biases.

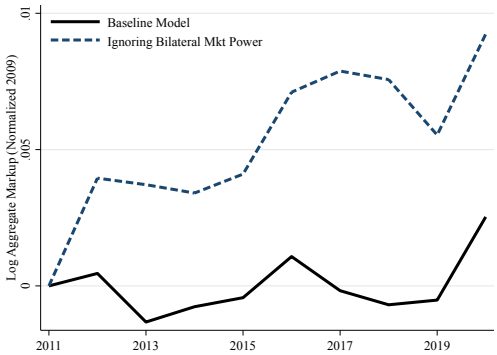
Figure 3 illustrates the evolution of aggregate import markup implied by different models, where all markup trends are normalized to their value in 2011. Panel (a) presents our baseline model, where both bilateral market power and the network structure of trade are taken into account. Panel (b) compares our baseline markup estimates with those that would be obtained in an alternative model, where we keep all parameters the same

Figure 3: Markup Trends in Different Models

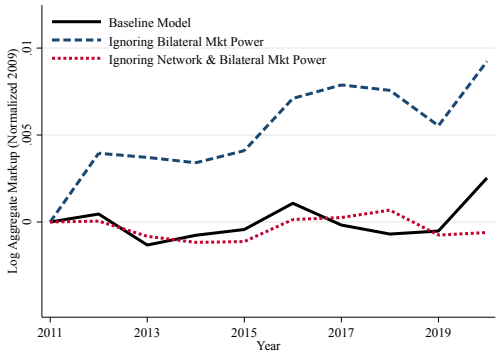
(a) Baseline Model



(b) Ignoring Bilateral Market Power



(c) Ignoring Network & Bilateral Market Power



except for the importers' bargaining power, which we set to 0. Panel (c) compares the previous two lines with the markup evolution implied by naive HHI-based analysis, using the formula in (17). This line ignores both the bargaining power of importers and considers a broad market definition where exporters sell to all importers in the industry.

The Figure illustrates that our baseline model implies no discernible trends in markups between 2011 and 2020, despite the significant increase in exporter concentration shown in Figure 2. The lack of a markup trend can be attributed to the significant bargaining power we estimate for Colombian importers. This implies that the upward trend in exporter concentration has only a mild anti-competitive effect, owing to the importers' countervailing power. The difference between the black line and the blue line illustrates that disregarding the role of importers' countervailing power would result in a considerable overestimation of markup evolution.

Perhaps surprisingly, Panel (c) shows that the bias seems small in naive HHI-based analysis. However, this pattern is purely coincidental. The absence of a trend in the red dashed line is attributed to the lack of trend in exporter concentration when using standard measures shown in Panel (b) of Figure 2. Additionally, the Figure depicts normalized markup trends. If markup levels were plotted instead, the differences between

the three models would be even more significant.

While this is a simple illustration, 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.

5 Conclusions

An essential aspect of GVCs, and of trade within modern production networks more broadly, is the presence of market power among both buyers and suppliers, who negotiate bilaterally over transaction prices within a sparse network of firm-to-firm relationships. This study delves into 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 fresh perspective on the role of concentration within production networks. It highlights the importance of considering concentration among both suppliers and buyers and introduces a unique understanding of the relevant market definition and concentration measures. Our empirical application highlights that the biases associated with ignoring these key features of trade in GVCs may be substantial.

Our study sheds light on the role of concentration in modern economies. Against the backdrop of the increasing attention on concentration and its impact on markups in recent years, our findings underscore the importance of exercising caution in evaluating these trends. As production networks rise to prominence, reflecting a secular shift towards production being spread across different firms and increased specialization within firms, it becomes imperative to reconsider traditional methods of assessing concentration.

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A Additional Tables and Figures

Table A.1: Colombian Imports: Statistics

	Imports (MLN USD)	UN Comtrade	Transactions	Pairs	Unique buyers	Unique suppliers
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.

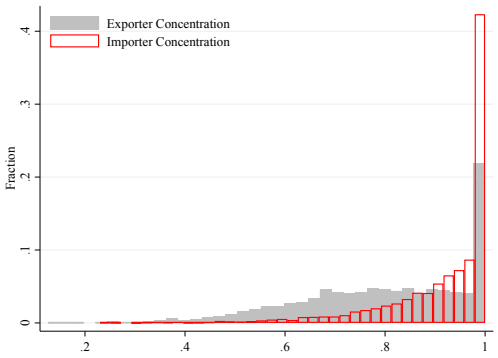
Table A.3: Estimates of ρ, θ and ϕ across Product Groups

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

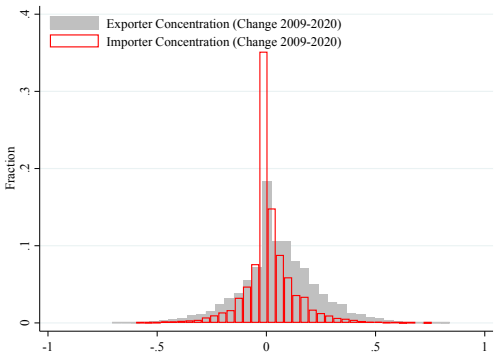
Notes: The table reports the average estimate of ρ, θ and ϕ across product groups. Estimates of parameters ρ and θ and at the HS2 level are obtained from the limited information maximum likelihood (LIML) routine developed in Soderbery (2018), which we apply to our Colombian import data. Estimates of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

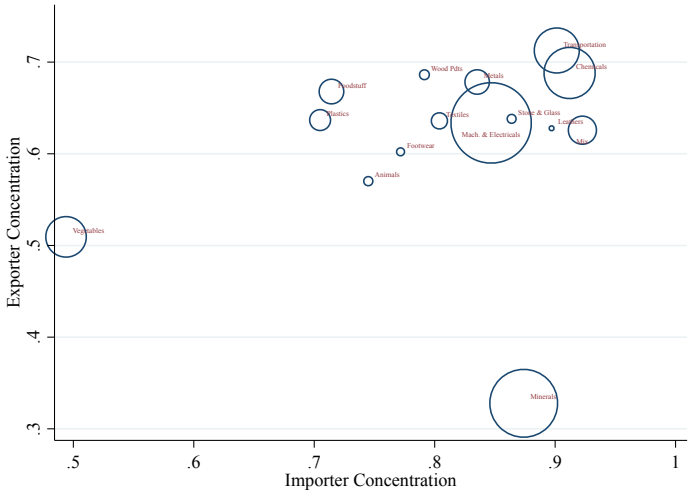


(b) Change (2009-2020)



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.

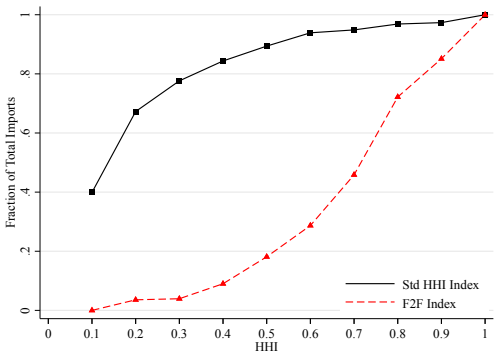
Figure A.2: Importer and Exporter Concentration: Correlation



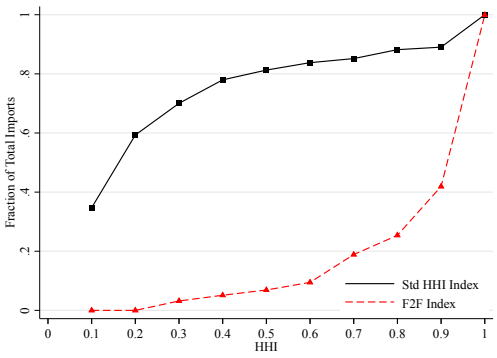
Notes: The figure plots the weighted scatterplot of the importer and exporter concentration indices (HHI_{ht}^{buyers} and $HHI_{ht}^{suppliers}$). Each dot corresponds to a broad product chapter, as defined by the official HS product classification (See, e.g., World Customs Organization). Within each 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: Comparison with Standard Measures

(a) Exporter Concentration



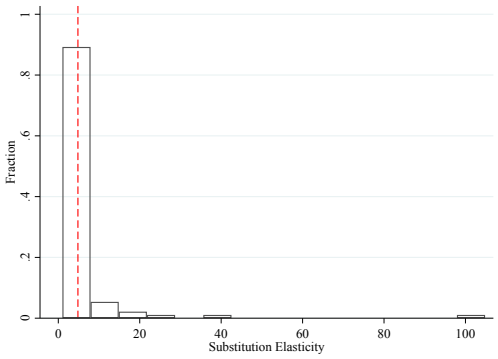
(b) Importer Concentration



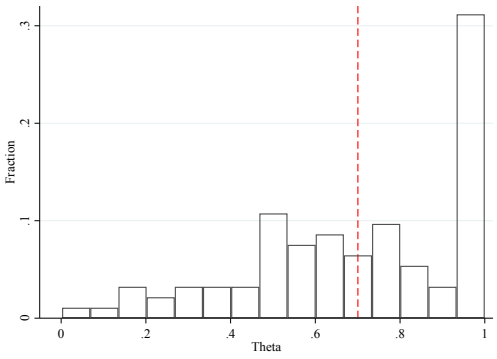
Notes: The figure displays the cumulative distribution function (CDF) of importer and exporter concentration, represented by the red and black lines, respectively. Both network-based (red) and standard (black) concentration measures are plotted. For each value of the Herfindahl-Hirschman Index (HHI), the figure illustrates the fraction of total imports corresponding to that level of concentration according to the different measures.

Figure A.4: 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.

B Theoretical appendix

B.1 Derivation of equation (15)

We approximate the aggregate markup in equation (12) 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 (12) around $\mu_{ij} = (1-\phi)\frac{\rho}{\rho-1}+\phi$ and substituting in equation (7), 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 (12).

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

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

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 (7) 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 $\mathbf{\Omega}_{ijkt} \equiv (\Omega_{ijt}, \Omega_{ikt})$, the expected difference in exporter $i's$ marginal cost across importers j and k is zero, namely, $E_u\left[u_{ijt}^h - u_{ikt}^h; \mathbf{\Omega}_{ijkt}\right] = 0$. Taking the difference of the expected prices that i charges to importers j and k yields the following moment condition:

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

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

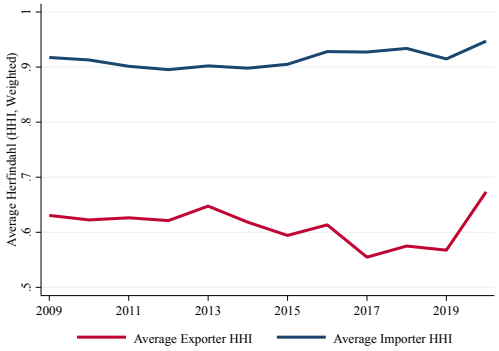
The moment condition (6) is estimated via generalized method of moments (GMM),

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

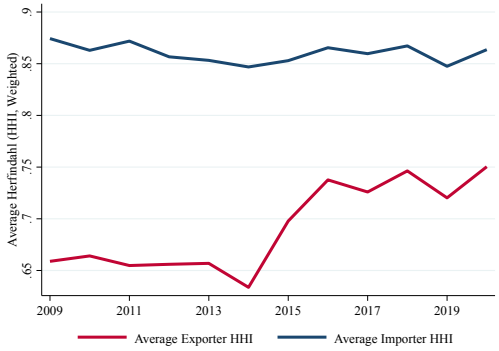
where $\mathbf{g}(\boldsymbol{\phi})$ stacks all moment conditions in (6) across all $i-j-k$ pairs and years and $\mathbf{W}$ is the optimal weighting matrix.

Figure A.5: Concentration and Markups: By Industry

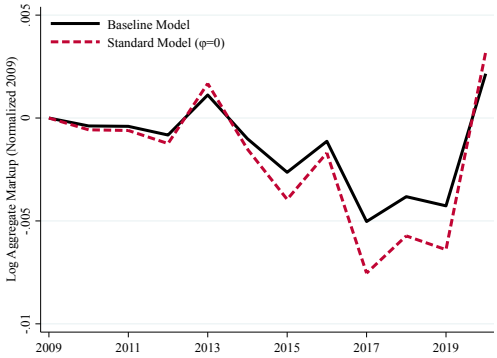
(a) Trends in Concentration: Leathers



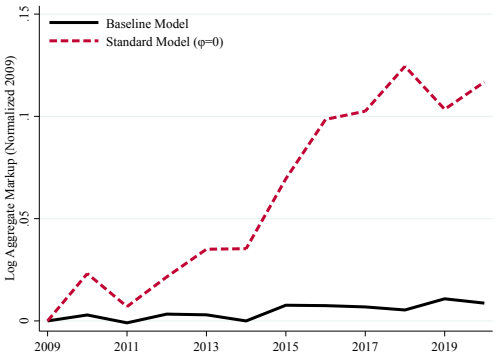
(b) Trends in Concentration: Machinery & Electricals



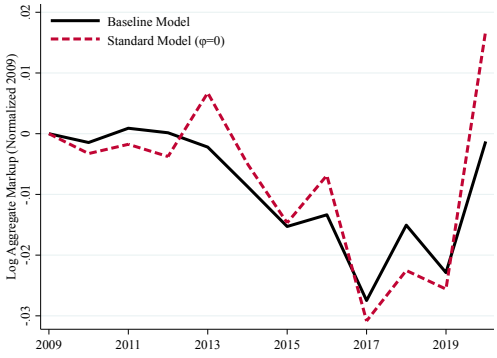
(c) Markup Evolution: Leathers



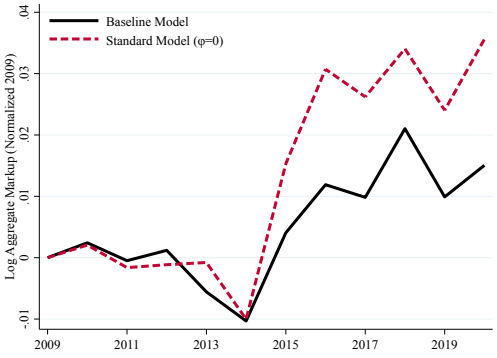
(d) Markup Evolution: Machinery & Electricals



(e) Markup Evolution: Leathers

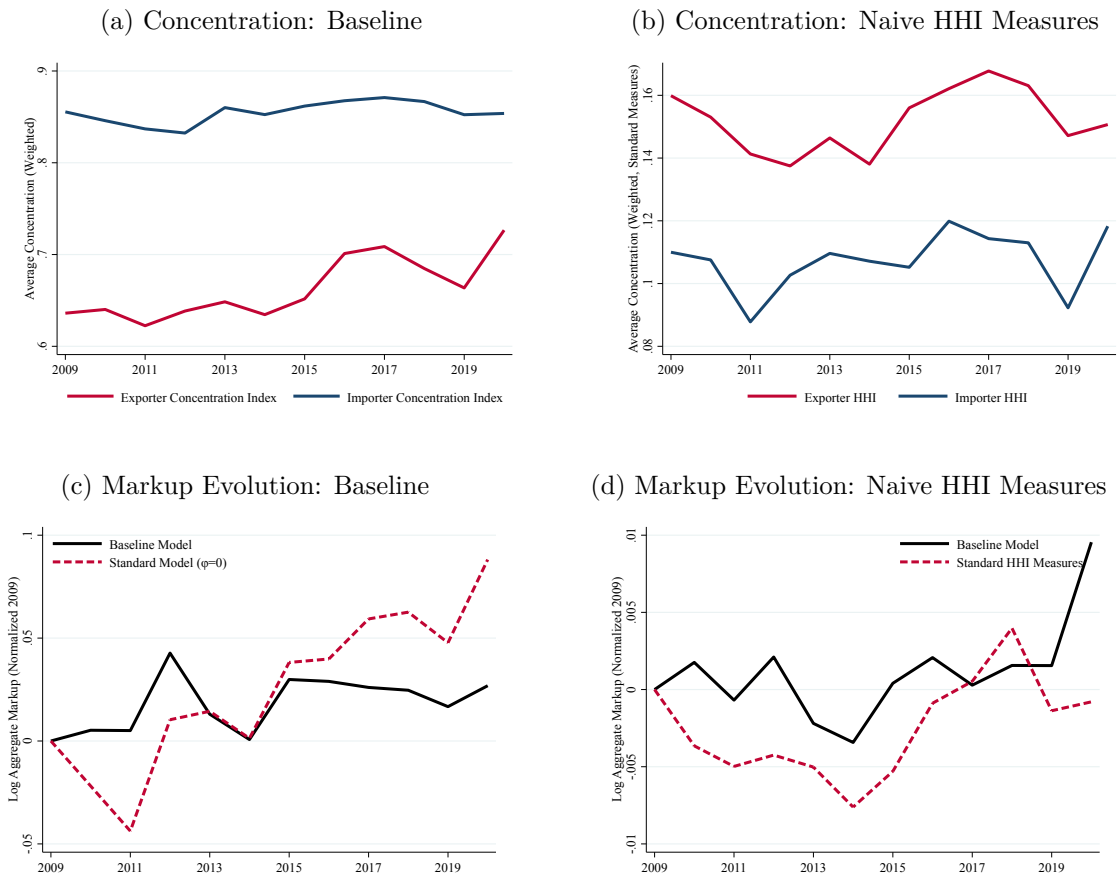


(f) Markup Evolution: Machinery & Electricals



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.6: Concentration and Markups: Baseline vs. Standard Concentration 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).